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ABSTRACT

This publication presents Humboldt State College's experience with the pilot testing of the Resource Requirements Prediction Model (RRPM), an analytic computer designed to aid management decisionmaking and planning in institutions of higher education. RRPM has great potential as a planning tool that can improve resource management in higher education. Its cost computations represent an important first step in the difficult task of allocating costs back to degree winners, the ultimate outputs of the educational process. Used in a predictive mode, RRPM generates a large amount of information relevant to the planning of both support and capital budgets. Used in a simulation mode it provides a powerful tool for examining the consequences of alternative policy formulations. Additionally, RRPM serves as a very suggestive starting point for the definition of a comprehensive data base on one hand and for the further investigation of phenomena that are not now included in the model itself on the other. (Author/HS)

A PILOT TEST OF THE RESOURCE REQUIREMENTS PREDICTION MODEL AT HUMBOLDT STATE COLLEGE

Donald F. Lawson, Project Director
Office of Institutional Research, Humboldt State College

John C. Busby, II
Office of Institutional Research, Humboldt State College

Alan P. Feddersen
Division of Analytic Studies, Office of the Chancellor

Frank I. Jewett
Department of Economics, Humboldt State College

William D. O'Grady
Division of Analytic Studies, Office of the Chancellor

September 1971

PREFACE

This publication presents Humboldt State College's experience with the pilot testing of the Resource Requirements Prediction Model (RRPM), an analytic model designed to aid management decision-making and planning in institutions of higher education. Both the development of RRPM and this pilot test were sponsored and supported by the National Center for Higher Education Management Systems (NCHEMS) at the Western Interstate Commission for Higher Education (WICHE) under a grant from the Office of Education in the United States Department of Health, Education, and Welfare. The Division of Analytic Studies provided assistance to the Humboldt State College staff during the pilot test.

The material covered in this publication is directed at the broad variety of individuals who become involved in both the decision on whether or not to implement models such as RRPM and the process of installation and use. Sections I, II, III, IV (Parts C and F), V, and Appendices A and B will probably hold the most appeal for planners and decision-makers using the product of the model. Sections IV (Parts A, B, C, and D), VI, and Appendices C and D will most likely be of greatest interest to analysts and those responsible for technical development and implementation. The Director of Institutional Research, or whoever is responsible for coordinating, directing, and/or supporting the program for analytic and information support to planning and decision-making will certainly want to have a hard look at Sections III, IV (Parts E and F), V, and Appendix B. Appendix B contains personal statements by members of the Humboldt State management group, who participated in the evaluation of RRPM, regarding models in general and RRPM in particular. Many readers will find their counterpart among these individuals.

Not included in this report is much of the flavor and content of the numerous hours spent in discussing philosophy, objectives, processes, planning problems, decision variables and parameters, definitions, organization, etc. Building a model in theory can be important and interesting. Adapting and installing a model with the intent of use in a specific institution can be quite another matter. Working with specific and unique problems and limiting factors; differing individual decision styles, concepts, definitions, etc.; and unique exogenous variables is exacting, tiring, exhilarating, and educational. One can learn a great deal about the system, his school, his colleagues, and himself by participating in such an experience.

A body of literature is building up in the area of the use of models and of planning and management systems in higher education. It would be quite helpful to the reader if he were familiar with the material contained in several of these publications which are contained in the Bibliography.

The views expressed in this paper should not be interpreted as reflecting the views or policies of the California State Colleges.

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I. RRPM – A SUMMARY STATEMENT

The Resource Requirements Prediction Model (RRPM) combines a set of student enrollment projections with a quantitative description of a campus to obtain an estimate of the resources (faculty, staff, operating expenses, and space) necessary to support those students in their educational programs. Once the relationships between student enrollments and resources are understood, it is possible for the administrator or analyst to test certain changes in the institutional system and thus simulate the resulting effects on the required resources.

The model is built around WICHE's Program Classification Structure (PCS) rather than the usual line item budget. The model gives as basic output the PCS Program costs as depicted below (a more detailed PCS is given in Figure 4 of Section V of this report).

Primary Programs
- Instruction
- Organized Research
- Public Service

Support Programs
- Academic Support
- Student Services
- Institutional Support
- Independent Operations

The Primary Program costs depicted above are computed for user-defined instructional units such as academic departments or HEGIS (Higher Education General Information Survey) disciplines.

Since Instruction cost is one of the most significant costs in the budget, a general model flow for the computation of Instruction cost is given in Figure 1. A very general description of this portion of the model runs as follows. For Instruction cost an induced course load matrix is used to convert a student enrollment projection by major to a loading on the various campus departments in terms of student credit hours. A series of factors convert these credit hours to the number of faculty positions required by each department. These faculty positions give rise to administrative, administrative clerical, and technical/clerical positions. Salary schedules are used to calculate salary costs. Equations then give rise to operating expense and equipment cost for each department. The generated positions also give rise to instructional and office space requirements.

Organized Research and Public Service cost computation logic will not be discussed since these costs are not significant for Humboldt State College or the California State Colleges in general and, therefore, were deleted from our version of RRPM.

Each of the Support Programs listed above is made up of various subprograms (nondepartment oriented). For each subprogram a set of equations whose coefficients are based on history data or policy evaluates staff positions and operating expense and equipment. Salary costs are evaluated; office space requirements are computed. Beyond the lecture, lab, and office space requirements which are computed another 18 possible space types may be enumerated.

The following list is indicative of the types of information available in the various output reports which are generated for each projected year of a run of RRPM:

1. Positions and dollars report for each PCS Program (e.g., Academic Support).

2. Positions and dollars report for each PCS Subprogram (e.g., Library within Academic Support).

3. Instruction costs by discipline and course level.

4. Average instructional course unit cost by discipline and course level.

5. Instructional costs by major and student level.

6. Average yearly instructional cost by major and student level.

7. Student class credit hours by course level.

8. Student class contact hours by course level and instruction type (lecture, lab, other).

9. Faculty contact hours by course level and instruction type.

10. Space requirements by type of space.

11. Construction costs by type of space.

Once the model is operational it is possible to test (or simulate) the effects over time on required resources for certain "what if?" questions. Examples of these questions include the following:

... What if a specific change is made in the mix of students either by degree program or by level or both?

... What if a change is made in the instructional techniques; e.g., independent study versus classroom study or classroom activities versus laboratory activity? How does such a change influence the resource requirements over an extended time frame?

... What if a specific new program is added or a current program is dropped? What are the resource implications for the total institution resulting from these types of changes?

... What if a change is made in the mix of faculty conducting an instructional activity; e.g., substituting, say, tenured faculty for graduate assistants (or vice versa)?

... What if a change is made in the faculty's salary schedule?

... What if a change is made in the average faculty load?

... What if changes are made in the staffing ratios of support staff to faculty?

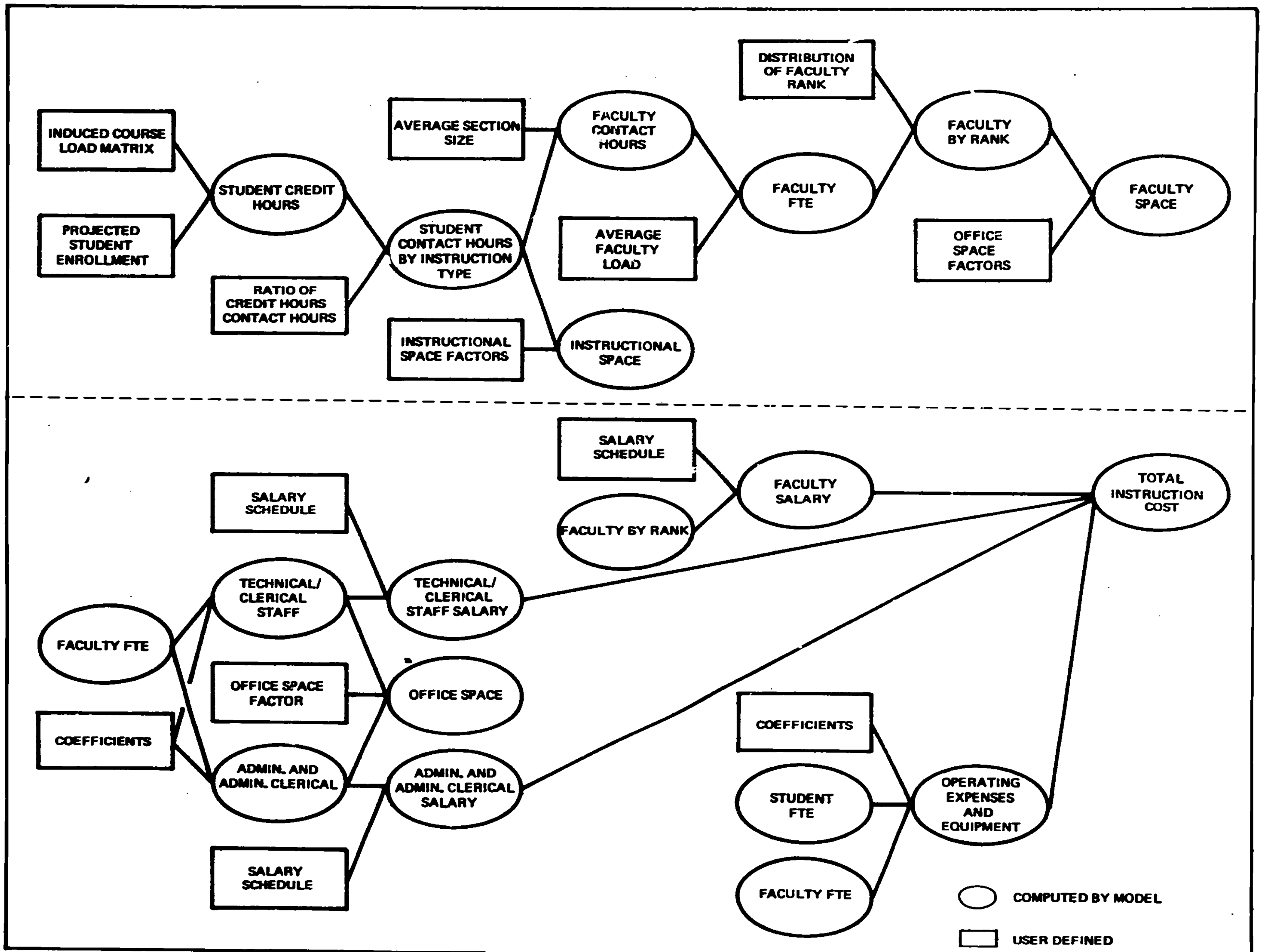

FIGURE 1. INSTRUCTION COST COMPUTATION LOGIC

. . . What if a change is made in the average section size, either across-the-board or in specific instructional programs? What implications will such a change have for both facility requirements and faculty resources?

The interested reader should see Gulko (5) for a more detailed account of RRPM; parts of the above description were drawn from Gulko's report.

II. PERSPECTIVE

This section is intended to briefly describe the historical background of RRPM, particularly as it relates to the California State Colleges and the Humboldt State College (HSC) campus.

In December, 1969, NCHEMS[1] hosted a workshop on the development of RRPM in Denver, Colorado. Interested representatives from numerous educational institutions around the country were invited to attend this first workshop. Mathematica, Inc., a consulting firm, had been selected to revise and program what had been George Weathersby's Cost Simulation Model (10) developed at Berkeley some time previous. The workshop served two purposes:

1. To describe the model (now called RRPM) and its purposes to the attendees.
2. To solicit interested institutions for participation in a pilot implementation of RRPM.

During January and February of 1970, consolidation of the RRPM "task force" occurred; simultaneously, programming of the RRPM proceeded at Mathematica. The eleven institutions invited to participate in the RRPM implementation are listed below.[2]

New Mexico Community College
Portland State College
The California State Colleges
Stanford University
State Center Community College at Fresno
State University of New York at Stony Brook
University of California at Los Angeles
University of Colorado
University of Illinois
University of Utah
Washington State University

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[1] NCHEMS encompasses what was once the Planning and Management Systems (PMS) Division of WICHE. NCHEMS terminology will be used throughout this report.

[2] For various reasons this number was reduced to eight actually being involved in pilot testing: New Mexico Community College, Portland State College, Humboldt State College, Stanford University, State University of New York at Stony Brook, University of California at Los Angeles, University of Utah, and Washington State University.

At a March RRPM workshop representatives of the eleven institutions met for the first time to critique the RRPM under development at Mathematica. Each participating institution was asked to select one member as a representative to the RRPM implementation task force.

In April formalization of the task force occurred. Alan Feddersen of the Division of Information Systems (later to become a member of the newly formed Division of Analytic Studies) in the Chancellor's Office was selected as the task force member for the California State Colleges. In early May the RRPM computer programs were distributed to the institutions. The next few months were concerned with gaining familiarization with the programs. Computer memory requirements due to the demands of a rather large program occupied a major portion of the effort of the California Colleges.

June and August task force meetings continued to be concerned with discussion of the model, its logic, and the amount of input data required.

At the August meeting operating procedures were defined for a formal pilot test of RRPM and institutions were asked to consider participation in the pilot test. It was determined that the participating institutions would receive a small grant to help offset the cost associated with the specific tasks.

Two significant events took place during the Fall of 1970. First, due to certain shortcomings in the existing RRPM computer programs and due to a number of desired model additions, NCHEMS personnel decided to reprogram RRPM. The improved RRPM programs (including a versatile report generator) became available in November.

Second, a decision was made in December to have Humboldt State College direct the pilot testing of RRPM for the California State Colleges. This decision was made for four reasons:

1. The lack of manpower at the Chancellor's Office resulted in RRPM being managed at less than full capacity; i.e., at least one full-time analyst was necessary for involvement with RRPM.

2. It was logical that a campus be involved with RRPM since it is a campus model requiring campus input data.

3. Humboldt State College had available an induced course load matrix, one of the major inputs to RRPM.

4. Most important of all, HSC had demonstrated a keen interest in planning models.

Interest in planning models at Humboldt State College dates back to late 1968 and has its roots in planning problems in the areas of facilities, enrollment mix, and admissions. By mid-1969 the Office of Institutional Research had described a model it planned to develop and was building the data base needed to drive the model (7). This same idea was being worked on independently at several locations and has become identified as the induced course load matrix (ICLM).[3] In early

[3]The ICLM is perhaps the single most vital component of many of the models being developed to aid administrative planning and decision-making in higher education – including WICHE's Resource Requirements Prediction Model.

1970 the Division of Information Systems, Office of the Chancellor, California State Colleges, entered into a joint venture with the Office of Institutional Research, Humboldt State College, to program, run, and examine some of the properties of the induced course load matrix (6).

The intention at Humboldt State was to follow up in January, 1971, with an induced facilities load matrix in order to get at pressing space planning problems. Instead the offer was accepted to represent the California State Colleges and join with the seven other institutions of higher education in pilot testing the Resource Requirements Prediction Model.

III. THE PLAN OF THE PILOT TEST

A. The People Involved

RRPM was implemented and evaluated at Humboldt State College by and through the Office of Institutional Research. Two groups were involved in the implementation and testing process: a project group and a management evaluation group.

Although the contract was with the college, the effort by the project group was in actuality a joint effort with the Division of Analytic Studies, Office of the Chancellor of the California State Colleges. The venture was truly a team effort. All four of the individuals involved participated as equals, each contributing his particular skills and talents. The project group consisted of:

Donald F. Lawson	Director of Institutional Research, HSC
John C. Busby, II	Analyst, Office of Institutional Research, HSC
Frank I. Jewett	Professor, Department of Economics, HSC
Alan P. Feddersen	Analyst, Analytic Studies, Chancellor's Office

The Director of Institutional Research acted as coordinator and led the strategy of implementation and evaluation. The two analysts took charge of the technical and data capturing problems and saw to it that the model became operational. The economist concentrated on the conceptual and quantitative aspects. Both groups were in almost constant communication discussing all aspects of the project. The three college members worked with the management evaluation group.

The management evaluation group, all from Humboldt State College, consisted of the following individuals:

Robert A. Anderson	Associate Dean, Admissions and Records
Michael Corcoran	Director of Public Affairs
James R. Cunningham	Director, Testing Center
Milton Dobkin	Vice President for Academic Affairs
Eugene Flocchini	Assistant Business Manager
Oden Hansen	Dean for Campus Development and Utilization
Donald Hedrick	Dean, School of Natural Resources
Don Koepp	College Librarian
Gary Montgomery	Vice President, Associated Student Body
John F. Pauley	Chairman, Department of Theater Arts and College Representative on Statewide Faculty Senate
Richard Ridenhour	Dean, Academic Planning
Donald F. Strahan	Vice President for Administrative Affairs
Lester Torgerson	College Personnel Officer and Acting Budget Officer

B. The Pilot Test Strategy

Briefly, the overall philosophy followed in the managerial aspects of RRPM testing and evaluation was that the various sub-units of an organization should work together as a team in a common endeavor to achieve the goals of the organization and that in such an environment collective wisdom takes precedence over personal convictions. With this in mind an effort was made to interest a wide variety of campus planners and decision-makers in evaluating models in general and RRPM in particular and then to involve them in a thorough and objective presentation of the subject. More than this, the Office of Institutional Research committed itself to represent this collective wisdom both in its program on campus and its reporting to WICHE and this publication.

This strategy began at the moment that the Office of Institutional Research was asked if it would like to become involved in pilot testing RRPM. The relevant organizational sub-units on campus were contacted and presented the facts of the issue: nature of RRPM, nature of the pilot testing process, possible benefits, probable costs in terms of time, resources, etc. Then the question was asked, "Do you think this college should become involved in such an endeavor and, if so, will you commit the necessary time and resources required of your office?" The reaction was unanimous, and Humboldt State College became involved . . . and committed.

Pilot testing and evaluation of RRPM consisted of essentially three phases.

Phase 1 occupied the first three months of the project (mid-January to mid-April). The primary goals for this phase were to examine the technical aspects of the model; relating these to the structure and processes of Humboldt State, the California State Colleges, and the computer facilities available;[4] meeting the specific data requirements of RRPM; and trying to get the software to perform with college data. Fortunately the existing data base, including the induced course load matrix, satisfied the data requirements quite well. During this time contact with those outside the project group was limited to:

1. Meetings with key administrators to discuss ways in which RRPM might best adapt to and reflect the college.
2. Biweekly meetings of the President's Council.[5]
3. People contributing random comments.
4. A formal presentation before the California State College Executive Deans and Building Coordinators.

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[4] On site CDC 3150 (16K words memory) and telecommunications to the California State Colleges Northern Regional Data Center in San Jose (CDC 3300 112K words memory).

[5] A group of about 25 key administrators, faculty, and students that meets with the College President about every two weeks.

Phase 2 of the effort was preparation for management evaluation of the model. This included (1) validating the technical aspects of the model and bringing it into reasonable tolerances so that it could be used in prediction and simulation, and (2) forming a management evaluation group. The target dates were April 1 for the first full run of RRPM with actual data, April 30 for bringing the model into control (including a certain set of additional revisions/adaptations), April 26 for formulation of the management evaluation group, and May 1 for the start of Phase 3 – training and evaluation.

The first run date slipped to April 10. Data transmission problems in the newly installed telecommunications system moved the model control target until almost the fourth week in May and precluded testing and installation of additional revisions and adaptations. This caused alterations in the timing, breadth, and depth of the management evaluation plan. An early April meeting of the Institutional Research Advisory Committee devoted to RRPM was held as planned, as was a one-and-a-half-hour mid-April presentation of models and RRPM before the President's Council, and a several-hour group discussion of planning models and RRPM with an individual who was spending quite a bit of time traveling around the country studying this subject.[6] The technical problems delayed formalization of the management evaluation group until mid-May. A great quantity of materials were sent to all members of the President's Council, Institutional Research Advisory Committee, and selected other individuals. Appendix A contains the original memo to the President's Council.

Phase 3, management and technical evaluation, began on May 14. Members of the Institutional Research Advisory Committee, President's Council, and the College Budget Officer were invited to join the management evaluation group. Nineteen voluntarily stated an intention to participate in the process. Sixteen participated in most or all of the training, decision, and evaluation sessions. Figure 2 depicts the schedule devised for Phase 3.

All of the individuals involved in management evaluation had gained a familiarity with the concepts and language concerning models and RRPM prior to this time through the efforts of the Office of Institutional Research. Building upon this background a two-hour session was held to examine inputs, outputs, and logic in greater detail. Due to its size the evaluation group was actually divided into two training groups and, therefore, two training sessions occurred (May 14-25). The entire evaluation group then met five more times to work with the model in testing and evaluation (May 27-June 9). These were called decision sessions – in the sense that policy and planning decisions were being simulated in order to test and evaluate RRPM. During the decision sessions certain errors in the input and technical deficiencies in the model were pointed out by the management group and appropriate action was taken by the project group.

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[6]Mr. Keith Evans, Office of the Vice-President of Academic Affairs, University of Michigan. In addition to representing the University, Mr. Evans was conducting a study of the eight pilot schools for NCHEMS and an independent study on decision-making in higher education.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
5/9	5/10	5/11	5/12	5/13	5/14 Start TRAINING SESSION A 10 – 12 a.m. Pres. Conf. Rm.	5/15
5/16	5/17	5/18	5/19 Complete TRAINING SESSION A 9 – 11 a.m. 214 Ad. Bldg. Make Decision	5/20	5/21	5/22
5/23	5/24 TRAINING SESSION B 1 – 3 p.m. Monday & Tuesday President's Conference Room Make Decision	5/25	5/26	5/27 Return Decisions and Discuss 11 – 12 a.m. Pres. Conf. Rm.	5/28 PROJECT GROUP at Chancellor's Office for RRPM discussions	5/29
5/30	5/31	6/1 Decision Session 11 – 12 a.m. 118 Ad. Bldg.	6/2	6/3 Decision Session 11 – 12 a.m. Pres. Conf. Rm.	6/4	6/5
6/6	6/7 Decision Session 11 – 12 a.m. Pres. Conf. Rm.	6/8	6/9 INTENSIVE GROUP EVALUATION OF RRPM 9 – 12 a.m. both days if needed President's Conference Room	6/10	6/11 PROJECT GROUP Start writing report	6/12
6/13	6/14	6/15	6/16	6/17	6/18	6/19
6/20	6/21 First Meeting of Design Group for 4-Year College Version of RRPM* 9 a.m. – 5 p.m. Pres. Conf. Rm.	6/22 Report to typist Personal RRPM Statements to IR Office	6/23 RRPM TASK FORCE MEETING IN PALO ALTO	6/24	6/25	6/26
6/27	6/28 EDIT REPORT	6/29	6/30 MAIL REPORT TO WICHE			

*SUNY, Ferris State College (Michigan), Portland State University, HSC, and WICHE

FIGURE 2. TIME SCHEDULE FOR RRPM MANAGEMENT EVALUATION AND OTHER MATTERS

The five sets of decisions made by the management group to exercise the model were as follows:

Decision set 1. Changed average section size by level and type of instruction from actual to a set of figures to reflect a possible policy statement, to reflect more reality in staffing projections (viz., if graduate area A had an average section size of one and a possible forecast increased enrollment in courses in graduate area A by twelve students, the model would produce twelve additional sections and a requirement of three new faculty positions), and to try and reflect a minimum section size concept. This was retained for future decisions.

Decision set 2. Made two sets of enrollment projections by major and level of student to master plan size. Set one was a proportionate increase, and set two reflected a number of possible planning and policy decisions concerning the ultimate character and objectives of Humboldt State. This also displayed the relative ease in making such a decision set. An administrator could create the input in a half-hour or so – more quickly if he only wanted to make limited changes.

It was particularly interesting to note the disproportionate demand created by a change in student mix (through the distribution mechanism of the ICLM) in the second enrollment projection. This was quickly seen and commented upon by the management group. Visualize that a doubling of, say, Forestry majors would result in almost a proportionate increase in demand for Forestry courses; but that a doubling of Theater Arts majors is accompanied by less than a twenty-five percent increase in demand for Theater Arts courses. This gives added insight into costing and analysis – cost per major information is superior to cost per departmental credit hour for many purposes. The latter has predominated because of availability. The former is becoming available through program budgeting, the ICLM, and the development of models using both of these concepts.

This set of decisions was retained for future decisions.

Decision set 3. By using the preprocessor described in Section IV, Part A, certain instructional costs (data processing, oceanographic research vessel, marine laboratory, forest maintenance, fisheries food supply, wildlife supplies, equipment, travel, and operating expenses) were distributed according to actual department use rather than by student credit hours across all departments. This showed the ease with which planners can try out differences in instructional technique, etc., and its impact upon costs – most especially relative costs. A percentage of computer costs were distributed in this manner. Even though the Department of Theater Arts, for example, was not charged with any instructional computer expense and costs based upon the department usage, the cost of a Theater Arts major now increased (through the ICLM) by a few cents. Apparently at least one Theater Arts major took instruction in an area where the computer was used. Even though RRPM was designed for long-range prediction the reader can see that it is, in this case, being tested and adapted in a short-run simulation mode.

This decision set was used in the following decisions.

Decision set 4. Several space factors were changed: (1) utilization was changed from actual to standards where appropriate; (2) the physical education formula was changed from actual to a rule-of-thumb supplied by the Chancellor's Office; and (3) for fun the change in formula needed to show that one program needed the entire space of the building in which it was displayed. To the delight of some they could now see (on the computer print-out) that more laboratory space was needed in some of their departments to serve even the existing student load – and they provided forceful prodding to plan for additional special use space for the master plan campus (mix yet to be determined). These space changes were kept for the next and last decision set.

Decision set 5. An attempt was made here to express (1) a nine-unit load, (2) a quality program and, (3) an intensive utilization of resources. A nine-unit load was expressed in one relatively semicontained instructional unit. In two others instructional load, faculty mix, and average class size (all by level of course and instructional type) were adjusted to reflect one of the two conditions. One gentleman, who had recently joined the Humboldt team from a well known university said, in response to the higher quality program changes, "Now these costs are more in line with what they were from where I came, and what they ought to be here!"

As might be expected, evaluation was taking place through all of the decision sessions. Two three-hour sessions were planned (June 9, 10) to probe deeper and summarize. Only one of these was needed.

IV. THE RESULTS OF THE PILOT TEST

This section summarizes the experiences which occurred during the pilot testing of RRPM. Six areas of experience are discussed, ranging from the technical aspects of changes in the RRPM to accommodate the Humboldt State College situation to the comments made by members of the management evaluation group.

A. Adaptation of RRPM

Initial examination of the model disclosed certain model features that might preclude serious consideration as a usable tool by the administration. At the discretion of the project group, and with the advice of the management evaluation group, a number of significant changes were made in the model to permit a more useful and accurate representation of a California State College, in general, and Humboldt State College in particular.

In the interest of making the output of the model most usable for planning purposes at this institution, it was decided not to use the 30 HEGIS discipline categories but to consolidate 44 departments into 33 departments. This would allow the maximum amount of detail information to be retained during the processing.

One of the changes involved the classification of personnel in a manner which differed from the standard usage of the model. The model was designed to represent four non-academic staff ranks in each of the Program Classification Structure Support Subprograms (professional/management, technical/craft, clerical/secretarial, and unskilled/semi-skilled). In the California State Colleges staff personnel are classified for reporting purposes according to function. Figure 3 indicates a possible crossover of Humboldt's functional areas to the various program budget subprograms. Examination of the crossover table revealed that a maximum of four functional areas fell under any one of the Support Subprograms; for example, business manager's office, accounting office, payroll, and financial aids business management appear under 6.2, Financial Operations. Since the administrators at Humboldt prefer to think in terms of the functional areas rather than of personnel aggregated by rank within the subprograms, the functional areas were substituted for the staff ranks.

A second change was made in the regression portion of RRPM, particularly in the Instruction Program. In general for the California State Colleges, administrators, administrative clerical, and technical/clerical personnel under Instruction are allocated by formula at the campus level rather than at, say, the department level. RRPM, utilizing history data for the various departments, projects the requirements for these categories of personnel by department. Since history data by department is difficult to obtain (for more discussion of this problem, see Part D of this section on validation of RRPM) it was decided to use one regression each for determining total positions for administrators, administrative clerical, and technical/clerical personnel. The resulting positions of each category were then prorated to each department according to the number of faculty already estimated for each department. The result is that certain personnel requirements were estimated using a normative approach rather than an approach based on historical data.

To handle supply cost under Instruction it would be necessary to gather history data for each department in order to develop coefficients for a regression for each department. Since supply and equipment costs for the Colleges are allocated to a campus and not to departments, one regression was developed to generate supply cost on an overall basis and then administratively derived coefficients were used to apportion this cost across departments.

A second problem arose in relation to Instruction supply cost. Certain Support Subprograms which directly service the departments also contribute to the cost of Instruction via supply cost. Approximately 60 percent of the cost of Computing Support, subprogram 4.4 is attributable to Instruction. Of this $140,000, 38 percent is incurred by students enrolled in mathematics courses. When this portion is added back into the other Mathematics department costs, the cost per credit hour is increased by approximately five dollars. The prototype version had no provision for allocating any of the support subprogram costs back to the departments. A preprocessor was developed to permit portions of the Support Subprogram costs which could be identified with a department to be included as a cost of the department. Using this method a weighted distribution of the costs of up to 25 items could be made. Those costs used in the preprocessor at HSC were data processing, oceanographic vessel, marine laboratory, forest maintenance, fisheries food supply, wildlife supplies, equipment, travel, and operating expenses. It should be emphasized that only those costs selected by the user are included with the supply and salary costs for computation of the total cost and average unit costs of the departments.

Another change was in the ICLM. A matrix of coefficients is used rather than the values for weekly student credit hours. Used with factors for average student load, by level of student, this change facilitates examination of the effects of changing student demand and the effects of increasing enrollment with no increase in faculty.

	Instruction				Organized Research		Public Service					Academic Support					Student Services					Institutional Support								Independent Operations	
	1.1	1.2	1.3	1.4	2.1	2.2	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	7.1	7.2
GENERAL ADMINISTRATION																															
Executive																						●									
Business Management																															
Business Manager's Office																							●								
Accounting Office																							●								
Personnel																								●							
Payroll																							●								
Purchasing																									●						
General Institutional Services																									●						
Automated Data Processing Services															●																
INSTRUCTION																															
Instructional Administration	●																														
Administrative Clerical	●																														
Faculty	●																														
Technical/Clerical	●																														
Instructional Services																															
Audio Visual														●																	
Natural Resources																●															
Cooperative Fisheries																●															
LIBRARY																															
Administration												●																			
Processing Services												●																			
Public Services												●																			
STUDENT SERVICES																															
Dean's Office																						●									
Admissions and Records																								●							
Counseling and Testing																			●												
Activities and Housing																	●														
Placement																			●												
Foreign Student Program																			●												
Health Services																					●										
PLANT OPERATION																															
Administration																										●					
Maintenance of Structures																										●					
Maintenance of Grounds																										●					
Security																									●						
EDUCATIONAL OPPORTUNITY PROGRAM																															
Administration																			●												
STUDENT FINANCIAL AIDS																															
Business Management																							●								
Student Services																				●											

FIGURE 3. CROSSOVER FROM LINE ITEM BUDGET TO PROGRAM BUDGET

The Research and Public Service Primary Programs were omitted from this implementation of the model because these two programs account for such a small percentage of the budget in this State College system. In general, four-year colleges, such as this one, will be primarily oriented toward providing a regular instruction program. Figure 4 indicates with boxes which of the PCS Subprograms were used for Humboldt.

Analysis of ten years of data collected from the Governor's Budget (1960/61 to 1970/71) revealed that staff positions and operating expenses of most of the Support Subprograms were directly related to the number of FTE students and FTE faculty. The equations in the prototype were changed to reflect these relationships.

In an effort to preclude misinterpretation of any of the output information which might leave the Humboldt campus, the evaluation group directed that the report titles be changed to include the words "Management Game."

B. Input Data for RRPM

Data collection for the prediction module, which is composed of two FORTRAN programs, designated RP and RQ,[7] was not as large a task as estimated at the beginning of the project. A significant amount of effort was saved when certain factors were found to be available as a result of studies done at the Chancellor's Office.

An examination of the input requirements of the model indicated that approximately 60 percent of the data would be available from existing machine-readable files. The remaining portion related to the personnel and accounting functions of the college and would have to be collected manually. The decision was made to use the more readily available budget information for the years 1961 to 1970 rather than actual position and operating expense information.

Based on the experience at Humboldt and with a view toward a systemwide implementation of RRPM at all of the California State College campuses it is worthwhile examining the various inputs in terms of quality (accuracy) and the amount of effort necessary to attain various levels of quality. Data accrual techniques can range from sophisticated programs operating on well developed data bases to "quick and dirty" approaches for gathering input data serving as a first approximation. Both extremes can be appropriate, the latter especially when it is desired to get a model up as quickly as possible.

Figures 5 and 6 summarize a number of remarks for the major data elements of RP and RQ. The development times spelled out for the various inputs assume an average effort and data files that are in good shape. Unedited data files can add significant time to the development of input data. Each of the major data elements for RP and RQ will be discussed below in terms of level of effort to attain various levels of quality.

[7] The RP computer program essentially computes Instruction cost while RQ handles the Support Subprogram costs. The resulting two output files are merged and sorted for report generation.

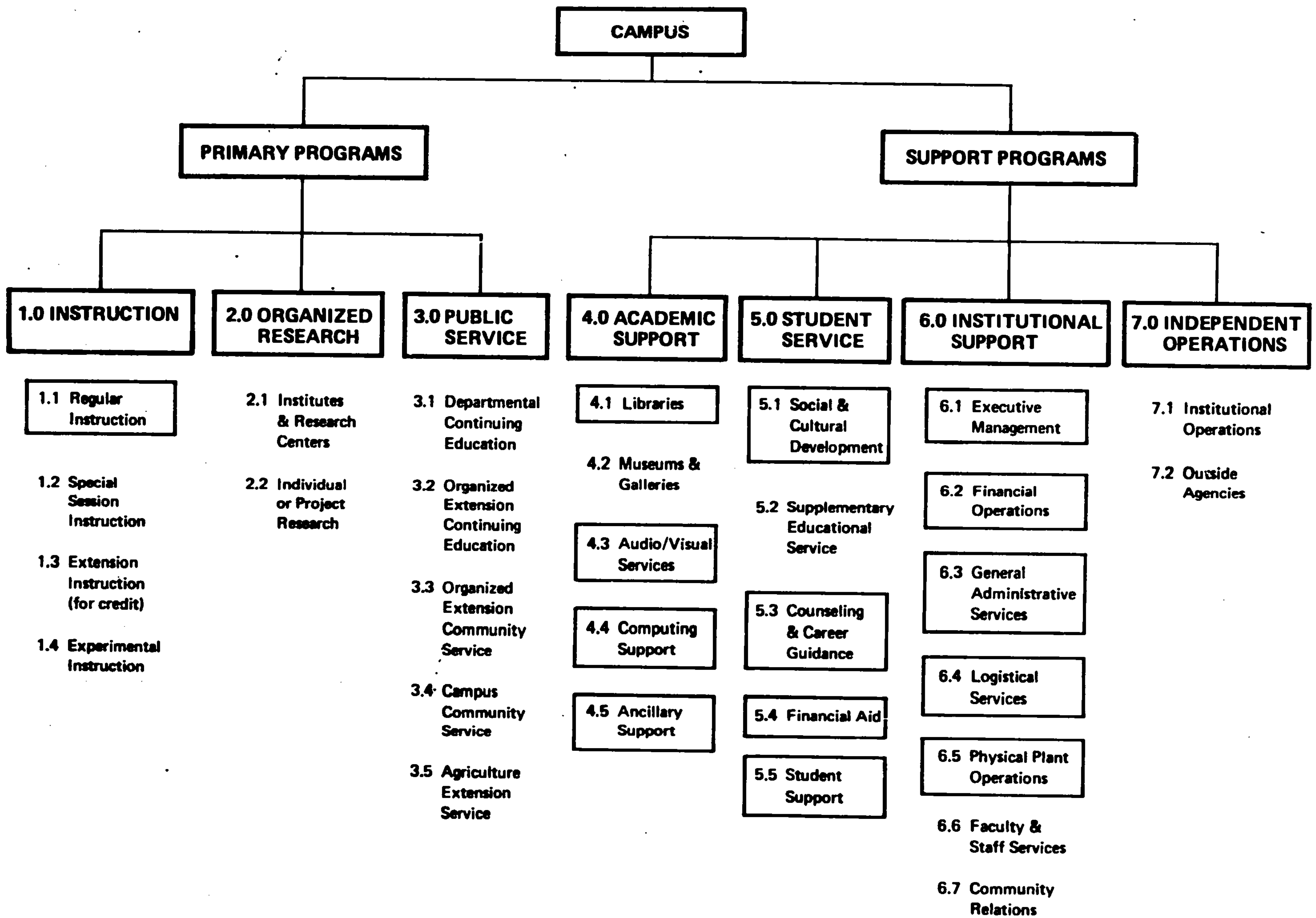

FIGURE 4. SUBPROGRAMS OF PROGRAM BUDGET USED FOR RRPM AT HUMBOLDT

Input Data Elements	Possible Data Sources	Assumptions	Development Time	Comments
ICLM (Induced Course Load Matrix)	Course File Student File Curriculum File	Files in *good shape* for term of ICLM development	File creation: 80 hrs. Program to create ICLM: 16 hrs.	Development time is for *each* campus
WSCHO (Ratio of Student Contact Hours to Credit Hours)	Course Section Report	File available in a timely manner	Program development: 24 hrs.	Program is a one-shot effort
AVESEC (Average Section Size)	Course Section Report	File available in a timely manner	Program development: 24 hrs.	Program is a one-shot effort
FACLD (Faculty Load)	Faculty Workload File	File available in a timely manner	If HEGIS disciplines are used, development time is nil since programs were developed at Chancellor's Office	If policy rather than history data is utilized, the data is even more straight-forward
DIVCO (Distribution of Faculty by Rank)	Faculty Workload File	File available in a timely manner	If HEGIS disciplines are used, development time is nil since programs were developed at Chancellor's Office	Campus-wide figures are readily available but don't reflect wide variations possible in individual disciplines
Salary Schedule	Governor's Budget	Using budgeted info	Computation: 4 hrs./campus	Program is a one-shot effort
	Comptroller's Tape	Using actual info	Program development: 16 hrs.	
Enrollment Data	Campus Academic Affairs	Whatever assumptions are necessary to develop enrollment projections	16 hrs./campus	Student info by major and level not gathered at Chancellor's Office
Regression Coefficients	Analytic Studies at Chancellor's Office	Existing staffing patterns will continue (although coefficients can be changed to reflect policy rather than history)	Negligible	Done in a Chancellor's Office study determining the feasibility of a budget model for California State Colleges

FIGURE 5. MAJOR DATA ELEMENTS FOR RP

Input Data Elements	Possible Data Sources	Assumptions	Development Time	Comments
Salary Schedule	Governor's Budget	Using budgeted info	Computation: 8 hrs./campus	Program is a one-shot effort
	Comptroller's Tape	Using actual info	Program development: 24 hrs.	
Space Data	Space and Facilities Data File	Space standards used in many instances	16 hrs./campus	Much of data requires expert opinion rather than use of data files
History Data a. Positional b. Cost	Previous Governor's Budgets	History as depicted by past Governor's Budgets will approximate future	40 hrs./campus	Crossover from line item budget to a program budget is contained in this effort
Regression Coefficients	Data is history data derived above	Future similar to past (although coefficients can be changed to reflect policy rather than history)	32 hrs./campus	A multiple regression program is available

FIGURE 6. MAJOR DATA ELEMENTS FOR RQ

The ICLM is probably the major data input of RRPM. The primary decision in developing the ICLM is whether to do it for departments or HEGIS disciplines. The campus will want information available in a form that is useful for decision-making. There is, however, a general trend toward the use of data reported in HEGIS discipline format. Humboldt used three student levels and three course levels for the ICLM. If one thinks in terms of utilizing a student flow model, then consideration might be given to using five student levels. Deciding to use HEGIS disciplines over departments and five versus three student levels costs nothing in ICLM development time *unless* the institution ends up doing it both ways.

It has been suggested that the ICLM can be built rather simply by using the campus catalog to determine the requirements of the various majors in their own and other departments. It is the opinion of the technical group that such an approach may give some rather gross results due to the following:

1. Students generally take courses in many more departments than indicated by a catalog.

2. A large number of Junior College transfers complicate such an approach.

3. Students transferring and changing majors causes additional credits to be taken over those necessary to graduate; a catalog approach assumes the number of credits taken is the number required for graduation.

The variables WSCHO (ratio of student contact hours to credit hours) and AVESEC (average section size) which are developed by department, course level, and instruction type proceeded quite easily from the campus course file. FACLD (faculty workload) was established by policy rather than by development from campus files. The results of using this policy, which is representative of how faculty positions are established at the state level, rather than actual data will be discussed in Part D describing model validation.

For developing DIVCO (distribution of faculty by rank, course level, and discipline) comprehensive faculty files existed at the Chancellor's Office. The *overall* campus distribution at Humboldt was used for each department. Future efforts will be directed toward deriving DIVCO at the department level. Obviously large fluctuations in faculty rank distribution occur among departments. Derivation of this variable ignoring disciplines is an example of a "quick and dirty" technique when expediency is necessary.

The derivation of salary schedule information is relatively straightforward. Any problem with inaccuracy in the output is more likely to be attributable to aggregation designed into the model where, for example, the average salary cost for a particular class of employee is the result of averaging over perhaps two or more rather diverse pools of employees. Averages may tend to lose some meaning.

Enrollment data projections continue to be a source of possible inaccuracy. Techniques for projection are generally based on past trends with no capability, for example, to introduce a new major or eliminate a major at some point in the future (at least without writing additional software somewhere in the model). To fill this gap, NCHEMS has been directing efforts toward a student flow model. Similar efforts are beginning at the Chancellor's Office.

The few regression coefficients utilized in RP are available from a recent study done at the Chancellor's Office (2).

As for RQ (see Figure 6) any discussion relating to salary data is covered by what was mentioned above in regard to RP salary schedules. Space data continues to be a problem for at least one reason, i.e., many of the space-type computations depend upon factors or standards which are not fully established (class and lab standards are well established and these space-types make up the most important portion of space modeling). While the space computation portion of RRPM is in some respects a secondary spin-off of the model, the growing interest in space allocations and analysis for capital outlay should prompt further and more detailed examination of the space input data.

History data regarding the number of positions and salary dollars for the various categories of personnel are contained in the past Governor's budgets at the proper level of detail. Regression analysis of the appropriate data yields coefficients for use in the model.

RRPM as it stands contains some rather elaborate equation forms for the Support Subprograms with the option for the user to enter his own equations. Undoubtedly every user will exercise the option since the basic equations represent a generalized approach and illustrate the potential of the model. It is therefore possible to go into an extensive regression analysis to determine the best equations for the particular institution. Fortunately, the California State Colleges are almost entirely student-driven, i.e., simple linear equations whose independent variable is student FTE handle the job rather remarkably in most cases so that the regression analysis necessary to run RRPM for a California State College is quite straightforward (for some exceptions see Part D of this report dealing with model validity).

The other inputs include the titles for departments, majors, course levels, student levels, faculty ranks, and non-academic staff ranks.

C. RRPM Output Reports

The exhibits on the following pages are indicative of the types of output reports available for RRPM. An examination of these reports provides an effective way of obtaining a grasp of the scope of RRPM. The model forecasts virtually all positions and expenditures for a campus. This type of information is directly relevant to the development of support budgets. The forecasts of space requirements are relevant to facilities planning and the development of capital budgets. At the option of the user this data may be obtained at several levels of aggregation ranging from all campus totals to positions and supplies at the department level. The capability for examining instructional costs at a high level of disaggregation, coupled with the cost per student computations provides a powerful means for experimenting with the cost consequences of alternative resource configurations.

Figure 7 summarizes the reports by title, gives an indication of their contents, and refers the reader to examples provided in the exhibits. *It must be emphasized that the numbers appearing in the exhibits should be considered for illustrative purposes only.* On one hand they represent our best effort given the data base and the time available for implementation and evaluation. On the other hand it was during implementation and evaluation of the model that we became acutely aware of some of the limitations of the data base (e.g., in the way majors are reported) and some remaining definitional problems in the model (e.g., the distinction between a student in the head count and the FTE sense).

REPORT	CONTENTS
Cost Summary by Subprogram and Year (see Exhibit 1)	
Cost Summary across all Programs (see Exhibit 2 for examples of items (a), (b), (c), (d), and (g)	(a) academic FTE and salaries (b) administrative FTE and salaries (c) non-academic FTE and salaries (d) supplies and expense (e) distribution of student enrollments, credit hours and contact hours (f) distribution of faculty contact hours (g) space requirements (h) construction costs
Report by Program Level (not shown)	Items (a) through (g) above where applicable
Report by Subprogram Level (see Exhibit 3 for examples of items (a), (b), (c), (d), and (g); Exhibit 4 for examples of items (c), (d), and (g))	Items (a) through (g) above where applicable
Report by Program Sector Level (applies only to academic departments in subprogram regular instruction, see Exhibit 5 for examples of items (a) through (g))	Items (a) through (g) where applicable
Total Instruction Costs by Discipline and Course Level (see Exhibit 6, page 1)	
Average Unit Cost by Discipline and Course Level (see Exhibit 6, page 2)	
Total Instruction Costs by Major and Student Level (see Exhibit 7, page 1)	
Average Cost per Student by Major and Student Level (see Exhibit 7, page 2)	

FIGURE 7. OUTPUT REPORTS OF RRPM

Exhibits 1 and 2 contain examples of the most highly aggregative reports produced by RRPM. They summarize total costs (exclusive of new construction) for the campus in two different ways. Exhibit 1 shows a total cost summary by subprogram for each run year of the model. Exhibit 2 shows the same cost data arrayed by the components that give rise to costs (academic, administrative and non-academic FTE and salaries, supplies and expense) summed over all programs. In addition, this report shows space requirements over all programs by space type.

Exhibits 3 and 4 illustrate two of the fourteen subprogram reports. Exhibit 3 shows part of the report for the single primary subprogram, 1.1, Regular Instruction. It will be noted that the academic portion of this report duplicates that of Exhibit 2 but the non-academic FTE and salaries and space requirements are those needed for Regular Instruction only. Exhibit 4 is a complete illustration of the most disaggregated report available for each of the Support Subprograms.

Exhibit 5 is an example of a complete report for one of the thirty-three academic disciplines (departments) within Regular Instruction. In addition to academic and non-academic FTE and salaries, supply and expense, and space requirements, the report also contains a detailed distribution of student and faculty contact hours by course level and type of instruction. (Although not shown in the exhibits, these distributions are also available in reports at the subprogram and program level.)

Exhibit 6 is an example of the report showing Instruction costs by course level and discipline. The second page of this exhibit shows the unit costs of Instruction by course level and discipline, obtained by dividing the total Instruction costs by the appropriate values of student credit hours taught by the discipline. Exhibit 7 shows the cost data of Exhibit 6 allocated (by means of the ICLM) to students by major and level. The first page of this exhibit shows total Instructional costs by major and level. The second page shows per student cost by major and level obtained by dividing the total cost data by appropriate student enrollments.

D. Validation of RRPM

The 1970/71 academic year at Humboldt was selected for numerical validation of RRPM. RRPM was run so that projections for resource requirements proceeded from 1970/71 as a base year, 1970/71 representing the most recent year for which data existed; e.g., average salary costs, an induced course load matrix, etc. The obvious task was to check the predicted model figures against what was actually budgeted for 1970/71. Years 1971/72, 1972/73, etc., in the model output, of course, became the actual forecast years for planning purposes. Using 1970/71 as a base year for forecasting makes sense intuitively since forecasts tend to be made based on the most recent information. If the base year of 1970/71 does not validate well, then forecasts become questionable; if validation looks good, there are no assurances that the forecasts are infallible but rather there does exist some justifiable confidence in them taking into consideration the assumptions underlying the model.

Before discussing the validation results two important topics related to validating RRPM need to be treated. The Instruction portion of RRPM (handled in RP) is undoubtedly the most significant element of RRPM both in terms of the amount of cost that Instruction contributes to the overall budget cost and in terms of the amount of beneficial information available to the

HUMBOLDT STATE COLLEGE - MANAGEMENT GAME   DATE 6/ 4/71

(WICHE - PMS / RRPM-1.2)   RUN NUMBER 10

TOTAL COST SUMMARY BY SUBPROGRAM AND YEAR

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1.0 INSTRUCTION										
REGULAR INSTRUCTION	6620613.	9995074.	10164802.	0.	0.	0.	0.	0.	0.	0.
SPECIAL SESSION INST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EXTENSION INSTRUCTN.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EXPERIMENTAL INSTR.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
****SUBTOTAL****	6620613.	9995074.	10164802.	0.	0.	0.	0.	0.	0.	0.
4.0 ACADEMIC SUPPORT										
LIBRARIES	600935.	1130995.	786835.	0.	0.	0.	0.	0.	0.	0.
MUSEUMS AND GALLRS.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
AUDIO/VISUAL SERV.	94269.	133860.	135171.	0.	0.	0.	0.	0.	0.	0.
COMPUTING SUPPORT	236537.	420212.	426295.	0.	0.	0.	0.	0.	0.	0.
ANCILLARY SUPPORT	71913.	94965.	95729.	0.	0.	0.	0.	0.	0.	0.
****SUBTOTAL****	1003655.	1780032.	1444030.	0.	0.	0.	0.	0.	0.	0.
5.0 STUDENT SERVICES										
SOCIAL CULT. DEVELOP	70784.	78908.	79177.	0.	0.	0.	0.	0.	0.	0.
SUPPLEM. EDUCAT SERV	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
COUNSEL. CAREER GUID	242603.	339981.	343206.	0.	0.	0.	0.	0.	0.	0.
FINANCIAL AID	57736.	99442.	100823.	0.	0.	0.	0.	0.	0.	0.
STUDENT SUPPORT	120501.	163451.	171072.	0.	0.	0.	0.	0.	0.	0.
****SUBTOTAL****	491624.	687741.	694277.	0.	0.	0.	0.	0.	0.	0.

EXHIBIT 1 Page 1 of 2

HUMBOLDT STATE COLLEGE - MANAGEMENT GAME   DATE 6/ 4/71

(WICHE - PMS / RRPM-1.2)   RUN NUMBER 10

TOTAL COST SUMMARY BY SUBPROGRAM AND YEAR

6.0 INSTITUTIONAL SUPPORT	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
EXECUTIVE MANAGEMENT	450928.	623927.	635855.	0.	0.	0.	0.	0.	0.	0.
FINANCIAL OPERATIONS	337205.	507229.	512859.	0.	0.	0.	0.	0.	0.	0.
GENL. ADMIN. SERVICE	231651.	301689.	304009.	0.	0.	0.	0.	0.	0.	0.
LOGISTICAL SERVICES	277921.	339828.	341879.	0.	0.	0.	0.	0.	0.	0.
PHYSICAL PLANT OPER.	1487385.	2234990.	2239623.	0.	0.	0.	0.	0.	0.	0.
FACULT. STAFF SERV.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
COMMUNITY RELATIONS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
****SUBTOTAL****	2785091.	4013663.	4034225.	0.	0.	0.	0.	0.	0.	0.
*****TOTALS*********	10900983.	16474550.	16337334.	0.	0.	0.	0.	0.	0.	0.

EXHIBIT 1 Page 2 of 2

HUMBOLDT STATE COLLEGE MANAGEMENT GAME

REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP B (WICHE-PMS/RRPM-1.2)

DATE 06/04/71 RUN NUMBER 10 PAGE 1

PROGRAM *.* ALL PROGRAMS

SUB-PROGRAM *.* ALL SUB-PROGRAMS

DISCIPLINE CODE ** ENTRY 00 ALL DISCIPLINES

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
ACADEMIC FACULTY FTE										
PROFESSOR	75.4	111.5	117.8							
ASSOCIATE PROFESSOR	61.2	90.3	95.7							
ASSISTANT PROFESSOR	165.7	248.1	256.9							
INSTR/LECT	50.6	76.4	77.4							
**** TOTAL	352.9	526.3	547.8							
ACADEMIC FACULTY $										
PROFESSOR	1554077	2297327	2419226							
ASSOCIATE PROFESSOR	977729	1441723	1524644							
ASSISTANT PROFESSOR	2030706	3041155	3148702							
INSTR/LECT	482497	727696	737981							
**** TOTAL	5045009	7507901	7830553							
ACADEMIC ADMIN FTE	22.9	30.5	31.2							
ACADEMIC ADMIN $	433100	569882	586439							
TOTAL ACADEMIC FTE	375.8	556.8	579.0							
TOTAL ACADEMIC $	5478109	8077783	8416992							
NONACADEMIC FTE*										
1-	98.2	137.6	139.7							
2-	265.8	436.9	395.1							
3-	75.1	95.6	96.2							
4-	11.8	16.8	16.9							
**** TOTAL	450.9	686.9	647.9							
NONACADEMIC $*										
1-	1090469	1535439	1551492							
2-	2080036	3386477	3077963							
3-	692910	895768	902487							
4-	126560	174699	176294							
**** TOTAL	3989975	5992383	5708236							
TOTAL PERSONNEL FTE	826.7	1243.7	1226.9							
TOTAL PERSONNEL $	9468084	14070166	14125228							
SUPPLIES AND EXPENSE	1432898	2406396	2212117							
TOTAL DOLLARS	10900982	16476562	16337345							

*For this report, aggregation of positions by function results in nonmeaningful titles.

EXHIBIT 2 Page 1 of 2

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)

REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP H DATE 04/04/71 RUN NUMBER 10 PAGE 7

PROGRAM *.* ALL PROGRAMS

SUB-PROGRAM *.* ALL SUB-PROGRAMS DISCIPLINE CODE ** ENTRY 00 ALL DISCIPLINES

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
SPACE REQUIREMENTS										
CLASSROOM	41418	62050	62353							
CLASS LABORATORY	105844	161899	160456							
RESEARCH LABORATORY										
OFFICE - CONFERENCE	110036	165064	164246							
LIBRARY	41965	59122	60787							
MUSEUM/GALLERY	5283	7922	8009							
AUDIO/VISUAL	26415	39610	40047							
DATA PROC/COMPUTER	3396	5088	5153							
ARMORY										
CLINIC										
DEMONSTRATION	445	681	678							
FIELD SERVICE										
ATHLETIC-PHYS. ED.	44508	68087	67840							
ASSEMBLY	15849	23766	24028							
LOUNGE	15849	23766	24028							
MERCHANDISING	15849	23766	24028							
RECREATION	15849	23766	24026							
RESIDENTIAL										
DINING	5283	7922	8009							
STUDENT HEALTH	4755	7130	7209							
MEDICAL CARE										
PHYSICAL PLANT	431	647	649							
**** TOTAL	453177	680286	681548							

EXHIBIT 2 Page 2 of 2

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)
REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP B DATE 06/04/71 RUN NUMBER 10 PAGE 1

PROGRAM 1.0 INSTRUCTION
SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE ** ENTRY 00 ALL DISCIPLINES

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
ACADEMIC FACULTY FTE										
PROFESSOR	75.4	111.5	117.8							
ASSOCIATE PROFESSOR	61.2	90.3	95.7							
ASSISTANT PROFESSOR	165.7	248.1	256.9							
INSTR/LECT	50.6	76.4	77.4							
**** TOTAL	352.9	526.3	547.8							
ACADEMIC FACULTY $										
PROFESSOR	1554077	2297327	2419226							
ASSOCIATE PROFESSOR	977729	1441723	1524644							
ASSISTANT PROFESSOR	2030706	3041155	3148702							
INSTR/LECT	482497	727696	737981							
**** TOTAL	5045009	7507901	7830553							
ACADEMIC ADMIN FTE	22.9	30.5	31.2							
ACADEMIC ADMIN $	433100	569882	586439							
TOTAL ACADEMIC FTE	375.8	556.8	579.0							
TOTAL ACADEMIC $	5478109	8077783	8416992							
NONACADEMIC FTE										
1- ADMINISTRATIVE CLERICAL	11.2	13.2	13.7							
2- TECHNICAL/CLERICAL	78.1	115.9	120.4							
3-										
4-										
**** TOTAL	89.3	129.1	134.1							
NONACADEMIC $										
1- ADMINISTRATIVE CLERICAL	79951	94945	96759							
2- TECHNICAL/CLERICAL	567837	846623	880363							
3-										
4-										
**** TOTAL	647788	941568	977122							
TOTAL PERSONNEL FTE	465.1	685.9	713.1							
TOTAL PERSONNEL $	6125897	9019351	9394114							
SUPPLIES AND EXPENSE	494717	975738	770698							
TOTAL DOLLARS	6620614	9995089	10164812							

EXHIBIT 3 Page 1 of 2

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)
REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP B DATE 06/04/71 RUN NUMBER 10 PAGE 7

PROGRAM 1.0 INSTRUCTION
SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE ** ENTRY 00 ALL DISCIPLINES

SPACE REQUIREMENTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
CLASSROOM	41418	62050	62353							
CLASS LABORATORY	105844	161899	160456							
RESEARCH LABORATORY										
OFFICE - CONFERENCE	69993	103343	107380							
LIBRARY										
MUSEUM/GALLERY										
AUDIO/VISUAL										
DATA PROC/COMPUTER										
ARMORY										
CLINIC										
DEMONSTRATION	445	681	678							
FIELD SERVICE										
ATHLETIC-PHYS. ED.	44508	68087	67840							
ASSEMBLY	15849	23766	24028							
LOUNGE										
MERCHANDISING										
RECREATION										
RESIDENTIAL										
DINING										
STUDENT HEALTH										
MEDICAL CARE										
PHYSICAL PLANT										
**** TOTAL	278057	419826	422735							

EXHIBIT 3 Page 2 of 2

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)
REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP B DATE 06/04/71 RUN NUMBER 10 PAGE 31

PROGRAM 5.0 STUDENT SERVICE
SUB-PROGRAM 5.3 COUNSELING AND CAREER GUIDANCE DISCIPLINE CODE ENTRY 00 NO DISCIPLINES IN SUPPORT PROGRAMS

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
NONACADEMIC FTE										
1- COUNSELING + TESTING	10.2	14.8	15.0							
2- PLACEMENT	6.4	9.0	9.1							
3- FOREIGN STUDENT PROGRAM	1.3	2.2	2.2							
4- E.O.P.	3.5	3.8	3.8							
**** TOTAL	21.4	29.8	30.1							
NONACADEMIC $										
1- COUNSELING + TESTING	122525	177618	179443							
2- PLACEMENT	66108	92669	93548							
3- FOREIGN STUDENT PROGRAM	13635	23222	23540							
4- E.O.P.	35113	37739	37826							
**** TOTAL	237381	331248	334357							
TOTAL PERSONNEL FTE	21.4	29.8	30.1							
TOTAL PERSONNEL $	237381	331248	334357							
SUPPLIES AND EXPENSE	5222	8732	8849							
TOTAL DOLLARS	242603	339980	343206							

EXHIBIT 4 Page 1 of 2

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)

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PROGRAM 5.0 STUDENT SERVICE

SUB-PROGRAM 5.3 COUNSELING AND CAREER GUIDANCE DISCIPLINE CODE ENTRY 00 NO DISCIPLINES IN SUPPORT PROGRAMS

SPACE REQUIREMENTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
CLASSROOM										
CLASS LABORATORY										
RESEARCH LABORATORY										
OFFICE - CONFERENCE	2360	3277	3308							
LIBRARY										
MUSEUM/GALLERY										
AUDIO/VISUAL										
DATA PROC/COMPUTER										
ARMORY										
CLINIC										
DEMONSTRATION										
FIELD SERVICE										
ATHLETIC-PHYS. ED.										
ASSEMBLY										
LOUNGE										
MERCHANDISING										
RECREATION										
RESIDENTIAL										
DINING										
STUDENT HEALTH										
MEDICAL CARE										
PHYSICAL PLANT										
**** TOTAL	2360	3277	3308							

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HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)
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PROGRAM 1.0 INSTRUCTION
SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE 18 ENTRY 18 FORESTRY

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
ACADEMIC FACULTY FTE										
PROFESSOR	2.6	4.4	2.9							
ASSOCIATE PROFESSOR	2.2	3.7	2.4							
ASSISTANT PROFESSOR	5.4	9.2	6.0							
INSTR/LECT	1.4	2.4	1.6							
**** TOTAL	11.6	19.7	12.9							
ACADEMIC FACULTY $										
PROFESSOR	53969	91209	59704							
ASSOCIATE PROFESSOR	34612	58451	38293							
ASSISTANT PROFESSOR	66486	113003	73206							
INSTR/LECT	13612	23151	15094							
**** TOTAL	168681	285814	186297							
ACADEMIC ADMIN FTE	.8	1.1	.7							
ACADEMIC ADMIN $	14284	21374	13775							
TOTAL ACADEMIC FTE	12.4	20.8	13.6							
TOTAL ACADEMIC $	182965	307188	200072							
NONACADEMIC FTE										
1- ADMINISTRATIVE CLERICAL	.4	.5	.3							
2- TECHNICAL/CLERICAL	2.6	4.3	2.8							
3-										
4-										
**** TOTAL	3.0	4.8	3.1							
NONACADEMIC $										
1- ADMINISTRATIVE CLERICAL	2637	3561	2273							
2- TECHNICAL/CLERICAL	18728	31753	20678							
3-										
4-										
**** TOTAL	21365	35314	22951							
TOTAL PERSONNEL FTE	15.4	25.6	16.7							
TOTAL PERSONNEL $	204330	342502	223023							
SUPPLIES AND EXPENSE	18527	36541	28862							
TOTAL DOLLARS	222857	379043	251885							

EXHIBIT 5 Page 1 of 7

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)

REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP 8 DATE 06/04/71 RUN NUMBER 10 PAGE 128

PROGRAM 1.0 INSTRUCTION

SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE 18 ENTRY 18 FORESTRY

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
STUDENT CRED HOURS										
LOWER DIVISION	359	593	455							
UPPER DIVISION	1498	2549	1596							
GRADUATE	35	48	51							
**** TOTAL	1892	3210	2102							

EXHIBIT 5 Page 2 of 7

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)

REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP B DATE 06/04/71 RUN NUMBER 10 PAGE 129

PROGRAM 1.0 INSTRUCTION

SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE 18 ENTRY 18 FORESTRY

STUDENT CONT HOURS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
LOWER DIVISION										
CLASSROOM	226	374	286							
LABORATORY - DEMO	402	665	509							
OTHER INSTRUCTION										
**** TOTAL	628	1039	795							
UPPER DIVISION										
CLASSROOM	944	1619	1006							
LABORATORY - DEMO	1528	2621	1628							
OTHER INSTRUCTION	30	51	32							
**** TOTAL	2502	4291	2666							
GRADUATE										
CLASSROOM	12	17	18							
LABORATORY - DEMO										
OTHER INSTRUCTION	12	16	17							
**** TOTAL	24	33	35							
**** GRAND TOTAL	3154	5363	3496							

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HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)
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PROGRAM 1.0 INSTRUCTION
SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE 18 ENTRY 18 FORESTRY

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
STUDENT CONT HOURS										
CLASSROOM										
LOWER DIVISION	226	374	286							
UPPER DIVISION	944	1619	1006							
GRADUATE	12	17	18							
**** TOTAL	1182	2010	1310							
LABORATORY - DEMO										
LOWER DIVISION	402	665	509							
UPPER DIVISION	1528	2621	1628							
GRADUATE										
**** TOTAL	1930	3286	2137							
OTHER INSTRUCTION										
LOWER DIVISION										
UPPER DIVISION	30	51	32							
GRADUATE	12	16	17							
**** TOTAL	42	67	49							
**** GRAND TOTAL	3154	5363	3496							

EXHIBIT 5 Page 4 of 7

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)
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PROGRAM 1.0 INSTRUCTION
SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE 18 ENTRY 18 FORESTRY

FACULTY CONT HOURS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
LOWER DIVISION										
CLASSROOM	4	7	5							
LABORATORY - DEMO	18	30	23							
OTHER INSTRUCTION										
**** TOTAL	22	37	28							
UPPER DIVISION										
CLASSROOM	40	69	43							
LABORATORY - DEMO	102	175	109							
OTHER INSTRUCTION	30	51	32							
**** TOTAL	172	295	184							
GRADUATE										
CLASSROOM	2	2	2							
LABORATORY - DEMO										
OTHER INSTRUCTION	12	16	17							
**** TOTAL	14	18	19							
**** GRAND TOTAL	208	350	231							

EXHIBIT 5 Page 5 of 7

HUMBOLDT STATE COLLEGE MANAGEMENT GAME (WICHE-PMS/RRPM-1.2)
REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP 8 DATE 06/04/71 RUN NUMBER 10 PAGE 132

PROGRAM 1.0 INSTRUCTION
SUB-PROGRAM 1.1 REGULAR INSTRUCTION DISCIPLINE CODE 18 ENTRY 18 FORESTRY

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
FACULTY CONT HOURS										
CLASSROOM										
LOWER DIVISION	4	7	5							
UPPER DIVISION	40	69	43							
GRADUATE	2	2	2							
**** TOTAL	46	78	50							
LABORATORY - DEMO										
LOWER DIVISION	18	30	23							
UPPER DIVISION	102	175	109							
GRADUATE										
**** TOTAL	120	205	132							
OTHER INSTRUCTION										
LOWER DIVISION										
UPPER DIVISION	30	51	32							
GRADUATE	12	16	17							
**** TOTAL	42	67	49							
**** GRAND TOTAL	208	350	231							

EXHIBIT 5 Page 6 of 7

HUMBOLDT STATE COLLEGE　　MANAGEMENT GAME　　(WICHE-PMS/RRPM-1.2)
REPORT TITLE- DECISION SET 3 FOR TRAINING GROUP B　　DATE 06/04/71 RUN NUMBER 10 PAGE 133

PROGRAM 1.0 INSTRUCTION
SUB-PROGRAM 1.1 REGULAR INSTRUCTION　　DISCIPLINE CODE 18 ENTRY 18 FORESTRY

SPACE REQUIREMENTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
CLASSROOM	790	1343	876							
CLASS LABORATORY	6275	10684	6951							
RESEARCH LABORATORY										
OFFICE - CONFERENCE	2308	3876	2522							
LIBRARY										
MUSEUM/GALLERY										
AUDIO/VISUAL										
DATA PROC/COMPUTER										
ARMORY										
CLINIC										
DEMONSTRATION										
FIELD SERVICE										
ATHLETIC-PHYS. ED.										
ASSEMBLY										
LOUNGE										
MERCHANDISING										
RECREATION										
RESIDENTIAL										
DINING										
STUDENT HEALTH										
MEDICAL CARE										
PHYSICAL PLANT										
**** TOTAL	9373	15903	10349							

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HUMBOLDT STATE COLLEGE - MANAGEMENT GAME DATE 6/ 4/71 PAGE 1

(WICHE - PMS / RRPM-1.2) RUN NUMBER 10

TOTAL INSTRUCTION COSTS BY DISCIPLINE AND COURSE LEVEL

1970

COURSE LEVELS

DISCIPLINE	LOWER DIVISION	UPPER DIVISION	GRADUATE	TOTAL
EDUCATION	7528.	233863.	253759.	495149.
GEOGRAPHY	28876.	59956.	0.	88831.
HISTORY AND POLITICAL SCIENCE	112427.	232271.	22193.	366891.
PSYCHOLOGY	132747.	152549.	67599.	352895.
SOCIOLOGY	68838.	174814.	14095.	257747.
SPEECH AND HEARING	0.	32834.	22973.	55807.
BUSINESS ADMINISTRATION	121628.	190426.	51537.	363590.
ECONOMICS	51935.	73401.	2108.	127444.
ART	169003.	163992.	9727.	342722.
ENGLISH	142390.	131703.	28989.	303082.
FOREIGN LANGUAGE	79979.	42976.	567.	123522.
JOURNALISM	22167.	45867.	0.	68034.
MUSIC	89220.	154512.	6726.	250458.
PHILOSOPHY	48611.	42465.	0.	91076.

EXHIBIT 6 Page 1 of 2

(WICHE - PMS / RRPM-1.2)   RUN NUMBER 10

AVERAGE UNIT COSTS BY DISCIPLINE AND COURSE LEVEL

1970

COURSE LEVELS

DISCIPLINE	LOWER DIVISION	UPPER DIVISION	GRADUATE	ALL LEVS
EDUCATION	53.85	23.81	87.42	38.48
GEOGRAPHY	15.66	28.43	0.00	22.47
HISTORY AND POLITICAL SCIENCE	14.31	24.74	79.02	20.94
PSYCHOLOGY	16.93	19.14	56.52	20.75
SOCIOLOGY	15.45	20.19	60.10	19.31
SPEECH AND HEARING	0.00	27.22	69.54	36.32
BUSINESS ADMINISTRATION	26.54	24.89	63.62	27.87
ECONOMICS	16.71	29.71	14.83	22.28
ART	28.95	52.34	94.66	37.77
ENGLISH	18.39	23.72	63.09	22.04
FOREIGN LANGUAGE	19.53	31.47	74.14	22.59
JOURNALISM	25.04	35.38	0.00	31.19
MUSIC	28.75	65.89	84.14	45.31
PHILOSOPHY	15.59	23.51	0.00	18.43

EXHIBIT 6   Page 2 of 2

HUMBOLDT STATE COLLEGE - MANAGEMENT GAME DATE 6/ 4/71 PAGE 8

(WICHE - PMS / RRPM-1.2) RUN NUMBER 10

TOTAL INSTRUCTION COSTS BY MAJOR AND STUDENT LEVEL

1970

STUDENT LEVELS

MAJOR	LOWER DIV	UPPER DIV	GRADUATE	ALL LEVS
PSYCH	49843.	161136.	97772.	308751.
PE	40233.	180148.	70904.	291285.
ENGR C	4187.	48545.	0.	52732.
ENGR S	3918.	14696.	0.	18614.
ENGR	41903.	40000.	0.	81903.
SOC SCI	13346.	84367.	39040.	136752.
ASIAN	971.	5460.	0.	6432.
ECON	5017.	37464.	12245.	54726.
GEOG	7184.	20439.	1714.	29337.
HIST	46803.	173585.	76901.	297290.
POLSCI	31734.	38056.	13919.	83709.
SOC WEL	11444.	39891.	0.	51339.
SOC	41839.	149227.	51105.	242171.
PRE MED	0.	4715.	0.	4715.
BIOL	94423.	218756.	127771.	440950.
BOT	1457.	11531.	0.	12988.
ZOOL	12311.	57095.	5740.	75145.
SCI	2042.	1551.	2092.	5685.
CHEM AB	3402.	7360.	0.	10762.
CHEM BS	6874.	13860.	0.	20734.

EXHIBIT 7 Page 1 of 2

HUMBOLDT STATE COLLEGE - MANAGEMENT GAME DATE 6/ 4/71 PAGE 11

(WICHE - PMS / RRPM-1.2) RUN NUMBER 10

AVERAGE COST PER STUDENT BY MAJOR AND STUDENT LEVEL

1970

STUDENT LEVELS

MAJOR AVERAGE UNIT LOAD =	LOWER DIV (14.8)	UPPER DIV (14.5)	GRADUATE (11.8)	ALL LEVS
PSYCH	859.	1026.	1321.	1068.
PE	981.	1098.	1338.	1129.
ENGR C	1396.	1867.	0.	1818.
ENGR S	1306.	1633.	0.	1551.
ENGR	1193.	1481.	0.	1241.
SOC SCI	953.	1042.	1446.	1121.
ASIAN	971.	1092.	0.	1072.
ECON	1003.	1135.	1113.	1117.
GEOG	1026.	1076.	857.	1048.
HIST	936.	1085.	1183.	1081.
POLSCI	907.	1087.	1071.	1009.
SOC WEL	954.	907.	0.	917.
SOC	973.	982.	1278.	1031.
PRE MED	0.	1179.	0.	1179.
BIOL	984.	1243.	1389.	1211.
BOT	728.	1281.	0.	1181.
ZOOL	1026.	1298.	957.	1212.
SCI	681.	1551.	1046.	948.
CHEM AB	1134.	1227.	0.	1196.
CHEM BS	1146.	1386.	0.	1296.

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decision maker. Since the Instruction element of RRPM performs its computations by department, it is appropriate to validate the model for 1970/71 by checking predicted versus actual faculty, staff, etc., by department. This approach introduces a number of problems.

First, actual figures for validation are readily available at the system (campus) level, but are not easily obtained for the department level; i.e., a rather extensive effort would be involved in obtaining faculty and staff position counts and their associated salary dollars. Obtaining operating expense and equipment costs by department is even more difficult. In the near future when the campuses become fully operational under the automated Allotment Expenditure Ledger (AEL) system, actual expenditures by department should be more accessible.

Validation by department offers a second problem. While positions are budgeted by formula, their actual allocation often occurs otherwise. For example, budgeting formulas for the Colleges allow for 0.22 technical/clerical positions for each faculty position. Yet there is no reason to expect departmental allocations for technical/clerical given the departmental budgeted faculty to approach this ratio in reality. In this respect then RRPM becomes at times a normative model predicting *what should* be rather than *what is*. All of this can be stated in a different manner: at the campus level resources are budgeted quite quantitatively, but less so for smaller organizational units within the campus.

The other important topic which should be discussed in relation to model validation is faculty work load. One of the input variables of RP is FACLD which is the average faculty load measured in contact hours/week by discipline and type of instruction (lecture, lab, and other). The California State Colleges basically receive a faculty position for each 12 "weighted teaching units." Essentially each credit unit that an instructor teaches is weighted by the type of instruction of which that unit consists. Each course in the Colleges is designated by a code which determines its specific type of instruction, the maximum size the class is to be and its weighting factor for allocating faculty. For example, in lecture situations the weighting factor is 1; i.e., 12 credit hours of instruction result in 12 weighted teaching units (equivalently 12 lecture contact hours give rise to one faculty position). Certain laboratories require three hours of class time a week for one unit of student credit. In this case the designated weighting factor is 2; i.e., 6 credit hours of these labs result in 12 weighted teaching units (equivalently for this type of lab 18 lab contact hours give rise to one faculty position). These are only two examples of the types of situations which can be encountered.

Validation of Instruction Subprogram Cost

For our purposes in RRPM we used faculty load inputs which represent the policy of 12 weighted teaching units (WTU) per faculty position described above. The effects of using policy rather than actual faculty work load figures raise some interesting points with regard to use of the model and its validation. Using policy faculty load in running RRPM leads to the number of faculty positions Humboldt should be budgeted for, not what it actually was budgeted for. The running of RRPM for 1970/71 results in 397 faculty positions as compared to a figure of 348 actual budgeted faculty positions. Although information is not yet available for any quarter of the 1970/71 academic year, information for the three quarters of the 1969/70 academic year indicate that the faculty at Humboldt consistently teach well above the rate of 12 weighted teaching units. If 1969/70 figures are indicative of 1970/71, then the predicted faculty (397) as compared to budgeted faculty (348) is biased in the correct direction; i.e., using higher faculty teaching loads in RRPM rather than policy loads would result in a projected faculty allocation lower than the above 397.

To perform a validation of RRPM what is obviously wanted is a comparison of predicted costs with actual costs. By using a policy faculty work load predicted faculty positions and costs are too high to compare with actual costs which are based on 348 faculty positions. How can this source of error be removed for validation purposes?

If actual WTU/faculty at Humboldt were, for example, 13 rather than 12, then using adjusted input data utilizing 13 WTU would result in a reduction of faculty for a run of RRPM of (13-12) (100)/13 = 7.7% which is approximately 30 faculty positions. Knowing generally the distribution of faculty by rank, faculty salary schedules, the staff to support them and its salary schedule, it is possible to derive the overage cost associated with the 30 faculty positions and subtract it from the RRPM run cost for 397 faculty in order to *then* make validation comparisons. The differences then remaining between predicted and actual costs will be due to other sources and random error.

Unfortunately, as mentioned above, WTU information for 1970/71 (our validation year) is not available at this time. It is, however, possible to conjecture various faculty loads, determine the associated overage faculty and its cost, subtract it from the base RRPM run, and compare the results to actual cost. These results are tabulated below. The error rates given are for the Instruction Subprogram cost only.

Actual Weighted Teaching Units	No. of Faculty Generated by RRPM	Error[8]
12.0	397	14.4%
12.75	372	7.7%
13.5	348	1.1%

If in fact the faculty load at Humboldt is 12, then the model results would stand and the Instruction cost error would be substantial. At the other end, if faculty load is near 13.5, then the number of faculty generated by RRPM would be very close to those actually budgeted for 1970/71 and the error due to other sources would be approximately 1%. This latter case for the Instruction Subprogram cost is shown in Figure 8. Note the rather significant cost differences for administrative and administrative clerical personnel. The regression coefficients used in these computations were derived from systemwide figures of a previous study. Using systemwide data rather than data specifically for Humboldt expedites data collection but introduces some inaccuracy.

Final model validation for Instruction Subprogram cost will have to wait on 1970/71 faculty load data at Humboldt.

[8] Error is computed as: $\frac{\text{Predicted Cost-Actual Cost}}{\text{Actual Cost}} \times 100\%$

	Predicted	Actual
1.0 INSTRUCTION		
Faculty*	$ 4,995,744	$ 4,845,729
Administrative	429,574	488,432
Administrative/Clerical	79,586	94,211
Technical/Clerical	560,780	572,279
Operating Expenses & Equipment	378,707	373,487
	$ 6,444,391	$ 6,374,138
4.0 ACADEMIC SUPPORT		
4.1 Libraries	$ 600,935	$ 522,739
4.3 Audio/Visual Services	94,269	85,191
4.4 Computing Support	236,537	222,426
4.5 Ancillary Support	71,913	77,629
	$ 1,003,654	$ 907,985
5.0 STUDENT SERVICE		
5.1 Social & Cultural Development	$ 70,784	$ 69,237
5.3 Counseling & Career Guidance	242,603	232,321
5.4 Financial Aid	57,736	53,841
5.5 Student Support	120,501	173,209
	$ 491,624	$ 528,608
6.0 INSTITUTIONAL SUPPORT		
6.1 Executive Management	$ 436,175	$ 443,037
6.2 Financial Operations	337,205	335,454
6.3 General Administrative Services	231,651	234,112
6.4 Logistical Services	277,921	258,994
6.5 Physical Plant Operations**	1,312,531	1,249,274
	$ 2,595,483	$ 2,520,871
Total	$10,535,152	$10,331,602

*Non-teaching faculty not included.

**Revised prediction of $1,418,622 with changes in space standards (see discussion).

FIGURE 8. COMPARISON OF PREDICTED AND ACTUAL COSTS

Validation of Support Subprogram Costs

Figure 8 also contains a summary of predicted versus actual costs for the Support Subprograms. The previous discussion concerning the attempt to adjust faculty positions in order to facilitate Instruction Subprogram cost validation has no effect on validation of the Support Subprogram costs since these costs are evaluated by equations which in general are student-driven or space-driven. A few of the larger cost discrepancies in the Support Subprograms will be briefly discussed below.

The Library area for the Colleges is a difficult area to model. First, numerous budgeting techniques have been utilized in the Colleges over the last few years to determine the various types of Library positions. Second, often positions are allocated differently than the formulas dictate in order to balance fluctuating work loads in various libraries at the Colleges. Thus the historical data for the number of positions for a library tend to be anything but smooth, making the simple linear regression analysis inappropriate.

For the Student Support Subprogram Humboldt received an unusually large increase in positions for 1970/71. The linear regression would underestimate such a sudden increase.

Physical Plant Operations Subprogram cost is dependent, among other variables, on the total building space of a campus. Very simply, space can be divided into two gross categories: (1) classroom, lab, office, and study and (2) all of the rest. For the first category space standards exist and are quite firm, particularly for classroom and lab (space standards being measured in terms of room utilization rate, station occupancy rate, and station assignable square feet). Few standards exist for the second category of space which includes such space-types as museum/gallery, athletic-physical education, recreation, etc.

The validation run of RRPM used actual classroom and lab space factors at Humboldt and some guesses for the factors relating to all the other types of space. The predicted Physical Plant cost is shown in Figure 8 as a result of these space inputs.

The model was rerun once using (1) CCHE space standards for classroom and lab and (2) some revised estimates of some of the other space-type factors. Overall, space increased approximately 30,000 square feet (roughly 10,000 square feet attributable to classroom, lab, and office and the remaining 20,000 square feet attributable to the other space-types). As a result Plant Operations cost rose $100,000. The point here is that Plant Operations cost is sensitive enough to space so that careful analysis of space and space factors would be beneficial.

Overall, for the Colleges, rather simple linear equations do a quite adequate job of predicting Support Subprogram costs.

E. The Resource Requirements of RRPM

The costs of RRPM to a campus should be considered from several viewpoints: there is the cost of implementing the model as distinct from the cost of using the model after it has been implemented. In both cases costs arise because of the need for resources, primarily in the form of personnel and computer time. The use of personnel and computer time, in turn, involves costs arising because of actual expenditures to acquire additional resources to devote to the model and costs arising when existing resources having other potential uses are devoted to the model. The actual outlay of funds any campus incurs to either implement or operate the model depends then upon the particular mix of these two types of costs encountered.

Individuals with skills in leadership, communications, quantitative analysis, and computer programming are needed to implement and operate RRPM. Programming skills are necessary for processing the input data for the model, to get the programs representing the model running on a computer and to modify the programs as necessary. Analytic skills are necessary for data acquisition, for understanding what the model is and does, for adapting the model to particular circumstances on a campus, and for interpretation of model outputs. Communication skills are needed in order to work with and involve a broad spectrum of administrators in understanding RRPM and how it relates to the administrative process. Finally, and perhaps most important, leadership skills are necessary to organize implementation, training, and evaluation and to guide the integration of the model within the administrative process.

More specifically, at Humboldt State the implementation effort required about one man-year of effort distributed over a six-month period. One member of the project group accounted for one-half of a man-year developing and processing the input data,[9] modifying the computer programs, running these programs, and participating in the interpretation and evaluation of the model. The other members of the project group accounted for the bulk of the remaining time. They participated on a part-time basis variously organizing and guiding the project, modifying and interpreting the model and its programs, and taking part in the training and evaluation sessions. Between one and two man-months of the effort was accounted for by the members, primarily administrators, of the evaluation group.

Implementation required about thirteen hours of central processing unit (CPU) time on the CDC 3300. Half of this time was accounted for at the California State Colleges' Southern Regional Data Center in reducing the program's core requirements, testing some overlay schemes, performing the general modifications to adapt the model to a California State College, and to run the model for validation purposes. The other half of this time was at the CSC Northern Regional Data Center and was used to get RRPM running in a communications mode with the CDC 3150 on-site at Humboldt State, to make some additional modifications to the model, and to run the model for training and evaluation purposes. (This latter use accounted for most of the computer usage at Humboldt.)

Assuming that some of the learning that occurred on this project is transferable, that good machine-readable files exist, and that the computer time used at the CSC Southern Regional Data Center represented a one-time development effort, it is estimated that three to four man-months of effort and the equivalent of three hours of CPU time on a CDC 3300 would be sufficient to implement (in the sense of getting the model running on a computer with campus data) RRPM on another State College campus. (A computer comparable to the CDC 3300 is minimal for running RRPM.)

[9]This does not include development of an ICLM which was already available at HSC. Refer to Figures 5 and 6 in Part B of this section for more detailed time estimates of obtaining input data.

The use of RRPM on a continuing basis on a campus will require all of the skills discussed at the beginning of this section. It will require a substantial involvement upon the part of one or two individuals on the campus who are intimately familiar with the model and who can serve as interfaces between the model and the administrators involved with planning problems. Computer time will depend upon the extent to which the model continues to evolve (thus requiring modifications to the programs) and how often the model is run. Actual run time for RRPM will require approximately four minutes of CPU time per simulated year (half of this time being used for generating all reports).

F. Comments From the Management Evaluation Group Sessions

Contained in Appendix B in memo form are the personal statements made by various members of the management evaluation group at the conclusion of the evaluation phase. What follows is a reconstruction of the conversation derived from the notes taken by one of the members of the project group durirg the decision sessions Of course, only a fraction of the topics and language is contained in what follows.

... The general indoctrination scheme we used was of limited use ... until we used our own (HSC) data – then learning really took place.

... We need the capability to distribute some support costs back over instruction.

... It would be nice to be able to go beyond four support levels and thirty-three disciplines.

... The ICLM is of more use (than RRPM) in the generation of admissions policy (by the Office of Academic Affairs) – but then we can try this policy out through RRPM to get a finer fix on the quantity and type of faculty, space, etc. This can sharpen our thinking ... a different/added specificity than we now have. It could make the admissions officer's job more difficult – the requests upon him will be more specific. Then, if he produces the student input requested, and if those students act as the ICLM predicts ... (pause) we really need a student flow model to get at the total distribution of students, their movement from major to major, etc. (This led into quite a discussion of student flow models, quality of information concerning majors, a student flow model as an input to the RRPM, stability of the ICLM, the tightening of requirements for transfer students, etc., and what to do about these items – and to a request for an added hour at the next scheduled evaluation meeting to discuss "majors information.")

... Our "majors" data are questionable. Are students reporting accurately? How often do they change majors? Do some types of students change more than others? Are most changes within similar subject matter areas? Obviously, if our data is bad then the results are questionable. How much faith can we have in the data we have? The ICLM is based upon majors data, and this is fundamental in the Facilities Analysis Model and the Cost Estimation Model as well as RRPM. How much faith can we place in any of these models?

... It appears to me that one of the problems facing modeling is the securing of accurate information – and not merely the identification of majors.

... The (curriculum) requirements for a major are not in this model. In Fisheries, for example, some schools require more math, etc. than others, and so it is difficult to compare one program to another... and we can't be compared to any other Fisheries major in the State Colleges because we have the only one.

... (In an experimental mode) can we add a new support program? Yes. A new department? It wouldn't be easy and I'm not sure how accurate we would be. How about dropping a department? That would be easier. And how about adding a new curriculum? We can try. An analyst is needed to activate, and to modify and rewrite sections of the model to handle many of the innovative attempts.

... It looks as though it will take quite some time to refine the input to the model so as to make it an allocative mechanism.

... It has its greater use in showing differences. The absolute figures are not as accurate as the relative figures – bias is more or less constant (comments directed at a single campus data base).

... The change aspect is important in the use of RRPM.

... My conclusion is that RRPM is of greater use to the Schools (of Natural Resources, Business and Economics, etc.) than the College, and to the College than the Chancellor's Office, etc. It is most useful nearest the scene of action – most useful at the lowest level of application.

... I'm impressed by the flexibility of this model.

... There needs to be a statement, in prose, to introduce the model (on the printouts) – a sort of preface to the run declaring the principles involved (underlying the changes, decisions, etc.), the base, how the parameters were changed, etc.

... Yes, the data needs to be explained as it is presented – salaries averaged, etc., and cover statements giving definitions for Year 1, Year 2, etc.

... When showing unit costs it would be helpful to display the number of (credit) units involved along side the dollar figures.

... A profile of the input data should be displayed.

... The reporting of costs by lower division/upper division/graduate without attention paid to the mode of instruction is not good.

... The "all levels" average is rather meaningless and could be misleading.

... You should at least round off to the nearest dollar – or perhaps to hundreds.

... Where appropriate you should show the number of students, etc., alongside the dollar figures.

. . . Unit cost is useful for an institution in looking at itself – much less useful, in fact, in comparing institutions.

. . . (Regarding extensions of RRPM) attention needs to be paid to the methodology and criteria for allocating costs to programs.

. . . RRPM locates inaccuracies in information and forces us to ask how can we correct our input (and upgrade the information system and data base). This is good.

. . . I see effective administrative technique springing from this model.

. . . This model can be valuable in the simulation of change without going through the actual experience.

. . . Yes, and I see it better for simulating changes rather than making projections.

. . . I feel it is best to make these changes in a step-by-step manner – add an element at a time across the page (printout). We can then see a sort of chain effect.

. . . It is difficult to get away from the notions of (1) the magical computer model – it somehow gets the data and gives the answers – after all, we have the printouts right here before us; (2) that we are not tied to operating conditions and can, *should*, be thinking in a less restrictive planning – what if?, frame of mind; (3) that this is not a budget generator; and (4) that this is not a decision generator.

. . . RRPM has good possibilities as a training device – we've certainly seen this.

. . . In looking ahead to the uses of this model, the implications of the allocations (changes) of these resources can be quite severe. RRPM does not show impact on the organization (people, program, structure, etc.) – particularly the qualitative aspects. I am directing this statement to everyone – on this campus, in the Chancellor's Office, and elsewhere.

. . . I agree. Innovations (and also merely change) cause impact problems. If I want to do (try) something really different can the qualitative aspects be shown through this model? No, not as a stand alone instrument.

. . . If we go to a heavy class challenging system can this model show impact? Resource wise, yes – with some adaptations by our analyst.

. . . What about the self-instruction center I am working on? Maybe.

. . . And what about our (departmental) ideas on investigative labs, modular courses, etc. Apparently yes, but it will need heavy use of our analyst.

While discussing the use of RRPM by the Chancellor's Office, California State Department of Finance, Coordinating Council for Higher Education. etc., the following four comments, among others, were made.

. . . I fear the use of this information.

. . . I fear the decision not made with the best information – and many decisions are made today with no, little, or bad information. Rather than fear the use of information, let's provide good information and encourage proper use of it.

. . . (And) RRPM (and these tools in general) can serve as a channel and mechanism for sending along *our* analysis of *our* data. If we send it along – and you (Director of Institutional Research) stated that the fellow from Finance said he would receive it, "they" are bound to look at it for they may be called on it later.

. . . In looking at the use of RRPM and similar tools by the Chancellor's Office and a campus, they have a control orientation and we a planning orientation in respect to the use of AEL (Accounts Expenditure Ledger) as an input to RRPM; they will tend to look at actual expenditures (costs) and we at allocations; they look at history and we look at "what if?" questions, they look at FTE allocations to the colleges and we admissions policy formulation, etc.

The evaluation process ended with a final question; "Would you use RRPM in the course of your job?" Answer, "Yes." Of course, there were modifying and explanatory statements . . . but we had come a long way from "What is it?" and "It frightens me!" to "Yes."

V. CONCLUSIONS

1. RRPM can be implemented and run with actual data developed on a State College campus.

2. RRPM has great potential as a planning tool that can improve resource management in higher education. Its cost computations represent an important first step in the difficult task of allocating educational costs back to degree winners, the ultimate outputs of the educational process. Used in a predictive mode, RRPM generates a large amount of information relevant to the planning of both support and capital budgets. Used in a simulation mode it provides a powerful tool for examining the consequences of alternative policy formulations. Additionally, RRPM serves as a very suggestive starting point for the definition of a comprehensive data base on one hand and for the further investigation of phenomena that are not now included in the model itself on the other.

3. If RRPM is to be implemented on a campus, administrators should be fully aware of what implementation at this state of the art implies. The remaining conclusions are addressed to these implications.

4. The administrators, faculty, and students who worked with us on the implementation and evaluation of RRPM at Humboldt State College indicated a concern with the uses to which the model may be put. We share this concern. It involves at least two major problem areas: misinterpretation of the model and the question of who will use it. The possibility of misinterpretation of the model arises in two interrelated senses. First is a possibility of misinterpretation of what the entire model is in concept. *RRPM is not an optimization model. It cannot, therefore, be relied upon to make decisions. It is in no sense a substitute for human responsibility in the decision-making process.* Rather, RRPM

is designed to describe resource needs and some of the consequences of particular resource allocations as an aid to the decision-making process. The second possibility for misinterpretation arises in regard to the meaning of the particular outputs of the model. Many of the data produced by RRPM, especially those describing student costs, have not yet been completely defined in concept. Interpretation and use of these data *in their present form* should be undertaken with extreme caution. The second problem area relates to the question of who will use the model. Decisions concerning public higher education in general and the California State Colleges in particular are made at three levels: the campus level (local administration), the system level (Chancellor's Office and Board of Trustees) and the State level (Coordinating Council for Higher Education and State government). We believe RRPM has its greatest potential as a campus planning tool used at the campus level. It would indeed be unfortunate, therefore, if one of the higher levels of decision making adopted RRPM without providing local campus administrators with the opportunity for participation in the use and development of the model.

5. At this stage, we view the primary potential of RRPM as *motivating a learning process* concerned with the cause and effect relationships that generate and describe an institution's resource requirements. Another extremely important potential of the model is as a vehicle for improving the level of communications among the various administrative and legislative levels of decision-making referred to in the previous conclusion.

6. We have no actual forecasting experience with RRPM. Prudence dictates, therefore, that in the early stages of implementation the model be run in parallel with existing planning and forecasting techniques. Thus users can gradually acquire a feel for how well RRPM forecasts by comparing its forecasts first with those obtained by existing methods and later with the actual observed values of the forecast variables.

7. RRPM is not a static thing but an evolutionary process. At this stage of its development it would be fruitless to estimate a version of it and simply make it available for administrative use. Instead, wherever the model is implemented, responsibility for its maintenance, interpretation and further development should be assigned to an administrative unit which has access to personnel possessing both analytic and programming capabilities. Based upon the experience at Humboldt State College it is strongly recommended that, at least during the implementation stage, a single individual be assigned full-time to the task.

8. The benefits of the evaluation process to the management evaluation group were (at least):

    1. Increased knowledge about this college and how it operates.

    2. Insight into the interrelatedness of the various programs, subprograms, and impact of decisions.

    3. A better understanding of models in higher education, the WICHE NCHEMS program, and the security gained through knowledge.

VI. FUTURE DEVELOPMENT AND USE OF RRPM

The use and feasibility of RRPM, the ICLM, and models in general have been considered by Humboldt State and the Chancellor's Office. RRPM and the ICLM are up and running at Humboldt State. The management group at Humboldt State has gone on record as being in favor of utilizing these tools. Interest in systemwide application centers in the Division of Analytic Studies in the Chancellor's Office. The California State Department of Finance has expressed keen interest in RRPM and the ICLM. The California Coordinating Council for Higher Education has its own model – Facilities Analysis Model (FAM), and is very interested in the ICLM. The California State Legislative Analyst's Office is on record supporting a hard look at the usefulness of these tools.

Certain steps need to be taken to place RRPM in an *operational* mode at HSC (or any other campus):

1. Some simple documentation needs to be completed.

2. Decision forms for RRPM to be used by campus administrators need to be developed.

3. The structure and procedures for the use of a planning model need to be designed and installed.

4. A capability to work with analytic tools for decision-making needs to be built into the organization.

At present NCHEMS is in the process of making changes to the RRPM software as a result of the pilot test experiences. The following list contains a set of additional changes proposed for consideration in the future development of RRPM. The items range from rather simple programming changes to quite extensive studies.

1. Reprogramming of the RRPM report generator to allow changes in the titles for the functional areas within the Support Subprograms which do not appear on the reports; e.g., 4.1 – Libraries, 1 – Administration, 2 – Processing Services, 3 – Public Services. This is a result of substituting functional areas for non-academic staff ranks at HSC.

2. Provision for either a footnote or a cover page on the reports to allow an indication of which parameters were changed for a given run of the model.

3. Developing software to change various model parameters at the end of each simulated year.

4. Development of an edit program for the input files which displays the information in a convenient form and allows for remarks about the source and accuracy of the data. (A series of edit programs was developed by another of the pilot institutions but was not tested at HSC.)

5. A methodology for determining degree-winner costs.

6. Guidelines for determining instruction utilization of Support Subprogram resources and methods of allocating these costs to disciplines.

7. Procedures for utilizing Cost Finding Principles software to make the crossover from Allotment Expenditure Ledger files to the Program Classification Structure.

8. A student flow model to help improve enrollment forecasts and provide guidance for determining enrollment policies.

9. An examination of the standards, utilization, and allocation of space.

10. A study of equipment and building amortization and the effects on the costs of instruction.

The use of a model such as RRPM will hopefully be in response to a demand by the management of educational institutions for aid in planning and decision-making. An example of this demand is exemplified in the following discussion.

In early 1971 the Chancellor of the California State Colleges presented a number of proposals to the Trustees some of which, he felt, would make it possible to serve a greater number of students with the resources made available without reducing the quality of education. RRPM, being a resource requirements planning tool, should be able to be of service in working through these ideas. Without going into any great detail let us look at the possibility of using RRPM as an aid to planning in this situation. All excerpts are taken from Vol. IV, No. 1 of *The Chancellor Comments*, February, 1971.

> "I propose that we challenge the lockstep, time-serving practice of offering a degree based on the accumulation of credits, hours, semesters, and classes attended. I propose that we offer, instead, degrees based on academic achievement, carefully measured and evaluated by competent facilities."

With the aid of an analyst RRPM could support the planner in looking at this idea. Measures of faculty and student load would have to be worked out and interpreted; the type of demand placed on library, audio-visual, and other support areas would have to be estimated, etc., but it could be done and would probably prove quite helpful.

> "I believe that the period of time spent in college can be reduced by one-half to one full year or more for many, if not for most, students, by a deliberately strengthened advanced placement working relationship with the high schools and through comprehensive examinations given lower-division students. Through such programs credit could be given for much of our required general education."

RRPM could also be of assistance in estimating the impact on resources for this idea. The ICLM would need quite a bit of attention, but thinking could be brought into sharper focus with RRPM.

"The effective use of advanced placement, comprehensive entrance examinations, and challenge examinations might reduce the minimum time spent in the undergraduate work to 2 1/2 to 3 1/2 years. An average reduction of from only 4 to 3 1/2 years between freshman admission and graduation would be equivalent to serving at least 12,500 more students with only modest additional resources directed to increased recordkeeping, advising, and the handling of examinations."

Once the change in resource mix is identified and defined it can be placed in the RRPM framework and resource requirements estimated.

"Such fundamental changes as I here propose would change in many ways the task and function of the college faculty. The individual faculty member would serve more in the capacity of advisor and resource consultant for students, and evaluator of student achievement. Proportionately less of his time would be spent in classroom lecture or laboratory supervision because over a period of time the number of class offerings would be reduced proportionately. This is why we must devise a new method of measuring faculty workload. The 12-hours-in-class rule would be outdated.

"In like manner, much greater responsibility would be placed on the student for his own learning, which could be largely or entirely independent study. Classes would be available, as in the past, for those students who feel this need, but the total campus would become a resource for learning, with people, books, electronic gadgets, and advisement available for those who wish to learn, but with much more initiative demanded of the student himself. The penalty for lack of such initiative would be swift. Spoon feeding would be at an end. As space becomes more and more difficult to provide, a larger number of students might be forced to independent work or to rethink their educational objectives.

"Related to this proposal is the possibility of providing degree opportunities for substantial numbers of students other than through an on-campus program as students in-residence – students who, under our present rigid systems, we cannot hope to serve. Our extension operations should provide a degree aspirant with an alternative to the on-campus program. The new British "Open University" has within it a number of concepts which, with modifications, might well work in the State College context. The application of modern technology to high education-televised instruction, correspondence courses, self-study combined with intensive short-course on-campus programs, taped lectures with study guides to comprise programmed learning, as well as classroom instruction on or off campus – can be utilized to extend college opportunities to many more students on a self-support basis, with a consequent reduced demand upon on-campus education facilities and resources. This would also provide for the giving of degrees through extension, and the consequent upgrading of current extension offerings."

The emphasis is on a different mix of resources and a different definition of workload. Resources that are treated rather lightly in the pilot-test version of RRPM would have to be made more sensitive. Some attention is being given to this by the NCHEMS development staff.

Some thought and programming effort would be needed to adapt RRPM to this specific simulation situation. A much better tool would result – and hopefully a payoff in better decisions. Throughout the pilot test a pressure was felt to alter RRPM to be not only a long-range forecasting device, but also an experimental tool. Here is an excellent example of just such a use.

It seems that RRPM can be of use in approaching the ideas put forward by the Chancellor – i.e., in evaluating resource requirements. The impact on the qualitative aspects is another matter.

VII. EPILOGUE

We have found the task of pilot testing RRPM a rather unique and, for that reason, a rather exciting experience. The existence of an analytical planning instrument in education being utilized at this time is undoubtedly rare. We are just on the frontier of an era of new management tools for educational administrators.

We seem to be at last moving from the often discussed theory to the often alluded to notion of implementation. The last six months have indicated that there are many problems in gathering data, testing, and implementing an RRPM, but the resulting involvement of management as evidenced by its dialogue (constructive as well as destructive) is a reward worthy of the effort.

The obvious danger at this point lies in the tendency to relax, to "rest on one's laurels," to assume that RRPM will magically continue to function on the impetus given to it in the last few months. We feel that more effort must be exerted to make it an ongoing affair. This is the direction in which we are continuing to exert effort and influence.

APPENDIX A.
MEMORANDUM TO PERSIDENT'S COUNCIL

HUMBOLDT STATE COLLEGE
INSTITUTIONAL RESEARCH

M E M O R A N D U M

April 12, 1971

TO: President's Council

FROM: D. F. Lawson, Director
Institutional Research

SUBJECT: INTRODUCTORY COMMENTS CONCERNING THE RESOURCE REQUIREMENTS PREDICTION MODEL (RRPM)

Various materials are to be sent to you in support of, and preparation for, (1) the visit of Mr. Keith Evans on April 16, (2) our presentation on models and RRPM before the President's Council on April 19, and (3) your involvement in evaluating RRPM as a planning tool for HSC, specifically, and higher education generally. You have already been sent two articles from College and University Business and one from the Journal of the College and University Personnel Association.

This Wednesday - Friday you should be receiving (if the U. S. Mail comes through as expected) An Approach to Planning and Management Systems Implementation by James Farmer; WICHE Technical Report 16, The Resource Requirements Prediction Model 1 (RRPM-1): An Overview by Warren Gulko; and a copy of a talk by Alan Feddersen on modeling given at a recent California Association for Institutional Research Forum. On April 19, you will be given materials on the program classification structure, the budget crossover, RRPM input elements, and sample printouts. A copy of The Feasibility of Analytic Models for Academic Planning: A Preliminary Analysis of Seven Quarters of Observations on the Induced Course Load Matrix, by Jewett, Feddersen, Lawson, and O'Grady, is enclosed with this memorandum to those of you who were not on the original distribution list (additional copies are available if you have misplaced your copy).

The purpose of this memo is to provide a generalized and non-technical statement tying together models, WICHE, PMS, RRPM, current HSC involvement in those areas, and why we should be interested in them.

DFL:jmh
Enclosures*
cc: IR Advisory Committee
Davis (Pat)
Underwood

* An Approach to Planning and Management Information Systems Implementation
Contract
The Feasibility of Analytic Models for Academic Planning: A Preliminary Analysis of Seven Quarters of Observations on the Induced Course Load Matrix

A Model is . . .**

Models can be variously defined and classified. For our purposes it is appropriate to consider a model as a tool used in policy and decision development, expressed in quantifiable terms and adapted to a modern high speed computer to facilitate data storage and manipulation. In this sense, then, RRPM can be described as a mathematical model, translated into a series of computer routines. It is intended to provide conditional forecasts of the resource requirements associated with operating an institution of higher education over a specified period of time. The output from RRPM is intended to be useful in aiding decision-makers in the allocation of educational resources.

As educational decision-makers we find that in most situations there are a few central cause-and-effect relationships which are of overriding importance in determining the outcome. Models generally concentrate upon these important cause-and-effect relationships. Other aspects of a particular situation may be studied independently or disregarded as unimportant. Thus a model of a campus system, subsystem, or process, reduces the number of variables to manageable proportions so that the more significant relationships can be identified and studied. A model or formal structure which specifies the nature of the important relationships among these variables provides a tentative explanation of the system or process. In other words, a model is a description of a system or process. In a computational model, the theoretical relationships are depicted in mathematical formulations and/or computer programs which are capable of yielding solutions in the form of predicted outcomes.

Models are more widely used in decision-making than is realized. Unless an individual makes decisions entirely by instinct or guesswork, he must have in his mind some explanation of the relationship between the alternatives he faces and the expected outcomes of the various alternatives. However sketchy or incomplete they might be, the rational decision-maker utilizes models.

As stated, a model is a simplified representation of an actual system or process. Therefore, its explanation of the system or process will be simplified. But even then the simplified explicit model provides the opportunity for a more clearly understood starting point than a less explicitly formulated, unarticulated model which the decision-maker might carry about in his head. An explicit model pinpoints the relationships which appear to be significant and requires that they be considered systematically and in context. This limits the dangers of overlooking important factors or overemphasizing relatively minor factors in reaching decisions.

The decision environment contains a set of interrelated variables, some under the control of the institution (and capable of manipulation), and some not (which can be taken as given). The specification of these interrelations within a certain scope of activity is the starting point of a model. Though not necessary, such specification is generally sought in equation form, for this is the most precise means of specifying relations,

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** This section leans heavily on Chapter 9 in Ferber, Robert and P.J. Verdoorn, Research Methods in Economics and Business, The Macmillan Company, New York, 1962.

of testing their adequacy, and of subjecting them to further analysis. The resultant model may be a very complicated one, involving numerous interrelated equations, or it can consist of perhaps a single linear equation in two variables.

The process of constructing the type of model to which we are addressing ourselves can be reduced to four more or less distinct steps:

1. Specification of a set of hypotheses purporting to explain the (one or more) phenomena being studied. These hypotheses may be based on past studies, empirical findings and/or a priori reasoning. This set of hypotheses constitutes the structure of the model.

2. Translation of these hypotheses into a form amenable for testing, usually into mathematical equations.

3. Estimation of the parameters of the model. This step necessitates prior assumptions about the various mathematical characteristics of the variables so that a proper estimation procedure can be specified.

4. Evaluation of the adequacy of the model and of the underlying assumptions and hypotheses, generally by empirical tests.

The adequacy of a model is evaluated in essentially the same way as is any hypotheses. The actual process of evaluation may be quite intricate if the model is a large one. Before empirical estimates of the model parameters have been derived, the adequacy of the theoretical model has presumably already been established to the satisfaction of the researcher. After the parameters have been estimated, further tests of the adequacy of the model can be made based on the forecasts generated by it. These tests may be classified into two general groups, those relating to the statistical properties of the model and those tests dealing with its substantive implications.

Evaluation of the adequacy of a model should bring to bear as much pertinent external data as is available--and which has not already been used in the model--and should involve examination of the results from many different perspectives. Ideally, for a model to be acceptable, it should:

1. Satisfy all the statistical prerequisites--justify the assumptions underlying the estimation procedures, have statistically significant coefficients, explain variations in the endogenous variables within the range of tolerable error and without systematic or highly unusual disturbances.

2. Make "sense" from a substantive point of view--the estimates should reconcile with such other information as is available and with a priori expectations.

3. Survive the acid test of predictive accuracy.

RRPM - A Summary Statement

RRPM is a model which basically takes student enrollment projections for a set of years and converts them to the resources necessary to support them (e.g., faculty, staff, operating expenses, and space) for each one of those years.

The model is built around WICHE's Program Classification Structure (PSC) rather than the usual line item budget. The model gives as basic output the PCS Program costs as depicted below:

Primary Programs
- Instruction
- Organized Research
- Public Service

Support Programs
- Academic Support
- Student Services
- Institutional Support
- Independent Operations

The model is also designed to operate in terms of Higher Education General Information Survey (HEGIS) disciplines rather than, say, departments. The Primary Program costs depicted above are computed to the discipline level.

A very general logic of the model runs as follows. For Instruction Cost an induced course load matrix is used to convert a student enrollment projection by major to a loading on the various campus disciplines in terms of student credit hours. A series of factors convert these credit hours to the number of faculty positions required by each discipline. These faculty positions give rise to administrative and support positions. Salary schedules are used to calculate salary costs. Equations then give rise to operating expense and equipment cost for each discipline. The generated positions also give rise to space requirements and associated construction costs.

Organized Research and Public Service computation logic will not be discussed since these costs are not significant for HSC or the California State Colleges and, therefore, were deleted from our version of RRPM.

Each of the Support Programs listed above is made up of various sub-programs (nondiscipline oriented). For each sub-program a set of equations evaluates staff positions and operating expense and equipment. Salary costs are evaluated; space requirements and associated construction costs are computed.

The following list depicts the output reports available from RRPM and are generated for each year that RRPM is run:

1. Positions and dollars report for each PCS Program.
2. Summary PCS report.
3. Instructional costs by discipline and course level.
4. Average instructional course unit cost by discipline and course level.

5. Instructional costs by major and student level.
6. Average instructional course unit cost by major and student level.
7. Student total class credit hours by course level.
8. Student total class contact hours by course level and instruction type (lecture, lab, other).
9. Faculty total contact hours by course level and instruction type.
10. Space requirements by type of space.
11. Construction costs by type of space.
12. Total student enrollments by major and level (which is input data).

Once the model is operational it is possible to test the resource effects over time of certain "what if?" questions. Some of these are listed in the following section.

WICHE, PMS, and RRPM

The Western Interstate Commission for Higher Education (WICHE) is a public agency through which the thirteen western states work cooperatively in the area of higher education. An important WICHE effort is their Planning and Management Systems (PMS) Project. The emphasis in this project is on

> effective application of the new management techniques in colleges and universities . . . This task involves: (1) development of an adequate data base related to all aspects of institutional operations; (2) development of planning, programming, and budgeting systems applicable to colleges and universities; (3) development of information concerning the demands and needs generated by various types of students as they move through higher education institutions; (4) development of methods of measuring the outcomes of educational programs; (5) development of procedures for standard reporting and exchange of compatible data among institutions; and (6) development of methods for planning and managing college and university physical facilities.

The Resource Requirements Prediction Model (RRPM) is the first model to be developed in the WICHE Planning and Management Systems Program.

WHY SHOULD THE PRESIDENT'S COUNCIL BE INTERESTED IN RRPM?

This model is of interest to those of us at HSC and in the CSC system for many reasons:

1. Much will be learned about the possibilities, problems, and prospects concerning the use of mathematical models in higher education.
2. RRPM has many features in common with the (California) Coordinating Council for Higher Education Facilities Analysis Model (CCHE-FAM) which is currently the subject of much controversy, conversation, and rumor.

3. Many WICHE PMS definitions, classifications, and concepts relevant to RRPM are finding their way into the environment of higher education in California. For example, RRPM incorporates the WICHE Program Classification Structure being used by the California Department of Finance in presenting the CSC budget for 1971-72.
4. Apparently the CSC Chancellor's Office is committed to using models and other analytical and informational support in decision-making, planning, and control. On pages i and 1 of <u>An Approach to Planning and Management Systems Implementation</u> we find:

> The California State Colleges are pursuing an evolutionary approach to development of a management information system similar to the plan suggested in this paper. They have received legislative direction to implement the Western Interstate Commission for Higher Education (WICHE) Planning and Management System (PMS) and will use many of the WICHE products. (p.i)
>
> . . . many officials--including governors, legislators, and heads of funding agencies--have developed an interest in planning and management systems, and in one case--California--the WICHE Planning and Management System has become mandatory for the public institutions of higher education. (p. 1)

5. One of the generally recognized advantages of models of the RRPM type is the increased knowledge and insight gained by decision-makers concerning their institution, its structure, process, environment, etc.
6. RRPM's main objective is that of improved planning and management in institutions of higher education; viz., RRPM is intended to help us deal with "What if?" planning questions in the area of resource requirements such as (see pp. 6-7 of <u>RRPM: An Overview</u>, to be sent to you):

. . . What if a specific change is made in the mix of students either by degree program or by level or both?
. . . What if a change is made in the instructional techniques; e.g., independent study versus classroom study, classroom activities versus laboratory activity? How does such a change influence the resource requirements over an extended time frame?
. . . What if a specific new program is added or a current program is dropped? What are the resource implications for the total institution resulting from these types of changes?
. . . What if a change is made in the mix of faculty conducting an instructional activity; e.g., substituting, say, tenured faculty for graduate assistants (or vice versa)?
. . . What if a major change is made in the faculty's salary schedule?

. . . What if a change is made in the average faculty load?
. . . What if changes are made in the staffing rations of support staff to faculty?
. . . What if a change is made in the average section size, either across the board or in specific instructional programs? What implications will such a change have for both facility requirements and faculty resources?
. . . What if changes are made in the mix of the student body? What resource implications will such changes have on, say, library resources?

There is no shortage of incentive for us to be interested in RRPM.

WE WANT SOMETHING FROM YOU . . . FOR ALL OF US.

Humboldt State College is one of eight schools pilot testing RRPM.*** As stated in our contract with WICHE (attached), we are to report and evaluate our experience with RRPM by the end of June, 1971. All of you are invited to participate in this process. For some it is critical that you are involved. Our aim is that our (HSC) combined wisdom is expressed in both the final report and a useful college version of RRPM--if, in fact, there ought to be such a final product.

How can you become involved? Identify yourself to me as one who is willing to commit the time necessary to join with others in testing this model and evaluate the results. You need not be a "heavy" in mathematics, statistics, computers, etc. You should be (and are by virtue of what places you on the President's Council) involved and/or interested in the planning and decision-making process at this college--particularly in the allocation of educational resources.

You will be asked to participate in making decisions and formulating policy concerning planning matters for this college. This will then be fed into the computer and the results returned to you. Then you will evaluate, retest, etc. You will be asked to get a good "feel" for what this model can and can't do. You will be asked to enter into group discussion sessions with your associates. You will be asked to provide the basis for our response to WICHE as to the adequacy and usefulness of this version of RRPM in regards to the substantive and predictive aspects of evaluation.

A FEW PARTING COMMENTS

. . . RRPM is essentially a space and staff model--both as to quantity and dollars.
. . . RRPM is a long-range planning model--not a budget model.
. . . In its present form RRPM is not designed for information exchange between institutions or for comparing institutions. It is an internal planning instrument. However, RRPM will be used by some for information exchange and comparison. This is a misuse . . . unless inputs, objectives, etc., are comparable. Only rarely, if ever, would there be by chance such comparability--even among the California State Colleges.

***UCLA, Stanford, SUNY (Stony Brook), University of New Mexico (for Community Colleges), University of Utah, Washington State University, Portland State University, and Humboldt State College.

. . . WICHE in many ways keeps saying to the funding and control agencies that some of the benefits of its PMS are comparability and interchange of information. Since RRPM in its present state is not designed to do this, much confusion has been generated. As long as it is "dealer's choice" on definitions of costs, etc., this will remain a problem.

. . . Unit cost, average cost, and total cost as used in this model have very special definitions and do not include all cost components . . . so be cautious in this area.

. . . In RRPM, as given to us, non-staff and non-space instructional costs (such as faculty travel, instructional o.e. and equipment, etc.) are lumped together and distributed back over disciplines (departments) by FTE students. This greatly weakens, we feel, the ability to ask many "what if?" questions related to instructional techniques, etc. To shore up this area we have developed a preprocessor with the ability to distribute o.e., equipment, instructional ADP, language labs, vessel charter, etc., back over instructional cost centers in a more meaningful/sensitive fashion.

. . . Support Program costs do not get distributed back over instructional areas.

. . . As you go through WICHE technical report 16, the "Overview" (and you should--it is a fine report), please note that some elements are not included in RRPM to date--viz., projected degree-winner cost.

. . . My observation is that CCHE-FAM is RRPM with a greatly expanded space and facilities sector.

. . . In recognition of the fact that colleges (at least the California State Colleges) do not have the staff necessary to place an analyst between RRPM and campus decision-makers/planners, we are in the process of designing decision-forms that can be forwarded to a control clerk at the ADP Services Center who will routinely produce the output and return it to the decision-makers/planners. This would make RRPM potentially a more appealing and useful tool. In spite of all of our desires and efforts to eliminate the analysts, however, it is becoming quite evident that some level of analyst support will be required.

By the time you receive this, we (Frank Jewett, John Busby, Alan Feddersen, and myself) will have spent Easter weekend in Los Angeles trying for the first time to run the HSC adaptation of RRPM on a computer (CSC Southern Regional Data Center). We hope to have it running on our campus by the first part of May. Then we will be able to enter into the evaluative process.

DFL:jmh

Note: The contract with WICHE mentioned on Page 7 is not attached in this appendix.

APPENDIX B.
PERSONAL STATEMENTS
BY
MEMBERS OF MANAGEMENT
EVALUATION GROUP

State of California

HUMBOLDT STATE COLLEGE
ARCATA, CALIFORNIA 95521

Memorandum

To : Dr. Lawson, Director
Institutional Research

Date: June 11, 1971

ADMINISTRATIVE AFFAIRS
HUMBOLDT STATE COLLEGE

JUN 15 1971

RECEIVED
INSTITUTIONAL STUDIES OFFICE

From : Richard L. Ridenhour, Dean, Academic Planning
Office of the Vice-President for Academic Affairs

Subject: Thoughts and Comments About RRPM

I see RRPM as having a great deal of potential as a planning tool. What I cannot evaluate is the cost/benefit ratio of using RRPM. I see it as a useful means of evaluating the effects of different sets of parameters. At this stage, it seems less valuable as a means of predicting what might be construed as actual resource demands under different conditions.

RRMP, though designed basically for projecting institutional resource requirements, probably is not really ready to accomplish this objective. At least at Humboldt State College, some of the basic data, such as the numbers of students in particular majors and the mix of courses taken by various majors, are not very precise. Also, the method of allocating faculty resources by average class size, though practically this may be a fairly accurate approach, does not reflect the actual method which involves the complex faculty-staffing formula. Point estimates of resource requirements may well be biased, although how badly is difficult to guess; and, further, precision of estimates is not indicated.

The program does seem more valuable as a means of identifying differences between resource requirements resulting from the use of different parameters. Evaluation of differences, though influenced by the precision of the basic data used, would be less affected by biased estimates.

Specifically, RRPM seems to provide the means whereby the effects of possible changes in such factors as faculty work load, student class load, and resource allocations can be evaluated. Preferably, changes of parameters should be evaluated singly and then in combination so that main effects can be separated from interactions. Particularly, as new, more efficient methods of instruction are being sought, RRPM should provide the means to "try" various innovations.

I realize that the program, as it is presently written, is not really designed to compare the effects of different resource allocation parameters. The program would be more useful to me if it were written so that different parameters could be used each "year".

More minor and more specific problems exist. Implied precision by carrying costs to the nearest dollar or even, in some cases, cents should be avoided unless the data warrant such precise results. The printing of averages, even though they are weighted such as by numbers of students or units per class level, should be avoided because they inevitably tempt one to compare estimates with others based on different weights.

Possibly the most important conclusion concerning RRPM is that it must be used with caution. It has the capacity to give someone a good introduction to the operation of a college. However, unless that person is already well informed about the general functioning of a college, it would be easy for many inappropriate conclusions to be reached. It must be recognized that RRPM does not in any way indicate the quality of the institutional product whether it is a unit of credit or a graduate. Also, it must be recognized that what normally appears to be the same program in different institutions, may actually be very different. It must be recognized that, although RRPM is a very complex model of an institution, it still is basically simplistic. It should be a valuable tool for a college administrator, but it should not be used indiscriminately by individuals who are not well versed in the operation of a college. I am most concerned about the potential use of RRPM by individuals who think they know how a college operates or should be operated.

RLR:ro

ADMINISTRATIVE AFFAIRS
HUMBOLDT STATE COLLEGE

JUN 16 1971

RECEIVED
INSTITUTIONAL STUDIES OFFICE

Humboldt State College
SCHOOL OF NATURAL RESOURCES

M E M O R A N D U M

DATE: June 11, 1971

TO: Dr. Don Lawson, Director, Institutional Research

FROM: Donald W. Hedrick DWH

SUBJECT: My personal comment as Dean, School of Natural Resources, to be included in the appendix of the RRPM report

Having sat through most of the briefing and review session of RRPM on the Humboldt State College Campus, I am both disturbed and pleased with the problems and potential of academic planning possible with this and similar models for institutions of higher education. Use of models can be dangerous if employed by administrators without an adequate understanding of educational processes and appreciation for the limits of error attendant with input and output data. On the other hand, when used to simulate changes in instructional resources, teaching loads, support services and so forth, much valuable information on the consequences of contemplated action can be learned vicariously.

Certainly a major value of this and similar models is in learning more about the operation of educational institutions and how instructional programs are influenced by varying faculty work loads, class size, space allocations and support services. The exchange of philosophies and ideas with various colleagues on the Research Advisory Committee for Institutional Research was a most valuable by-product of reviewing the RRPM Model on the HSC campus.

In summary, I see academic modeling as an effective tool in the hands of responsible faculty and administrators on individual campuses, but an ominous threat if used as a decision making process by a central office remote from the scene of action.

DWH/kla

cc: Dr. Richard Ridenhour

MEMORANDUM
HUMBOLDT STATE COLLEGE

June 15, 1971

TO: DR. DON LAWSON

FROM: JOHN F. PAULEY

SUBJECT: PERSONAL EVALUATION, RRPM MANAGEMENT EVALUATION

My reactions to the recent management evaluation sessions of the RRPM at Humboldt State College are favorable to the group, to the process and to the integrity and honesty of the report. I would think that such a study would be most beneficial to Humboldt State College as long as it remained an "in-house document". From the information gathered by this study, I am sure we could improve instruction at Humboldt State College without the loss of excellency.

However, based on experience in the California State College system, I am not optomistic about the future use of this or any similar study. I predict that such studies will not remain "in-house documents". Rather they will be used for decisions on educational policy based on economic efficiency. Lip service will be paid to excellence in teaching, but in the end this excellence will be rationalized away. I do not feel that I am being pessimistic when I think that the use of studies such as this will lead to more economic efficiency in higher education and at the same time result in mediocrity of that same higher education and a society which believes in mediocrity of education, will certainly become a mediocre society. I do not think that that is pessimistic so much as it is realistic.

John Pauley

John F. Pauley
Chairman of the Faculty
of Theatre Arts

JFP/mb

HUMBOLDT STATE COLLEGE
ARCATA, CALIFORNIA 95521

PERSONNEL OFFICE

TO: Don Lawson
Dir., Instit. Studies

DATE. June 18, 1971
LJT-71-071

FROM: Lester J. Torgerson
College Personnel Officer

SUBJECT: Evaluation of RRPM

RRPM is a useful management tool for estimating manpower requirements, facilities requirements, and estimated cost projections on a "what if" planning basis. The first two estimations have special application to the budgeting and personnel management activities at the college. The cost projections are the weakest part of the RRPM due to the difficulties of costing outputs of an educational institution. It is my hope that the cost projections of RRPM based on student contact hours, course costs or space costs would not be used as a "standard" to compare one institution with another. Too many unique, local factors influence the "output" costs and projections to enable the costs to be used for comparison purposes, except in a very general sense.

LJT/arp

State of California

HUMBOLDT STATE COLLEGE
ARCATA, CALIFORNIA 95521

Memorandum

To : Dr. Donald F. Lawson
Director, Institutional Research

Date: June 21, 1971

From : D. F. Strahan, Vice President for Administrative Affairs DFS

Subject: WICHE MODEL

The following are some comments which I feel are of value for review by others who may be assessing the appropriateness of the WICHE Model for their institution:

1. The introduction of the WICHE Model to this campus is a natural next step following the work on the Induced Course Load Matrix undertaken by Professors Jewett and Lawson. This implies that the data bank on the history of courses selected by majors is inherent to the implementation of the model. Fortunately, we had prepared ourselves to that extent.

2. It has been my observation that the various members of the college community are receptive to the request for proper input data and met in a very constructive manner with the Director of Institutional Studies for the development of input data.

3. From the model, we realize we can request and be given much "trial" prediction data. We now need to learn effectively how to handle such trial data. Turn around is fairly fast; we can thereby modify our input to work toward more desirable outcomes with reasonable ease. One of our most difficult tasks will be to assess the "rolling effect" of successive changes that are bound to occur in the natural evolution of an institution annually.

In summary, I feel the WICHE Model can be an important tool for those of us who must make major decisions on the best use of resources. Much promise in this regard is indicated by the model.

DFS/ns

TESTING CENTER

Humboldt State College
Arcata, California

MEMORANDUM

TO: Donald F. Lawson, Ph.D.
Director, Institutional Research

FROM: J. R. Cunningham, Ph.D. DATE: June 23, 1971
Director, Testing Center

SUBJECT: Comments on words and numbers and things concerning RRPM

As with many reports, the printout produced by the RRPM computer program attempts to reduce a mass of statistical data to the point where it is understandable and usable to the members of the various constituency to whom the report may be directed. Again, as with many reports, it does not follow the first principle of report writing, i.e.; a report should be directed toward the intended reader. The second principle of report writing is that the more diverse the background of the intended readers, the more careful the writer must be in his choice of words. The word "average" as used in the report is a case in point. To a statistician the word "average" has semantic meaning devoid of affective value but this is not true to many other classes of individuals. To the "man in the street", the word average when modified by the adjective below has a "good" or "bad" meaning dependant upon the data described. It is "bad" when describing one's income level but "good" when describing one's tax rate. This problem can be somewhat avoided by using technical terms, such as the mean, which have not become part of the common vocabulary.

The writer of these comments would prefer that the report be written so as to not require the use of either of the above words. There are times when reducing data to a mean loses too much information in the reduction process. If we can compute a mean, that means that we already have at hand a distribution of values and if we have a distribution, we also have a range of values and we can compute the variance. When looking at unit costs, it would seem that the range of these costs, by discipline and course level, their standard deviation and the shape of their distribution in addition to their mean value would be valuable planning information. One would assume that the unit costs in lower division education courses would have a leptokurtic distribution while upper division courses in chemistry would have a platykurtic distribution. As is common knowledge, the more platykurtic a distribution becomes, the less accurate the mean becomes in describing that set of data. If we knew the degree of kurtosis of a distribution, we could then decide how much weight to give to the mean unit cost of a discipline in any decision about that discipline.

Another piece of information hidden by the use of the mean is the atypical value. It is not known now the program handles atypical values but since the atypical value affects the mean out of proportion to its significance, it needs to be considered.

The reporting of average unit costs to the penny leads one to believe that the report is accurate to a degree which is not inherent in the input data. What is truly needed is a computation of the variance of these values so that a standard error could be reported. A unit cost of \$51 ± \$6 would more truly reflect the accuracy of the input data than does the present method. At the very least, the unit cost values should be rounded to the nearest whole dollar.

Combining lower division, upper division and graduate unit costs to give an all level unit cost makes about as much sense as combining the average weight of oysters, mussels and tritons in a pot and calling it a shellfish dinner. As community colleges and graduates schools will attest, these programs are more than a time series. They are different programs in more than level. They have different objectives, different ends, and different methods of instruction. To lump them together and report one value for the data leaves much to be desired. The reporting of the all disciplines average by levels is of the same caliber of thought and could provide a not-too-bright individual the means to do a quick and dirty comparison of institutions.

- MEMORANDUM -

TO: Dr. Donald F. Lawson
Director of Institutional Studies

DATE: June 25, 1971

FROM: Gary Montgomery

SUBJECT: Evaluation of RRPM

I am afraid I have to approach the evaluation of the Resource Requirements Prediction Model (RRPM) with somewhat mixed feelings. There is no question that our institutions of higher learning are in desperate need of an efficient, equitable means of resource allocation. However, in our search for such a system of resource allocation, we should never lose sight of the fact that the cure may be far more damaging than the disease if not properly applied.

Our evaluation of the RRPM pointed up some problems with the model which will have to be corrected before the model is implemented. These problems are not dealing with the structure of the model, but with the accuracy of the input data which the model uses to generate its cost information. The unit costs generated for a particular major by the model are questionable when it is known that majors information forwarded by the Admissions Office for use in the model is notoriously inaccurate. This is not an indictment of the Admissions Office, it is simply an illustration of the problems inherent in the procedures currently used to gather such information. At present, a student's major is not actually known until he has a degree check in his senior year.

The problems of accurate input data are serious but not insurmountable; with any number of procedural changes, the input data error can be minimized. I am far more concerned with how the model may be used and the ramifications of such use on higher education. I feel that the model may be used very effectively as a means of equitably apportioning resources to the various functions in our colleges and universities, and that such a system is necessary, can hardly be disputed. The more information an educator or administrator has at his disposal, the better able he is to make decisions (student body officers not excepted). However, I see a very serious danger in relying too heavily on the RRPM or a similar model in educational decision making particularly for high level decisions such as are made in the Chancellor's Office of the California State Colleges. My reasons for feeling this way are simple -- the farther up the line the model is used, the less the figures generated by the model have meaning, for the context which gave them meaning disappears. When this happens, we end up with the Chancellor's Office comparing the programs of one state college against those of another -- which is somewhat like comparing apples and oranges. Unfortunately, the model allows for the possibility of such comparisons and, in fact, encourages them.

Perhaps the gravest danger the model presents to higher education is the subtle unconscious definition of education itself. I realize that I sound like some kind of Cassandra before the walls of Troy, but I consider this a very real and pressing long run problem. If you ask a number of professors and administrators what education is and what its purpose is, I will venture to say that you will have nearly as many different answers as you have people answering the question. Education is usually defined in terms of itself or with synonyms. It is one of those words which, like "good", is very nearly an irreducible primary and has definition only in the minds of the individual educator which is how it should be. This allows the student and the educator to experience and gorw. Perhaps education is the experience and fusion of the various conflicting definitions. At any rate, a system such as the RRPM would, in time, erode and destroy a good deal of what we now call education. Just as nature abhors a vacuum, so too does such a model abhor the lack of standardization and quantification. In time, the comparison of costs and programs at the various colleges would lead to the cheapest and most efficient method of teaching being employed throughout the State College system. The most alarming aspect of this possible turn of events is that it would be completely unconscious on the part of the people implementing it. The system would, in essence, refine and procreate itself very much as does the state bureaucracy. The chaos and inefficiency in state government is not any one person's fault. The fault, if any, lies with the system itself which, like an amoeba, engulfs and ingests things to survive but doesn't realize what it is doing at all. One year, Finance cuts back in chemistry as the number of students graduated in chemistry is too few to warrant the large expenditure. The next year the Chancellor's Office, seeing the difference in cost between English at Humboldt State and English at San Diego State, cut back at Humboldt to bring it into line. And so it goes, a clerk asking a question here and a secretary asking a question there. After ten or twenty years, we will have homogenized milk and later we will ask why our society curdled and have no answers in triplicate.

Admittedly, what I am saying is an exaggeration to some extent, but I believe that it points up what I am trying to say. I feel that the RRPM can be a very effective tool on the individual campuses for both planning and resource allocation and control, but I feel that its use beyond the campus in, for example, a state system's central offices, should be tempered as much as possible. In other words, I feel that the model should be used to aid both the colleges and the state. However, the men who make decisions for education should be well aware of what the system is and what can happen of every decision based on the model is not carefully considered in the light of quality as well as cost. Finally, when decisions are made, those in positions of responsibility will project the impact of the decision over the long run and not just hop from crisis to crisis as they have in the past. For with such a cost accounting and planning system, as the RRPM promises, the consequences of thoughtless or emotional decisions could prove deadly over the long haul.

HUMBOLDT STATE COLLEGE
ARCATA, CALIFORNIA 95521

ADMINISTRATIVE AFFAIRS
HUMBOLDT STATE COLLEGE

BUSINESS MANAGEMENT

JUN 29 1971

June 28, 1971

RECEIVED
INSTITUTIONAL STUDIES OFFICE

To: Don Lawson
Director of Institutional Research

From: Eugene A. Fiocchini
Assistant Business Manager

Subject: Why RRPM for Financial Management

The Resource Requirement Prediction Model as designed will give institutions of higher education a system for long range planning and management. It should be used for intra-college comparisons not for comparing institutions unless there be comparability of input, objectives, etc.

Although it may be expensive and difficult to implement, I feel the technology associated with RRPM does significantly improve the art of management by improved insight into the planning and decision making process at the college relative to allocation of educational resources.

With our current conversion of our Subsidiary Accounting system for reporting budgetary and expenditure data, by program disciplines, which was developed by WICHE utilizing the HEGIS Discipline Classification Structure RRPM can become a useful tool for more effective and efficient decision making process.

EAF
fe

HUMBOLDT STATE COLLEGE LIBRARY
Arcata, California 95521

DATE: June 29, 1971

TO: Dr. Don Lawson, Director
Institutional Research

FROM: Don Koepp, College Librarian

SUBJECT: RRPM

Initially I was interested in RRPM because of a general academic interest in the use of decision making tools in public organizations. This interest has been intensified and, at the same time, forced into a somewhat less theoretical mode by the experience during the past several years of having to perform management functions in two very different academic organizations which have been affected, in varying degrees, by the application of such decision making tools to the budgeting process.

Unfortunately, at the point at which intensive consideration of RRPM started on this campus I became involved in other activities which took precedence. About all I was able to do during the period of intensive consideration was to check from time to time on what the model was or was not doing with respect to the allocation of resources to library functions.

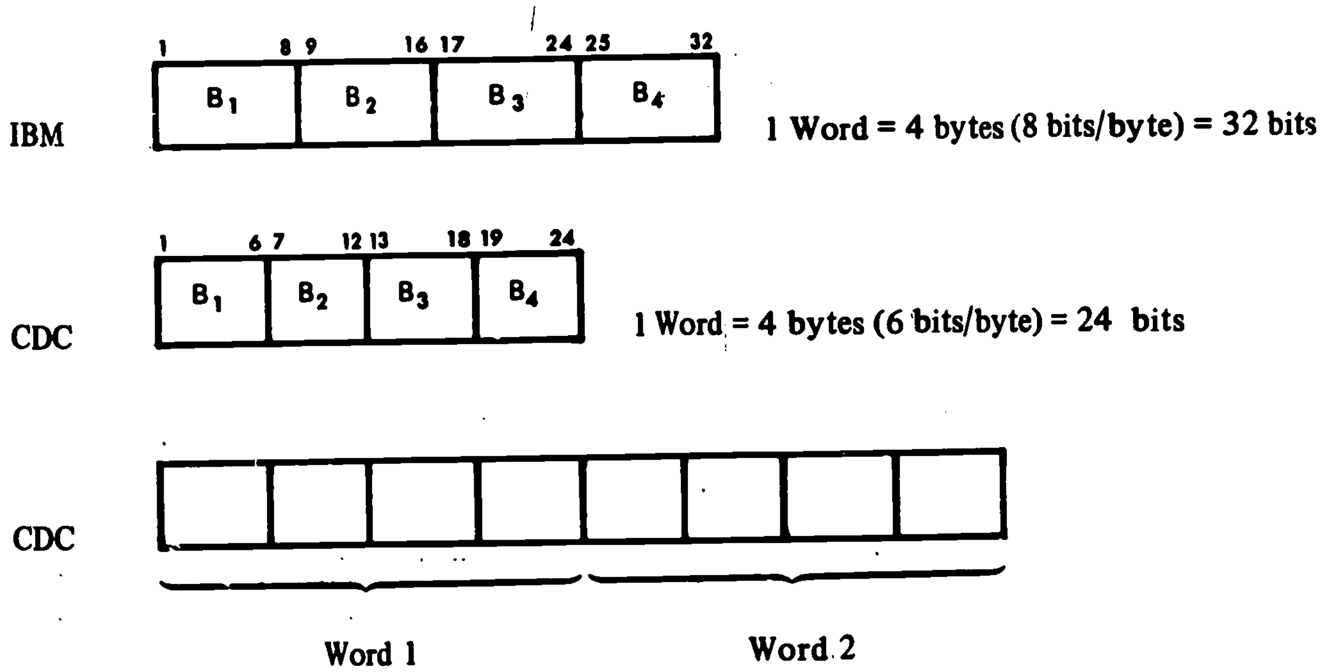
I am satisfied that RRPM does a reasonably good job of registering the effects upon the gross requirements for library resources of various changes in the overall college program. I feel the use of such a model has obvious benefits for library programs. It assures automatic consideration of the impact upon the library of various possible alterations in the overall college program, and reduces such consideration to quantifications which are easily turned into fiscal requirements. The facility with which it does this has implications at the local level, at the Chancellor's Office level, and for the budgeting processes within the State Department of Finance and the Legislature. Obviously, this ease with which various alternatives can be reduced to dollar figures is either an advantage or a disadvantage, depending upon your point of view. My point of view is that, even with data which may not be exactly relevant, the advantages inherent in the use of such a model on any level are greater for library programs than are the disadvantages.

DWK/gvm

APPENDIX C.
CORE REDUCTION

Two possible sources of core reduction will be discussed. The first relates to the reduction of core by reducing the size of certain key system parameters, thus reducing the dimension of the various arrays in the COMMON areas (virtually all of the arrays in programs RP and RQ are in COMMON). The second productive area for core reduction is the development of an overlay scheme.

Before discussing possible core savings it is necessary to define what the term "word" will mean in the analysis that will follow. For IBM equipment (S/360) one word is four bytes of eight bits each for a total of 32 bits. On the CDC 3300 one word is four bytes of six bits each for a total of 24 bits. For the CDC 3300 a real (floating point) variable utilizes two 24-bit words. The situation is depicted below.



For the CDC 3300 a real (floating point) variable uses *two* words.

Because of these differences the discussion that follows will key on the notion of the IBM-type word. We will not then have to be concerned whether a variable is floating or fixed point.

Dimension Analysis

Figure C-1 contains the sizes of the subroutines and COMMON for RP and RQ. The COMMON sizes do not include the single dimensioned arrays. It should be noted that the subroutine sizes will obviously vary according to computer and compiler. They are given here to denote their magnitude only. RP and RQ differ significantly in that RP's overall size is determined mostly by its COMMON while for RQ the program size is the more consequential size contributor.

All of the two- and three-dimensional arrays for RP are listed in Figure C-2. Across the top of the figure are listed the various program variables making up RP's arrays. For each array the program variables it contains are checked. For each program variable a standard dimension has been selected for RP; e.g., the number of disciplines (departments) is 33, the number of student levels is 7, etc. One of the program variables is entitled Other Instruction Subprograms. The use of the term "Subprogram" here is in the WICHE Program Classification sense, not in the computer programming sense. These Other Instruction Subprograms include Special Session Instruction, Extension Instruction, and Experimental Instruction; i.e., all arrays with this variable are dimensioned with a 3.

To proceed with a determination of the effects on core reduction by reducing the dimensions of the arrays, we perform the following calculation. Selecting any one program variable and reducing its dimension by 1 we can determine the resulting reduction in dimension size in all of the arrays in which it is contained. The table below then summarizes the COMMON core reduction upon examining each variable individually by reducing its dimension by 1.

Reduction Policy	Words Saved
Remove 1 discipline	498
Remove 1 student level	405
Remove 1 course level	1,287
Remove 1 faculty rank	726
Remove 1 staff rank	396
Remove 1 other instruction subprogram	3,036
Remove 1 instruction type	1,617
Remove 1 major (regular instruction)	21

These results are applicable only when considering one variable at a time. If two or more variables are simultaneously reduced by 1, the resulting COMMON core savings are *not* additive. For example, removing one discipline and one student level does not result in a saving of 498 + 405 = 903, but rather in something less than 903. In general, it can be shown that reducing two or more variables simultaneously will result in a core reduction strictly less than the results of the variable reduction effects on core when analyzed separately and then summed. This results from the interaction of the variables when they happen to be in the same array.

The reduction policies listed above are useful to determine quickly where substantial core reductions are forthcoming when desired. It is obvious that reducing the Other Instruction Subprograms is the first most profitable core reduction scheme (if it is possible for the particular institution). In fact, this was the first strategy utilized at the California State Colleges to get RP loaded on the CDC 3300. Our second strategy was to reduce the student levels' dimension by 4. As it turns out from this analysis we would have done better to reduce the course level dimension by 2. However, the course level variable is contained in more arrays requiring somewhat more keypunching time for the analyst.

A similar analysis is performed for the RQ program. Figure C-3 contains the two and three dimensional arrays with the corresponding program variables making up the indices of the various arrays. (As before the term "Subprogram" contained in the variables in Figure C-3 is used on the Program Classification Structure sense; i.e., arrays containing Research and Public Service Subprograms are dimensioned for 7, arrays with Support Subprograms are dimensioned for 19, and arrays with Other Instruction Subprograms are dimensioned for 3.) In the table below are listed the results of decreasing each of the variables by 1.

Reduction Policy	Words Saved
Remove 1 discipline	299
Remove 1 faculty rank	759
Remove 1 staff rank	592
Remove 1 research or public service subprogram	1,156
Remove 1 support subprogram	44
Remove 1 other instruction subprogram	591

Comments made previously about RP hold here as well. Since RQ's size is more a function of program size, an overlay strategy may be more productive than COMMON size reduction. The reverse holds for RP.

Overlay-General Discussion

Overlay techniques are available on most computing systems. This type of technique can be quite valuable in reducing the core storage required for a given set of programs. In simple language, an overlay technique makes use of the principle that at a given instant it is not necessary that all subprograms in a package be resident in core storage. Indeed, at any given instant only very few (one?) instructions are active. Most overlay structures work on this principle at a higher level; i.e., the subprogram which is now in execution is loaded into core storage of the computer from auxiliary storage and overlays the area of core storage used by the previous subprogram when it was loaded for execution. As in many other situations, a "trade-off" is involved. The amount of core storage required for a given set of computer programs can be reduced by using an overlay but the amount of computer time required for execution of the set of programs is increased because it does require some computer time to continually load and re-load the necessary subprograms as they are required. In developing a proper overlay structure, the computer analyst will usually be aware of this "trade-off" concept and select a structure to provide an adequate "trade-off" based upon the real circumstances.

As an aid in visualizing the operations of an overlay, Figure C-4 is included. In this figure, core storage is displayed for a set of programs without using an overlay structure and also when utilizing an overlay structure at various points in time during execution of the set of programs.

Overlay-RP Program

This set of computer programs fits very well into an overlay structure. Most of the subprograms are called into execution either one time only or one time for each year of the simulation run. In regard to the "trade-off" mentioned above, the additional amount of computer time required to load a few subprograms ten times (for a ten-year simulation run) is minimal. It should be noted that had each subprogram been called thousands of times (such as might occur in a simulation of a missile shot) an overlay might not have been economically feasible due to an expected larger increase in the amount of computer time required.

Utilizing the CDC 3300 computing system the following overlay structure was created:

Program	Overlay
RP	Main
TERM	Main
YSTUDR	1
ALTMOD	1
UNCOST	2
UNIRPT	3
HEADR1	3
HEADR2	3
RDICLM	4
IFLTN	5
WRTAP1	6
WRSCRT	7
RDHEAD	8
RDINST	9
ENDYR	10
INIT	11

Subprogram, TERM. was placed in the Main Overlay because it was used by many of the other overlays and is a small subprogram. Our version of RRPM did not use the subprograms YSTUDO, RDCOF, and GETCOF. Both YSTUDO and RDCOF would be included as separate overlays with no increase in core. Since the subprogram GETCOF will be called numerous times during execution of RRPM it would be more beneficial to use more core and reduce running time; therefore, GETCOF would be placed in the Main Overlay and would require approximately 600 words. The results displayed below represent results which would include YSTUDO, RDCOF, and GETCOF.

Results of RP Overlay

	Core Required For Programs Only	Running Time (CPU)*
No Overlay	16,796	338 secs.
Overlay	10,021	353 secs.

In viewing the above figures, it should be noted that the amount of core required is that amount required for the computer programs of RP *plus* the amount required for subprograms needed from the computing system library. It does *not* include the amount of core storage needed for COMMON areas.

In summary, with very little effort it is possible to save a significant amount of core storage for RP (more than 6,000 locations on the revised programs on our computer system) at a minimal expense.

Overlay-RQ Program

In a manner similar to the RP program, the set of programs called RQ fits very nicely into an overlay structure. Most of the subprograms are called into execution either one time only or one time for each year of the simulation run.

For RQ the following overlay structure was created:

Program	Overlay
RQ	Main
ALTMOD	Main
INSTSP	Main
INIT	1
RDCALC	2
FACTRD	3
RDSCRT	4
IFLAT	5
ACASPT	6
SSSERV	7
INDOP	8
SPACE	9
SUBSQF	9

*For our purposes running time includes compilation time and time for creation of the overlay.

BOUND	10
WRTAP2	11
REPORT	12
SETDUM	12
SUMDUM	12

Subprogram INSTSP was included in the Main Overlay due to the additional entry point of PPLANT; however, it would be quite simple to break this subprogram into two subprograms and save an additional amount of core storage amounting to approximately 1,250 words. It should also be noted that the subprograms RESRCH and PUBSEV were not used in the California State College model. These subprograms could be replaced in the set of RQ programs with no increase in core storage requirements via this overlay structure. As before, we did not use subprogram GETCOF. Because of the frequency of its use, it would be placed in the Main Overlay and would require approximately 600 words. The results displayed below represent results which would include PUBSEV, RESRCH, and GETCOF. It should be noted that comparison between the results displayed below and those in Figure C-1 should be approached with caution. In effect, the results in Figure C-1 represent the amount of core storage needed by the programs in their "original" state. These programs were revised quite extensively for the California State Colleges' situation in order to load RQ. The results below are based on the revised program.

Results of RQ Overlay

	Core Storage Required For Programs Only	Running Time (CPU)
No Overlay	20,954	114 secs.
Overlay	12,778	116 secs.

As was the case in the discussion of the RP overlay, the amount of core storage required is that amount required for the computer programs of RQ *plus* the amount required for subprograms needed from the computing system library. It does *not* include the amount of core storage needed for COMMON areas.

In summary, with very little effort it is possible to save a significant amount of core storage for RQ (more than 8,000 locations on the revised programs on our computer system) at a minimal expense.

Overlaying of COMMON Storage Area

In conjunction with an overlay structure, one specific area is of concern in regard to reducing core storage requirements – COMMON. As was mentioned earlier, the amount of core storage required for the data elements in COMMON in these sets of programs is very significant. Use of an overlay scheme can reduce core storage requirements for the computer programs but does nothing to reduce the amount of core storage required for COMMON.

One method of reducing the amount of core storage required for data storage in COMMON is ideal in an overlay situation – the "overlaying" of data required by each overlay in the COMMON area. The concept here is quite basic. When an overlay is loaded into core, the required data is loaded into the COMMON area from auxiliary storage. Prior to transferring the overlay from resident core storage, the data in COMMON storage is placed back on auxiliary storage with any new values that have been calculated. When the next overlay is loaded into core storage for execution, the required data for *this* overlay is loaded into the COMMON area from auxiliary storage thus "overlaying" the area of COMMON used by the previous overlay. The cost in computer time for this type of procedure is usually not prohibitive. Data is loaded into core only for the same number of times that overlays are loaded into core.

For the set of programs called RP, this method of "overlaying" COMMON areas of each overlay would appear to be ideal due to the small number of times that the overlays are loaded for execution; however, the structure of the progams does not easily facilitate this. A few of the subprograms (e.g., WRTAP1, YSTUDR, UNCOST) use an extremely large percentage of the entire amount of COMMON. Since the amount of COMMON storage that can be saved using this technique is the mathematical difference between the total amount of COMMON storage and the largest amount of COMMON storage used by *any one* of the overlays (in this instance – subprograms) it does not appear that a significant amount of savings can be easily achieved within the current subprogram structure. If it becomes necessary, due to computer configuration restrictions, to save additional core, subprograms such as WRTAP1 and YSTUDR should be studied and divided into smaller subprograms to reduce the amount of COMMON storage used in any *one* of the newly created subprograms. This task might not prove to be very difficult and could provide considerable rewards.

Overlaying of Individual Arrays

Another method of reducing core requirements in a set of programs is to place arrays of data on auxiliary storage, read them in as they are needed by a given program (a section of COMMON storage is reserved for this), perform the necessary operations with the data, make changes in the data, where applicable, and write the data back out to auxiliary storage when finished. This same area of core storage is then used for temporary storage of other data as needed.

This procedure, of course, could be used to a very detailed level in which only one element of an array is used at any one time; however, most of the processing during an execution of programs using such techniques involves only the reading and writing of data elements and thus, the processing time could be significantly increased. The amount of savings in core storage could be significant utilizing this technique; however, the running time would more than likely also increase very much and offset any gains achieved by the corresponding decrease in core storage requirements.

This method of reducing core requirements can be quite costly from both the programming changes required in RP or RQ and the increase in running time. In short, it is believed that the computer analyst should attempt this method of core reduction only if the restrictions of the current computer configuration make it necessary. Prudent judgment should also be used in the selection of arrays to be placed on auxiliary storage and to the level of detail that this technique will be used.

PROGRAM RP		PROGRAM RQ	
SUBROUTINE:		SUBROUTINE:	
ALTMOD	73	ACASPT	2,206
ENDYR	15	ALTMOD	152
GETCOF	597	BOUND	86
HEADR1	373	ENDYR	15
HEADR2	289	FACTRD	686
IFLTN	199	GETCOF	599
INIT	174	IFLAT	178
RDCOF	774	INDOP	910
RDHEAD	224	INIT	153
RDICLM	429	INSTSP	2,665
RDINST	934	PUBSEV	2,848
TERM	47	RDCALC	282
UNCOST	660	RDSCRT	133
UNIRPT	822	REPORT	1,929
WRSCRT	125	RESRCH	1,139
WRTAP1	1,194	SETDUM	37
YSTUDO	888	SPACE	1,494
YSTUDR	1,443	SSSERV	1,956
	9,260	SUBSQF	410
		SUMDUM	68
COMMON*	19,021	WRTAP2	2,661
			20,607
TOTAL	28,281		
		COMMON*	9,471
		TOTAL	30,078

*Single dimensioned variables not included.

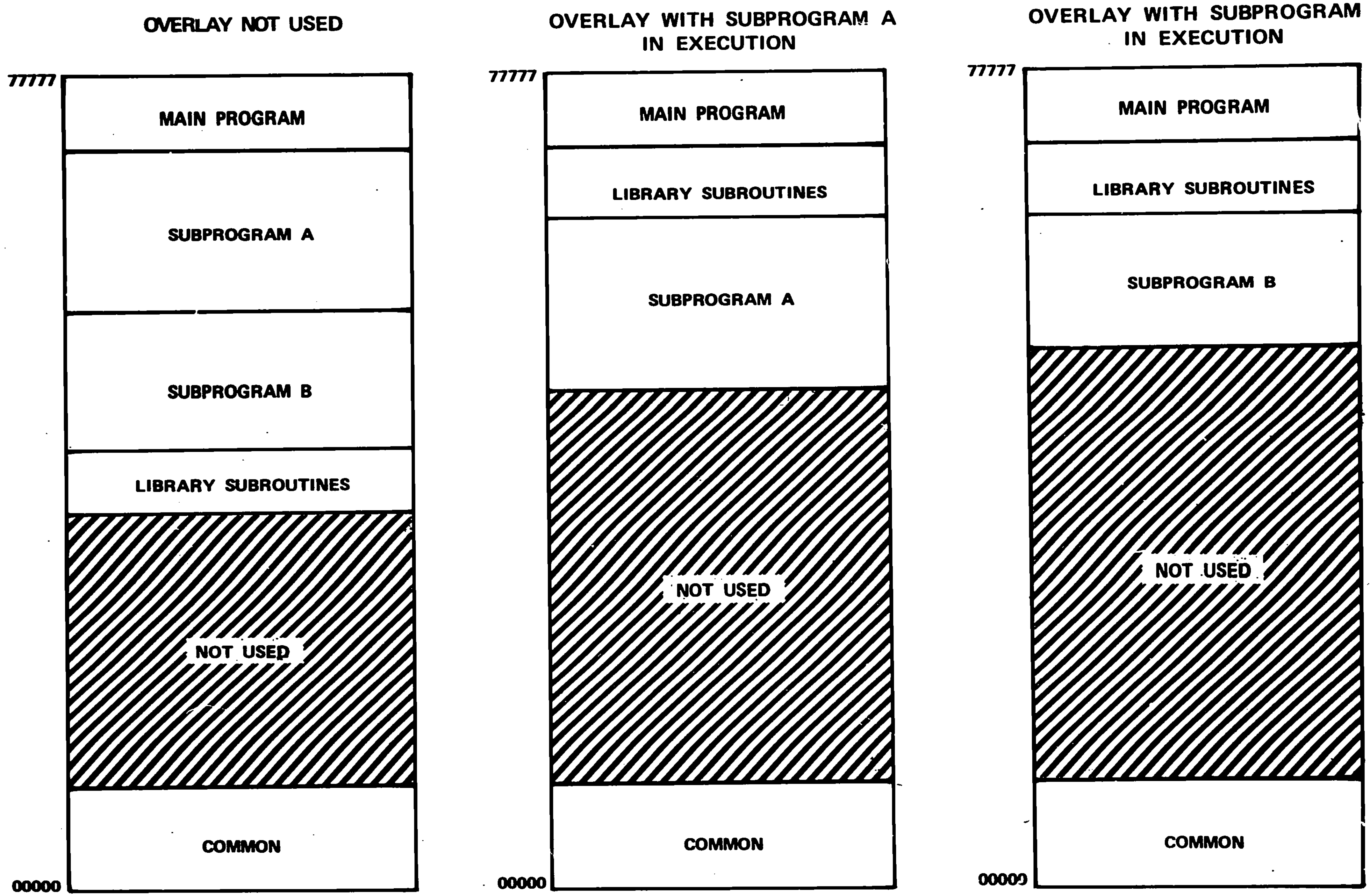
FIGURE C-1. PROGRAM SIZES OF RP AND RQ

	Disciplines	Student Levels	Course Levels	Faculty Ranks	Staff Ranks	Other Instruction Subprograms	Instruction Types	Majors
ACASAL (I,K)	X			X				
ACFTE (I,J,K)	X		X				X	
AFTE (I,J,K)	X		X	X				
AFTERD (I,K)	X			X				
AMSKS (M,K)		X						X
ANP (I,N)	X				X			
ANS (I,N)	X				X			
AVESEC (I,J,K)	X		X				X	
CIC (I,J)	X		X					
CRSLEV (I,J)			X					
DIC (I,J)	X		X					
DIVCO (I,J,K)	X		X	X				
DSCNAM (I,J)	X							
DSTAR (M,K)		X						X
FACLD (I,J,K)	X		X				X	
MJRTTL (I,J)								X
NACSAL (I,N)	X				X			
OACATC (LL,I)	X					X		
OACP (LL,I,K)	X			X		X		
OACS (LL,I,K)	X			X		X		
OAFTE (LL,I)	X					X		
ODIV (LL,I,K)	X			X		X		
OFAC (LL,I,K)	X					X	X	
OFTE (LL,I)	X					X		
OGACST (LL,I)	X					X		
OGAFTE (LL,I)	X					X		
OLOAD (LL,I,K)	X					X	X	
ONACST (LL,I)	X					X		
ONAFTE (LL,I)	X					X		
ONONAC (LL,I,N)	X				X	X		
ONONAS (LL,I,N)	X				X	X		
ONSAL (LL,I,N)	X				X	X		
OSCHC (LL,I,M)	X					X		X
OSCH (LL,I)	X					X		
OSECT (LL,I,K)	X					X	X	
OSPEXP (LL,I)	X					X		
OSTUD (LL,M)						X		X
OTNCST (LL,I)	X					X		
OTNFTE (LL,I)	X					X		
OTNSAL (LL,I)	X					X		
OTSAL (LL,I)	X					X		
OWCH (LL,I,K)	X					X	X	
OWSH (LL,I,K)	X					X	X	
OWSCH (LL,I,K)	X					X	X	
RSCH (I,J,K)	X	X	X					
SCH (I,J)	X		X					
STDLEV (I,J)		X						
STUD (M,K)		X						X
TOTFTE (I,J)	X		X					
TSAL (I,K)	X			X				
WFCH (I,J,K)	X		X				X	
WSH (I,J,K)	X		X				X	
WSHCO (I,J,K)	X		X				X	
WSHD (I,K)	X						X	

FIGURE C-2. RP ARRAYS AND VARIABLES

	Disciplines	Faculty Ranks	Staff Ranks	Research and Public Service Subprograms	Support Subprograms	Other Instruction Subprograms
ACASAL (I,K)	X	X				
ACFTE (L,I,K)	X	X		X		
ADSALD (L,I,K)	X	X		X		
ADWIP (L,I)	X			X		
AFTERD (I,K)	X	X				
AMSAL (L,I)	X			X		
ANP (I,N)	X		X			
CLASLB (I,J)	X					
CLASRM (I,J)	X					
CLBASF (I,M)	X					
CLSASF (I,M)	X					
DIVP (L,I,K)	X	X		X		
NACFTE (L,I,N)	X		X	X		
NASALD (L,I,N)	X		X	X		
NONAC (L,N)			X		X	
NSAL (L,N)			X		X	
NSALSC (L,N)			X		X	
NSSLS (L,N)			X	X		
OAC (LL,I)	X					
OACP (LL,I,K)	X	X				X
OFFIC 1 (I,J,K)	X			X		X
OFFIC 2 (L,K)					X	
OGAFTE (LL,I)	X					X
ONONAC (LL,I,N)	X		X			X
OTNFTE (LL,I)	X					X
OWSH (LL,I,K)	X					X
RESLAB (I,K)	X					
SNCST (L,I)	X			X		
SUMNAC (L,I)	X			X		
SUMSAL (L,I)	X			X		
SUPEXD (L,I)	X			X		
TACFTE (L,I)	X			X		
TCOST (LK,NY)				X	X	X
TNSAL (L,I)	X			X		
WSHD (I,K)	X					

FIGURE C-3. RQ ARRAYS AND VARIABLES



OPERATION OF OVERLAY
FIGURE C-4

APPENDIX D.
THE PROCESSING
OF
RRPM AT THE REGIONAL CENTER

Humboldt State College leases a CDC 3150 Computer System. This system is primarily used in a "stand-alone" mode for processing; however, the capability is also available to operate this system as a "terminal" in communication with a larger CDC 3300 Computer System at one of the Regional Centers of the California State College Computer Network System. Due to the amount of core storage required in the processing of the computer programs comprising RRPM, it was necessary to make use of the CDC 3300 Computer System at the Northern Regional Data Center located in San Jose, California. This appendix describes some aspects of communication with the Regional Centers and includes some "deck setups" and "program listings" for special processing required in the use of RRPM at the Regional Centers. It should prove to be a valuable aid to other colleges who desire to use RRPM in this mode.

There are two basic modules in RRPM. The first, called the prediction module, consists of two ANSI FORTRAN programs – RP and RQ. During the pilot test of RRPM each of these programs required approximately 43,500 words of core storage. (It is expected that this requirement will be significantly reduced very shortly with pending modifications.) The second module, called the report module, is an ANSI COBOL program – RR. This module requires approximately 30,700 words of core storage.

During the pilot test it was decided that several runs of RRPM were to be completed in order to evaluate the model with a variety of decision sets. It was, therefore, determined that a means of processing had to be installed that would eliminate the transmission of duplicate information a number of times. Included in this information to be transmitted at one time only was the ICLM file and the large source decks for RP, RQ and RR. It was planned to transmit these files to the Regional Data Center and save them on disc storage for processing at later times with various sets of data.

The three source programs were compiled at the Regional Center and the object code saved on three files. The object code was placed on the file by using the "P = XXXX" option on the FORTRAN control card where "XXXX" is the data set indicator with which the file is opened. It is important to note that the block size of these files must be 1280 characters.

In transmitting the ICLM file to the Regional Center for storage on disk some additional processing was necessary. The software used in communications (CABLE) was not designed to accept tape input; however, it was easily adapted to do so. To facilitate this, subroutine OUTILITY was modified. These modifications are displayed in Figure D-1.

The tape file that was transmitted consisted of two items:

1. A job consisting of a small FORTRAN program which reads the ICLM file from tape (immediately following the job) and creates a disk file. The listing for this FORTRAN job is displayed in Figure D-2.

2. ICLM File.

The listing of the job that was used to create the tape described above is displayed in Figure D-3.

After the above processing was completed, it was then quite easy to call for execution of RRPM and not "tie up" the CDC 3150 for long periods of time in transmitting.

In addition it should be noted that the "SAVE" feature is used so that after the information is transmitted to the Regional Center, normal operations of the CDC 3150 may resume. When using this feature, the output is temporarily "saved" on disc storage and may be retrieved by the remote user via a control card.

Deck Setup For Processing RRPM

The model was run as a stack of four (4) distinct jobs which were, of course, sequenced together as a "stack".

Job 1 – Prediction Module (RP and RQ)

A listing of the control cards and deck setup is displayed below. Two items are of special interest here – (1) an output file must be opened which allows for approximately 1,000 records for each year simulated in the run and (2) the object files containing the computer programs, the ICLM file, the auxiliary library file, and the library directory file must all be opened prior to calling the task.

```
$SAVE
$ JOB,30302505,RRPM0803,20,2000
$SCHED,841=1,CORE=85,SCR=70,CLASS=B
$MAP=N
$*DEF(R,,HUMBOLDT,RP-OUT,01,,,ALL)
$*DEF(A,,HUMBOLDT,RP-OUT,01,,,148,4000,,S,S,841,7730)
$*DEF(0,,POUT,HUMBOLDT,RP-OUT,01,,0)
$*DEF(0,,RP,HUMBOLDT,WICHE,RRPM,RP,02,RRPM)
$*DEF(0,,RQ,HUMBOLDT,WICHE,RRPM,RQ,02,RRPM)
$*DEF(0,,ICLM,HUMBOLDT,INDUCED-COURSE-LOAD-MATRIX,S1,RRPM)
$*DEF(0,,MDIR,MASTER,LIBRARY-DIRECTORY,AX,****)
$*DEF(0,,MLIB,MASTER,LIBRARY,AX,****)
$FILE,5=TMP
$FILE,6=OUT
$FILE,41=ICLM
$FILE,44=POUT
$XXX,RP
$AUX,MLIB,MDIR

     (DATA FOR RP)
$YY,RQ
$AUX,MLIB,MDIR

     (DATA FOR RQ)
$$
```

Job 2 – File Conversion Program

This program adds two words to the beginning of each record of the output file created by Job 1 to convert the file to a format acceptable by both the "SORT" program and the report module. The converted output file is designated as edition 02. A listing of the control cards and program is displayed below.

```
$SAVE
$JOB,30902505,RRPM0804,7,200,,RRPM0803
$SCHED,841=1,CORE=45,CLASS=B,SCR=10
$MAP=N
$*DEF(R,,HUMBOLDT,RP-OUT,01,,,UNUSED)
$*DEF(O,,POUT,HUMBOLDT,RP-OUT,01)
$*DEF(R,,HUMBOLDT,RP-OUT,02,,,ALL)
$*DEF(A,,HUMBOLDT,RP-OUT,02,,,136,4000,,S,S,841,7730)
$*DEF(O,,RRIN,HUMBOLDT,RP-OUT,02,,0)
$FILE,41=POUT
$FILE,42=RRIN
$FTN(X)
      PROGRAM FAKER
C  **  THIS PROGRAM IS AN ATTEMPT TO GET FORTRAN DISK OUTPUT INTO
C  **  A FORM WHICH SORT AND COBOL CAN READ
      DIMENSION IA(40)
      KOUNT1=0
      KOUNT2=0
5      CONTINUE
      READ (41,100) (IA(I),I=1,34)
100   FORMAT (34A4)
      IF(EOFCKF(41).EQ.1) GO TO 700
      KOUNT1=KOUNT1+1
      WRITE (42,101) KOUNT1,KOUNT2, (IA(I),I=1,20)
101   FORMAT (22A4)
      GO TO 5
700   CONTINUE
      ENDFILE 42
      WRITE (61,105) KOUNT1
105   FORMAT (1H0, I6, 2X, 17HRECORDS CONVERTED)
      STOP 777
      END
         FINIS
$LLL,LGO
$$
```

Job 3 – SORT

A standard CDC System SORT is used to arrange the file in an order for processing by the report module. The sorted output file is designated as edition 03. The report module requires the file in one of two sequences for processing. For a description of these options, refer to the remarks in the program listing of the report module or the documentation. A listing of the cards for Job 3 is displayed below. (It should be noted that the column locations have been distorted for a few cards in order to fit the listing into this report.)

```
$SAVE
$ JOB,30302505,RRB40805,11,200,,RRBM0R04
$SCHED,CORE=35,SCR=15,CLASS=9,841=1
$MAP=N
$#DEF(R,,HUMBOLDT,RP-OUT,01,,,UNUSED)
$#DEF(R,,HUMBOLDT,RP-OUT,02,,,UNUSED)
$#DEF(O,,STN,HUMBOLDT,RP-OUT,02)
$#DEF(R,W,LUN1,SORT,01,,,ALL)
$#DEF(A,W,LUN1,SORT,01,,,1368,500,,S,S,841,7730)
$#DEF(O,W,LUN1,LUN1,SORT,01,,0)
$#DEF(R,W,LUN2,SORT,02,,,ALL)
$#DEF(A,W,LUN2,SORT,02,,,1368,500,,S,S,841,7730)
$#DEF(O,W,LUN2,LUN2,SORT,02,,0)
$#DEF(R,,HUMBOLDT,RP-OUT,03,,,ALL)
$#DEF(A,,HUMBOLDT,RP-OUT,03,,,136,4000,,S,S,841,7730)
$#DEF(O,,SOUT,HUMBOLDT,RP-OUT,03,,0)
$SORT
01102210                    1100120009
1ADS0136    UF               STN HUMBOLDTRP-OUT     02            S0
1BTT01361368F                LUN1LUN1      SORT     01            S0
1CTT01361368F                LUN2LUN2      S0 T     02            S0
1D000136    UF               SOUTHUMBOLDTRP-OUT     03            S0
9ENDMSS
$#DEF(C,W,LUN1)
$#DEF(C,W,LUN2)
$#DEF(R,W,LUN1,SORT,01,,,ALL)
$#DEF(R,W,LUN2,SORT,02,,,ALL)
$#DEF(C,,STN)
$#DEF(C,,SOUT)
$#DEF(R,,HUMBOLDT,RP-OUT,02,,,UNUSED)
$#DEF(R,,HUMBOLDT,RP-OUT,03,,,UNUSED)
$$
```

Job 4 – Report Module (RR)

The report module is the last of the four jobs in the stack. One item to note here is that RR was changed to "accept" the edition number of the file from a control card. In the control card the Hollerith string "EDITION" appears in columns 1-7 and the edition number appears in columns 10-11. A listing of the control cards for this job is displayed below

```
$SAVE
$ACCT
$JOB.30902505.RRPM0806,5.2500..RRPM0805
$SCHED.841=1.CORE=60,SCR=20,CLASS=R
$MAP=N
$*DEF(0..RR,HUMBOLDT.WICHE.RRPM.RR.01.RRPM)
$OBL.RR
EDITION   03

      (CONTROL CARDS FOR RR)

$$
```

```
SEQUENCE,3
JOB,00000000,CDC
COSY
COSY V2.1          MSOS          06/28/71
            DELETE/   129
   C
   C
   C  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **
   C          THIS CHANGE WAS MADE TO ALLOW CABLE TO ACCEPT TAPE INPUT
   200    IF ( INCARD (1) .EQ. 00054060B ) INCARD(1) = 00054020B
          IF ( INCARD(1) .NE. 00054020B)GO TO 180
   C200   IF( INCARD(1) .NE. 00054020B ) GO TO 180
   C  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **
   C
   C
   CUTILITY DECK/      I,H
            ENDCOSY/
FORTRAN,I=54,L,A,M,P
```

FIGURE D-1

```
      SUBROUTINE CUTILITY( MODE )
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C        *           THIS ROUTINE IS COMPATIBLE WITH CALCOM. (03-01-71)
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
      COMMON BLOCK(129), LOCNAME(128), JCARD(80), KCARD(12)
      CHARACTER JCARD, KCARD
      DIMENSION INCARD(20), LCARD(2)
      EQUIVALENCE (INCARD, JCARD), (LCARD, KCARD)
      COMMON/DATA/JOBNO(12)
      DATA(( JOBNO(I), I=1,12 ) = 4H    1, 4H    2, 4H    3, 4H    4, 4H    5
     X    , 4H    6, 4H    7, 4H    8, 4H    9, 4H   10, 4H   11, 4H   12 )
      INTEGER BLOCK, DISKIN, RL
      INP=10
      DISKIN=5
      JCOUNT=1
      JHELP= 0
      NBN= 5
C
C        CLEAR THE JOB NUMBER TO ( -1 ).
C
      DO 5 I= 1, 128, 4
    5 LOCNAME(I)= -1
C
C        THE FIRST WORD OF THE DIRECTORY MUST BE 0 SO THAT
C        ROUTINE  DISKIN  WIL NOT FORMAT THE INPUT RECORD.
C
      LOCNAME(1) = 0
C
C        BUILD A DUMMY FIRST JOB ENTRY IN CASE OPERATOR SENDS JUST $$.
C
      LOCNAME(5)= 4H
      LOCNAME(6)= 4H
      LOCNAME(7)= 4H
      LOCNAME(8)= 2
C
C        MODE = 1 FOR CARD TO MASS STORAGE.
C             = 2 FOR MASS STORAGE TO PRINTER AND/OR PUNCH.
C
      IF( MODE .EQ. 2 ) 10000,6
    6 CALL LOCATE( DISKIN,2,JREJ )
      IF( JREJ .EQ. 1 ) 10, 7
    7 ILOC = ILOC + 1
      IF( ILOC .LT. 3 ) 6, 8
C        LOCATE ERROR ON DISC
    8 CALL MESGOUT( 10 )
      RETURN
   10 J = 4
C        INITIALIZE POFAC
      BLOCK(2) = 12
C        MAKE SURE CARD READER IS READY BEFORE FIRST CARD IS READ.
   15 GO TO( 15,16 ), UNITSTF(INP)
   16 CONTINUE
   20 IPAR= 0
      ILOC= 0
```

FIGURE D-1 (Cont'd)

```
      IDISC= 0
25    BUFFERIN(INP,0)(INCARD(1), INCARD(20))
30    GO TO( 30,40,200,200,180,170),UNITSTF( INP )
40    JDEX= J-1
      DO 41 I=1,20
      IDEX= JDEX+I

41    BLOCK(IDEX)= INCARD(I)
      IF(INCARD(1).NE. 4H$JOB) GO TO 45
C
C        TEST FOR JOB CARD. IF FOUND RECORD JOB NO., IDENT., AND BLOCK
C        FOR RESTART FUNCTION OF COMM. EXECUTIVE( COMEX ).
      JCOUNT= JCOUNT+ 1
      JHELP= JHELP+ 3
      KCT= JCOUNT+ JHELP- 1
      LOCNAME(KCT+1)= JOBNO( JCOUNT-1)
      LOCNAME(KCT+ 2)= 4H
      LOCNAME(KCT+ 3)= 4H
      LOCNAME(KCT+ 4)= NBN
C
      L= 0
      ISW= 1
      DO 43  I= 7, 22
      IF(JCARD(I-1).EQ. 4H000. ) ISW= 2
      GO TO(43 , 42 ) ISW
42    L = L+1
      KCARD(L)= JCARD(I)
      IF(JCARD(I).NE. 4H000. ) GOTO 43
      KCARD(L)= 1H
      GO TO 44
43    CONTINUE
44    LOCNAME(KCT+2)= LCARD(1)
      LOCNAME(KCT+3)= LCARD(2)
C
C        REMOVE TRAILING BLANKS.
C
45    CALL SQUEZ( RL, BLOCK(2), BLOCK ,J+19 )
C        SET THE RECORD LENGTH FOR THIS RECORD.
      BLOCK( J-1 ) = RL
      IF(BLOCK(J).EQ. 4H$$   )46, 50
46    BLOCK(J)= 17173636B
C
C        SET RL WORD TO SHOW EOF STATUS OF THIS RECORD.
C        AND WRITE BLOCK ON DISC.
C
      BLOCK(J-1) = 4H 004
      GO TO 60
50    CONTINUE
C        SET STARTING LOCATION FOR NEXT READ.
      J = J + RL/4 + 1
C        IS THERE ENOUGH ROOM FOR ANOTHER CARD....
      IF    ( BLOCK(2) + 80 .GT. 516 ) 60, 20
60    NBN=NBN+1
      BLOCK(1)=NBN
```

FIGURE D-1 (Cont'd)

```
90     BUFFER OUT(DISKIN,0)(BLOCK(1), BLOCK(128))
100    GO TO( 100, 110, 130, 110, 160, 150)(UNITSTF(DISKIN))
110    IDISC= IDISC+1
       BACKSPACE DISKIN
       IF( IDISC .LT. 3) 90,120
C         PARITY ERROR ON DISC.
120    CALL MESGOUT( 11 ) $ RETURN
C         END OF FILE ON DISC.
130    CALL MESGOUT( 12 ) $ RETURN
C         DISC UNIT INOPERABLE.
150    CALL MESGOUT( 15 ) $ RETURN
C         END OF DEVICE DETECTED ON DISC.
160    CALL MESGOUT( 16 ) $ RETURN
C         END-OF-DEVICE, CONTINUE READING.
170    CALL MESGOUT( 14 ) $  GOTO 40


C         REPLACE LAST TWO CARDS, MI/MI.
180    CALL MESGOUT(13) $ IPAR = IPAR +1
       IF( IPAR .LE. 3 ) 181, 182
181    PAUSE  $  GO TO 25
C      IRRECOVERABLE PARITY ERROR.
182    RETURN
C                                                                       **
C                                                                       **
C  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **   **
C         THIS CHANGE WAS MADE TO ALLOW CABLE TO ACCEPT TAPE INPUT      **
200    IF ( INCARD (1) .EQ. 00054060B ) INCARD(1) = 00054020B           **
       IF ( INCARD(1) .NE. 00054020B)GO TO 180                          **
C200   IF( INCARD(1) .NE. 00054020B ) GO TO 180                         **
C  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **  **   **
C                                                                       **
C                                                                       **
       BLOCK(1)=0
       BUFFER OUT(DISKIN,0)(BLOCK(1),BLOCK(128))
 280   GO TO(280, 290, 130, 110)(UNITSTF(DISKIN))
C
C         LOCATE TO BLOCK ONE AND WRITE THE DIRECTORY.
C
 290   CALL LOCATE(DISKIN, 1, JREJ)
       IF(JREJ.EQ.1) 310, 300
 300   ILOC= ILOC+ 1
       IF(ILOC.LT.3) 290, 8
 310   BUFFEROUT(DISKIN,0)(LOCNAME(1), LOCNAME(128))
 320   GO TO(320, 900, 130, 330) (UNITSTF(DISKIN))
 330   IDISC= IDISC+ 1
       BACKSPACE DISKIN
       IF(IDISC.LT.3) 310, 120
C
C         COME HERE FOR MASS STORAGE TO PRINT AND/OR PUNCH OUTPUT
C
10000  CALL PRNTPUN
900    CONTINUE
       RETURN
       END
```

FIGURE D-1 (Cont'd)

```
$ACCT
$ 109,30902505,HUMB100,10,10000,10,,CREATE ICLM DISK FILE
$SCHED,CLASS=B,CORE=45,SCR=10,841=1
$#DEF(A,,HUMBOLDT,INDUCED-COURSE-LOAD-MATRIX,01,RRPM,RRPM,144,3010,
$999999,,,841,7730)
$#DEF(0,,ICLM,HUMBOLDT,INDUCED-COURSE-LOAD-MATRIX,01,RRPM,0)
$FILE,41=ICLM
$FTN(X,I)
      PROGRAM RI
C   ** THIS PROGRAM CREATES A DISK FILE OF THE INDUCED COURSE LOAD
C      MATRIX.  THE INPUT MATRIX IS ON STANDARD INPUT (60).
C   ** THIS PROGRAM GOES ON TAPE AHEAD OF THE ICLM.  TO GET IT THERE,
C      USE PROGRAM *RI*.
      DIMENSION IA(80)
      DIMENSION ICLM (3,3,33)
      REAL ICLM
      KOUNT=0
      WRITE(61,100)
100   FORMAT(1H1)
      WRITE(61,101)
101   FORMAT(20H LOG FOR PROGRAM ONE)
      READ(60,107) IA(1)
107   FORMAT(I4)
      WRITE (41,107) IA(1)
10    CONTINUE
102   FORMAT(80A1)
      DO 20 K2=1,3
      DO 20 K3=1,33
      READ(60,106) (ICLM(I,K2,K3),I=1,3),M1,M2,M3
      IF(EOFCKF(60).EQ.1) GO TO 700
      KOUNT=KOUNT+1
20    CONTINUE
C
C   **   **   **   **   **   **   **   **   **   **   **   **   **   **   **   **   **
C
C NOTE - THIS FORMAT IS DIFFERENT FROM THE STANDARD ICLM FORMAT IN RRPM,
C          THIS CHANGE WAS MADE TO CONSERVE DISK SPACE.  A CORRESPONDING
C          CHANGE WAS MADE IN SUBROUTINE RDICLM OF PROGRAM RP.
C
C   **   **   **   **   **   **   **   **   **   **   **   **   **   **   **   **   **
      DO 30 N3=1,33
      WRITE (41,105) ((ICLM(N1,N2,N3),N1=1,3),N2=1,3),M1,N3
30    CONTINUE
105   FORMAT (9F10.6,2I2)
106   FORMAT(3F10.6,44X,3I2)
103   FORMAT(X,80A1)
      GO TO 10
700   CONTINUE
      ENDFILE 41
      WRITE(61,104) KOUNT
104   FORMAT(X,14HRECORD COUNT =,I4)
      STOP 1
      END
         FINIS
$OBJ,LGO
```

FIGURE D-2

```
=SEQUENCE,999
=JOB,9025051,INST, RESEARCH,,ND,,RRPM
=FORTRAN,X,I
      PROGRAM RT
C  **  THIS PROGRAM READS A PROGRAM DECK FROM THE CARD READER,
C      WRITES IT ON TAPE (31), READS THE INDUCED COURSE LOAD MATRIX
C      FROM TAPE (30) AND WRITES IT ON TAPE (31), THEN ADDS THE $$ AND
C      7/9 ENDSCOPE AND EOF TO MAKE THE TAPE SUITABLE FOR CABLE INPUT
C
      DIMENSION IA(80)
      DIMENSION IB(40     )
      K=0  $  KK=0
      DO 5 I=1,40
5     IB(I)=0
C  **  7/9E OF 7/9ENDSCOPE
      IB(1)= 00054020B
10    CONTINUE
C  **  READ PROGRAM *RJ* FROM THE CARD READER
      READ (60,102) (IA(I),I=1,20)
102   FORMAT (20A4)
100   FORMAT (80A1)
      IF(EOFCKF(60).EQ.1) GO TO 200
      K=K+1
      BUFFER OUT (31,0) (IA(1),IA(20))
20    GO TO (20,21,750,750,750,750) UNITSTF(31)
21    CONTINUE
      GO TO 10
200   CONTINUE
C  **  READ INDUCED COURSE LOAD MATRIX FROM TAPE
      READ (30,102) (IA(I),I=1,20)
      IF(EOFCKF(30).EQ.1) GO TO 700
      KK=KK+1
      BUFFER OUT (31,0) (IA(1),IA(20))
      GO TO 200
700   CONTINUE
      IA(1) = 4H$$
C  **  WRITE $$
      BUFFER OUT(31,0)(IA(1),IA(20))
710   GO TO (710,711,750,750,750,750) UNITSTF(31)
711   CONTINUE
C  **  WRITE 7/9 E
      BUFFER OUT(31,1)(IB(1),IB(20))
720   GO TO (720,721,750,750,750,750)UNITSTF(31)
721   CONTINUE
       ENDFILE 31
      WRITE(61,101) K,KK
101   FORMAT(1H0,5X,9HPROGRAM =,I3,5X,6HDATA =,I5)
      STOP 7777
750   STOP 1
      END
          FINIS
=EQUIP,30=MTC0E1U00
=EQUIP,31=MTC0E1U01
=LOAD,56
=RUN,01
```

FIGURE D-3

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