APPLICATION OF THE CAMPUS SIMULATION MODELS TO THE MAJOR PLANNING DECISIONS OF A LARGE UNIVERSITY

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ACKNOWLEDGEMENTS

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Administrative planning and budgeting procedures within universities usually center around an argumentative pie-cutting process. Various factions argue their case for incremental increases in their budgets by moving from general statements of objectives to very specific requests for additional resources. Lack of a formal link between these two extremes makes it virtually impossible for senior administrative bodies to assay the justification of the request. An exploration and structuring of this middle ground between generalized objectives and specific resource requests must be undertaken if colleges and universities are to meet the mounting pressures on them to use their resources wisely. Educators will have to be more systematic in deciding on the physical and financial needs of new or expanded institutions, justifying budget requests to governments, foundations, etc. and allocating funds to competing users within the institution.

CAMPUS (Comprehensive Analytical Methods for Planning in University Systems) is an attempt to close this gap. CAMPUS, under development since 1964 at the University of Toronto, is composed of three integrated components.

1. A Program Planning and Budgeting System

Program planning and budgeting gained fame in the Pentagon under Robert MacNamara. It has been widely copied and often misused. Used wisely, it provides a framework for the more specific articulation of objectives and the integration of systematic decision-making into the university's budgetary process. In CAMPUS it plays this integrating role.

2. A Series of Resource Planning Simulation Models

Intelligent choice requires information about the costs and benefits of alternatives. These models structure the link between objectives and resource requirements. The models can be used to explore the resource implications of wide ranges of alternatives both with respect to the impact of exogenous variables and internally controlled decision variables such as class sizes, professorial work weeks, extent of research programs and so on. With the exception of a few small portions of CAMPUS, programming is done in Fortran. Extensive input and output routines are incorporated on a hierarchical and modular basis. The level of detail, type of information, viewpoint, and a number of other controls are set by the user to determine the output package that he will receive. The present models all operate in a batch processing mode although considerable experimental capabilities are included. Interactive versions of some of the models are being constructed under a $750,000 Ford grant to do research on the applications of systems analysis to the problems of planning in higher education.

3. An Integrated Information System

Future possibilities and needs of a university will be greatly influenced by its past and present status. Information about status is vital for systematic decision-making and timely and accurate information is a primary component of the program planning and budgeting system and the simulation models. Information systems must be economical to operate and busy academic staff cannot afford to be bombarded by constant requests for data. Wasteful duplication of effort is avoided in the CAMPUS concept of integrated information systems on staff, space, students, finances and decisions.

Figure 2 gives a schematic outline of a program planning and budgeting cycle using these three components and Figure 3 outlines in more detail the scope of use for the CAMPUS system beyond the confines of the annual budgetary cycle. Figures 4, 5 and 6 contain a schematic flow diagram showing the logical structure of one of the CAMPUS simulation models. Sample

reports from the CAMPUS simulation models are shown in Figures 7 through 10.

Analysis of the Decision to Expand the Medical Faculty

Following is a description of the way in which one of the CAMPUS models, the JCL3W model was used in the planning of significant alterations and expansions to a health sciences complex. The medical school was expanding its enrolment from 175 students per medical year to 250. In conjunction with this increased enrolment, a number of other factors were to be considered:

. The change from a departmental to an organic systems curriculum

. The allocation of students to seven associated teaching hospitals

. The effect of reducing the number of teaching hospitals or specializing them

. The impact of altering basic parameters such as teaching group sizes

. The effect of alternative staffing policies.

Each of the three major periods of the curriculum had assigned to it a committee of staff members concerned with the detailed planning. Figure 11 shows the way in which the CAMPUS model was integrated into the planning process. Figure 12 is a rough schematic of the model and Figures 13 through 16 show sample outputs.

The model made detailed resource calculations for all university and hospital departments. The wide variation in the impact of changes on resource requirements helped to convince those involved in the planning process of the benefits of this approach. With 250 students per year the proposed systems curriculum method would require about 85% more academic staff contact hours for the entire faculty. However in clinical departments the requirements for academic staff hours would be about twice as large with the proposed systems curriculum as with the previous departmental one. On the other hand the total requirements for hospitalized patients would be less than 10% more under the new system.

Summary Comments

CAMPUS then, as seen above, is an attempt to formalize the budgetary and planning processes of the university. Vague statements of objectives are made more specific and the various pedagogical and administrative decisions that combine with these objectives to produce the requirements for resources have had their inter-relationships structured and been made more explicit. Under these circumstances decisions are not made automatically but they are focused on the evaluation of the values of basic educational parameters and their impact on resource requirements.

Figure 1

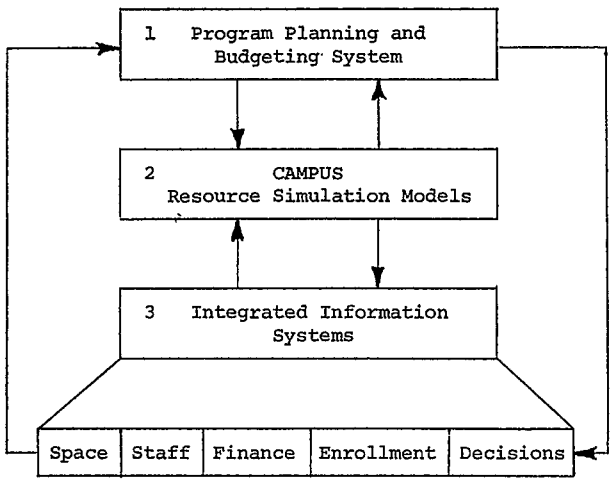


Figure 2

A Program Planning and Budgetary Cycle

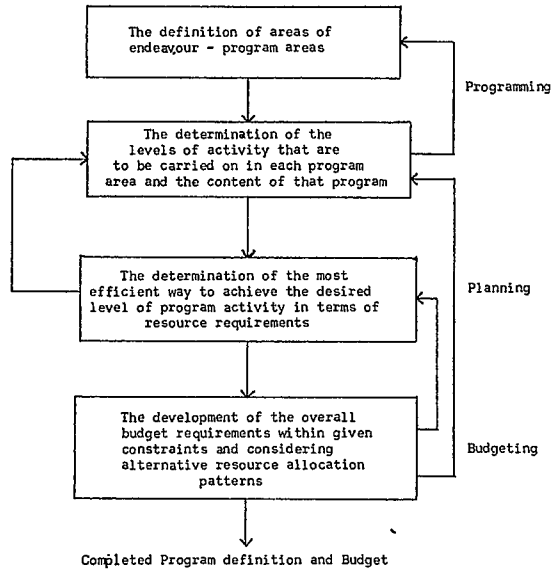


Figure 3

C.A.M.P.U.S.
Comprehensive Analytical Method of Planning
in the University Sphere

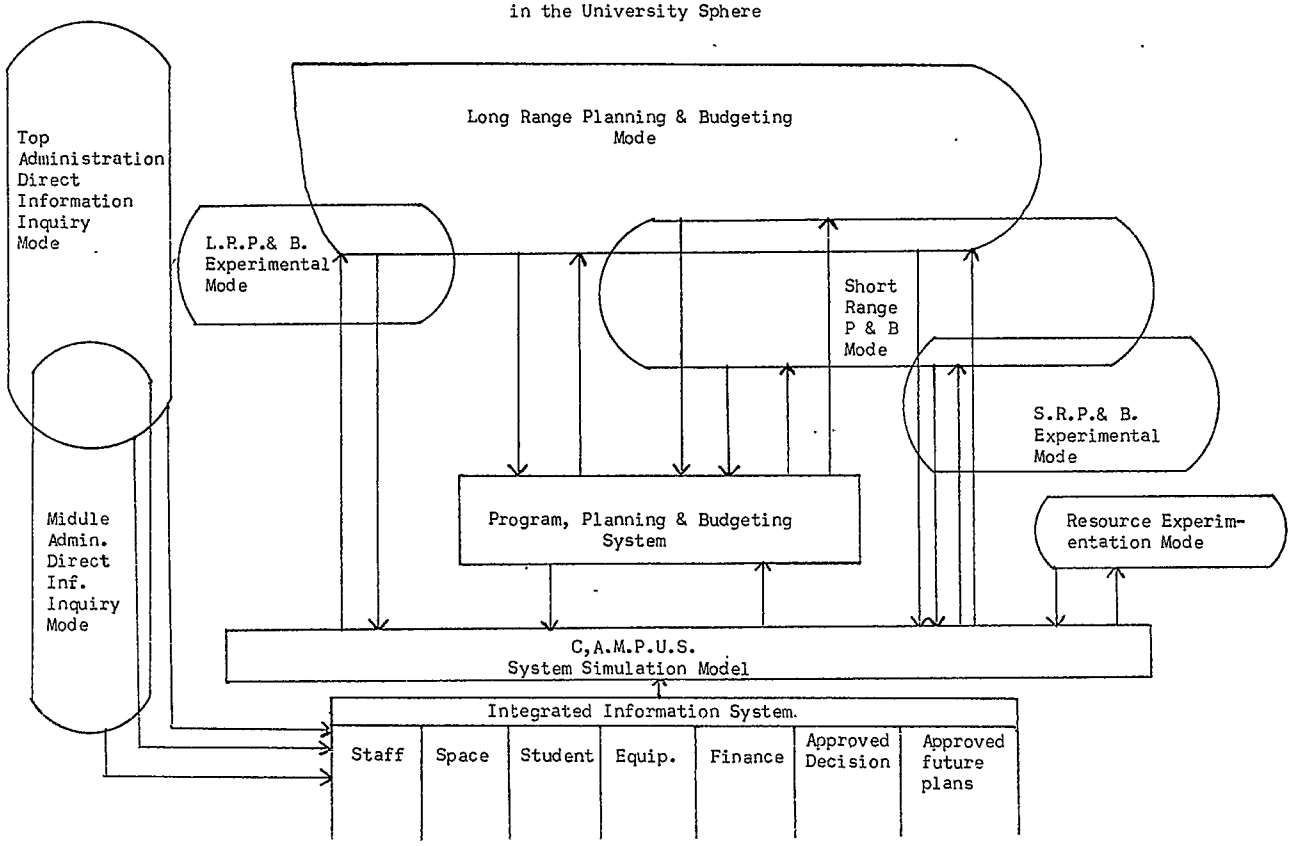


Fig. 4

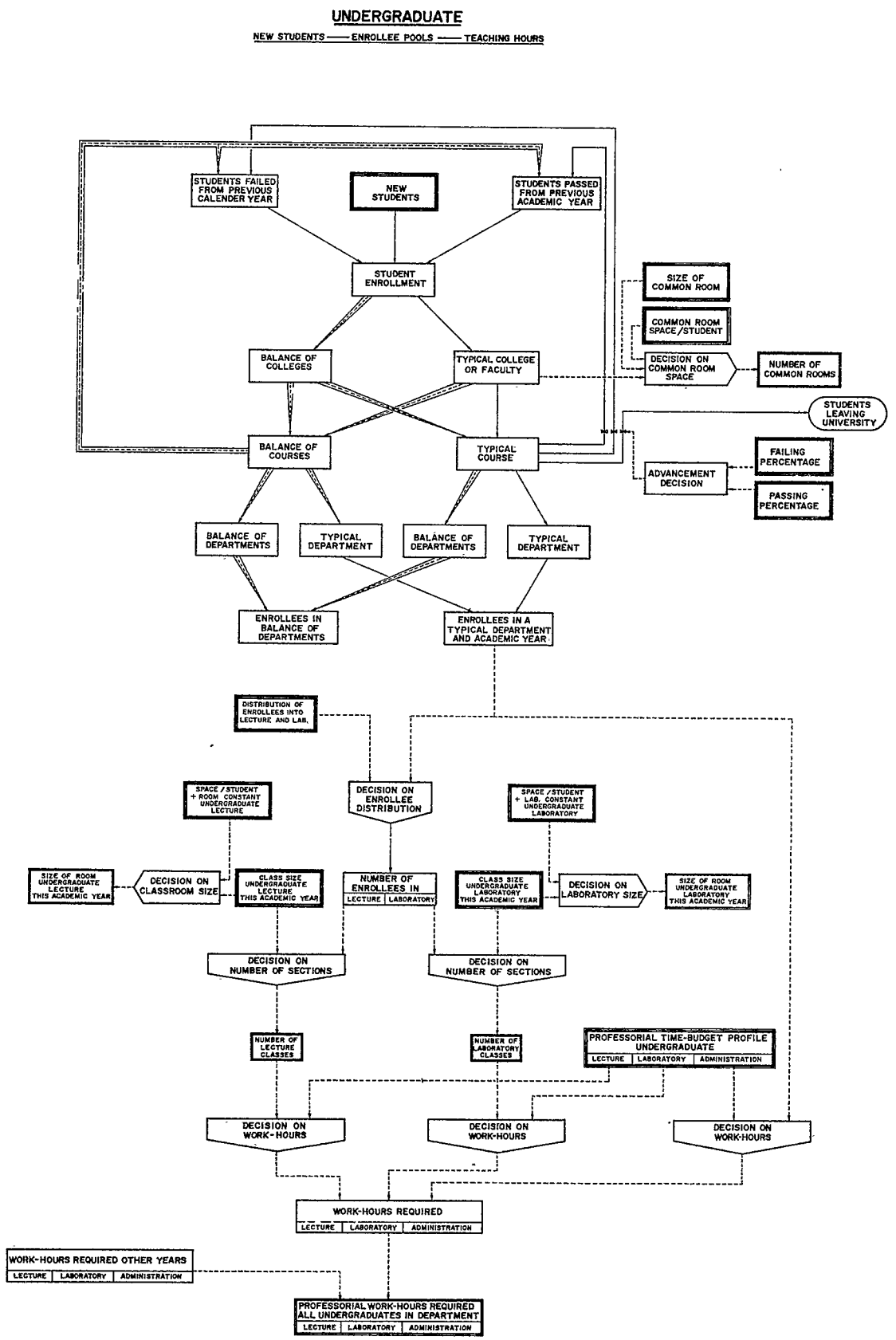

UNDERGRADUATE
NEW STUDENTS —— ENROLLEE POOLS —— TEACHING HOURS
STUDENTS FAILED FROM PREVIOUS CALENDER YEAR
NEW STUDENTS
STUDENTS PASSED FROM PREVIOUS ACADEMIC YEAR
STUDENT ENROLLMENT
SIZE OF COMMON ROOM
COMMON ROOM SPACE/STUDENT
DECISION ON COMMON ROOM SPACE
NUMBER OF COMMON ROOMS
BALANCE OF COLLEGES
TYPICAL COLLEGE OR FACULTY
STUDENTS LEAVING UNIVERSITY
BALANCE OF COURSES
TYPICAL COURSE
ADVANCEMENT DECISION
FAILING PERCENTAGE
PASSING PERCENTAGE
BALANCE OF DEPARTMENTS
TYPICAL DEPARTMENT
BALANCE OF DEPARTMENTS
TYPICAL DEPARTMENT
ENROLLEES IN BALANCE OF DEPARTMENTS
ENROLLEES IN A TYPICAL DEPARTMENT AND ACADEMIC YEAR
DISTRIBUTION OF ENROLLEES INTO LECTURE AND LAB.
SPACE / STUDENT + ROOM CONSTANT UNDERGRADUATE LECTURE
DECISION ON ENROLLEE DISTRIBUTION
SPACE / STUDENT + LAB. CONSTANT UNDERGRADUATE LABORATORY
SIZE OF ROOM UNDERGRADUATE LECTURE THIS ACADEMIC YEAR
DECISION ON CLASSROOM SIZE
CLASS SIZE UNDERGRADUATE LECTURE THIS ACADEMIC YEAR
NUMBER OF ENROLLEES IN
LECTURE | LABORATORY
CLASS SIZE UNDERGRADUATE LABORATORY THIS ACADEMIC YEAR
DECISION ON LABORATORY SIZE
SIZE OF ROOM UNDERGRADUATE LABORATORY THIS ACADEMIC YEAR
DECISION ON NUMBER OF SECTIONS
DECISION ON NUMBER OF SECTIONS
NUMBER OF LECTURE CLASSES
NUMBER OF LABORATORY CLASSES
PROFESSORIAL TIME-BUDGET PROFILE UNDERGRADUATE
LECTURE | LABORATORY | ADMINISTRATION
DECISION ON WORK-HOURS
DECISION ON WORK-HOURS
DECISION ON WORK-HOURS
WORK-HOURS REQUIRED
LECTURE | LABORATORY | ADMINISTRATION
WORK-HOURS REQUIRED OTHER YEARS
LECTURE | LABORATORY | ADMINISTRATION
PROFESSORIAL WORK-HOURS REQUIRED ALL UNDERGRADUATES IN DEPARTMENT
LECTURE | LABORATORY | ADMINISTRATION

Fig. 5

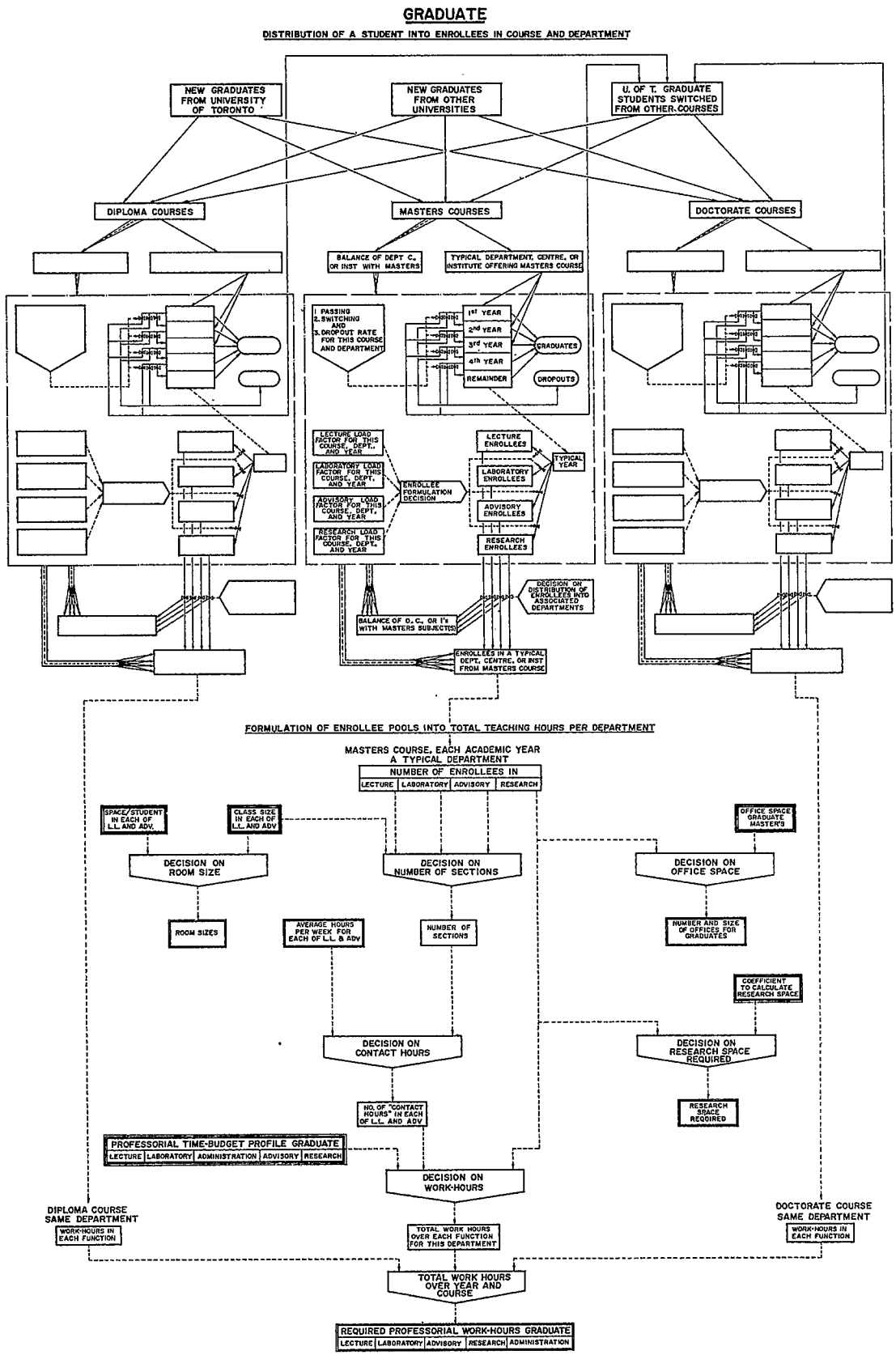

GRADUATE
DISTRIBUTION OF A STUDENT INTO ENROLLEES IN COURSE AND DEPARTMENT
NEW GRADUATES FROM UNIVERSITY OF TORONTO
NEW GRADUATES FROM OTHER UNIVERSITIES
U. OF T. GRADUATE STUDENTS SWITCHED FROM OTHER COURSES
DIPLOMA COURSES
MASTERS COURSES
DOCTORATE COURSES
BALANCE OF DEPT C. OR INST WITH MASTERS
TYPICAL DEPARTMENT, CENTRE, OR INSTITUTE OFFERING MASTERS COURSE
1. PASSING 2. SWITCHING AND 3. DROPOUT RATE FOR THIS COURSE AND DEPARTMENT
1ST YEAR
2ND YEAR
3RD YEAR
4TH YEAR
REMAINDER
GRADUATES
DROPOUTS
LECTURE LOAD FACTOR FOR THIS COURSE, DEPT., AND YEAR
LABORATORY LOAD FACTOR FOR THIS COURSE, DEPT., AND YEAR
ADVISORY LOAD FACTOR FOR THIS COURSE, DEPT., AND YEAR
RESEARCH LOAD FACTOR FOR THIS COURSE, DEPT., AND YEAR
ENROLLEE FORMULATION DECISION
LECTURE ENROLLEES
LABORATORY ENROLLEES
ADVISORY ENROLLEES
RESEARCH ENROLLEES
TYPICAL YEAR
DECISION ON DISTRIBUTION OF ENROLLEES INTO ASSOCIATED DEPARTMENTS
BALANCE OF D. C. OR I's WITH MASTERS SUBJECT(S)
ENROLLEES IN A TYPICAL DEPT, CENTRE, OR INST FROM MASTERS COURSE
FORMULATION OF ENROLLEE POOLS INTO TOTAL TEACHING HOURS PER DEPARTMENT
MASTERS COURSE, EACH ACADEMIC YEAR A TYPICAL DEPARTMENT
NUMBER OF ENROLLEES IN
LECTURE
LABORATORY
ADVISORY
RESEARCH
SPACE/STUDENT IN EACH OF L.L. AND ADV.
CLASS SIZE IN EACH OF L.L. AND ADV
OFFICE SPACE GRADUATE MASTER'S
DECISION ON ROOM SIZE
DECISION ON NUMBER OF SECTIONS
DECISION ON OFFICE SPACE
ROOM SIZES
AVERAGE HOURS PER WEEK FOR EACH OF L.L. & ADV
NUMBER OF SECTIONS
NUMBER AND SIZE OF OFFICES FOR GRADUATES
COEFFICIENT TO CALCULATE RESEARCH SPACE
DECISION ON CONTACT HOURS
DECISION ON RESEARCH SPACE REQUIRED
NO. OF "CONTACT HOURS" IN EACH OF L.L. AND ADV.
RESEARCH SPACE REQUIRED
PROFESSORIAL TIME-BUDGET PROFILE GRADUATE
LECTURE
LABORATORY
ADMINISTRATION
ADVISORY
RESEARCH
DECISION ON WORK-HOURS
DIPLOMA COURSE SAME DEPARTMENT
WORK-HOURS IN EACH FUNCTION
TOTAL WORK HOURS OVER EACH FUNCTION FOR THIS DEPARTMENT
DOCTORATE COURSE SAME DEPARTMENT
WORK-HOURS IN EACH FUNCTION
TOTAL WORK HOURS OVER YEAR AND COURSE
REQUIRED PROFESSORIAL WORK-HOURS GRADUATE
LECTURE
LABORATORY
ADVISORY
RESEARCH
ADMINISTRATION

Fig. 6

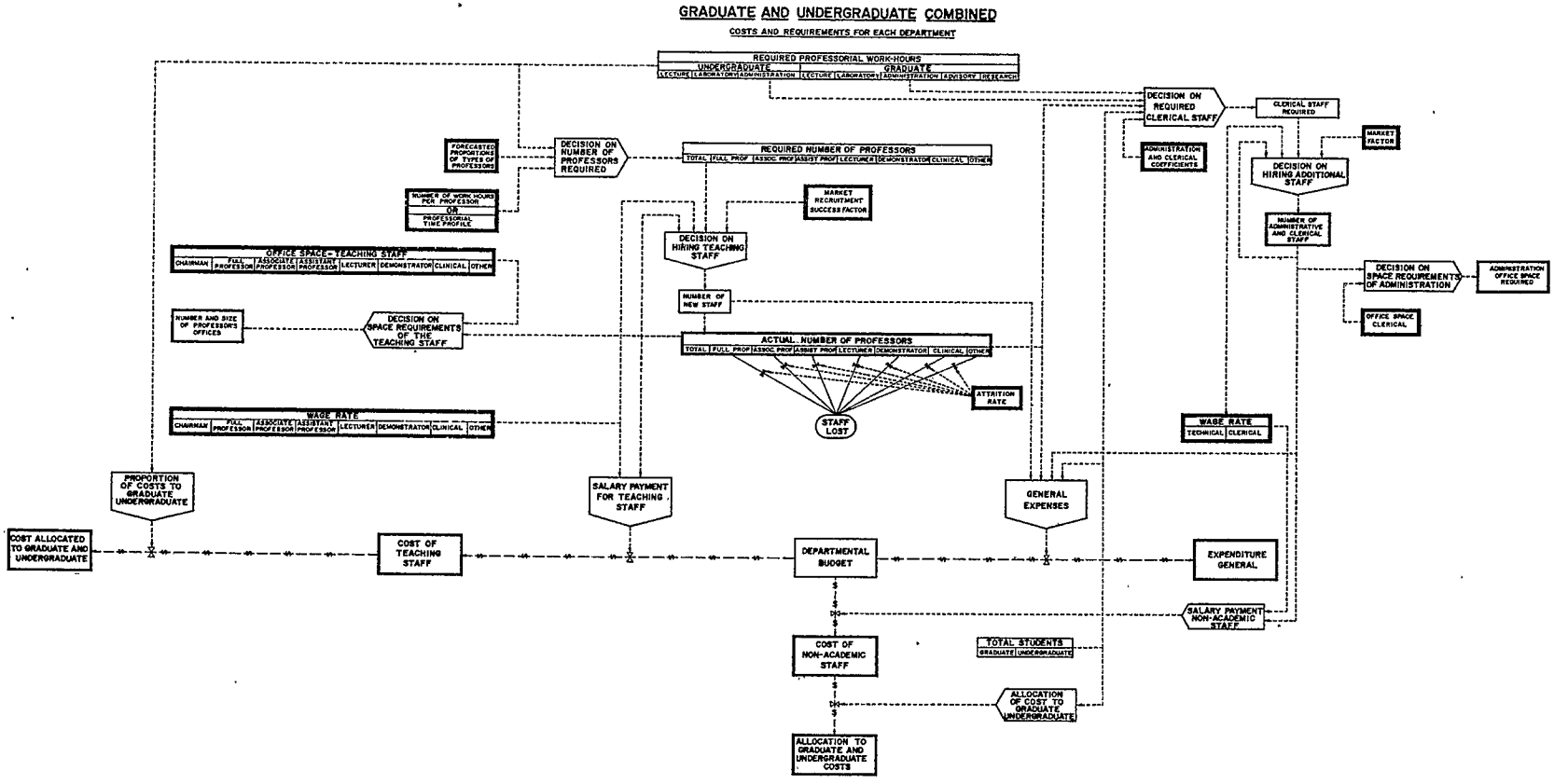

GRADUATE AND UNDERGRADUATE COMBINED
COSTS AND REQUIREMENTS FOR EACH DEPARTMENT
REQUIRED PROFESSORIAL WORK-HOURS
UNDERGRADUATE
LECTURE
LABORATORY
ADMINISTRATION
GRADUATE
LECTURE
LABORATORY
ADMINISTRATION
ADVISORY
RESEARCH
FORECASTED PROPORTIONS OF TYPES OF PROFESSORS
NUMBER OF WORK HOURS PER PROFESSOR
OR
PROFESSORIAL TIME PROFILE
DECISION ON NUMBER OF PROFESSORS REQUIRED
REQUIRED NUMBER OF PROFESSORS
TOTAL
FULL PROF
ASSOC PROF
ASSIST PROF
LECTURER
DEMONSTRATOR
CLINICAL
OTHER
MARKET RECRUITMENT SUCCESS FACTOR
DECISION ON HIRING TEACHING STAFF
OFFICE SPACE - TEACHING STAFF
CHAIRMAN
FULL PROFESSOR
ASSOCIATE PROFESSOR
ASSISTANT PROFESSOR
LECTURER
DEMONSTRATOR
CLINICAL
OTHER
NUMBER AND SIZE OF PROFESSORS OFFICES
DECISION ON SPACE REQUIREMENTS OF THE TEACHING STAFF
NUMBER OF NEW STAFF
ACTUAL NUMBER OF PROFESSORS
TOTAL
FULL PROF
ASSOC PROF
ASSIST PROF
LECTURER
DEMONSTRATOR
CLINICAL
OTHER
ATTRITION RATE
STAFF LOST
WAGE RATE
CHAIRMAN
FULL PROFESSOR
ASSOCIATE PROFESSOR
ASSISTANT PROFESSOR
LECTURER
DEMONSTRATOR
CLINICAL
OTHER
PROPORTION OF COSTS TO GRADUATE UNDERGRADUATE
COST ALLOCATED TO GRADUATE AND UNDERGRADUATE
COST OF TEACHING STAFF
SALARY PAYMENT FOR TEACHING STAFF
DEPARTMENTAL BUDGET
GENERAL EXPENSES
EXPENDITURE GENERAL
SALARY PAYMENT NON-ACADEMIC STAFF
COST OF NON-ACADEMIC STAFF
TOTAL STUDENTS
GRADUATE
UNDERGRADUATE
ALLOCATION OF COST TO GRADUATE UNDERGRADUATE
ALLOCATION TO GRADUATE AND UNDERGRADUATE COSTS
DECISION ON REQUIRED CLERICAL STAFF
CLERICAL STAFF REQUIRED
ADMINISTRATION AND CLERICAL COEFFICIENTS
MARKET FACTOR
DECISION ON HIRING ADDITIONAL STAFF
NUMBER OF ADMINISTRATIVE AND CLERICAL STAFF
DECISION ON SPACE REQUIREMENTS OF ADMINISTRATION
ADMINISTRATION OFFICE SPACE REQUIRED
OFFICE SPACE CLERICAL
WAGE RATE
TECHNICAL
CLERICAL

Figure 7

UNIVERSITY OF TORONTO

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

ADMINISTRATION SUMMARY REPORT

TERM 1965-6

DEPARTMENTAL BUDGETS

ACADEMIC SALARIES	$ 1495800.00
NON-ACADEMIC SALARIES	$ 229600.00
MISCELLANEOUS EXPENSES	$ 319600.00
TOTAL	$ 2045200.00
ASSISTED RESEARCH FUNDS	$ 1126500.00

ACADEMIC STAFF

	TOTAL SALARIES	AVERAGE SALARY	PERSONNEL
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.
ADMINSTRATIVE	69000.	69000.	100.

STUDENT ENROLLMENT

I	HONOURS	4693
	PASS	7485
II	HONOURS	3665
	PASS	6621
III	HONOURS	3214
	PASS	5891
IV	HONOURS	2966

GRADUATES

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

MASTERS	2153
PH. D.	508

*Data are illustrative only.

Figure 8

REPORT PAGE 1

UNIVERSITY OF TORONTO

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

DEPARTMENT OF CHEMISTRY REPORT

TERM 1965-6

DEPARTMENTAL BUDGET

ACADEMIC SALARIES	$ 240898.00
NON-ACADEMIC SALARIES	$ 81774.00
MISCELLANEOUS EXPENSES	$ 38791.00
TOTAL	$ 361463.00
ASSISTED RESEARCH FUNDS	$ 290000.00

ACADEMIC STAFF

	TOTAL SALARIES	AVERAGE SALARY	PERSONNEL
DEPARTMENTAL CHAIRMAN	$ 14000.00	$14000.00	1
FULL PROFESSOR	$ 76048.00	$10864.00	7
ASSOCIATE PROFESSOR	$ 72100.00	$ 8900.00	9
ASSISTANT PROFESSOR	$ 34750.00	$ 6950.00	5
LECTURER	$ 44000.00	$ 4000.00	11
TOTAL	$ 240898.00		33

PHYSICAL FACILITIES

STUDENT (SQ. FT.-HRS.)

	REQUIRED	ACTUAL	PCT. USE
LECTURE	59000.	93000.	63.
LABORATORY	42000.	99800.	42.
STUDY SPACE	22000.	15000.	146.

STAFF (SQ. FT.)

	REQUIRED	ACTUAL	PCT. USE
PROFESSORIAL	11000.	11000.	100.
CLERICAL	4000.	4500.	89.
ADMINSTRATIVE	3000.	3000.	100.

Figure 9

ACADEMIC YEAR	CLASS SIZE (STUDENTS PER CLASS)				STUDENT ENROLLMENT			
	LECTURE		LABORATORY		LECTURE		LABORATORY	
	HONOUR	PASS	HONOUR	PASS	HONOUR	PASS	HONOUR	PASS
1	100.0	150.0	50.0	75.0	631.0	983.0	587.0	827.0
2	75.0	125.0	50.0	75.0	580.0	850.0	520.0	791.0
3	30.0	80.0	25.0	50.0	502.0	773.0	491.0	620.0
4	15.0	0.	15.0	0.	460.0	0.	430.0	0.

ASSOCIATED COURSES OF THE CHEMISTRY DEPARTMENT

COURSE	ENROLLMENT I	II	III	IV	GRADUATES
GENERAL SCIENCE	650.	601.	582.	550.	522.
MATHEMATICS, PHYSICS AND CHEMISTRY	720.	609.	580.	563.	548.
MATHEMATICS AND CHEMISTRY	481.	411.	389.	352.	340.
PHYSICS AND CHEMISTRY	367.	303.	281.	240.	217.
CHEMISTRY	603.	569.	531.	500.	487.

*Data are illustrative only.

Figure 10

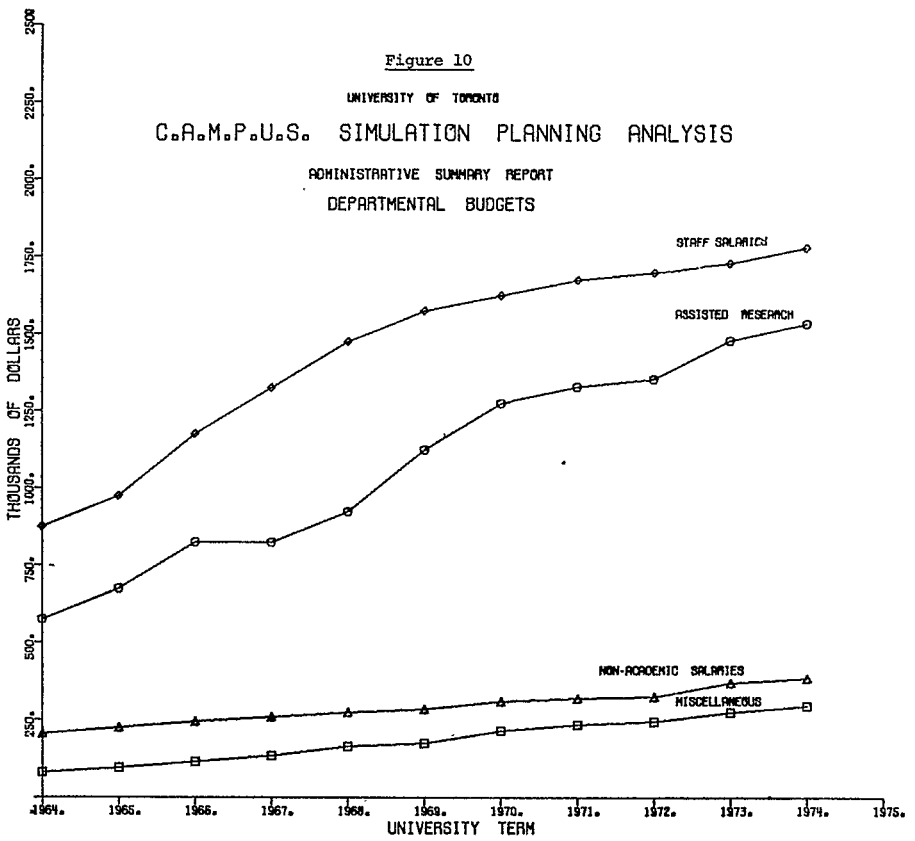
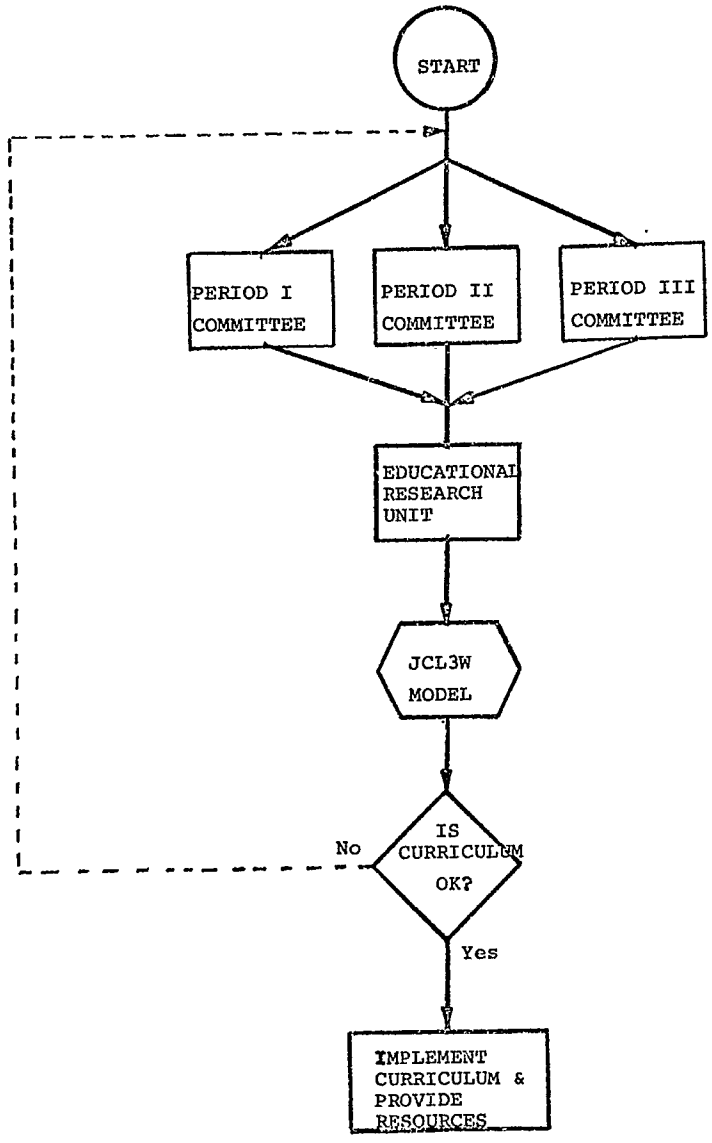


Figure 11



UNIVERSITY OF TORONTO

FACULTY OF MEDICINE

FLOW OF INFORMATION IN CURRICULUM PLANNING

1. The three systems committees generate a curriculum.

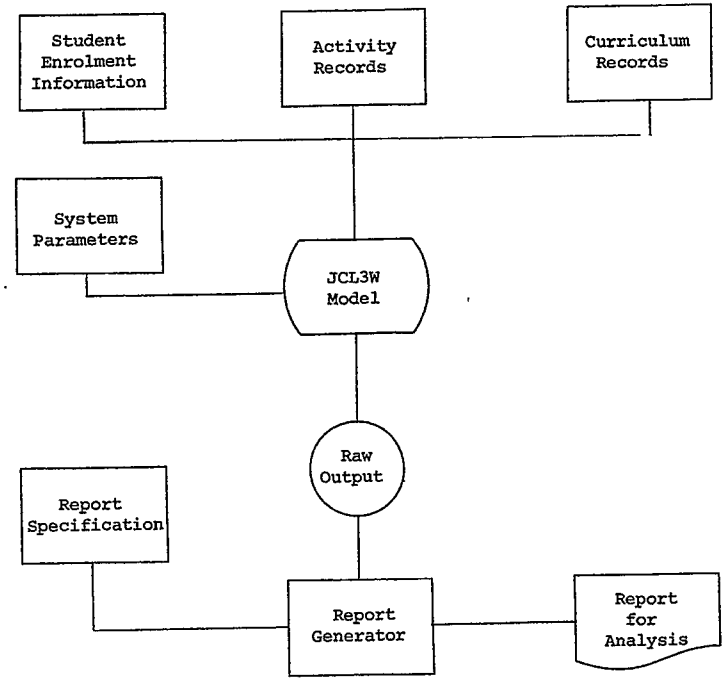
2. Curriculum is specified in detail and checked for timetable feasibility.

3. Resource input requirements estimated. These estimates retained in case curriculum is approved.

4. Pedogogic benefits and resource input requirements evaluated by Curriculum Committee, Departmental Chairmen and Faculty Council.

Figure 12

STRUCTURE OF THE HEALTH SCIENCES JCL3W MODEL



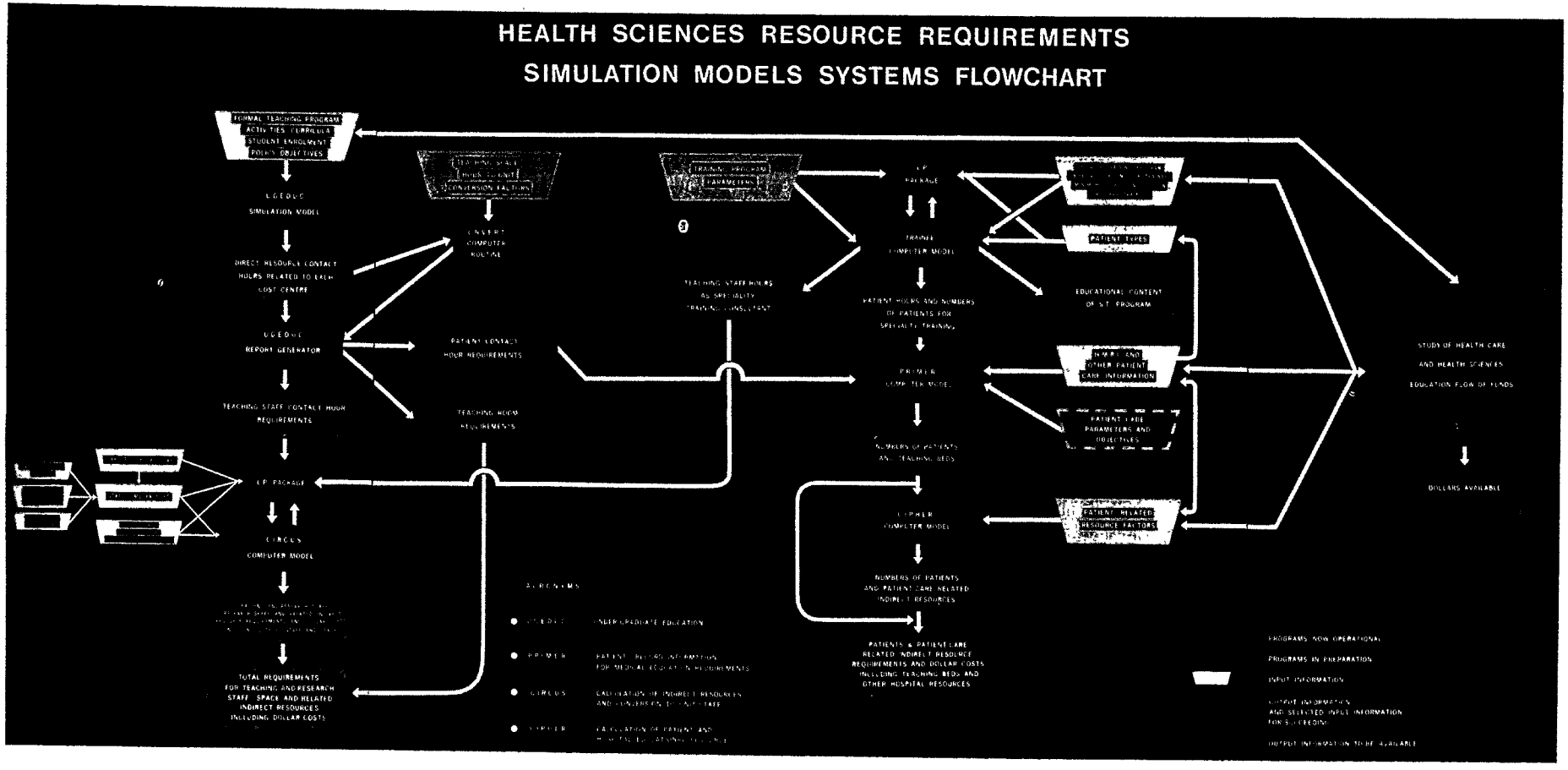

HEALTH SCIENCES RESOURCE REQUIREMENTS
SIMULATION MODELS SYSTEMS FLOWCHART
FORMAL TEACHING PROGRAM
ACTIVITIES CURRICULA
STUDENT ENROLMENT
POLICY OBJECTIVES
EDUCE
SIMULATION MODEL
DIRECT RESOURCE CONTACT HOURS RELATED TO EACH COST CENTRE
EDUCE
REPORT GENERATOR
TEACHING STAFF CONTACT HOUR REQUIREMENTS
PATIENT CONTACT HOUR REQUIREMENTS
TEACHING HOUR REQUIREMENTS
LP PACKAGE
CIRCUS
COMPUTER MODEL
TOTAL REQUIREMENTS FOR TEACHING AND RESEARCH STAFF, SPACE AND RELATED INDIRECT RESOURCES INCLUDING DOLLAR COSTS
TRAINING PROGRAM PARAMETERS
TEACHING STAFF HOURS AS SPECIALITY TRAINING UNFOLDS
LP PACKAGE
TRAINER
COMPUTER MODEL
PATIENT HOURS AND NUMBERS OF PATIENTS FOR SPECIALITY TRAINING
PRIMER
COMPUTER MODEL
NUMBERS OF PATIENTS AND TEACHING BEDS
PATIENT TYPES
EDUCATIONAL CONTENT OF S.T. PROGRAM
HOSP. AND OTHER PATIENT CARE INFORMATION
PATIENT CARE PARAMETERS AND OBJECTIVES
PATIENT RELATED RESOURCE FACTORS
LOPHER
COMPUTER MODEL
NUMBERS OF PATIENTS AND PATIENT CARE RELATED INDIRECT RESOURCES
PATIENTS & PATIENT CARE RELATED INDIRECT RESOURCE REQUIREMENTS AND DOLLAR COSTS INCLUDING TEACHING BEDS AND OTHER HOSPITAL RESOURCES
STUDY OF HEALTH CARE AND HEALTH SCIENCES EDUCATION FLOW OF FUNDS
DOLLARS AVAILABLE
PROGRAMS NOW OPERATIONAL
PROGRAMS IN PREPARATION
INPUT INFORMATION
OUTPUT INFORMATION AND SELECTED INPUT INFORMATION FOR SUCCEEDING
OUTPUT INFORMATION TO BE AVAILABLE

Figure 13

HEALTH SCIENCES FUNCTIONAL PLANNING UNIT

BREAKDOWN REPORT TABLE FOR LECT.ROOMS — OUTPUT IN HOURS PER SIMULATION PERIOD

REPORT BY SIMULATION PERIODS

1972/73 WEEKS(1-35) — RUN NO.55 ALL PERIODS WK-BY-WK NEW CURRICULUM GROUP RULE 2 2 50 STUDENTS

FACULTY OF MED

INSTITUTION BANT.INST

DEPARTMENT OF UNSPEC.DEPT

	(1-10)	(11-20)	(21-40)	(41-85)	(86-140)	(140-)
1	230	4	0	0	0	10
2	230	4	0	0	0	10
3	230	4	0	0	0	10
4	230	4	0	0	0	10
5	60	96	0	0	0	15
6	0	27	0	0	0	43
7	0	27	0	0	0	43
8	0	27	0	0	0	43
9	111	0	55	0	0	2
10	128	31	62	0	0	0
11	263	67	0	0	0	0
12	263	67	0	0	0	0
13	263	67	0	0	0	0
14	0	8	0	0	0	10
15	0	8	0	0	0	10

Figure 14

HEALTH SCIENCES FUNCTIONAL PLANNING UNIT

REPORT TABLE FOR PATIENT REQUIREMENTS — OUTPUT IN HOURS PER SIMULATION PERIOD

TOTALS FOR SIMULATION PERIODS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
1972/73 WEEKS(1-35) — RUN NO.58 PROPOSED U OF T CURR. ACT. 1 CURR. 3 250 STUDENTS

FACULTY OF MED

TOTALS PER DEPARTMENT OVER INSTITUTIONS. MED.BUILD BANT.INST T.G.H T.W.H S.M.H WELLESLEY W.M.S.H H.S.C SUNNYBROOK W.C.H P.M.H

	AMB.PAT	HOSP.PAT	SPECIAL PAT
IMMUNOLOGY	0.00	1242.00	0.00
MEDICINE	18199.10	52691.70	0.00
OBST.-GYN.	8399.80	18517.70	0.00
OPTHAL.	6237.30	4323.00	0.00
OTO-LARYN	5220.50	7917.30	0.00
PAEDIATRICS	8600.80	22693.20	0.00
PSYCHIATRY	8504.90	9336.80	0.00
SURGERY	23052.20	39221.10	0.00
UNSP. CL. DE	1239.70	2009.80	0.00

Figure 15

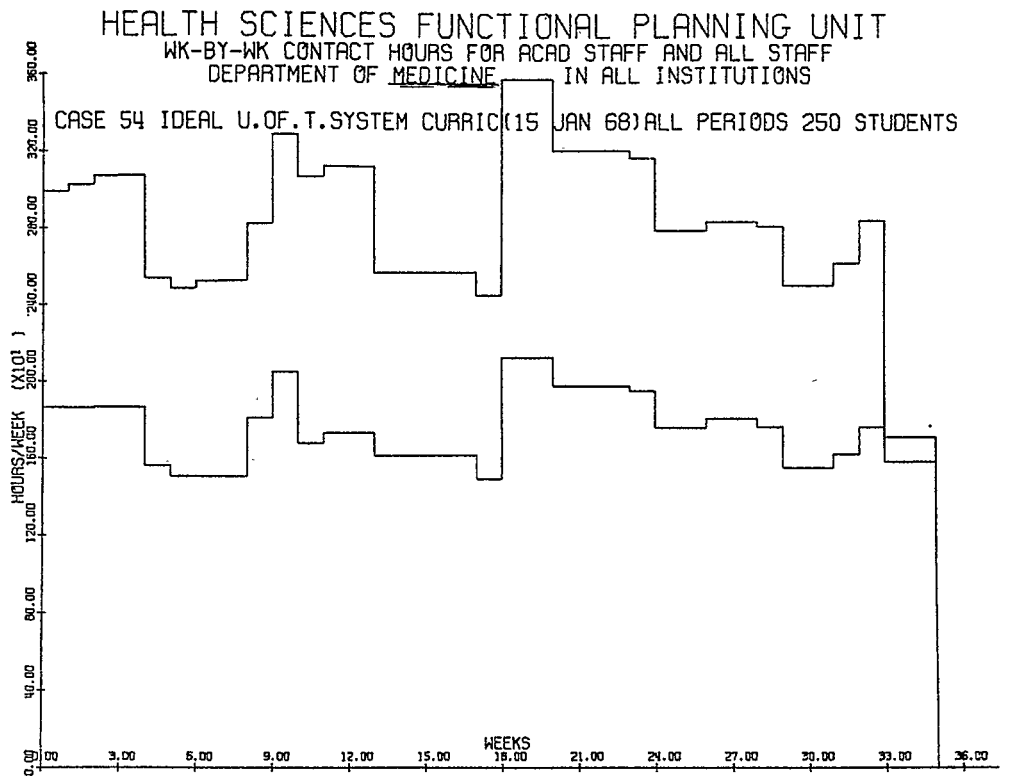


Figure 16