The historical pattern of resource allocation in American higher education as exemplified by public colleges in Colorado was examined. The reliance upon average cost information in making resource allocation decisions was critiqued for the special problems that arise from student enrollment decline or steady state. A model of resource allocation for institutional and interinstitutional decision making was designed based on the separation of expenditures into fixed and variable cost components. Measures for full costing, including partial opportunity cost accounting, were incorporated into the model. The University of Colorado at Boulder was used to examine the cost structure in terms of average, marginal, variable, and fixed cost elements. The change in this cost structure was examined for a five-year period, as personnel policies and enrollment changes were stimulated. Specific hypotheses were posited and tested. Results indicate areas of policy change and extensions for further research. It is concluded that a decrease in student number cannot be accommodated with the same policies as the growth period. A bibliography is included.

by

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PURPOSE

This paper examines the historical pattern of resource allocation in American higher education as exemplified by public colleges in Colorado. The reliance upon average cost information in making resource allocation decisions is critiqued for the special problems which arise from student enrollment decline or steady state.

A model of resource allocation for institutional and inter-institutional decision making was designed based on the separation of expenditures into fixed and variable cost components. Measures for full costing, including partial opportunity cost accounting were incorporated into the model. For the purpose of this thesis one institution, University of Colorado - Boulder, was used to examine the cost structure in terms of average, marginal, variable, and fixed cost elements. The change in this cost structure was examined for a five year period as personnel policies and enrollment changes were simulated.

Specific hypothesis were posited and tested with the results indicating areas of policy change and extensions for further research.

The fundamental concern was substantiated that a decrease in student number cannot be accommodated with the same policies as the growth period.
BACKGROUND

American higher education is a leading expenditure of each state's government. For example, Colorado higher education has represented 27.5 percent of the states total budget of over one billion dollars. Higher education is 21.9 percent of the state's General Fund expenditures (JBC - 1976). Most members of the legislature are college graduates and frequently have advanced college degrees causing the legislature, and in particular the members of the Joint Budget Committee, to bring into the review process a great degree of knowledge and expressed interest. Colorado has developed and for several years used a very detailed budgeting system for higher education. The budget system has reflected the desire of budget analysts to conduct budget analysis at the lowest common denominator. The system is very detailed containing thousands of data elements for each major institution. This detailed budgeting system also reflects the anxiety of funders over the inability of higher education to link outcome or performance information with expenditures, and the resultant inability to measure system productivity.

Lyman Glenny, a leading researcher in higher education finance has said, "the state government remains the chief source of funding for higher education and nothing on the horizon would appear to change that observation for the future."

(NACUBO, p. 2) Glenny goes on in this address and subsequent article (to college administrators),
...the state is confronted with serious policy issues relating to support of research, public service and adult education, to falling enrollments in some public institutions, to the probable closure of some private liberal arts colleges and perhaps some public ones, to the continuing over supply of doctoral graduates, to competition with the collegiate sector of new forms and new institutions offering postsecondary education, and to a host of issues relating to finance in a period of high inflation and severe recession. (NACUBO, p. 4)

Meanwhile, the Colorado Commission on Higher Education (CCHE), brought together over 100 of Colorado's business, government, union, and political leaders to form eight task forces which met for 18 months to develop long range policy for Colorado higher education. Two major factors were discussed by a majority of the task forces; one, that demographic shifts will cause college enrollment to decline or reach steady state, even in Colorado; and two, that while the cost of higher education keeps going up, the willingness of taxpayers to support higher education relative to other state activities is decreasing. Dr. William Adrian, then Deputy Director of CCHE has summarized these points as follows:

Enrollment:
"...although Colorado is in a more advantageous position than most states, prospects for continued growth in the system throughout the 1980's are not good. The future will be marked by fluctuations among programs and institutions and agonizing trade-offs in adapting to, at best, a limited growth environment for the State as a whole. Several Colorado colleges and universities are already learning to cope with a 'no-growth' environment including those universities which have been 'capped' and selected rural institutions which have reached an enrollment plateau. Most institutions are either at or close to their expected targeted enrollments. Institutional administrators will have to make difficult decisions in reallocating resources among programs, and likewise, the State must grapple with the same problem among institutions." (Adrian, 1976, p. 10)
Financing:

The loss of public confidence in education is reflected not only in Gallup-type polls, but in increasing public reluctance to continue to support education as it has in the past. Higher education has lost ground as a major national and state priority. It is no longer exempt from careful scrutiny as it finds itself in stiff competition with other state and national needs. A study by Lyman Clohony at the Center for Research and Development in Higher Education at Berkeley, reported that the proportion of state general revenue going to higher education has dropped steadily since 1968 in the Midwest and since 1971 nationally. Colorado has also experienced a decline in proportion of state financial assistance to higher education. (op. cit., p. 14)

As higher education is in a period of economic constraints and leveling enrollments, it is imperative that decisions be made with full understanding of the costs of adding or subtracting numbers of students. Information on cost structure should assist decision-makers at the institution and state levels in preparing for the eventuality or possibility of what Kenneth Boulding has called the "creative management of decline." (Boulding, 1974) It has become necessary to address questions such as the following: How many dollars are necessary for an additional hundred students at a certain institution? Can these dollars be taken from an institution which has had an enrollment decline? What is the level of resources which can be taken from one program or institution and redirected to another without violation of contractual obligations or personnel rules. In spite of great efforts to develop planning models, costing models, and average cost information, there is no work that has adequately addressed the effects of higher education cost structure upon changing inputs and outputs of that system.
More important to higher education cost analysis is the historical behavior of institutional management in deploying its resources between fixed and variable costs.

Budget Procedure - Average Cost

In a grant's economy it is difficult to link outcome or product to the cost of production (Boulding, 1973). Such is the case with higher education. In some functions higher education is within the exchange economy since identifiable products exist. However, these areas are usually the support functions, or auxiliary enterprises such as the dormitories, football teams, recreation centers, etc. The identification of specific product for instruction, or basic non-sponsored research is not well accepted. Thus the criteria for expenditure evaluation rests with the judgement of budgeting professionals. Without an explicit agreement on outcome or product for the major activities, budget analysts stress expenditure control. In higher education the fundamental cost to control is personnel cost, and faculty cost in particular.

Faculty cost is primarily dependent upon the number of faculty which exist. The student-faculty ratio becomes the primary tool for analysis. A slight upward change can bring delight to the cost accountant and fear of educational quality collapse to the academic. Historically, both sides have accepted the immaculate conception of the student faculty ratio since it varies little for a school once established and beyond a critical mass threshold of about 400 students. The student-faculty ratio's importance to higher education budgeting is but one example of the dependence upon
analytical ratios of input resources used in governmental resource allocation. In other areas of governmental service-resource allocation is based on the number of cases per caseworker, patients per doctor, or prisoners per guard, etc., most are average cost based.

Since the primary cost of higher education is faculty salary, we expect that a long term dependence upon the student-faculty ratio will lead to stability in average costs. Our expectation of a stable annual cost extends beyond faculty cost, since many other expenditures are based on ratios of student number, quantity of product. The number of staff are dependent upon student number, as are number of library workers, administrators, student counselors etc. In higher education budgeting most expenditures are dependent upon a series of these ratios, and in many states the budgeting process is based entirely on formulas which are dependent upon the number of students. (Glenny, 1976) Even our facilities are dependent upon student numbers. The average student is categorized by the courses taken, and each course has a facility demand based on historical utilization. The number of student spaces required is determined and a normative based utilization factor is assigned to weight the student stations needed. A laboratory may only be expected to achieve a 40 percent utilization of student spaces during a specified time period. Given those normative based ratios the institution develops a proposal for facilities needed which is accepted by the budgeting review groups all the way up the funding process to the governor or legislature, as long as the normative based utilization factors are met.
Thus in almost every way, from student-faculty ratio, to books per student by program, to support staff per faculty, or student resource need in higher education is developed based on average cost formulas. It follows that the average cost per student should be a linear function over time.

As figure one shows for our example institution, the University of Colorado at Boulder, the average cost curve is almost linear but it is not stable. During the period of rapid growth, from 1955 to 1967, the average cost per student increased, even in constant 1972 dollars. During its period of rapid growth the University of Colorado did not exhibit economies of scale, nor even of cost containment over time. Figure two shows that the average cost per student increased in both current and constant dollars. Since this is a picture of cost per student as student population increases, although occurring over time, the real dollar increase demonstrates the lack of an economy of scale in the system, and of the long term stability in the increase of per student average cost.

The third line on the long run average cost curve graph (Figure 1) illustrates the national trend of increasing average cost. The Carnegie Commission study on costing also used real dollar costs to illustrate that the educational system in general did not illustrate any economies of scale, actually increasing average cost in real dollars during a period of rapid growth or exhibiting dis-economies of scale (Carnegie, 1974, p. 25).

Both figure one and two show the cost curves of an institution during a period of rapid growth, and also during a period of steady state enrollment since the legislature has capped CU-Boulder at
Figure 1. Long Run Average Cost - Average Cost Per Student
<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Students</th>
<th>CU-Boulder</th>
<th>National</th>
<th>Price Deflator</th>
<th>Constant Dollar</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955-56</td>
<td>10,006</td>
<td>542</td>
<td>60.9</td>
<td>890.0</td>
<td></td>
</tr>
<tr>
<td>1956-57</td>
<td>10,647</td>
<td>575</td>
<td>62.8</td>
<td>916.0</td>
<td></td>
</tr>
<tr>
<td>1957-58</td>
<td>10,995</td>
<td>653</td>
<td>65.0</td>
<td>1005.0</td>
<td></td>
</tr>
<tr>
<td>1958-59</td>
<td>11,104</td>
<td>710</td>
<td>66.0</td>
<td>1076.0</td>
<td></td>
</tr>
<tr>
<td>1959-60</td>
<td>10,973</td>
<td>787</td>
<td>1007</td>
<td>1166.0</td>
<td>1492.0</td>
</tr>
<tr>
<td>1960-61</td>
<td>11,493</td>
<td>834</td>
<td>68.6</td>
<td>1216.0</td>
<td></td>
</tr>
<tr>
<td>1961-62</td>
<td>12,083</td>
<td>941</td>
<td>69.2</td>
<td>1360.0</td>
<td></td>
</tr>
<tr>
<td>1962-63</td>
<td>12,266</td>
<td>1127</td>
<td>70.5</td>
<td>1399.0</td>
<td></td>
</tr>
<tr>
<td>1963-64</td>
<td>12,538</td>
<td>1175</td>
<td>71.6</td>
<td>1641.0</td>
<td>1638.0</td>
</tr>
<tr>
<td>1964-65</td>
<td>13,380</td>
<td>1191</td>
<td>72.7</td>
<td>1638.0</td>
<td></td>
</tr>
<tr>
<td>1965-66</td>
<td>14,693</td>
<td>1242</td>
<td>74.3</td>
<td>1672.0</td>
<td></td>
</tr>
<tr>
<td>1966-67</td>
<td>15,681</td>
<td>1358</td>
<td>76.8</td>
<td>1768.0</td>
<td>1837.0</td>
</tr>
<tr>
<td>1967-68</td>
<td>16,877</td>
<td>1428</td>
<td>79.0</td>
<td>1808.0</td>
<td></td>
</tr>
<tr>
<td>1968-69</td>
<td>18,217</td>
<td>1434</td>
<td>82.6</td>
<td>1736.0</td>
<td></td>
</tr>
<tr>
<td>1969-70</td>
<td>18,882</td>
<td>1638</td>
<td>86.8</td>
<td>1887.0</td>
<td>2041.0</td>
</tr>
<tr>
<td>1970-71</td>
<td>19,294</td>
<td>1702</td>
<td>91.4</td>
<td>1862.0</td>
<td>2027.0</td>
</tr>
<tr>
<td>1971-72</td>
<td>19,957</td>
<td>1777</td>
<td>96.1</td>
<td>1869.0</td>
<td>2019.0</td>
</tr>
<tr>
<td>1972-73</td>
<td>20,475</td>
<td>1776</td>
<td>100.0</td>
<td>1776.0</td>
<td>2016.0</td>
</tr>
<tr>
<td>1973-74</td>
<td>20,000</td>
<td>1986</td>
<td>106.0</td>
<td>1874.0</td>
<td></td>
</tr>
<tr>
<td>1974-75</td>
<td>20,232</td>
<td>2079</td>
<td>116.6</td>
<td>1783.0</td>
<td>2005.0</td>
</tr>
<tr>
<td>1975-76</td>
<td>20,230</td>
<td>2276</td>
<td>127.3</td>
<td>1788.0</td>
<td>2033.0</td>
</tr>
<tr>
<td>1976-77</td>
<td>20,300</td>
<td>2476</td>
<td>133.2</td>
<td>1862.0</td>
<td>2056.0</td>
</tr>
<tr>
<td>1977-78</td>
<td>20,300</td>
<td>2802</td>
<td>140.0</td>
<td>2001.0</td>
<td>2090.0</td>
</tr>
</tbody>
</table>
Table 1 (continued)

1 - Nov. 1958, Audit of Budget exclude cont. educ.
2 - Dec. 1963 Audit of Budget exclude cont. educ.
3 - Budget Request Document
4 - Budget Request Document
5 - GNP implicit price deflator
6 - Annual Appropriations Report, JBC
7 - Gross Domestic Product deflation, 1976
   Econ. Rep. President, p. 192
8 - National data from Table 5, page 35, Carnegie, 1972
20,000 FTE students for several years.

This phenomena should not surprise anyone since we have already demonstrated that the primary methods for allocating resources are all based on an average cost expenditure per student.

During the period of growth higher education institutions were successful in getting resource allocators, legislatures and governors, to accept as funding basis the student faculty ratio, and resulting average number of staff per full time equivalent student concept. Thus if the student-faculty ratio was 20:1 then the marginal cost of adding one hundred students was the cost of adding five faculty. Associated with the five faculty would be a specified number of support staff, supplies, facilities, etc., all based on relatively stable ratios to each other. In some ways the entire system was built on a tautological basis.

Such a funding basis would have resulted in a constant real dollar average cost if it were not for the labor intensity of the industry. Since higher education is almost eighty percent labor expenditure (Halstead, p. 136), and since labor prices have risen higher than general expenditures (until 1974) the adjustment for real dollars illustrates the overall upward bias of higher education total cost, and resultant average cost, to increase at a greater rate than inflation. Thus the increasing level of average cost. (Hagstead, 1976)

It is apparent that the average cost has also been assumed to be equal to average variable cost, and any consideration for fixed costs has been ignored. Only in institutions of very small size, under 500 students have resource allocators acknowledged a
feeling for critical mass.

"Among all groups of institutions, exceptionally small colleges and universities tend to have relatively high costs. The cost per FTE student declines quite sharply as institutions increase in size from very small levels to moderate levels, after which the decline occurs at a diminishing rate or levels off." (Carnegie, 1972, p.164)

We can conclude that the state resource allocators, executive and legislative analysts have accepted the institutional argument that student faculty ratio is crucial to production. What has followed is a long history of funding based on average cost per student.

Further information on the financial crises in higher education can be found in most recent literature about higher education and the reader is referred to the works identified in the bibliography as well as the author's own doctoral thesis, especially for discussion of the many other policy issues arising from financial crises including governance confusion arising from the separation of authority and responsibility.
METHODOLOGY

A cost structure model of a higher education institution's budget was developed using a FORTRAN subroutine to the State Planning System (SPS) modelling framework developed at the National Center for Higher Education Management Systems. (Huckfeldt, 1977)

The model separates expenditures into fixed and variable cost. The model permits analysis of the present budgetary flexibility at the institution and permits examination of institutional sensitivity to policy changes. The model is capable of both inter-institutional and inter-departmental analysis. However, for the purpose of this paper the model was used only to examine the cost structure of the University of Colorado, Boulder campus in the aggregate.

Data for 1974-75, was gathered from budget request documents of 1973-77, Joint Budget Committee Appropriation reports, and Colorado Commission on Higher Education reports. Projections were made for the years 1976-79. A limited set of hypothesis were postulated and tested.

Model Design

The cost structure model is designed as both a deterministic simulation model and a goal programming optimization model. The system uses the NCHEMS State Planning System (SPS) as a general framework which permits both simulation and optimization. The
equations within the model permit both simulation and optimization within an institution. The analyst can test the effects of changes in student enrollment by program and level within an institution. Inter-institutional analysis could be achieved by placing all variables within a loop for each school, while maintaining a logical loop over all schools.

Other costs that are developed in the model and used in policy analysis include the traditional fixed cost of facilities, variable costs of supplies, etc., and most importantly the fixed cost of personnel to whom a long term contractual, or at least political-moral commitment has been made. This last category includes the classic tenured faculty and the classified civil servant.

Higher education's movement of costs from variable to fixed may have been made to follow private enterprise where growth has seen a shift of cost from variable to fixed. In the pure exchange economy such action is taken to improve the technical coefficient by using fixed capital expenditures for equipment to provide a reduction in the production cost per unit (Stigler, p. 135). The exchange economy model shows an economy of scale operating whereby total average cost declines over the relevant range of production, and marginal cost is less than average cost. Demand constraints, at a fixed price level, provide the incentive to fix the level of production. Higher education however, has shifted its variable cost into categories of fixed staff cost, and combined with the fixed cost facilities cannot demonstrate an economy of scale, beyond a low level critical mass.

Movement of costs from variable to fixed in higher education has not changed the technical coefficient of production in the aggregate as shown by the stabileness, and even increase in the average cost over time.
One reason for the lack of improvement is explained by examining the change in programming breadth which characterizes American higher education during its period of rapid growth since 1946.

...as institutions grow in size they tend to offer degrees in increasing numbers of fields often adding expensive fields, such as sciences and engineering. Our data suggest that the variable, 'number of fields', tends to exert its influence, at least to some degree, in the direction of increasing costs with rising enrollment, thereby acting as a counterforce to factors tending toward economies of scale. (Carnegie, 1972, p. 164)

This statement based on extensive research among American universities exemplifies the situation at the CU-Boulder campus, even to identifying the academic fields which grew the most at CU-Boulder, science and engineering. This is best explained by remembering that the criteria for resource allocation used by state budgeteers were the student/faculty ratio, and resultant average cost based ratios. Since the institution can experience marginal cost being below average at the micro level of course section size, and can also use the graduate students acquired with the doctoral program as low cost instructors, the marginal cost of additional students at the undergraduate level was well below average institutional cost. (Jedamus, 1970)

During a period of growth institutional policy seems to have been to expand role and mission and spend all resources in order to justify costs. This policy has led to the present breadth of program at its current student enrollment level. In Colorado the lowest cost per student schools are Fort Lewis, and Metro where institutional policy has been explicitly to avoid all graduate programs. Fort Lewis keeps its undergraduate curriculum at 22
academic program majors. Their president, an economist by training, has indicated that such a constraint upon their personal aspirations is necessary in order to contain costs. (Berndt)

**Budgetary Disincentives**

In state government financial policy there is no incentive to return monies saved to the general fund. Rather, the explicit policy is that any money saved one year will be expected as savings in subsequent years. A policy of cutting the base for one time savings will tend to lead government sector managers, including higher education administration, to seek to minimize reported savings by spending funds which might be saved as soon as discovered and definitely by the end of the fiscal year.

Higher education institutions made sure that any savings which occurred during the period of student growth were immediately reinvested in a programmatic expansion. State decision makers became concerned with this practice, and it was one of the reasons for establishing the Colorado Commission on Higher Education in 1966 to curtail the expansion of role and mission by the institutions. It cannot be proven here that the state level control over program curtailed the rising average cost shown for the 10 years prior to the commission formation, but the constant dollar average cost shown in figure one did level out at that point.

A further strengthening of state level control over institutional management began during the late 1960's as budget analysts were hired at the state agencies and began to conduct their analysis of budgets in a detailed manner. The appropriations from the legislature began to be at a lower level of control, more line items.
The erosion of confidence in institutional management paralleled the increase in the average cost curves, and were perhaps related. Lump sum appropriations to state agencies, particularly higher education, ended and institutional budgetary autonomy began to decline. This state level change in budgeting style and aggressiveness in review was not unique to Colorado but occurred throughout the United States. (Glenny, 1975)

Only with the recent stability of student enrollment at the major universities have state decision makers begun to reduce the level of appropriation detail, but the new level is meaningless. The analysis still occurs at the detailed level, and any change in expenditure must be justified at the detailed level. The aggregation of appropriation has little real affect upon management flexibility. The distrust of institutional resource allocation policy has led to state control, in Colorado, of the number of employees permitted. The appropriation of FTE (full time equivalent employees) was instituted in 1972 for all state agencies. This policy of controlling FTEs shows the concern which the legislature developed over the hiring practice of state government.

Also in this period of growth the Colorado legislature decided, through its Joint Budget Committee, to control the expenditure of all resources at the colleges and universities. The indirect cost recovery funds from sponsored research became part of the appropriated funds. In addition the cash income of computer centers and like activities became part of the appropriation. In several instances the state budgeteers provided an institution with a requested increase in expenditure, but indicated that this
increase would have to come totally from an increase in cash income, not from the general fund. Often this practice led an institutional manager to promise more income than possible which led to a supplemental appropriation from the legislature to offset the over expectation of cash. The tactics used by the institutional manager to acquire equipment, or even honest mistakes made in estimating outside revenue, increased the level of distrust held by state level decision makers and caused a movement to more tightly control expenditures.

Incentives for institutions to earn other income were diminished. Since the individual faculty member can earn little beyond his own salary, summer employment and a specified level of consulting, and since the institution cannot utilize the indirect cost recovery monies for programmatic expansion, or as seed money for additional research the incentive to seek outside income declines. One area of CU-Boulder where this is apparent is the computer center which has no incentive to seek outside users since the additional income cannot be used to increase the expenditures, even to cover the additional variable cost incurred at the center to serve the additional users. Rather the additional cash will only be used to diminish the portion of support provided by the general fund. Such a reduction will cause the general fund supported user to diminish his use of the equipment since federal contract policy requires equal treatment on a dollar cost basis.

Other examples of the dis-incentives for gathering outside, non-state funds exist and are openly discussed in budget request documents. The institutions general cost picture changes from this lack
of incentive since they seek fewer outside dollars, grow less, and
decrease their ability to have budgetary growth from any source
other than student increase. The reasons for this tight control are
justified in state decision makers minds since the institutions did
increase the fixed cost level of operations during their period of
student and outside fund growth. State resource allocators are
fearful of continued institutional growth which will cause a long
term financial commitment by the state. All too often the research
projects brought in, the computers purchased, the equipment and
buildings acquired became part of the institutions fixed costs while
the funding party originally responsible ceases to contribute to
the enterprises support.

The fundamental problem is how to provide institutional
flexibility and incentives to attract other funding sources without
leaving the state with a large fixed cost enterprise. Under present
policies of faculty expectation of tenured status, state personnel
and purchasing rules which seek to minimize rentals and non-
classified staff the problem continues. The state resource managers
are not going to provide institutional flexibility to obligate,
and the possible benefits of gathering outside activities to help
off-set existing fixed costs will not be achieved.

The potential for continued growth which would sustain the
current level of fixed versus variable cost is limited by the present
policies. A more detailed analysis of the cost structure and a
review of potential changes can lend insight into solution sets
for stable state.
RESULTS

Given that higher education budgeting is based on average cost, and given a shift in cost structure from variable to fixed costs, several hypotheses have emerged. These hypotheses relate to the causal factors of cost movement under conditions of both growth and decline. In order to test the hypotheses, the cost structure model was used to examine the costs of the University of Colorado-Boulder. Several computer simulations were made to determine the cost impact of changes in specific policies under varying conditions. All of the tests were run using 1974-75 as the base year and projecting forward to 1978-79. A longer time period could be examined but that would require a change in computer resource capability.

Simulation Runs Discussed in this Chapter

Run 1 - Initial data base after validation.

Run 2 - No change made to the 1974-75 conditions.

Projections made based on continuing relationships.

(See Appendix D for detailed listing of data elements and initial conditions.)

Run 3 - Students admitted decreased by 30 percent per year. All other values held constant.

Run 4 - Students admitted, including transfer students, increased by thirty percent per year. Other values held constant.
Run 5 - Net tenure attainment rate changed from current 1.09 percent to .99 percent while enrollment is held constant.

Run 6 - Net tenure attainment at .99 percent with students admitted decreased by 10 percent per year.

These computer simulations were utilized to develop an understanding for the sensitivity of the present cost structure to policy changes. The technological problems in developing analytic models of resource allocation strategies are relatively simple and for the most part accomplished. Analytical models have lacked two dimensions, cost structure, and revenue source tracking. This paper presents the need for, and a process by which, cost structure can be utilized for resource allocation analysis. A revenue tracking analytical framework is relatively simple to add to the cost structure model if institutions have the expenditures available by revenue source.

The most critical methodological problem still unresolved in higher education analytical modelling concerns the development of a procedure to determine the performance evaluation criteria. Research into the explicit and implicit criteria of each decision group and the relative weightings among the several conflicting goals and groups is necessary to focus resource allocation analysis.

The cost structure model has been developed in a computer based environment to permit the extension of its operation into analysis using multiple criteria in both a simulation and an optimization model. The basic relationships are simple enough to permit calculator style analysis, but detailed computer analysis provided insight into causal relationships which otherwise might
not have been possible. Simplification seems to come only after understanding has been gained.

A minimum of detailed information has been included in this chapter to simplify the analysis of the hypothesis. A copy of one full simulation run is contained in Appendix D and summary report samples are in Appendix E.

Hypothesis One

Cost is a direct function of the student full time enrollment as the enrollment increases. Figure one in chapter three (p. 40) shows that as the number of students increased the cost per student in both current and constant dollars maintained an upward trend both at the University of Colorado-Boulder and nationally.

Hypothesis Two

Cost is a function of the committed wages and salaries of faculty and staff as the enrollment declines.

Figure two, and table two illustrate present conditions. The breakpoints show the level of students who can be served by present facilities, tenured faculty and sixty percent of the classified staff (representing those who are most likely a fixed obligation of the institutions). Since the legislature has funded institutions on an average cost basis legislators would expect that the cost could decline along line AB under decline. However, costs will decline along line BIC since the fixed cost component of institutional commitments will serve up to 13,631 students before variable cost faculty need be hired. A drop below 13,631 students will not reduce the cost of faculty, nor of staff below 11,866 students.
Figure 2. Current Cost Structure - CU-Boulder
unless individuals who are presently under long term commitments are laid off. The actual number of students who can be served by committed personnel actually is more difficult to calculate since individuals are available only for their disciplines or work specialities and an under or over supply will occur at the academic discipline and student course levels.

Figure three shows a second effect of fixed cost personnel and facilities growth. There is an upward movement of fixed cost over time which causes an increase in the level of students needed to equal the supply of fixed cost resources. The breakpoint of $I_1$ is less than the second breakpoint, $I_2$. A higher level of student enrollment, 18,030 students in simulation run four, can be served with committed cost faculty. Present policies will increase the level of students who can be served by fixed cost personnel making the institution more susceptible to high cost in an environment of student enrollment decline.

Hypothesis Three

A static description of the costs in relation to full time equivalent enrollment reveals a discontinuous marginal cost curve. Figure four, page 75, shows that average fixed cost and average total cost decline as student enrollment increases. What is not shown is that with student decline below five thousand students the average total cost will become equal to average fixed cost plus supply and expense variable cost and average fixed cost will become asymptotic. The marginal cost is a discontinuous curve with breakpoints determined by the level of students served by fixed
Figure 3. Current and Potential Cost Structure
Figure 4. Average and Marginal Cost
### Table 2

**Higher Education Cost Structure**

<table>
<thead>
<tr>
<th>Run 2</th>
<th>1975-76</th>
<th>Cumulative</th>
<th>Run 4</th>
<th>1978-79</th>
<th>Cumulative</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Number of Students</td>
<td>21,000</td>
<td></td>
<td></td>
<td>21,000</td>
<td></td>
</tr>
<tr>
<td>Fixed Cost 1 - Facilities</td>
<td>2,721,296</td>
<td>2,721,296</td>
<td></td>
<td>2,721,296</td>
<td>2,721,296</td>
</tr>
<tr>
<td>Fixed Cost 2 - Tenured Faculty</td>
<td>18,782,487</td>
<td>21,503,990</td>
<td></td>
<td>26,957,976</td>
<td>29,659,022</td>
</tr>
<tr>
<td>Fixed Cost 3 - Classified Staff</td>
<td>6,874,205</td>
<td>27,375,246</td>
<td></td>
<td>28,633,936</td>
<td>38,295,166</td>
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<tr>
<td>Variable Cost 1 - Supply and Expense</td>
<td>2,057,000</td>
<td>35,433,246</td>
<td></td>
<td>2,442,615</td>
<td>40,737,777</td>
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<td>Variable Cost 2 - Other Expenses</td>
<td>3,102,157</td>
<td>33,537,403</td>
<td></td>
<td>1,139,137</td>
<td>41,376,899</td>
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<tr>
<td>Variable Cost 3 - Faculty</td>
<td>7,702,733</td>
<td>41,240,138</td>
<td></td>
<td>7,912,259</td>
<td>49,789,153</td>
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<tr>
<td>Variable Cost 4 - Staff</td>
<td>6,516,159</td>
<td>49,756,290</td>
<td></td>
<td>10,929,544</td>
<td>60,718,703</td>
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<tr>
<td>Variable Cost 5 - Facilities</td>
<td></td>
<td>391,963</td>
<td></td>
<td>61,160,66</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>110,000</td>
<td>49,756,290</td>
<td></td>
<td>61,160,66</td>
<td></td>
</tr>
<tr>
<td>Break Point 1 - Facility</td>
<td>21,000</td>
<td></td>
<td></td>
<td>21,000</td>
<td></td>
</tr>
<tr>
<td>Break Point 2 - Tenured Faculty</td>
<td>13,624</td>
<td></td>
<td></td>
<td>18,030</td>
<td></td>
</tr>
<tr>
<td>Break Point 3 - Classified Staff</td>
<td>11,866</td>
<td></td>
<td></td>
<td>13,674</td>
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</tbody>
</table>

Other expenses represents the difference between supply and expense costs, and the cost of variable cost faculty, staff, and facilities.
<table>
<thead>
<tr>
<th>Student Number (FTE)</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>5000</th>
<th>6000</th>
<th>7000</th>
<th>8000</th>
<th>9000</th>
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<tbody>
<tr>
<td>AFC 1 - Facility usage</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
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<tr>
<td>AFC 2 - Tenured Faculty</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
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<tr>
<td>AFC 3 - Classified Staff</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
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<tr>
<td>Total Average Fixed Cost</td>
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<td>9755</td>
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<td>AVC 1 - Supply and Expense</td>
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<td>100</td>
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<tr>
<td>AVC 2 - Other Expense</td>
<td>151</td>
<td>151</td>
<td>151</td>
<td>151</td>
<td>151</td>
<td>151</td>
<td>151</td>
<td>151</td>
<td>151</td>
<td>151</td>
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<tr>
<td>AVC 3 - Non-Tenured Faculty</td>
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<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
<td>374</td>
</tr>
<tr>
<td>AVC 4 - Staff</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
<td>414</td>
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<tr>
<td>AVC 5 - Facility Rental</td>
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<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
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<tr>
<td>Total Average Variable Cost</td>
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<td>1171</td>
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<td>1171</td>
<td>1171</td>
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<tr>
<td>Average Total Cost</td>
<td>57928</td>
<td>29540</td>
<td>6846</td>
<td>4008</td>
<td>3536</td>
<td>3243</td>
<td>2550</td>
<td>1982</td>
<td>1171</td>
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<tr>
<td>Total Marginal Cost</td>
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<td>251</td>
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<td>251</td>
<td>251</td>
<td>251</td>
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<tr>
<td>Marginal Cost 1 (VC1 + VC2)</td>
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<td>251</td>
<td>251</td>
<td>251</td>
<td>251</td>
<td>251</td>
<td>251</td>
<td>251</td>
<td>251</td>
</tr>
<tr>
<td>Marginal Cost 2 (VC4 + MC1)</td>
<td>666</td>
<td>666</td>
<td>666</td>
<td>666</td>
<td>666</td>
<td>666</td>
<td>666</td>
<td>666</td>
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<td>666</td>
</tr>
<tr>
<td>Marginal Cost 3 (VC3 + MC2)</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
<td>1039</td>
</tr>
<tr>
<td>Marginal Cost 4 (VC5 + MC3)</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
<td>1171</td>
</tr>
</tbody>
</table>
cost facilities, faculty, and staff as shown in Table three.

At all times the marginal cost is less than average total cost since the variable cost components being added during immediate growth are always at a lesser average cost than the long term fixed cost component. The temporary and part time faculty are always at a salary below full time, as are other personnel being added. Changing from variable cost to fixed cost faculty and staff has never been justified on the criterion of cost savings. Rather, these shifts have been justified on the need for faculty to perform functions other than teaching and these functions have historically been performed only by full time tenured faculty. The quality of full time tenured faculty has also been assumed to be greater than part time or short term faculty leading to a desire to limit the percentage of non-tenured, short term faculty. In the case of faculty tenure the decision is usually made by a department which does not have responsibility for keeping the cost low, but only for performance against qualitative standards set by university officials and outside accrededing boards.

**Additional Results**

Perhaps most important for policy consideration is finding that there is a continual growth in the proportion of costs which are fixed. During period of growth the fixed costs increase although not as dramatically as when an enrollment decline is introduced. The results of several simulations indicate that even with changes in policy the fixed cost percentage will not be affected significantly unless the faculty percentage who are tenured is reduced below or just under a present maintenance level. The ability to absorb
a decline in student enrollment lessens each year that total fixed costs are permitted to increase.

The key ratio in understanding budgetary flexibility is the tenure rate. As Figure 5 shows, the percentage of expenditures which are a fixed cost will continue to increase under conditions of stable enrollment and current tenure attainment policy, given the present age of faculty (Run 2). Under conditions of student enrollment growth and decline, but with current policy, the percentage of fixed cost will also increase as shown in runs three and four. Of course, under condition of student decline the percentage grows faster, and under growth certain changes in policy should make a drastic difference in flexibility for future years. Under conditions of tenure attainment becoming less than attrition, runs five and six, budgetary flexibility begins to improve.

Other policies could be changed to improve flexibility, such as classified staff policy, or facilities flexibility etc., but the primary determinant is the policy regarding tenured faculty. It should be noted that these runs are based on only six percent of classified staff being considered a fixed cost. In political terms perhaps classified staff are a fixed cost. If this assumption is made then budgetary flexibility goes to almost 85 percent five years under a condition of student enrollment decline as fixed cost becomes greater than 2% of total expenditures, run seven.

The stabilizing effect shown particularly in run 3 results from some expenditures, such as supply and expense, being considered in the simulation as necessary, although variable, throughout the range of operation.
<table>
<thead>
<tr>
<th>Run</th>
<th>Description</th>
<th>74-5</th>
<th>75-6</th>
<th>76-7</th>
<th>77-8</th>
<th>78-9</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>no changes</td>
<td>.60</td>
<td>.60</td>
<td>.64</td>
<td>.71</td>
<td>.71</td>
</tr>
<tr>
<td>3</td>
<td>Admities down 30%</td>
<td>.60</td>
<td>.62</td>
<td>.68</td>
<td>.73</td>
<td>.73</td>
</tr>
<tr>
<td>4</td>
<td>Admities up 30%</td>
<td>.60</td>
<td>.59</td>
<td>.60</td>
<td>.66</td>
<td>.66</td>
</tr>
<tr>
<td>5</td>
<td>Tenure rate to .99% enrollment constant</td>
<td>.60</td>
<td>.60</td>
<td>.62</td>
<td>.66</td>
<td>.64</td>
</tr>
<tr>
<td>6</td>
<td>Tenure rate to .99% Admities down 10%</td>
<td>.60</td>
<td>.62</td>
<td>.66</td>
<td>.72</td>
<td>.71</td>
</tr>
<tr>
<td>7</td>
<td>Admities down 30% classified staff all</td>
<td>.82</td>
<td>.87</td>
<td>.93</td>
<td>.93</td>
<td>.93</td>
</tr>
</tbody>
</table>
Figure 5. Flexibility Index - Fixed Cost as a Percent of Expenditures
Analysis Summary

Although student enrollment decline causes the institution to encounter budgetary problems sooner, even with constant student enrollment the present policies of tenure attainment, staff employment policy, and the cost of existing facilities will lead to a reduction in budgetary flexibility for future years.

The combined effect of these movements in cost structure is to increase the level of students needed to cover a break-even point. Long term conversion from variable to fixed will make the predicted student enrollment decline quite costly.
IMPLICATIONS FOR HIGHER EDUCATION POLICY

Decisions regarding public higher education are made within an environment of demand factors, and of basic societal conditions. Policies are made to maximize performance toward a set of prescribed goals. The degree to which goals are met is determined by a set of evaluators who primarily represent groups which provide the revenue to operate. Each of these evaluation groups has a set of criteria, but the criteria are not always shared, nor even complimentary. The conclusion from studying and developing an understanding for higher education cost structure is that several policies need to be changed in order to better operate the system given the current and projected environment.

Environment

A change in student enrollment growth patterns to steady state or decline alters the basic nature of the industry. Policies which may have produced excellent goal-satisfying behavior may have the opposite effect when the system experiences student enrollment decline. Higher education policy is also made in an environment where the general price structure of the factor inputs, personnel, supplies, utilities, facility cost, etc., may have large scale structural changes. Recent inflation has affected higher education as an industrial sector more greatly than the general economy due to the mix of factor inputs peculiar to the higher education
industry. (Halstead) Higher education policies may have to change if the societal price structure was to change.

American higher education is also in a particular cultural environment, where education has been utilized at the onset of a career, and used very little for life-long learning or career change. A culture such as modern day China might necessitate radical policy change since the provision of continuous changes in roles, between teacher, student, factory worker, farm worker would necessitate a radical change in the higher education policy set.

Public higher education policy primarily reflects these broader societal conditions, and does not have a great deal of influence upon overall inflation, or work conditions, or even student enrollment. Rather these are exogeneous or given factors for higher education to work within, and to which it responds.

Policy Alternatives

Public higher education has such a large percentage of its costs committed primarily due to personnel policy. As table four shows the University of Colorado-Boulder currently has 64 percent of all expenditures committed to fixed costs. An enrollment decrease of 30 percent of admittees per year (run 3) will cause 73 percent of expenditures to be fixed leaving only 27 percent of cost as controllable. Under policies and conditions of 1974-75 this move would occur by 1978-79.

If departmental faculty tenure policy was to continue as in 1974-75, and other conditions, such as the retirement rate were to hold steady, almost the total faculty would be tenured by 1980. Since some departments already have 100 percent tenured faculty
some shift in this indicator is already occurring.

Throughout the country a group of younger faculty are adjusting to the possibility that tenure will not exist for them at any institution. They are becoming a group of academic nomads. They are denied tenure when individuals of lesser quality were granted such tenure only five years ago. This nomadic group continues to suffer from other conflicting policies, such as rules which permit no one to stay at an institution without tenure for more than three years. Of course, the academic administrator who is reviewing applicants for positions can also no longer use the number of jobs within the last 10 years as an indicator of probable applicant quality. But, many administrators still think in the old manner and will begin to pass up the earlier nomadic entrants, for more recent graduates who do not have the stigma of many jobs on their record.

The movement of staff from yearly contracts to long term civil servant status also inhibits management flexibility. Long term commitments should be made in the context of employment for the State, or for the total higher education system, not promises of long term employment at any one specific institution, location or department.

Other feasible policies could be developed regarding non-teaching staff to provide less of a need for and expectation of longevity. Perhaps a greater acceptance of student labor, coupled with internships in their academic program will provide staff support and academic meaning.
Personnel policy regarding retirement plans, and reward structures should also be examined. Early retirement plans have proven financially beneficial to several institutions and CU-Boulder might also be able to improve flexibility and perhaps even save money by encouraging early retirement. Specific studies are necessary to cost the alternative retirement plans. Extensions of work conducted by Toole and by Hopkins would be necessary for detailed evaluation. (Hopkins, Toole, 1972) An examination into increasing work loads while increasing salary, or year round work for faculty might prove cost effective in the long run if coupled with a reduction in tenure expectations.

A reduction in an employee's contractual expectation of long term employment will lead to higher present salary demands since long term employment reduces risk, and the increase in perceived risk will create a demand for higher pay now.

Since facilities represent the other component of fixed cost any improvement in utilization rate will reduce the demand for replacement or enhancement. The present policies have led to very low utilization rates when considering a 24 hour day, 7 days a week. The policy of building facilities to accommodate a peak load of approximately fifteen hours a week, from 9:00 am to noon seems a costly policy and may reflect the lack of personnel control through an incentive or positive reward system. The construction of facilities to meet evening student demand in urban areas needs even greater study since it would seem reasonable to expect that evening utilization of other facilities, such as the public schools, government conference rooms, private business facilities, etc.
would prove less costly, in both the short and long term. The ability of continuing education programs to make such use, and realize the cost savings, should illustrate the need for consideration of this policy for state supported programs. Both changes in staff long term employment expectations and the reduction in facility demand provide greater flexibility to management by offering a larger percentage of expenditures as controllable resources.

Perceived fiscal crises seems to cause employees to become insecure about job status and reject technological improvements. During the period of enrollment growth several technological improvements were offered as resources to aid instruction at a lower cost than increasing the faculty. Computer Assisted Instruction (CAI), and Education Television (ETV) were both promoted as technological means to improve instruction at a lower cost than providing additional personnel. However, the experience has been that CAI and ETV have been purchased along with additional staff leaving funding agents disenchanted with the prospect that either innovation would provide a cost savings. CAI and ETV have only been qualitative improvements. An increase in the use of Computer Assisted Instruction and Educational Television may provide a means of reducing long term cost, but such an argument will be difficult to test and prove if discretionary resources continue to diminish. Perhaps an environment of competition for student consumers will provide the necessary incentive to lead to technological changes.
Higher education has primarily been a supply dominated industry where access was controlled and demand very high. With a reduction in demand the urge to attract consumers might encourage innovation, and in particular the use of Computer Assisted Instruction. It is still not proven, however, that Computer Assisted Instruction and other improvements are any less expensive than faculty cost, nor any less a fixed cost investment.

Other policy changes to improve the productivity of higher education might focus on the use of existing faculty and staff. The present, and long standing, policy of providing undergraduate instruction with about a twenty to one student to faculty ratio, while doctoral level education operates at about four to one can be challenged. The simulation model illustrated the high cost of graduate instruction. The relationship with student faculty ratio is very direct. It has already been suggested by a former chairman of the Colorado Legislative Joint Budget Committee that the need for direct faculty involvement with students is probably greater at the elementary-secondary school level, or the remedial and undergraduate level in college, than at the doctoral or masters degree level. The historic reasons for developing such a low graduate level student faculty ratio were primarily due to the small numbers in the program, as well as a means to protect senior faculty members from a heavy teaching obligation thus permitting them greater opportunity for unsponsored research and public service activities. CU-Boulder could reassign over 250 faculty members by making their graduate level student faculty ratio the same as undergraduate. (1976 CU-budget book, format 50m)
The quality of graduate education might be reduced, but since this idea has not been studied, it may be worthwhile to examine. The two most likely prospects are, one, that the faculty member is wasting that much time per week, or two, that the faculty member is indeed working hard, but perhaps on unsponsored research, committees, and other non-instructional duties. A review of faculty time commitments could lead to a re-structuring of the reward system to encourage heavier teaching loads. Presently, research produced is the primary criterion to measure individual achievement, reducing the incentive for quality instruction. Making the research commitment more explicit and seeking direct funding for it a faculty member's contribution would be a reasonable effort and provide for greater institutional credibility. Of course, it could merely separate research activity out and cause it to be eliminated from the budget. However, if the decision process is explicit then a decision maker must operate in the open and be accountable.

Perhaps the total role and mission of the institution relative to research needs to be examined. Research is a secondary goal of the University of Colorado-Boulder according to the resource allocators in Denver. However, it is the most important of missions if one asks the departmental hiring, promotion, and tenure committee. Several alternatives for correcting the goal conflict are possible. Research could be identified as a consumer of faculty time more explicitly and legislators could be educated about the need for such research. Such a separation from instruction would be beneficial in a time of student decline, and research continuity.
A shift in staff assignments to permit aggressive research support seeking faculty members to spend more time in proposal writing, while using less research-oriented faculty for teaching should increase outside support for research. A switch to aggressive searching for outside research support would need to include an expansion of support staff available to help generate resources. Such a move would also need a change in state budgeters' attitudes to permit the use of outside income in a more positive manner thus providing the individual and the institution an incentive for seeking external funds. This response set is very appropriate to a period where excess staff, fixed or sunk cost individuals might exist. Many academic departments have already decreased in enrollment and excess faculty time may exist, but not the incentive and support for seeking funds. More fundamentally the department which first has excess staff might also be the academic area least likely to be able to get outside funding. A minor retraining of the excess faculty to help the more 'in style' departments with both their teaching and research loads could be developed.

Proposals have already been made to use faculty as a pool of research talent to be applied to state needs. Such proposals might be better understood as a package of fundamental changes to help cover a sunk cost. If buying out a 50 year old faculty member's contract for a cost savings of perhaps only 20 percent seems feasible, then one should consider what other products are possible from that individual which will return at least 20 percent of each dollar. It is not necessarily a credit to our universities to become
the leaders in early retirement when society is just becoming aware of the negative effects of early retirement to many individuals.

There is an even more comprehensive set of responses which are possible. China has shown that a total shift in lifelong employment patterns can have some positive benefits. Perhaps an extension in exchange programs between professors and executives makes the teacher role temporary in nature. Each professional should plan to spend part of their time teaching, and each teacher should become identified with the larger work force of his profession, and not as a full time tenured for life professor. Such fundamental change is not as likely as other alternatives, but movement in this direction would have a powerful effect on the rigidity of faculty employment expectations, and should reduce the fixed cost component of faculty salary.

A review of academic program offerings to determine the specific ones which are of high quality and high demand relative to other programs is often discussed but seldom conducted. The rapid expansion of programs, both of type and level, which occurred during the growth period of the sixties has led to a wide range of offerings within each institution, and each state. The control of program offerings is deemed to be most effective means to control costs. (Carnegie, 1972)

Determining the criteria for program review has been the major difficulty in undertaking, and completing such program evaluation efforts. Criteria for review appears the fundamental difficulty in any policy study of the higher education industry.
This study has focused primarily on the criteria of a balanced budget, or cost containment. The study of higher education cost structure has been undertaken to produce an understanding for the lack of current budgetary flexibility and the potential of fiscal crises if current policy is maintained during a period of static enrollment, or enrollment decline. However, higher education has many goals to serve, many of which are contradictory.

Beside the goal of cost effectiveness the institution is attempting to educate, or train students; provide access to education according to principles of equality; provide an economic stimulus to local communities; and to operate in a process of employee equity by providing equal opportunity employment, and promotion rights.

Another important goal is to use higher education as an economic stimulus to a local community. Cutbacks at the University of Colorado-Boulder and at other institutions would have a dramatic effect on local economies, and in the aggregate state economy. The movement to Boulder and growth of research and development enterprises such as the National Center for Atmospheric Research (NCAR), the National Oceanic and Atmospheric Administration (NOAA), the Bureau of Standards (NBS), International Business Machines (IBM), etc. have occurred simultaneously with the growth of the University and its emphasis on the physical sciences. A reduction in the quality or quantity of the University's effort could stop growth and perhaps erode these organizations. Any downward change in these groups would only contribute to a negative cycle of economic loss for the local community and the state. (Cross)
Any review of higher education productivity needs to address these multiple goals and the numerous quantitative objectives upon which performance toward these goals is evaluated. Simple arithmetic might be sufficient sophistication to examine policy alternatives directed toward the single objective of a balanced budget, but a thorough performance review should permit the evaluation of multiple policies against multiple performance criteria, some of which have non-linear and indirect interdependencies.

Performance Criteria

Acknowledging that public higher education has many goals still does not provide an understanding for the evaluation process. Higher education provides services to many funders each of which has performance review criteria. The legislature seeks to represent all state residents in evaluating an institution's progress toward the goals which the legislature has set. Legislative goals tend to focus on student credit hours produced, working conditions, and student access. Legislators also seek to help the institution satisfy the numerous accreditation boards, another set of evaluators with perhaps different criteria than the legislature.

The legislators seek to represent the general public's demands and criteria but frequently the public will develop its own set of criteria, particularly the citizens located within a university town. The local population may force the institution to provide amenities, or services, that the legislature will not explicitly fund, such as a symphony performance although such an action affects institutional cost.
Conflict over performance criteria frequently occurs between the legislative funders and research sponsors. Federal government agencies and private foundations which support research are primarily concerned with the institution's research performance, even if research activity may have to be at the expense of student instruction. Students are in competition with the research sponsors for institutional resources. The battleground is explicit when the federal government audits the overhead reimbursement rate for the institution. The institution tries to provide justification for a very high rate, while at the same time telling the legislature that research overhead represents a small portion of its resources and is solely an adjunct activity to instruction. The research sponsor is told that research is their primary mission and that the institution can provide research more inexpensively than outside research companies because it has lesser paid faculty and the availability of low cost, high quality student research assistants.

An additional problem also exists since the stated criteria are not always the criteria upon which a judgement is made. The institution must develop an understanding for the implicit criteria being utilized in their review. Students may have explicit criteria of instructional quality standards while deciding to attend primarily on the basis of dormitory quality, or college location, or auxiliary enterprises. Legislators may be more concerned with the football team's performance than academic awards. Research sponsors may be seeking to spread funds geographically, not solely on quality. Some decision makers may even be using less socially acceptable criteria, such as racial or personal bias for their own
family, or ego's.

Public higher education policy analysis can be summarized as a study and analysis of the goals and review criteria, explicit and implicit, of each funding and servicing group, and the priority ranking within and between these groups.

The present lack of budgetary flexibility and potential for worsening should provide stimulus for quick response by administrators. Past flexibility has been obtained by the extra revenue available when student enrollment growth is funded on an average cost basis, while incremental expenditures occur at less than the average cost. A stable enrollment, and even more so a decline in enrollment, illustrate that future budgetary flexibility will only occur through careful management. An institution's response set can be categorized according to the present level of budgetary flexibility. If there is little budgetary flexibility then the response set is truly draconian. People may be laid off, buildings closed, programs eliminated without careful review. Given some budgetary flexibility and time for review the response pattern can be graceful. An orderly set of policies to cope with an impending problem would lead to changes in tenure rates, shifts to non-long term contracting, the elimination of new building plans, the rental of short term facilities for short term needs, the orderly review of programs, a shift in role and mission, etc.

Of course, the most far sighted manager will have already begun to make policy changes in anticipation of a student decline, or stable state. Such a response pattern could be creative as suggested by Kenneth Boulding. (Boulding, 1974)
Managers who heeded the early warning signs and began program review, and personnel policy changes should have greater budgetary flexibility now, and to have created a positive attitude within which creative ideas flourish. Technological innovation is more likely among a group of faculty who are looking to future conditions with their own security established. A positive attitude would use the enrollment change as a catalyst to new policies which may be difficult unless an outside threat is perceived, but not yet felt.

Summary

It has been the basic intent of this paper to provide insight into the cost structure of higher education. This paper is prepared on the premise that a mode of inquiry which is based on analytical thought will provide information for decisions which are conflict reducing and knowledge enhancing. Kenneth Hammond has developed a paradigm of inquiry modes which gives a framework for analytical efforts such as this thesis. (Hammond, 1977)

Figure 6 shows that efforts to deal with the experimental method, including data analysis, will provide more conflict reducing, analytical, decision processes. In that sense I have tried to provide an insight into the cost structure of higher education and the resultant flexibility problem which might lead us from level six toward level five.
Figure 6. Modes of Inquiry
POTENTIAL EXTENSIONS OF THIS STUDY

This thesis is a policy thesis and as such utilized the structural cost model only on aggregate data and relationships with the information necessary to raise the policy issue of resource allocation inflexibility caused from a change in the cost structure of a higher education institution. The implications for additional research are numerous. The need for utilizing a computer based model increases when one extends the present study to include a number of explicit and implicit evaluation criteria in a framework of maximizing performance against an objective function containing multiple objectives which have various weightings and interdependencies.

Intra-Institutional Analysis

In making resource allocation decisions within an institution, it would be important to understand the cost structure of each production unit, department. Some academic departments may already have reached the point of maximum inflexibility, and resultant high cost. Other departments may be on the verge of losing the flexibility which they may need in the near future. An analysis of intra-departmental cost structure would be beneficial, and can be accomplished using the structural cost model, but with a dis-aggregation of data elements.
Inter-Institutional Analysis

The state needs to consider its higher education institutions as a multi-plant facility which provides a differentiated product for a set of market segments. This would lead the management structure, state (corporate) and institutional (plant) to seek a greater understanding for the cost structure of each plant, and of departments within the plant, where comparable programs are offered, in a shared geographic market place.

The structural cost model provides the capability to evaluate policies which have interdependent effects upon multiple institutions. The optimization feature which the goal programming capability of SPS provides could examine cost minimization production levels for various student populations and mixes. The optimality of supply among multiple institutions, can be discovered using the goal programming feature.

Detailed Staff Flow Modelling

The structural cost model makes very simple assumptions about the more crucial policy elements of faculty and staff flow. A more detailed module to track individuals through their potential employment patterns would provide greater accuracy in the prediction of future cost functions. Such flow modelling could be an adaptation of work already developed by Bloomfield, Toole and others. (Bloomfield, 1977; Toole, 1976)
Revenue Modelling

The structural cost model has the logic established to examine alternative tuition policies. The effect upon revenue of changes in percentage or type of cost charged for tuition; the breakout of tuition cost base for graduate, undergraduate, or even for students by program and level is possible, and should be examined. It would be possible to simulate the point of marginal cost = marginal revenue to help guide resource allocation in a framework similar to an enterprise in the pure exchange economy.

Decision Analysis

A very interesting extension of the cost structure model would be its use in developing interactive dialogue coupled with policy capture techniques. The model could easily be adapted to real time simulation. The extension of its logic to include the policy weight capturing and analysis techniques developed by Hammond and Stewart would provide an excellent analytical extension, and attitude change tool. (Hammond, 1975)

The differing perceptions of institutional administrators, department versus university; budgeting staffs of state agencies, and of board and legislative members would be valuable to understand. The differing perceptions of the existing level of flexibility and potential policies could expand the work of Balke and others in terms of labor-management negotiations. (Stewart, 1974)
Graphics Extensions

The model does have a plotting capability available within the SPS framework for developing initial pictures of policy changes. An extension to incorporate interactive plotting would provide greater initial understanding of complex policies.

Theoretical Extensions

An important additional analysis would be an exploitation of the application of this structural cost analysis to other enterprises within the governmental (grants) economy. It may be that all governmental activities are exhibiting this movement to an increasing level of fixed costs. If so, then the implications identified for higher education become even more significant when applied to all governmental operations. The closer examination of the private sector might also lead to a change in our theoretical expectations of industrial cost behavior, due to the structural changes caused with increasing unionization, white collar contracting, etc. Under conditions of decline or steady state the same forces acting on higher education might operate on private enterprises.

Another interesting comparison could be made with other economies. A study which included Britain, and Japan might provide insight into the effects of long term employee commitments. Examination of lesser developed countries might provide a totally different set of policy implications. Inter-economy analysis should be beneficial.
Summary

The last, and only thesis found, which examined cost structure was conducted by Joel Dean in 1937. (Dean, 1937). His work on marginal costing was conducted at the upward end of a long decline and he felt that in decline the value of understanding marginal cost, and other structural cost characteristics was very important. Perhaps the apparent paucity of further work emphasizes our lack of need for such analysis during periods of growth. This could become a fruitful area of research again, if societal growth patterns are really changing.
Bibliography


Bartram, Jack, Interview on May 16, 1977, University of Colorado, Boulder.


Berndt, Rexer, Testimony to Colorado Legislative Joint Budget Committee, November 15, 1975.


Danish, Paul, Discussion on March 15, 1977 citing work by the National Tax Foundation.


Denver Post, November 14, 1976, p. 29.


, and Bushy, John, "What Are the Effects Upon Inter-Institutional Resources Allocation When Institution-Specific Planning and Management-Systems are Available?" Presentation at Association of Interinstitutional Research, 14th National Forum, Washington, D.C., May, 1974.


Smith, George Albert Jr., "Managing Geographically Decentralized Companies," Harvard University Graduate School of Business Administration Division of Research, 1958.


University of Colorado, Budget Request Documents, 1963-77-78.

Fact Book, 1976, University of Colorado, Boulder.


Wartgow, Jerome F., "Implementing a Distributive Cost Matrix," Reformation and Reallocation in Higher Education (Ed. Stewart), Claremont, California: Association for Institutional Research, Claremont University Center, 1972, pp. 30-34.


Weathersby, G. B., The Development and Application of a University Cost Simulation Model, Graduate School of Business Administration and Office of Analytical Studies, University of California, 1967.


