MAPPING AND MATCHING RESOURCE UTILISATION AND RESPONSE PATTERNS IN FURTHER AND HIGHER EDUCATION

by

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My wife, Ann, has displayed an adventurous spirit in translating my manuscript into the typed word. Throughout she has coped admirably with my three young

sons who were frequently asking me - "Haven't you finished it yet?"

CHAPTER 1

INTRODUCTION

PREFACE

"The significant universities of the western world vary greatly in age, legal form of organisation, institutional style, and mode of financing. Yet they have in common the coupling of teaching and research, the offering of a diversity of programs up to the most advanced stages of systematic learning, and the implicit commitment to human ideals and scholarly interests that cross the boundaries of governments. They are (mostly but not entirely) focussed on the young and paid for by the old through governments. They are supposed to endure forever and they make their budgets one uncertain year at a time.

"Today, universities in all parts of the United States and in much of the rest of the world have other features in common. Their sponsors consider them too important to leave alone, in a world where knowledge counts, too costly to forget about and yet dangerous to tinker with. Universities thus face new requirements for planning, new accommodations to coordinate and control, and demands for explicit rational management."

[1]Balderston, F E (1974)

In a national context of a poor economic performance, a declining birth rate, a levelling off in the demand for places and some disenchantment with education as a panacea for inequalities and low productivity, universities and colleges of further and higher education in the United Kingdom are increasingly being asked to justify their activities and to account for their use of resources. To pose these questions of effectiveness and efficiency seems entirely reasonable: how far institutions can be expected to provide exact and credible answers is another matter. The evaluation of any organisation includes a large subjective component. This is expecially true where, as in higher and further education, the academic staff are traditionally autonomous, their missions open-ended and modes of operation unstructured. Nevertheless there are some parts of the system which can be monitored and measured now and it is on these parts that this study is focussed.

What is understood by the terms 'effectiveness' and'efficiency'? An organisation is effective if it achieves objectives which are appropriate to the needs of society. It is efficient if it achieves these objectives with the optimal use of resources in ttthe long run. (Note 1) Therefore an organisation can be effective but not efficient; can only be efficient if it is effective and may be efficient in the short run at the expense of being ineffective and inefficient in the long run. In a rational and a simply mechanistic world organisations would be able to judge precisely

how effective and efficient they were and resources would be allocated to them accordingly. Running in parallel with these definitions is the planning cycle of the textbooks viz:-

1. Forecast future needs;
2. Audit existing provisions;
3. Formulate objectives and develop strategies to close the gaps, if any, between (1) and (2);
4. Translate these strategies into operating plans for the medium term and more detailed budgets by 'responsibility centres' for the current year; and
5. Continually compare actual with planned performance and establish the feedback to improve short-run performance and to update, modify and improve longer-term planning.

Following this sequence it is claimed will ensure that the organisation sets and achieves objectives (ie is effective) and checks and improves input-output ratios (ie is concerned with efficiency)

In those situations where the output is well defined and can be easily measured, needs are stable, technical innovations are infrequent and the precise nature of the relationship between inputs and outputs is known, the implementation of the planningcycle poses behavioural and not technical problems. Indeed in these situations mathematical models can often be developed to obtain an 'optimum' allocation of resources.

However, in those situations where joint costs and products are normal the environment is complex, technical innovations are common and the nature of the relationship between inputs and outputs is unknown, the implementation of the cycle is immensely more difficult and its potential benefits more problematical. Education appears at the hard end of this continuum between, on the one hand certainty and simplicity and, on the other, uncertainty, ambiguity and complexity. There are some theoretical formulations of optimising models in education but there are none widely operational. Their usefulness must await our ability to identify and weight each output and to specify the precise technical relationship between inputs and outputs.

At this point there are those who eagerly admit the impossibility of complete rationality and fall back on arguments such as 'leave well alone' and/or 'more means better'. However, the uncertainty and complexity of education may well strengthen the case for more (not less) concern with mapping and matching needs with provision and inputs with outputs. An attempt to establish a data base of national application for those parts of the system which are currently quantifiable would expose the extent of our ignorance and prompt the research to remedy this state. It would also enable both central and institutional decision takers to ask 'discerning questions', It may well be that the system will defy quantitative

analysis in the end. But even if we could specify the education production function precisely the resulting model would not recognise the local case or satisfy people's inherent need to bargain their way to a concensus. Nevertheless, quantitative data, no matter how partial a representation, forms a basis from which the political process may start.

There are many different perspectives from which we can ask about the efficiency and effectiveness of resource use in education: the investments of time and money by students as they pursue their education (Note 2); the investment of money in education by governments in the hope of achieving socially desirable ends (Note 3); the acquisition and use of resources by individual institutions as they seek to accomplish the institution's objectives (Note 4); the impacts on student achievement, attitudes or other characteristics associated with institutional resource use (Note 5); or the interaction of faculty and student decisions about how to allocate their time and efforts (Note 6). In this study the problems faced by the college and university with many and often conflicting objectives seeking to acquire and use resources in the most productive manner is the perspective. The major focus, however, is on the individual institution's management of resources in the provision of instruction, ie the teaching function.

Chapter 2 outlines the 'state of the art' in the specification of the 'production function' in further

and higher education. Chapters 3 and 4 constitute a case study of the teaching activities in Lanchester Polytechnic and Loughborough University for the academic years 1972/73 and 1973/74. This investigation concerned to "identify and develop performance indices for the teaching function in higher education" was financed by the Department of Education and Science and sponsored by the Institutional Management in Higher Education Programme of the Centre for Research and Innovation in Education of OECD. The author was Deputy Director of this project and details of the Project Team and of the Steering Committee are given below. (See Note 7) Some parts of this study have been published elsewhere. References to these papers are made at appropriate points in the text and copies of the actual publications together with others written by the author either wholly or in part in the general area of resource management in education are provided in a separately bound accompanying volume. Arising out of this study a model of a management information system of general application in further and higher education in the United Kingdom is developed and tested on data for the Spring Term 1977 from the Hertfordshire College of Building in Chapter 5. Chapter 6 concludes with summary observations.

Examining the actual resource use behaviour of colleges and universities and inferring the appropriate production function from observed data have several implicit assumptions. These assumptions and their critiques follow:

1. All institutional managers have full information about the production function. Cohen and March (1974) dispute this assumption and claim the technology is largely unknown by education decision takers at all levels. Liebenstein (1976) argues that even with perfect information, managers have differential ability and enthusiasm which make the assumption moot.
2. Managerial discretion exists over which inputs are obtained and how they are used to produce educational services. In reality, tenure, collective bargaining and many other rigidities limit the managerial discretion. The perceived degree of managerial flexibility is often low even when in legal terms it may be substantial.
3. A competetive market exists for the services produced by colleges and universities. However, educational services are not sold at prices reflecting a competetive market. Almost all institutions see their income as largely proportional to student enrolment (and perhaps research services provided). Up to quite recently the total demand for places has exceeded supply and consequently whilst there may have been competition within certain discipline areas (science and technology for example) in the main universities could achieve their student targets without a great deal of effort. The situation in polytechnics has been somewhat more competitive as is evidenced by their investment in institutional

marketing. Nevertheless it is true that there are few market indicators of success and input and output prices are not market determined. (Note 8)

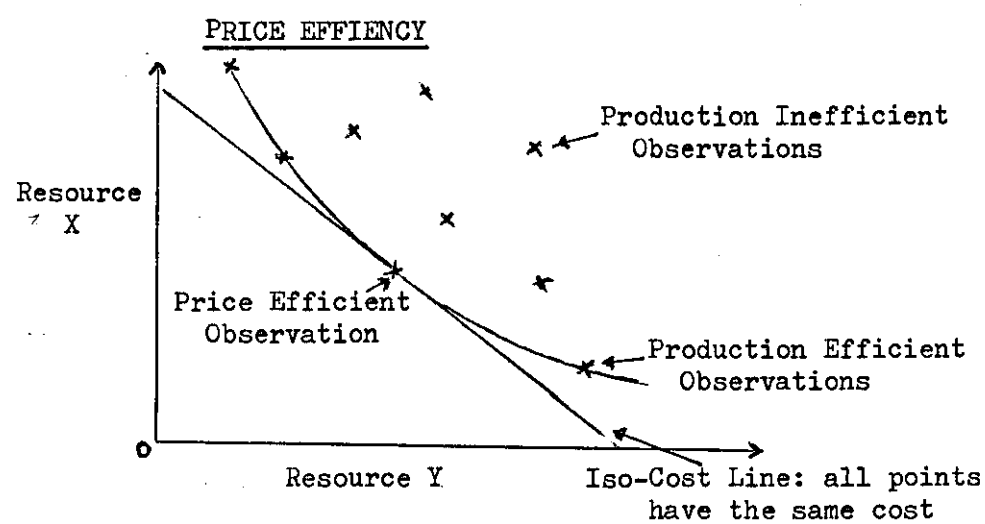
4. Institutions are free from external constraints on their choices of resource use. In reality institutions are subject to a range of constraints and relatively little is known about the costs of compliance with these restrictions and their effects on effectiveness and efficiency.

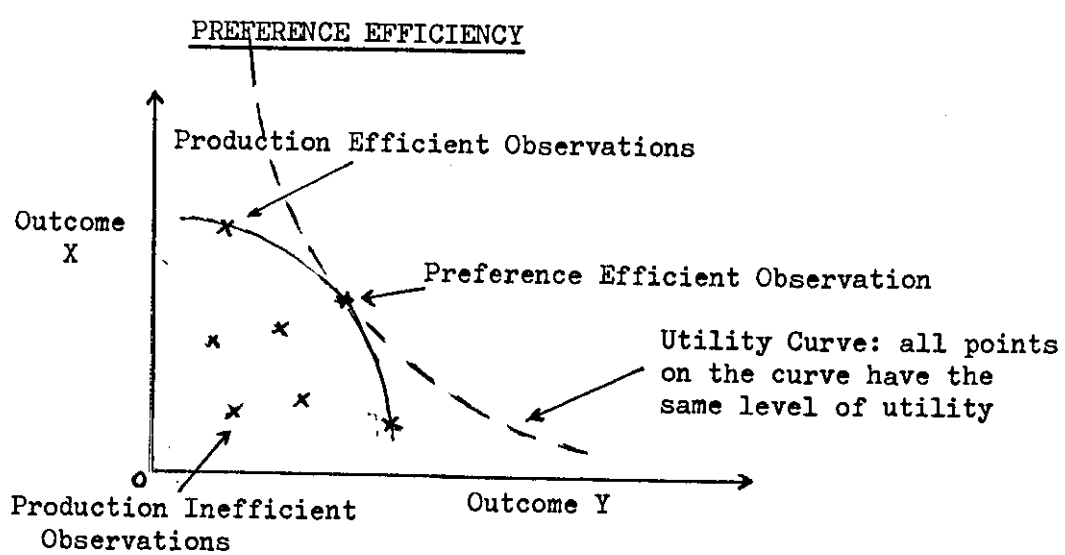
5. Inputs and outputs can be measured. This is rarely possible in education. First, it is difficult to find agreement on which inputs and outputs ought to be measured. Subsequently it is difficult to construct valid, unbiased and robust measures of both quantity and quality. Finally, little is known about the exogenous and intervening variables necessary to describe fully the relationships between inputs and outputs. Previous empirical studies in educational productivity have used proxy measures for inputs and outputs: this thesis is not an exception to this practice!

At some points in the case studies described below, 'rankings' both within and across named institutions may be inferred. These statements of 'relative efficiency' whether implicit or explicit need to be hedged by numerous caveats such as those outlined above and they are valid only within the narrow context defined in the text.

NOTES

1. The theory of the firm assumes the existence of a production function where a production function describes the maximum output that can be achieved with a given mix of inputs and, correspondingly, the minimum amount of inputs required to achieve a given level of outputs. A production function is the technically most efficient means by which 'physical' units of inputs can be used to produce 'physical' units of outputs. There are two other concepts of efficiency from the neoclassical theory of the firm (see Henderson and Quandt 1971):- "price" efficiency which describes the least costly mix of resource inputs and "preference" efficiency which describes the utility maximising mix of multiple outputs. Different colleges will probably face different input prices and have different outcome preferences; consequently the only generalisable conclusion about allocative and preference efficiency is that they lie on the production efficient surface as shown below:





SOURCE: Carlson (1975) pp 42-43

2. Student demand for places in education can be considered as investments in human capital as pioneered by Becker (1964 or as manifestations of student demand in a consumer theory framework as reviewed by Jackson and Weathersby (1975).

3. The social returns to educational investments are discussed by Freeman (1976); the income distributional effects are analysed by Hansen and Weisbrod (1969) and Jenks et al (1972) and the impact of education on economic growth by Denison (1967).

4. See Wallhaus (1975)

5. The student achievement literature is large. See Coleman et al (1966) and Hanushek (1975) for a review.

6. The application of consumer theory to faculty-student interactions is demonstrated by Kirshling and Staaf (1975)

7. Project Team:

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8. The degree of competition existing in higher education post Robbins is discussed by Professor M H Peston in Coombe Lodge Report (1976)

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CHAPTER 2

THE FURTHER AND HIGHER EDUCATION PRODUCTION FUNCTION - THE STATE OF THE ART

Introduction

A production function in general may be defined as a technical or engineering relation between the inputs and the outputs of a system. The optimal planning of a system requires a clear specification of its production function. This would involve:

1. The agreement of objectives in operational terms;
2. The identification and measurement of outputs;
3. The identification and measurement of inputs; and
4. The establishment of the relationship between inputs and outputs.

What follows is an outline description of the 'state of the art' in the specification of the 'further' and higher education production function:

Objectives

The attainment of objectives is a system's raison d'etre and its argument for commanding a share of scarce resources. Most educational systems have a number of objectives which not infrequently are inconsistent necessitating the determination of priorities and the mediation of conflicts. Universal agreement among educators is confined to large generalisations which tend to establish the boundaries of social policy rather than give content to realisable goals - 'to preserve and enhance the intellectual stock' 'to facilitate equal opportunity' 'to produce useful citizens'.

It is difficult to disagree with any common understanding of such bromides and equally difficult to deploy them usefully in a planning context.

DES Planning Paper No 1 (1970) suggests that the main objectives for the teaching function of higher education are:

for undergraduate programs:

"to provide higher education for those who could benefit from it; to meet the requirements of society for qualified manpower;" and

for postgraduate education:

"to meet the requirements of society for highly qualified manpower with particular qualifications or research experience."

A rather more extensive list for a university has been set out by Gross (1973) as follows:

(1) To stay in existence;

(2) To provide undergraduate, graduate, doctoral and post-doctoral level education opportunities;

(3) To advance knowledge through research and publication and to re-discover and re-interpret existing knowledge;

(4) To organise knowledge into manageable form for efficient learning through texts, references, lectures and curricula;

(5) To provide continuing education;

(6) To enable the cultural, economic and political advancement of society by increasing the accessibility of learned men to society, government, commerce and industry.

The more detailed a list of institutional goals the more likely it is to be disputed in terms of inclusions, omissions and interpretations. However,

there seems to be broad agreement on the major output programs for further and higher education at institutional level: ie instruction or the transmission of knowledge, research or the acquisition of knowledge and service or the application of knowledge. Moreover, at the detailed level of syllabuses there seems to be broad agreement on the 'core' knowledge and understanding required by established disciplines between institutions nationally and internationally.

Not infrequently a system's stated objectives differ considerably from its actual objectives as inferred from its behaviour:

> "general statements of aims, even by those engaged in teaching, tend to be little more than expressions of benevolent aspiration which may provide a rough guide to the general climate of a school, but which may have a rather tenuous relationship to the educational practices that actually go on there. It was interesting that some of the head teachers who were considered by HM Inspectors to be most successful in practice were least able to formulate their aims clearly and convincingly"
>
> The Plowden Report Para 497 (1967)

Merewitz and Sosnick (1971) probably reflect the growing frustration of administrators attempting to introduce a systems approach into an educational context when they point up the dysfunctional effects of overmuch concern with arriving at an <u>agreed</u> specification of ultimate objectives:

> "describing objectives has no effects that we regard as beneficial. In contrast, we anticipate that decisions preferred by high level officials occasionally will emerge from describing targets, choices made, alternatives considered, outputs and effectiveness"
>
> (p 57)

In this context Merewitz and Sosnick define objectives as long range goals; targets as quantified goals to be aimed at in the short run; choices made as courses of action selected; alternatives considered as courses of action that were recognised but rejected; outputs as immediate results; and effectiveness as the degree to which objectives or targets were attained.

Outputs

Insofar as there is hesitancy among educators to agree the objectives of education there is hesitancy to define its outputs. At a conference sponsored by the Western Interstate Commission for Higher Education to identify the outputs of education Lasrence, Weathersby and Petersen (1970) in summarising the proceedings classified the outputs into four broad categories, namely, instructional, institutional environment, research and public services. However, they were not able to record general agreement on outputs or their measurement. A similarly broadly constituted conference held by the IMTA in the United Kingdom was also unable to come to conclusions or make recommendations. (CIPFA 1974) Even when there is agreement on an output category - such as research - there is disagreement as to its measurement as is illustrated by the following quotations:

> "One physical measurement might well be the number (or the volume?) of scientific publications classified by specialties and covering any work or articles published in scientific journals ... But a further distinction would have to be made between strictly educational publications (textbooks) and

> "research publications and if possible the volume of publications should be weighted on the basis of scientific reputation which would be measured for example by the references made to them in other scientific or technical publications ... Another measure might be the outside research funds attracted to the institution".
>
> Benard (1973) p 7

> "No satisfactory independent measure of the output of research and scholarship can be found; the best we can achieve is likely to be a subjective ranking by fellow professionals. No more can be expected than a ranking in categories such as 'highly significant or productive', 'significant' and 'pedestrian'. In most subjects one would, I think, find that in the judgement of acknowledged professional leaders most university departments rank as 'pedestrian'."
>
> Carter C F (1972) p 79

The evaluation of educational output is difficult and disputed for a number of reasons. Firstly, as was indicated above, there is no single authoritative statement of objectives. Secondly, where universal agreement is attained it is at a level which is concerned with ultimate aims - with 'preparation for life'. Since life is multidimensional the outputs of education are multiple and its impacts long term. Thus some educators will only concede the validity of measurement if it covers the whole spectrum of educational aims. Progress in reading, writing and arithmetic can be assessed but what about the encouragement of enquiring minds and civic consciousness? Moreover, we are faced with monitoring these effects long after the formal education process has been completed. Further, since education is but one factor

influencing life-time chances we have to unscramble and partition the effects of education from the influence of home and parents, other agencies such as social services and housing and ultimately settle the 'nature versus nurture' controversy - formidable tasks! In the short run the resolution of the problem may be found in concentrating on the refinement of more proximate goals and the measurement of intermediate output:

> "A broad objective, such as preparation for life is really a composite of innumerable sub-objectives, each one of which has to be tackled separately if a meaningful answer is to be obtained. To tackle them simultaneously would demand a combination of data and analytical resources unlikely to be available in the foreseeable future. What was earlier characterised as a plain man's view of educational output - increased knowledge and understanding - thus has the great merit of being more amenable to measurement, and hence capable of reducing uncertainty about attainment of educational objectives, even though it is open to the theoretical objection of being really an intermediate rather than a final output."
>
> Rodmell (1974) p 37

In assessing the ultimate impacts of the educational process economists have probably made more progress than most in the development of a model. Schultz (1963) and Becker (1964) have done pioneering work in establishing the increase in lifetime earnings expectancies following the investment in education as an effective proxy measure of educational benefits. This 'human capital theory' establishes a direct link between education and a student's productivity and marketability. Education improves a student's skills

level; he can therefore contribute more to gross national product and consequently he earns more. Morris and Ziderman (1971) and Ziderman again (1973) have established the rate of return for various levels of further and higher education in the United Kingdom in 1967. The author with a colleague, John Calvert, has made a modest contribution to the literature in this area with a study of the Private Rate of Return to the Investment in a Teacher's Certificate. (Birch and Calvert 1973) Other economists examining the educational system at a macro level have used economic growth as a proxy. Denison's(1964) work in this connection is well known.

However, the measurement of educational output solely in money terms has been attacked from a number of quarters not least by other economists -

> "We have damaged the cause of civilisation and culture by trying to convince people that they are 'good business' and that education has a yield as good as that of the jam factory ... Perhaps the greatest harm that has been done by the jam factory approach is to rob that part of education which is concerned with the summits of human achievement, and with the boundaries at which we confront our vast ignorance and inadequacy of the awe and wonder which should surround it. It is a poor silly thing to attach to the discovery of the imperishable beauty of great writing, of the profundity of philosophy, of the orderly subtlety of pure mathematics, a money value in increasing national production"
>
> Carter C F (1973) p 210

This quotation is representative of a view of education as a civilising process whereby the student acquires thebehaviour and discipline patterns

necessary to appreciate, to perpetuate and to enhance his culture and contribute to society. This approach also embraces the concept that education is a worthwhile consumption good. Education 'stimulates mental activity', 'fosters a habit of wise inquisitiveness', 'raises the tone of life' and 'regarded as an end in itself, it is inferior to none of those which the production of material wealth can be made to subserve'. Vaizey (1970) is another economist who is opposed to quantifying education outputs simply in money terms and advocates instead that the outputs of education be measured by objective tests of achievement duly weighted. Clearly there is the problem of how much of observed earnings can be attributed to the investment in education and how much to innate ability, home environment and socio economic class. Data can be standardised for labour force participation rates, unemployment probabilities, life expectancy and, perhaps with a larger margin of error, for individual abilities, but problems still remain.

Recently, Arrow (1973) and Wiles (1974) have developed an approach usually referred to as the filter or screening theory which suggests that lifetime earnings differentials reflect no productivity enhancing effects of education but only its effects as a method of signalling ability differences that existed before the education process began. Hence education is simply a sorting device - a 'filter'.

All these views of the education process see it affecting an individual's lifetime chances. Therefore, they are concerned with education's ultimate impacts. Education, whether general or vocational gives rise to benefits - some of these may be more easily measured than others, but it is usually agreed that they are benefits and not 'disbenefits'. Moreover education is beneficial to the community at large beyond whatever benefits may be enjoyed by the individual: culture is enriched, political and social institutions improved and productivity increased by the more efficient use of resources within existing knowledge and by the development of new technologies pushing the production possibility curve outwards.

Consequently, so far as the individual student is concerned the returns to further and higher education (Re) can be characterised thus:

$$Re = \sum_{t=4}^{n} \frac{R_t \ (s,g,j)}{(1+r)^t} \qquad j \in Je \ \ldots\ldots \ (1)$$

where

t = time period of one year;

n = years in working lifetime typically to age 65;

s = skills endowment - a proxy for the 'vocational' aspects of education;

g = a proxy for the 'general' educational aspects (eg a 'civilising process');

j = job choice

Je = set of all jobs available to those qualified by further and higher education; and

r = discount rate.

In other words the returns to the individual who obtains a degree ((1) assumes a three year study programme) are the summation of annual benefits each year after three given his skills endowment, 'general' education, and job choice; the returns over a lifetime are of course discounted to present value at some appropriate rate.

Similarly discounted lifetime returns beyond school to the non-educated (Rn) are given by:

$$Rn = \sum_{t=1}^{n} \frac{R_t\ (s,g,j)}{(1+r)^t} \quad j \in Jn \quad \ldots\ldots (2)$$

where

Jn = Set of jobs available to school leavers

Returns begin in year one but the choice set of jobs is more restricted.

There are costs involved in further and higher education and, so far as a three year degree programme is concerned, these may be characterised as

$$Ce = \sum_{t=1}^{3} \frac{Ct}{(1+r)^t} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where C_t = annual costs of tuition andmaintenance net of any grants

Hence a measure of the benefit or output of education would be Re - [Ce + Rn]. It must be conceded that an assumption that earnings exactly reflect the value of marginal contributions to productivity is clearly not true in particular cases; but there is now sufficient information available to support the contention that education does materially improve earnings expectations in the general case. These improvements in lifetime chances probably reflect the vocational more than the general (cultural and social) aspects of education. Nevertheless, if general education is seen to cover the cultural skills and social behaviour necessary for posts available only to graduates, or has no effect on skills level yet acts as a label conveying some information on the job market (as according to the filter theory), then it might be argued that the resulting earnings streams at least signal the effectiveness of the education process. Therefore, the optimisation of enhanced lifetime earnings expectancies is an overall objective which embraces a large part of the aims of higher education and the <u>total</u> system's success or failure in achieving it can be measured. However, in the absence of alumni age earnings profiles it is not an objective which is operationally useful at the <u>institutional</u> level.

Anticipating some of the criticism that rate of return studies ignore some of the intangeable effects of education, Schultz (1963 op cit) classified teaching outputs into two broad categories - investment and

consumption. The investment component corresponds to what has been described above as the vocational element and the consumption component relates to the knowledge and skills to be used in the non-job situation - ie the general education aspects. However, when we come to quantify the distinction we are faced with the overlapping nature of knowledge - skills to be used on the job may also be used for personal interests and hobbies. This problem is compounded when we look at the system from society's rather than the individual's point of view: it is exceedingly difficult to trace all the benefits of 'externalities' in money terms.

It may be that a composite scheme using several measures of output may ultimately prove the practical approach. Burkhead et al (1967), for example, identified the outputs of education as increased skills, socialization, knowledge, opportunity for higher education, employability and prevention of delinquency. They suggested that some of these outputs like skill and socialization led to increased productivity and could be measured by increased income. However, other measures might be more appropriate for the other aspects - knowledge could be measured by scores on standardised tests, and prevention of delinquency might be assessed in terms of reductions in arrest rates, contacts with police and acts of vandalism.

In an attempt to assess social and cultural benefits as well as the long term economic returns to education, Keller (1970) has suggested and attempted to collect information on:

- first wage offered;
- cumulative income (over 5, 10 and 15 years);
- proportion into management level (by fifth or tenth year);
- rate of selection to professional group or select posts;
- rate of award of civic and professional honours;
- proportions holding government posts of significant responsibility;
- proportion holding elected office;
- rate of participation in local affairs;
- drunkenness, arrest and divorce rates;
- book and magazine reading frequency;
- personal evaluations of intellectual and social satisfaction.

A number of these 'benefits' are neither readily attributable to the effect of education, nor are they readily quantifiable. A considerable effort would be required to develop reliable and consistent methods of gathering and evaluating the relevant data and from an institutional management point of view (as opposed to the national decision level) it is problematical whether the returns would be worth the cost of mounting the exercise.

Birch and Parkes (1972) in attempting to set up some criteria of success for a college of further education identified student satisfaction as an important output and suggested that in the non compulsory sector this might be measured by the attraction and

retention rates of the college or the inverse - the dropout rate. Blaug (1968) while reviewing reports and documents on the productivity of universities commented that since universities have more than one objective one ends up, at least in principle, with various alternative output valuations each of which yields a different measure of productivity.

If in the beginning we concentrate on the refinement of intermediate measures of output as seems sensible we are concerned not with lifetime impacts but with assessing the difference in a student between entering and leaving an institution attributable to the education process. This would involve sensing all the knowledge, skills, insights and attitudes - all the developed aptitudes and capabilities - that a student carries away from the educational system beyond what he/she brought to it initially. So far as post school education is concerned where the student is pursuing examination aims a lead on this 'value added' or some part of it might be obtained by reference to formal examination standards at entry and exit. Such an approach within higher education where both syllabuses and examinations are internally determined would rely heavily on the comparability of examination and student assessment standards both within and across institutions. Objective or multi-choice questions coupled with question banks organised on a national scale could be a viable alternative or supplement to formal institutional assessment schemes

in the measurement of learning gain. These sets of standardised tests are a feature of the American university scene. As well as overcoming the problem of institutional comparability they also offer the advantages of minimal interference with curriculum development, less time to sit than is required for normal examinations, susceptibility to computer marking and, with skilful question formulation, the possibility of exploring the attainment of higher order processes - interpretation, comprehension and application.

So far as the acquisition of skills and the transmission or verification of knowledge is concerned, ie the teaching activity - the immediate and short-run outputs of a university or college might be categorised thus:

Students Enrolled classified by year and course who represent outcomes in the process of training;

Successes: students passing an examination as a condition of access to another level of study classified by year and course;

Graduates classified by course amd degree level who represent outcomes which are not only finished but final;

Failures: students who have completed a cycle of their course and have sat and failed an examination and opt to give up their studies classified by year and course;

Dropouts: students who give up their studies before sitting an examination classified by year

and course (Both failures and dropouts represent finished but not final outcomes) and

Repeaters: students who have sat and failed an examination but who have opted to repeat their studies classified by year and course.

These seem to be the natural units of the physical measurement of the short-run outcomes from the teaching function. The unit of value is more controversial. Some attempt to assess the outcomes in terms of learning gain might be made. Alternatively added value could be measured by reference to human capital theory. In this context, Benard (1973 op cit) has suggested:

> "in the case of graduates: the present value of the additional earnings available as a result of their degrees discounted with reference to the duration of their future active career;
>
> - in the case of students in the course of their studies: the opportunity costs represented by the average earnings they could claim in their active lives as a result of their lower level of qualification but which they give up to continue their studies;
>
> - in the case of dropouts; these generally revert to the value of the diploma or level of studies which is directly below the level they are aiming for;
>
> - in the case of the failed degree studies these sometimes receive an intermediate value between that of the graduates and that of the dropouts."

Layard and Verry (1973) measured output from the teaching function in terms of undergraduate and post-graduate student years. To aggregate students with different classes of degree or years of dropouts,

they used weights corresponding to their relative wages to obtain a gross undergraduate output index gU where U is the number of undergraduate student years. Their measure of input quality for undergraduates was the number of passes and grades at A level or its equivalent. Students with different A levels were again aggregated using a weighting system based on relative wages to yield an input quality index a. Thus the value added is given by (g-a) U. Because they lacked data on postgraduate quality they assumed the postgraduate teaching output to be simply the number of postgraduate student years.

Thus far, this review has concentrated on the output from the teaching function - research, the other major output is even more difficult to measure. Layard and Verry (1973 op cit) approximated the output by a weighted sum of the number of books and articles written by the faculty. As a result of a small survey of teachers a book was treated as equivalent to ten articles. In an analysis of publications in economics Cartter (1965) weighted 'substantive books', 'textbooks', 'substantive articles' and 'notes and communications' in the ratio 10: 3.3: 2.5: 1. However, as Fox et al (1968) have shown, scientists write fewer books and more articles than teachers of arts and social scientists, which suggests that their rate of transformation is higher. This was confirmed in the Layard and Verry survey where the rates of transformation between books and articles ranged from

10 in arts and social science to 16 in engineering. A more objective weighting of the worth of publications might be obtained by a count of the references made to them in other academic journals or technical publications; or, for scientific and technological research the number of patents granted. The level of research funds attracted to an institution or the quality weighted hours spent on personal research are other possible proxies for research output with the added advantage of value, as opposed to physical, measurement. However, these last two are in effect input measures and their inclusion in cost, rather than production, functions can only be justified as an attempt to obtain more meaningful estimates of teaching costs.

Inputs

On the face of it the identification and measurement of the inputs to higher education appears to be a relatively easier task. Burkhead et al (1967 op cit) identified the inputs of education under four heads; namely, student time, personnel time, materials and supplies, and buildings and equipment. Included under peronnel was the time of administrators, teachers, maintenance personnel and auxiliary services such as guidance, health and welfare and library. They observed that the qualitative characteristics of these inputs like age, experience, professional competence, motivation and so on were not only hard to define but were also difficult to measure. Nevertheless they considered

these qualitative aspects to be important inputs to the system. An interesting omission from the list of inputs here is students' time and individual and group characteristics.

Stone (1966) and Mood (1969) are two examples of studies identifying students as an important input. Stone categorised the inputs to education as either 'primary' or 'intermediate'. The primary inputs were the students whilst the intermediate inputs included supplies, buildings and equipment, faculty and administrators. Mood emphasised the need to assess the qualitative as well as the quantifiable aspects of inputs and opened up the system to consider not only the students' own abilities and attitudes but also the support of their families, their peers, the community, and society's posture with respect to education.

Correa (1967) defined the inputs to education "as goods and personnel whose services were used in the process of education". Because of the heterogenous nature of these inputs he suggested they be measured in terms of cost. However, this raises the question of the nature of costs. Correa distinguished between social, consumer's and supplier's costs. Social costs he defined as "the income which the society could obtain if the resources utilised in education were employed in the production of goods and services"; consumer's costs were the student's costs of tuition, books and foregone earnings; and supplier's costs were defined as the price paid for the goods and services used in

the education process. Clark (1963) offered two alternatives for measuring the inputs of education - in real quantity and in money terms. Inputs were identified as student hours, land, buildings, equipment and personnel. Measuring these units in money terms, however, raised a number of problems of what items of expense should be included and excluded.

Total costs might be defined to include actual expenditure recorded by the accounting system plus non recorded costs plus opportunity costs. Depreciation on fixed assets is an example of unrecorded costs at least in the current practice of public accounting. An example of opportunity cost, indeed the most widely cited instance of opportunity cost in higher education, is the 'income foregone' by students or, from society's point of view, the loss in GNP occasioned by the withdrawal from working life of a proportion of the population of working age. Once we move outside the actual, historical cash flows recorded by the accounting system into concepts of 'notional' and 'opportunity costs' we move from a matter of fact to a matter of opinion and of context.

> "far from there being a single definitive concept of cost, there are a number of concepts equally valid in its own particular context. This means that before attempting to define cost one must define the purpose for which the concept is to be used. This involves a number of major problems ... Cost of what? Cost to whom? Cost when? The cost 'per student' for instance will differ according to whether one allocates the whole expense of university activity to teaching students, or whether one extracts costs attributable to other activities such

> as personal research of the members of staff. The cost to the student is very different from the cost to the UK University Grants Committee which in turn is different from the cost to the public sector as a whole and from the cost to the national economy. The current cost is different from the total costs (including capital expenditures of previous years), and the average cost obtained by spreading past outlays over existing students is different from the marginal cost that would have been incurred if one extra student had been enrolled."
>
> Bottomly et al (1972) p 12

In the last analysis the ultimate cost of higher education is what is foregone by devoting resources - staff, space, equipment and students - to this purpose rather than to something else. However, the alternative uses of these resources are manifold and there is no way of ensuring that the most 'profitable' has been identified.

When we come to the stage of allocating these costs (however defined) to outputs we discover that virtually every internal resource of the institution contributes to more than one output - ie that the majority of costs are in one way or another joint costs. Staff teach and research; technical staff aid the teaching activity and service research laboratories; laboratory space is available to students and researchers; central services the library and student facilities are used to differing degrees by teachers and students from different disciplines and different courses. Hence, an 'accounting' allocation of inputs in real or money terms to outputs is ultimately an arbitrary process.

The Relationship Between Inputs and Outputs

The problem of establishing production functions is a classical one in econometrics and multiregression techniques are an obvious choice for attempts to establish the technical relationships in education. In their most general form, production functions are relationships between a number of outputs and a number of inputs. In this form, however, the problem of obtaining quantitative relationships would be almost intractable. Consequently the form of the relationship is frequently of the kind:

$$P = g\ (f_1 \ldots., f_k;\quad B_1 \ldots\ldots, B_n)$$

Where g is a function containing one or several parameters, P indicates production and $f_1 \ldots\ldots, f_k$ the k inputs. Since the greatest simplification occurs when the model is linear in the independent variables the relationship can generally be written as

$$g_o\ (P) \;=\; B_1 g_1\ (f_1 \ldots\ldots f_k) \;+\; \ldots.+\ B_h\ g_h\ (f_1 \ldots\ f_k)$$

where g_o, g_1 ..... g_h are mathematical functions of the variables which might be the variables themselves or, for example their logarithms. This formulation is certainly realistic where there is only one homogenous product. In cases of joint production the various outputs have to be combined into a single figure giving value or volume of output for the form of relation to be applicable. So far as the education production function is concerned Mood (1969 op cit) has pointed out that no serious penalty would result from arbitrarily

forcing relationships between inputs and outputs as linear. He also observed that the biggest problem of establishing relationships between inputs and outputs was the interaction effects among various inputs, as well as among various outputs and that thus far efforts to disentangle the effect of the different forces have had little success and it was altogether possible that they may never be separated. Cohn (1968) is an example of an attempt to establish the production function of high schools by least squares methods. The output was measured using incremental test scores and the inputs were defined in quantitative and qualitative terms. Raymond (1968) is another example of multi-regression analysis in education. His output measures included test scores and 'freshman grade point averages'. The input variables included teachers (using their salaries as a proxy measure of quality), staff/student ratios, the number of books in the library in excess of standards, current expenditure per student and the socio economic background of the student. The results showed that only one input variable - teachers' salaries - had a significant effect on output!

An alternative but related approach to establishing the relationships between inputs and outputs in education is via a cost function. Carter (1967) and Layard and Verry (1973 op cit) are examples of the study of cost function in higher education in the United Kingdom. In such studies there are at least two approaches. In the first the outputs of education (teaching and

research for example) are treated as exogenous, assuming that each can be varied independently of the other. In the second, cost is regarded as the exogenous variable which determines the quantity and mix of outputs. Layard and Verry estimate for the most part functions of the first type, for example:

$$C = g\,(D, U, P, R, (g-a))$$

where:

C = Subject group cost composed of academic, administrative and technician wages and salaries, other expenditure not financed by research funds and expenditure from specific research funds;

D = Number of departments in a subject group,

U = Number of undergraduate student years,

P = Number of postgraduate student years,

R = The weighted sum of the number of articles and books written by departmental staff (a proxy for research); and

(g-a) = the 'value added' to undergraduates.

The assumption may be made that for a unit of any one product, a fixed number of inputs have to be used. The inputs may then be combined in different proportions but in doing so a different mixture of outputs will be obtained. The inputs required are then homogeneous linear functions of the quantities produced. With restrictions on the available inputs or some of them, and with given costsof inputs and benefits of outputs an objective of maximising the difference

between benefits and costs reduces to a linear programming problem. In such an approach the parameters are not estimated by regression methods but by a priori technical knowledge or by methods of statistical measurement. A linear programme requires fixed production coefficients and, therefore, constant outputs and valuation coefficients of the objective function which are also fixed. However, as Vaisey (1962) has observed, in our present state of ignorance of cause and effect the education production function is more often "socially than technically determined". Benard (1973 op cit) has provided an elegant linear programming formulation of the operations of a university. He sees it as "didactic and in no sense operational" but nevertheless having "the merit of clearly and precisely showing the relationship between the primal and dual problems and their respective optimum solutions on the one hand and the relationship between optimum prices and costs appearing in the dual on the other". Stockdale (1974) has demonstrated the operational possibilities of a partial LP formulation of the activities of a department in a college of further education. His model maximises the Burnham points score of the departmental course mix subject to the constraints of available lecturer hours - formal teaching and preparation - and administrative support. Apart from doubts about the objective function his assumptions of strict linearity in the teaching hours and administrative support constraints in an era of

increasing cross course modular teaching patterns is questionable.

Examples of the use of mathematical programming for both departmental management and university level planning in the USA are numerous. The following are illustrative examples. Fox (1968) has used an LP approach to allocate a given faculty among alternative teaching and research assignments. Recursive and dynamic programming are used to extend this effort to compute optimal decisions over a number of years. A two-level decision model involving interaction between a dean and department chairman is also provided Briefly the objective functions for the various departments at one organisational level are all viewed by the dean as constraints. The dean's objective function involves maximisation across all his departments. This problem is handled using a two-stage optimisation model. Geoffrion, Dyer and Feinberg (1971) have designed an interactive mathematical programming approach to a multi-criterion optimisation problem within an academic department. Six criteria functions are used simultaneously in an effect to model the allocation of the faculty among three activities - formal teaching, departmental duties such as administration and curriculum development and other tasks such as research. Since the aggregate objective function is not explicit, interaction on the part of the decision maker is required at various stages in the solution algorithm.

An alternative approach - simulation - explores the association of cause and effect and does not require the explicit objective function of the mathematical optimisation model. A well-known example of this approach is the CAMPUS (comprehensive analytical model for planning in the university sphere) model developed by Judy (1965, 1969) and tested in the University of Toronto. This computerised model was designed to simulate the interaction of system parameters and resource inputs on the output activity levels of a university system. It answered questions such as: Assuming that forecasts for the next decade exist, what resources would be required to meet the demand? How sensitive would these input requirements be to changes in factors beyond the control of educational decision makers? For specific subject areas what would be the cost of producing additional graduates or changing the curriculum? The educational environment is often not susceptible to precise mathematical formulation - in these circumstances the computerised simulation approach allows the decision-takers to test the significance and sensitivity of their decisions under laboratory conditions - to obtain a wealth of experience in the shortest possible time.

Another analytical method that can be used to integrate theory and practice is goal programming. Goal programming, instead of trying to maximise or minimise the objective function directly, sets out to minimise the deviations between

the various goals and what can be achieved within the given set of constraints. The general model can be expressed mathematically as:

$$\text{Minimize } Z = \sum_{i=1}^{m} (d_1^+ + d_i^-)$$

$$\text{Subject to } Ax - Id^+ + Id^- = b$$

$$x, d^+, d^- \geq o.$$

Where there are m goals, A is an m x n matrix which expresses the relationship between goals and subgoals, x represents variables involved in the subgoals $(x_1, x_2 \ldots\ldots x_n)$, d^+ and d^- are m component vectors for the variable representing deviations from goals and I is an identity matrix in m dimensions. The manager must analyse each of his goals in terms of whether over or under achievement is satisfactory. If over achievement is acceptable d^+ can be eliminated from the objective function. On the other hand, if under achievement is satisfactory d^- should not be included. If the exact achievement of the goal is desired both d^+ and d^- must be represented in the objective function. The variables d^+ and d^- must be ranked from the most important to the least important. In this way the low order goals are considered only after the higher order goals are achieved as desired.

Lee and Clayton (1972) have demonstrated the use of such a model to enable the Dean of a College of Business to achieve a number of goals such as maintaining the necessary requirements of accreditation,

assuring adequate salary increases for academic staff, maintaining acceptable staff/student ratios, meeting student credit hour requirements, attaining a desirable distribution of the academic staff with respect to rank, and minimising the cost.

One difficulty of the decision models reviewed above is that they are in the main based on quantitative computer-formed rationality. "Political rationality, economic rationality, the valuing process or human relations concerns may be equally appropriate 'rational' approaches to the same problem" (McNamara 1973 p 23) The technical coefficients deployed in the majority of the models are rather more a function of existing standards of provision and of ways of doing things or of preferred targets than they are based on a sound knowledge of cause and effect in education. Insofar as interactive devices like goal programming involve the participants and take note of their subjective views they lead to greater satisfaction with the decision outcomes. However, optimality awaits a firmer specification of the production function. In the move towards a better data base and greater understanding of the operational characteristics of the system a strategy of 'little by little' may be appropriate. We cannot satisfactorily model the whole system at present and maybe some aspects will always defy analysis. In our present state of comparative ignorance, however, any empirical study of one or more parts though sub-optimal promises some reward.

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CHAPTER 3

THE OBJECTIVES, SCOPE AND CONTEXT OF THE LANCHESTER/LOUGHBOROUGH ENQUIRY

Objectives

Any institution of higher education comprises a complex of activities which are combined to achieve the institution's purposes. If the organisation wishes to operate effectively and efficiently it will seek that combination of activities and allocation of resources which maximise its objective function whether this is explicit or not. To move towards this 'state' the organisation must specify (or assume) its production function. As indicated above no educational institution has yet been able to do this completely. However, it is hoped that this study makes some contribution towards this ultimate objective.

Specifically the research aims to move towards a clearer understanding of the teaching activities of higher education in the United Kingdom. It attempts:

1. to identify and define the inputs and outcomes of the teaching function in two institutions of higher education - Lanchester Polytechnic and Loughborough University;
2. to collect and (as far as is possible) measure the variables and parameters identified in (1) for the comparable first degree study programmes for the academic years 1972/1973 and 1973/1974;
3. to test some of the relationships between the inputs and outputs identified and measured; and
4. To establish sets of performance indices.

Insofar as it is successful it facilitates the initial internal allocation of resources and the subsequent

AN EDUCATION INSTITUTION'S ACTIVITIES, OUTPUTS AND INPUTS

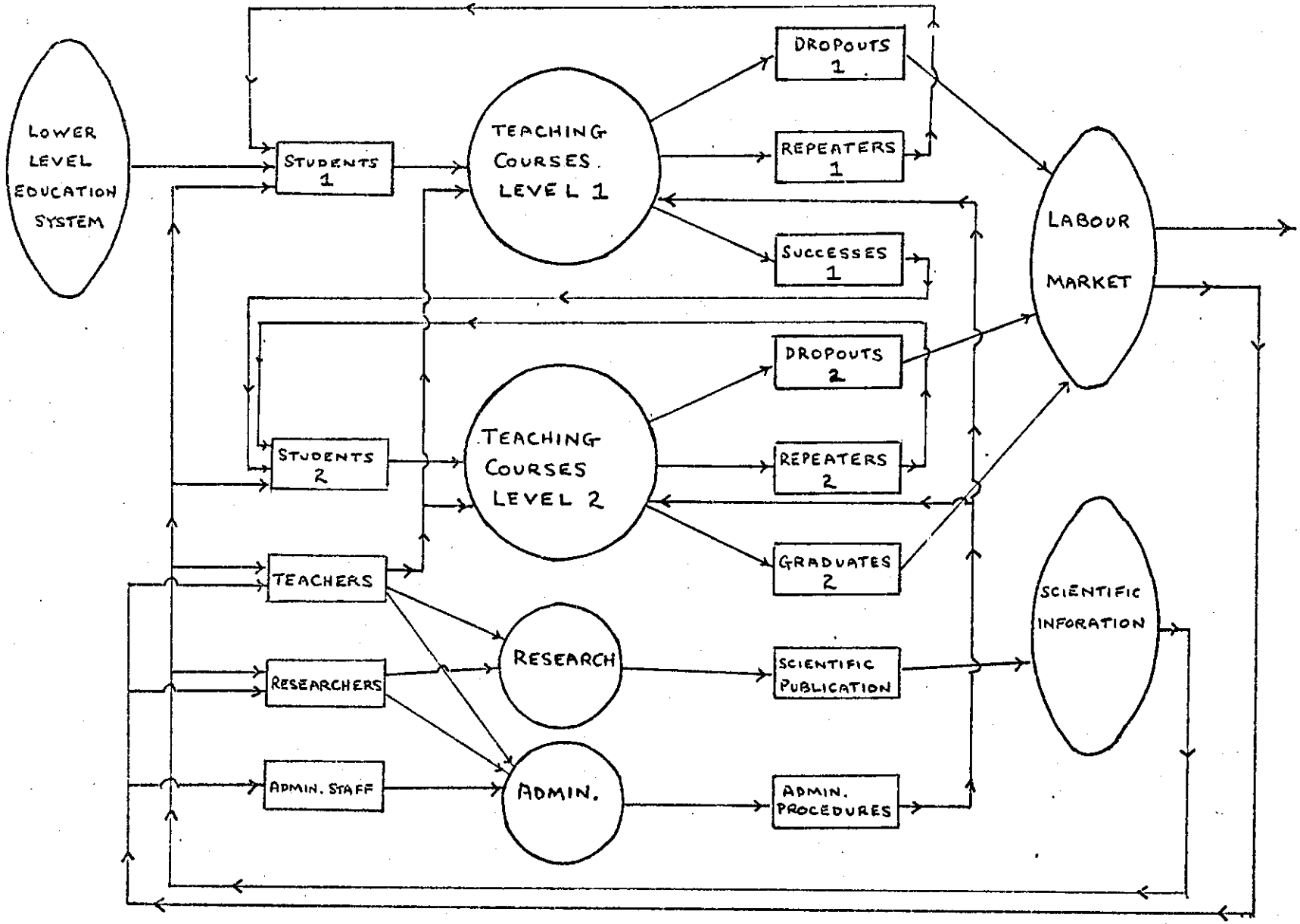


DIAGRAM 3.1

institutional monitoring of resource utilisation, and permits valid comparisons across universities and polytechnics.

Scope

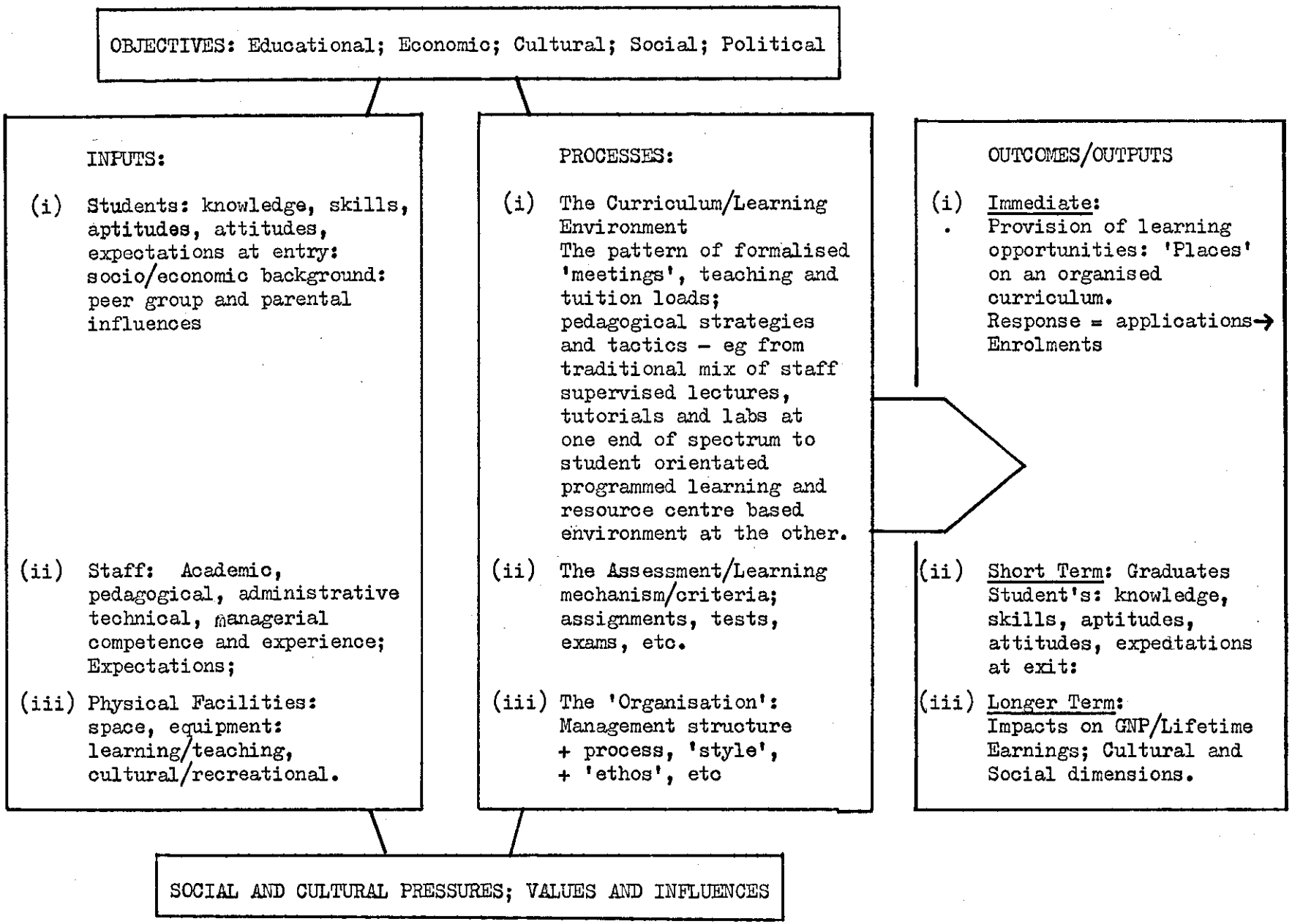
Diagram 3.1 sets out some of the interconnections described in the previous chapter. It is limited to human inputs at two levels of teaching the second of which issued certificates/diplomas/degrees. Outcomes and inputs are represented by rectangles and activities by circles; environmental factors are shown in the ovals.

In addition to their teaching function, polytechnics and universities pursue research and public service and these latter activities also contribute to the quality of the teaching role. However, a consideration of research, and public service was outside the terms of reference of the research effort sponsored by the Department of Education and Science and for the purposes of this study they are defined as residual activities. It is recognised that their existence gives rise to joint costs and products which it will be impossible to precisely unscramble.

Diagram 3.2 identifies what is believed to be the major components of the teaching system. Within the constraints of a modest budget and a tight time-scale it was not possible to collect and analyse data on all the components identified. Accordingly this study concentrates on those aspects for which data was most readily available..

DIAGRAM 3.2

MAJOR COMPONENTS OF THE TEACHING SYSTEM



If the aim is to test 'effectiveness' a critical task is to establish a set of objectives which are congruent with society's needs and expectations, but drawing the boundaries to the aims of an institution as open ended in its inspiration as a polytechnic or a university probably requires a direct line with God! It has been argued that university objectives are not only ambiguous but are destined to remain so since both faculty and administrative staff feel this to be beneficial (Cohen and March 1974). That education influences lifetime chances is not disputed, but how exactly is less certain. Whether further and higher education's role is conceived in terms of a capital goods industry (Schultz 1963) or more liberally to include the social and cultural dimensions or simply as an elaborate (and expensive) filtering device signalling ability differences which existed before the process began (Arrow 1973), its ultimate impacts are by definition long term and obscure. The assessment of institutional performance requires more proximate goals.

However, students may choose to enrol or not in higher education and, having enrolled, the majority of them are aiming for specific qualifications and gainful employment. The major reasons for going to university identified by the largest groups in Startup's Survey (1972) were occupational in nature and this phenomenon applied particularly to applied science and science students (Startup and Birk 1975). Consequently, the following proximate goals for the teaching activities in both institutions are postulated:

Given a student intake target determined externally by the DES/UGC/Regional Advisory Council, etc, or internally by reference to the institution's academic plan or otherwise; and subject to maintaining academic standards and meeting cost constraints to attain a satisfactory level of:

(1) Student intake in terms of both numbers and quality;

(2) Pass Rates;

(3) Value Added; and

(4) Student 'Employability'.

This set of objectives is not inconsistent with those articulated at various times by the Department of Education and Science (1970), nor is it at variance with the 'missions' identified in Lanchester Polytechnic's Development Plan (Note 1). It was approved by the members of the first meeting of the Steering Committee of the DES/IMHE programme. The membership of this committee was representative of a number of interests - academic and administrative - in both institutions studied as well as associated institutions and the Department of Education and Science. (See Membership in Note 7 Chapter 1).

The form of words accords nicely with the 'satisfying' phenomenon of Simon (1957). Nevertheless, goals (1), (2) and (4) are capable of being defined as targets, ie in quantified terms. 'Value Added' presents problems of definition and is less susceptible to quantification. If it is interpreted as being concerned primarily with educational (ie knowledge and skills acquisition)

rather than with experiential, attitudinal, cultural and social gains plus personal consumption, then it overlaps with the pass-rate goal and the latter may serve as a proxy. However, accurately to measure and compare this learning gain, standardised pre- and post-course tests covering common syllabi would be required (Attiyeh and Lumsden 1971).

All is not lost if we accept the inevitability of the generality and inoperability (in a management context) of 'goals' in education. It is possible to move directly to the measurement of outcomes and it may be that this sort of exercise will lead to an improved understanding of, and sensitivity to, the sophistication of the educational process.

Data on the following behavioural aspects was not collected:

- the students' socio-economic background or their attitudes and expectations at entry or exit or peer group pressures and parental influences; or
- the 'quality', expectations and values of the staff; or
- the management structure and process.

These variables have been identified as significant in a number of investigations (Coleman et al 1966 for example) but the collection and analysis of data on each of these aspects would have been a major exercise in itself.

Teaching (unlike learning!) is an activity which takes place in formal meetings between students and

academic staff. Each meeting can be defined in terms of subject, level, time, enrolment and type of accommodation - specialist/non specialist. The pattern of meetings is set down in the timetable and it was thought that any attempt to explain the teaching process must begin here. Timetables are not one hundred per cent accurate but as a data source they are at least as accurate as the staff and/or student diary, questionnaire or interview (See NCHMS at WICHE 1973). Data from the timetables for all the first degree programmes at Lanchester and Loughborough for the academic years 1972/1973 and 1973/1974 was collected and analysed. So far as is known this is the first time that such detailed timetable data has been collected across a university and a polytechnic on a comparable definition basis.

The timetable analysis has provided a base for the allocation of resources - academic, administrative and technician staff, recurrent expenditure and space to the study programmes. The apportionment of resources to courses comes up against the well-known problems of joint input allocation. Several bases are available - students, academic staff, space, etc - any method will be to some extent arbitrary but an allocation on the basis of a timetable analysis does appear to have certain advantages.

The first teaching task is to provide a variety of learning opportunities in an organised curriculum. This 'course mix' reflects the institution's perception of the needs of society. The result may be quantified

in terms of potential student 'places' on a study programme. Society's response may be assessed by the number and quality (as measured say by entry qualifications) of applications and ultimately by enrolments. Potential places, applications and first year enrolments are the immediate outcomes of the teaching function (Davies J L 1974). The value added to the students between entry and exit is described in Diagram 3.2 as the short term outcome. One measure of this learning gain might be the shift from points on an A-level scale at entry to class of degree at exit. Indices of student achievement built on this sort of data inevitably rely on the comparability of examinations, progress tests and degrees as supposedly ensured by the system of external examiners and assessors. However, some doubts have been cast on the comparability of degree standards in the United Kingdom even within the same subject group (Nevin 1972). The longer term outcomes of the teaching process are its impacts on the students' post institution lifetime chances - economic, social and cultural. A calculus for assessing the economic effects exists as described above (Chapter 2) but so far little progress has been made in identifying and measuring the cultural and social outcomes. However, it is generally accepted that they have a positive rather than a negative effect. The study has not been concerned with these longer term impacts beyond the collection of data on employment at six months after leaving the institution with starting salaries where this information was available

A classification of outcomes/outputs in line with the institutional objectives postulated above would result in the following for a course cycle:

- At the beginning of the course:
  - (a) potential places;
  - (b) applications.
- At the beginning of each year of the course cycle:
  - (c) enrolments.
- At the end of each year of the course cycle:
  - (d) successes = students who have satisfied the assessment system and have been allowed to proceed to the next year of the cycle: = graduates in the final year of the cycle;
  - (e) repeaters = students who have failed to satisfy the assessment system but have been allowed and have opted to recycle and/or resit;
  - (f) failures = students who have failed to satisfy the assessment system and have been required or have opted to leave the course;
  - (g) dropouts = students who have opted to leave the course for reasons other than failure to satisfy the assessment system;
  - (h) learning gain
- In the case of graduates, failures and dropouts:
  - (i) in employment at six months after leaving the institution;
  - (j) enrolled on a further full-time study program at six months after leaving the institution.

Arising out of the above definition of objectives, inputs and outputs/outcomes a number of performance indicators suggest themselves:

- At the beginning of a study course cycle as some measure of society's response to the institution's provision:
  - (i) the ratio of applications to places;
  - (ii) the ratio of enrolments to places;
  - (iii) average A-level points score of enrolments compared with the average A-level points score anticipated as a proxy for the 'quality' of the response.
- At the end of each year of the course cycle:
  - (iv) the ratios of successes, repeaters, failures and dropouts to enrolments.
  - (v) the learning gain;
  - (vi) the relationship of each direct input expressed in quantities and/or monetary terms to places, enrolments, successes and learning gain.
- At the end of the final year of the course cycle:
  - (vii) the proportion of graduates (not proceeding to further full-time study programmes) in employment at six months after leaving the institution and their starting salaries.

This set of performance indices was tentatively agreed by the first meeting of the project Steering Committee. The establishment of a data base to support these input/outcome comparisons over two academic years

- 1972/1973 and 1973/1974 for the first degree study programmes in both institutions proved to be a formidable task. Pre 1969 the polytechnics had not been designated, post 1969 had been a period of rapid development and at the beginning of the investigation - November 1973 - the information system at Lanchester Polytechnic was still in its infancy. In particular the student record was handwritten, dispersed and in parts incomplete. In the event most of the data requirements were satisfied but information on 'places' and 'applications' proved unreliable and ultimately these statistics were not included.

The Lanchester Context

Mr Anthony Crosland's Woolwich Speech in 1965 (Crosland A 1965) was the first major public statement on the development of a new public sector policy in advanced higher education - the polytechnics. He argued for a separate sector setting up a dual system with the universities on four criteria:

> "First ... there is an ever-increasing need and demand for vocational, professional and industrially based courses in higher education at full-time degree level, at full-time just below degree level, at part-time advanced level and so on. This demand cannot be met fully by the Universities ...
> - Secondly, a system based on the ladder concept must inevitably depress and degrade both morale and standards in the non-University sector. If the Universities have a 'class' monopoly of degree -giving and if every College which achieves high standards moves automatically into the University Club, then the residual public sector becomes a permanent poor relation perpetually deprived of its brightest ornaments, and with a permanently and openly inferior status ...
> -

- Thirdly, it is desirable in itself that a substantial part of the higher education system should be under social control, and directly responsible to social needs. It is further desirable that local government, responsible for the schools and having started and built up so many institutions of higher education, should maintain a reasonable stake in higher education.
- Fourthly, we live in a highly competetive world in which the accent is more and more on professional and technical expertise. We shall not survive in this world if we in Britain alone down grade the non-University professional and technical sector."

Subsequently, in a further speech at Lancaster University in January (1967) Crosland sought to clarify what he meant by "social control".

> "I expressed this badly at Woolwich because I could have been understood to imply that the universities were not socially responsive. Of course I did not intend to imply any such thing. I would not suggest for a moment that they are not responsive to any intimation of the national need that they can discern for themselves, or that the Government are able to give them. They have always been responsive and never more so than today. Yet given the high degree of autonomy which they enjoy, there is a sense in which the other colleges can be said to be under more direct social control. This becomes clear if we consider (to take one or two rather extreme examples) the 20 per cent productivity exercise in the colleges of education or the control over courses and class size in the technical colleges."
>
> (Note 2)

The arguments of whether the polytechnics are cheaper than the universities have gone on ever since. Crosland's Lancaster speech also stresses the importance of "the open-ended role of the technical colleges - the role of providing the second chance, the alternative route." He was also at pains to emphasise that polytechnics would be primarily teaching rather than research institutions.

The White Paper A Plan for Polytechnics (1966) nominating the colleges to be designated underlined the 'comprehensive' nature of the new institutions and codified a further criterion for their development - the need to concentrate courses in the interests of the most effective use of resources.

> "The object of developing a new pattern now is to see that the rapidly mounting demand for higher education within the system of Further Education is met in such a way as to make the best possible use of these resources without prejudicing opportunities for the tens of thousands of less advanced students who wish to take courses at intermediate and lower levels."

A Plan for Polytechnics indicated that in 1965 there had been 40,000 full-time and sandwich students in advanced courses in technical, commercial and art colleges in England and Wales. The governments intention was to have over 60,000 full-time and sandwich students following advanced full-time study programmes in further education in England and Wales by 1969-1970. By 1968-1969, 52,500 of these were already accommodated in the colleges listed to become polytechnics (Coombe Lodge Reports 1970). The DES Planning Paper No 2 (1972) postulated 750,000 places as the full-time and sandwich degree target for 1981. The White Paper Education a Framework for Expansion (1972) assigned 180,000 of these places to the polytechnics. In May 1975 the Committee of Polytechnic Directors (CDP Press Release 1975 'Polytechnics True to their Purpose') published statistics showing full-time and sandwich enrolments in November 1974

of 81,824 - an increase of 56% over the enrolments in 1968-1969 representing a compound annual growth rate of over 9%. Obviously, a further objective could be added to the list - that of growing bigger rapidly.

By 1975, however, the 1981 targets for full-time and sandwich students in higher education as a whole had been revised downwards to 640,000 to take account of a declining birth rate and a slowing up in the rate of growth of the 'demand for places' (Cmnd 5879). Alongside these changed trends we had a sick and deteriorating economy and consequently pressures to curb and to cut public spending. As a result, both polytechnics and universities were forced to move from 'go' to 'stop'. Interestingly, in an inflationary period, the denial of full inflation supplementation has proved to be a more effective brake on the universities than the 'social control' of the LEA's on the polytechnics.

The major difference between the universities and polytechnics is in their respective financing arrangements. Briefly, at the time the study was undertaken, the university sector received funds agreed in advance on a quinquennial time-scale subsequently supplemented for inflation, and apparently based in part, so far as recurrent expenditure was concerned, on student enrolments. In the polytechnics, at the time the study was undertaken, recurrent costs on 'advanced' further education were met originally by their own LEA's and subsequently recouped from the Advanced Pool established in 1959.

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Each and every LEA contributed to the Pool according to a formula based on rateable values and numbers of school leavers. Capital expenditure on buildings in both universities and polytechnics was and is subject to more stringent and direct control from the DES. However, rented accommodation is not controlled by the DES.

The Pooling arrangements have long been a subject of controversy. The system can be criticised on a number of grounds. The total commitment is decided in arrears by those local authorities with polytechnics submitting claims to cover their total recurrent costs on advanced work (Note 3). Thus, it represents an open ended financial commitment for the majority of LEA's without polytechnics and offends against the principle that an Authority should only be committed to expenditure over which it has control. It allows an Authority to establish and maintain a large and prestigious institution at a fraction of its actual costs. Therefore, it is over-dependent upon the maintaining LEA's perception of itself as guardian of the public purse and may well invite extravagance rather than economy. In an attempt to meet this second criticism the Pooling Committee have since 1972 laid down academic staffing norms (Note 4). In the future it could be that LEA's submitting claims over and above the agreed norms will be required to meet the adverse variances out of their own rates income, but, for the moment, the norms are advisory and not mandatory. Insofar as the norms are successful

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the polytechnics, like the universities, are financed largely by reference to their enrolments.

Summarising the general context of polytechnics: they were conceived as offering vocationally and professionally based courses with a variety of attendance patterns on a supportive escalator and safety net of levels of work, remaining within the social control of local government, and emphasising teaching rather than research. Initially they were encouraged, indeed required, to grow at a rapid rate. Apart from their relationship with the LEA's, it is arguable how far these objectives were already satisfied or could have been satisfied by the existing or an expanded university system.

So far as the particular context of Lanchester Polytechnic is concerned, it was designated on 1 January 1970. It was formed from three institutions of higher education - Lanchester College of Technology, Rugby College of Engineering Technology and Coventry College of Art. As a consequence the Polytechnic occupies sites in Coventry and Rugby some 14 miles apart.

In 1972/1973 the first year examined by the enquiry the enrolment was over 5,000 of which over 3,000 were full-time and sandwich students. The Polytechnic has four faculties - Engineering, Applied Science, Social Science and Art and Design with full-time and sandwich enrolments in 1972/1973 of 929, 688, 1204 and 267 respectively. The majority of these

students were registered for first degrees awarded by the Council for National Academic Awards although the Polytechnic offers a range of study programmes from sub-degree to postgraduate level. In 1972/1973 over 40 independent degree programmes were offered.

Table 3.1 gives details of the numbers of students enrolled on first degree study programmes included in the survey at Lanchester Polytechnic for the academic year 1972/1973. They were grouped in accordance with the following broad discipline areas (Note 5):

Discipline Group	Illustrative Departments Falling within Group
1. Education	
2. Health	Pharmacy; other departments allied to medicine and health.
3. Technology and engineering	Aeronautical, chemical, civil, electrical, mechanical, and production engineering; mining, metallurgy, building, surveying and general engineering. General technology and manufacturing, eg textile technology printing and book production.
4. Agriculture	
5. Science and applied sciences	Biology, botany, zoology and combinations of biological sciences, mathematics, physics, chemistry, geology.
6. Social (Administrative and business) studies	Management studies, economics, geography, government and public administration, law, sociology, liberal studies, accountancy.
7a. Vocational - architechture and town and country planning	Architecture, town and country planning.

Discipline Group	Illustrative Departments Falling Within Group
7b. Vocational - other	Catering, institutional management, home economics, librarianship, nautical studies, transport.
8. Languages (literature and area) studies	
9. Arts (other than Languages)	History, archeaology, philosophy.
10. Art and Design	Art and design, drama, music.

The Loughborough Context

Loughborough University of Technology received its charter in April 1966 the first of the former Colleges of Advanced Technology (CATs) to achieve university status. The raison d'être of the CATs had been set out in the White Paper Technical Education (1956)

> "The prizes will not go to the countries with the largest population. Those with the best systems of education will win. Science and technical skill give a dozen men the power to do as much as thousands did fifty years ago. Our scientists are doing brilliant work. But if we are to make full use of what we are learning we shall need many more scientists, engineers and technicians."

The White Paper sought to show how far behind other nations Britain was falling in the output of technologists. However, it was only by comparison with the USSR that Britain was clearly lagging. Further, it is doubtful whether there was evidence of an increased demand for technologists (Burgess and Pratt 1970). Nonetheless the White Paper argued for a substantial increase in the production of technologists from 9,500 to 15,000 "as soon as possible". It was thought that

TABLE 3.1

LANCHESTER POLYTECHNIC

1972/73 ENROLMENTS TO FIRST DEGREE STUDY PROGRAMMES

INCLUDED IN PROJECT SURVEY

		YEARS OF STUDY PROGRAMME					
DISCIPLINE		1	2	3	4	TOTAL	%
Sandwich							
1	Education	-	-	-	-	-	-
3	Engineering and Technology	270	234	212	-	716	31.1
5	Science and Applied Science	72	60	49	-	181	7.8
6	Social and Business Studies	133	130	127	8	398	17.3
7a	Urban and Regional Planning	24	23	19	21	87	3.8
7b	Librarianship	-	-	-	-	-	-
8	Languages	-	-	-	-	-	-
	TOTALS	499	447	407	29	1382	60.0
Full-Time							
1	Education	-	-	-	-	-	-
3	Engineering and Technology	-	-	-	-	-	-
5	Science and Applied Science	150	103	108	-	361	15.7
6	Social and Business Studies	182	147	129	-	458	19.9
7a	Urban and Regional Planning	-	-	-	-	-	-
7b	Librarianship	-	-	-	-	-	-
8	Languages	38	33	30	-	101	4.4
	TOTALS	370	283	267	-	920	40.0
OVERALL TOTALS		869	730	674	29	2302	100.0

Note: Sandwich students who spent the whole of the academic year 1972/73 out of college are omitted from the above enrolments.

for the highest technological qualifications sandwich courses would become more appropriate and the bulk of these courses should be concentrated on a small number of colleges - the CATs. These colleges were to increase the volume of advanced work, drop lower level work and develop a substantial amount of research. Subsequently in 1956 eight colleges were designated - Bradford, Battersea, Birmingham, Cardiff, Chelsea, Northampton, Loughborough and Salford followed by Bristol (1960) and Brunel (1962). In none of the colleges except Loughborough did the advanced work account for more than 40% of the total. Whilst the shedding of lower level work was crucial to the CAT concept the pattern of attendance was left open (Min of Ed Circular 305 1956) In the event the CATs concentrated on full-time and particularly sandwich students (Burgess and Pratt op cit 1970 pp 48-76).

Initially the colleges were left within the local authority framework. Although Loughborough had been since 1952 and continued to be a direct grant college. From April 1962 the remaining colleges also received their grants direct from the Ministry of Education. The new arrangements proved to be only temporary.

In 1963 the Robbins Committee reported. So far as the CATs were concerned the committee thought:

> "It is anomalous that such colleges should not have the power to grant their own degrees. Many of them have a long history and extensive academic experience. While the universities founded in the last two or three years are allowed to award degrees from the beginning subject only to the

> "presence of an academic advisory committee, these colleges are kept in a position of tutelage so that they are less attractive to students and their recruitment of staff is impeded."
>
> 'Higher Education' Report of the Committee under the Chairmanship of Lord Robbins Cmnd 2154 HMSO (1963)

Consequently the committee recommended that the ten colleges should become technological universities. As universities the colleges should retain technology as their major discipline but should be strengthened in pure science and extend into the "social and human studies". The government agreed with the Robbins Committee and eight of the colleges were granted their charters in 1966. Chelsea became a school of London University and the Welsh CAT at Cardiff became a constituent member of the University of Wales.

Certain aspects of the philosophy of Loughborough are bedded in its earliest years rather than the comparatively recent history of the CATs briefly reviewed above. Unlike the other CATs Loughborough was not based on an intensively industrialised urban area. It owes its present importance almost entirely to the efforts of Herbert Schofield. He arrived at Loughborough in 1915 to take over the Loughborough Technical Institute which had been running for six years and had fewer than 1000 students. It offered craft and technician courses for local industry with science and art evening classes. During the first World War Loughborough was one of the first colleges to develop the training of unskilled women workers to munitions production.

Schofield's great contribution to this venture was to introduce the then revolutionary principles of "training in production". This idea of industrially-based education became firmly established at Loughborough and was extended to most of the engineering subjects - an airfield for aeronautical engineering - a service station for automobile engineering and so on. Coupled with this philosophy was Schofield's idea that this education should be based on residential and recreational facilities. The first students were in residence by 1918 and the first hall built by staff and students opened in 1923. Thus, nearly all students at Loughborough were from the beginning housed on the campus and this remains the case today.

In 1972/1973 the enrolment was over 3000 of which 2541 were full time or sandwich first degree students. The University has four schools - Engineering, Pure and Applied Science, Human and Environmental Studies and Educational Studies - with enrolments in 1972/1973 of 1250, 738, 461 and 92 undergraduates respectively. Table 3.2 gives details of the numbers of students enrolled on study programmes included in the investigation.

Comparing Tables 3.1 and 3.2 we note that the total numbers of undergraduates involved in Lanchester and Loughborough in 1972/1973 are very similar and and the split between sandwich and full-time in each institution is virtually identical. In both institutions the large majority of students are to be found

PTD ?
Sandwich only

TABLE 3.2

LOUGHBOROUGH UNIVERSITY

1972/1973 ENROLMENTS TO FIRST DEGREE STUDY PROGRAMMES

INCLUDED IN PROJECT SURVEY

		YEARS OF STUDY PROGRAMME					
DISCIPLINE		1	2	3	4	TOTAL	%
Sandwich							
1	Education	22	7	2	-	31	1.2
3	Engineering and Technology	549	313	257	-	1119	44.3
5	Science and Applied Science	87	84	64	-	235	9.3
6	Social and Business Studies	72	24	29	-	125	5.0
7a	Urban and Regional Planning	-	-	-	-	-	-
7b	Librarianship	-	-	-	-	-	-
8	Languages	-	-	-	-	-	-
	TOTALS	730	428	352	-	1510	59.8
Full-time							
1	Education	-	-	-	-	-	-
3	Engineering and Technology	148	100	94	-	342	13.5
5	Science and Applied Science	127	108	97	-	332	13.1
6	Social and Business Studies	103	56	33	-	192	7.6
7a	Urban and Regional Planning	-	-	-	-	-	-
7b	Librarianship	29	21	15	-	65	2.6
8	Languages	39	19	27	-	85	3.4
	TOTALS	446	304	266	-	1016	40.2
OVERALL TOTALS		1176	732	618	-	2526	100.0

Note: Sandwich students who spent the whole of the academic year 1972/1973 out of college are omitted from the above enrolments

in either technology and engineering, pure and applied science, or social and business studies. However, within these three discipline areas the mix is different: engineering and technology (58%) is clearly the most popular discipline area at Loughborough reflecting the institution's original raison d'être; at Lanchester there is a more equal balance between engineering and technology (31%) social and business studies (37%) and pure and applied science (24%).

The Financial Climate of Higher Education Immediately Prior to the Investigation:

Tables 3.3 and 3.4 examine the growth rate in full-time equivalent students and public expenditure in England and Wales from 1966-1967 to 1970-1971. If we allow for the relative price effects of a labour intensive industry like education; and also in the case of advanced further education, allow for an improvement factor (a necessary element if the resource provision in advanced further education is to approximate to that obtaining in the universities) then expenditure has not noticeably outrun the rather crude productivity measure of full-time equivalent students. On the other hand, there is little evidence that higher education has been able to take advantage of economies of scale and the possibility of economies of scale was implicit if not explict in much of the debate surrounding higher education at this time.

Over the period 1966/1967 to 1970/1971 the average annual percentage rate of growth in public expenditure for all higher education in England and Wales was

TABLE 3.3

PERCENTAGE GROWTH PER ANNUM ENGLAND AND WALES

STUDENT FULL-TIME EQUIVALENTS

	66/67	67/68	68/69	69/70	70/71	Average
Universities	9.9	8.5	5.9	3.7	3.9	6.4
Colleges of Education	16.7	18.7	8.2	2.7	1.6	9.6
Advanced FE (full-time and sandwich)	16.0	21.0	8.0	8.5	5.9	13.5
Total	12.9	13.7	8.6	4.5	3.7	8.7

Source DES Statistics of Education HMSO

TABLE 3.4

PERCENTAGE GROWTH PER ANNUM ENGLAND AND WALES

PUBLIC EXPENDITURE

	66/67	67/68	68/69	69/70	70/71	Average
Universities	9.6	8.3	1.7	3.4	17.4	8.1
Colleges of Education	17.6	16.1	10.3	7.3	8.6	12.0
Advanced FE (full-time and sandwich)	20.2	22.5	14.5	13.3	16.0	17.3
Total	12.6	12.0	5.6	6.0	15.3	10.3

Source DES Statistics of Education HMSO

10.3 per cent. Over this same period the average growth in the gross national product at factor cost was 6.0 percent. In the context of successive governments' avowed interest in curbing public expenditure this situation was bound to attract publicity. The GNP comparisons apart, in the rather more parochial local authority finance field the growth in absolute terms in advanced further education pooled expenditure from £44 million in 1966/1967 to £81 million in 1970/1971 inevitably caused concern. It was in this climate of increasing interest and financial concern that this study was mounted.

NOTES

1. "(a) To make a substantial contribution to the expansion of higher education in accordance with the rate of expansion prescribed in the White Paper;

(b) To offer education of a consistently high quality in every respect while exercising reasonable economiy in cost;

(c) To provide greater opportunities in comprehensive higher education at district, regional and national level in order to satisfy the needs of society and the individual;

(d) To plan the comprehensive development of the Polytechnic to achieve an integrated academic community having a strong regional attachment and effective student participation;

(e) To ensure that increases in the total of home-based and other student accommodation adequately provides for the growing student population;

(f) To provide a course programme offering the student a wide and flexible choice of studies while retaining a proper emphasis on integrated professional experience where appropriate;

(g) To secure a high degree of student tranferability both between the Polytechnic's courses and with other educational institutions in this country and abroad;

(h) To encourage the development of improved approaches to study;

(j) To encourage postgraduate and research activity with particular reference to industrial and social needs, part-time provision, and the requirements of the locality."

Lanchester Polytechnic Development Plan

2. See DES National Advisory Council on Education for Industry and Commerce. A Report by the Committee on the More Effective Use of College Resources. Chairman Lord Pilkington The Size of Classes and Approval of Further Education Courses HMSO (1966)

3. Providing Authorities submit claims on the Advanced Pool on the Basis of the following formula:

$$\frac{\text{Volume of Lecturers' Salaries on Advanced Work}}{\text{Total Lecturers' Salaries}} \times \text{Net College Expenditure}$$

From the Providing Authorities point of view this formula argues in favour of as low a staff student ration as is possible for advanced work!

4. See DES 'Advanced Further Education; Pooled Expenditure' Memorandum by the Pooling Committee on Student/Staff Ratios for Advanced Level Work in Polytechnic and Colleges of Further Education July 1972

"Laboratory-based subjects 7.5 - 8.5
Classroom-based subjects 9.2 -10.2"

5. This grouping corresponds with that proposed by the Pooling Committee: Assessment of Curricular Activity and Utilisation of Staff Resources in Polytechnics and FE Colleges Councils and Education Press (1972)

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CHAPTER 4

A FRAMEWORK FOR ANALYSIS

AND THE RESULTS OF THE LANCHESTER/LOUGHBOROUGH STUDY

(Note 1)

Introduction

The Lanchester/Loughborough case was premised on the view that an institution is assessed in terms of its effectiveness and its efficiency. An institution is effective if it achieves its objectives; it improves its efficiency if it achieves these objectives with fewer resources. Therefore, performance assessment involves firstly, comparing the level and quantity of an institution's outcomes with its objectives and, secondly, examining input-output (ie cost benefit relationships.

Some indication of society's response to an institution's provision of learning opportunities is provided initially by the number and quality of enrolments and subsequently by how successful these students are progressed through their studies and are accepted by the economy. Dropouts, failures, repeaters, successes and graduates are all outcomes of various stages of the educational process and a careful monitoring of these outcomes at Lanchester and Loughborough for the academic years 1973/1974 and 1974/1975 was undertaken and the results appear below.

But first the question of how both institutions deployed their resources in pursuit of these outcomes is examined. Usually the input-output relationship is summarised in the form of a unit cost but in the United Kingdom the popular approximation for the teaching function is the student-staff ratio. This ratio is a function of a number of variables. Decisions on

these variables are significant in determining the costs of instruction. An examination of resource utilisation at the micro level needs to take account of them. Depending on the complexity of the curriculum this may involve a detailed timetable analysis such as is described below.

Teaching takes place for the most part in formal meetings between students and academic staff. These meetings may be defined in terms of time, place, size, frequency, discipline and the pedagogical technique deployed. The formal pattern of meetings is set down in the timetable which thus constitutes a written record of the allocation of students, academic staff and teaching space to the teaching function. The collection and analysis of timetable data is one approach to an improved understanding of the teaching process. Teaching requires academic staff commitment not just to formal classroom time, but also to preparation, the correction of students' assignments, the preparation and marking of examinations and other students' assessments and sundry administrative tasks. Information on these 'outside-the-classroom' activities is difficult to obtain and, when obtained probably subjective and, therefore, suspect. Preparation time is likely to be a function of the level of work and of the experience of the teacher, whereas marking and feedback is a function of student numbers. However, of this total commitment the major portion is concerned

with the classroom hours programmed in the timetable. If we assume that a teacher will have a mix of levels of 'new courses' and of class sizes which does not vary greatly from the average for his institution, (This in the event proved to be the case in a representative sample across all departments in both institutions) then a timetable analysis provides information on faculty teaching loads; it also defines the demand for teaching space and specifies aspects of the students' learning environment - class sizes and tuition load. Doubts may be cast on the accuracy of timetables but the data they contain is at least as reliable as that obtained by questionnaire or faculty-student diaries.

Staffing Formulae (Note 2)

The largest single element in most institution's budgets is academic staff. To be able to calculate the total requirement for academic staff and to distribute this rationally between competing departments and sections is, therefore, of critical importance. Add to this the fact that other costs tend to follow academic staff costs and it is not surprising to find a considerable effort to derive academic staffing formulae. Any attempt to identify the important parameters in a timetable profits by some study of these formulae.

The traditional academic staff resource allocation mechanism was, and is, the staff to student ratio. However, successive studies have gone behind this rather crude device to further examine the factors which

determine the requirement for academic staff. All the investigations are agreed that the requirements for academic staff is influenced by:

(a) the students' tuition load,

(b) the teachers' teaching load and

(c) the class size provided.

One simple specification of the relationship would be:

$$T = \frac{s}{g} \cdot \frac{h}{t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where

T = fte academic staff;

s = fte students;

t = average teaching load (formal class-contact) hours per fte academic staff member;

g = average group (class) size; and

h = average tuition load (formal teacher-contact) hours per week of the average group (class) g.

and, hence, the SSR (staff to student ratio) is defined as:

$$SSR = \frac{h}{g.t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

This relationship is the one postulated by John Delany (1971) and is the basis for the Pooling Committee's recommendations in the Assessment of Curricular Activity and Utilization of Staff Resources (Pooling Committee 1972)

There are of course possible developments to Equation (1). For example the total number of teaching house provided per week (h) might be divided into hours given in the form of lectures (k) and hours given in smaller group situations called, for the sake of a name, seminars (m). ie $h = k + m$

Assuming that a lecture can be delivered to an audience of 200 or more (ie group size is not critical for lectures although accommodation, saving the deployment of educational technology, may be) then the average group size (g) now refers to seminar group size. Again, since the parameters (k) (m) and (g) may vary by the level of students a distinction could be drawn along these lines too. Thus, with two level (say undergraduates and postgraduates) Equation (1) might be rewritten:

$$T = \frac{k_1 + \frac{s_1}{g_1} m_1 + k_2 + \frac{s_2}{g_2} m_2}{t} \quad \ldots\ldots\ldots\ldots (3)$$

where subscripts 1 and 2 refer to first and higher degree students respectively. Equation (3) is similar to the relationship proposed by Legg (1971).

Bottomley et al (1971) have put forward a more generalised version similar to Equation (4) below which emphasizes the importance of the educational strategy deployed reflected in the pattern of different types of meeting:

$$T = \frac{\sum h_{ij} \cdot s_j / g_{ij}}{t} \quad \ldots\ldots\ldots\ldots (4)$$

where

h_{ij} = average number of formal tuition hours per week received by each type of teaching meeting i in the jth year of the course;

s_j = number of students enrolled in year j of the course; and

g_{ij} = maximum size of each type of meeting in the jth year of the course and the meeting types are analysed under the following classifications:

Lectures; Exercise Classes; Discussion Classes; Seminars or Small Group Discussion; Tutorials; and Practice Classes or Laboratories.

The University of Lancaster CERI-OECD research group (Simpson M G et al 1971) in determining their teaching load have developed a model which takes account of lecture and seminar preparation and post mortem time as well as the actual formal student-teacher contact time and have derived a relationship roughly similar to Equation (5):

$$T = \frac{k(1 + p) + \frac{s}{g}m\left(1 + \frac{g}{r}\right) + su}{t} \quad \ldots\ldots\ldots\ldots (5)$$

where

p = average preparation time hours per week per seminar;

r = average number of seminar repeats per week per member of staff; and

u = average post-mortem time per student per week

However, they experienced difficulty in collecting data on preparation times and conceded that a teacher's estimate of these might be more a measure of his experience than of his industry. Insofar as it is difficult to obtain reliable data on preparation and post-mortem times directly, it seems preferable to allow for them indirectly as a part of the reciprocal of (t) - the average formal class contact of a fte teacher.

A survey by the OECD Centre for Educational Research and Innovation of universities in member countries based on the Legg formula (approximating to Equation (3)) revealed the information tabulated in Table 4.1. An analysis of variance of the data supported the contention that each subject field has its own peculiar pedagogical problems and the teaching and learning environments developed (as reflected in (h) (k) and (m) at any rate) will be much influenced by subject field (Note 3).

In the Spring Term of 1970 a similar survey of all further education colleges with 50% or more of their work at A_1 and A_2 level (Note 4) was commissioned by the Pooling Committee. The date was collected under ten broad subject classifications and analysed according to the equation (1) to reveal for each institution the factors (g) (h) and (t). The response rate was high but, unfortunately, an understanding given by the Pooling Committee to the Institutions and Authorities providing the data has prevented the publication of the results. What is known is that there were fairly wide dispersions around the means for each of the factors; the pattern across subjects reflected the CERI study except that (h) and (t) were consistently higher and (g) was consistently lower; and the analysis apparently supported the making of a broad distinction between laboratory-based (eg science and technology etc) and classroom-based (eg humanities and social sciences etc) disciplines. (Note 5)

TABLE 4.1

Student hours per week scheduled, group size and teaching load hours per week by subject field

Subject field	Student hours per week scheduled								Group size								Teaching load	
									Seminar						Lecture*			
	First degree				Higher degree				First degree			Higher degree			Higher degree			
	Total	Lectures	Seminars	Observations	Total	Lectures	Seminars	Observations	Average	Maximum	Observations	Average	Maximum	Observations	Average		Average	Observations
Pure sciences	19.5	9.9	9.6	(47)	14.9	6.2	9.0	(32)	16	30	(40)	7	13	(33)	18		8.1	(61)
Technology	25.5	13.8	11.7	(33)	20.9	11.1	9.8	(21)	17	34	(17)	7	12	(13)	11		8.9	(48)
Medical sciences	24.2	12.6	11.6	(7)	19.5	11.5	8.0	(2)	16	28	(5)	5	12	(2)	-		6.2	(4)
Humanities	14.9	9.0	5.9	(35)	11.4	7.7	3.7	(23)	14	23	(16)	6	10	(13)	10		8.4	(45)
Law	19.3	15.3	4.0	(7)	16.3	11.6	4.7	(3)	15	38	(4)	-	-	(9)	-		5.9	(9)
Social sciences	17.0	12.8	4.2	(31)	12.7	9.3	3.4	(23)	17	29	(18)	10	15	(15)	15		9.2	(4)

* Evidence on the group size for the first Degree lectures was scanty but suggested an average close to the average seminar size.

Source: B Fredriksen Subject Field and Regional Variations in student to Staff Ratios, Academic Programmes and Recurrent Expenditures Paris CERI-OECD

A Timetable Analysis

Of the formulae reviewed above the Bottomley approach seems the most promising in terms of the detail it identified. However, it views the 'course' as self-contained and hence the upper limit of a class size for the jth year of a study programme is given by the enrolments to the jth year. The situation at Loughborough proved to be more complex approximating to that represented in the matrix below where the columns represent courses and the rows subject elements.

		Courses				
		A	B	C	D	E
Subject Elements	1	x		x	x	
	2		x		x	
	3		x	x		x
	4	x	x	x		
	5	x	x			x
	6			x	x	
	7	x			x	x

If a subject element is compulsory then the upper limit of a class size is the sum of the total enrolments in the study programmes taking that particular topic - courses A, C and D for subject element 1. If a subject

element is optional the enrolment to meetings in that subject will be equal to or less than the total enrolments of the courses participating in that topic.

The Bradford study also defined the meetings as either 'lectures', 'exercise classes', 'discussion classes', 'seminars', 'tutorials', or 'laboratories'. However, from the point of view of the pedagogical techniques likely to be deployed or the learning situations created the critical variable would seem to be the number of students in the class rather than its timetabled description. There would seem to be no point in perpetuating the myth of the 'lecture' to five and the 'tutorial' to fifty! Therefore, in the Lanchester/Loughborough study the basic unit of analysis is the timetabled hour of formal contact between a member of the academic staff and students - the 'meeting'. A course constitutes a set of meetings. The set can be broken down into subsets on the basis of the department providing the tuition, the type of space utilised and the size of the student groups, each assigned to one teacher, formed. For a particular course this subset may be compulsory or optional, can be taught to a single course or may involve a number of courses.

Consider an institution with two departments X and Y with two courses A and B (Exhibit 4.1). Course A is based in Department X and Course B in department Y. There are 30 enrolments to course A and 20 to course B. Following a course involves

EXHIBIT 4.1

Timetable Parameters

	Department	X			Y	
	Subject Elements	L	M	N	O	P
[g]	No of Groups Formed	2	1	1	1	2
[h]	Students' Contact Hours	20	15	30	20	20

Course [E]	= Enrolment	[S] Enrolments to Subject Elements				
A	30	20	20	30	5	
B	20	-	5	20	20	20
[E*] Enrolments from All Courses		30	25	50	25	20

Hence a TIMETABLE ANALYSIS requires the following information:

For a year of a course - ("course-year")

Total Enrolment = E

For a particular subset of meetings for a course

Enrolment from a particular "course-year" = S

Enrolments from all "course- years" of all courses = E*

Number of classes formed each assigned to ONE teacher = g

Hours per annum attended by a student = h

Department providing tuition

reading a number of subject elements and attending a set of meetings with academic staff. For example, students enrolled on course A study subject elements L, M, N and O; subjects L and N are compulsory whilst M and O are optional. L involves just course A whereas M, N and O involve joint meetings involving both courses A and B. Therefore, to analyse a set of meetings information on E, S, E*, g, h and the type of space utilised - specialist or non-specialist is required (Exhibit 4.1). This information was collected for all the undergraduate courses at Loughborough and Lanchester (except art and design) for the academic years 1972/1973 and 1973/1974.

From this data it was possible to establish for each year of a course, for a department's courses, for discipline areas and for each institution the following 'values':

(1) Student load: this is the average hours of time-tabled contact that the student received, ie

$$\text{student load} = \frac{\Sigma (h.S)}{E}$$

(2) Total Meetings timetabled for a particular study programme

$$\Sigma (h.g)$$

Summed over a department or discipline area or institution this statistic counts 'joint' meetings several times hence:

(3) Allocated Meetings: where several study programmes attend the same set of meetings (ie $E^* > S$) the teaching hours were allocated pro rata to the number of students attending from a study programme, ie

$$\text{allocated meetings} = \Sigma \left(h.g. \frac{S}{E^*}\right);$$

(4) Class size: This is the size of meeting the student actually attended, ie

$$\text{Class size} = \frac{E^*}{g}$$

(5) Average class size attended by the student, ie

$$\frac{\sum\left[\frac{E^*}{g}\left(\frac{h.S}{E}\right)\right]}{\sum\left(\frac{h.S}{E}\right)} \text{ ; and}$$

(6) Average class size provided by the institution

$$\frac{\sum\left[\frac{E^*}{g} \cdot \left(h.g. \ \frac{S}{E^*}\right)\right]}{\sum\left(h.g. \ \frac{S}{E^*}\right)}$$

In each case the summations are made over the relevant subsets

(See Note 6 for a precise mathematical definition of these 'values')

From (5) and (6) it is possible to derive two frequency distributions: (5) shows the range of group sizes an average student attends and can be summed for a course, department, discipline or institution; whereas the frequency distribution derived from (6) shows the range of group sizes provided and is meaningful only when summed for the whole institution.

All courses are based in a particular department and, therefore, discipline area. To connect inputs with outcomes and, ultimately, to identify costs it is important to know whether the demand from a course is from its own department or from some other depart-

ment and whether it is specialist space or not. Accordingly the data was further analysed to reveal for each course the source of its tuition and the split between specialist and non-specialist space.

The Results of the Timetable Analysis 1972/1973 (Note 7)

Some of the results of the timetable analysis for the academic year 1972/1973 are presented in the Tables below. Fuller results for both 1972/1973 and 1973/1974 are presented in Appendix A (accompanying volume). Considerable differences in the students' formal learning environments between the two institutions in both academic years are revealed.

Table 4.2 summarises the timetable parameters for the major comparable discipline area for both institutions over the normal three year undergraduate cycle. For all disciplines the Lanchester student had a tuition load greater than his Loughborough counterpart. The differences ranged from 783 hours over three years for science and applied science to 19hours for social and business studies. Engineering and technology and science students in both institutions had more teacher contact than their social and business studies colleagues: a phenomenon identified by Frederikson (1971 op cit) for a larger and wider sample in Europe. However, the difference at Lanchester was more than 1000 hours compared with 400 hours at Loughborough.

The greatest divergence between the two institutions lay in the difference between 'meetings' and 'allocated

TABLE 4.2

Summary of timetable parameters for three year undergraduate cycle 1972-73

	All disciplines		Engineering & Technology		Science		Social and business studies	
	Lan	Lou	Lan	Lou	Lan	Lou	Lan	Lou
Students' tuition load (hours over 3 year cycle)	1,930	1,612	2,229	1,685	2,471	1,688	1,325	1,306
Meetings (hours per annum)	146,086	118,468	62,217	50,394	44,067	32,884	33,378	25,475
Allocated meetings (hours per annum)	141,606	62,418	62,102	31,990	44,067	16,987	30,469	7,089
Students' average class size	18	43	13	49	12	37	30	41
Institution's average class size	10	21	9	23	10	20	12	20

Lan = Lanchester

Lou = Loughborough

meetings'. For the institution as a whole meetings are the formal teacher/class contact hours per annum that would be required if each course was self-contained and timetabled independently: allocated meetings are the teacher/class contacts actually provided; any difference arises out of 'joint' meetings involving more than one course. In the event in 1972/1973 joint meetings reduced the one hour classes required for the undergraduate programmes from 146,086 to 141,606, ie 3%, at Lanchester, whereas at Loughborough the reduction was from 118,468 to 62,418, ie 47%.

Partly as a result of these joint meetings the Loughborough undergraduate found himself in much larger classes on average than his Lanchester counterpart and experienced a wider range of class size: this difference is particularly marked for engineering and technology. At Lanchester students in social and business studies were on average in larger groups than their engineering and science colleagues: at Loughborough the opposite was generally the case.

In both institutions the average student spent over 10% of his teacher contact in classes of ten or below (Table 4.3). However, at Lanchester 66% of the student's class size experience was in groups of twenty or less compared with only 36% at Loughborough: at Loughborough 26% was in groups larger than sixty and 11% in classes of one hundred or more.

TABLE 4.3

Relative frequency distribution
of average student's class sizes 1972-73

	Lanchester		Loughborough	
Class size	Per cent	Cumulative Per cent	Per cent	Cumulative Per cent
1- 10	34	34	11	11
11- 20	32	66	25	36
21- 40	19	85	23	59
41- 60	8	93	15	74
61- 80	4	97	11	85
81-100	2	99	4	89
100+	1	100	11	100

It is important to appreciate the difference between the students' average class size and the institution's average group size. The latter identifies the class size the institution on average is required to provide: the former identified the typical class size in which the student finds himself. For example, an enrolment of 20 students receiving one hour in a group of 5, one hour in a group of 10 and one hour in a class of 20 has a students' average class size of 11.7. The institution, on the other hand, provides four hours of class size 5, 2 hours of class size 10, and one hour of class size 20, ie the institution's average class size is 8.6. It is the institution's average group size which forms part of

the basis for the Pooling Committee's recommendations on student/staff norms for Advanced Further Education (Note 5).

Almost 67% of the demand for teaching space at Lanchester was for classes of 10 or below compared with 41% at Loughborough (Table 4.4). On the other hand, 12% of the demand at Loughborough was for groups greater than 40, whereas at Lanchester only 2% of the demand was for classes of 40-plus students.

TABLE 4.4

Relative frequency distribution of demand for teaching space 1972/73

	Lanchester		Loughborough	
Class size	Per cent	Cumulative Per cent	Per cent	Cumulative Per cent
1- 10	67	67	41	41
11- 20	23	90	32	73
21- 40	8	98	15	88
41- 60	1	99	6	94
61- 80	0.6	99.6	3	97
81-100	0.3	99.9	1	98
100+	0.1	100	2	100

Table 4.5 is a relative frequency distribution of the demands in both institutions for specialist teaching space (ie in workshops, laboratories or drawing offices) in 1972/1973. At Lanchester 29% of the total demands for teaching space were for specialist space compared with 21% at Loughborough.

TABLE 4.5

Relative Frequency Distribution of Demand for Specialist Teaching Space 1972/73

Class Size	Lanchester Per Cent	Lanchester Cumulative Per Cent	Loughborough Per Cent	Loughborough Cumulative Per Cent
1-10	78	78	32	32
11-20	15	93	46	78
21-40	7	100	18	96
41-60	-	-	4	100

Timetable data for both institutions was also collected and analysed for the academic year 1973-74. There were no significant changes between the 1972-73 and 1973-74 timetables. (See Appendix A).

Some Economic Implications

To summarise - in 1972-73 the average Lanchester student was by comparison with the Loughborough undergraduate, timetabled for 20 per cent more hours in classes of approximately half the size invariably with students from his own course. Higher tuition loads, smaller groups and a much lower incidence of joint meetings were consistently observed at Lanchester in all disciplines. What are the economic implications of these differences? A measure of the percentage 'savings' in undergraduate demands for tuition brought about by joint meetings is given by:

$$100\ \left(1 - \frac{\text{Allocated meetings}}{\text{meetings}}\right)$$

	Lanchester	Loughborough
Engineering	0.2	36.5
Science	0.0	48.3
Social and Business Studies	8.7	72.2
All disciplines	3.1	47.3

These figures indicate that where a modular structure exists involving joint meetings (whether planned or simply 'emerging' as apparently at Loughborough) the critical variable in forecasting the economic impact of 'new' courses is not necessarily the projected enrolment. If a new course can be merged for large parts of its curriculum with existing classes, its marginal demands for tuition may be minimal. During 1972-73, with very similar total enrolments to undergraduate programmes at both institutions, there were (in our survey) 49 courses at Loughborough and only 39 at Lanchester. At Loughborough the enrolments to any one year of a course ranged from one to 90, whereas at Lanchester they ranged from 5 to 125. However, the average class size of the sole student enrolled on a particular 'new' course at Loughborough was 57, whereas the students average class size of the course at Lanchester with an enrolment of 125 was 51! Thus whenever joint classes are a feature of a timetable the recommendations of the Pilkington

Committee (1966) on minimum ~~class sizes~~ enrolments to courses in further education would seem to be inappropriate. Moreover, if a new course is to be timetabled jointly with existing classes for some part of its curriculum, then this factor should be taken into account by the Regional Staff Inspector and the Regional Advisory Council in deciding ~~in deciding~~ to allow recruitment to proceed in advanced further education.

Thus far we have examined the economic possibilities of joint meetings , but there are also clear differences between the institutions in class sizes and formal tuition loads. A measure which summarises the cumulative effects of these differences is:

$$\frac{\text{Allocated Meetings}}{\text{Enrolments}}$$

For 1972-73 this ratio of undergraduate tuition demands in hours per annum per student enrolled in college was as follows:

	Lanchester	Loughborough
Engineering	90	26
Science	81	30
Social and Buriness Studies	36	22
All disciplines	63	27

Thus the tuition demands are higher at Lanchester by a factor of nearly 3.5 in engineering and technology, 2.7 in science and 1.6 in social and business studies, Assuming that the preparation, marking and other

out-of-class activities of the academic staff concerned are comparable across the two institutions (probably a large assumption!) it appears that in 1972-73 the average undergraduate at Lanchester made over double the tuition demands of his Loughborough counterpart. There are two possible consequences of this. If the teaching load (timetabled hours per annum) of the average full time equivalent member of the staff and his salary were similar for the two institutions, the academic staff cost per undergraduate at Loughborough would be less than half that at Lanchester. Alternatively, the average Loughborough lecturer could have half the timetable commitment, devote more time to research, so that academic staff unit costs are approximately the same in both institutions. Given

Given an assumption that the teaching efforts of an institution are directly related to its timetable, a timetable analysis such as described above offers an alternative and, wherever service teaching and joint meetings are a feature, maybe a more accurate method of allocating costs to courses and to students than the traditional allocation on the basis of departments. A cost is only valid within a particular context - different contexts will produce different costs and this is particularly so where, as in higher education, joint outputs exist. In assessing the performance of an institution factors other than those discussed above need to be taken into account: the nature, quantity and quality of the outcomes of the teaching

process - cultural and social as well as educational; the quality, aspirations and attitudes of the staff and students; the explicit and implicit objectives of the institution and the organisation structure and managerial climate. Information on these variables was not collected but data on A level and other entrance examination scores and subsequent examination performance was collected and is dealt with below.

The Student Record

For convenience, the overall results of the student record analysis is presented in Table 4.6. A more detailed analysis by discipline area is presented in Appendix A (Accompanying Volume).

TABLE 4.6

Some Undergraduage Statistics 1972-73

	Lanchester "Course Years"			Loughborough "Course Years"		
	1	2	3	1	2	3
A-Level Entry*						
Mean (Standard Deviation)	2.1 (0.8)	2.2 (0.8)	2.2 (0.8)	2.9 (0.8)	2.9 (0.8)	3.0 (0.8)
% of Enrolments						
'Pass'	60	88	97	82	85	95
'Transfer to Ordinary'	11	1	0	4	4	0
'Successful'	71	89	97	86	89	95
'Fail'	22	9	3	9	9	3
'Not Taken' ('Dropout')	7	2	0	5	2	2
	100	100	100	100	100	100
Mean Marks (Standard Deviation)	51.8 (10.2)	55.3 (8.2)	58.4 (7.5)	53.3 (10.8)	54.3 (10.9)	58.2 (9,7)
Correlations						
Internal Examinations v A-levels	+.15	+.05	+.14	+.29	+.27	+.15
2nd year v 1st year		+.46			+.63	
3rd year v 2nd year			+.68			+.71

*The A-level grades were calculated on the normal UCCA basis of A = 5, B = 4, C = 3, D = 2 and E = 1

73% of the undergraduates 'qualified' for entry to Lanchester via A-levels compared with 85% at Loughborough. The average Loughborough student with a mean A-level of just below 'C' was about three quarters of a grade above his Lanchester counterpart. The correlation between A-level grades and subsequent degree examination performance was consistently higher at Loughborough but even here A-levels 'explain' less than 9% of subsequent degree examination performance. This result agrees with those identified by Entwistle and Percy (1971). The correlation between A-levels and degree examinations was not materially affected by alternative measurements of A-level such as the 'mean of best three A-levels' or 'number of A-levels'.

Apart from the results for first year students the pass, failure and 'not taken' (wastage) rates were similar in both institutions. The higher failure rate for first year students at Lanchester might be ascribed to the lower A-Level entry, but the low correlation between A-Level and degree examinations suggests this explanation be treated with caution. It could be argued that with more 'safety nets' available and with an academic reputation to build Lanchester was quicker to fail students than Loughborough. These arguments were presented at various times but they were not investigated in depth. In the event, the 1973/74 first year results showed a closer relationship (Lanchester 80% 'pass': Loughborough 85% 'pass'. See Appendix A

At this level of aggregation there was a remarkably similar improvement in mean marks as the study years proceed from years one to three in both institutions. This trend is accompanied by a tightening of the distribution of marks as the study years proceed. This phenomena may be evidence of learning gain. On the other hand, it may be merely illustrative of a tendency for examiners to fulfil their original 'labelling' prophesies.

The large sample sizes mean that all the correlations are statistically significant. In both institutions the correlation between one study year and the preceding examination (ie between entry and exit marks) is increased as the study years proceed but is stronger at Loughborough. At Lanchester, first year results 'explain' just over 20% of second year results whilst second year results 'explain' about 45% of third year results. At Loughborough the equivalent percentages are 40% and 60%.

A comparison of mean ONC/OND marks and degree examinations resulted in the following correlation coefficients which are all significant at the 5% level:

Study Year:	Lanchester		Loughborough	
	Sample size	r	Sample size	r
1	69	+.40	93	+.44
2	75	+.29	66	+.37
3	50	+.31	65	+.27

In all cases the coefficients are somewhat higher than the A-level correlation and 'explain' about 16% of first year results. This stronger correlation may be accounted for by the higher probability of a 'good match' between ONC/OND syllabus content and degree syllabuses.

Information on initial salaries was available for just over 20% of the 1972/73 graduates at Lanchester and 50% at Loughborough. The overall mean salaries and the pattern across discipline area in each institution are similar (Table 4.7). It would seem that discipline area rather than institution is a more important determinant of initial salary. The correlation between final degree marks and initial salary was positive (but by no means strongly positive) for all the disciplines at Loughborough and most of those at Lanchester.

TABLE 4.7

Initial Salary Data of Graduates 1972/73 and Correlation with Final Marks

Discipline Area	Sample size	Mean Salary £	(Standard Deviation)	r
Lanchester				
Engineering	56	1 778	286	-.10
Science	32	1 523	364	+.13
Social and Business Studies	51	1 696	359	-.01
All Undergraduates	145	1 681	347	+.03
Loughborough				
Engineering	190	1 725	388	+.17
Science	83	1 503	279	+.02
Social and Business Studies	26	1 756	346	+.55*
All Undergraduates	318	1 654	365	+.19*

* Significant at the 5% level

Costing the Teaching Activity (Note 8)

If differences in educational outcomes prove to be not statistically significant, the emphasis shifts from cost benefit to cost effectiveness narrowly defined. Usually the outcomes in this context are defined as either students enrolled or 'successful' students and the relationship between inputs and outcomes is conveniently summarised in the form of a unit cost. In this section, a formula is developed for allocating expenditures on the basis of the 'meetings' identified by a timetable analysis such as that described above and tested on data from Lanchester and Loughborough for the academic year 1972/1973.

The usual starting point in the search for an historical cost is actual expenditure recorded on non-capital items recorded by the accounting system during the period under review. To this may be added that proportion of capital outlays (past and present) which it is deemed appropriate to set against present outputs and which may or may not be recorded by the accounting system. Depreciation of equipment and fittings is an example which, in the current practice of public accounting, is not recorded by the accounting system. To the economist the cost of using resources one way rather than some other is the 'best' alternative foregone. In an uncertain world there is no one way of forecasting and ranking all these alternatives and, therefore, no one way of identifying the economic cost. Nevertheless some foregone oppor-

tunities may be recognised and accounted for: the common example in higher education cost studies being the economy's loss of the student's contribution to GNP as a result of his withdrawal from paid employment. Once we move away from actual cash flows recorded by the accounting system to concepts of depreciation and of 'opportunity costs' we move from a matter of fact to a matter of opinion.

In this section, outlays on the teaching activity are defined to include the salaries, superannuation and national insurance of academic, technician and administrative staff deployed at the level of the school or faculty and department together with expenditure on materials consumed directly by the teaching activities, the maintenance and hire of teaching equipment and the cost of short courses and field work. Outlays under these heads account for between 60% and 70% of the total recurrent expenditures of universities and polytechnics and insofar as they are cash outflows recorded by the accounting system they are facts rather than opinions.

To produce a unit cost these outlays need to be set against the outcomes of the enterprise. In the case of a homogeneous product the averaging process is not controversial. However, the outcomes of education are not homogeneous: staff used on teaching are also employed on research, students vary by level, discipline, pattern of attendance and not all of them survive to graduation. Consequently unit costs in education are

by no means clear cut. The analysis presented below proceeds on the basis that firstly, universities and polytechnics are predominantly teaching institutions and that any research output is a 'bonus'; and, secondly, that the outcomes from the teaching function are students enrolled rather than students graduating. This second assumption is relaxed subsequently. These are maybe gross simplifications but the road to most 'costs' is littered with assumptions and pot-holed by value judgements. No claim is made to have discovered the teaching costs.

Given a definition of the costs to be allocated, the question of concern is: how should these costs be assigned to courses and, subsequently, to the students taking these courses?

There is no one elegant way of handling the problem and a case can be made for having the allocations done by the academics themselves. An example of this approach is the Faculty Activity Analysis Programme of NCHEMS at WICHE (1971, 1973 and 1974). Briefly, this programme employs a five page questionnaire which asks the academic staff to identify how they spend their time - in scheduled teaching (contact hours, preparation and administrative time) unscheduled teaching, student advising, course and curriculum development, research, scholarship and personal development, administrative duties, committee participation and public service activities! The programme also provides the respondents with an opportunity to

distribute these activity hours over the major institutional objectives of teaching, scholarship and research, and public service.

Succinctly, the objections which can be raised to the questionnaire/diary sdution are concerned with time scales, the validity of the data and the cost of collection. Typically the teacher's workload is unprogrammed and variable with significant peaks and troughs. Hence - when should the survey be conducted? How frequently should it be administered? Over what time scale should it relate? - are formidable questions. "It is always possible that inviting staff to estimate the times taken on various activities may result in over estimates of these parameters: lecturers are unlikely to give replies which would show them as not working intensively" (Simpson et al 1971 op cit p 48) Thus questionnaires may be reliable so far as they reproduce similar results in similar situations but their validity remains suspect. Accuracy may be improved by random sampling, follow up interviews and cross checking with other data sources, but these all add to the costs of collection. Questionnaires rely heavily on the goodwill of the respondents and involve a significant investment of their time. Therefore, "if it is accurate and current, data that is available from other sources should be obtained from these sources and should not be sought from faculty members" (NCHEMS at WICHE 1971 op cit p 45)

Given an assumption that the teaching efforts of an institution are directly related to its teaching timetable, a timetable analysis such as that described above offers an alternative and, wherever joint meetings and service teaching are a significant feature, maybe a more accurate method of assigning staff costs to courses and to students than an allocation on the basis of questionnaires or a multi regression approach such as that employed by Layard and Verry (1975) It might be argued that some part of the cost relates directly with enrolments - student recruitment for example. The following formula is flexible enough to accommodate these sorts of subjective decisions: Specifically, if we denote:

enrolment to a course by E;

enrolment to all the courses based in a department by E_D;

departmental cost by C;

allocated meetings (ie assigned 'class contact') from a department to a course by M;

allocated meetings from a department to all courses by M_T;

the proportion of departmental cost allocated to a department's students on the basis of enrolments by α;

the proportion of cost allocated on the basis of allocated meetings by β ;

(Hence $1 - (\alpha + \beta)$ = the proportion of cost assigned to research and other activities not associated with the teaching functions)

then for a course the cost is given by:

$$\alpha\left(\frac{E}{E_D} \cdot C\right) + \beta\left(\frac{M}{M_T} \cdot C\right) + \left[\sum_{\substack{\text{other} \\ \text{depart-} \\ \text{ments}}} \beta'\left(\frac{M'}{M_T} \cdot C'\right)\right]$$

and if β is the same for all departments by:

$$\alpha\left(\frac{E}{E_D} \cdot C\right) + \beta\left[\sum_i \frac{M_i}{M_{Ti}} \cdot C_i\right]$$

for i departments

and unit cost by:

$$\alpha\left(\frac{E}{E_D} \cdot C\right) + \beta\left[\sum_i \frac{M_i}{M_{Ti}} \cdot C_i\right]\left[\frac{1}{E}\right]$$

Exhibit 4.2 illustrates the cost allocation in the case where $\alpha = 0$; $\beta = 1$ and β is the same for all departments

Unit Costs at Lanchester and Loughborough 1972/73

Table 4.8 collects the 'direct' inputs - academic staff, departmentatl administrative staff, technician staff and expenditures on teaching materials, the maintenance and hire of teaching equipment and the cost of short courses and field work. The amounts identified are total institutional inputs under these heads. The question of how these expenditures might be apportioned to the undergraduate courses and to postgraduate work and to research was discussed above.

TABLE 4.8

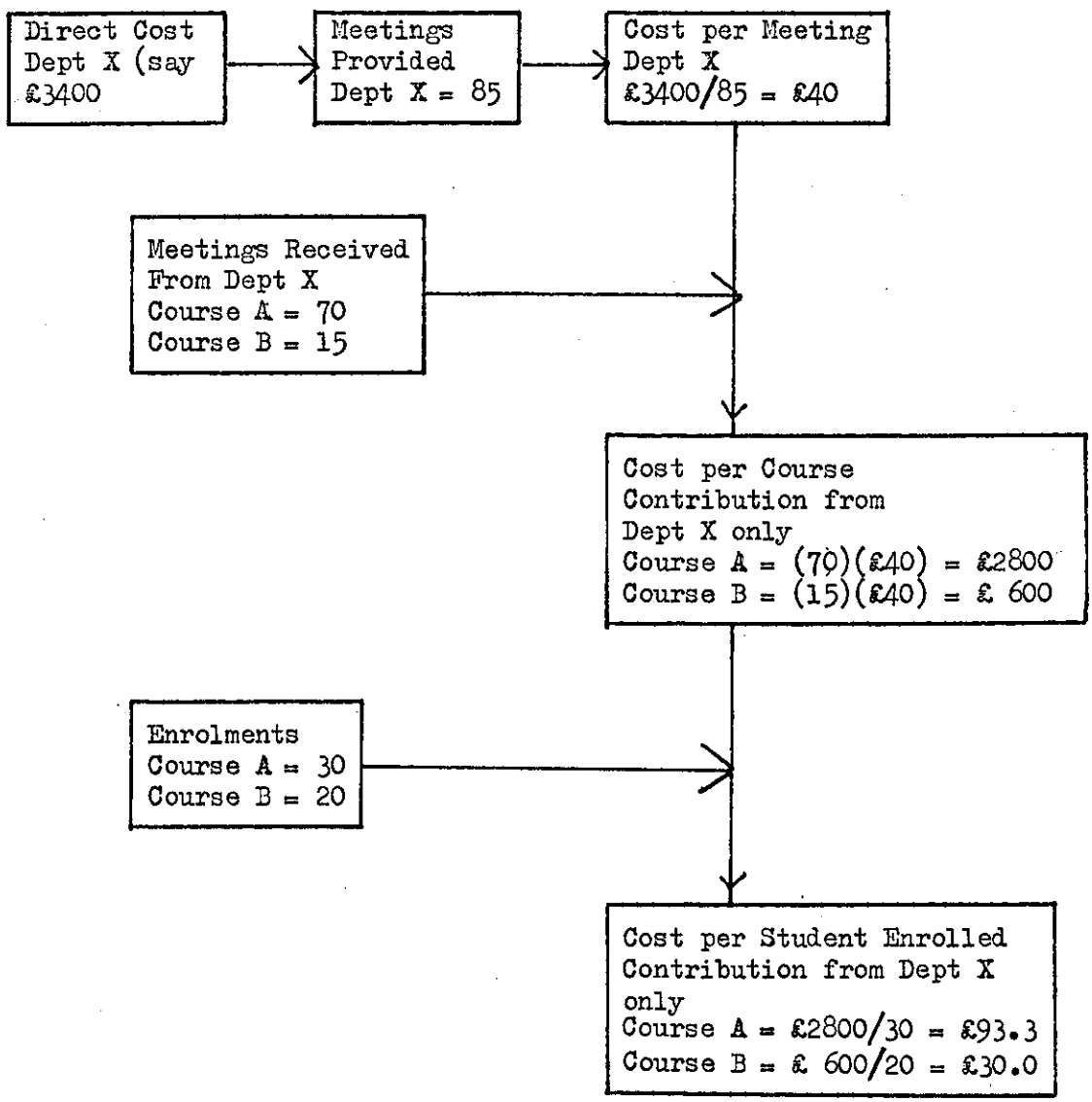
Expenditure £'000s 1972/73

	Lanchester	Loughborough
Academic Staff	1 830	1 284
Administrative Staff	60	120
Technician Staff	294	323
Recurrent Expenditures	170	154
	2 354	1 881

EXHIBIT 4.2

	Department		X		
	Subject Elements	L	M	N	
	Groups Formed (g)	2	1	1	
	Contact Hours (h)	20	15	30	
Course	Enrolment (E)	Enrolment to Subjects (S)			
A	30	30	20	30	
B	20		5	20	
(E*)	Enrolment from All Courses	30	25	50	
	Meetings Provided (g)(h)	40	15	30	Total = 85
	Meetings Received (g)(h)(S/E*)				
	Course A	40	12	18	Total = 70
	Course B		3	12	

THE LOGIC OF A DEPARTMENT COST ALLOCATION ON A MEETINGS BASIS



Notes: to Table 4.8:

(i) The costs for tull time staff were established by reference to salary scale mid points in 1972/73 plus employers' contribution (10% Loughborough, 6% Lanchester) plus employers' social security on the assumption of 'all male contracted out' ie £1.31 per person per week

(ii) The costs for 'part time' staff are actual.

(iii) Full time research workers financed by research grants and contracts were excluded.

(iv) In the case of Lanchester the Dean's salaries were apportioned equally between the departments for which they were responsible.

The expenditure identified in Table 4.8 were allocated firstly on the basis of enrolments (ie where $\alpha = 1$; $\beta = 0$) and secondly, on the basis of allocated meetings (ie where $\alpha = 0$; $\beta = 1$). In the latter case β was assumed to be the same for all departments. Details of the total enrolments and allocated meetings in 1972/73 are given in Table 4.9

TABLE 4.9

Total Enrolments and Allocated Meetings 1972/73

	Lanchester		Loughborough	
	Enrolments	Meetings	Enrolments	Meetings
Undergraduates	2 599	137 731	2 660	65 862
Postgraduates	35	1 963	574	52 697
Short Courses	996	1 256	1 238	14 611
'Other'	2 150	63 581	-	-
Total	5 780	204 531	4 472	133 170

Notes to Table 4.9

Notes: In calculating the allocated meetings:

(i) for sandwich undergraduates, 10 hours per student has been allowed for industrial training supervision; and

(ii) for postgraduate research students, personal supervision on a one to one basis has been provided for as follows -

150 hours per annum for full time students
75 hours per annum for part time students

The enquiry into the use of academic staff time commissioned by the Committee of Vice Chancellors and Principals (CVCP 1971) produced inter alia the following information:

"Staff paid wholly or partly from general university funds: proportion of total working time:

	Loughborough	All Universities
Undergraduate time	36%	37%
Graduate course work time	8	5
Graduate research time	7	6
Personal research time	19	24
Unallocatable internal time	18	18
External professional time	12	11
	100	100

The information was collected by means of diaries maintained by lecturers. This approach is subject to the same criticisms levelled at staff questionnaires (Faculty Activity Analysis NCHEMS) above. Nevertheless, on the basis of this evidence an assignment of 20% to 30% to non-teaching activities would appear conservative. On the other hand, it might be argued that the major objective of Higher Education in the United Kingdom is the transmission of knowledge and that

non-teaching activities are merely a 'gloss' or 'bonus'. Whatever assumption is made the resulting arithmetic amounts simply to an adjustment of the full cost assignments made below by the agreed proportion

TABLE 4.10

Cost per Undergraduate Student Enrolled 1972/73 £'s

	Enrolment Basis			
Year:	1	2	3	Average
Engineering				
Lanchester	442	480	520	476
Loughborough	362	367	375	375
Science				
Lanchester	527	596	571	575
Loughborough	510	495	466	489
Social and Business Studies				
Lanchester	349	337	324	328
Loughborough	501	455	496	489
All Undergraduates				
Lanchester	441	460	463	457
Loughborough	442	426	421	430

	Allocated Meeting Basis			
Year:	1	2	3	Average
Engineering				
Lanchester	851	1161	1405	930
Loughborough	330	448	380	411
Science				
Lanchester	555	966	1107	773
Loughborough	291	384	592	381
Social and Business Studies				
Lanchester	364	430	372	380
Loughborough	215	379	460	313
All Undergraduates				
Lanchester	572	797	887	667
Loughborough	310	438	451	399

Table 4.10 sets out the unit cost in 1972/1973 for each of the three years of the normal undergraduate programme analysed by discipline area. Table 4.11 provides details of the unit costs on an enrolment and allocated meeting basis for the other major teaching areas.

TABLE 4.11

Unit Costs for other than Undergraduate Programmes 1972/73 £'s

	Enrolment Basis	Allocated Meeting Basis
Postgraduates:		
Lanchester	808	1005
Loughborough	461	1147
'Short Courses'		
Lanchester	501	19
Loughborough	382	130
'Other' (ie art and sub-degree courses		
Lanchester	297	264
Loughborough	-	-

An allocation on the basis solely of enrolments (where a one day short course student is counted equally with a full time student) distorts the cost picture. Since each student involves documentation there may be a case for assigning a small proportion of the total direct inputs (or maybe a larger proportion of administrative cost) on the basis of enrolments. However, the author is of the opinion that an allocation on the basis of allocated meetings

(ie staff class contact) better reflects an institution's commitment to its teaching functions: the allocated meetings are indicative of the 'weights' the institution is implicitly assigning to its courses.

When comparing average costs across institutions some adjustment for the discipline mix should be made. Engineering and science were the most expensive disciplines in both institutions. Engineering and science students accounted for about 75% of the total undergraduate enrolment at Loughborough compared with about 55% at Lanchester. Consequently, if a discipline mix adjustment had been attempted, the apparent cost advantage of Loughborough would have been enhanced. Whichever method of cost allocation is used - enrolments or meetings - the difference in costs between the major disciplines was smaller at Loughborough. This is explained by the high incidence of joint meetings across disciplines. Predictably the average undergraduate unit costs increase as the years of study proceed: at Lanchester from £572 to £887 and at Loughborough from £310 to £451 on an allocated meetings basis. Thus in both institutions the final year student costs about half as much again as the 'fresher'. This result reflects the fact that although in both institutions the finalist student had a lower tuition load, this was outweighed by much reduced class sizes and, in the case of Loughborough, fewer joint meetings.

TABLE 4.12

Components of Undergraduate Unit Cost 1972/73

	Lanchester		Loughborough	
Enrolment Basis	£	%	£	%
Academic Staff	362	79	298	69
Administrative Staff	11	2	28	7
Technician Staff	51	11	70	16
Recurrent Expenditure	33	7	34	8
	457	100	430	100
Allocated Meetings Basis				
Academic Staff	519	78	273	68
Administrative Staff	16	2	26	7
Technician Staff	85	13	67	17
Recurrent Expenditure	47	7	33	8
	667	100	399	100

The components of the average undergraduate unit cost are given in Table 4.12. The technician and recurrent components were roughly equivalent. Loughborough enjoyed an advantage in the provision of administrative support but this only accounted for a small proportion of the total cost. The major difference between the two institutions was in academic staff input which was higher at Lanchester irrespective of the method of allocation. Table 4.12 permits a calculation of the unit cost on the basis of academic staff assigned on the basis of allocated meetings and technician, administrative staff and recurrent expenditures assigned on the basis of enrolments - ie Lanchester £614 and Loughborough £405.

Tables 4.13 and 4.14 provide details of the cost per 'successful' student and of a 'graduate' in each of the comparable broad discipline areas and overall.

Given the slightly higher failure rate at Lanchester the economic advantage of Loughborough is widened at this stage of costing. On the other hand, the Lanchester student started from a lower base (A-level score) on average and, therefore, the 'learning' gain at Lanchester may be higher.

TABLE 4.13

Cost per Successful* Undergraduate 1972/73 £'s

	Enrolment Basis		
Year:	1	2	3
Engineering			
Lanchester	648	567	530
Loughborough	410	415	395
Science			
Lanchester	830	699	605
Loughborough	614	557	493
Social and Business Studies			
Lanchester	429	359	332
Loughborough	563	512	504
All Undergraduates			
Lanchester	611	517	477
Loughborough	533	482	441

	Allocated Meetings Basis		
Year:	1	2	3
Engineering			
Lanchester	1246	1372	1432
Loughborough	374	507	401
Science			
Lanchester	873	1133	1173
Loughborough	350	431	627
Social and Business Studies			
Lanchester	448	458	381
Loughborough	241	427	468
All Undergraduates			
Lanchester	792	896	914
Loughborough	374	496	472

* 'Successful' = the students who successfully sat the examinations in that year

TABLE 4.14

Cost per Graduate 1972/73 £'s

	Enrolment Basis	Allocated Meeting Basis
Engineering		
Lanchester	2114	4667
Loughborough	1435	1445
Science		
Lanchester	2682	3989
Loughborough	1621	1513
Social and Business Studies		
Lanchester	1287	1306
Loughborough	1809	1201

Summary and Conclusions

The major purpose of the Lanchester/Loughborough study was to examine the potential for performance indicators for the teaching activities in higher education in the United Kingdom. Performance can be assessed in terms of 'effectiveness' and 'efficiency'. Effectiveness is concerned with the degree of success in achieving objectives and targets: efficiency is concerned with the relationship between a system's inputs and the corresponding outputs. An institution may be effective insofar as it has achieved its objectives yet inefficient in resource use in the strategy and tactics it has deployed. In assessing performance 'standards' are required. Two natural bases for standards are available to an institution - its own performance over time or comparison with similar

institutions at particular moments in time. Inter-institutional comparisons require careful data element definition and are the most difficult to achieve.

Postulating institutional objectives concerned with minimising attrition rates and optimising students' employability subject to maintaining academic standards, the Lanchester/Loughborough project has explored 'effectiveness' in terms of society's immediate response to the institution's provision of learning opportunities and 'efficiency' in terms of unit costs The boundaries of the problem have been narrowed by simplifying assumptions about institutional objectives, by ignoring a number of input and process variables and by concentrating on the more easily quantified outcomes.

Using data for the undergraduate programmes at Lanchester and Loughborough for the academic years 1972/o973 some significant differences in response in terms of pre-entry scores (A-level grades) and first year failure rates were isolated. However, at a discipline level of aggregation, outcomes defined as examination marks or second and third year pass rates or first salary levels proved to be very similar across the two institutions. A detailed timetable analysis revealed a number of differences in the formal (ie timetabled) learning/teaching environments. Larger classes, lower tuition loads and a much greater incidence of joint meetings were consistently observed at Loughborough. The economic implications of this

strategy were examined by calculating unit costs which proved to be much lower at Loughborough. The question of what is the cost of a student does not admit of one answer -

> "If cost accounting sets out determined to discover what the cost of everything is and convinved in advance that there is one figure to be found ... which will furnish exactly the information desired for every possible purpose, it will necessarily fail, because there is no such figure."
>
> J M Clark (1923)

Hence it is prudent to summarise the context in which the unit costs in this exercise were derived. Firstly, the costs allocated were those for the faculty and their administrative, technician and 'materials' support - the problems of measuring and assigning capital expenditure and of identifying opportunity costs were thereby avoided. Secondly, it was assumed that polytechnics and universities are solely concerned with teaching. Finally, it was assumed that the timetable reflects the direction and intensity of an institution's teaching efforts and is a fair basis for the allocation of expenditures to courses and thence to students. An accurate identification of outcomes would involve the measurement of the cultural, social, educational and economic value added to the students by the institution between their entry and exit. This is not a practical possibility now nor in the foreseeable future. Concequently we shall continue to rely on the existing examining arrangements and the comparability of degree standards across

institutions. In these circumstances, improvements in unit costs may prove to be misleading: more students may pass through the system at the same or with a less than proportionate increase in costs but the value added to the extra students may be outweighed by the decline in value added to the existing students.

Table 4.14(A) summarises the means of the response, and resource utilisation parameters for the courses examined. Apart from the differences and similarities noted above, Loughborough is characterised by lower enrolments per course, wider dispersions in examination marks and a higher percentage of married students.

The relationships between average exit marks for each course and the relevant unit costs (calculated on a meetings basis) timetable parameters and student characteristics are summarised in Table 4.15. A proxy for student 'quality' - entry marks (ie A-level for first year students and previous examination marks for second and third year students) were the most strongly correlated 'explaining' about one third of the variation in exit marks. This result is in agreement with that found by Entwistle and Percy (1974 op cit). The consistency of the correlation coefficients for class sizes (negative) classes 'saved' by joint meetings (negative) and unit costs (positive) lends some support to the argument that the economic advantages of large classes and joint meetings may be matched by some educational disadvantages. There is also some evidence that married students and students qualifying

TABLE 4.14(A)

Summary of Lanchester (LAN) and Loughborough (LOU) Course Parameters 1972/73

"Response"	All Disciplines			Engineering		Science		Social and Business Studies	
	BOTH	LAN	LOU	LAN	LOU	LAN	LOU	LAN	LOU
Average A-Level Score (+)	2.51	2.06	2.80	1.91	2.87	1.82	2.79	2.38	2.64
Average Percentage without A-Level	20	27	15	42	22	25	5	12	16
Average Enrolment per Course	20	25	17	18	21	19	14	43	12
Average Pass Rate Percentage	87	86	88	85	87	85	87	90	89
Average Fail Rate Percentage	10	11	9	14	10	12	9	8	6
Average Dropout Rate Percentage	3	3	3	1	2	3	4	2	5
Examination Mark: Average	55	56	54	58	55	56	53	53	54
Examination Mark: Coefficient of Variation	15	14	16	14	17	16	18	13	12
Average Percentage Female	15	15	15	1	2	15	19	30	23
Average Percentage Married	3	1	4	0	4	0	1	2	8
Average Percentage Overseas	7	7	6	9	10	8	4	4	5
Resource Utilisation									
Average Student's Tuition Load (Hours)	584	671	529	773	561	764	561	425	448
Student's Average Group Size	33	18	43	13	49	12	37	30	41
Standard Deviation of Student's Group Size	24	9	34	6	41	5	29	24	28
Average Percentage Meetings "Saved"	37	3	59	0	57	0	59	9	71
Average Percentage Meetings "Serviced"	31	28	32	24	30	36	21	29	46
Average Direct Cost per Student Enrolled Allocated on a Meetings Basis £	635	939	441	1126	411	1150	486	445	399

(+) 'A' = 5; 'B' = 4; 'C' = 3; 'D' = 2; 'E' = 1

TABLE 4.15

Some Correlations with Average Exit Marks Per Course 1972/73

	All Disciplines			Engineering		Science		Social and Business Studies	
	Both	Lan	Lou	Lan	Lou	Lan	Lou	Lan	Lou
Timetable Parameters									
Students' Tuition Load	15*	12	5	-22	-24	-22	39*	-10	22
Students' Average Class Size	-23*	-32*	-11	-47*	- 6	-26	-15	5	-32
Standard Deviation of Students' Class Size	-20*	-26*	- 7	-40*	- 9	-19	- 8	3	-19
Percentage Meetings 'Saved'	-32*	-33*	-31*	-11	-36*	0	-22	-63*	-39*
Percentage Meetings 'Serviced'	-20*	-37*	- 9	-47*	-38*	-40*	- 2	-16	- 8
Cost per Student Enrolled calculated on an Allocated Meetings Basis	33*	37*	19*	38*	20	32	13	-40	36
Student Characteristics									
Average Entry Mark	57*	63*	51*	59*	52*	63*	59*	68*	17
Percentage 'Without A-level'	25*	34*	10	26	8	17	0	7	26
Percentage 'Female'	-03	-22*	8	-19	-15	-17	40*	21	-19
Percentage 'Married'	16*	10	25*	0	27*	21	28*	53*	38
Percentage 'Overseas'	3	22*	- 7	6	- 7	43*	- 8	-26	-30

* = Significant at 95% level - two tailed test

Note: (i) All the correlations have been multiplied by 100
(ii) Lan = Lanchester Lou = Loughborough

Course - See Text

for higher education by routes other than A-level perform better. There is also some indication that courses receiving a high proportion (relatively) of their tuition from 'service' departments do less well than those courses which receive more of their class contact within their 'home' departments.

If it is accepted that institutions of higher education have functions other than teaching then consideration has to be given to the trade-offs between teaching and these other roles. Pedagogical innovation may improve the effectiveness and the efficiency of the teaching function but prove to be detrimental to research and, hence, to overall effectiveness and efficiency. Various measures of research output have been suggested but peer evaluation seems to find most support and, therefore, assessment may be only possible in a qualitative manner. Today's practical solution seems to be to measure research output by counting the inputs. If the mix of teaching to non teaching activities is roughly equivalent across institutions then student cost comparisons such as those outlined above provide a reasonable guide to relative efficiencies. If the involvement in non teaching varies significantly from institution to institution, consideration has to be given to unscrambling the joint costs and products. The probability is that decisions in this area will continue to require the exercise of subjective judgement and it is a moot point whether the

benefits from having more sophisticated data available would justify the costs of obtaining this information.

Measurement in education is immensely difficult. Precise quantification may be impossible in some parts of the system. However, the immediate task is not so much to obtain an overall, technically perfect efficiency measure permitting valid inter-institutional comparisons, but to produce a range of indicators monitoring significant changes in direction and pace which would assist management within an institution. Regular reports at the course level on response and resource utilisation patterns would facilitate 'management by exception' and establish a data base and prompt the research from which a greater understanding of the educational process might be achieved. There were examples in both institutions of 'rogue elephant' courses with outcomes and class contact patterns significantly different from the norms for their institution and for their discipline. Had these divergences been systematically monitored they would have prompted 'discerning questions'. The qnswers might have helped the decision takers to isolate and to support the genuine cases of development and diversity. However, a large part of education can only be assessed qualitatively and there is considerable scope for the exercise of subjective judgements. Given the present state of ignorance about the nature of educational processes it is to be hoped that whatever 'standardising tendencies' emerge through the increasing

role of central planning authorities and agencies (Trow 1974) these judgements will continue to be exercised.

NOTES

1. Parts of this chapter have been published elsewhere: see -

   Birch D W Calvert J R Sizer J "A Study of some Performance Indicators in Higher Education with Particular Reference to Lanchester Polytechnic and Loughborough University" A research report presented to the Third General Conference of Member Institutions of the Centre for Educational Research and Innovation OECD September 1976

   Birch D W Calvert J R "A Comparative Study of Some Performance Indicators in Higher Education" Education Administration Vol 5 No 2 Spring 1977

2. Substantial parts of this section have been published elsewhere: see -

   Birch D W Calvert J R "A Review of Academic Staffing Formulae" Educational Administration Bulletin Vol 3 No 1 1974

   Birch D W Calvert J R "Academic Staffing Schemes Reconsidered - A Comment" Educational Administration Bulletin Vol 3 No 2 1975

   Birch D W Calvert J R Davies J L "Academic Staffing Formulae: with Particular Reference to Advanced Further Education" in Resource Planning in the Polytechnics NELPRESS 1975

3. The null hypothesis that (i) the total number of teaching hours provided for first degree students does not vary according to subject field and (ii) that part of the total teaching scheduled as lectures for first degree students does not depend on subject field were both rejected at the $p = 0.01$ level. See p 45 and p 46 "Subject Field and Regional Variations in Student Staff Ratios Academic Programmes and Recurrent Expenditure Fredriksen B CERI IMHE OECD Paris 1971

4. A_1 and A_2 work was defined by the Burnham Report as first degree or first degree equivalent or above.

5. See Delany V J "Cost Efficiency Indicators in Further Education Association of Colleges of Further and Higher Education: (1971) and "Assessment of Curricular Activity and Utilisation of Staff Resources in Polytechnics and FE Colleges Councils and Education Press 1972 and Memorandum from the Pooling Committee on "Staff/Student Ratios for Advance Level Work in Polytechnics and Colleges of Further Education" distributed by the Association of Education Committees in August 1972 identifying the following student staff 'norms':

5 con'd "Laboratory Based Subjects 7.5 - 8.5
Classroom Based Subjects 9.2 - 10.2"

6. See Page 129

7. Parts of this section have been published elsewhere: see -

Birch D W Calvert J R "A Comparative Timetable Analysis for Undergraduate Programmes in a Polytechnic and a University" Higher Education Review Summer 1977

8. Parts of this section have been published elsewhere: see -

Birch D W "Comparative Undergraduate Unit Cost in a University and a Polytechnic" Coombe Lodge Reports 9,5 1977

Birch D W Calvert J R Sizer J A Note on Costing the Teaching Activity in Higher Education" Higher Education 7 (1977)

Note 6

Consider the jth year of a course i ["course-year" (i,j)] which attends a set of meetings k in a subject element as part of its timetable. Then:

Enrolment to course-year (i,j) is E_{ij}

Enrolment from course-year (i,j) to this set of meetings k is S_{ijk}

Total enrolment from all course-years to this set of meetings k is E^*_k

$$= \sum_{ij} S_{ijk}$$

If this set of meetings is split up into groups, the number of groups each assigned to <u>one</u> teacher is g_k

and

The hours per annum attended by a student involved in this set of meetings is h_k

Thus, <u>for a course-year (i,j)</u>

1 STUDENTS' TUITION LOAD = Hours of timetabled contact with faculty that the student on average received $= \sum_k \left[(h_k)(S_{ijk}) \right] / E_{ij}$

2 CLASS HOURS timetabled for a course $= \sum_k \left[(h_k)(g_k) \right] = a$

3 Summed over a department or discipline area or for the institution the statistic "Meetings" counts joint meetings (ie meetings involving two or more courses) several times. Therefore, when several courses attend the same subset of meetings the timetabled hours may be allocated pro rata to the number of students attending from a course, ie

ALLOCATED CLASS HOURS $= \sum_k \left[(h_k)(g_k)(S_{ijk}/E^*_k) \right] = b$

4 Hence CLASS HOURS "SAVED" $= a - b$

5 STUDENTS' AVERAGE GROUP SIZE = Average Class Size that the student typically experienced

$$\frac{\sum_k \left[E^*_k/g_k \right] \left[\frac{(h_k)(S_{ijk})}{E_{ij}\ 100} \right]}{\sum_k \left[\frac{(h_k)(S_{ijk})}{E_{ij}} \right]}$$

INSTITUTION'S AVERAGE GROUP SIZE = Average Class Size provided by the Institution

$$\frac{\sum\sum\sum_{ijk} \left[E^*_k/g_k \right] \left[(h_k)(g_k)(S_{ijk}/E^*_k) \right]}{\sum\sum\sum_{ijk} \left[(h_k)(g_k)(S_{ijk}/E^*_k) \right]}$$

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CHAPTER 5

DEVELOPING AND TESTING

A MANAGEMENT INFORMATION SYSTEM

FOR COLLEGES OF FURTHER EDUCATION

> "An ideal data system for a (college) would contain, in accessible form, all the raw facts necessary to supply the pertinent information - no more and no less - to a decision maker having a valid need for it. The system would draw these facts from all the scattered sources and combine them in just the right way. It would translate the information into terms convenient to the decision maker. It would deliver the information instantly, and it would operate at zero cost! Such a data system is not of this world, and this chapter is thus concerned with the burdens and hazards of arriving at tolerable compromises."
>
> Balderston F E (1974)

Preamble

The question of whether it would be possible to develop a management information system of general application to Further Education in England and Wales was first raised at "Conference 75/50 for College Finance Officers" held at the Further Education Staff College, Coombe Lodge by one of Her Majesty's Inspectors. The other conference members thought that the Lanchester-Loughborough data collection might prove to be a suitable base for development. Subsequent discussion with the staff of the Further Education Staff College and with Principals and Staff from individual colleges agreed the following objectives for the exercise:

1. To be concerned with recording (with a view to subsequently developing a prediction model) the major resource (ie teacher) usage patterns;
2. To facilitate institutional planning and control from 'course' level upwards;

3. To be compatible with LEA and DES data requirements;
4. To be capable of enhancement to an integrated system; and
5. To be amenable to 'hand' as well as computer manipulation (so far as possible).

A Conceptual Framework

Without information management is likely to be a series of reactive gambles. On the other hand, information-overload may induce paralysis in an otherwise normal human being. The borderline between too much and too little is finely drawn and a conclusion that the information system should concentrate on the important merely raises the questions of What? and To Whom? Answers will be subjective.

There are at least two schools of thought on how to conceptualise the teaching outcomes of a college: firstly, the changes in students' characteristics associated with various institutional input and process variables; and, secondly, the characteristics of the instruction made available by a college. The changes wrought in students' skills, knowledge, attitudes and values reflect their learning functions and are only indirectly related to the institution's production function. The outcomes attributable to a college (and the college only) are the magnitude, quality and duration of the instruction patterns made available. This amounts to the student 'places' made available on an organised curriculum. Usually data on total theoretical places is not verifiable - we merely observe the intersection of institutional supply and student

demand. Below it is assumed that this actual 'take-up' of places (ie enrolments) is an adequate proxy for the magnitude of instructional services made available. It is also assumed that the relative quality of instruction offered by colleges, or within colleges by departments, is comparable. This is not to say that an equal quality student attends each college or department or that each college or department deploys teachers of equal quality but the author knows of no absolute measures of quality in this context (Note 1).

Therefore, in sum, objectives in education are usually vague, outcomes to be optimised are diverse decision making is diffused and the technology uncertain, However, in the rest of this chapter the following simplified scenario is assumed:

- Teaching staff and other teaching resources are recruited to <u>departments</u> who are accountable for their deployment.
- Students enrol on <u>courses</u> which may be administered by one department (the 'home' department) but which normally receive tuition from a number of departments.
- It is the purpose of departments to provide places and instruction; it is the purpose of students to receive instruction and to learn. (The 'value-added' to students between their entry to and exit from the college is <u>primarily</u> a function of their individual learning efforts. Nevertheless 'response' patterns in the form of enrolments

pass and drop-out rates provide limited but important information on the effectiveness of the college.

The State of the Art

Interest in the development of management information systems (MIS) leading to institutional planning models in education is a comparatively recent phenomenon. Of the three major systems in general use today - CAMPUS, RRPM and HIS - only CAMPUS was operational before 1970.

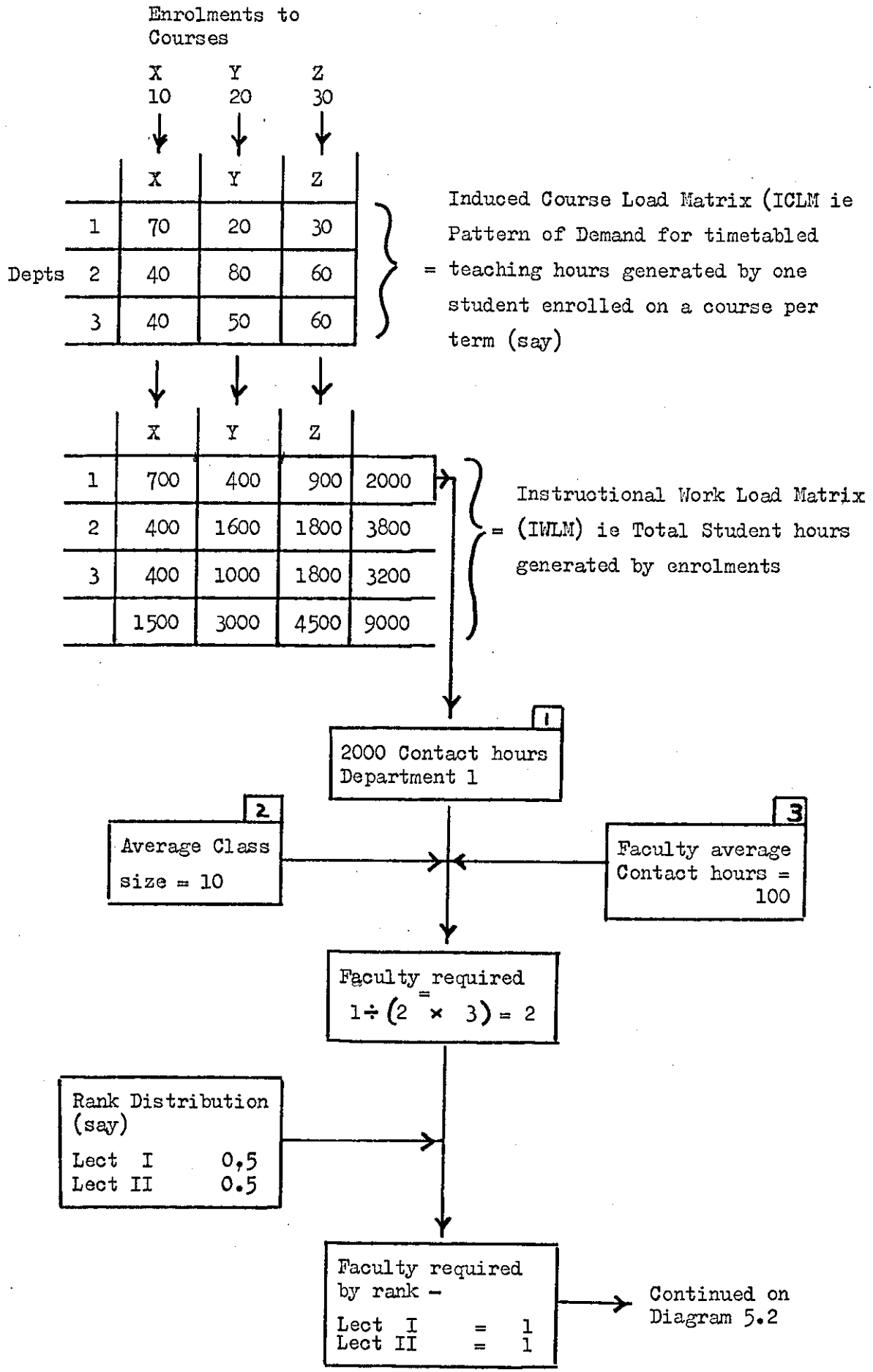
CAMPUS (Comprehensive Analytical Methods of Planning in University Systems) has its origins in the work done by Judy and Levine (1965) in simulation in higher education. The first operational version CAMPUS V involved a large investment in detailed data collection and was beyond the scope of most institutions. Nevertheless it was implemented in a small number of large and daring universities and demonstrated the feasibility of a comprehensive computer-based resource planning model. What was required, however, was a system which made fewer demands on data and equipment. To achieve this objective the USA Office of Education funded a proposal for model development by NCHEMS (National Center of Higher Education Management Systems) at WICHE (Western Interstate Commission for Higher Education) The result was RRPM (Resource Requirements Prediction Model) currently the most widely implemented information system in higher education. RRPM 1.3 was released in mid 1971 (Hussain and

Martin 1971) and a simpler version RRPM 1.6 in 1973 (Clark et al 1973) Meanwhile CAMPUS underwent changes making it modular, more flexible and less demanding in data and equipment requirements. The result - CAMPUS VII was implemented in Ontario Community Colleges. Development in Europe is probably best seen in the HIS (Hochschule Informations Systems) model (Dettweler and Frey 1972) HIS was founded in 1969 and financially supported by the Volkswagen Foundation to develop operational systems that would be applicable to all institutions of post school education in Germany.

The 'core' of RRPM is represented diagramatically in Diagram 5.1. CAMPUS and HIS start from a similar base. Predictably this core fastens on the actual and/or predicted timetable contract between faculty and students as the 'key' to the requirements for resources. Diagram 5.1 is a simplified version of the actual model. For example, in the original version the "Induced Course Load Matrix" and the "Induced Work Load Matrix" are drawn up in credit hours (Note 2) which are subsequently converted to contact hours by an appropriate conversion factor. Nevertheless the diagram captures the essence of the logic. The major difference between RRPM, on the one hand, and CAMPUS and HIS on the other, lies in the amount of detail produced at the instructional loading stages. In CAMPUS and HIS the load induced is in terms of specific courses and activities whereas RRPM is at a higher level of aggregation in terms of student 'majors' at

DIAGRAM 5.1

Basic Logic for CAMPUS, HIS, RRPM



different levels - undergraduate lower and upper divisions and postgraduate. Further, the planning variables, such as class sizes, are more detailed in CAMPUS which allows for maximum and minimum as well as average sizes.

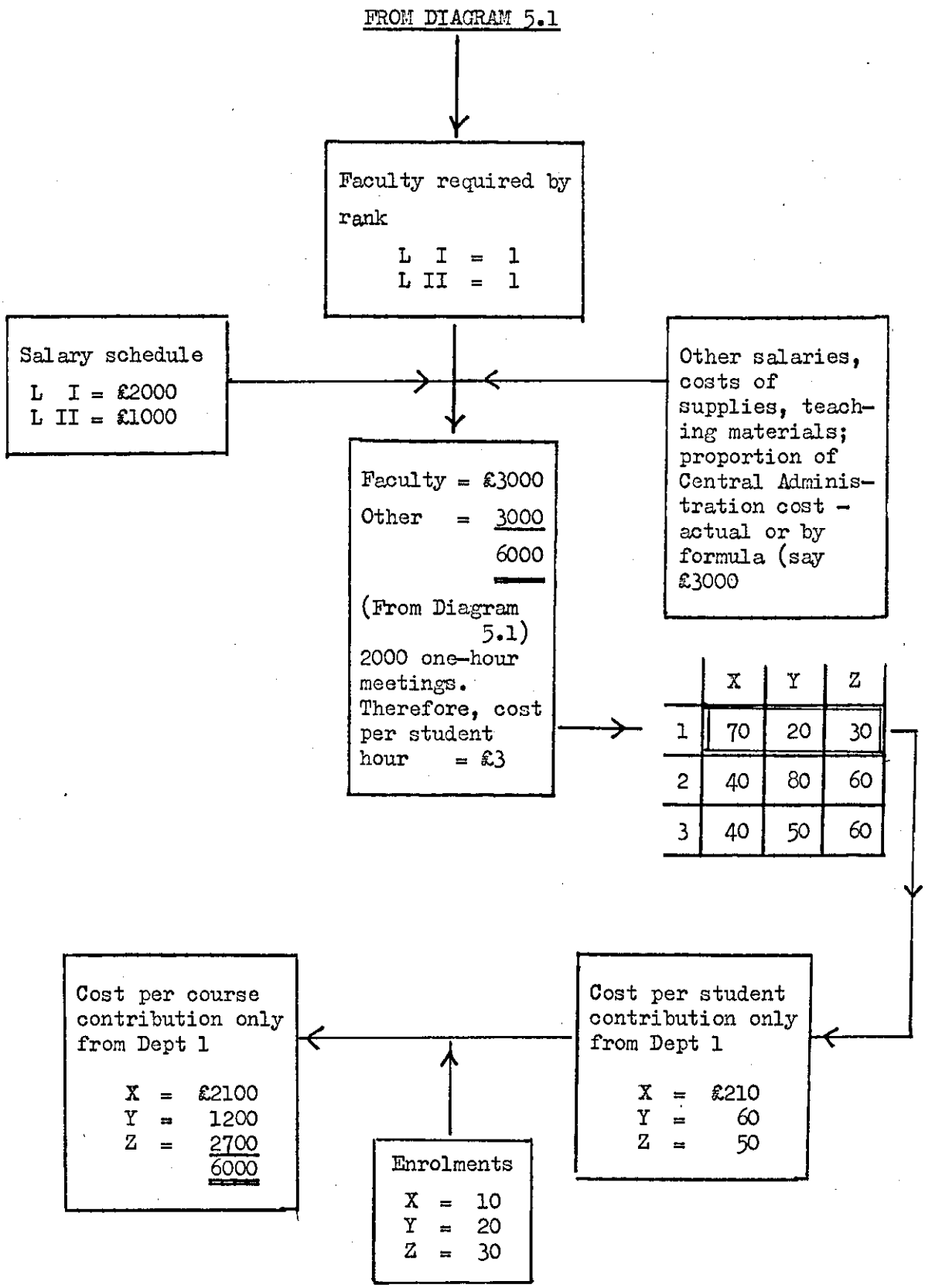
The determination of the requirement for academic staff in Diagram 5.1 closely reflects the arguments in Delany (1971), Legg (1971, Bottomley et al (1971), and Simpson et al (1971) and outlined above in Chapter 3.

Diagram 5.1 presents only one module in the RRPM system. Typically it is preceded by a student flow module and followed by modules calculating other resource requirements and producing costs. The basis of the costing module in RRPM is set out in Diagram 5.2 The student flow module in CAMPUS determines the flow of students through the system by using pass-fail rates at each level, repeat rates at the same level, drop-out rates at all levels and transfer rates between courses. This is conceptually similar to the student flow module developed by NCHEMS to interface with RRPM. Both student flow modules still have problems concerned with the calculation, aggregation and stability of the transitional probabilities and the validity of the underlying assumptions. Both CAMPUS and HIS calculate space requirements by size and type and CAMPUS also computes and analyses revenues from fees and funding agencies. All three systems can answer 'what-if' questions of the following types:

- What if the current staffing ratio of support personnel was increased or decreased by x%?

DIAGRAM 5.2

The Basis of the Costing Module for RRPM



- What if a change is made in the faculty rank mix?
- What if there was an x% rise in salaries?
- What if a new programme of studies is added or dropped?
- What if a change is made in instructional strategies eg class sizes, contact hours, etc.?
- What if a change in the mix of students - disciplines or level - is made?

The answers produced are concerned solely with the resource implications of the changes in staffing, curriculum and admissions policies.

In summary, HIS and CAMPUS are the more detailed in input requirements and in outputs produced. Therefore, they are more suitable for decision-making at the departmental and course level. The price of such a capability is a larger computer core requirement and higher development and operating costs. HIS is confined to teaching personnel and teaching space resources and, unlike RRPM and CAMPUS, does not cover non-academic personnel, costs and budgets. All three systems are simulation and not optimising models, have mostly linear equations for calculating their non-salary costs (where this is done) and hence ignore discontinuities, they do not predict new entrants to the institution nor do they relate enrolments to manpower requirements, they are all (apart from the probability matrix used in the student flow module) deterministic models.

Components of a College Information System

Diagram 5.3 illustrates the major components of a college information system for the teaching function. Given a student flow model box (2) a course file (6) and planning parameters (10), a projection of contact hours (11) resources required (12) and operating and capital budgets (13) can be produced. Comparisons of (12) with (7), (8) and (9) identifies the extent and location of short falls and excess capacity, This part of the system is concerned with the planning function. In the absence of an accurate specification of cause and effect in education the planning parameters of box (10) will be historical, subjective and arbitrary. Therefore, the model should allow the decision takers to test the sensitivity of the system to variations in these parameters.

Boxes (3), (14), (15) and (16) monitor actual resource utilisation patterns whilst box (4) collects data on actual student performance. Boxes (5) and (17) compare actual with planned performance and produce reports and indices. This part of the process is concerned with the control function.

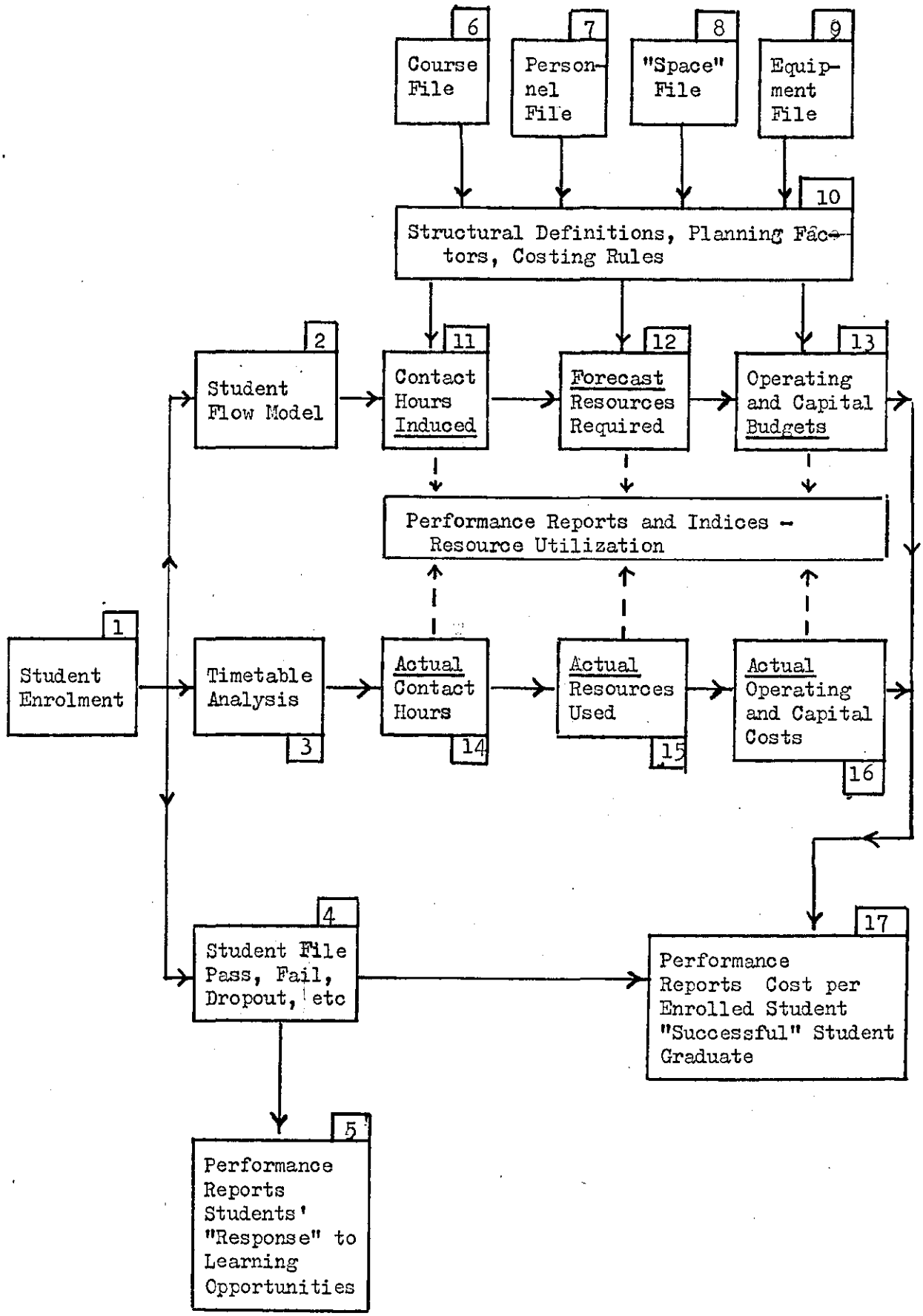
The collection of data on existing resource patterns is the first step in the development of a system leading on to a planning model. Below a mechanism to achieve this first step is developed and tested.

A First Stage Solution

Currently in the majority of Further Education Colleges in the United Kingdom students enrol on courses

DIAGRAM 5.3

Components of a College Management Information System



and teachers are recruited to, and are organised in, departments. Usually for administrative purposes, a course is located in a particular department (the 'home' department) but may receive tuition from other departments ('service' departments). In the main instruction is received in timetabled meetings between students and teachers. Following a course involves inter alia receiving instruction in a number of subject elements, and for each subject element, attending a set of meetings. Some of these meetings may be optional, some may be compulsory: attendance at some will be confined to one course whereas courses may be combined in other meetings. Consequently (and recapping on the Lanchester-Loughborough study) to analyse a set of meetings the following information is required:

- The total enrolment to a course ..... E
  and for each subset of meetings in each subject element of the course:
- The enrolment from a course ..... S
- The enrolment from <u>all</u> courses attending ..... E*
- The department providing the instruction.
- The number of groups formed each assigned to <u>one</u> teacher ..... g
- The hours per week attended by a student ..... h
- The number of weeks per term or per annum attended by a student ..... w

Consider the 'Blagda College' with three courses X, Y and Z with enrolments of 10, 20 and 30 respectively. The college has three departments - mathematics, social

science and science. Course X is administered by the mathematics department, Y by the social science department and Z by the science department. A summary of the weekly teaching pattern is provided in Exhibit 5.1. Students enrolled on course X, for example, attend classes for 15 hours per week in four subject elements - mathematics A, mathematics B, social science A and Science A. For mathematics A and science A, students from course X only attend but students from all three courses attend mathematics B, and X and Y are combined for social science A. Mathematics A and social science A are split into two groups for instruction, mathematics B is taught in four parallel classes but only one group is formed in science A.

Exhibit 5.2 summarises the timetable parameters E, E*, S, g, h and w (for a ten week term) for the Blagda College.

EXHIBIT 5.1

BLAGDA COLLEGE SUMMARY OF WEEKLY TEACHING PATTERN

Department/ Subject	Code	Courses X	Y	Z	Details of combined courses and/or split group workings
		Hours per week			
MATHS DEPARTMENT					
Maths A	1.1	5	-	-	Split into two groups
Maths B	1.2	2	2	2	XYZ combined and split into four groups
Maths C	1.3	-	-	1	Split into two groups
		7	2	3	
SOCIAL SCIENCE DEPARTMENT					
Social Science A	2.1	4	4	-	XY combined and split into two groups
Social Science B	2.2	-	4	-	One group
Social Science C	2.3	-	-	6	One group
		4	8	6	
SCIENCE DEPARTMENT					
Science A	3.1	4	-	-	One group
Science B	3.2	-	5	5	YZ combined and split into three groups
Science C	3.3	-	-	1	One group
		4	5	6	
TOTAL HOURS		15	15	15	

Exhibit 5.2

SUMMARY OF TIMETABLE PARAMETERS

	Matrix of Enrolments from Courses [S]								
DEPARTMENTS	Maths			Social Science			Science		
SUBJECT ELEMENTS	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3
Enrolments to Courses Course [E] X → 10 → Y → 20 → Z → 30 →	10	10 20 30	30	10 20	20	30	10	20 30	30
Enrolment from all Courses [E*]	10	50	30	30	20	30	10	50	30
Number of Groups formed [g]	2	4	2	2	1	1	1	3	1
Students' Contact Hours [h]	5	2	1	4	4	6	4	5	1
Number of Weeks [w]	10	10	10	10	10	10	10	10	10

At the base of the system are two documents

- the 'Course File' to be completed for each course and
- the 'Workload Matrix' to be completed for each mode and grade for each 'home' department and aggregated for the institution

Each subject element is given a unique code. Information on the enrolment from a course to a subject element is provided by the course tutor to the department providing instruction in that subject element. In return he receives from the department information on the number of hours per week a student enrolled on this subject will attend (h), the number of weeks per term (or per annum) the subject element will meet (w), the number of groups formed (g) and the total enrolment from all courses attending the subject element (E*).

So far as data analysis is concerned the scheme supposes that course tutors are interested in the formal teaching environment of their students whilst the head of department is concerned with identifying his department's teaching load and thereby controlling his department's requirements for academic staff and space.

Accordingly the course file identifies for each course:

- The enrolment to the course
- The notional student contact hours .... $= \sum(S)(h)(w)$
- The student contact hours at a particular class size ..... $= \sum(S)(h)(w)(E^*/g)$

- The number of one-hour teacher contacts required if the course were taught entirely separately (the number of classes formed remaining unchanged

  ..... $= \Sigma (h)(w)(g)$

- The number of one hour teacher contacts ('allocated meetings') allocated to the course in the ratio S/E*

  ..... $= \Sigma (h)(w)(g)(S/E^*) \rightarrow \Sigma (S)(h)(w)/(E^*/g)$

(Subsequently in the testing of the 'system' at the Hertfordshire College of Building the above data was collected and analysed to show the above 'values' by type of accommodation used - classroom or laboratory/ workshop).

From the data it is possible to derive:

- The students' average tuition load (average s tudent hours 'ASH' in Delany notation Note 3)

  ..... $= \Sigma \left[(S)\ (h)\ (w)\right] \ /\ (E)$

- The students' average class size

  ..... $= \Sigma \left[(S)(h)(w)(E^*/g)\right] \ / \Sigma \left[(S)(h)(w)\right]$

- The degree of 'savings' achieved by combining courses for instruction in some sbject elements

  ... $= \left\{\Sigma \left[(h)(w)(g)\right] - \Sigma \left[(S)(h)(w)/(E^*/g)\right]\right\} / \Sigma \left[(h)(w)(g)\right]$

  (Subsequently this parameter was omitted from the list of 'values' reported as the Principal and staff at the Hertfordshire College of Building were agreed that it was not of any great significance)

In each case in the 'Course File', the summations are over all the relevant subject elements. Exhibit 5.3 illustrates the process for Course X at the Blagda College.

COURSE X

ENROLMENT 10

COURSE FILE

"BLAGDA COLLEGE"

"HOME" DEPARTMENT	MATHS
TERM	SPRING 1977
GRADE/LEVEL	V
MODE	FULL TIME

SUBJECT ELEMENT	CODE	TIMETABLE PARAMETERS						DEPARTMENTS PROVIDING INSTRUCTION															
								MATHS				SOCIAL SCIENCE				SCIENCE				ALL DEPARTMENTS			
		S	h	w	g	E*	E*/g	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
MATHS A	1·1	10	5	10	2	10	5	500	2500	100	100									500	2500	100	100.0
MATHS B	1·2	10	2	10	4	60	15	200	3000	80	13·3									200	3000	80	13·3
SOCIAL SCIENCE A	2·1	10	4	10	2	30	15					400	6000	80	26·7					400	6000	80	26·7
SCIENCE A	3·1	10	4	10	1	10	10									400	4000	40	40	400	4000	40	40.0
TRANSFERRED TO WORKLOAD MATRIX :								700	5500	180	113·3	400	6000	80	26·7	400	4000	40	40	1500	15500	300	180
																				[A]	[B]	[C]	[D]

S = ENROLMENT FROM THIS COURSE
h = CONTACT HOURS PER WEEK
W = NUMBER OF WEEKS
g = NUMBER OF GROUPS FORMED
E* = ENROLMENT FROM ALL COURSES

[1] = (S)(h)(w)
[2] = (S)(h)(w)(E*/g)
[3] = (h)(w)(g)
[4] = [(S)(h)(w)]/(E*/g)

TUITION LOAD [A]/ENROLMENT	150
STUDENTS' CLASS SIZE [B]/[A]	10.3
MEETINGS 'SAVED' ([C]-[D])/[C]	0.4

EXHIBIT 5.3

Working from the same data base the 'Workload Matrix' identifies for each department and for the institution:

- The 'allocated meetings' ie teacher class contact

$$\ldots\ldots\ldots = \Sigma\left[(h)(w)(g)\right]$$

- The notional student contact hours

$$\ldots\ldots\ldots = \Sigma\left[(S)(h)(w)\right]$$

- The average class size provided

$$\ldots\ldots = \Sigma\left[(S)(h)(w)\right] \Big/ \Sigma\left[(S)(h)(w)/(E^*/g)\right]$$

('ACS' in Delany notation Note 3)

In each case the summations are over the relevant courses in the appropriate mode or grade for the 'home' department and for the institution. Exhibit 5.4 illustrates the process for the Blagda College.

The Hertfordshire College of Building Case

A test run of the data collection and analysis outlined above was made at the Hertfordshire College of Building in the Spring term 1977.

The College is the main centre of education for the construction industry and related trades and professions in the County of Hertford. Three departments - Building and Engineering Services (BES), Craft and Supervisory Studies (CSS), and Technical and Professional Services (TPS) - recruit a wide range of courses at all levels from craft to technician Burnham Grades V, IV, III and II Note 4) and at four modes of attendance - Full-time (FT), block release (BR), Part-time day and evening (PT) and evening only (Ev). A fourth department - General and Communication Studies (GCS) - is wholly a service department.

WORKLOAD MATRIX

"BLAGDA COLLEGE"

		DEPARTMENTS PROVIDING INSTRUCTION															
		MATHS				SOCIAL SCIENCE				SCIENCE				ALL DEPARTMENTS			
COURSE	ENROLMENT	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
X	10	700	5500	180	13·3	400	6000	80	26·7	400	4000	40	40	1500	15500	300	180
Y	20	400	6000	80	26·7	1600	28000	120	93·3	1000	16667	150	60	3000	50667	350	180
Z	30	900	13500	100	60·0	1800	54000	60	60·0	1800	34050	60	100	4500	101550	320	220
	60	2000	25000	360	200·0	3800	88000	260	180	3200	54717	350	200	9000	167717	970	580
		[A]	[B]	[C]	[D]	[A]	[B]	[C]	[D]	[A]	[B]	[C]	[D]	[A]	[B]	[C]	[D]

AVERAGE CLASS SIZE PROVIDED [A]/[D]	10.0	21.1	16.0	15.5
TEACHER CLASS CONTACT HOURS	200	180	200	580

TRANSFERRED FROM COURSE FILE

[1] = $\Sigma[(s)(h)(w)]$

[2] = $\Sigma[(s)(h)(w)(E^*/g)$

[3] = $\Sigma[(h)(w)(g)]$

[4] = $\Sigma\{[(s)(h)(w)]/(E^*/g)\}$

STUDENTS' AVERAGE TUITION LOAD [A]/TOTAL ENROLMENT	33.3	63.3	53.3	150
STUDENTS' AVERAGE CLASS SIZE [B]/[A]	12.5	23.2	17.1	18.6
MEETINGS 'SAVED' ([C] − [D])/[C]	0.44	0.31	0.43	0.40

EXHIBIT 5.4

15.A

The data was collected and analysed by hand over three man weeks. For each course the following timetable parameters were identified:

- enrolment;
- students' average class contact hours (tuition load);
- students' average class size;
- percentage of course 'serviced'
- direct teaching cost per student;

For each department the total demands for instruction were generated and aggregated by mode of attendance and grade of work distinguished between laboratory and classwork and the following parameters identified:

- student class contact hours ÷ full-time equivalent students;
- teacher class contact hours = 'allocated meetings';
- average class size provided.

Some of the results are illustrated in the tables below. No conclusions are drawn, however, since the objective of the exercise was primarily to test the practicability of the system and, if it proved to be acceptable to the Principal and his staff, to move forward to a simple teaching staff requirement prediction model.

Enrolments in the Spring term 1977 totalled 1,852 (Table 5.1). Just over half of these students (52%) were attending on a part-time basis, a further 38% were block release students, 6% were full-time

and the remainder (4%) evening only. The distribution of enrolments across the grades was II - 10%, III - 39%, IV - 26% and V - 25%.

TABLE 5.1

Enrolments (E) Courses (n) Average Course Enrolment ($\bar{E}$)

Spring Term 1977

Mode	Grades											
	II			III			IV			V		
	E	n	$\bar{E}$	E	n	$\bar{E}$	E	n	$\bar{E}$	E	n	$\bar{E}$
FT	-	-	-	-	-	-	34	2	17.0	85	6	14.2
BR	-	-	-	233	17	13.7	253	16	15.8	2.4	15	14.3
PT	165	8	20.6	475	29	16.4	167	12	13.9	151	11	13.7
Ev	12	1	12.0	12	1	12.0	28	2	14.0	23	2	11.5

Overall:

Enrolment	1852
Number of Courses	122
Average Course Enrolment	15.2

Table 5.2 provides another view of the distribution of tuition demands across grades and modes of attendance.

TABLE 5.2

Student Contact House Spring 1977

Mode	Grades			
	II	III	IV	V
FT	-	-	12 444	30 169
BR	-	47 191	37 096	33 377
PT	18 684	48 255	19 962	15 242
Ev	432	360	1 344	1 104

Using the data on the class contact hours (tuition load) of a full-time student (Table 5.3) it is possible to translate Table 5.2 into a distribution of full-time equivalent students as set out in Table 5.4.

TABLE 5.3

Students' Average Tuition Load (Hours) Spring Term 1977

Mode	Grades			
	II	III	IV	V
FT	-	-	366	355
BR	-	203	147	156
PT	113	101	120	101
Ev	36	30	48	48

TABLE 5.4

Full Time Equivalents Spring Term 1977*

	Grades			
	II	III	IV	V
FT	–	–	34	85
BR	–	133	105	94
PT	53	136	56	43
Ev	1	1	4	3

* 30 169 full time student contact hours and 85 full time students = 354.93 student contact hours per full time student.

Prior to the data collection it had been thought that in the large majority of cases in further education courses were 'self contained', ie there would be very few examples of class contact with combined groups of students from more than one course. In the event, on average the College of Building student found himself in combined groups for about 15% of his total timetable. The incidence of these joint meetings varied greatly from zero for evening only students to about 25% for full time and block release students. Joint meetings were wholly confined within grades and only rarely were courses combined (within a grade) across modes of attendance. The staff of the College believed that one of the impacts of the development of TEC (Technician Education Council) courses would be an increase in the proportion of joint meetings in 'core' subjects such as mathematics.

The possibility of a significant incidence of joint meetings potentially increases the complexity of the resource requirements prediction problem. However, the practice at the Hertfordshire College of Building was to join courses for common subject elements, but then to split these combined groups into class sizes approximating to the orginal course enrolment. For example, if for 'industrial studies' four courses each with an enrolment of 15 were combined in a group of 60, this group was subsequently taught in four classes of 151 Classroom size constraints was the popular reason given for this strategy. It is true that there was only one large lecture theatre available but the majority of class rooms could accommodate about 20 to 25 students, whereas class sizes were tightly bunched around size 15.

Table 5.5 presents the typical class sizes experienced by the student in each grade and mode of attendance whilst Table 5.6 identifies the average class size provided by the institution.

TABLE 5.5

Students' Average Class Size Spring 1977

Mode	Grade											
	II			III			IV			V		
	L	C	B	L	C	B	L	C	B	L	V	B
FT	~~-~~	~~-~~	~~-~~	~~-~~	-	-	17	17	17	14	15	15
BR	-	-	-	12	15	14	12	16	15	12	16	14
PT	18	19	19	15	18	18	15	16	16	15	16	15
Ev	12	12	12	12	12	12	10	18	15	12	12	12

Overall

L = Laboratory/Workshop	13
C = Class	17
B = Both	16

TABLE 5.6

Average Class Size Provided Spring 1977

Mode	Grade											
	II			III			IV			V		
	L	C	B	L	C	B	L	C	B	L	C	B
FT	–	–	–	–	–	–	17	17	17	14	14	14
BR	–	–	–	~~11~~	~~14~~	~~13~~	10	15	13	12	14	13
PT	16	18	18	14	17	17	15	15	15	15	15	15
Ev	12	12	12	12	12	12	10	17	14	12	12	12

Overall

L = Laboratory/Workshop	12
C = Class	15
B = Both	14

Predictably, laboratory/workshop work was undertaken in smaller groups. There is a close correspondence between course enrolments and average class size provided - an indication that the potential economies (in terms of teacher class contact commitment) of combining courses for common subject elements are being dissipated by the subsequent splitting of these larger groups. Compared with the Lanchester-Loughborough case the distribution of class sizes is very slight and there is not a great difference between the average class size experienced by the student and the average class size provided by the institution.

The total teacher class contact hours (ie "allocated meetings") for the Spring Term 1977 are summarised in Table 5.7. Laboratory/workshop supervision accounted for about 28% of the total teacher class contact - a lower proportion than had been forecast by the Principal and his Heads of Departments prior to the investigation.

TABLE 5.7

Teacher Class Contact Hours Spring Term 1977

Mode		Grade II	III	IV	V
FT	Lab/Workshop	-	-	17	925
	Classroom	-	-	719	1239
BR	Lab/Workshop	-	843	1210	1236
	Classroom	-	2698	1623	1326
PT	Lab/Workshop	7	217	75	440
	Classroom	1017	2669	1269	607
Ev	Lab/Workshop	18	30	42	48
	Classroom	18	-	54	48

Overall

Lab/Workshop	5108
Classroom	13287
	18395

In a complex context of four levels of work and four modes of attendance data on the average student and the typical situation of formal instruction may not be particularly helpful. Nevertheless in the interests of a simple summary the institutions teaching commitment and timetable parameters follow:

Students' Instruction Environment:

- Average Tuition Load (Hours):

Laboratory/Workshop	33.0
Classroom	110.5

- Average Class Size Experienced:

Laboratory/Workshop	12.9
Classroom	15.7

- Percentage of Course 'Serviced' 16.0
- Percentage of 'Joint Meetings' 15.0

Institutional Provision of Instruction

- Average Class Size Provided:

Laboratory/Workshop	12.0
Classroom	15.4

Total
- Teacher Class Contact Hours

Laboratory/Workshop	5108
Classroom	13287

- Student Contact Hours:

Laboratory/Workshop	61081
Classroom	204579

The academic and technician staff costs for each department for the academic year 1976/77 and the resulting cost per teacher contact hour for each department are set out in Table 5.8.

TABLE 5.8

Teacher and Technician Costs Per Contact Hour

Spring Term 1977

	Department			
	BES	CSS	GCS	TPS
	£	£	£	£
Academic Staff*	108396	115521	43601	136031
Technician Staff*	24869	14916	1655	8906
	133265	130437	45256	144937
Costs Per Term				
Staff (1/3 above)	44422	43477	15085	48312
Overtime (Actual)	2220	1778	176	1022
Part Time (Actual)	1509	6698	917	1365
	48151	51955	16178	50699
Staff Class Contact Hours	4974	6512	2208	4701
Staff Costs Per Class Contact Hour £	9.68	7.98	7.33	10.78

* Cost of full time academic staff = mid point of salary scales plus £312 + £141 + 6% superannuation

** Cost of full time technician staff = mid points of salary scales plus £312 + £120 + 6% superannuation

Table 5.9 identifies the unit costs calculated on the same basis as outlined in Exhibit 4.2 in Chapter 4.

TABLE 5.9

*Unit Costs £'s Spring 1977

Mode	Grade			
	II	III	IV	V
FT	-	-	214	205
BR	-	138	93	71
PT	64	58	83	64
Ev	29	20	33	40

* Costs distributed = Full time Teacher and Technician mid point of scales plus employers' superannuation plus actual part time and overtime expenditures.

The unit costs for each course 'threw up' some interesting 'rogue elephants' particularly in the part time mode across and within grades. Further investigation revealed that the divergencies were due to enrolments or (more rarely) small class sizes due to excessive 'splitting'! The Principal and his Heads of Departments were agreed that the data on unit costs was particularly helpful in alerting them to 'centres' in the organisation requiring their attention.

Using the distribution of teacher class contact hours at each grade of work across departments (one of the outputs from the system) the theoretical teaching establishment according to the Burnham Report (Note 4) was also calculated. Below the process is illustrated for the General and Communications Studies Department in Exhibit 5.5.

EXHIBIT 5.5

Calculation of Teaching Establishment GCS Department Spring 1977

1. Based on the least favourable interpretation of Burnham ie

"Grade V =	Lecturer II (LII)	95%
	Lecturer I (LI)	95%
IV =	Lecturer II	40%
	Lecturer I	60%
Grade III =	Principal Lecturer (PL)	10%
	Senior Lecturer (SL) /Lecturer II	90%
Grade II =	Principal Lecturer	10%
	Senior Lecturer/Lecturer II	90%

Grade	Teacher Class Contact Hours	PL	SL	SL/LII	LII	LI
V	723	-	-	-	36	687
IV	670	-	-	-	268	402
III	767	77	-	690	-	-
II	48	5	-	43	-	-
	2208	82	-	733	304	1089

Teacher Class Contact Hours per Staff Grade for a 12 week Term:		
Principal Lecturer	12 x 15 =	180
Senior Lecturer	12 x 17 =	204
Lecturer II	12 x 19 =	228
Lecturer I	12 x 21 =	252

Hence on a 'least favourable interpretation' establishment:

Principal Lecturer		0.46
Senior Lecturer/Lecturer II	Senior Lecturer (50%)	1.80
	Lecturer II (50%)	1.61
Lecturer II		1.33
Lecturer I		4.32
		9.52

2. Similarly on a 'most favourable' interpretation of Burnham ie

"Grade V =	Senior Lecturer	5%
	Lecturer II	15%
	Lecturer I	80%
Grade IV =	Senior Lecturer	5%
	Lecturer II	65%
	Lecturer I	30%
Grade III =	Principal Lecturer	25%
	Senior Lecturer/Lecturer II	75%
Grade II =	Principal Lecturer	25%
	Senior Lecturer/Lecturer II	75%

Grade	Teacher Class Contact Hours	PL	SL	SL/LII	LII	LI
V	723	-	36	-	109	578
IV	670	-	33	-	436	201
III	767	192	-	575	-	-
	2208	204	69	611	545	779

Leading to a theoretical establishment on a 'most favourable' basis of

Principal Lecturer		1.13
Senior Lecturer		0.34
Senior Lecturer/Lecturer II	Senior Lecturer (50%)	1.50
	Lecturer II (50%)	1.34
Lecturer II		2.39
Lecturer I		3.09
		9.79

In the event the actual teacher establishment for the GCS Department for the Spring Term 1977 was:

Principal Lecturer	0
Senior Lecturer	1
Lecturer II	2
Lecturer I	5
	8

Plus 410 hours provided by part time teachers at (18 x 12) 216 hours per full time teacher = 1.9 part time teachers

Overall the actual establishment of the College fell midway between the theoretical establishment on a 'least favourable' and 'most favourable' interpretation of the Burnham Report.

Finally, to the question of student staff ratios (SSR's). This statistic had been identified by the Hertfordshire Local Education Authority as the most important of their teacher resource data requirements from a control point of view. A calculation of these for each department based on an approach recommended by the Pooling Committee (1972) is illustrated in Exhibit 5.6.

To summarise - the Hertfordshire College of Building project set out to develop the framework of a management information system of general application to further education covering the utilisation of the major resource - teachers. A first-stage solution was developed and tested which monitored the existing resource patterns and also provided a data basis from which planning parameters might be identified.

EXHIBIT 5.6

Calculation of Student Staff Ratios Spring 1977

Full Time Equivalent Teaching Staff

Department	Part Time Class Contact Hours	Full Time Equivalent*	Full Time Staff	Total FTE
BES	401	1.9	HOD + 20	HOD + 21.9
CSS	1202	5.6	HOD + 21	HOD + 26.6
GCS	410	1.9	HOD + 8	HOD + 9.9
TPS	384	1.8	HOD + 21	HOD + 22.8

* Converted at 18 class contact hours per week for 12 weeks

Full Time Equivalent Students

Department	Student Class Contact Hours		Full Time Equivalent Students
BES	Within College 70937 Outside College 72	71009	200.1
CSS		84034	236.8
GCS		33292	93.8
TPS		77397	218.1

Student Staff Ratios

Department	Student Staff Ratio
BES	200.1/21.9 = 9.14
CSS	236.8/26.6 = 8.90
GCS	93.8/9.9 = 9.47
TPS	218.1/22.8 = 9.57

At this point the Principal, Heads of Departments and Course Tutors were asked to comment on the potential usefulness of the system. It has been suggested (Mason 1973) that 'usefulness' in this context has the following characteristics:

- Is the scheme believable? Are the assumptions made at various points in line with the potential users perception of reality?
- Is the scheme relevant? Do the elements and variables identified and highlighted focus on the problems faced by the decision takers?
- Is the scheme flexible? Can the system be easily re-defined and restructured to fit changing circumstances?
- Is the content communicable? Can the potential users participate and do they understand and can they act upon the output produced by the system at least through an effective interpreter?

With the exception of 'savings achieved by combining courses' (ie $\left\{\Sigma\left[(h)(w)(g)\right] - \Sigma\left[(S)(h)(w) \;/\; E^*/g\right]\right\} / \div\Sigma\left[(h)(w)(g)\right]$) the Principal and his senior staff were agreed that the system met these criteria. They had found the outputs to be meaningful and helpful in focussing their attention on 'centres' within the institution which required further investigation. Moreover, they were satisfied that the system could meet both LEA and DES requirements for information on teacher deployment. Accordingly, they were keen for the project

to move forward to the design of a simple mechanism for predicting the requirements for academic staff.

Exhibit 5.7 illustrates such a model for the mythical Blagda College. The planning parameters postulated are (1) a student's typical teacher contact (ie tuition load) from each of the departments providing instruction to his course; and (2) the average class size provided by each department. From these parameters and forecast enrolments it is possible to arrive at a prediction of teacher class contact hours and, given agreed teacher class contact hours, a forecast of teacher establishment. It is assumed in Exhibit 5.7 that tuition loads and average class sizes provided would be taken from previous 'course files' and 'workload matrices' respectively (ie they are historical). However, these parameters might be determined by policy and a computer based model would allow the decision takers to test the effect of changes in them.

At the Hertfordshire College of Building it was decided that the model should operate at a level of aggregation of grades across modes of attendance. This would facilitate the projection of staff establishment by grade according to Burnham agreements. It would take a number of years to examine the stability of the planning variables and to test the sensitivity of the final outcomes of the prediction to variations in these parameters and to inaccuracies in the estimates of enrolments. However, it was decided that a preliminary

166

EXHIBIT 5.7

Logic of "Blagda College" Teaching Establishment Forecast
(10 Week Term)

Forecast Enrolments			1
X Course	Y Course	Z Course	
15	20	25	

Depts	Tuition Load Induced (Hours)*			2
Maths	70	20	30	
Social Science	40	80	60	
Science	40	50	60	
All Depts	150	150	150	

* See Exhibit 5.3 "Course File"

Depts	Student Contact Hours Induced [1] x [2]			3
Maths	1050	400	750	
Social Science	600	1600	1500	
Science	600	1000	1500	

Depts	Average Class Size Provided**			4
Maths	10.0	10.0	10.0	
Social Science	21.1	21.1	21.1	
Science	16.0	16.0	16.0	

** See "Workload Matrix" Exhibit 5.4

Depts	Teacher Class Contact Hours [3] + [4]			5
Maths	105	40	75	
Social Science	28	76	71	
Science	38	63	94	

220
175
195
590

examination of the likely operation of the model should be undertaken for the BES Department's 'home' courses comparing actual outcomes in the Autumn Term 1977 with a prediction based on data from the Spring Term 1977.

Exhibit 5.8 sets out the procedure for Grade V courses based in the BES Department. The calculations reflect actual data for the Spring Term 1977. The results of this exercise were checked against actual outcomes for the Autumn Term 1977 with the following results for a teacher establishment based on the 'least favourable' interpretation of Burnham:

BES 'Home' Courses

Projected Teacher Establishment for Grade V Courses

Dept	Teacher Class Contact Hours	LII	LI	All Staff
BES	1564	0.3	5.9	6.2
CSS	111	0.02	0.4	0.42
GCS	341	0.1	1.3	1.4
		0.42	7.6	8.02

Teacher Establishment Based on Actual Teacher Class Contact Hours

Dept	Teacher Class Contact Hours	LII	LI	All Staff
BES	1914	0.4	7.2	7.6
CSS	96	0.02	0.4	0.42
GCS	313	0.1	1.2	1.3
		0.52	8.8	9.32

Error:	LII	LI	All Staff
BES	-25%	-18%	-21%
CSS	0	0	0
GCS	0	+ 8%	+ 8%
All Depts	-19%	-14%	-14%

EXHIBIT 5.8

BES Grade V "Home" Based Courses

Mode		FT	BR	PT	Ev
Forecast Enrolments		13	136	35	12
1 Tuition Load Hours					
BES	LAB	24	79	45	24
	CLASS	177	73	49	24
CSS	LAB	–	–	–	–
	CLASS	111	–	–	–
GCS	LAB	–	–	–	–
	CLASS	93	20	15	–
2 Student Contact Hours					
BES	LAB	360	6241	3465	288
	CLASS	2655	5329	2773	288
CSS	LAB	–	–	–	–
	CLASS	1665	–	–	–
GCS	LAB	–	–	–	–
	CLASS	1395	2300	1155	–

3 Average Class Size Provided					
BES	LAB	15.0	12.4	13.0	11.5
	CLASS	17.2	16.3	15.8	11.5
CSS	LAB	–	–	–	–
	CLASS	15.0	–	–	–
GCS	LAB	–	–	–	–
	CLASS	15.5	13.9	13.5	–
4 Teacher Class Contact Hours					
BES	LAB	24	503	267	25
	CLASS	154	327	239	25
CSS	LAB	–	–	–	–
	CLASS	111	–	–	–
GCS	LAB	–	–	–	–
	CLASS	90	165	86	–

819		
745		
–		
111		
–		
341		

5	Dept	Class Contact	LII	LI	ALL
	BES	1564	0.3	5.9	6.2
	CSS	111	0.02	0.4	0.42
	GCS	341	0,1	1.3	1.4

It was thought that a higher level of aggregation might improve the accuracy of the prediction and a check against the results for a forecast based on Spring Term 1977 data for all BES 'home' courses as compared with actual outcomes for the Autumn Term 1977 led to errors as follows:

	Predicted	Actual	Error
P/L	0.92	1.12	-18%
S/L	3.6	4.4	-18%
LII	6.3	6.6	- 5%
LI	12.7	11.7	+ 8%
All Staff	23.52	23.82	- 1%

The Principal and the senior staff of the Hertfordshire College of Building were reasonably satisfied with this level of accuracy. However, they realised that the model would need to be run a number of times to establish confidence in the outcomes. Further to obtain the best use of the system it would need to be computer-based and thus permit 'what if' questions aimed at examining the likely effects of changes in policy and in patterns of demand and provision. The first step towards this position would be to implement the historical data collection and analysis and work on this is scheduled to continue throughout the academic year 1978/79.

Some Caveats

The way to more effective management is through a deepened and expanded rationality brought about by a better information system - this has been the underlying presumption of this chapter. However, attempts to

develop and improve management information systems are not always welcomed by those who profess to have a commitment to more rational ways of doing things. Indeed information systems often engender resentment and resistance. Many express opposition in terms of:

(a) they do not understand the technology; or

(b) they do understand the technology and do not believe it wise to rely on it in its primitive state.

These reasons are valid but temporary: skills can be disseminated and the state of the art improved. The real explanation of managers' opposition may be the realisation that in the longer run MIS will bring about fundamental changes in their managerial styles.

In some circumstances valid and verifiable information may be thought bad - bad because it is threatening. The more sophisticated and comprehensive the information system the more decision takers are denied room to manouvre and the more they are pressurised to conform. Withdrawal from responsibility and from involvement on the part of the managers may be the end result of the introduction of MIS. Today the successful manager is often the one who enjoys ambiguity, who thrives on the political game and who revels in 'flying by the seat of his pants' making his personal forecasts and commitments come true. With MIS intuition is at less of a premium, more people have the facts, co-operation and openness and not competition and secretiveness are the orders of the day.

The Lanchester-Loughborough study and to a lesser extent the Hertfordshire College of Building case suggested

inter alia that there may be wide divergencies between institutions and, within institutions, between departments in modes of operation. Given the present economic climate, attempts to monitor these resource utilisation patterns seem appropriate. These across and within comparisons would be facilitated by a common data base and an agreed information system. The danger of across and within institution comparisons is that individual institutions and departments may be required to come into line with national norms. It is possible that a standardised data collection and reporting system would inhibit local experiments and encourage conformist curriculum designs and pedagogical practices. If so the result could be depressing in its homogeneity and mediocrity. An alternative approach would be to encourage institutions to use the information from their own and other institutions as a base for their own 'management by exception'. A requirement to provide answers to questions prompted by significantly adverse deviations from a discipline norm might general further enquiry into causes and suggest remedies. Ultimately, whatever the reasons for a deviation it is a matter for the decision takers within an institution (and not central funding agencies) to approve exceptions and to decide which parts of the organisation are to be nursed and which parts are to be allowed to wither and die.

There may be a case for resource allocation to reflect in part past performance. However, until a great deal

more is known about the nature of the educational process and finer measurements of outcomes have been developed, resource allocation will rely heavily on personal evaluations particularly of the 'quality' dimensions.

NOTES

1. Conceptually in the are of instruction a college makes certain educational services available. In turn students bring a variety of preparations, motivations, aspirations and abilities to their learning. Hopefully, the net effect of these interactions is some change - 'value added' - in the students' characteristics. Jencks et al (1972) Levin (1974) and Hanushek (1975) are all examples of studies in the change in student achievement as a measure of college outcomes. Carlson (1965) and Bowen and Douglas (1971) are examples of studies which view the 'places' provided by a college as the appropriate measure of outcome for the college.

2. A 'credit hour' is a unit of academic achievement. When a student successfully sits an examination his academic record is credited with the appropriate credit hours. The accumulation of an appropriate number of credit hours leads to the award of a degree. Typically the credit hours for a programme of study are equal to the lecture contact hours in a semester week. However, in the case of laboratories the credit hours often differ and invariably are less than the contact hours involved.

3. One of the requirements of the Hertfordshire system when developed was that it should produce data in the form required by LEAs and the DES. The average class size provided (ACS), average student contact hours (ASH) and average lecturer contact hours (ALH) are one means by which student staff ratios (SSRs) can be calculated.

See Delany (1971) and the Pooling Committee (1972)

4. See "Scales of Salaries for Teachers in Establishments for Further Education in England and Wales" 1974 (The Burnham Report) Appendix II Part A para 2(2) and 3(2)

"Category of Work

I Courses above first degree level and research training.

II Study above Ordinary National Certificate or equivalent standard leading directly to a university degree or equivalent standard.

III Study of equivalent standard to that in Category II but not necessarily leading to the qualifications mentioned in that category.

IV Study of courses above the Ordinary Level of the General Certificate of Education or comparable level leading directly to the Ordinary National Certificate, or courses or parts of courses of a comparable standard.

V Courses other than those described above."

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CHAPTER 6

SUMMARY OBSERVATIONS

The time when education could count on continued growth and expansion has likely gone for ever. Even if the economic climate in general was not so bleak, it is probable that education would now be receiving a smaller share of gross national product. Not only has education turned out to be not an economic panacea but it has also failed to produce the social revolution which some idealists had thought it might. Add to this a declining birth rate to darken the future and falling enrolments (in some areas) to dampen the present and it is not surprising that all institutions face increasing pressures to "show cause" and to engage in explicit re-examination of what they are doing and of the consequences of their actions. On the face of it there seems to be no valid reason why educational institutions should not be asked to account. However, there is a complexity inherent in the educational process which means that answers must be tentative.

In previous chapters two cases have been reported. In the first case - the Lanchester/Loughborough study - a comparative examination of the inputs and outcomes of the teaching process in two institutions of higher education across the "binary divide" was undertaken and some performance indicators were identified. In the second case an information system, a pre-requisite for purposeful action, was developed and tested in a college of further education. In both cases the focus was on the quantifiable parts of the complex set of activities which comprise the teaching function.

During the course of the work a distinction has been drawn between on the one hand outcomes defined as 'places', 'enrolments', 'successes', and 'graduates' and, on the other hand, outcomes defined as 'value-added' and ultimate 'impacts' on the social, cultural, political and economic dimensions of the State. As the study has developed the argument has come down on the side of the former as the appropriate framework for performance assessment since an institution is solely responsible for the mix and magnitude of the learning opportunities on offer.

Immediately three large gaps in the approach are apparent: the concentration on the quantifiable, the concern with teaching to the exclusion of other equally valid activities and the foreswearing of 'value-added' and ultimate 'impacts'.

It is clear that quality considerations loom large in any evaluation process in education. Even though we cannot order in a cardinal sense it may be that we can rank and systematise our subjective assessments of quality. So far as the jointness of costs and benefits are concerned there is at the moment no right way of allocating inputs to outputs. Nevertheless, diary/questionnaire studies may provide guidance to support one basis rather than another. So in the areas of ordering subjective evaluations and of tracing the relationship between inputs and major activities and outputs there is considerable scope for continuing research.

A vigorous research effort has already been made (and continues to be made) in unscrambling the effects of 'outside influences' and in quantifying 'value added'. Moreover the move towards common syllabi and standardised tests, one pre-requisit of more accurate measurement in this area, is gathering momentum particularly in core subjects at the lower levels of work.

It is conceded then that the conceptual framework supporting the cases reported above may be attacked from a number of viewpoints. However, the performance indices identified do at least go some way towards satisfying the criteria set up by the American Accounting Association's "Statement of Basic Accounting Theory" (AAA 1969) These are: relevance, verifiability, freedom from bias and quantifiability.

The question of relevance raises subjective issues: Who decides relevance? Is a relevant performance indicator one which bears upon the activity or is useful to those managing the activity? Should relevance be the dominant test applied to any proposed or existing performance indicator? (Sizer 1978) In the case of the Hertfordshire College of Building the staff were apparently agreed that the performance indicators constructed were important and relevant to them in guaging and evaluating resource utlisation within their institution. In the Lanchester-Loughborough study the indicators were not specifically debated by the respective staffs within the institutions although they satisfied the Steering Committee (representative of a number of interests) and have been tested in open conferences in this country and abroad on a number of occasions.

The American Accounting Association's statement defines "verifiability" as "that attribute of information which allows qualified individuals working independently of one another to develop essentially similar measures or conclusions from an examination of the same data, evidence or research." Raw data is presumably of itself neutral but decisions on what data and from then on how it is to be packaged and presented may call into question its neutrality and in some cases its verifiability. This leads naturally to the standards of "freedom from bias". Statistical bias may result from inappropriate techniques of measurement and personal bias from conscious (or maybe and worse perhaps unconscious) manipulation of information. At various points in both the Lanchester-Loughborough study and the Hertfordshire College of Building exercise decisions were taken in favour of simplicity and the presentation of raw data wherever possible. At no point were the indicators presented the result of explicit weightings. Hence, for example, preparation time and marking and feedback time were not used because they were not verifiable in many cases; again in the absence of verifiable evidence to the contrary first year work was counted as equally demanding as final year instruction. Undoubtedly the standards of verifiability and freedom from bias point up the importance of the choice of raw data and the design of information systems and, where formulae are employed, the importance of an adequate education of the users and/or the importance of a competent interpreter.

So to the question of "quantifiability". As was stated in the first chapter this work has concentrated throughout on the quantifiable. This is not to say that the quality dimensions are unimportant. There may be a trade-off between quantifiability and relevance. For example, in the particular case the quality of the teaching is more relevant than the teacher class contact hours. However, given our present state of knowledge about ordering subjective judgements it is not likely that information on the quality of teaching would be verifiable or free from bias.

A fifth standard has been proposed by the American Accounting Association's Committee on Managerial Decision Models which is relevant to performance indicators in education - the standard of "feasibility". Simply put this requires that the benefit anticipated from the availability and use of the indicator should be weighed against the costs of producing it. Economic feasibility is clearly part of the trade-offs between relevance, freedom from bias, verifiability and quantifiability. To an extent "the costs of gathering, storing and presenting information are expected to encourage rather than deter requirements in information systems" (AAA 1969 op cit). Computer-based information systems make possible attention focussing reports backed up by on request reporting facilities designed to meet demands for additional data. Such developments shift attention away from the routine chores of gathering, storage, retrieval, manipulation and aggregation and permit a serious consideration of how best to communi-

cate to facilitate action. For "without communication all the information revolution can produce is data".

Sibley (1977) has traced the evolution of planning in colleges and universities through three phases. Prior to the expansionist 60's planning was simple. For the most part the institution was a peaceful enclave regarded by its environment with tolerance perhaps even with "benign neglect". The internal coding was simple, coherent and stable. The information system was rudimentary but it sufficed. It was the age of "authority" and "empiricism". The late 60's and very early 70's was an age of affluence and rising expectations. Institutions grew quickly and this growth in scale and complexity was accompanied by increased differentiation and specialisation of function. The pressures were enormous but the environment was supportive. More sophisticated information systems appeared and there was a high confidence that problems would yield to analysis. It was the age of "rationalism" and "participation". Early in the 70's came the Ice Age. The environment became critical even hostile, "accountability" became fashionable. The enrolment curves have flattened out and so has financial support; this trend taken with inflation has squeezed out the 'fat' from most institutions and is gnawing away at the "slack" which some believe is so necessary to absorb uncertainty. Instability - the enemy of rational planning - is the most notable characteristic. Extrapolation from past experience is more precarious than at any other time.

Thus planning horizons have contracted and we have entered the age of "pragmatism" operating in a reactive and tentative way.

This description of the North American scene applies to the United Kingdom for the most part although it may be argued that the widespread deployment of mathematical modelling and sophisticated information systems hardly touched the university world here and has never been evident in further education. Does the current environmental instability and complexity now argue against investment in the design development and implementation of planning and control mechanisms? It is certainly true that the development of institutional planning and control must now be done in the face of diminished resources and diminished internal simplicity and cohesion. Paradoxically, the need to map and sense trends and shifts in response to the institution's provision of learning opportunities and its utilisation of resources is probably greater in the face of increasing environmental turbulance . However, it may have to be conceded that planning in the grand style will give way to devising short term second best expedients. The Hertfordshire College of Building exercise was undertaken from the beginning with the knowledge that the 'system' must be above all economically feasible. As a consequence, it is only partial and in some respects crude. Nevertheless it was welcomed by the staff who, under threat from the environment, saw the information produced as a base from which they might account and justify outside the College and modify and persuade

within. Hard times go hand in hand with hard choices. In a world of plenty, options can always be found which satisfy Pareto conditions making some parties better off and none worse off. In a time of scarcity, we move into a zero-sum game situation where a gain to one means a loss to somebody else. Decisions ultimately reflect subjective judgements and rightly so for statistics are not a substitute for judgement particularly in education. However, quantified verifiable evidence which is seen to be free from bias so far as is possible narrows the choices before the decision takers and maybe teases out the inherent logic of the situation.

In the final reckoning there are two directions in which we can move. We can do nothing least of all invest time and energies in developing the mechanisms which might enable us to account and justify and plan within the constraints imposed by society. In which case the State may well step in to fill the void and impose their system and order. Alternatively, we can impose upon outselves the discipline and reforms required to accommodate our institutions to reality and try to discover "better" ways of pursuing our basic purposes.

Inevitably, for the author, the work reported here and in the accompanying volume has been a modest beginning of the research and scholarship required to begin to understand the response and resource use patterns of institutions of education. The work continues (See Calvert and Birch 1978) Hopefully the studies are a fruitful beginning.

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