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WORKFORCE GOALS PLANNING FOR THE NAVAL LABORATORY SYSTEM.(U)

AUG 77 W W COOPER, R J NIEHAUS, D NITTERHOUSE

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RESEARCH REPORT NO. 31

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BY
W.W. COOPER
R.J. NIEHAUS
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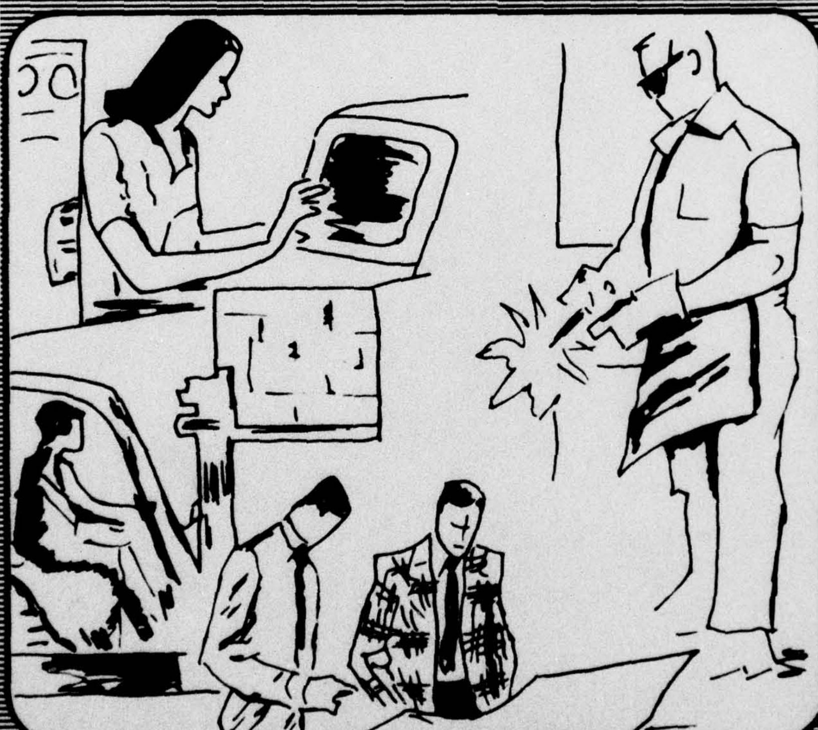
(12)



OFFICE OF CIVILIAN PERSONNEL
NAVY DEPARTMENT
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(6) Workforce Goals Planning
for the
Naval Laboratory System ,

(14) OCP-RR-31

by

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Office of Civilian Personnel
Navy Department
Washington, D.C. 20390

Introduction

Manpower management has been a particularly grave concern for the Navy R&D laboratories in the past several years. After years of expansion, the past few years have brought stringent controls, not only on dollars but also on the total number of personnel. Emphasis is also shifting between in-house work and contracting out. Technology is changing faster than ever. EEO considerations complicate further the manpower planning decisions. All these factors are providing impetus to the development of aids to decision makers for managing the workforce.

The Navy has extensive research ongoing in this area. The Shore Activity Manpower Planning System (SAMPS) is aimed at large scale feasibility tests of manpower models embedded in a data communications network accessible via interactive terminals. "Aggregate planning" models deal with categories of personnel; "assignment" models deal with individual employees. SAMPS is an aggregate planning model for policy evaluation and overall planning.1/ Workload related workforce requirements are vital inputs to an aggregate planning model. Because of the peculiar characteristics of a research and development environment it has proven especially difficult to develop a systematic, scientific method of determining future workforce requirements on the basis of projected workload. Funding systems further complicate the problem for Navy Research Development Test and Evaluation (RDT&E,N) Laboratories, since even workload is not directly determined by laboratory management, but by other major claimants who receive appropriations for RDT&E.

1/ This research, which is supported by the Navy Personnel Research and Development Center, is described in a report by Niehaus and Sholtz [17] and depends upon manpower models developed by Charnes, Cooper and Niehaus [10]

Laboratory management is just beginning to track program and funding relationships, to provide top level communication between laboratories and the agencies who actually fund the programs. Concurrently, the planning horizon is being extended to 5 years, to provide the lead time needed to effect major workforce composition changes. These efforts could be facilitated by development of a computerized data base composed of the projected workforce, related to programs and support functions. It would ideally be interactive, and accessible to several levels of laboratory managers. This would be combined with computer programs to relate man years to end-strengths, and to assess the impact of a change in workload, ceilings, organization structure, etc., on each other and on workforce goals. It would initially be based on estimates made by principal investigators. Once a sound data base exists, development of more sophisticated techniques such as regression coefficients and Input-Output models can be pursued. The information obtained from the data base and impact assessment programs would provide improved understanding of the workload/workforce relation to all levels of managers, and allow computations of change impacts which are now infeasible because of time constraints in the planning process. The "output" of this system, a set of workforce goals, could then directly provide the workforce goals input required by SAMPS.

This paper explores these complex situations and the current efforts dealing with the workload projection problem and workload related workforce goals planning in more detail. Alternative systems are proposed for developing workforce goals by using knowledge and estimating procedures which already exist at lower organizational levels. Potential applications for concurrent use of the SAMPS aggregate planning model and the workload related workforce goals system are explored. The final section deals with longer range research extensions for this type of modeling.

Funding Relationships and Workload Projections

As has often been discussed in management literature, research and development is one of the most difficult functions to manage. The high concentration of professionals and the difficulty of evaluating the results of R&D efforts have plagued private sector management for years. Public sector R&D has the same problems, but compounded by civil service regulations, by personnel ceilings and often rapid policy turnabouts by Congress or the Executive Branch. The task of developing and maintaining an R&D workforce which can stay at the forefront of technology, provide the applied engineering skills needed, and respond to changes in both the military and congressional environment (which do not always seen to go in the same direction) is a difficult one at best. It is further complicated by the existing relationships and systems of funding which, although they provide some advantages, also make life even more difficult for laboratory management.

Funding for most of the RDT&E,N Laboratories does not go directly to the laboratories, but goes to the various Systems Commands (SYSCOM's) and other major claimants for resources. Certain categories of funding, mostly for more exploratory, independent types of research, do go directly to the laboratories but this is only about 2% of the total RDT&E program funding. The balance of the program funding for RDT&E goes to the SYSCOMs and other major claimants for their use in acquisitions. SYSCOM and other major claimant personnel, usually at the project manager levels, then have the option of going directly to outside contractors, or going to Navy laboratories (which might either do the work themselves or let and manage a "sub-contract") to get the work done. The SYSCOM and other major claimant project managers deal directly with senior project engineers in the laboratories, to negotiate the work to be done and the resources required to be funded.

This system leaves direction and control of all but a small portion of the research with the SYSCOMs and other major claimants. This makes sense, since

> "The Navy laboratories exist to support the operating forces by developing, through invention and innovation, the technology required to solve problems and initiate new capabilities."2/

The problem is that this leaves planning and communication at the lowest levels of the organization. While this may be effective for "operating" decisions, it leaves the laboratory management at a loss as to the direction to guide their workforce, for which they have hiring, firing, promotion and training responsibilities. Since many of the personnel require extensive training, or retraining if a shift of technological emphasis occurs, and since the civil service system to which all civilian personnel are subject does not facilitate rapid change, a rather long 'lead time' is needed by laboratory management to effectively adapt its workforce. This could best be effected by a long range planning and policy making process at the top levels of SYSCOM and laboratory management, with controls by each down to the operating personnel to assure that the policies and plans are being effectively carried out.

The current situation, and the one expected for the foreseeable future,

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2/ H. Tyler Marcy (ASN(R&D)) ltr to DDR&E of 4 Jan 1977, Subj: Comments on DDR&E Proposal for Managing the DOD Technology Base Labs is of funding for much more R&D than can be accomplished by allowed R&D in-house personnel. The increase in funding and decrease in personnel are diverging faster than can be explained by wage rate increases alone, indicating a move toward increased contracting out which is what the Office of Management and Budget (OMB) has decreed will happen. The task now is for laboratory and funding agency management to determine what types of functions and programs are crucial to be kept "in-house" as opposed to those which can be more safely entrusted to outside contractors.

Work Unit Summaries (DD Form 1498M) and Assignment Summaries together are the basic program planning documents for the laboratories. They presently provide (along with other identifying data) one year of actual and three years of "planned" data on the resources devoted to each unit of work for which the laboratory is responsible. (See Figure 1 for sample Work Unit Summary - DD Form 1498M and Figure 2 for sample Assignment Summary.) It is the data from these forms which is summarized to provide virtually all the information on program direction of the laboratories. Semi-annually the principal investigator for each work unit completes a Work Unit Summary and Assignment Summary for each work unit for which he is responsible. These are bound into a volume which is the Laboratory Program Summary (LPS).

At present the Director of Laboratory Programs (DLP) is beginning to develop a system of communication about long range plans between himself and upper level management in the SYSCOMs and other major claimants. Each laboratory develops a Laboratory Five Year Plan, all of which are then consolidated into the <u>Corporate Plan for Laboratories Commanded by the Chief of Naval Material</u>. In terms of funding and resource utilization this reflects

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY	1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISB'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS ☐ YES ☐ NO	9. LEVEL OF SUM A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY				
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE *(Precede with Security Classification Code)**

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:*
c. TYPE: d. AMOUNT:
e. KIND OF AWARD:

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS *(In thousands)*
FISCAL YEAR	PRECEDING		
	CURRENT		

19. RESPONSIBLE DOD ORGANIZATION
NAME:*
ADDRESS:*
RESPONSIBLE INDIVIDU[AL]
NAME:
TELEPHONE:

20. PERFORMING ORGANIZATION
NAME:*
ADDRESS:*
PRINCIPAL INVESTIGATOR *(Furnish SSAN if U.S. Academic Institution)*
NAME:*
TELEPHONE:
SOCIAL SECURITY ACCOUNT NUMBER:
ASSOCIATE INVESTIGATORS
NAME:
NAME:

21. GENERAL US[E]

22. KEYWORDS *(Precede EACH with Security Classification Code)*

23. TECHNICAL OBJECTIVE.* 24. APPROACH. 25. PROGRESS *(Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)*

Figure 1

*Available to contractors upon originator's approval.

DD FORM 1 MAR 68 1498 STOCK No.-0102-014-9300 PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

ASSIGNMENT SUMMARY

ASSIGNMENT NUMBER	INCLUSIVE JOB ORDERS
26. PRIOR IDENTIFICATION	27. TECH. AGENT (IF DIFFERENT FROM BLOCK 19)

28. MANPOWER AND COST ESTIMATES	FY 76 & 7T (2220 HRS)	FY77 (1775 HRS)	FY 78 (1768 HRS)	FY 79 (1768 HRS)	
TOTAL DIRECT MANYEARS (PEOPLE)					
TOTAL LABOR AND OVERHEAD ($K)					
MATERIAL AND TRAVEL ($K)					
MAJOR PROC/CONTRACTS + 2038's ($K)	*	*	*	*	*
TOTAL FUNDING ESTIMATE ($K)	+	+	+	+	+
* INCLUDES 2038's AMOUNTING TO: ($K)					
+ INCLUDES CARRYOVER FROM PREV FY AMT TO: ($K)					

29. BACKGROUND, 30. PLANS AND MILESTONES, 31. REFERENCES, 32. MAJOR PROCUREMENTS AND CONTRACTS.
(Precede each paragraph with security classification.)

Figure 2

what each laboratory expects, on the basis of negotiations with sponsors, to be doing for the next five years. The SYSCOMs and Director of Navy Technology have also been requested to provide the R&D centers with program/project planning information, in the form of a "letter of intent" indicating planned funding levels based on the FYDP. The Corporate Plan is reviewed by the DLP to determine what directions (in terms of funding, programs, etc.) this indicates that the sponsors want the laboratories to go. He then discusses this with SYSCOM and other major claimant management to ascertain the validity of these indications, and to discuss any needed modifications which can be effected either by laboratory management, via workforce management on the resource side, or by SYSCOM management on the funding and program direction aspects. Although the LPS covers only three years, data for the years covered by both the LPS and Laboratory Five Year Plan are to be in agreement. This process appears to provide for improved communication of workload projections for laboratory management.

Workforce Requirements Planning

The same system just described for workload planning is the only one available for workforce planning above the level of individual laboratory management. One problem with this is that workforce needs per the Assignment Summaries are stated only in total in-house man years and the related dollars. There is no reference to what kinds of particular skills the man-years are required to possess. Another problem is that the current system is cumbersome and time consuming to modify. It gives a "snapshot" of one alternative only. Once the LPS is complete, even estimates of the impact on total man-years of changes by higher level managers must be either done manually (usually too cumbersome a process to be worthwhile) or by seat of the pants "guesstimates", which, even if correct are difficult to defend. This limits alternative assessment severely. There is presently no formal analysis of how accurate estimates from Assignment Summaries are, but they are used extensively in the planning process. However, from discussion with laboratory personnel it appears that much additional information which would be helpful for workforce planning is generated in the process of preparing the Work Unit and Assignment Summaries but is not formally recorded and/or communicated beyond individual laboratory management.

There is currently a Navy wide effort in progress to develop a manpower determination and projected manpower requirements model. This system is SHORESTAMPS (Shore Requirements, Standards and Manpower Planning System) which will generate C-MARP (Civilian Manpower Allocation/Requirements Plan), the data file which will display aggregate civilian requirements. Other approaches, such as regression analysis, are also being studied as a supplement or alternative to SHORESTAMPS type standards. All of these requirements generating models are presently in the developmental stage, and the timeframe for expected completion appears too long for the status quo situation to be a desirable interim alternative. On the other hand, additional efforts in those directions are not likely to be more fruitful or to accelerate completion of existing projects.

Certain functions are generally recognized to be more succeptable to these types of scientific, systematic analysis than others. The more routinized, constrained, and/or well defined a task is, the easier it is to determine the relative efficiency and effectiveness of various alternatives for its accomplishment. However, research and development is by definition not routine, constrained or well defined. Simply put, if a task is well enough defined to be closely specified as to how it can and will be done, it is no longer in the research and development stage, but in the production phase. This is not to say that no one can have any idea of how many Man-Years (MY) of a specified skill level and occupation will be required to research area X or develop item Y. Scientists and engineers with knowledge of the technological state of the art, and with experience in performing similar extensions or applications thereof, can often provide reasonable estimates. This estimate usually is more accurate if it is done close to the level of direct supervisor or the personnel who will actually do the work, instead of several levels up the management ladder. (This is not always true, of course, and valuable insights and different perspectives are often contributed by higher level personnel.) This is partly because the rapid change in technology quickly outdates a once-proficient technical person when they leave technology to enter management ranks. This combination of factors has left -- any may well continue to leave -- workload planning at the "operational" level of the R&D organization.

Thus an alternative which has potential usefulness is developing a method of aggregating and using information already available to laboratories but not recorded and accumulated. This would be available for use in decision making until a more sophisticated alternative becomes available. This involves aggregating to a set of workload goals, consistent with SHORESTAMPS, which are determined from additions to the LPS as provided directly by the principal investigators. Data would be available on an interactive computer network to the designated managers at each heirarchical level.

Within this alternative, there are many possible variations of detail, flexibility and sophistication which could be attempted. Basic tradeoffs to be made in determining the appropriate path to follow are cost and time to implement versus usefulness as a decision making tool. This will be explored in detail after a discussion of the SAMPS model uses to date, and the extensions possible with improved workforce requirement information.

SAMPS Capabilities and Usage

Major modules which are required for the proposed Navy Manpower Planning System (NAMPS) are personnel inventory analysis; inputs required, losses required, projected manpower requirements, training required, alternative generator and manpower determination model. (See p. 16 of [13]). SAMPS, a goal programming model with embedded Markov processes, can now provide the personnel inventory analysis, inputs required and losses required modeling capabilities. Later versions will also incorporate training required and EEO models. SAMPS is designed for use in activities with large civilian populations, and therefore is being implemented in sections of NAVMAT which have such populations. The operational version of SAMPS is known as CAMAS (Computer-Assisted Manpower Analysis System). SAMPS will be used in this report to refer to both.

The SAMPS model, roughly described, considers the projected future manpower requirements (goals) and current on-board personnel, by grade and occupation code (CAMAS Code), estimated attrition and transition rates between grade/code states, a set of penalties for the various possible personnel actions which the manager could take (hire, fire, missing manpower goals, deviating from proposed transition rates), and externally imposed budgets, ceilings and high grade controls; it then uses a linear programming solution to find those personnel action schedules that minimize the total penalty incurred in trying to come as close as is possible to meeting goals. Thus, given workforce and various other goals, and the relative desirabilities of personnel actions, SAMPS will compute the "best" solution in terms of personnel actions to be taken.

Ceilings and high grade controls are usually given by higher management levels. Even if they are not known with absolute certainty, the impact of changes from the anticipated level can be fairly easily examined by varying these values in either direction and seeing how this affects the solution. That is, the "sensitivity" of the solution to changes in these values can be assessed. Current on-board is of course given. Transition and attrition rates used are historical, with modifications for any known unusual situations which might make historical data unrepresentative, and/or for proposed changes to be made for future periods.

Penalties for the various possible personnel actions which could be taken are determined partly by the nature of the organization and partly by individual managerial style. Thus, for example, one manager might weight fires much more heavily than another. These penalties represent not only dollar costs, but also the impact on the organization in terms of disruption of work patterns or impact on accomplishment of objectives. However, results of all of the above studies indicate that the most critical feature is the rank ordering of the penalties and that outputs are insenstive to exact values used if rank order is constant.

Workforce goals used for the RDT&E,N Laboratories have been primarily "expected ceiling, proportionalized on the basis of current grade/occupation code configurations". This means that the organization plans the same percentage change in each grade/occupation category, which does not allow for evaluation of complex changes in organization design or workforce skill mix. This has provided an acceptable first cut for model testing and served to illustrate some decisions for which this type of aggregate planning model can be adopted. However, now that laboratory workload projections are becoming more readily available, it is highly desirable to be able to evaluate the impact of workload projection changes on workforce requirements, and vice versa.

The SAMPS application to the Naval Air Rework Facility (NARF), San Diego, utilized manpower requirements generated by the Computerized Workload Planning and Budgeting System (CWPABS), an in-place system at the NARF. CWPABS is based on a combination of engineered standards applied to projected workloads and manual estimation procedures performed by the cost estimating department. Comparisons of regression analysis and constant skill balance assumptions to the cost center analysts' projections indicated that use of the latter provided the best estimates for workforce goals. Seasonal transition patterns and a more flexible workforce, combined with a five quarter workload planning horizon make a short run time frame appropriate to the NARFs, while a three to five year time frame is considered more appropriate for laboratory planning. The manpower action plans generated by the model appeared reasonable and in accord with expectations given the manpower requirements specified, according to research reported by Bres and Niehaus [4]. Work is continuing on implementing CWPABS at other NARFs and on linking the workforce requirements generated by CWPABS to SAMPS. Projections from SAMPS continue to be in line with expectations and are being used increasingly by NARF managers for analysis and decision making.

The application of the SAMPS modeling system at NUSC (Naval Underwater Systems Center), Rhode Island, is the only single-laboratory implementation to date and has focused primarily on conversational computer applications.

The only model currently available with conversational capabilities is the Recruiting Requirements Model (RRM), and accordingly all research into conversational applications refer to the Conversational Use of Recruiting Requirements Model (CURRM). The study reported by Niehaus, Sholtz and Thompson in [18] used a small numerical example for training purposes as well as actual data from NUSC. The primary objective was to test managerial acceptance of the models and gain further insight into probable usage patterns, needed modifications, and interrelationships of model variables. Use of the conversational (instead of batch) mode appeared to improve managerial acceptance of the models because managers felt they, rather than computer specialists, could control the model. Resolution of technical and implementation difficulties, revisions made as a result of the earlier tests, and extensions of possible manpower planning strategies to be analyzed by the aggregate planning model are covered by Albanese, Niehaus and Padalino in [1].

The idea that "...manpower planning must be synchronized with budgetary and program planning activities", was addressed earlier by Charnes, Cooper, Niehaus and Padalino [11]. This apparently has not been pursued further than is indicated in that report. The effort reported involved supplemental coding systems and a program structure peculiar to NUSC. Personnel and financial data files were merged to link program planning to personnel projection information. However, pursuant to the NUSC reorganization implemented in June 1976, the system was no longer directly applicable and a usable revision has not yet been developed. This type of system, however, was one attempt to link workforce requirements to workload goals stated in program planning terms. Results from this limited use of the system was said to be "encouraging" when compared to actual and may provide valuable groundwork for a similar extension in the future. From discussions with various Naval Material Command personnel it appears that other individual laboratories also have their own data bases and systems for workforce planning, but they are not used with SAMPS.

A third application of SAMPS being explored at NUSC is the Promotion Policy Model (PPM), which is also a goal programming model with embedded Markov processes. It extends the RRM to also allow promotion rate changes to be prescribed by the model.3/ Deviations from planned promotion rates are assigned penalty weights as are all other possible personnel actions. This essentially means that all parts of the hiring/promotion/attrition cycle are viewed as tools for goal attainment in the model solution.

The PPM is presently in the research stage of SAMPS, with certain mathematical extensions to facilitate cost-effective machine implementation still in progress. However, a prototype PPM is operational at the Office of Civilian Personnel where research has been done on both NUSC data and aggregated data for all the DLP laboratories, as reported by Albanese, Korn, Niehaus and Padalino in [2]. As with the RRM, changing the rank order of penalties can cause significant changes in the optimal solution, but changing relative weights without changing rank ordering causes little or no change in the solution. Average Grade and High Grade limits were incorporated in

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3/ In particular this is an extension of the EEO applications of the RRM. See [5], [6], [9], and [14].

the NUSC runs to explore their impact on personnel actions. It is noted that over-emphasis of these limits could lead to personnel actions which help to meet them but are otherwise inefficient. NUSC runs also explored the impact of goals and hiring policies for a particular class of employees, by using different goal and promotion rate deviation penalties for the population of interest. It was found that manpower goals for this class of employees would have to be revised downward in order to achieve Center policy for developing a technologically advanced workforce and still meet other goals and constraints. Partially on the basis of the results of these model results recruiting efforts were lowered.

The larger population of all DLP laboratories allowed use of finer personnel categories for graded personnel, i.e. single digit occupation codes by grade level. No high or average grade constraints were incorporated in these runs. Note that since the mix of personnel categories was not planned to change, any existing undesirable profile (such as middle-grade bulge) has been perpetuated insofar as these workforce goals are met.

Indications in the preceding research are that maximum usefulness of manpower planning models is contingent on workforce goals. The next section proposes alternatives for developing laboratory workforce goals based on projected workload. In addition to providing required inputs to SAMPS, it should be noted that such a workforce goals planning system is extremely useful in its own right.

Alternatives for Generating Workforce Goals

Two promising efforts to determine workforce requirements from projected workloads for non-routine tasks are the NARF cost analysts' estimations and the experimental integration of program planning with workforce requirements at NUSC. Based on these efforts, a preliminary investigation was made of similar processes for possible use up to and including the DLP level of aggregation for the Navy laboratories. This section proposes alternative systems to generate workforce requirements based on projected workloads.

All proposed alternatives are intended to be compatible with other in-process efforts (e.g. SHORESTAMPS), and to be interactive and accessible to various management levels. They all rely on information which currently exists at some level in the organization but is not consistently recorded, collected, summarized or reported in a useable fashion. They also rely heavily on tieing in and adding to existing procedures and documents rather than developing completely new ones. Advantages of this are minimization of duplication of effort, ease of assuring comparability or agreement with other data systems, and acceptability to laboratory personnel for implementation. The existing system proposed to be the base for the additions is also one which is used at several different management levels, which should help to ensure integrity of the inputs. Multi-level accessibility can also facilitate continuation of the Navy's traditional decentralized management philosophy. Decision making will not be tied to a particular level just because that level has the only access to the data base, even though it lacks other crucial information which is available to another level. Relevant degrees of aggregation or detail can be used by each level, as required for the decisions it is responsible for making.

The alternatives proposed are summarized in figure 3. They do not cover all possibilities, of course, but are a representative exerpt from the range of those deemed feasible and useful. Note that all include the capability for "generalized information retrieval", which is a set of programs which allows the user to develop individualized reports as needed, including or excluding data elements as desired. This allows the user to extract and modify various items one at a time, or together, to see what impact this has on other items. It is not a modeling capability, however; it merely "recomputes" what it is given by the user. The speed with which it can do this is its primary asset.

The simplest alternative is to automate existing available data and combine the data base with programs for generalized information retrieval. Data on direct man years for each work unit is available from the Assignment Summaries, and data on support personnel could be obtained from department budgets.[3/] This would allow a manager to determine the impact of a program change on total direct in-house man years by accessing the computer program, and asking for a change in values on the appropriate variables. This could involve a change in MY by eliminating the work unit(s), or partially reducing or increasing them, or even adding units given appropriate estimates of resource needs. Proposed reorganizations of support

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3/ The Resource Plans and Programs Branch (MAT 08T12) has already developed a computerized "Project Listing" (pursuant to CNM Letter 08T1/TBW, Ser 225, 5 May 1977) which includes most of this data, but for only 2 years, and not available at individual laboratory sites in an interactive mode. Also, indirect man years are fully allocated to individual work units by each laboratory prior to submitting the data, and a "total" (i.e. Direct + Indirect) MY figure is the only one reported in the Project Listing.

SUMMARY OF ALTERNATIVES

ALTERNATIVE #	REFERENCE	DESCRIPTION	PRO'S	CON'S
I	NO SKILL MIX	COLLECT WORKFORCE DATA BY MY (SIMILAR TO CURRENT DATA) AND HAVE ACCESSIBLE TO BOTH HQ AND LABORATORY MANAGERS VIA GENERALIZED INFORMATION RETRIEVAL SYSTEMS OPERABLE BY A STAFF ANALYST.	LEAST INVESTMENT. NO NEW DATA ELEMENTS REQUIRED.	LACK OF SKILL MIX LIMITS USEFULNESS. NO MODELING CAPABILITIES
II	SKILL MIX ONLY	COLLECT SUPPORTING DETAIL OF MY DATA BY SKILL MIX, ACCESSIBLE TO HQ AND LABORATORIES VIA GENERALIZED INFORMATION RETRIEVAL SYSTEMS OPERABLE BY A STAFF ANALYST.	DATA ON SKILL MIXES BECOMES AVAILABLE, GIVING INCREASED CAPABILITY FOR ASSESSING ORGANIZATIONAL CHANGE.	REQUIRES COLLECTION AND MANAGEMENT OF NEW DATA. REQUIRES INCREASED INVESTMENT. NO MODELING CAPABILITIES.
III	SKILL MIX COMBINED WITH MODELS	ALTERNATIVE 2 COMBINED WITH MINIMUM MODELING CAPABILITIES.	SAME AS 2 PLUS: MODELING CAPABILITY FACILITATES ASSESSMENT OF PERSONNEL POLICIES.	REQUIRES COLLECTION AND MANAGEMENT OF NEW DATA. REQUIRES INCREASED INVESTMENT.
IV	COMPLETELY INTEGRATED AND CONVERSATIONAL	ALTERNATIVE 3 EXTENDED TO BE COMPLETELY CONVERSATIONAL, WITH THE SYSTEMS INTEGRATED BETWEEN HQ AND LABORATORIES.	SAME AS 3, PLUS: "CONVERSATIONAL" WOULD ALLOW USE BY MANAGERS, WITHOUT NEED FOR STAFF ANALYST. INTEGRATION WOULD MEAN THAT CHANGES MADE AT ONE LEVEL WOULD BE INCORPORATED IN ALL MANAGERS SYSTEMS.	REQUIRES GREATLY INCREASED INVESTMENT AND TIME FOR DEVELOPMENT.

FIGURE 3

departments could also be assessed, but much more laboriously. The shortcoming is that it does not incorporate sufficient detail to assess the impact of workload and/or organization changes on occupation or grade level mixes.

The second alternative involves collection of additional data (the availability of which also makes it desirable to develop a more complex ADP system to take advantage of it.) The data proposed to be collected is the supporting detail of what is currently shown only as Total In-House MY and contract dollars. Data could also be provided on other personnel mixes that could be used to accomplish the task if necessary. Figure 4 is a possible example of the form to be used. In addition to the possibilities of selecting and sorting data on those bases proposed in alternative one, sorting by job categories and departments would then be possible. This would provide projections of each job category of personnel expected to be required in each of the years for which the data is collected.

The third alternative proposes that the workforce goals system in alternative 2 be used in conjunction with SAMPS to provide a tool for policy evaluation. Although the workforce goals have value in their own right, they can also be used as the workforce goal inputs to SAMPS. Use of these two systems together in an iterative process should aid managers in reaching workable manpower plans.

A fourth alternative is a completely conversational and integrated system. This would have substantially the same capabilities as the third alternative, but with both input and output in a completely conversational

SAMPLE OF SUPPLEMENTARY MY DATA FORM

Work Unit Number ____________ Year ________

IN-HOUSE					CONTRACTS			
Perf. Dept. (1)	CAMAS Occupation Code (2)	Min. Grade (3)	# Direct MY (4)	Direct Labor $ (5)	CAMAS Occupation Code Estimate (6)	I.D. (7)	# Direct MY (8)	Direct Labor $ (9)
TOTAL								

ALTERNATIVE MEANS OF PERFORMANCE (10)

As Proposed Above					Could Substitute				
Perf. Dept.	CAMAS Occupation Code	Grade Min	Total # Direct MY	Total Direct Labor $	Perf. Dept.	CAMAS Occupation Code	Grade Min	Total # Direct MY	Total Direct Labor $

Figure 4

Item Explanations

(1) Perf. Dept. is the organizational unit which has direct supervisory responsibility for the MY to be utilized. This is mainly for the use of top level laboratory management, to see how much interdepartmental "borrowing" is planned and to facilitate allocations between departments.

(2) CAMAS Occupation Codes define the occupational category of the personnel expected to be required to perform the projected workload. (Refer to OCMM Instruction 12280 of 28 June 1974 for further information. Current codes will be provided in a forthcoming Secretary of the Navy Instruction.) An example of a category is Physicists, CAMAS Code #2205.

(3) Min. Grade specifies the lowest grade-series which could be utilized to perform the work. If two or more different grade levels of a single CAMAS code are required, they should be listed separately. For example, if 6.0 MY of Electronic Engineering is required, the 6 years may include different grades. GS-13 may be the minimum for 1.0 MY, GS-11 the minimum for 2.5 additional MY, and GS-7 the minimum for the remaining 2.5 MY.

(4) # Direct MY is the number (to one decimal place) of in-house man years projected to be required for each Department, CAMAS Code & Grade combination. The sum of all the MYs must equal the amount of Total Direct Man-Years for the corresponding year in item #28 of the Assignment Summary.

(5) Direct Labor $ is the estimated cost related to (4).

(6) CAMAS Occupation Code Estimate is principal investigator's best estimate of the CAMAS state equivalent of the personnel the contractor will use to perform the work.

(7) Contractor Identification. This is primarily to distinguish between inter-laboratory sub-contracting and private industry sub-contracting. Ø would designate "outside" contractors, and the U.I.C. code would be used to identify any other Navy activity.

(8) Estimated number of M.Y. for each CAMAS state in (5).

(9) Estimated direct personnel contract dollars associated with (5).

(10) If there is a type (i.e. Department, CAMAS Code and/or Minimum Grade) of personnel other than the ones listed in (1) - (9) which could be used to accomplish the task, this is to be indicated here. Information in the columns corresponds to the descriptions above.

Figure 4

form. This would facilitate its use by noncomputer-trained managers, thus requiring less reliance on staff analysts. The "integration" refers to the possibility of a change in one part of the system providing an immediate update to all other parts of the system. Unfortunately, this would entail a loss of flexibility for modification, and it would also require a significantly longer time and greater cost to design and implement.

Recommendations and Example of a System

The third alternative is seen as the one providing the best cost/benefit ratio. The first alternative really does not address the issue of changing workloads and organizational design. The second begins to address these issues, but only in the sense of "where do (or might) we want to go" without consideration of actions necessary to get there. The third alternative, via SAMPS, incorporates this consideration of the personnel policies necessary to achieve a desired set of workforce goals. Since the modeling capability is already fairly well developed, a limited investment is needed to extend and test its use with the workforce goals generating system. The third alternative also provides the major beneifts in terms of information availability, but still within a flexible system. As this is a new tool to laboratory managers, substantial experimentation and revision may be necessary in the development process. This is the primary drawback to the fourth alternative. It requires substantial commitment to a more closely specified system. If the conversational and integrated capabilities are desired, the best tack is probably to develop the basic system first, then convert later to add these options. Although the total cost is likely to be somewhat greater, the improved usefulness and efficiency of the resulting system would be likely to outweigh the increased cost.

The following section gives an example of the way in which the systems proposed in the third alternative might be used. Figure 5 provides a flow chart of the major modules and decision points to help systematize the following discussion.

PROPOSED LABORATORY WORKFORCE PLANNING SYSTEM

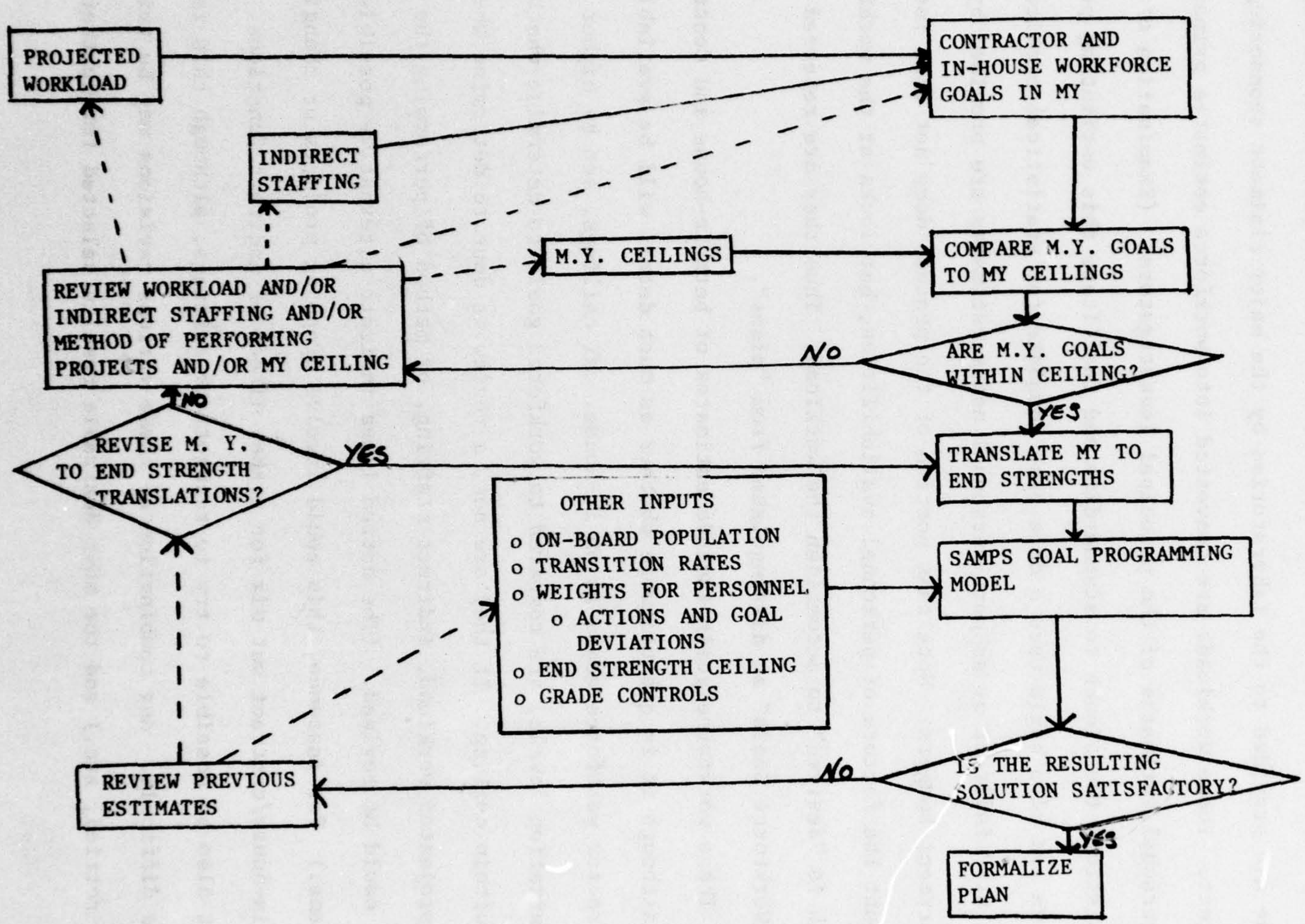

Figure 5

The starting point for the process is "Projected Workload", usually stated in terms of the task to be accomplished or the product to be developed. These are provided to the Laboratories by the major claimant sponsoring a project. These workloads are converted into workforce estimates primarily by personal estimates of the principal investigators. (Examination of statistical techniques to standardize and facilitate this estimating procedure can also begin once a data base adequate for statistical applications exists.) Indirect or support personnel needs estimates are provided by department budgets. Note this portion of the process does not take into account the factors of personnel availabilities, but looks at the workforce which is "desired" to accomplish the workload. Thus they are referred to as "Workforce Goals" as distinguished from "plans".

These workforce goals include estimates of both In-house and Contractor MY, although it is questionable whether as much detail will be available on contractor workforce goals as on in-house. MY ceilings, set by higher organization levels, are compared to workforce goals to determine whether goals are within ceiling. If they are not, a review is done to determine whether the projected workload, indirect staffing, or method of performing the workload could be revised. (The dotted lines indicate alternative possible actions.) For instance, this could involve dropping projects or changing the in-house/contract out mix for either direct or indirect functions. It might also be possible to try to renegotiate ceilings, although this is likely to be difficult. Any combination of these various revisions may be tried, (and retried, etc.) and the most desirable results selected for further use.

Once MY goals are consistant with MY ceilings, MY must be translated into End Strength (ES) goals. This includes planning for overtime and personnel who do not count against ES ceiling. These ES goals can then be used along with other inputs to SAMPS to project the personnel actions necessary to come as close as possible to meeting the goals. If the personnel policies per the SAMPS solution are not acceptable to management, they must then review their previous estimates and assumptions. This involves a number of options, any or all of which can be taken. One option is to revise the other inputs. For example, the effect of a change in transition rates could be examined. The MY to ES translation might also be able to be modified, e.g. by increasing overtime or use of employees who do not count against end strengths. The third option is, as it was earlier in the process, to review workloads and direct and indirect staffing patterns for possible modification. Revisions at this point are likely to deal with skill mix (i.e. job category) substitutions, as well as workload and in-house/contract revisions. The possibility of or need for retraining may also enter the picture at this time, if one job category appears to be increasingly underutilized and another (reasonably closely related one) understaffed. Once revisions have been made, the process is repeated until an acceptable solution is reached. Operating personnel policies can then be set.

The workforce goals system would greatly facilitate this process, particularly the initial development and subsequent review/revision of workload projections, indirect staffing patterns, and method of performing the projected workload. Estimates of personnel needs would be taken from the supplementary data to the Assignment Summaries and from department budgets. Counts of data by job category would provide organization profiles. Comparisons of projected personnel data for a program element, a department, an entire activity, or all the laboratories over the planning horizon would give management an idea of what direction the organization needs to move in order to fulfill its mission. Comparisons of departments, programs, or activities could facilitate understanding of organization and/or workload differences and variations.

Figure 6 is an example of an output report of interest to a laboratory manager contemplating a major change in a large program. It gives a "profile" of the (hypothetical) MY commitments of various job categories of personnel to a program element over the 5-year planning horizon. Figure 7 shows the supporting information, by activity, for CY+1. Figure 8 shows a report which might be used to find out what work units or program elements require a category of personnel which is not expected to be available in the desired quantity.

These are only a few examples of how the Workforce Goals System might be used. The Generalized Information Retrieval capability could allow virtually any information that was included in the data base to be extracted. As managers use the system, new applications will undoubtedly develop. A modular design is suggested to facilitate additions and revisions as needed.

The potential benefit of such a system lies in it's use as both a learning device and problem solving tool for decision makers (DMs). As a learning device, it may provide more knowledge to the DM about the organization as it exists and functions, without changing the way decisions are

PROGRAM ELEMENT PROFILE
FOR PROGRAM ELEMENT #XXXXX
BY CAMAS CODE JOB CATEGORIES
FOR THE 5-YEAR PLANNING PERIOD FY 77-81
ALL ACTIVITIES COMBINED

		ACTUAL	PROJECTED				
		CY-1 FY 1976	CY FYE 77	CY+1 FYE 78	CY+2 FYE 79	CY+3 FYE 80	CY+4 FYE 81
2205	PHYSICIST	43.2	42.6	34.1	20.2	11.3	6.4
2315	ELECTRONIC ENG	31.0	40.7	58.2	64.5	79.5	60.3
2421	MATHEMATICIAN	19.5	24.0	20.6	5.1	.0	.0
5061	ELECTRONICS TECHN.	27.3	47.2	31.3	31.8	39.9	44.4
	TOTAL M.Y.	121.0	154.5	144.2	121.6	130.7	111.1

(All data is hypothetical)

Figure 6

PROGRAM ELEMENT PROFILE
FOR PROGRAM ELEMENT #XXXXX
BY CAMAS CODE JOB CATEGORIES
BY ACTIVITY
FOR CY+1

JOB CATEGORY / ACTIVITY	NUSC	NSWC	NWC	TOTAL ALL ACT.
2205 PHYSICIST	10.1	8.6	15.4	34.1
2315 ELECTRONIC ENG.	20.4	23.3	14.5	58.2
2421 MATHEMATICIAN	9.3	6.1	5.2	20.6
5061 ELECTRONICS TECH.	11.5	13.7	6.1	31.3
	51.3	51.7	41.2	144.2

(All data is hypothetical)

Figure 7

PROJECTED REQUIREMENTS OF MY OF
CAMAS CODE #2311 - CHEMICAL ENGINEERS
BY WORK UNIT
FOR THE 5-YR PLANNING PERIOD FY 1978-1981

	ACTUAL	PROJECTED				
WORK UNIT #	CY-1	CY	CY+1	CY+2	CY+3	CY+4
123456	2.1	5.1	7.9	6.2	4.0	1.1
133456	11.5	4.8	1.0	0.0	0.0	0.0
144456	3.4	3.4	3.4	2.0	0.0	0.0
157916	6.8	9.2	7.3	5.1	2.3	2.3
182044	0.0	3.0	5.7	9.1	9.6	7.5
197171	0.0	0.0	2.4	4.6	3.0	2.0
	23.8	25.5	27.7	27.0	18.9	12.9

(All data is hypothetical)

Figure 8

made. It may also (or alternatively) provide the DM with a new way to make decisions. Either or both can be valuable. In any case, its eventual objective is the production of "better decisions", leading to a more efficient and effective organization.

But even a workforce goals planning system used in conjunction with SAMPS aggregate modeling capabilities will not make decisions for a manager. It will only give increased analytical capabilities to assess the impact of various possible situations and decisions. It is not a crystal ball; it requires either (a) historical data with related statistical treatments; (b) someone's best guess as to the future; or (c) combinations of the preceding. It will let a manager factor in many more assumptions and variations than can be done without EDP and mathematical modeling capabilities, and assess their impact more rapidly and accurately. It can also be made to provide a systematic record as a basis for improving both the estimates and their planning consequences in the future.

Directions for Research

One group of research issues revolve around the impact of systems on decision making. Integration of sophisticated goal programming models into the kinds of negotiation processes involved in developing workload and workforce projections is likely to become more common as data processing and modeling capabilities are improved. Use of large data bases and generalized information retrieval systems are already becoming common. Since "improved decision making" and "more efficient and effective management" are the espoused objectives of such systems, research is needed to support or refute these claims, and to improve management scientists' understanding of what does or does not contribute to these objectives.

There are many different areas to be considered in attempting such research. Even delineation of the current situation as to (1) what decisions are made, (2) how, (3) by whom, and (4) using what information, has not been done. Changes in any of these can be caused by structural organization changes, personnel shifts, management training, policy or rule changes, new information or information processing capabilities, environmental changes, etc. Attempting to "hold the rest of the world constant" while varying one or two of these possible agents of change is not likely to be a feasible research method. The complexity of any real-life situation makes it difficult to isolate the impact of that agent which one wishes to measure. Research into measurement of "decision quality" is also required, as assessing the impact of x on y, where y cannot be measured, is extremely difficult. Use of information even in well defined decision making processes, is an area still in the beginning stages of research by social and management scientists.

A strong criticism of management scientists is that their techniques are too complex, and that they will not be used by managers who do not have mathematical and or computer backgrounds. Comparative research on alternative implementation methods, managerial backgrounds or style, organization objectives, etc., would primarily concern organizational receptivity to a particular type of innovation. This could have implications for facilitating adaptation to new decision making tools via implementation methods, managerial training, or possibly even management selection criteria.

Another tack which can be taken is to assume that a system or model is achieving its basic objective in a general sense, and to investigate issues such as alternative "system designs" in terms of hardware, report formats, frequency of reporting, direct use by managers versus use of staff analysts, level of aggregation and data communicated. Although the underlying assumption may be questioned, useful and generalizable results may be obtained in terms of the specific aspect of a system or process being investigated. These issues are more closely delineated and are therefore more susceptible to examination, although they still provide very complex issues. Limited results, not generalized or statistically supported, were discussed in [1] and [11].

The multi-level use of the proposed system also poses its own questions. Accessibility of information that is currently available only at lower levels to a higher level decision maker provides the possibility of researching what different types of information are actually selected for use at the different levels. This should provide additional insight into the decision making process, although it may well be changing it at the same time.

Estimation of workforce requirements for program planning has proven difficult in the laboratory community. The proposed method of getting these estimates for the present is from professionals in charge of the projects. If their estimating procedures can be systematized and quantified, a more generalized resource requirements planning method could be developed. Input-output analysis utilizing support-on-support ratios could be used to aid in understanding the complex interactions of various parts of a project or activity.

A similar area is that of developing rough analytical measures, similar to financial ratios, for evaluation of laboratory or project operations. Indices such as Indirect:Direct MY, Contract:In-House Dollars, or Program $/MY are examples of the types of indices which have been proposed. The complexity of the situation, however, requires careful study of the various factors which influence these figures. Differences in types of funding, types of research, etc. may impair the usefulness of such ratios for direct comparisons between different entities. Their potential usefulness, if they do provide valid indicators of qualities that management desires to measure, is great enough to warrant further study. Potential for misuse, if they are not carefully examined, is even greater.

Improvement of quality of inputs and the interaction of the system with changes in external variables are also areas for further study. A system would have to be in use over a long time span for evaluation of improvement of internally determined values, but integration of "internal" and "external" information systems can be assessed more readily. Particularly with EEO applications, where goal setting is very much a function of external factors and availability of information thereon, and possibly also on other applications where transition rates may be affected by, e.g., the state of the economy, assessment of impact and feasibility of direct linkages warrant further study.

Models which consider dual goal sets, such as workforce goals related to the accomplishment of program and EEO goals related to social objectives, also provide an area for investigation, both in terms of model and systems development and the organizational and decision making impacts. Linkages with personnel tracking systems, task assignments, and organization design models are also long range types of issues to be investigated. Research on such systems and models is currently in process.

As always, possible research areas include extensions into improving modeling capabilities, the efficiency of computer facility useage, and input-output mechanisms, etc. However, research into the organizational impact of a basic system is of crucial importance at this point. This is best examined in the environment in which the system will operate, rather than attempting to study one piece at a time in isolation or with "clinical" experiments. Results of this type of research can then be used to guide future systems design and improvement.

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Manpower management has been an issue of increasing concern to most large, complex organizations in recent years. Research organizations have particular difficulties in this area, due to technological changes and long project and training lead times. Government laboratories must deal, in addition, with Civil Service regulations and the dictates of Congress and the Office of Management and Budget.

This paper explores several alternative workforce goals planning systems for use in the Naval Laboratory community. The Proposed workforce goals system is comprised of a data base of workforce estimates combined with a generalized information retrieval system for examination and modification of the data base. Its use in conjunction with Shore Activity Manpower Planning System, an aggregate modeling system of the goal programming variety, is explored. Possible management uses of the workforce goals planning system, with examples of appropriate reports, are discussed. Immediate research issues such as the organizational impact of introducing such systems, and future research issues including integrated and conversational applications, are discussed in the final section.