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A chapter for a larger volume which discusses the rise of the multiuniversity and the possibilities for planning in systems analysis. The system described is the C.A.M.P.U.S. system, an acronym for Comprehensive Analytical Methods for Planning in University Systems. Three subsystems are discussed--(1) program planning and budgeting, (2) simulation models, and (3) integrated information system. A variety of applications are suggested under the latter two categories. (FPO)

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TECHNIQUES OF SYSTEMS ANALYSIS FOR UNIVERSITY PLANNING

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1. Complexity in the Modern University

In three decades the Universities of North America have been transformed. Before World War II, they were typically small and sheltered places where relatively homogenous groups of scholars taught and learned. Student numbers rarely exceeded ten thousand per campus; faculties were small, intimate and poorly paid; instructional and research programs were traditional; physical plants were fixed and budgets were painfully modest.

After the War, the universities were hit by successive waves of change. The G.I. Bill of Rights opened the Halls of Academe to thousands who never could have come without it. Government, having discovered the value of academic science in waging war, enlisted its aid in waging cold war. The Post-War "baby-boom" swelled the population of potential students. Popular appreciation of the value of higher education boosted the proportion of that population seeking a university education. Sputnik shocked the public and its legislators into willingness to finance higher education on scales inconceivable in the past.

New instructional programs sprang up to meet the needs of government, business and the university itself for special skills and knowledge. Foundations gave fortunes to encourage research and scholarship. A new breed of academic entrepreneur arose to meet the needs and realize the opportunities offered by the times. Thus, the multiversity was born.

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Universities are now huge and complex. Campuses of twenty-five thousand students are common; some are nearly twice that size. Faculties, numbering in the thousands, divide their energies among diverse and far-flung programs of undergraduate and graduate instruction, research, public service and consulting. Vast and growing libraries, computer facilities and physical plants support those programs. Capital and operating budgets are calculated in hundreds of millions of dollars.

2. The Challenge to University Administrators

Once upon a time, according to Clark Kerr, university presidents had to provide only three things: football for the alumni, parking for the faculty and sex for the students.

Those simple days are no more. The alumni still like football but students demand much more than sex. And the faculty, having sampled professionalism, power and prestige, have acquired expensive tastes. They want office space and laboratories, research grants and lighter teaching loads, specialized graduate programs and interdisciplinary institutes, higher salaries....... and still more parking.

Meanwhile, the environment changes rapidly. Public programs of health, defense, space exploration and urban reconstruction place great demands on government finances. Taxes rise and public pressure mounts for more efficient resource use in education.

University administrators face two kinds of challenges: On the outside, they must marshall better evidence to con-

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vince Government and other sources of funds of the universities' needs. On the inside, they must choose from the many competing claims and allocate resources in a way that best realizes university objectives.

So great are the benefits of higher education and so sizeable are its costs that we must strive to gain the greatest benefits from our investment in learning. In this important respect, the administration of higher education whether at the level of one institution or at the level of a government agency responsible for financing higher education is a task of resource management.

If citizens have a right to demand that their tax dollars be used to the greatest educational advantage, then university administrators deserve the most modern and effective management tools available. The tools of systems analysis have greatly aided managers in business and government. They are now being harnessed to the tasks of university planning and administration.

3. The CAMPUS System

In 1964, at the University of Toronto, a group of systems analysts began developing a set of university management tools which was given the acronym CAMPUS (Comprehensive Analytical Methods for Planning in University Systems). CAMPUS is an attempt to close the gap between the challenges facing university administrators and the management techniques with which they must work. By early 1969, the CAMPUS system was

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composed of the three sub-systems which are described below:

3.1 The Program Planning and Budgeting Sub-system

The Program Planning and Budgeting System (PPBS) gained fame in the Department of Defense. It has been widely copied and often misused. Used wisely, it provides a framework for a more specific articulation of objectives and the integration of systematic decision-making into the university's planning and budgetary processes.

Conventional methods of budgeting and accounting in universities may satisfy the needs of fiduciary control, but they fail to provide administrators with information useful for making decisions. Their fundamental flaw is that they are not oriented toward institutional objectives.

The basic purposes of PPBS are:

(1) To encourage decision-makers to think in terms of objectives.

(2) To stimulate a more creative search for alternative ways of achieving objectives.

(3) To promote more conscious evaluation of probable costs and benefits of alternative decision possibilities.

(4) To encourage longer-range planning.

In a fundamental sense, PPBS is not so much a technique or a method as a way of confronting allocation decisions. But to promote rational resource allocation in universities, administrators need not only new program budget formats; they need a means to facilitate the analysis without which PPBS is merely a display of old numbers in new forms.

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Unfortunately, the analysis of costs and benefits of alternative decision possibilities involves long and laborious computations. No university officer has the time or resources to perform these computations. He needs tools that will permit rapid, accurate and economical exploration of the implications of alternative decision possibilities. The CAMPUS simulation models provide such tools and thereby permit the potentials of PPBS to be realized.

3.2 The CAMPUS Simulation Models

The CAMPUS models simulate university operations over a time period of any length. Loaded into a digital computer, the models accept descriptions of the university's structure, statements of the levels of various university programs, detailed specifications of basic activities which constitute the programs, and various policy and planning factors concerning utilization of staff, space and other resources. With these inputs, the models compute the resulting resource requirements. These requirements are displayed by several computer-prepared reports and graphs.

3.2.1 Using CAMPUS Simulation Models in University Administration

What is the scope of CAMPUS university simulation models? For what are they useful? How can they be used? The purpose of this section is to suggest answers to these questions by posing concrete problems and illustrating the usefulness of the models in their analysis. For each of the problems examined, the task is to assess the resource implications of alternative programs or alterations in the university system itself.

3.2.1.1. Resource Implications of Enrollment Projections

Assume that enrollment forecasts exist for the coming decade. These forecasts pertain to total university enrollment; they are not disaggregated to the level of specific programs.

Problem: What are the resource implications of the enrollment forecasts? How many instructors of various qualifications will be required? What physical facilities will be needed? What quantity of money will be called for?

How sensitive to errors in the forecasts are the answers to these questions? Do they depend crucially upon an assumed pattern of program enrollment?

It is easy to pose the questions; it is difficult to answer them with the analytical techniques now available to educational planners. Let us suppose that a CAMPUS simulation model were available. It would be used in the following way.

Taking the forecasted enrollments as data, the model would compute the quantities of staff, money, and facilities required to handle the load. For each year of the simulation, the computer would present results in a form similar to the CAMPUS Administration Summary Report shown in Table 1. Here the estimated total dollar magnitude of the departmental budgets are shown together with the needs for staff and physical facilities. For more detailed analysis, the computer

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would provide information similar to that contained in the CAMPUS departmental reports of which Table 2 is a specimen. The data shown in all tables and figures are purely illustrative.

The computations would be repeated with alternative assumptions about key factors such as the pattern of change in staff salaries, the distribution of students among the various faculties and courses, class sizes, rates of utilization of classrooms, etc. University operations would be simulated for the decade with a range of possible enrollment projections; this would illuminate the sensitivity of the results to errors in the projections.

To facilitate analysis, the simulation results could be displayed in graphic form similar to that of Figure 1 and Figure 2. Here the computer output has been arranged by a CALCOMP plotter to ease analysis of the simulated decade's data.

Assisted by the simulation results for the coming decade, university planners and administrators should be able to make their decisions in cognizance of more and better information than is now possible.

3.2.1.2. <u>Resource Implications of Graduation Goals</u> √

<u>Assume</u> that manpower studies show requirements for certain numbers of graduates of various programs during the next decade.

<u>Problem</u>: What are the resource requirements of providing the graduates in the numbers needed? What staff, facilities, and money will be required? How sensitive are these requirements to changes in factors beyond control of

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TABLE 1

UNIVERSITY OF TORONTO

C.A.M.P.U.S. SIMULATION PLANNING ANALYSIS

ADMINISTRATION SUMMARY REPORT

TERM 1966-67

DEPARTMENTAL BUDGETS

ACADEMIC SALARIES	$	1495800.00
NON-ACADEMIC SALARIES	$	229600.00
MISCELLANEOUS EXPENSES	$	319800.00
TOTAL	$	2045200.00
ASSISTED RESEARCH FUNDS	$	1126500.00

ACADEMIC STAFF

DEPARTMENTAL CHAIRMAN	$ 221000.00	$ 13000.00	17
FULL PROFESSOR	$ 430500.00	$ 10500.00	41
ASSOCIATE PROFESSOR	$ 461100.00	$ 8700.00	53
ASSISTANT PROFESSOR	$ 227200.00	$ 7100.00	32
LECTURER	$ 156000.00	$ 3900.00	40
TOTAL	$1495800.00		183

PHYSICAL FACILITIES

STUDENT (SQ. FT.-HRS.)

	REQUIRED	ACTUAL	PCT. USE
LECTURE	565000.	941000.	60.
LABORATORY	310000.	675000.	46.
STUDY SPACE	186000.	150000.	124.

STAFF (SQ. FT.)

	REQUIRED	ACTUAL	PCT. USE
PROFESSORIAL	193500.	206000.	94.
CLERICAL	16000.	21000.	75.
ADMINISTRATIVE	69000.	69000.	100.

STUDENT ENROLLMENT

I	HONOURS	4693
	PASS	7485
II	HONOURS	3665
	PASS	6621
III	HONOURS	3214
	PASS	5891
IV	HONOURS	2966
MASTERS		2153
PH. D.		508

GRADUATES

UNDERGRADUATE	
HONOURS	2760
PASS	5435
POST-GRADUATE	
MASTERS	901
PH.D.	267

TABLE 2

UNIVERSITY OF TORONTO

C.A.M.P.U.S. SIMULATION PLANNING ANALYSIS

DEPARTMENT OF ZOOLOGY REPORT

TERM 1966-67

DEPARTMENTAL BUDGET

ACADEMIC SALARIES	$ 132889.95
NON-ACADEMIC SALARIES	$ 40170.72
MISCELLANEOUS EXPENSES	$ 11312.50
TOTAL	$ 184373.17
ASSISTED RESEARCH FUNDS	$ 48375.00

ACADEMIC STAFF

	TOTAL SALARIES	AVERAGE SALARY	PERSONNEL
DEPARTMENTAL CHAIRMAN	$ 20569.15	$ 20569.15	1
FULL PROFESSOR	$ 29822.22	$ 14911.11	2
ASSOCIATE PROFESSOR	$ 56102.00	$ 11220.40	5
ASSISTANT PROFESSOR	$ 26396.58	$ 8798.86	3
LECTURER	$ 0.00	$ 0.00	0
TOTAL	$ 132889.95		11

DEPARTMENTAL BUDGET

UNDERGRADUATE

ACADEMIC SALARIES	$ 81453.95
NON-ACADEMIC SALARIES	$ 29271.30
MISCELLANEOUS EXPENSES	$ 7207.00
TOTAL	$ 117932.25

GRADUATE

ACADEMIC SALARIES	$ 51436.00
NON-ACADEMIC SALARIES	$ 10899.42
MISCELLANEOUS EXPENSES	$ 4105.50
ASSISTED RESEARCH FUNDS	$ 48375.00
TOTAL	$114815.92

TABLE 2 cont.

ACADEMIC YEAR	CLASS SIZE (STUDENTS PER CLASS)				STUDENT ENROLLMENT			
	LECTURE		LABORATORY		LECTURE		LABORATORY	
	HONOUR	PASS	HONOUR	PASS	HONOUR	PASS	HONOUR	PASS
UNDERGRADUATE								
1	125.0	150.0	60.0	75.0	147.9	744.8	37.0	186.2
2	80.0	125.0	40.0	60.0	74.0	47.5	18.5	11.9
3	75.0	80.0	35.0	40.0	208.3	545.5	52.1	136.4
4	15.0	0.0	15.0	0.0	192.3	0.0	48.1	0.0
DIPLOMA	10.0		8.0		42.0		17.0	
MASTERS	9.0		7.0		107.0		43.0	
PHD	9.0		5.0		84.0		19.0	

ASSOCIATED COURSES OF THE ZOOLOGY DEPARTMENT

COURSE	UNDERGRADUATE							
	I		II		III		IV	
	TOTAL STUDENTS	ENROLLEE LOAD	TOTAL STUDENTS	ENROLLEE LOAD	TOTAL STUDENTS	ENROLLEE LOAD	TOTAL STUDENTS	ENROLLEE LOAD
GENERAL SCIENCE	334	715	296	48	192	473	0	0
GENERAL	857	216	1150	11	917	209	0	0
LIFE SCIENCES	43	103	37	47	32	157	30	102
BIOL. & MED. SCIENCES	38	52	34	31	27	72	33	74
MATH. & PHYSICS	112	30	80	14	65	31	59	64

TABLE 2 concl.

PHYSICAL FACILITIES

	STUDENT (SQ. FT.-HRS.) REQUIRED	ACTUAL	PCT. USE
LECTURE	129300	179583	72
LABORATORY	84620	124441	68
STUDY SPACE	15000	12500	120

	STAFF (SQ. FT.) REQUIRED	ACTUAL	PCT. USE
PROFESSORIAL	41310	44419	93
CLERICAL	4100	5395	76
ADMINISTRATIVE	9000	9474	95

SPACE REQUIREMENT DISTRIBUTION

LECTURE ROOMS SIZE (SQ. FT.)	NUMBER	LABORATORY ROOMS SIZE (SQ. FT.)	NUMBER
0 TO 250	12.0	0 TO 500	0.0
250 TO 500	5.3	500 TO 1000	4.8
500 TO 750	9.0	1000 TO 1500	0.0
750 TO 1000	8.0	1500 TO 2000	3.5
1000 TO 1250	0.0	2000 TO 2500	11.2
1250 TO 1500	0.0	2500 TO 3000	12.0
1500 TO 1750	0.0	3000 TO 3500	0.0
1750 TO 2000	0.0	3500 TO 4000	0.0
2000 TO 2250	0.0	4000 TO 4500	0.0

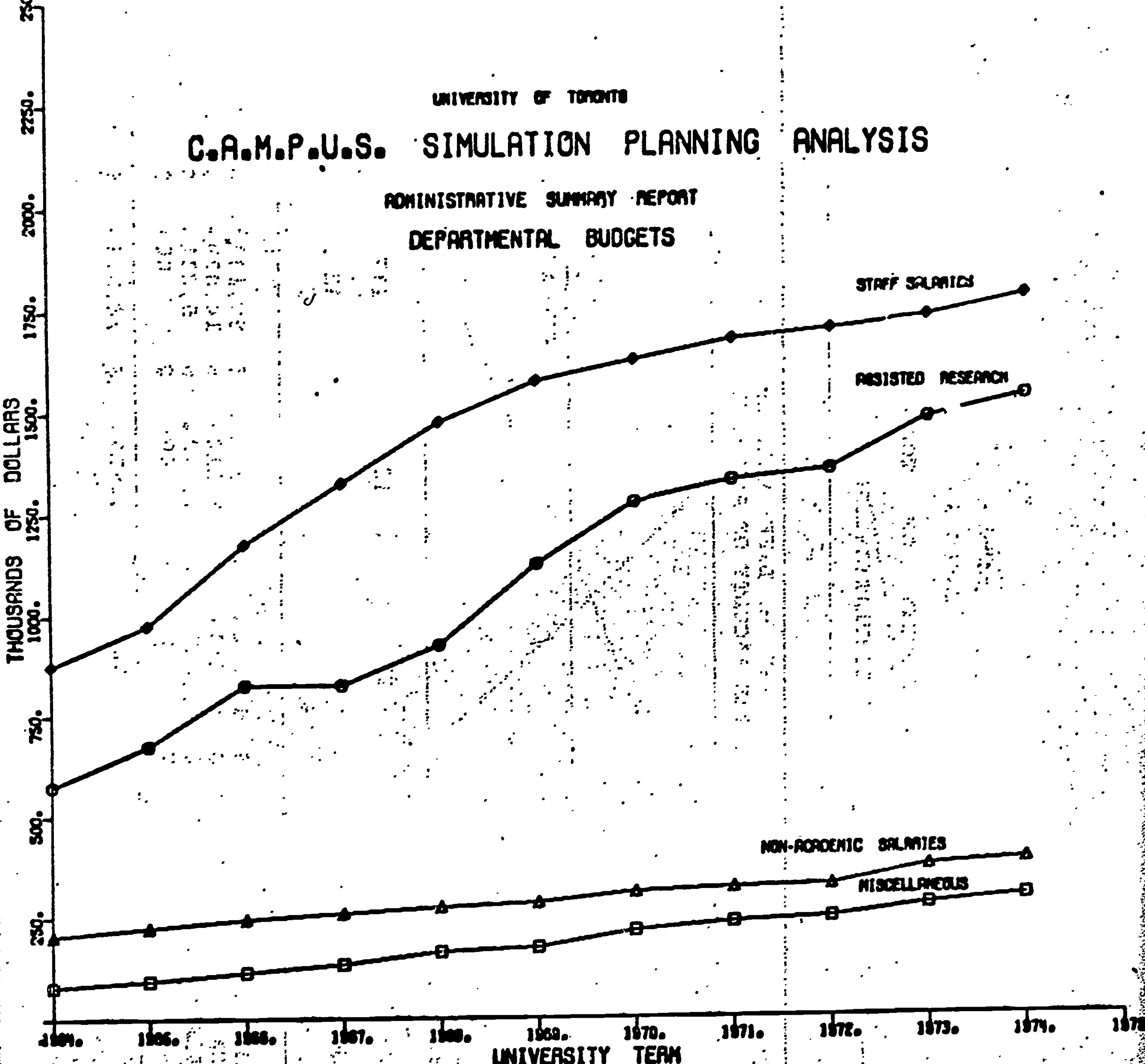
UNIVERSITY OF TORONTO
C.A.M.P.U.S. SIMULATION PLANNING ANALYSIS
ADMINISTRATIVE SUMMARY REPORT
DEPARTMENTAL BUDGETS
STAFF SALARIES
ASSISTED RESEARCH
NON-ACADEMIC SALARIES
MISCELLANEOUS
THOUSANDS OF DOLLARS
250.
500.
750.
1000.
1250.
1500.
1750.
2000.
2250.
2500
1965.
1966.
1967.
1969.
1970.
1971.
1972.
1973.
1974.
UNIVERSITY TERM

Figure 1

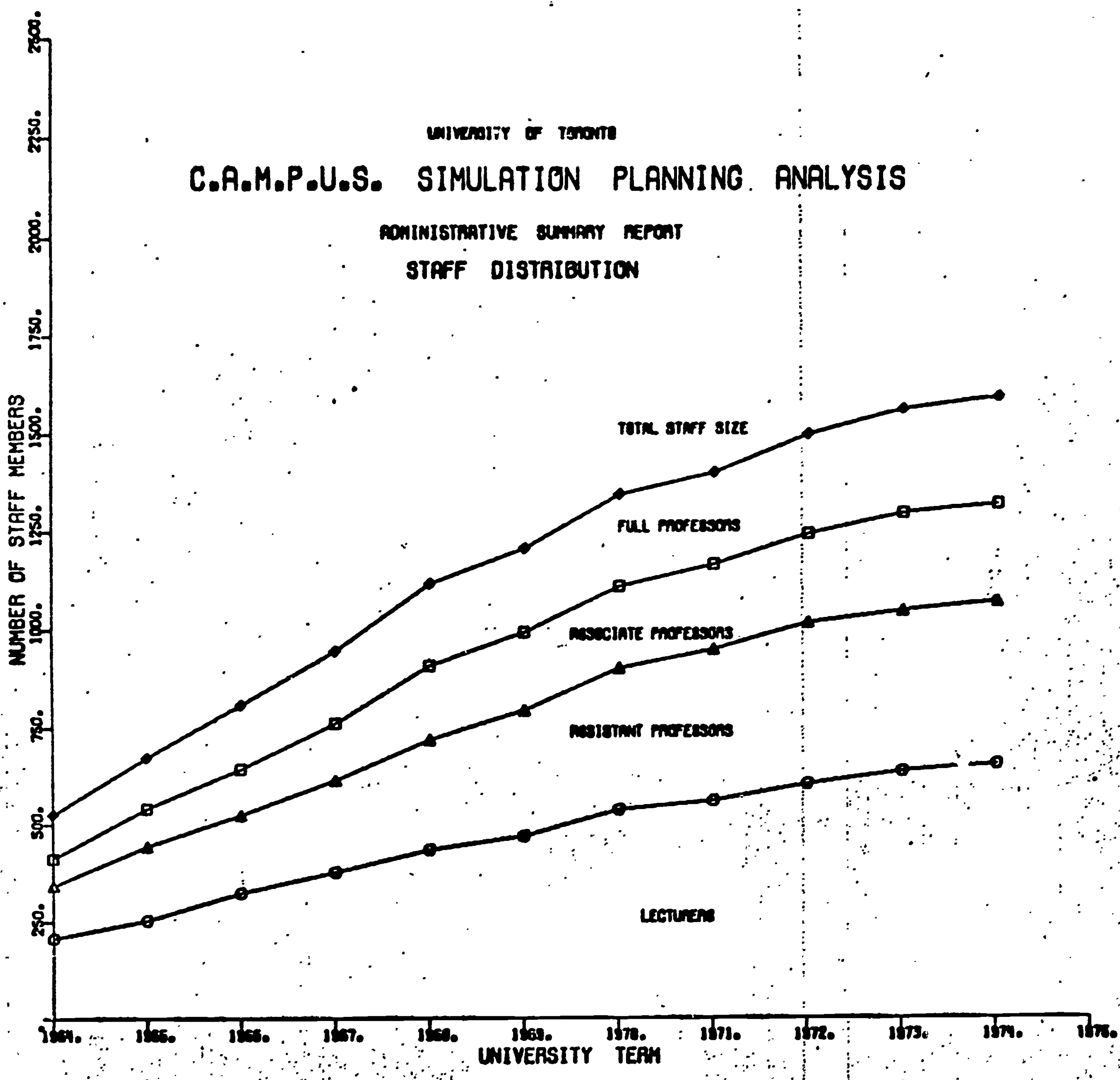
UNIVERSITY OF TORONTO
C.A.M.P.U.S. SIMULATION PLANNING ANALYSIS
ADMINISTRATIVE SUMMARY REPORT
STAFF DISTRIBUTION
NUMBER OF STAFF MEMBERS
250.
500.
750.
1000.
1250.
1500.
1750.
2000.
2250.
2500.
TOTAL STAFF SIZE
FULL PROFESSORS
ASSOCIATE PROFESSORS
ASSISTANT PROFESSORS
LECTURERS
1964.
1965.
1966.
1967.
1968.
1969.
1970.
1971.
1972.
1973.
1974.
1975.
UNIVERSITY TERM

Figure 2

the educational decision makers? For certain graduation levels, what would be the incremental cost of additional graduates from the various programs?

This problem differs from the one preceding in that graduation goals have replaced enrollment projections. Given data such as the passing and failing rates of the various programs, it is easy for the computer to convert graduation goals into the enrollments necessary to attain those goals. From here, the computation and analysis proceed identically to that outlined above.

3.2.1.3. Resource Implications of Alternative Campus Configurations

Consider a multi-campus university planning the development of a remote campus. The principal objective of the remote campus is to provide under-graduate liberal arts programs to students residing in close proximity to that campus. The argument is adduced that recruitment of qualified staff will be impossible without substantial provision for graduate instruction and research at the remote campus.

Problem: What are the resource implications of providing facilities for graduate instruction and research at the remote campus? What alternative means of attracting staff exist? How do the probable costs and effectiveness of the alternatives compare?

The first step in analysing this problem would be to elaborate alternative ways of attracting and retaining staff.

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Two possibilities follow:

1. Raise staff salaries by a premium to compensate faculty members for lack of graduate students and research facilities.

2. Provide research facilities and graduate student teaching opportunities at the central campus. Time for work at the central campus would be provided to faculty members at the remote campus. Transportation from remote to central campus would be provided by the university.

Each of the alternatives would be translated into different sets of system parameters and program levels. The simulation would be run for each set with unchanged values for all other parameters and program levels of the university. Computed resource requirements of each alternative would appear in reports such as those illustrated. The simulation would be allowed to run for a substantial time period, e.g., ten or fifteen years. Time series could be prepared by the plotter on

1. Number and type of staff at the remote and central campuses.

2. Salary costs (based on forecasted competitive salary levels plus fringe benefits and any "compensatory premia".

3. Facilities needs at the central and remote campuses including classrooms, laboratories, library space and reading rooms, offices, etc.

4. Capital construction costs based on type of building and local indexes of building costs.

With information about the estimated costs, university decision makers could juxtapose the probable effectiveness of each alternative. Other alternatives may be suggested by this cost/effectiveness analysis. The following "tradeoffs" can be examined:

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1. Academic salaries versus research facilities and costs of low volume graduate training at the remote campus.

2. Research and graduate instructional cost at the central campus versus analogous costs at the remote campus.

Finally, choice could be made by university decision-makers in the light of information provided by the cost/effectiveness analysis.

Obvious extensions of this sort of analysis are:

1. Study of the economics of specialization (or duplication) of programs among campuses or universities.

2. Study of the functional relationship between a program's level and its cost.

These two extensions could lead to a study of optimal campus size and optimal integration and co-ordination of several campuses (or universities) in a multi-campus university (or state university system).

3.2.1.4. Resource Implications of Redesigning a Medical School

At the University of Toronto a set of CAMPUS models was developed and used to analyse many alternative designs of the expanded Faculty of Medicine and other health science faculties. An impressionistic idea of these models and their interrelationships can be gained from Figure 3. These models, with modest modification, can be used at any other medical school. Several aspects of the real problems faced at the University of Toronto are simplified and presented below.

Consider a university School of Medicine faced with the necessity of doubling its annual output of doctors. Suppose, further, that major redesign of the medical curriculum is contemplated in order to take advantage of new medical knowledge and to accommodate the increased number of students. Clinical

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instruction now is to be organized on a systemic (respiratory, circulatory, reproductive, etc.) rather than on a departmental (Surgery, Medicine, Paediatrics, etc.) basis.

There exist many alternative ways of combining instruction in the basic medical sciences (Anatomy, Bacteriology, Biochemistry, etc.) with the clinical instruction. Two macro-level alternatives would be:

1. Build a large integrated university medical complex which would include facilities for instruction in the basic and clinical sciences, research, and treatment of patients.

2. Build a basic science complex at the central university campus where medical students would receive instruction during their initial period in the School.
   Build facilities at existing metropolitan hospitals to provide clinical instruction.

Each of these broad alternatives embraces many alternatives within it. And each of the latter entails its associated resource requirements: How many and what kind of lecture rooms, examining rooms, study areas, teaching laboratories, autopsy facilities, locker rooms, teaching beds, etc. are required at each of the clinical schools?

Answers to the questions posed above depend upon the number of students at each clinical school, the number of subjects that are taught, the size of clinical instruction groups, the degree of specialization of teaching at each clinical school, etc.

For simulation-assisted cost/benefit analysis to proceed, each alternative was translated into an unambiguous set of parameter values and, where necessary, into new equations and routines of the computer models. From the simulation results, the implications for each department

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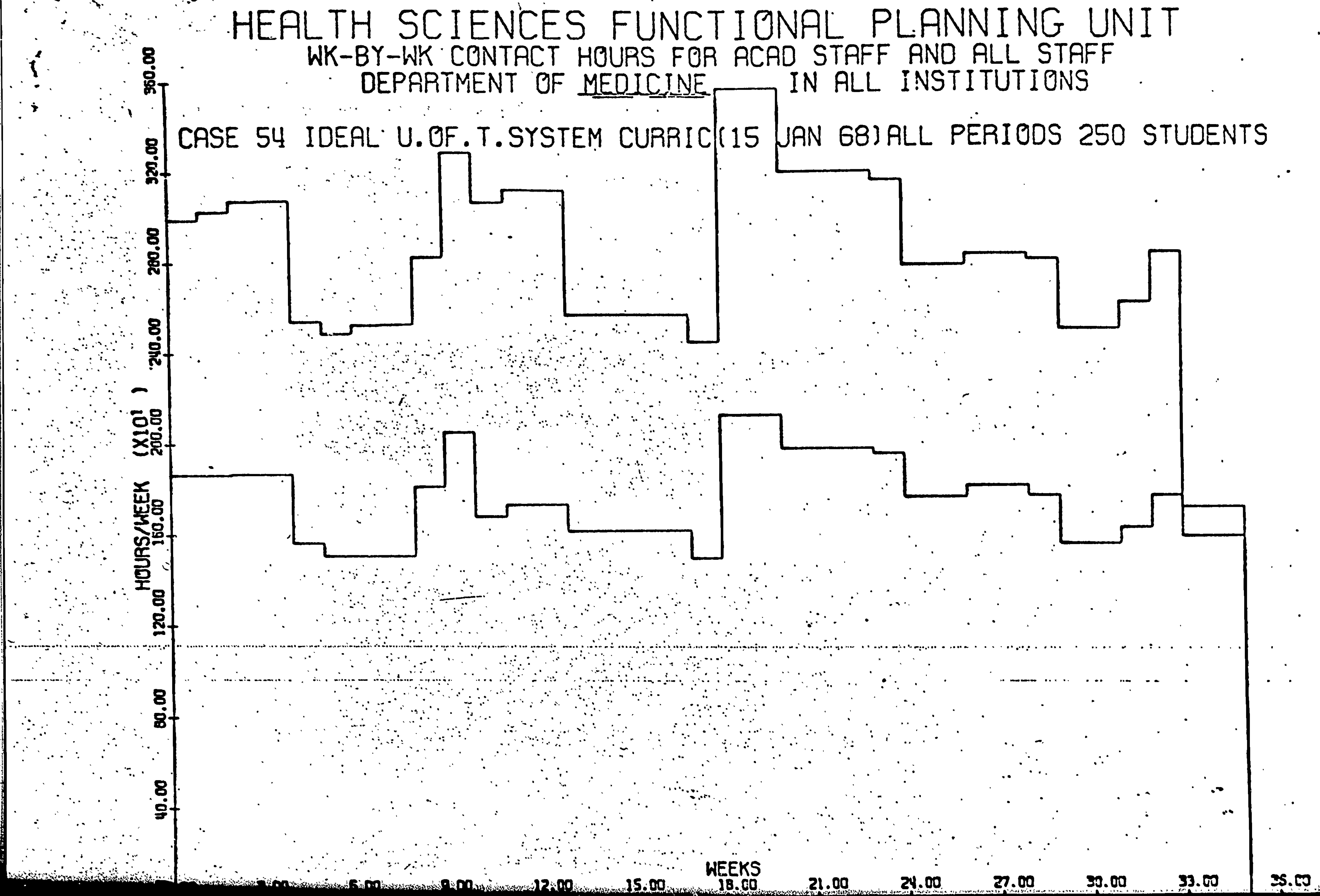
Figure 4


HEALTH SCIENCES FUNCTIONAL PLANNING UNIT
WK-BY-WK CONTACT HOURS FOR ACAD STAFF AND ALL STAFF
DEPARTMENT OF MEDICINE IN ALL INSTITUTIONS
CASE 54 IDEAL U.OF.T.SYSTEM CURRIC(15 JAN 68)ALL PERIODS 250 STUDENTS
HOURS/WEEK (X10[1])
360.00
320.00
280.00
240.00
200.00
160.00
120.00
80.00
40.00
WEEKS
12.00
15.00
18.00
21.00
24.00
27.00
30.00
33.00

and teaching hospital of each alternative curriculum is apparent. Figure 4 displays one of the many computer-prepared reports which are available.

3.2.1.5. Other Problems

CAMPUS models can facilitate the analysis necessary to resolve many other problems. A partial list of these follows:

* Justification of space needs to capital granting agencies.
* Detailed space and facilities specifications for architects.
* Estimation of the resource implications of comprehensive use of computer-assisted instruction and instructional television.
* Evaluation of the benefits to be gained from better classroom scheduling.
* Preparation and updating of university master plan.
* Expansion of existing campuses or creation of new ones.
* Evaluation of alternative policies concerning academic staff workloads.
* Evaluation of semester vs. tri-mester vs. quarter systems.
* Annual budgeting and Five-Year Program Planning and Budgeting.
* Expansion or contraction of various academic programs.
* Adjustment to severe budgetary constraints imposed from above.

It should be stressed that CAMPUS models are no more than tools. They do not substitute for good judgement. Used imaginatively and creatively, they can greatly extend the administrator's analytical powers. They are powerless in the hands of administrators who do not know how to ask the right questions.

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CAMPUS models are being used by the University of Toronto and three Community Colleges in Ontario. Other universities and colleges in Canada and the United States are developing CAMPUS models.

2.3 Integrated Information Systems

The information needs of university decision-making are great. The quantity, quality, relevance and timeliness of the information available to most university administrators is notoriously poor. A gap yawns between informational needs and informational availabilities. In a fundamental sense, the purpose of all systems analytic techniques like CAMPUS is to close that gap.

The CAMPUS models and the PPBS make heavy demands for input information. Coupled with these are the operational information needs of day-to-day university administration. To meet these demands and needs, the third CAMPUS sub-system is an integrated information system (IIS).

The heart of the IIS is a set of files on students, staff, physical plant, programs, activities, finances and policies. These major groups are subdivided into smaller areas of required information and finally into individual reports. In the discussion of information systems, major groupings are referred to as major systems and sub-divisions thereof as subsystems.

2.3.1. Student Files

The major system on students contains a minimum of seven basic data files. These include admission records, student personal data, non-academic records,

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academic records, housing data, alumni records, and academic controls.

2.3.2. Facilities File

The major system of facilities displays a minimum of six basic files. They are land and building inventory, rooms and facilities inventory, special laboratories data, equipment inventory, expendable items inventory and maintenance control data.

2.3.3. Finance Files

There are ten basic files on finance - three in the area of budget, budget data, income data and expense data; four files as a support to the accounting system, budget allotment, payment data, expense data, payroll charges and credits. Other files included are accounts receivable, accounts payable and student loans.

2.3.4. Activities File

Goal oriented programs are the dominant part of any future planning system. It is with respect to these programs that effectiveness will be gauged. Ten files are provided in six categories. The area of instruction has two files - current instructional contact and past instructional contact. In the area of research two files are alloted for research data and publications data. In the area of public services three files are created, one on extension activities, one on conferences and short courses and one called adult education. The fourth category contains data

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relating to student activities. The fifth shows control data and the only file suggested is curriculum control data. The sixth category shows a file for projected programs, the intent of which is to portray the activities related to the planning of research proposals, new curriculum and similar combinations of facilities and people to satisfy needs.

2.3.5. Staff Files

There are five basic files for staff.

a) A current personal data file provides current status data relating to resident's marital status, dependents, current pay deductions, departmental assignments, office address,etc. This type of data is in a separate file because it is used frequently and must be curre t with each use.

b) A payroll and deduction file provides a history of all salary and wage payments and all payroll deductions. In all cases this file should indicate the source of pay, the amounts of pay, the payroll deduction codes, deducted amounts by period, in order to provide an audit trail.

c) An historical data file provides data concerning past activities.

d) A staff activities file contains detailed data concerning current task assignments including all levels of activity.

e) A manpower control data file carries all necessary data for routine staff decisions. Its primary purpose is to facilitate the routine examination of staff eligible for or requiring change in status, fringe benefits, deductions, awards and similar matters.

The appropriate physical maintenance of these files in a separated or amalgamated form depends upon the type of data processing and storage equipment available at the individual university. The integration of the files is maintained in order to permit accessing and updating as illustrated by Figure 5.

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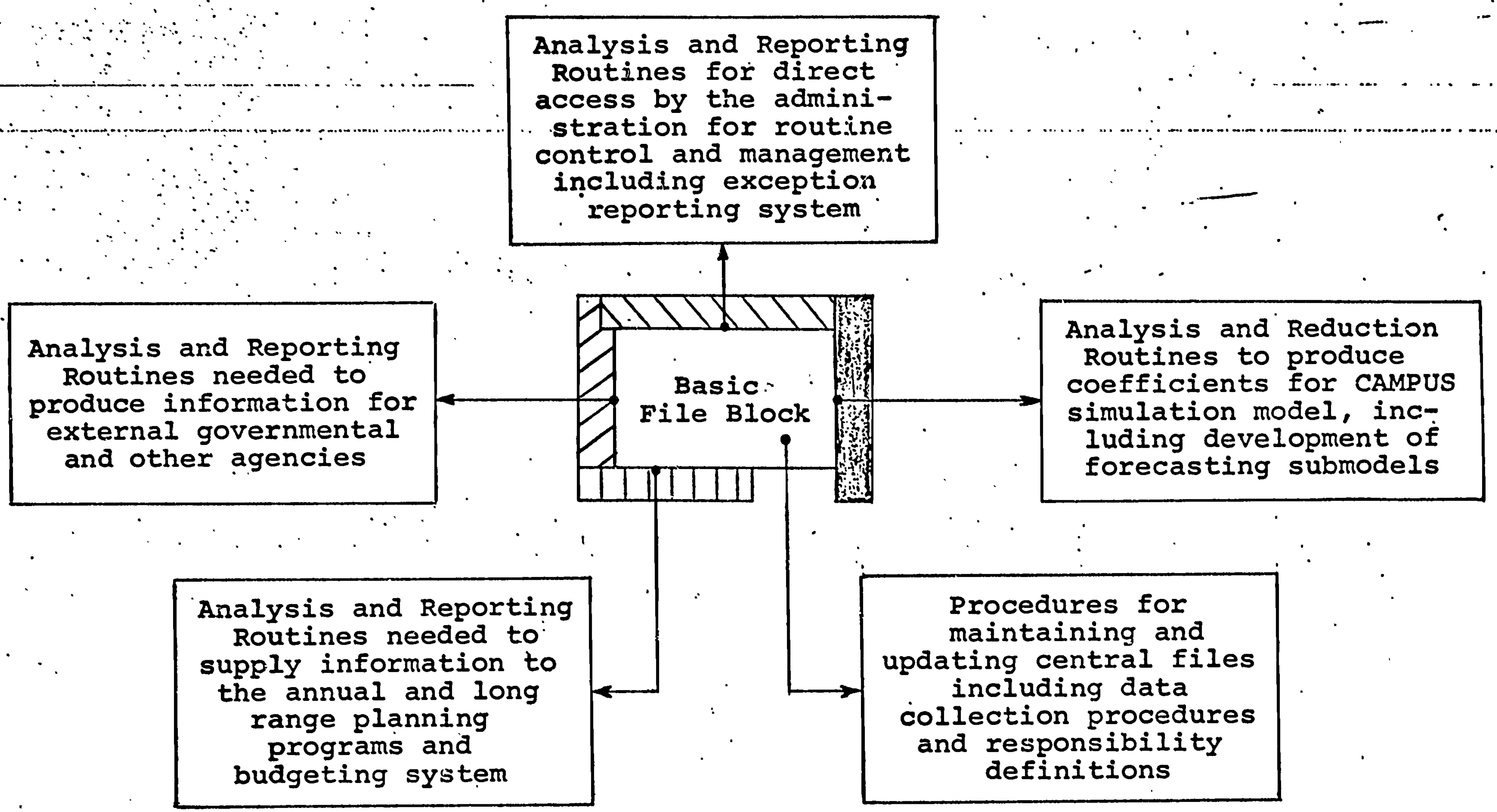
FIGURE 5

INFORMATION SYSTEM STRUCTURE FOR ELEMENT 'X'



Elements: Staff
Space
Finance
Students
Administrative Decisions
Structural Decisions

3.4 Linking the Programming Planning and Budgeting System, the Integrated Information System and the CAMPUS models

Basic information on past program levels, costs, decisions and statistical projections are fed from the IIS to the PPBS. A Program Director, who is responsible for setting the level of activity in a program area, and the cost center (e.g. department) chairman are provided historical information and projection information to use as reference points in making decisions. In addition, either of these persons can use the CAMPUS models to estimate the resource implications of their plans, evaluate alternatives, search for efficient combinations of resources and decisions, assess short-range plans in terms of long range ones, and in general provide analytical backup.

3.4.1 A Typical PPBS Cycle

Perhaps the easiest way to clarify the function of the PPBS, its usefulness and the way in which it combines with the IIS and CAMPUS models is to follow through a typical cycle of events.

3.4.1.1 Programming

The Programming phase attempts to display more clearly the basic objectives of the university in order to induce more substantive inquiry into the allocation of resources to programs. It is essential that the short term programs be an integral part of the long-term development plan. A typical set of university programs would be as follows:

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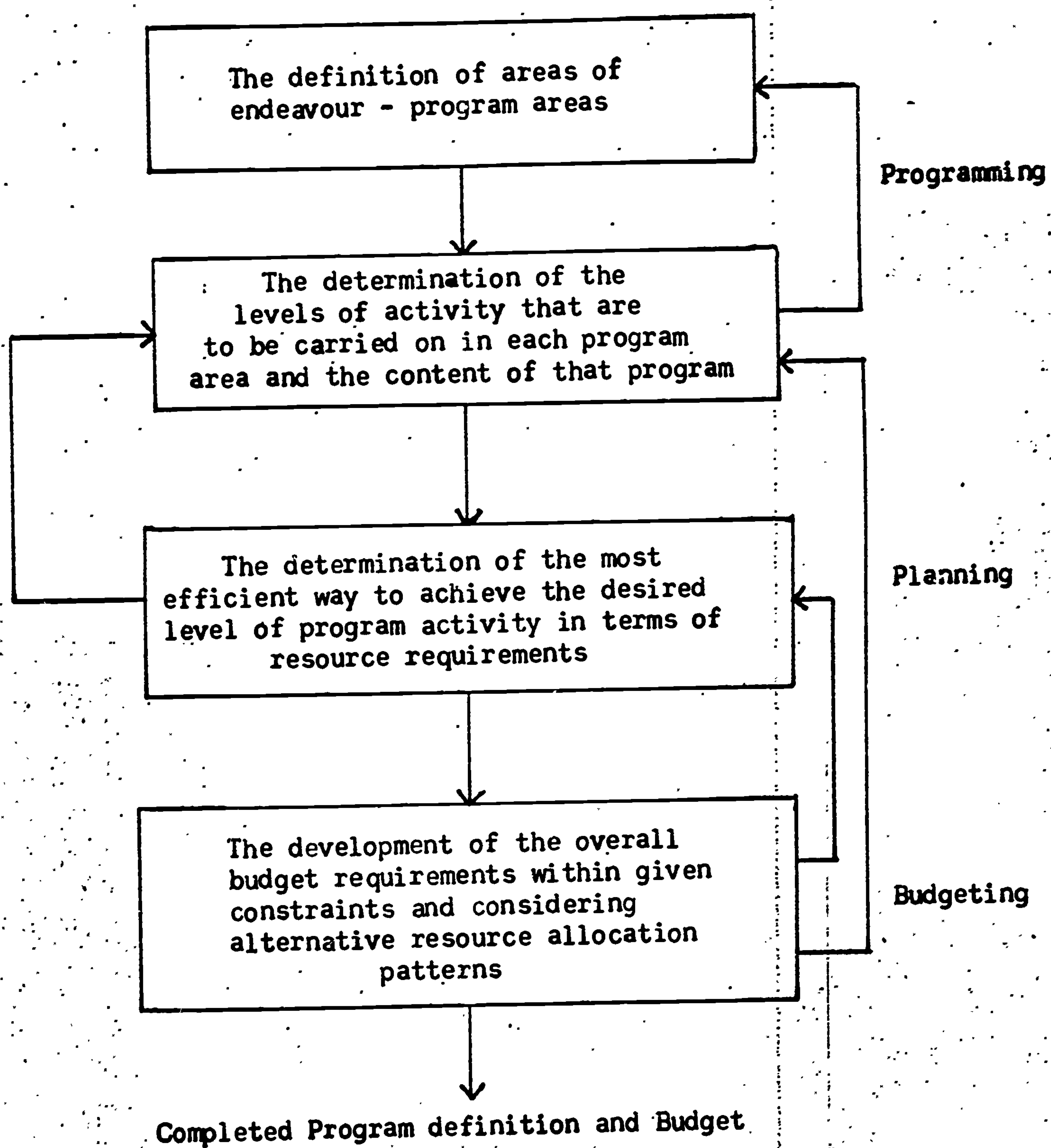
Figure 6

A Program Planning and Budgetary Cycle



Instruction

Undergraduate Studies

Arts

Graduates from the Programs in

* Philosophy
* Modern Languages & Literature
* Commerce and Finance
* Fine Art
* Sociology
* (et cetera)

Sciences

Graduates from the Programs in

* Mathematics
* Physics
* Chemistry
* Geological Science
* Biological & Medical Sciences
* (et cetera)

Engineering

* Graduates in Mechanical Engineering
* Graduates in Electrical Engineering
* Graduates in Chemical Engineering
* (et cetera)

* Education
* Journalism
* (et cetera)

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Instruction (continued)

Graduate Studies

*Philosophy M.A.'s and Ph.D.'s

* French Language & Literature M.A.'s and Ph.D.

* Physics M.A.'s and Ph.D.'s

* (et cetera)

Research in

* Chemistry

* History

* Zoology

* (et cetera)

*Library Development

* Scholarly Development of Faculty

* Public Service

* (et cetera)

It is not necessary to allocate every category of expenditure to some kind of teaching or a research program. Such expenditures as a portion of those on a library can be treated as separately pursued programs. However, when beginning an implementation program for PPBS it is desirable to introduce people gradually to the concept. Instructional programs, because they are easier to define, are a good place to start. These programs can be related to easily definable degree programs and then ultimately all of the other program categories can be aided.

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Figure 7.

UNIVERSITY OF TORONTO

PROGRAMME WORKLOAD. PROJECTION (FORM A)

PROGRAMME ____________

DIVISION ____________

PAGE ______

FISCAL YEAR																																				
ACADEMIC YEAR		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
STUDENTS	F.T.																																			
	P.T.																																			

SUPPORT DEPT. / DIVISION. SUBJECT. CODE. SUBJECT. NO. & ACADEMIC YEAR	YEAR	TYPE OF SUBJECT	TYPE OF SESSION	AVERAGE HOURS PER WEEK	STDNT.	STUDENT HOURS	STDNT.	STUDENT HOURS	STDNT.	STUDENT HOURS	STDNT.	STUDENT HOURS	STDNT.	STUDENT HOURS	STDNT.	STUDENT HOURS	STDNT.	STUDENT HOURS

The following are the major steps to be taken during the programming phase.

1. Develop the broad areas that are to be developed by the university. Decisions such as these must be made by the Academic Senate or other ultimate decision-making body.

2. Establish a program director (an individual or group) who will be responsible for defining the level and curriculum of each program.

3. Have program directors report in detail on the objectives, output measures and curricular activities that make up their programs.

4. Submit to each program director a computer-prepared report similar to that shown in Figure 4. Such a report displays relevant historical information present in the student and program files together with forecasts prepared on the basis of the historical information. Program directors should evaluate the historical information and forecasts.

5. Have program directors evaluate the likely effect of proposed changes in either program content or program level by using a CAMPUS model.

6. Obtain a corrected and updated version of Figure 4 incorporating all program changes. This should cover a five-year period.

3.4.1.2 <u>Planning</u>

Planning is concerned with determining the most effective way to achieve the desired level and curriculum of each program. Mainly, it involves the decisions of those at the load centers as to how they are going to bear the imposed loads.

The steps in the planning process can be illustrated as follows:

1. Identify each of the possible load centers in the university from which resources can be drawn. These normally are departments, centers, institutes, and facilities such as the library and computer centers.

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2. Designate for each load center a chairman (individual or group) who is responsible for determining how the load placed on that center will be met.

3. Assemble consolidated load information from the various program directors (see programming step 6). Provide each load center chairman with a report similar to that shown by Figure 5. The report, computer produced, displays the loads on the facilities of the department produced by all programs serviced by that load center.

4. Have each department chairman examine alternative ways of meeting the 5-year forecasted load. These alternatives will concern such matters as teaching loads per staff member, class sizes, emphasis on research, office space per staff member, clerical and secretarial assistance per staff member, salary levels, promotional practices and so on. This list is not exhaustive but only demonstrative of the kinds of logistical decisions to be made.

   The chairman can use a CAMPUS simulation model to assess the costs of alternative policies and decisions. He must be prepared to justify the resources implied by his decisions in terms of estimated departmental outputs.

5. Obtain tentative departmental plans for the planning period. These should include provisional decisions on such matters as those enumerated in the preceeding step.

6. Submit programs and departmental plans to a CAMPUS model to develop estimates of average and marginal program costs for planning period.

7. Review costs of various programs and evaluate the relative desirability of all programs and their proposed levels. Evaluate justification of departmental decisions.

8. If programs and plans seem satisfactory, proceed to budgeting phase. If they are not satisfactory, recycle to the programming or planning stages.

3.4.1.3. Budgeting

While some budgeting, or tailoring of requests to available resources, will take place at the subunit level of the organization, the major budgetary evaluation will be initiated

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Figure 8.

UNIVERSITY OF TORONTO

DIVISION/DEPT. WORKLOAD SUMMARY FORM B.

DIVISION ______

DEPT. ______

PAGE ______

PROGRAMMES OFFERED																			
TO DIVISION OF	TO YEAR	GENERAL OR HONOUR	TYPE OF SUBJECT	SUBJ. STDNT	STUDENT HRS/WK	SUBJ. STDNT	STUDENT HRS/WK	SUBJ. STDNT	STUDENT HRS/WK	SUBJ. STDNT	STUDENT HRS/WK	SUBJ. STDNT	STUDENT HRS/WK	SUBJ. STDNT	STUDENT HRS/WK	SUBJ. STDNT	STUDENT HRS/WK		

and carried out by the top administration. The attempt to bring requests for funds into line with the funds available will cause the programming and planning stages to be recycled in order to rationally and objectively change program areas, program levels and decisions that will enable the total activities of the university to be carried out within the budget.

During this feedback process, a CAMPUS model is an essential part of the evaluation process in order to make informed decisions on the changes that have to be made to meet budgetary constraints. In addition, the model can be used to evaluate the explicit decisions that have been made in the programming and planning stages in order to assess the resource requests that have been made.

Analysis of this kind will not always provide definitive and literal quantitative solutions to problems of resource allocation. Nevertheless, analytically supported programs budgeting of this kind should at least help to raise the right questions and direct attention to the important tradeoffs.

Normally, university budgets are prepared in terms of a number of line items. Such a presentation means that those in charge of allocating scarce resources during the budgetary phase find it extremely difficult to discern the rationale behind such requests. In this case, by using a PPBS, all the pertinent facts are presented in a framework that allows others to analyze their impact and presumably come to the same conclusions with respect to the resources required, since the

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framework for analysis, the PPBS, the IIS, and CAMPUS models are open to scrutiny.

3. Introducing Systems Analysis at a University

A university normally has many areas for the application of systems analysis. Some problems may be of a "one-shot" type. In the rare situation where problems are few and all of this type, it may be best for the university to engage capable consultants to the job. More usually, the university has many areas where the payoffs to systems analysis will be great. A significant share of problems in these areas will be of a chronic or recurring nature because they are closely related to the constant management functions of planning, budgeting and control. When this is true, there is a strong case for introducing systems and analysis directly into the administrative organization.

By "introducing" systems analysis into a university, we mean two things:

(1) The creation of a systems analysis group that will develop and adapt effective management tools and apply them to specific university problems.

(2) The diffusion of an analytic and systematic approach to decision-making to all levels of university administration.

3.1 The Proper Atmosphere

The most crucial condition for a successful introduction of systems analysis is that the proper atmosphere be established by the attitudes and expectations of the to, administration itself. It should be expected that decision-

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makers at all levels will try to be unambiguous about setting their objectives, specific in selecting criteria for their evaluation, creative in developing alternative means of achieving their objectives, conscientious in estimating the probable costs and benefits of the alternatives, and consistent in choosing from the alternatives. If the top administration clearly displays these expectations, the demand for systematic analysis will tend to develop its own supply at all levels.

Certain attitudes are inimical to the introduction of systems analysis. Some administrators fear that cherished ambitions will be jeopardized in the cold light of objective information. Charisma and obfuscation do not mix well with systems analysis. Neither does inflexible adherence to precedents and rules of thumb. Any who wish to conceal the underlying causes of requests for resources will not welcome the introduction of systems analysis.

3.2 Establishing an Analytical Group

Few universities, even the largest ones, provide adequate staff support to their top decision-makers. Decisions of great consequence are made without the kind of study that business firms would lavish on much less significant problems. As the potential benefits of systems analysis becomes more apparent, many universities will establish analytical groups to help realize those benefits. Specific conditions will dictate how and where the group should be organized in each university but a few generalizations are possible.

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First of all, it is extremely desirable that the top administration should form specific expectations of the group. To do this, the administrators must become sufficiently informed about the potentials of a systems analysis group. They can best do this by learning from the experience of others, e.g., by consultation with knowledgeable people from another university or from a management consulting firm with experience in this field. Such firms include Ernst and Ernst in the United States, Stevenson and Kellogg in Canada and the Systems Research Group in both countries.

The analytical group should be oriented toward decision-making. This sounds obvious but often there is a tendency for such groups to degenerate into data processing units or generators of "quick and dirty" staff studies. The other extreme, equally undesirable, is for the group to become isolated from the decision process and become devoted exclusively to "pure" research. To maintain the group's decision orientation, it is necessary that its director constantly be exposed to university problems at all levels. This means that he should be an ex-officio member of the most important university committees and be consulted on major policies and decisions.

The director of the analytical group should ideally be both experienced in management and skilled in the development and use of analytical tools. If it proves impossible to find both qualities in the same person, it is usually wise to sacrifice the second and hire a deputy director with the needed technical skills.

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It is impossible to make general organizational prescription because local circumstances will condition what these ought to be. Here, again, the advice of experienced consultants may be valuable.

4. Conclusion

By 1969, a number of universities have made good use of the tools of systems analysis in university administration. These tools promise to contribute significantly to better university decision-making. The contribution will be realized by the work of specially created analytic groups and by the diffusion of the systems analytic approach to decision-making throughout the entire administrative structures of universities.

The benefits from the introduction of systems analysis are better use of resources within universities and greater credibility of the universities' statements of requirements for financial and other support.

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