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ABSTRACT

Problems with the Information Exchange Procedures (IEP) developed by the National Center for Higher Education Management Systems are discussed. IEP procedures analyze student records, faculty effort, and annual expenditures. The particular approach taken in the analysis of the student faculty relationship has important theoretical problems, is too complex and costly, and adds little significant insight for use in university administration. The descriptive approach of IEP is based on the faculty activity report which has numerous validity problems that destroy the potential use of its major contribution: the calculation of unit costs. The complex relationships between faculty and students, which are causes of the costs, are concealed by this effort. The errors of measurement chiefly center around the accuracy and validity of the faculty activity reports and the "representativeness" of data from a particular time period. Additional error results from problems such as social security matches between salary and faculty activity records, program classification structure matches between student records and faculty activity records, and the consistency across institutions of the types of operational decisions necessary in any large project. The complexity of the calculations used to produce the indices serves to compound the errors of measurement of the inputs. (SW)

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NCHEMS IEP - PROBLEMS AND CONSEQUENCES

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IEP - Problems and Consequences

Higher Education, in responding to societal pressures in the related areas of accountability and funding, has tried to find ways to maximize productivity (defined here as some measure of output per dollar input by the state), to compare the productivity and efficiency of the institution to those of other states, and to find better ways of budgeting available resources (at both the University and University System level).

For these reasons, several institutions have adopted the Information Exchange Procedures (IEP) developed by the National Center for Higher Education Management Systems (NCHEMS). It offers the advantages of a nationally standardized expenditure analysis which produces reports showing institutional expenditures by activity (Program-Subprogram shown in Table 1), average dollars per credit hour expended by departments (disciplines) at the various levels of instruction and the total and average dollars per credit hour spent on each student degree program during the period under study. It is, however, extremely complex and expensive, especially in terms of staff and computing time, to run. Although much useful information is presented by the IEP software, it is the contention of this paper that the particular approach taken in the analysis of the student/faculty relationship has important theoretical problems, is too complex and costly, and adds little significant insight for use in university administration. Specifically, IEP is merely a descriptive tool. It does generate data which in turn has the potential of being analyzed to yield useful insights, however, the insights themselves are not provided by IEP. Furthermore the descriptive approach taken is based on the faculty activity report which has numerous validity problems that destroy the potential use of its major contribution - the calculation of unit costs. Unfortunately this effort is probably misdirected since it only serves to conceal the complex relationships between faculty and students which are causes of the costs.

What IEP Does

The IEP software and procedures are broken up into three modules which analyze university data in three areas - student records, faculty effort and annual expenditures - and combine them in a fourth module which is used for the manipulation and reporting of data. All four modules allow user intervention to adjust outputs. A requirement of the model is that all inputs be classified by program classification structure or PCS. (attachment I).

Student Data Module (SDM)

The SDM has as its inputs the student records for the period under study. It generates an Instructional Workload Matrix (IWLM) which calculates total student credit hours taught at each discipline (department) and level, and the total student credit hours taken in

each department by students in each degree program. This information is then passed to the Data Management Module (DMM).

Patterson (1976) has described a method of inverting this information to graphically describe the relative integration or autonomy of each department and its students into the curriculum of other departments. One use of this would be assessment of the university-wide impact in terms of student credit hours of deleting a particular degree program or department.

Personnel Data Module (PDM)

This module develops a description of the faculty activity in each department which is forwarded to the Account Crossover Module (ACM) and used to cross each academic department's expenditures into the program classification structure.

Account Crossover Module (ACM)

The ACM has two purposes. It first adjusts departmental ledgers to conform to the standard definitions of Direct Costs as specified by NCHEMS. Examples would be removed of expenditures for utilities from each account or transferring equipment purchases from a Dean's or Vice President's account for a particular academic department. Basically this step compensates for variations in accounting practices which may occur between universities or even colleges within a single university. The second step crosses the adjusted departmental expenditures into the program classification structure based on the faculty activity analysis (for academic accounts) or a manual classificaton of activities (all other accounts). Expenditures by PCS generated by this step are then forwarded to the DMM.

Data Management Module (DMM)

The DMM is used to display and relate information generated by the previous modules. This involves : 1) the display of direct costs by activity generated by the ACM and PDM. 2) the allocation of expenditures in Support Activity Centers (physical plant, academic administration, the president's office, etc.) to Final Cost objectives (instruction, research and public service) and the calculation and display of Full (Direct plus Support) costs of these centers. 3) The calculation of Direct and Full costs per credit hour by discipline (department) and level of instruction. 4) The calculation of the total costs and average student credit hour costs for each student degree program.

While the various modules of IEP do produce a variety of useful reports, advances in computer technology and the availability of highly flexible software packages such as MARK IV, Easytrieve, etc. have made it increasingly easy to produce reports tailored to

particular issues, reducing the importance of the generalized reports produced by IEP. Further, the main purpose of computer modeling is to provide the capability of performing calculations or describing relationships which are too complex to do by hand. (Lee, 1973). The main effort in and contribution of IEP is directed at allowing the analysis of faculty activity to drive the distribution of faculty salary across activities on an individual by individual basis, and in the calculation of student program costs and unit costs. Unfortunately, numerous theoretical problems cause both of these efforts to be largely non-productive.

Departmental Activity Analysis

"Probably the best description of a college or university is a description of what its faculty are doing" (Lelong, 1971).

In IEP, descriptions of faculty activity are used to spread academic accounts into categories of instruction, research, public service, etc. (see PDM above). The percent of these accounts moved into instruction in a given discipline and level has as great an impact on discipline unit costs, and their derivatives, student program costs and program costs, as the total amounts expended from those accounts. Thus, the accuracy of the descriptions of faculty activity is a primary factor in determining the quality of most outputs of IEP. Unfortunately the quality of such data is usually bad. The "faculty activity report" approach may be implemented at least two ways. Direct observations of faculty can be conducted, however, this approach is too costly or bothersome to be done other than on a highly selective, sampling basis (Virginia, 1975). Where system- or even university-wide data is to be collected, a questionnaire must be used. However, this approach also has problems. For example, the distinction between teaching and research activity is often unclear, if not misleading. (many citations) Graduate students and some undergraduate students are often involved with faculty members in research activities (Virginia, 1975). In response to the Texas study on faculty workload (TACT, 1976) one faculty member replied, "Although I listed time thus spent under Research and Writing, it could be justified as class preparation; my research is nearly all linked to my teaching specialties and is therefore a teaching preparation function." Similarly, federal agencies often allow graduate instruction as cost-sharing for research grants.

Cost-sharing instruction, as a result, may be included under instruction in studies of institutional workload or costs, but may be included under research preparation in indirect studies looking primarily at research costs (NACUBO, 1975; NACUBO/NCHEMS, 1977). To quote Hansen (1972), "How does the professor separate out processes which he considers inseparable? ... I should like to make the point here that professors and department chairmen are for the most part responsible people. They want to respond to necessary questions if they are logical. By the same token, if you ask them to break out processes they consider inseparable to programs (categories) they had no part in determining. You cannot expect serious responses, willing cooperation, or respect for your intentions." Secondly, if the results of faculty activity surveys are used to reduce budget or evaluate departmental programs, future surveys are likely to become very biased (Warden, 1974). Thirdly, the faculty activity report is distributive, not a quantitive measure. In other words it tells nothing about how hard faculty in a particular department are working. Finally, if a faculty activity report is instituted as an ongoing quarterly or annual project, it is not altogether unlikely that a long term degradation of the quality of the data reported will result. For example, filling out the report could eventually be regulated to departmental support staff and never even be seen by the professor.

Unfortunately the analysis of departmental activity performed in the PDM does nothing to address these issues. At best it only addresses the impact of salary differentials between graduate students, and junior and senior faculty on the costs of activities performed by each group. Even this may be misleading since part of the indirect cost of undergraudate instruction by graduate students is the education of those students by senior (Doctoral directive) faculty.

Beyond these problems, a distribution of departmental expenditures to all areas of faculty activity may not always be desirable. For example if unit costs are being used as the basis for a funding formula, it may be desirable to consider the research and public service activities of faculty as simply overhead costs of instruction (Triezenberg, 1976). In other words, funding sufficient to provide a given level of free time to allow faculty to perform professional activities is one necessary component of the recruitment of faculty of a given caliber. In this case all departmental costs would need to be distributed to instruction.

The distribution of departmental expenditures to a wide range of activities may also cause problems if IEP products are used in reports to State Government. In our case, the higher levels of expenditures reported in research, public service, and academic support than produced by other, less detailed approaches resulted in an adverse reaction by the Governor's office.

The Cumulation of Error in Complex Models

"Long chains of argument are the delight of theorists and the source of their mistrust by practical men." -(Alonso, 1968).

Much of the pioneer work in the practical applications of large scale models was done with urban growth and transportation models for Urban and Regional Planning. The results of this experience were described as early as 1968 in the landmark article "Predicting Best with Imperfect Data" by William Alonso - that complex models are more appropriate for theoretical research than for applied endeavors. This is due to the cumulation of error in the model which occurs in two ways, errors of specification, where the model does not mirror reality and errors of measurement. The most critical error of specification for IEP lies in the problems related to the "joint" or "common" products of the activity of faculty (NACUBO, 1975, 1976; Bacchetti, 1977) which may be unresolvable (Bacchetti, 1977). The errors of measurement chiefly center around the accuracy and validity of the faculty activity reports and the "representativeness" of data from a particular time period. Additional error results from more mundane problems such as social security matches between salary and faculty activity records, PCS matches between student records and faculty activity records and the consistency across institutions of the types of operational decisions necessary in any large project (Bacchetti, 1977).

The exact way error cumulates was described by Alonso as a function of the arithmetic operations of the model. If Z is some function of X and Y where $X = 10 \pm 1$ ($\pm$ 10%) and $Y = 8 \pm 1$ (+ 12.5%):

Addition

$$Z = X + Y$$
$$18 = 10 + 8$$

$$e_z^2 = e_x^2 + e_y^2 = 2$$

$$e = 1.4$$

In the case of addition, the absolute magnitude of error is greater (1.4 vs 1.0) however, the percentage error is smaller (7.8% vs 10% and 12.5%) than is the independent variables. Addition is relatively benign.

Subtraction

$$Z = X - Y$$
$$2 = 10 - 8$$

$$e_Z^2 = e_X^2 + e_2^2 = 1 + 1 = 2; \quad e_2 = 1.4$$

The result of subtraction is the same absolute error as addition of the same variables. The relative error, however, is explosive (70% vs 10% and 12.5%)

Multiplication and Division

$$Z = XY$$
$$80 = 10 \times 8$$

$$e_Z^2 = e_X^2 + 2\, e_Y^2 = 164; \quad e_Z = 13.3$$

Multiplication not only greatly raises the absolute error, but also raises the relative error to some degree (16.9%). Divison behaves exactly like multiplication.

Raising to a Power

$$Z = X^2$$
$$100 = 10^2$$

$$e_2^2 = (2X) - e_X^2 = 400; \quad e_Z = 20$$

Raising to a power, described by Alonso as the multiplication of perfectly intercorrelated variables, is another explosive operation. In this case relative error reaches 20 percent.

From these equations, Alonso generalized the following rules for building or choosing models:

1. Avoid intercorrelated variables.
2. Add where possible.
3. If you cannot add, multiply or divide.
4. Avoid as far as possible taking differences or raising variables to a power.
5. Avoid as far as possible models which proceed by chains.

The last point has particular relevance for IEP as its primary outputs, discipline costs per credit hour and, to an even greater extent, student program total and average costs per credit hour are the products of long chains of calculations. Thus the second major contribution of IEP has significant problems and may generate more "noise" than real effects.

Major problems aside, the unit costs generated by IEP are impacted by significant variables which are not controlled by the study. Current inflation rates create problems with the comparison of expenditure data generated in different years, or in different areas of the country. Furthermore, funding adjustments by state legislatures not only rarely keep up with inflation, but the exact relationship between percentage increase in funding for a particular year and the percentage increase in inflation for that year is itself variable in nature. At its most extreme case, state revenue problems may cause a hiatus in raises and funding increases for a limited period, causing a highly misrepresentative support dollars/workload relationship for any expenditure analysis conducted during that year.

The expenditure/enrollment relationships described by direct unit costs are to a large degree a description of the relationship between departmental staffing - the largest cause of university expenditures - and enrollment. Unfortunately, this ratio is not extremely stable, particularly for public institutions. For example, although the recent total enrollments at FSU have fluctuated no more than 3% from the previous year, fluctuations at the departmental level have averaged approximately 10% per year. Further, short term (annual) fluctuations are not always in the same direction as long term trends. Because of the delays required for recruitment and the fact that faculty resources are necessarily budgeted prior to the academic year, staffing changes must respond to long term trends. This is further complicated in a steady state and collective bargaining situation because reallocations of faculty positions are contingent upon faculty turnovers which are outside the control of central university administration. As a result, there could easily be a two or three year lag between enrollment shifts and resultant staffing adjustments. In the case of a department with declining enrollments this lag could be even greater and result in a dramatic increase in unit costs.

IEP shares many of the problems of the large scale models used and abandoned by the field of Urban and Regional Planning in the 1960's (Alonso, 1968; Lee, 1973; Nayler and Jeffress, 1975).

1. It is "designed to replicate too complex a system in a single shot "(Lee, 1973; in reference to Urban and Regional Planning models) While the total departmental expenditures and enrollments by department and level analyzed by IEP in a particular year are

probably an accurate representation of that year, they are a snapshot look at a dynamic situation and may not be representative, or generate representative unit costs. This problem could probably be controlled by averaging data over several years as could the problem in the relationship between inflation and funding for a particular year. Further, standardized procedures for controlling these sources of variance could probably be developed; however, this would only serve to make an already complex project even more complex. Furthermore, any adjustments would still leave the relationship between departmental expenditures and student credit hour productivity described only in terms of a distribution based on faculty effort, and student credit hours by department and level. Issues such as faculty contact hour loads, faculty/equipment ratios, instructional mode, qualitative measures of students, full-time, part-time student ratios, quality of instruction, etc. are ignored.

2. Although "excessive data is required ... to provide microscopic detail, the actual level of detail is much too coarse to be of use" (Lee, 1973).

The data requirements of IEP include a student data file containing the degree program and department discipline and level of all credit hours taken during the year of each student and an estimate of the distribution of each faculty member's activity across disciplines and levels of instruction, and various research, public service and academic support activities. Despite the detail of the inputs, the outputs all derive from a single analysis which, as discussed above, have a variety of problems.

3. Build only very simple models. Complicated models do not work very well, if at all ..." (Lee, 1973).

Since IEP has as its purpose the exchange of data between institutions, it needs to be widely adopted. Unfortunately its complexity and resultant cost restrict its adoption. On the other hand, complex models place high demands on the quality of data (Alonso, 1968; Lee, 1973) which are not met by faculty activity data (Hansen in Stewart, 1972; Virginia, 1975; Kansas, 1975; NACUBO, 1975).

4. "... the strategy is not to build one master model of the real world, but rather a set of weak models as alternative models for the same set of phenomena. Their intersection will produce robust theorems." (Alonso, 1968).

It seems quite likely that Alonso's comments directed at models in the field of Urban and Regional Planning are relevant to Higher Education. One possibility would be the development and exchange of departmental profiles containing whatever information is easily available from university data files and budget reports, such as

contact hour loads, average class sizes, support staff/faculty ratios, average salaries, etc. These relatively simple measures involve less commitment of resources on the part of institutions, which would in turn encourage greater participation, appear to be more useful, and avoid the problem of compounding errors of measurement.

While the discipline and program costs and unit costs generated by IEP are quite precise in appearance they are based on data and relationships which are probably not stable enough to produce consistently valid results. Furthermore the complexity of the calculations used to produce these indices serves to compound the errors of measurement of the inputs. On the other hand, insufficient detail is provided to determine the causes of the costs reported by the study. For example, excessive costs may be the product of high salaries, high faculty/student ratios, high support staff/faculty ratios or some other condition. High costs merely indicate that further examination of departmental data is necessary. Since comparative data is needed for this and since the calculation and examination of more objective data such as that discussed above is probably quicker, easier and less subject to error than the calculation of unit costs, why bother with unit costs?

Considerations of the above problems along with others such as the variation in costs due to the mix of tenured vs. nontenured faculty, the distribution of faculty among ranks, or the department chairman's ability to cover numerous courses using part-time instructors (adjuncts) bring us back to the unsolvable problem. Unless similar situations obtain, comparisons are questionable. The IEP is a usable tool only when very similar institutions are considered. We still have not solved the questions asked by our legislators - i.e. we are not able to supply simple answers to simple questions.

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Figure I

Program Structure Reporting Level

	CODE	TITLE
*	1.1.XXXX.XX	General Academic Instruction (delineated to discipline and course level)
*	1.2.XXXX.XX	Occupational and Vocational Instruction (delineated to discipline and course level)
*	1.3	Community Education
*	1.4	Preparatory and Adult Basic Education
*	2.1.XXXX	Institutes and Research Centers (delineated to program subcategory where appropriate)
*	2.2.XXXX	Individual or Project Research (delineated to program subcategory where appropriate)
	3.1	Patient Services
*	3.2	Community Services
	3.3	Cooperative Extension Services
	3.4	Public Broadcasting Services
	3.5	Museums and Galleries Public Services
	4.1	Libraries
	4.2	Museums and Galleries
	4.3	Audiovisual Services
	4.4	Computing Support
	4.5.XXXX	Ancillary Support (delineated to program subcategory where appropriate).
*	4.6.XXXX	Academic Administration (delineated to program subcategory where appropriate)
*	4.7.XX	Course and Curriculum Development (delineated to program category)
*	4.8	Academic Personnel Development
	5.1	Student Service Administration
	5.2	Social and Cultural Development
	5.3	Counseling and Career Guidance
	5.4	Financial Aid Administration
	5.5	Student Auxiliary Services
	5.6	Intercollegiate Athletics
	6.1	Executive Management
	6.2	Fiscal Operations
	6.3	General Administrative Services
	6.4	Logistical Services
	6.5	Physical Plant Operations
	6.6	Faculty and Staff Auxiliary Services
	6.7	Public Relations and Development
	6.8	Student Admissions and Records
	7.1	Independent Operations/Institutional
	7.2	Independent Operations/Outside Agencies
	7.3	Independent Operations/Demonstration School
	8.1	Scholarships
	8.2	Fellowships
	8.3	Student Loans
	9.1	Cost of Purchases for Resale
	9.2	Capital Expenditures
	9.3	Capital Cost - Building and Land Improvements
	9.4	Capital Cost - Equipment
	9.5	Auxiliary Holding Accounts
	9.6.XX	Reserves
	9.7.XX	Invalid Accounts

* Derived from the PDM