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ABSTRACT

This review examines how goals, processes, resource inputs, and funds will be viewed at different levels of university organization: the campus administration; the schools or colleges, the academic departments and organized research units; and the support organizations on the campus. The review encompasses the main features of complementarity, independence, and substitutions in an examination of some basic budgetary strategies that have been used or are being considered for use by a multi-campus university. (Author/MJM)

COMPLEMENTARITY, INDEPENDENCE AND SUBSTITUTION IN UNIVERSITY RESOURCE ALLOCATION AND OPERATION

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Aspirations for programs and for budgetary resources in universities follow the Law of Indefinite Augementation -- that is, there nearly always seems to be a good case for adding a program or increasing a budget component, and there is almost never perceived to be a good case for dropping a program or cutting a budget. This law apparently contradicts another -- the Law of Competition at the Margin -- which says that the claims made for resources all need to be considered as competing with one another, with the necessity to make adjustments among all of them at the margin to fit allocations within a budgetary ceiling.

Looking more deeply into the structure of university operations, we can perhaps find out how to cope with this apparent contradition between two equally respectable laws of resource commitment and budgetary adjustment in universities.

Definitions for the Goal Domain, the Process or Activity Domain, the Resource-Input Domain, and the Funding Domain.

Four domains of analysis need to be considered: funding (the acquisition of financial balances with which to defray the money costs of resource-inputs); resource-inputs (personnel; raw materials and supplies; and the services of capital goods); processes or activities (which use resource-inputs to produce outputs); and goals (indicators of achievement or welfare of the institution).

The general character of institutional operation is sketched in Figure 1.

Two goals may be defined as independent of one another if an increment

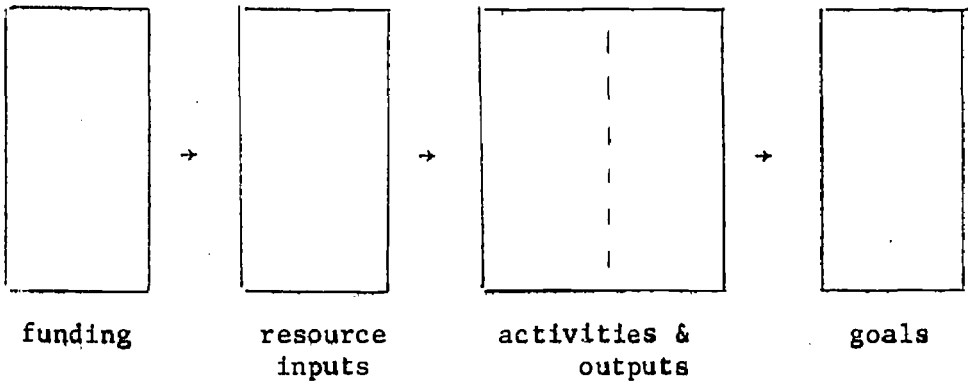

Figure 1

of change in one of them is not affected by the level of achievement of the other. The outputs obtained from two or more processes or activities may map into a single goal, or a single output may be contributory to the amount of attainment of one or more than one goal.

Two goals are complementary if the increment in attainment on the first, from a given output contribution, is positively affected by the level of attainment of the second. Two goals are (partial) substitutes if the increment of attainment of the first is negatively affected by the attainment level of the second.

Turning now to processes or activities, we can define one activity as independent of another if, once again, the size of the marginal

increase in output obtained by means of a unit increase in usage of resource inputs is unaffected by the output level of the second process or activity.

The neo-classical literature of the economic theory of production defines two inputs as substitutes if their proportions can be varied in producing a given level of output, and complementary if their proportions must remain fixed. But there is another way to look at the problem in the context of university programs: we may regard students as "inputs" from a market environment, and faculty as "inputs" from another market environment, and it may be true, as we compare one university's situation with another, that in terms of both student and faculty quality, it is easier for a university to attract good students if it has good faculty, and vice versa. Because this is a linkage of the response function of these two market environments to the institutional offer, it differs from the notion of complementarity or substitution in the production process as such.

We will have to defer further definition of these production and input characteristics until the later discussion, because the peculiarities of the institutional processes in higher education make it necessary to be very careful about the characterization of "processes," "activities," "programs," and "inputs."

A final category for interpretation is funding, by source, and purpose. The finance of resource inputs is in part drawn from general university funds, and in this event, a unit increase in usage of any given resource is a competitive claim on a funding pool, the size of the claim being determined by the unit price the institution pays for that input.

Also, in the short run certain of the physical or real resources of an institution are fixed in amount and must be rationed over alternative uses. In both of these cases, alternative claims on the fund or the fixed real resource must be considered as substitutes for one another. But there is an important class of funding cases in which an increment of funding is strictly tied to the resources needed for one subset of processes or activities, which contributes to one specific part of the goal domain, and may not be used for any others. In this case, the earmarked funding is independent of the institution's general funds, and a "client" -- the funding source -- is supporting the resource inputs and the subset of activities because of the client's interest in a specific part of the goal domain. In this instance of funding independence, an increase of general university funds has no positive effect, and a decrease, no negative effect, either on the willingness of the client to supply earmarked funds or in the results obtained from the special subset of processes and activities supported from the earmarked funds.

We may also find instances of complementation in funding: that is, where a unit increase in the general university funding pool induces an increase in an earmarked fund, and/or vice versa. In this case, an increase in an earmarked fund brings about not only an increase in the activity-levels specific to that clientele interest but also an increase in other processes and activities, financed by the increment in the general funding pool, and in addition to the increment in goal performance specific to the clientele interest, other parts of the goal domain are positively affected.

Complementarity, Independence and Substitution as Viewed by Different Organizational Levels and Types of Organizational Unit in a University

Given the above definitions, we can examine how goals, processes, resource inputs and funds will be viewed at different levels of university organization: the campus administration; the schools or colleges; the academic departments and organized research units; and the support-organizations on the campus.

A. The Campus Administration: Management of the Goal Domain and External Relationships.

The campus administration, like Janus, must look in two directions: to the relations of the university with its external environments (for sources of students, external resource markets, clientele relationships, and funds); and to its internal relations with the ongoing institutional processes and constituencies. (Thus, the frequent accusation that a college president is two-faced is functionally accurate!)

The campus administration must look to two levels of interpretation of the goal domain: the global image of the campus; and the valuation of particular degree programs and their impact relationships upon the occupational and academic marketplaces.

The global image of a campus conveys signals to its public of its quality and distinctiveness. Its academic programs and departments contribute to this positively if they are of recognized quality and negatively if they are recognized to be poorer than the general impression for that campus. They contribute to its distinctiveness if they are

part of an image of related strengths as to specialization (e.g., Massachusetts Institute of Technology's programs in physics, computer science, and electrical engineering) or convey independent special distinction (e.g., Cornell University's Medical School in New York City, which is separated both geographically and functionally from the Ithaca campus).

In the operating character of a campus, doctoral and professional degree recipients usually go to distinct and segmented career destinations. Evaluation of the campus by those who make hiring decisions at these career destinations is normally in terms of the character of the campus as a source for the specific specialties in which they are hiring. There may, however, be some (positive or negative) halo effect on the image or general reputation of the campus in other areas than those immediately identified as training specialties for which the hiring officers are doing recruiting.

The chief academic administrators of the campus, looking at this aspect of their responsibilities, are interested in how successfully the graduates from each degree program are placed and how well each program is regarded by those at the career destinations and those who are knowledgeable about program quality in each field at other institutions. The analytic interpretation of this, then, is that each degree program contributes to the institution two components: a largely independent and separable impact relation upon a clientele community; and a (generally mild) impact on the general image or reputation of the campus. At this stage of evaluation, then, each degree program is generally either independent of the others or is complementary to them from the standpoint of the campus-level administrator. Only if the program actively detracts from the perceived acceptability of the campus and its other degree programs (because

of, for example, very much lower perceived quality than the average quality of programs on the campus) would the institutional administrator draw the inference that the reduction or elimination of a given degree program would improve the acceptability and position of the campus overall. (At another level of reasoning, to be discussed below, we take up the quite different issue of reallocating resources away from one degree program or field and thereby buying an improvement of performance and acceptability of other programs.)

When might the campus-level administrators come to the view that a given degree program ought to be dropped on the ground that it is incompatible with, or a competitor in the impact markets with, other existing programs? Part of the answer to this has been given: if the program in question is of a quality well below the perceived campus average, its presence in the menu of things done may detract. Here are additional reasons why a given program might be viewed as incompatible with the intentions and market-locus of a campus:

(1) the program might violate an image of highly defined specialization in degree markets that the campus is seeking to build;

(2) the program might require a student clientele that is seen as incompatible with the characteristics of students with whom the campus normally expects to deal.

A comprehensive university campus having a reasonably wide range of degree programs and dealing both with undergraduate and graduate students is unlikely to perceive incompatibility restraints of either of the above types. Thus, as to the degree-recipient stage of evaluation, degree programs are either independent of or complementary with one another. They

are very unlikely to be competitors of one another.

Furthermore, at the stage of final-market evaluation, any campus can identify new degree programs which it does not yet offer, and these too are in general likely to satisfy the criterion of non-substitution with existing ones. Thus, from the standpoint of relations with degree-recipient markets, a campus that is already comprehensive has no incentives to avoid additional programs (the case of independence) and may have active incentives to initiate them (the case of complementarity).

All of the above reasoning concentrates on the interdependencies among programs in the institution's evaluation of the worth to it of various types of degree-recipients it turns out.

The campus administrator's interpretation of this aspect of the goal domain, then, is measured by the acceptability and placement success of degree recipients in specific programs and by the academic reputation and quality of these programs. In general, these goal valuations are either independent or complementary. This helps us to show the logical basis of the Law of Indefinite Augmentation. A university administration typically has no direct incentives, with respect to its goal valuations, to reduce or eliminate an existing degree program because of any negative impact of that program on another part of its goal domain; and, in principle, a university administration has an incentive in its goal domain for an expanding mandate over time: to find new programs to offer, which will add new elements directly to its goal performance, and which will have no penalizing effects on the valuation placed on its existing programs and their rates of operation.

The prowess and reputation for basic research of a university's

faculty in a particular discipline has several consequences, from the point of view of the university administration. First, it adds to the general eminence and global image of the institution. Second, it increases the value and prospects for placement of the recipients of advanced professional and scholarly degrees in that discipline, both because of the reputation effect and because those faculty who are eminent in research are also visible and influential among their peers in the discipline, nationally and internationally. Third, reputation attracts better students, from a wider market; and it is often said with considerable truth that the outstanding degree recipient was, with high probability, an outstanding student at the time of admission to his degree program. Fourth, there is a funding market for support of basic research, from federal agencies and foundations. The outstanding researcher in fields with an active funding market may thus attract funds for part or all of the costs of his research activities, or may even be a nucleating agent in attracting funds for the support of junior faculty and graduate students. Finally, an eminent research faculty is, by definition, at the most important frontier of its field. It thus contributes to the atmosphere of intellectual striving and excitement not only in its own specialty but more broadly on the campus.

From the viewpoint of the university administration, the case of applied research and service activity is somewhat different. Here, the purpose is to solve a specific problem of a clientele group or organization, or to provide a service or problem-solving capability for that group or organization. In scholarly fields where basic research dominates reputation and prestige, there is not likely to be a positive

linkage from the applied research and service activity to the attracting power of the institution for scholars or for outstanding students. The attitude of the university administration is likely to be "Why not" if the clientele organization is willing to provide full funding for the applied research program or service activity. The added funding is thought to be independent of any other funding and not available unless the applied program or service activity is undertaken. Furthermore, an additional external clientele is pleased and (hopefully) no existing one is offended. And finally, the added resources bought with the earmarked funding may be partly contributory to other purposes if used in joint-output processes, and the existing overheads of the institution can be spread over the additional activity.

Nevertheless, the university administration may find that problems arise from the accumulation of applied research and service functions. Within the institution, those committed to basic scholarship may complain that the priorities are wrong and seek control over the funding and resources for "higher-level" purposes; the consequent conflict with the faculty and research cadres who are devoted to the applied research or service activity may be an administrative problem itself; and if the proponents of basic scholarship are successful, the external clientele may be disappointed by the diversion of attention from its perceived needs and interests. Also, the external clientele may impose conditions -- tight control of the earmarked funds to assure their specialized use; or in the case of the military, security classification of research results and clearance for the personnel involved -- which run into conflict with other policy standards of the institution. Those devoted to basic scholarship may also argue

that the applied activity is prestige-diminishing, and thus reduces the valuation placed on other goal performance of the institution. Finally, although the applied activity may have been thought to be manageable with no increase of overheads, an accumulation of it expands the loading on support administrators and adds to the complexity of the institution's management tasks.

We have already mentioned the attracting power for high-achievement students of the scholarly reputation of an institution. The university administration must keep a deep interest in student admission policies for several other reasons. There are well-known correlations between the high-school achievement level of a student and the educational level, income, and assets of his or her parents. A private college or university which must charge tuition and regard it as a major funding source for general institutional purposes, thus conventionally has an interest in pursuing a selective admission policy as far as it can. Lower-income students cost it money in financial aid that offsets tuition income, and less-qualified students cost it greater academic resources to educate to a given level of attainment or, when graduated, have less prospect of success in graduate school or in occupational placement. (A private university also expects to make money on its undergraduates and use the surplus to support its graduate programs.) Yet private colleges and universities devoted increased resources in the 1960's to the admission of minority members and economically-disadvantaged students. Often this was stimulated by the liberal social views of faculty and the existing, upper middle-class students. In broad, public-policy terms it is a good thing that many private universities and colleges broadened their admissions policies, but for the top administrators there is no question that

this caused problems of varying acuteness, both in the temporary heightening of internal stresses from the presence of a new student constituency and in the dissatisfaction of conservative alumni and donor clienteles.

Administrators of a state-supported university always have had to pursue an admissions policy that takes more cues from the political context. The linkage of admissions policy to tuition income is less, or is broken altogether. The same favorable conventions apply to selective admission from the standpoint of institutional prestige and the academic performance and career success of graduates. But to these considerations is added the necessity to justify the basis on which admission is denied to a son or daughter of a citizen of the state. Admissions policy has to be supported by political bargains. If a public university is to exercise some selectivity in admissions policy, it must do so under the shelter of such political bargains, and these in turn have to provide for the needed response to educational opportunity of every influential political constituency -- if not in the state university, then, in some other part of a differentiated array of publicly supported institutions. Even while it sings the virtues of its academic prestige and tries to demonstrate the worth of that prestige to the political power-structure and general citizenry of the state, the administrative leadership of a high-quality state university has to pursue a generally less-selective admission policy than its counterparts of similar academic prestige among private universities, and it seeks in various ways to avoid the elitist label. Politically, the greatest enemy of the high-quality public university is the right-wing populist politician, who attracts away the support of the conservative establishment while, at the same time, denying the university support

on egalitarian grounds!

The administration of a high-quality public university also may face significant problems in the goal domain, of justifying graduate degree-programs which "fail to meet the manpower needs of the state" or which have high loss-rates of mobile degree-recipients to jobs outside the state. (This topic of the clientele and constituency politics of state university support deserves much more detailed treatment than can be given in this paper.)

B. The Academic Departments as viewed by the Campus Administration.

Now we turn to an examination of the interdependencies among academic departments and their degree programs in the stages prior to degree completion.

The academic organization of a campus according to classically-defined scholarly disciplines -- physics, chemistry, biology, history, English, etc. -- entails establishment of a faculty cadre into an academic department for each, often with an exclusive mandate to control what is offered to any student on the campus in that field. A curriculum major is then designed as a set of courses (usually with a menu of choices) offered within that department or listed, from the courses offered in other departments, as required or optional within course categories of the curriculum for the major. Students then distribute themselves over majors and over individual courses in which they have choice within the major. The fundamental principle is that no disciplinary department can poach another's territory. Even while competitive choices of where to major and where to spend electives determine this enrollment distribution, the departments are not permitted to be direct substitutes of one another in the academic content of what

they offer. They are all independent or complementary in the supply of course offerings, by type of content. It would be a violation of this principle, for example, to have two departments of mathematics competing with each other in direct substitute courses. To see how one academic department interacts with another in the operation of curricula, we can summarize the main properties of the "Induced Course-Load Matrix." This was developed at the University of California for analysis of resource-absorption in academic programs and has been used as a major element of the NCHEMS/WICHE Resource Requirements Prediction Model.

Academic operations are defined in a Leontief N X N input-output matrix. From historical course enrollment statistics of the student majors in a given field, the proportions of academic work they take both in their "own" major field and in every other field are derived. These fractional coefficients are either zero or positive, and they are ordinarily assumed to be invariate with respect to changes in the number of majors in the field. (This assumption of constant coefficients can be relaxed just as it can in input-output economics, but at the cost of substantially increasing the complexity of an academic operations resource-absorption model.)

Using this matrix of coefficients and the distribution of FTE student enrollment by major, the analyst can quickly compute the total amount of instructional load in each field that is generated by student majors from that and every other field; and the sum of these components for any one field is its total instructional workload.

If all off-diagonal coefficients were zero, no interdependencies among academic areas would need to be considered by the institutional administrators: doubling enrollment in a given major would affect only the number

of classes, faculty, and other resources in that academic area; and eliminating that major entirely would eliminate the workload for that field but leave all others unaffected. Typically, of course, the historical enrollment distributions, and the curriculum requirements that are legislated by faculties and approved in an institution, do show substantial cross-relations between fields. Thus, the chief academic administrator of a campus, implicitly viewing these interdependencies as a fact, sees them as implying independence (zero coefficients) or complementation (positive coefficients) among programs. If it is suggested that a given academic area be dropped, and if it has a history of substantial cross-relations with other academic areas, the costs in reorganization, redesign of curricula in the remaining fields, and dislocation of student and faculty preferences are likely to be substantial. From this point of view, "trade-off" consolidations often require complex sequences of administration - faculty study, debate, and negotiation - the costly process known as "academic reform." We will take up below the questions of department-level and campus-level response to events which may make it necessary to explicitly modify the coefficients; it is sufficient for this part of our discussion that, in the normal circumstances and on an institution-wide basis, academic program areas are not seen as substitutes for each other.

The above holds when a campus is committed to the organizing principle of distinguishing each academic discipline, establishing an academic department for it, and giving that department exclusive mandate, not only to administer a program for degree majors in that field, but also to provide instruction in that field ("service course load") for students in other majors who have requirements or elective interests in the field in question.

There are two important dimensional alternatives to this principle of academic design: the professional schools, and the decentralized collegiate organization. The professional schools often claim their expertise not in a scholarly discipline but in the design of a curriculum to fit students for a professional vocation and the inculcation of students with the mores and attitudes of that profession. Some of the intellectual content may overlap with one or another of the basic scholarly disciplines. The faculty of the professional school may then have to decide whether to send its students to the academic discipline departments for this background or assign some faculty of the professional school to the offering of especially designed courses within the school.

Organization of a campus into decentralized colleges strikes even more deeply at the fundamental principle of complementation because each college may seek a faculty and a set of courses or seminar requirements which is chosen to be integral to that college's style and mission. Adams and Michaelsen make this point in their study of UC Santa Cruz.[1]

C. Program and Process Relationships Among Departments: The Departmental View.

When a campus is organized according to academic specializations or scholarly disciplines, with a distinct budgetary unit for each, the faculty and chairman of each department face, from their standpoint, both complementary and competitive relationships with other departments. There are four aspects of the analysis at this level: academic process and operating interactions; relationships in the design of curriculum;

[1] Assessing the Benefits of Collegiate Structure: The Case at Santa Cruz, Report No. P-14, Ford Foundation Program for Research in University Administration, University of California, Berkeley, 1971.

competition within departments for priorities; and budgetary relationships between departments.

Faculty in two fields are sometimes strongly dependent upon one another. Historian and linguist, chemist and physicist, lawyer and political scientist, may trade mutually helpful background and techniques and may share in the training of students who, in effect, are hybrid products of the respective specialties.

Academic departments may also rely on each other in a milder form of complementarity, any given department sending students to the department which has the expertise and the jurisdictional mandate to provide essential background to students. "Service" courses offer institutional efficiencies through economies of scale; but the students arrive from a variety of majors, and the design of a service course is often, necessarily, a compromise that does not quite fit any one of the components of student flow into it.

Thus, we find, on many university campuses, that the mandate of exclusive jurisdiction partly breaks down. An example is the proliferation of introductory statistics courses on many university campuses. The mathematical statisticians may offer to majors in the Math or Stat department an introductory statistics course which presumes mathematical background and ability. They may also offer an introductory "service" course for non-majors with less mathematics prerequisite. But on a large university campus, we are likely also to find educational statistics, engineering statistics, psychological statistics, business statistics, bio-statistics -- all offered in the respective departments and tailored to the topics that the discipline faculty in question regards as most

important for applications in that field and to the needs for learning and the passing standard that the department feels it desirable to impose on a particular stream of students. A single, large-scale introductory statistics offering might be considerably cheaper than this menu of specially tailored courses (and it might be better statistics) but it would entail compromises of course design and course administration. These compromises have to be evaluated as a "loss" of seeking the large-scale solution.

A department is a coalition of faculty with mutuality of scholarly interest in the shared discipline and a collective interest in the welfare and prestige of its members and of the field on the campus. The department exhibits a strong interest in offering and manning service courses, and defending its jurisdictional mandate, if it has a strong philosophical commitment concerning instruction in its field and if the rules of budgetary allocation on the campus reinforce the departmental interest. This is the case if departmental justifications for additional teaching positions and other components of budget are keyed to student enrollment in courses the department offers, for the department can then use the additional faculty appointments to satisfy ever-present needs for rounding out its roster of complementary specialties or adding an occasional "star" or exceptionally promising junior faculty member.

If the campus budgetary mechanism is, roughly speaking, an internal budgetary market driven by such evidence of the volume of instructional activity, the department can maximize the resources at its command through the following devices: (1) maximizing its own capture of student course enrollments by making its major fields attractive to students, and

retaining to itself the course elections or requirements of its major students as nearly as possible within the rules of what it can decide about curriculum and how it can influence its "own" students; (2) seeking to have other departments specify its courses as required courses or as preferred electives, and making its courses attractive to students over the whole campus as "free" electives; and (3) developing new curricula and emphases which will result in expanded numbers of majors.

The budgetary standards that are written into the resource allocation mechanism also exert profound influence. For example, the laboratory sciences typically claim that they cannot conduct instruction properly unless they have a large amount of building space, equipment, and operating support per faculty member and per student. These standards are indispensable to the budgetary mechanism; once adopted, they are not easy to reopen as an explicit issue of resource allocation (although the actual allocation may fail to approximate the standard, exceeding it temporarily if the department's enrollment falls after a large allocation of space or equipment was previously made, or falling below it if enrollment rises too quickly to allow the allocation to catch up). A significant change in the preferred style of work in an academic field, leading to a demand for an increase in budgetary standard, is likely to arouse acute controversy between the department and the campus administration.

An academic department, as a coalition of specialists within a discipline is generally responsible for the design and offering of both graduate and undergraduate degree programs for student majors in that field, and sometimes for a series of specialties within the field, with each subgroup of the departmental faculty most deeply interested

in the courses, the students, and the research activities in its own specialty.

Once again, elements of both competition and complementarity appear in the struggle to define programs, evaluate their worth to the department and the campus, set priorities, and allocate budgetary resources. Once again, also, the contradiction is in evidence between the Law of Indefinite Augmentation and the Law of Competition at the Margin.

Assuming that the department faces a campus-wide regime of justification for resources according to student workload, one concern of the department as a whole about a proposed new program of work is whether it will attract some additional student enrollment without taking away the enrollment support of some existing areas of activity. If so, the new specialty can be financed through budget augmentation; but if not, the potential losing factions may oppose the improvement of position of the potential gainers.

The department may also assert priorities of its own that run counter to wider interests of the campus as the campus administration sees them. For example, during the great period of doctoral expansion at the major universities, academic departments in many disciplines saw needs, and their interests, best served by a sharp increase of effort in doctoral-level instruction. If they wanted to pursue this more rapidly than additional net resources (faculty positions, support budget, etc.) could be made available, they often did so by reducing the amount of resources allocated to undergraduate teaching, allowing class sizes to increase in undergraduate courses while assigning faculty to new doctoral-level courses and tutorial instruction. Only an assertion of counter-pressure

by college deans or campus-level administrators could prevent this from occurring. Also, many departments had been accustomed to admitting graduate students as master's degree candidates; some of these students might be destined for eventual entry into doctoral programs, but many of them were interested in terminal master's degrees, either as a basis for secondary-school teaching or community college teaching or for professional administrative or industrial careers. Academic departments frequently modified their priorities to de-emphasize or eliminate these terminal master's degree programs, consolidating their attention on doctoral students. Unless the administrators at a higher level saw some harm to institutional interests, more broadly defined, they tended to be complaisant about the many informal and occasionally formal departmental actions which implemented these priorities. Only when the Ph.D. hiring market turned sour, beginning around 1970, did many academic departments begin to reconsider whether their cut-off of terminal master's degree candidates had been wise.

In budgetary relations between the academic department and the campus-wide administration, another aspect of the process emerges. A department can expert a ready acceptance of any proposal for reduction of budgeted resources it makes to the campus administration, but it must expect an uphill fight to obtain an increase of resources. A department's proposed reallocation of effort may well be separated into its two distinct components: reductions of activity in area A and increases of activity in area B. The latter must have all the scrutiny which program expansions entail; and, under significant resource constraint, the campus administration typically has a negative bias about such expansions. At the same time, however, the campus administration typically has a positive bias

about departmental proposals for budget reductions. Thus, the department must anticipate differential acceptance probabilities of the two parts of any reallocation proposal. In such a climate, the only safe departmental strategy is to avoid showing the possibility of any budgetary reductions, and to press for budgetary expansion to support areas of its desired growth in activity.

Extramural funds for training grants and research support from foundations and federal research agencies have provided a seeming escape from all institutional dilemmas of resource allocation. If a vigorous faculty group in a department could find outside support for what it wanted to do, and if what it wanted to do was academically respectable or even innovative in some way, then that group was not likely to find opponents either within the department or in the higher administration for expansion financed by extramural funds. (True, the envy of non-participating colleagues could be a barrier, but the entrepreneurs could either suggest, "Go thou and do likewise!" or use some portion of the funds secured for things that everybody could enjoy.) Once obtained, the extramural funds would result in concurrent demands for enrollment, and for space to house the expanded program. Also, some foresighted campus administrators might raise cautions about the contingent liabilities of the institution in the event that extramural funds were not available in the future for continued support of the expanded area of activity. But, in the short run, the opportunity to expand programs and institutional activities in areas to which there was no inherent objection on academic grounds tended to muffle arguments about future risks.

D. Complementarity, Independence and Substitution: Supporting Units and Activities.

Supporting units and activities of a university are exemplified, in an academic area, by the general library and the computer center, and in student services by the residence hall system, and in the administrative structure by the accounting office and the grounds and building department. Of these, only the general library may contribute significantly to the global image of the university's quality and distinctiveness. Even the library justifies its existence mainly in support of the teaching and research operations of the academic cadres; and the other units of this type have to justify themselves entirely on the basis that they assist others to make the direct contributions of the institution that are evaluated in its academic goal domain.

Occasionally, a support unit is able to generate a constituency relation with an external clientele group; the intercollegiate athletic department may succeed in doing this both by cultivating relations with alumni factions and by securing prestige in a different marketplace than the academic. Some state universities are obliged to take their athletic performance seriously for political reasons.

The university library is regarded as so central to the academic operation that it gains large subsidy from the general funds of the institution. It supports and defends this subsidy mainly by cultivating complementation with academic departments which, in their turn, will put pressure on the university administration to assure that the library budget is adequate.

The quality of a library as a research resource is a function of

collection size in each field, the uniqueness of research materials present, the timeliness of inclusion and accessibility of new materials in fields where ideas and evidence obsolesce rapidly, and the skill with which cataloguing is done. Different scholarly fields and disciplines rely differentially on the library as a supporting resource and are also differentially concerned with these dimensional properties of the library resource.

From the standpoint of the individual user, particularly the less advanced student user, factors of convenience and accessibility of library materials often outweigh factors of uniqueness and collection size. The library administration is often caught in budgetary cross-pressures between these demands for convenience (which often result in pressures to establish duplicative branch collections and emphasize allocations of budget for circulation service as against acquisitions) and the long-term demands for collection size and uniqueness.

When budgets tighten, the library's subsidy budget is likely to come under attack, first, because it is mainly a supporting activity and not a direct contributor to the goal attainment of the institution. (It stands in weak complementation to the goal domain.) Second, its circulation of books is an observable workload factor, but the penalty to scholarship from a cutback in numbers of new titles is hard to prove (and is, in any event, tied to the more exotic research outputs, which are themselves likely not to find as much favor with legislative or alumni fundors as the accommodation of students). Finally, the yardstick of collection quality in each field is a moving target, consisting ideally of the inclusion of everything old and everything new. No one library can hope to meet

this ideal completely; the issue is therefore how far to compromise, and when put in these terms, the subsidy investment in the library collection is very difficult to objectify. Finally, if access to general institutional funds is reduced, library administrators and key faculty find only occasional and partial success in replacing the reduction from external funding markets.

Other support operations are less fortunate than the library. Many of them are elements of the institution's overhead -- accounting, general administration, etc. -- which must operate but which nobody loves. Others are exempted in part from the necessity to justify overt subsidy by arranging to have them organized on the principle of self-funding and recharge.

Residence halls are often administered on the self-funding principle, with the room and board charges paid as fees for service by the resident student, and set to cover principal and interest payments on the capital cost, maintenance, and operating costs. Failure of the residence hall system to break even (and thus, the appearance of a necessity for a subsidy to meet losses) then becomes a signal for administrative alarm. (In some private colleges the residential experience is held to be strongly coupled to educational values and is made more or less mandatory for all enrolled students. In this event, the segregated income and expenditure accounts typical of self-funding may be replaced by a consolidated set of charges for tuition, room and board, and the break-even principle may be disregarded.)

Some purely administrative functions, such as grounds and buildings charges to academic departments, may operate on a recharge basis with a captive market, whereby the department is not permitted to use an outside contractor for the work to be done but must use the internal service unit.

Computer centers at numerous universities got their start as adjuncts to the science and engineering departments and their research operations, with billings to extramural funds on a price schedule set to amortize the equipment over its useful life and cover personnel and other operating costs. Many would-be computer users, however, had no external funds against which to charge their desired use of the computer, and the marginal operating cost of keeping the machine running for extra time each day was low. This led to two-price systems, to which the federal research-funding agencies reacted negatively, demanding that the projects they funded not be charged more for each unit of usage than internal campus users were charged. This in turn led to the demand for institutionally budgeted funds against which to bill otherwise unsupported computer users. The continued expansion of instructional uses, not in replacement of any other expenditures but as enrichments of program in the sciences, engineering, and now the social sciences, has caused continuing strain on the general institutional funds of many universities.

Complementarity, Independence and Substitution in the Multi-Campus University

A. The View From the Central Administration.

All of the above analysis holds for the single-campus university. In a multi-campus university system, however, it is not obvious whether:

a. each campus is free to prosper as an integral institution, subject only to formula budget allocations derived from general budgetary standards for each main function across all campuses, and driven by workload measures (such as student enrollment attracted by each campus); or

b. the multi-campus system is viewed as requiring to be managed as to goal payoffs, program commitments, and operating characteristics.

Most student, faculty and administrative perceptions, and most perceptions of external publics, make the individual campus the natural unit of identification. If this is the context, the observations previously made on behalf of the university administrator concerning complementarity, independence and substitution as to the goal domain and as to programs now hold for each campus administration and in particular for its chief executive officer. In addition to the matter of natural identification, there are good reasons, in the complex setting of university operation, to accord substantial decentralization of responsibility to each chief campus officer and his staff, in relation to the central administration of the multi-campus university.

For a considerable time, in the University of California, these elements of the situation were joined with the "general campus concept." In effect, this was the mandate for eventual rounding out of all desired programs and types of academic work at each campus location, although each new step would be subject to review and approval.

The task of the chief campus officer, in these circumstances, is to jockey for the largest possible allocation of the aggregate multi-campus budget and then demand the right to make discretionary allocations of the allocated budget among those uses he deems best. If the central administration is willing to play the game in this way, it has two main allocative tasks:

(1) to maximize the size of the total multi-campus budget from the state; and,

(2) to set forth plausible rules for each general function and category of expenditure which will permit equitable allocation among campuses and minimize disputes. In a regime of generally expansive state funding, all goes reasonably well.

But suppose that justification of the aggregate subsidy from the state becomes more difficult, and resources are in short supply. Then, suddenly, awkward questions materialize, because the external authorities may require that the goal domain and the major elements of resource usage for the system as a whole be looked at together. The state authorities, in order to reduce the budgetary claim on them, may demand a look at systemic properties. Here once again, are some examples from the recent experience of the University of California:

(1) The Riverside and Santa Cruz campuses had planned to initiate engineering programs. The Coordinating Council for Higher Education commissioned a study of the needs for engineering education in California (the Terman report, so named after its author, the former Provost of Stanford University), which recommended against the establishment of new schools of engineering. The planned programs at Riverside and Santa Cruz were postponed indefinitely.

(2) The Irvine campus wanted to initiate a doctoral program in classics. Here the central administration of the University found grave doubt of the justification for another classics Ph.D. program, in the face of lack of student enrollment demand. The program was not approved.

(3) In a different dimension, the auditors of the State Department of Finance made a series of studies, a significant one being a study which found a need for considering all of the libraries of the nine campuses

to be a single system (and indeed, to provide service through inter-campus exchange not only to the nine University of California campuses, but to other public and private institutions in the area near each university library). The 1973-74 Governor's budget, transmitted to the Legislature in January, 1973, contained modest augmentations for book purchases only at the major research libraries at Berkeley and Los Angeles, and specifically included increased funds only to pay for book circulation at the other campuses, with standstill budgets for acquisitions at these campuses.

In many areas of academic program, too, what appear to be complementary or independent programs to the chief campus officer of one campus are bound to have features of possible substitution when the multi-campus institution is viewed as a whole. Many superboards and state coordinating and budgeting agencies, looking at the entire span of state-supported higher education, are inevitably asking such questions as, at how many campuses must we have doctoral programs in physics? law schools? teacher training programs?

In this context, then, substitutive program alternatives reappear because the requirement is to view the system as a whole. This cannot help colliding with the desirable principle of institutional integrity and mutuality at each campus, for elements of its menu of complementation may come under attack. Campus identity suffers unless it is possible to rebuild it on a definition of more specialized and limited mission.

Concluding Comment

This review of main features of complementarity, independence and substitution in universities needs further elaboration through the analysis of technologies and detailed processes and activities. The

purpose is to examine the micro-organization of productive activities and discover some possible modes of regrouping and different combinations, to take advantage of economies of scale in the application of some resources. This topic is currently undergoing investigation by Roy Radner and David Wise, with assistance from the present author.

Also, the concepts developed here can be quite usefully applied to the re-examination of some basic budgetary strategies that have been used or are being considered for use by universities: workload budgeting; zero-base budgeting; every tub on its own bottom; proportional redistribution; and budgeting for results. This will be done by the present author in a forthcoming paper.

The concepts presented here may have wider pertinence than to universities alone. Problems of goal characterization, activity analysis, and funding are common to public-sector, non-market institutions more generally. What we may have here is a means of looking at some more general attributes of the complex, formal organization which is not strictly driven in its resource getting or spending, by a market discipline.

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