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# MEASURING PERFORMANCE IN HIGHER EDUCATION

By

JOHN ROBERT CALVERT

B.Sc. (Dunelm), M.Sc. (Warwick), M.Sc. (Hull)

VOLUME II

A Doctoral thesis submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of the Loughborough University of Technology

## APPENDIX 2 - PUBLISHED PAPERS

## STATEMENT OF AUTHOR'S CONTRIBUTION TO THE FOLLOWING SET OF PUBLISHED PAPERS

In accordance with section 3.3. of the Regulations for Higher Degrees by Research of the University of Technology, Loughborough, the following papers are submitted in support of the thesis set out in Volume 1.

All these papers, save the last, were written by several authors but in each case the research described and the finished article have involved a substantial contribution by the Author. In particular, the last two paperswere written almost wholly by the Author about research carried out wholly by the Author.

APPENDIX 2.1.

"HOW PROFITABLE IS TEACHING?"

by BIRCH, D.W. and CALVERT, J.R.

in HIGHER EDUCATION REVIEW, 5, 4, AUTUMN, 1973

# How profitable is teaching?

D W Birch and J R Calvert

What are the economic benefits derived from the decision to invest in a teacher's certificate, or to obtain a degree, a postgraduate teaching certificate and then follow a teaching career? Are these benefits greater than the costs involved in becoming a qualified teacher?[1] These are the questions we attempt to answer in the first part of this paper. We do so from the point of view of the individual taking the decision to become or not to become a teacher rather than from the nation's standpoint. It may be as well to preface our analysis by emphasising the point that we are concerned solely with an economic evaluation. Plainly there are educational, cultural and social ramifications to the investment but a calculus for assessing these objectively has yet to be developed. It seems reasonable to assume, however, that these other aspects would add to rather than subtract from the economic return.

Economic evaluation of an investment opportunity:
The theoretical framework of the economic evaluation of an investment in education is well settled and is not different from the economic appraisal of the opportunity to invest in an item of capital equipment.[2] We may define an investment in this context as an outlay of cash or resources now or in the near future to acquire an asset in the expectation of receiving in the longer run a larger stream of cash or other economic benefits as a result of holding the asset: the extent of the investment horizon is the expected lifetime of the asset. To evaluate an investment, therefore, we have to measure and compare outflows (costs) and inflows (benefits) which arise at different points in time. This is accomplished by discounting the costs and benefits by an appropriate rate of interest to achieve a comparison at present values. Formally the net (benefits less costs) present value of an investment is given by

$$\sum_{t=0}^{t=n} = (B_t - C_t)\ (1 + r)^{-t} \qquad (1)$$

where

$$\sum_{t=0}^{t=n} = \text{the sum of from } t=0 \text{ to } t=n;$$

(eg if we were assessing the decision at the age of 15 to aim for a teachers certificate and then follow a teaching career t=0 would correspond to age 15 and t=n to retirement at age 65.)

$B_t$ and $C_t$ = respectively the benefits and costs which are assumed to arise at the end of year t; and

r = the discount factor.

What r should be in investment appraisal in the public sector is a matter of some controversy. Therefore, it is usual to employ an alternative investment appraisal formula - the 'internal rate of return'. The internal rate of return is that rate i which solves the following equation

$$\sum_{t=0}^{t=n} (B_t - C_t)(1 + i)^{-t} = 0 \qquad (2)$$

The rates of return we derive below are for the most part the result of following a slight variation on (2). Specifically they are those rates i which equate the present value of the lifetime benefits stream of the total population with the lifetime benefits stream of teachers: ie

$$\sum_{t=0}^{t=n} (F_{xt} - F_{yt})(1 + i)^{-t} = 0 \qquad (3)$$

where

$F_{xt}$ = the expected cash flows of the total population in year t; and

$F_{yt}$ = the expected cash flows of teachers in year t.

**The relevant benefits and costs**

The identification and estimation of the benefits and costs is a hazardous business in any investment appraisal exercise. This is particularly so in education investment appraisal where the investment is in human beings. The discounting models discussed above appear to be exact but the precision of the calculations depends upon the accuracy of the benefits and costs estimates and in the appraisal of an education investment opportunity we are relying on proxy measures at various points. If we are examining an education investment opportunity from the point of view of an individual the relevant benefits are the extra earnings he might expect to receive during his working lifetime as a result of undergoing the educational process; the relevant costs are largely his loss of earnings less any grant received during his study period. Strictly speaking the benefits should be calculated net of personal tax. The tax rates, of course, will depend upon domestic circumstances and will vary from individual to individual. It is usual to assume some representative personal tax situation and that this will remain stable over time. In fact unless one assumes that the tax situation for teachers in terms of fixed allowances and tax rate is different from that for the total population the rates of return will be only slightly affected by tax adjustments. On the grounds that the necessary tax assumptions compound the articificiality of the investment appraisal exercise, and in the belief that individuals assess career opportunities on the basis of gross rather than net salaries, we have ignored the tax adjustments.

The most meaningful view of the rate of return on an investment in a given educational qualification is to compare its net benefits (ie expected lifetime earnings net of costs) with those of the next lower level of education. However, we are concerned with the economic implications of the individual's decision at the age of 15 to opt for a teaching career as against all other career possibilities. Consequently, the type of comparison we have used is of the lifetime earnings of teachers, taking into account their students grants and vacation earnings, with the lifetime earnings of the total population. The age earnings profiles of the total population might also be taken as a proxy for the unqualified.[3]

The data base

Consider a group of people aged 15: what are their expected lifetime earnings? An estimate of the expected cash flows at a particular age is given by

$$(A)(B)(C) \qquad (4)$$

where

A = Proportion of the group that would be alive;

B = Proportion of the group that, if alive, would be economically active/employed;

C = The median salary at a particular age of the economically active/employed members of the group.

Each of these values requires a longitudinal study but, as is normal in educational rate of return studies, we have used cross sectional data. The age-earnings profiles were derived from DES Statistics of Education 1970 and the New Earnings Survey 1970; information on the proportions economically active and the proportions employed was obtained from the 1966 Sample Census; and the survival rates were derived from data in the Registrar Generals' Decennial Supplement 1961 and Report 1968. The data were divided by sex and also, for teachers, by graduates/non graduates and primary/secondary. The nature of our data base and our analysis of and adjustments to it are summarised in the appendix.

These calculations gave us the annual expected earnings from the age of 15 to 65 after adjusting for the probability of survival and the probability of being economically active. An adjustment substituted for the latter the probability of being employed. As the survival rates are high except in the later years which are heavily affected by the discounting process the survival correction has little influence on the final present value calculations. The overall effect of the economic activity/employment adjustments is to reduce the expected benefits particularly for females. However, women teachers have a higher activity/employment rate than women generally and this is reflected in the final rates of return.

## The rates of return

The benefit streams thus derived were discounted by various rates of interest from 0 to 40 percent to obtain the present values. A search was then made to identify that rate of interest which equated the present values of the expected benefit streams of the total population with those of teachers (ie the rates of interest which satisfy equation (3) above). These rates of return are shown below in Table 1.

**TABLE 1**

***Alternative estimates of private rates of return on the investment in a teaching career from age 15 (1970)***

| | | Percentages economically active | Percentages in employment |
|---|---|---|---|
| **Males** | All graduates | 11.7 | 11.9 |
| | graduates : secondary | 11.9 | 12.1 |
| | graduates : primary | 8.7 | 8.9 |
| | All non graduates | 6.9 | 7.0 |
| | non graduates : secondary | 6.9 | 7.0 |
| | non graduates : primary | 6.8 | 6.9 |
| **Females** | All graduates | 27.5 | 29.0 |
| | graduates : secondary | 28.1 | 29.8 |
| | graduates : primary | 26.5 | 28.3 |
| | All non graduates | 26.8 | 28.5 |
| | non graduates : secondary | 27.5 | 29.5 |
| | non graduates : primary | 26.5 | 28.3 |

In 1970 it was possible to leave school at 15 to obtain full-time employment: today the school leaving age is 16. The rates of return in Table 1 are based on lifetime earnings expectations at the age of 15; if these are corrected to expectations at age 16 the effects are to raise the rates for men by about ½ percent and for women by about 3½ percent. It is popularly claimed that one of the 'perks' of teachers is their longer than average holidays. Plainly some of this extra holiday expectation is taken up with further study, class preparation and so on but some of it might be used to earn extra money or to pursue activities of equal value to the teacher. Therefore, to take some account of this 'perk' all the benefit streams for teachers, from age 21 for non graduates and age 22 for graduates, were adjusted upwards by 1/12 (ie one extra month's salary). The results in terms of the new rates of return are given in Table 2. The effects of the holiday adjustment are to narrow slightly the differences between the returns to graduates and non graduates and to increase the returns to men overall from 2½ percent to 3 percent and the returns to women overall from 1½ percent to 2½ percent.

## Conclusions so far

In all cases the rates of return are positive and therefore we may conclude that under the present free tuition and maintenance grant

TABLE 2

*Alternative estimates of private rates of return on the investment in a teaching career from age 15 adjusted for holiday 'perks' (1970)*

| | | Percentages economically active | Percentages in employment |
|---|---|---|---|
| Males. | All graduates | 14.1 | 14.4 |
| | graduates : secondary | 14.3 | 14.6 |
| | graduates : primary | 11.2 | 11.4 |
| | All non graduates | 9.6 | 9.8 |
| | non graduates : secondary | 9.7 | 9.9 |
| | non graduates : primary | 9.4 | 9.6 |
| Females | All graduates | 29.3 | 31.0 |
| | graduates : secondary | 29.8 | 31.5 |
| | graduates : primary | 28.3 | 29.9 |
| | All non graduates | 29.0 | 31.0 |
| | non graduates : secondary | 29.8 | 31.5 |
| | non graduates : primary | 28.8 | 30.5 |

provisions the decision to invest in a teaching career is economically a worthwhile one. The decision to teach is much more profitable for women than for men. However the high rates of return enjoyed by women teachers are more a commentary on the poor state of the female labour market than they are evidence of high salaries for women teachers. They are the result firstly, of equal pay and secondly, of female teachers' high economic activity as compared with women generally. For the present, teaching fits in better with a woman's child-bearing and subsequent domestic responsibilities than most other careers. In the longer run future equal pay legislation and the changing social climate on women at work are likely to erode the substantial economic advantages currently enjoyed by female teachers. Apparently the important decision for women is the one to become a teacher; thereafter the choices between graduate and non graduate status and between a career in secondary rather than primary education have little effect on the economic rate of return. However, for men graduate status clearly enhances economic rate of return expectations although this advantage is reduced somewhat if the male teacher opts for a career in primary rather than secondary education.

A recent paper by Adrian Ziderman[4] offers us the opportunity of a limited comparison of teachers' rates of return with other 'qualified' career opportunities. He uses the age earnings profiles of the total population as a proxy for the 'unqualified' and compares this with data on earnings for graduates and holders of GCE A level. His adjustments for life expectancy, economic activity and employment appear to be similar to our own. However, he uses mean rather than median (the more usual measures in education rate of return studies) salaries and he corrects for personal taxation. He also adds on 2 percent to the rates of return as a 'conservative' estimate of the expected increase in real earnings over a lifetime. This adjustment is reasonable if we assume that the supply and demand for each type of educated manpower moves in line so preserving current relative income differentials. His findings after these adjustments are as follows.

TABLE 3

*Private rates of return on education from age 15 (1966-67)*

| | Percentages | |
|---|---|---|
| | Males | Females |
| First degree .. | 15.0 | 20.5 |
| GCE A level | 10.0 | – |

Note: There were insufficient data to calculate the rate of return for female holders of GCE A Level.

It might be argued that so far as teachers are concerned past experience has been to narrow rather than widen their absolute income differentials over the rest of the community. Therefore, the addition of 2 percent to take some account of future expected increases in real earnings is unjustified. Nonetheless if we add 2 percent to the rates identified in Tables 1 and 2 a more direct comparison with the results of Table 3 is possible. However it should be noted that Tables 1 and 2 are based on earnings data for 1970 whilst Table 3 is based on the pattern of earnings in 1966-67. The rate of return for female graduate teachers is from 9 percent to 11 percent higher than that identified by Ziderman for all female graduates. This confirms our view that teaching is, at this moment, a very profitable career for a woman. As might have been expected the rates of return for male graduate teachers are less than for male graduates generally. However, the economic return for male graduates teaching in secondary education is only slightly lower – 14 percent as compared with 15 percent – and much closer to the rate of return for all male graduates than we had expected. If account is taken of teachers' longer than average holidays the rates of return for male graduate teachers compare favourably with male graduates following other careers.

So much for the good news, the bad news so far as teachers are concerned is the rather indifferent rate of return for male non graduates, 9 percent as compared with 10 percent for GCE A level holders. However, since age specific earnings data relating to GCE A level holders was not obtainable from the earnings sub-sample follow up to the 1966 sample census, Ziderman was forced to use a less than satisfactory alternative estimate: ie the salary scales of the executive class of the Civil Service (for which A level is the normal entry requirement) and assuming representative promotional patterns within the class. Given the high level of Civil Service salaries Ziderman concedes that this could have resulted in an over estimate of the rate of return. Hence it might be safer to suggest that for male non graduates a career in the executive class of the Civil Service appears on average to be slightly more profitable than a teaching career.

### The non graduate teacher and the Open University

Thus far we have examined the economic returns to the decision at age 15 to invest in a teaching career as compared with all other career opportunities. We now turn to briefly consider the investment opportunity offered by the Open University to the non graduate teacher at various points in his teaching career.[5] A degree at the Open University is granted after a student has successfully completed two foundation courses plus four other 'credits' for a pass degree and six for an honours degree. A teacher who has attended a three year full time course at a college of education may claim three 'credit' exemptions if he opts to follow further studies in education at the Open University. We shall assume that teachers take advantage of this possibility. We have made a number of other assumptions which are detailed below:

That the teacher follows an honours course spread over four years thus:
Year one : two credits
Year two : one credit
Year three : one credit
Year four : one credit;
That the teacher pays his own tuition fees (£10 initial registration fee plus £25 per credit) and spends £25 on books for each 'credit';
That the teacher receives a grant from his LEA to cover the cost of any 'summer schools'; and
That each 'credit' involves the teacher in 400 hours' study. (We cannot put a precise value on this foregone leisure but bearing in mind the importance of opportunity cost we have assumed three different values of 0 new pence, 50 new pence and 100 new pence per hour.)

Table 4 sets out the pattern of monetary and opportunity costs resulting from the above assumptions.

TABLE 4

*Annual monetary and opportunity costs of a degree course at the Open University*

| Year course: | Value per hour of foregone leisure: 0p | 50p | 100p |
|---|---|---|---|
| 1 | 110 | 510 | 910 |
| 2 | 50 | 250 | 450 |
| 3 | 50 | 250 | 450 |
| 4 | 50 | 250 | 450 |

The matrices of private rates of return based on six ages of entry to the Open University and three alternative valuations of foregone leisure time; and assuming that the teacher will immediately move from the non graduate to the graduate age earnings profiles are presented in Tables 5 and 6.

**TABLE 5**

*Private rates of return to MALE non graduate teachers investing in a degree course at the Open University:-*

| Age of Entry | All | | | Primary | | | Secondary | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0p | 50p | 100p | 0p | 50p | 100p | 0p | 50p | 100p |
| 25 | 50.0 | 18.0 | 11.5 | 29.0 | 8.0 | 4.0 | 51.0 | 19.0 | 12.5 |
| 30 | 53.0 | 19.0 | 12.0 | 26.0 | 7.0 | 3.5 | 54.0 | 20.5 | 13.0 |
| 35 | 53.0 | 19.0 | 12.0 | 25.0 | 7.0 | 3.0 | 57.0 | 21.5 | 13.5 |
| 40 | 54.0 | 20.0 | 11.5 | 27.5 | 7.0 | 2.5 | 59.0 | 22.0 | 14.0 |
| 45 | 55.5 | 19.5 | 10.5 | 31.0 | 7.0 | 1.0 | 61.0 | 22.5 | 13.0 |
| 50 | 55.0 | 17.0 | 7.5 | 33.0 | 4.5 | $<0$ | 62.0 | 21.0 | 10.5 |

**TABLE 6**

*Private rates of return to FEMALE non graduate teachers investing in a degree course at the Open University*

| Age of Entry | All | | | Primary | | | Secondary | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0p | 50p | 100p | 0p | 50p | 100p | 0p | 50p | 100p |
| 25 | 38.0 | 14.0 | 9.0 | 27.0 | 8.0 | 4.0 | 35.0 | 13.0 | 8.5 |
| 30 | 45.0 | 16.5 | 10.0 | 28.0 | 8.5 | 4.0 | 41.0 | 15.0 | 9.5 |
| 35 | 50.0 | 18.0 | 11.0 | 31.0 | 9.0 | 4.0 | 47.0 | 17.0 | 10.5 |
| 40 | 54.0 | 19.0 | 10.5 | 34.0 | 9.0 | 3.0 | 52.5 | 18.0 | 10.5 |
| 45 | 54.0 | 17.5 | 8.5 | 35.0 | 7.0 | 0.5 | 54.0 | 18.0 | 8.5 |
| 50 | 50.0 | 12.5 | 2.5 | 33.0 | 2.5 | $<0$ | 51.0 | 13.0 | 3.0 |

If the teacher places no value on his lost leisure time, the rates of return on the investment in an Open University degree are formidable (from 27.0 to 62.0 per cent) for all ages of entry for both primary and secondary, male and female teachers. However, this assumption of nil opportunity cost is probably unrealistic in the majority of cases. When each leisure hour lost in study is valued at 50p, the rates of return are reduced substantially but are still very worthwhile for secondary teachers varying from 13.0 to 22.5 per cent. For primary teachers at this level of opportunity cost the economic viability of the venture is more marginal (from 2.5 to 9.0 per cent for women and from 4.5 to 8.0 per cent for men). At an opportunity cost of 100p per lost leisure hour the economic case for primary teachers investing in an Open University degree is somewhat shaky. Indeed, at age 50 the returns to both male and female teachers are negative. For secondary teachers the investment remains profitable (especially for men) even at this level of opportunity cost.

A general conclusion from the preceding analysis is that the Open University will continue to receive substantial support from non graduate teachers. We would expect this support to come primarily from male secondary teachers: for them the investment opportunity is very profitable for all six ages of entry and three levels of opportunity cost examined.

## Notes

1. Our attention was drawn to these questions by Colin Turner of the Further Education Staff College. However the responsibility for our answers is ours alone!
2. M Blaug 'The rate of return on investment in education in Great Britain', *Manchester School*, September 1965 pp 205-62.
3. See for example V Morris and A Ziderman 'The economic return on investment in higher education in England and Wales', *Economic Trends* No 211, May 1971.
4. A Ziderman 'Does it pay to take a degree? The profitability of private investment in university education in Britain', *Oxford Economic Papers* Vol 15 No 2, July 1973, pp 262-274.
5. This question was first considered by K Hinchliffe, 'Teachers, the Open University and the rate of return', *Higher Education Review*, Summer 1971.

## APPENDIX

*The data base, analysis and adjustments*

**A Survival rates**

Teachers, male/female
*Registrar General's Decennial Supplement 1961*
Proportions of 10,000 aged 0 dying in age ranges with mid points 20, 30, 40, 50, 60;
Translated into proportions of 10,000 aged 15;
Converted to survival proportions;
These points were then plotted on a graph and the yearly values for ages 15-65 were read off the smoothed curve.

**Total population**

male/female
*Registrar General's Report 1968*
Proportions of 10,000 aged 0 surviving to reach at least 20, 25, 30, 35, 40, 45, 50, 55, 60, 65
Translated into proportions of 10,000 aged 15;
These points were then plotted on a graph and the yearly values for ages 15-65 were read off the smoothed curve.

**B Economically active/employed**

| All qualified females | Qualified in education level 'C' females | Total population females | Total Population males |
|---|---|---|---|

*1966 Sample Census*

Medians for both sexes for ranges with mid points, 23, 27½, 32½, 37½, 42½, 47½, 52½, 57½, 62½,
There seems no reason to suppose that qualified males are less active than unqualified males and there

Medians for each sex for each age 15-20 and for ranges with mid-points 23, 27½, 32½, 37½, 42½, 47½, 52½, 57½, 62½,.

is little room for them to be more economically active. Thus little error should result from assuming that all males, qualified and unqualified, are equally economically active. The qualified rates involve males and females and in fact mirror the two population curves. This indicates that women have a consistent pattern of economic activity, although at varying levels for qualified and unqualified. Hence, assuming all males are equally active we can deduce the qualified female rates (given the proportion of qualified males and females) with a small expectation of error;

These were then plotted on a graph and the yearly values for ages 21-65 were read off the smoothed curve.

These points were then plotted on a graph and the yearly values for ages 15-65 were read off the smoothed curve.

Since average student earnings are used elsewhere we have put the rates to 1 for ages 15-20 for all teachers.

An identical procedure to that described above for the economic activity rates was used to derive the proportions employed.

C Expected earnings:

Teachers
Male/female
Graduate/non graduate
Primary/secondary
DES *Statistics of Education* Vol IV March 1970 (Total Population of teachers)
Medians for age ranges with mid-points 23, 27½, 35, 45, 55, 62½ were calculated;
These points were plotted on a graph and the yearly values for ages 21-65 were read off the smoothed curve;
Benefit flows for ages 15, 16, 17 taken as 0 and for 18, 19, 20, for non graduate teachers, and 18, 19, 20, and 21, for graduate teachers taken as grant £360 plus Vacation Earnings £100 = £460.

Total population
Male/female
New Earnings Survey April 1970 Department of Employment (1 percent Sample)
Medians for age ranges with mid-points: 16½, 19½, 23, 27½, 35, 45, 55, 62½.
These points were plotted on a graph and the yearly values for ages 15-65 were read off the smoothed curve.
The benefit flows for ages 15 onwards were adjusted by the "student rate" to include cash flows 0, 0, 0, 460, 460, . . . . . . . to incorporate student income into total population figures.

## APPENDIX 2.2.

"ACADEMIC STAFFING FORMULAE: WITH PARTICULAR REFERENCE TO ADVANCED FURTHER EDUCATION"

by BIRCH, D.W., CALVERT, J.R. and DAVIES, J.L.

in RESOURCES PLANNING IN THE POLYTECHNICS

NELPRESS, 1975

# ACADEMIC STAFFING FORMULAE: WITH PARTICULAR REFERENCE TO ADVANCED FURTHER EDUCATION

*Derek W Birch, John L Davies and John R Calvert*

## *The Environment*

We begin by rehearsing some of the background to the Pooling Committee's recent investigations into academic staffing levels in advanced further education, culminating in the memorandum to local authorities which sets *norm* staff to student ratio bands of 7.5 to 8.5 for laboratory-based subjects and 9.2 to 10.2 for classroom-based subjects. Serious public concern to improve the management of institutions of higher education (in terms of cost per student) is a comparatively recent phenomenon. True, as far as further education is concerned, we have had the Pilkington and Hunt Committee sitting since 1964 exhorting the system to 'do better'(1) cost-wise, but in the main, until about 1967 to 68 expansion rather than cost per student was the primary interest. During the 1960s the development of criteria for planning and assessing the effectiveness of resource allocation at the macro level in education was emphasized and the so-called *manpower forecasting* and *rate of return* schools prospered. There has long been a need for diagnostic planning and control tools at the institutional level. The staffing formulae discussed below are indicative of the switch in emphasis from macro to micro analysis in the management of further and higher education.

Tables 1 and 2 examine the growth rate in full-time equivalent students and public expenditure in higher education in England and Wales from 1966-67 to 1970-71. If we allow for the *relative price effects* of 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 is implicit if not explicit in much of the debate surrounding the polytechnic policy.

Table 1

Percentage growth per annum England and Wales students full-time equivalent.

| | 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 Further Education full-time and sandwich | 16.0 | 21.0 | 8.5 | 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 2



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 Further Education 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.

It has been argued(2) that the methods of financing higher education have in the past precluded any economic advantage from increased size. The allocation of current expenditure in the universities and colleges has been, and is, largely based on the staff student ratio. So long as this was maintained constant the best we could hope for was a situation of constant costs. As far as advanced further education is concerned current resources have been determined by class contact hours. If Burnham(3) *understandings* are maintained this again leads, at best, to a situation of constant costs.

However, there was some basis for the belief that marginal costs in advanced further education would rise, initially at any rate, with expansion. Firstly, an increase in the proportion of advanced work leads to an upgrading of a college's academic staff establishment, and these higher post gradings in turn lead to fewer *contact hours*, (i.e. on the face of it the same staff could be paid more for teaching less). Secondly, the *pooling* procedures were suspect. *Providing* authorities submit claims on the advanced pool on the basis of the following formula:

$$\frac{\text{Volume of lecturers' salaries on advanced work}}{\text{Total lecturers' salaries}} \times \text{Net college expenditure}$$

whilst *all* authorities contribute to the pool on the basis of their population and rateable value. From the providing authorities' view-point, the formula argues strongly in favour of as low a staff student ratio as is possible for advanced work. The total of *poolable* expenditure is determined in arrears and until recently no generally accepted criteria for assessing the *reasonableness* of a claim existed. In theory at any rate there were opportunities for unscrupulous authorities to *milk* the pool. As far as we know there is no evidence to suggest that this was indeed happening. However, so long as the *net contributing* authorities believed that an inequitable distribution of resources between institutions was possible there was mounting pressure for a review and a reform of the pool's operations, and an end to its *open-ended* commitment.

Referring back to Table 2 we see that over the period 1966-67 to 1970-71 the average annual percentage rate of growth in public expenditure for all higher education in England and Wales was 10.3 percent.(4) 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 *state* was bound to attract publicity. The gross national product 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 1966-67 to

£81 million in 1970-71 inevitably caused concern.

*The Development of Staffing Formulae*

The largest single element in most institutions' 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 research effort in this area.

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.

The Robbins Committee[5] identified the parameters as follows:

$T = f(s,t,h,g)$

where T = fte academic staff;

s = fte students;

t = average teaching load (formal *class-contact*) hours per week 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.

One simple specification of the relationship would be:

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

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

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

This relationship is the one postulated by John Delany[6] and is the basis for the Pooling Committee's recommendations in the *Assessment of Curricular Activity and Utilization of Staff Resources*.[7]

There are, of course, possible improvements to Equation (1). For example the total number of teaching hours 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). i.e. h = k + m

Assuming that a lecture can be delivered to an audience of 200 or more (i.e. 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:-

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

where subscripts 1 and 2 refer to first and higher degree students respectively. Equation 3 is similar to the relationship proposed by Legg[8].

Bottomley et al[9] have put forward a more generalized version similar to Equation (4) below which emphasizes the importance of the educational strategy deployed reflected in the pattern of different types of meeting:-

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

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 classification:-

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

The University of Lancaster CERI-OECD research group[10] 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):-

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

Where p = average preparation time hours per week per lecture;

q = 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 concede 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 (approximately to Equation (3)) revealed the information tabulated in Table 3 (overleaf). An analysis of variance[11] 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.

In the Spring Term of 1970 a similar survey of all further education colleges with 50 percent or more of their work at $A_1$ and $A_2$ level was commissioned by the Pooling Committee. The data 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 (e.g. science and technology etc.) and classroom-based (e.g. humanities and social sciences etc.) disciplines.

*The Uses and Limitations of Staffing Formulae*

The first and most obvious use of academic staffing formulae such as those defined above is that they provide a basis for resource provision. However, whilst individual institutions (Loughborough University for example) may apply such formulae to assess internal allocations, at a national level the distribution of academic staff resources continues on the basis of staff to student ratios.

A second use of staffing formulae, which follows directly from the previous paragraph, is that they form a basis for data collection which can be used to support staff student ratio targets. The recently introduced targets for advanced further education were (presumably) based on the data analysis of the 1970 survey. If staff student ratio *norms* are based on historical measures of central tendency then care is needed to ensure that the data is collected in a reasonably *stable-state* situation or that it is continuously updated, or, preferably, both. In the Spring Term of 1970 polytechnics were newly established and, arguably, in a period of rapid change and development. Insofar as SSRs are a function of (g) (h) and (t) and these, in turn, reflect the educational strategy deployed, it might be argued that *norms* based on yesterday's behaviour were a poor guide for tomorrow's provision and that, say, national committees charged with identifying future optimum pedagogical practice, were to be preferred. However, even if it was possible to obtain a measure of agreement from academics on optimum teaching and learning environments, the resultant standardization of practice would be at odds with the British tradition in education. There is nothing particularly golden about the mean and if all institutions were forced towards it the result could well be a triumph of mediocrity.

At institutional and sub-institutional level staffing formulae provide a means of self-analysis and a guide for future action. Faced with specific staff student ratio targets they can be used internally to examine some of the cost aspects of alternative educational strategies. From such utterances as they have made on the topic this would appear to be the use that the Pooling Committee have in mind for Formula (1). This tactic of allocating resources at the centre via an overall staff student ratio and allowing institutions to discover their own roads to salvation has the merit that it allows for flexibility and, hence, creativity in teaching and learning methods at course level. Pressure in the form of staff student ratio targets may prompt a search for alternative, less labour intensive and may be educationally superior ways of achieving the learning objectives i.e., it may prove to be an effective change-agent; whereas pressure in the form specific targets for (g) (h) and (t) might well atrophy the system in the form of present, or worse, past pedagogical practice. On the other hand, Bottomly et al[12] have demonstrated that, as far as Bradford University is concerned, supporting expansion with a constant staff student ratio could result in more staff being allocated than were necessary to maintain existing average class-contact loads. Therefore, they recommended that consideration be given to using a teaching commitment rather than a staff student ratio in calculating the extra staff necessary to support the expansion of student numbers.

The Bradford exercise is particularly interesting in that it illustrates the use of staffing formulae to investigate the potential economies inherent in various educational strategies. They studied the effects of varying various parameters on cost per student via a staff cost index (SCI):-

$$SCI = \frac{\dfrac{x.M_p.100}{t.s_p}}{\dfrac{x.M_q}{t.s_q}}$$

$$= \frac{M_p.s_q}{M_q.s_p} . 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

where x = Average salary per member of staff;

M = The number of meetings = $h_{ij}.s_j/g_{ij}$ from equation (4)

s = The number of students enrolled;

p = The original situation; and

q = The new situation.

With regard to the economies arising from the expansion of students they held the pattern and types of meetings, the tuition loads, and the teaching loads constant (i.e. the *quality* of the teaching inputs to the educational process was unimpaired) and discovered that, over the eight departments investigated the SCI fell between 52 percent and 82 percent with an approximate doubling of enrolment. This result is due to the potential economies inherent in the open-ended (in terms of the numbers of full-time equivalent students) lecture. However, the extent to which a class can grow without diminishing the educational effectiveness of the teacher is a moot point. The importance of an abundance of small class teaching is nevertheless not yet proved.

*'Naturally, it is harder to teach more students than it is to teach less, but the prevalent ideas about this subject are scarcely based on rational analysis. Some time ago a colleague and I studied the matter briefly and interviewed a good many teachers and other educators. We concluded that, according to our informants, the optimum size of any class is three less than are in it, and we came away with the impression that each teacher can name the three he wants out.'* (13)

*Some Questions Needing Answers*

If an organization wishes to operate effectively and efficiently it will seek that combination of activities and allocation of resources which maximizes its objective function. To move towards this state it must, firstly, be agreed on its targets; secondly, it must be able to specify and measure its inputs, immediate outputs and ultimate impacts on the wider society; and, thirdly, it must be able to define its processes and establish the relationship between its inputs and outputs. As far as educational institutions are concerned they are some way off such a complete specification of their production function. Most of the work done so far has been in the area of inputs

Table 3

<u>Student hours per week scheduled, group size and teaching load hours per week by subject field</u>

| 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) | - | - | ( 0) | - | 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 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 1971 and teaching processes and the major attention has focussed on the deployment of academic staff.

The academic staffing formulae discussed above have implicitly defined output in terms of (s) the numbers of full-time students. Moreover they have taken as the system's objectives either maintaining constant the academic staff cost per full-time student, or (hopefully) minimizing this cost or maximizing the full-time student throughput for a given level of academic staff expenditure. The studies have demonstrated some of the economic consequences of particular learning and teaching environments as reflected in the pattern and sizes of formal staff student meetings and teaching and tuition loads. The economic effects of the implied trade-offs between academic staff on the one hand, and technician staff, space and equipment on the other, have yet to be explored; as have the educational consequences of alternative pedagogical strategies from the traditional mix of staff supervised lectures, tutorials and laboratories at one end of the spectrum to the student-orientated programmed learning and resource-centre based environment at the other. We know that an increase in the average class size and a reduction in students' tuition loads will lead to savings in academic staff but what will be the effects on examination pass-rates, students' wastage rates and students' ultimate employability? If the quality of the educational process and its outputs is to be maintained how far would savings in academic staff need to be offset by increased investment in technician staff, library facilities and the hardware and software of educational technology? Can we identify and meaningfully categorise the alternative learning and teaching strategies? How much will they cost and what effects, if any, will they have on outputs? Can we agree on the recognition of the system's outputs? Is the output merely the number of full-time students; or is it the number of successful graduates; or yet is it the purpose of an educational institution to maximize the *learning gain* as measured, say, by the difference between points on an A-level scale at entry and class of degree at exit? Is a college effective if both its examination pass-rates and its contributions to graduate unemployment are high? We have hinted at some of the difficulties of constructing performance indicators on the educational and economic planes, how then do we begin to recognize the system's contributions on the cultural and social fronts? These are a few of the many questions which need ultimately to be answered or at least attempted.

It is likely that large parts of the system will not be susceptible to quantification in the normal sense but hopefully 'subjective judgements may be ordered and categorised even when they cannot be placed on a calibrated scale.'(14) What is important is that we attempt to sort out those areas which can be quantified to leave exposed those parts which cannot for discussion by all the interested parties. Even if we could specify the relationship between inputs and outputs precisely we would still have to make judgements on the scale of activity and the levels of resource allocation:-

'How much money should be allocated to a programme depends on what outputs and effectiveness would emerge if various amounts were to be spent - a question of fact - and on what increments in output and effectiveness the decision-makers feel are worth the extra money - a question of taste. How much output or effectiveness should be sought depends on how expenditures would change if various levels of output or effectiveness were to be sought - a matter of fact - and on which increments in expenditures the decision-maker feels are justified by the extra output of effectiveness - a matter of taste.'(15)

The staffing formulae for higher education developed in the UK in recent years have been in response, in part, to increasing pressures to cope with *more* with *less more* resources. They have examined only part of the total system and to that extent they may have come up with sub-optimal answers. However, they provide useful conceptual frameworks for further research and development.

*The Immediate Position*

The foregoing survey has attempted to trace the development of thought on performance measures in higher education. However, at this point in time, polytechnics are confronted with a problem of strategic and tactical dimensions: how to react to the Pooling Committee recommendations. Much as one may dislike or welcome the document, it seems to us that it is impossible to ignore it. At one level, its acceptance by LEAs and Governing Bodies obviously determines the global staffing which will accrue to the institution, and if one faculty is hopelessly over the top in terms of its staff student ratio, the potential for growth of other faculties is likely to be seriously curtailed. If the concept of the norm factors is accepted and investigated within an institution, the repercussions are likely to be even more profound in terms of the questioning of the way in which the learning process is set up; the deployment of staff; processes of marketing courses etc. Those who claim to be ignoring the document or dismissing it as being unworthy of attention are, in fact, doing nothing of the sort: they are merely accepting the global ratios set out (1:7.5-8.5, and 1:9.2-10.2) and not implementing anything else. Staff student ratio, of course, is not a new concept or practice, either for planning staff establishments or for control purposes. It is subject to the usual changes of *creeping incrementalism,* of course, which may be levelled against any budget based on forward projections from the status quo.

Thus, the Pooling Committee's recommendations on staff student ratio bands based on equations (1) and (2) above have caused the polytechnics to recalculate their staff student ratios according to the new formulae and to compare their positions with the *norms*. It is too early to assess the precise nature of subsequent decision-making but two distinct groups of reactions are likely - those based on problem-resolution through devices which are primarily *cost* orientated; and those based on producing more favourable cost effects through a thorough-going analysis of *educational* objectives and alternative learning strategies and teaching models. In the short-run it is probable that the former reaction will be in the ascendancy exhibiting the following characteristics:

The substitution of capital (equipment etc.) for labour.
The substitution of student initiative for staff supervision (technicians/clerical),
The substitution of low cost labour for high cost labour (teaching staff).
An increase in the intensity of labour utilization.
The non-filling of academic staff vacancies and the re-education and subsequent redeployment of staff in other related disciplines and departments.
A closer look at the efficiency of the marketing function with a possible change in priorities, e.g. a search for full time equivalent student-worthy courses and increased enrolments in low cost (in terms of academic staff) subjects.
A curtailment of the option range in courses.

In themselves, each of these are perfectly valid activities, since they attack an immediate problem by attempting to reduce staffing costs and increase student numbers, and it is arguable that polytechnics ought to have been striving after such economies anyway, with or without the stimulus of the Pooling Committee. However, in the position of reacting to an immediate problem, it would be unfortunate if precipitate action, justifiable in cost terms, neglected other significant factors. In particular:

1. The primary aim must be to maintain and extend the academic excellence and social responsiveness of the institution.
2. Any staffing adjustments require a humane and supportive personnel policy.
3. Staff with managerial responsibilities ought to be induced with the incentive to be cost-conscious and economic in their planning and deployment of staff (consistent of course, with their educational goals). Staff who design and run courses are making various types of decisions but it is debatable whether resource consumption is a factor high in their minds. At present, there are no such incentives, and it is not the purpose of this paper to consider them. However, the notion of cost centres within departments has something to commend it.
4. To facilitate 2 and 3 there should be an increased investment in attempts to establish: a finer definition of output than the numbers of full-time equivalent students, and the extent to which it is possible to make substitution in input and the relationship between inputs and outputs.

*The Future*

It is one thing to tear apart the attempts to Bottomley, Delany, and others, to develop an analytical system; we are all conscious of the pitfalls. It is rather more difficult to be more constructive, and it is the contention of the authors that the problem needs to be approached thus;
establish the nature of the educational objectives of one's activities, in behavioural terms;
identify a range of alternative instructional and learning models which would enable these objectives to be fulfilled;
cost these alternatives;
select that which offered the optimum in terms of educational benefits and resource consumption.

The accompanying Appendix indicates a range of such alternatives, principally drawn from American sources,[16] and not at all complete. (It omits reference to the Keller Plan, for instance, which is finding appropriate application in the UK). Clearly, a considerable act of judgement has to be made at the conclusion of the analysis; in educational decision-making it was ever thus. However, the judgement is clearly directed primarily towards educationally-based alternatives, not cost-based alternatives.

One of the fears of the authors in the current situation is that analytical experiments will be rejected out of hand. This is disturbing for two reasons. First, it is contended that this is a process which we must go through to find out more about ourselves and what we are doing. If we can learn from these experiments and find a method that satisfies a series of acceptable criteria, a great deal will have been achieved, but the criteria needs a great deal of thrashing out first. Second, Robbins based a number of his assumptions on the management and government of higher education on the notion of the *academic self-governing community*. This involved freedom, but also responsibilities, one of which was to manage resources carefully and effectively. In the stretching of infant wings, polytechnics would be well advised not to be too arrogant or insensitive of external perceptions, by LEAs, DES etc. If we reject a whole series of planning devices, do we not have an obligation to produce one of our own?

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11 The Null Hypotheses that: (i) The total number of teaching hours provided for first degree students does not vary according to subject field; and (ii) The 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 41 and p 45 *Subject Field and Regional Variations in Student-Staff Ratios, Academic Programmes and Recurrent Expenditures* B Fredriksen CERI-OECD Paris, 1971

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13 J A Kershaw 'Productivity in American Schools and Colleges' in Blaug (Ed) *Economies of Education* Penguin Books, 1969

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Figure 1 A SYSTEMS MODEL OF AN EDUCATIONAL INSTITUTION AND THE CONTEXT OF ORGANIZATIONAL EFFECTIVENESS

Figure 2: Alternative instructional models

1 *Conventional Model*

Traditional mix of lectures, tutorials, lab. work.
Common course for all students moving at same speed.
Generally: High priced labour consumption (low use of support staff).
Passive students.
Intensive for staff and students.
Capital a supplement for labour, not a substitute.
Poor use of equipment.
Quality questionable - inefficient use of individual time.
No incentive to learn.
Incentive to *pass*.
Fragmented use of time.

2 *Ruml Model*

Emphasis on large lecture groups for ½ course, supplemented by intensive tutorials.
Generally: Concentration of academic offerings into major areas of excellence.
Considerable reduction of smaller courses and options.
Labour productivity high, but also reduced loads.
*Star* lecturers, + *pastoral* academics + assistants (C + Burnham!) salary savings.
Capital costs lower - larger rooms
Higher utilization of teaching and library facilities.
Lower instructional costs.
Quality unclear: Complaints of large classes + impersonality.
No active encouragement of *fringe* subjects.

3 *Programmed independent study model*

Broad-frame syllabus within which student pursues tailor-made programme.
Considerable latitude for students - lecturer a resource centre/consultant.
This would replace ½ existing curriculum.
Generally: Savings in staff.
Role change for staff.
More courses possible with same staff (?).
Less capital cost for classrooms - more for individual work space.
Considerable potential for raising quality of instruction.
Active students.
But - students unable to take responsibility rejected?
Or increased individual supervision time which would negate savings.

Figure 2: (Continued)

4 *Bakan Model*

Compressed + unstructured curriculum + extensive use of tutorials.
Arrangement of curriculum so that tutorials used without undue cost.
Student free to select from a list of courses + develop individual plan of study per term.
Staff free to decide own role + frequency of activities, for
determining student assignments;
review progress;
evaluate results.

5 *Kieffer Model*

Creation of courses based on
programmed learning and instructors;
students selection of pace of work;
sequential phases (with instructions, assignments etc.);
learning resource centres.

Independent study base differing from 3 & 4 in that
it requires heavy preparation by staff: 1 year in advance;
staff must be experienced in learning behaviour;
major investments must be made in software and hardware;
major investments must be made in support staff;
individual staff are denied much creativity in actual operation of programmes.

Effects of increased labour productivity;
increased labour savings (by capital substitution);
more integrated courses;
maximizing learning momentum;
behavioural objectives for courses;
teaching students how to learn effectively.

| Summary<br>Instructional Model | Labour costs | Capital costs | Labour intensity | Relative labour productivity | Rel. cost of outputs | Rel. quality of outputs |
|---|---|---|---|---|---|---|
| Conventional | H | M | H | M | MH | M |
| Ruml | VH | M | H | VH | ML | M |
| Programmed indep. study | H | M | M | H | M | MH |
| Balkan | H | M | H | ML | H | MH |
| Kieffer | H | H | M | H | H–VH | MH |

## DISCUSSION

The principal issues arising were as follows:

**Dr Jones, Bolton Corporation**
I cannot help feeling that the whole issue is being made considerably more complex than it need be. Educational planning, as has been indicated, primarily requires a policy stated in clear, unequivical terms. It seems that the whole debate around the Pooling Committee activities has produced a massive smokescreen, designed to cloud the issues, not expose them. The purposes of the document itself are unclear and, in fact, there are two documents. One is the memorandum issued by the Pooling Committee to LEAs referring to explicit staff to student ratios for the two groups of norm bands for classroom and laboratory based facilities respectively. We can argue about them, but they are defined. The second document, the *psychedelic* book, is the one which has produced the confusion. It has impossed false measures of quantity, and ignored aspects of quality. The problem is that one can spend considerable time on this measurement, and it will take one no way forward in policy planning.

Furthermore, the emphasis on linking staff allocations to student hours is inflationary, and encourages overteaching, to inflate student hours, and thus obtain more staff.

**T Burgess, North East London Polytechnic**
I also feel that the whole thing is being made very mystifying when it is actually rather simple. We can leave aside the Pooling Committee's document, whichever version we choose, because the staff to student ratio does not depend on any factors. It depends on the number of students and the number of staff. A government may wish to say that when higher education expands it must do so with fewer staff per student. A polytechnic may say that in order to serve the community it will take on more students than other polytechnics take on with that number of staff. How can either of those things be affected by all these elaborate calculations contained in the paper or Pooling Committee document? Furthermore, how can we proceed if we regard student places as an output of our system?

*Response by J L Davies*

Can we first respond to the question of simplicity and complexity. We have observed in the paper a situation where various people have been attempting to analyse what the factors are which are likely to determine the requirements of staff within a polytechnic. Thus, it is apparent to us that the norm formula is being used both for planning and diagnosis, and this is clearly one of the sources of confusion. In the diagnostic situation, people have begun to look at the learning process in higher education and at how the learning process has been set up. The learning process, it is contended by various people who are quoted in the paper, has been set up presumably with some educational assumptions and objectives. But some learning situations appear to be more costly than others as a result of the way in which one working week for the student is evolved in terms of the way in which students are timetabled *eyeball to eyeball*. Relative costliness of courses may be a result of the high amount of time which staff actually spend in a teaching situation, or the fact that one may have a large number of small working groups. Each of these factors is likely to mean that staff consumption is high, and therefore resource consumption will rise in estimate terms. These are the findings of all the various researchers which we have analysed within the main document and Professor Bottomley's paper also demonstrates this. Now it is of course true that if one is concerned with planning future projections of staff, the conventional staff to student ratio is perfectly adequate. If on the other hand one is trying to diagnose areas of inefficiency in resource consumption, the norm factors are more useful. Certainly, it becomes more complicated. Would we argue that polytechnics are simple institutions anyway? Complexity comes from the problem itself.

Presumably we all have our own methods of allocating resources between departments. In my experience, few polytechnics do not have as one of their criteria the extent to which departments are over or understaffed, and this is usually assessed against some ratio or another. This is normally tempered by the natural urge to make resources available to enable developments to take place before student numbers have been produced, and I see nothing in the Pooling Committee document which prevents this. What I would say is that the excellent original analysis of abnormal factors, which explained variations from the norm, has been omitted from the final document, which quite clearly detracts from its appeal.

Mr Burgess criticized our using *provision* as a form of output or as a result of the educational organization's activities. In my view, the term *output* is far too simple a term since it has been used to contain many different concepts, which need separating. The Polytechnic, as I see it, takes in raw resources of finance, space, equipment, staff, and converts these into an integrated provision of student places, which can be measured in terms of quality, quantity, location and type. The student then makes a *behavioural response* to this provision by deciding to use the facilities or not, and this can be assessed in terms of involvement, wastage, dropout, etc. Furthermore, his response may be improved as a result of the provision. As a result of being improved, there may well be a longer term *impact*, both on himself and society at large.

If we are interested in using this model for planning or assessment purposes, it is important to try to detect casual relationships between these three elements, and this requires considerable social, economic and pedagogical information. I would, of course, entirely accept the point that it is a device to test whether a policy aim (impact) is capable of being fulfilled by a host of subsidiary activities, and not a substitute for them.

D Birch, Loughborough University
Essentially, the Pooling Committee document aside, there are two ways of looking at staffing establishment. The traditional way is the staff to student ratio; the more students you have the more staff you are entitled to. The alternative way of deciding upon a staffing establishment is to look at the teaching commitment, where it does not necessarily follow in those circumstances that you, with an increase of students, should get a proportionate increase in the number of staff required to cope with them. Instead, it may be the function of the three factors identified. It depends where you want to start. What cannot be dismissed is that resources in higher education are limited, and that cost-effectiveness, if practised sympathetically within the institution, should be to everyone's advantage, including the student.

N Garnham, Polytechnic of Central London
I would like to offer a slightly alternative interpretation of the purpose of this exercise. It is characteristic of analytical techniques that they are complex. The purpose of the complexity is actually to fog the issues. It is a political device used to disguise the real conflict of interest in a situation. Now I think we have a real conflict of interest in higher education at the moment. On one hand there are institutionalized teachers with a large body of people who have, comparatively speaking, a comfortable life and good salaries which they wish to protect, and this is perfectly understandable. On the other hand we have had a series of governments who have been committed to an ideology of education which says "Education is a good thing; we must have more of it but the trouble is we cannot pay for it." In fact education, particularly higher education, protects a hierarchical and devisive social structure, but governments cannot openly discuss this situation because electoral pressures would be so colossal. Therefore both sides have an interest in putting up a smokescreen of jargon to disguise the real conflict of interests. The jargon will continue, in fact it will grow, until the conflict of interests burst open. The sooner these conflicts are discussed openly the better for all of us.

D Heeley, Department of Education, Dublin
I feel we are neglecting one important part of the paper. In order to attain certain objectives there are various strategies that can be adopted. In education we must be prepared to look at alternative models and alternative modes of operation, as the paper indicates. I would think that one of the problems in this exercise is to evaluate the relative quality of the alternatives postulated and to select appropriate criteria.

*Response by J L Davies*

The particular examples of learning methodologies quoted are taken from developments in liberal arts colleges in the United States. In state government they were faced with the same sort of problems as we are now, namely, the attempt to impose some sort of staffing and efficiency controls from the outside. The criteria used included the extent to which they fulfilled educational objectives in relation to student needs; labour costs; labour productivity; capital costs (space and equipment) among others. I am interested in the alternative learning methodology approach because it starts from educational policy premises, rather than the demands of economic crises - a rather more convivial starting point!

Nevertheless, let us not forget that politically we have an immediate situation in polytechnics where we have to decide what we are going to do as a matter of tactics, in response to the Pooling Committee Document. Numerous options are open: You could tear the whole thing up and have nothing to do with it. I have not seen any polytechnic authority which has, despite the bold words uttered in this debate! What we tried to identify in the paper were quite different responses, some are cost solutions, others stem from a basically educational orientation, and I am not particularly defending one of these responses against the other. I would prefer, naturally, to start from the premise of the alternative learning methodologies described in the paper, which stem from policy and argue costs from there. But it cannot be denied that, arising from this particular document and its implications, a number of institutions may be having to think about things like identifying student need, staff redeployment and development in particularly difficult areas in a more accelerated manner than they would have liked! Not every consequence of this movement is necessarily evil.



In many ways we have a reaction which one finds in any professional sector. If certain awkward questions are asked by external agencies, we tend to put up defences and argue the irrelevance and ignorance of the external agent. I think we would be unwise to judge this therefore on emotional grounds, and very unwise to put up the barricades to prevent a thorough examination of our management practices. Failure to recognize the force of environmental opinion and public accountability could be damaging in the long term.

APPENDIX 2.3.

"A NOTE ON ACADEMIC STAFFING FORMULAE"

by BIRCH, D.W. and CALVERT, J.R.

in EDUCATIONAL ADMINISTRATION BULLETIN

3, 1, AUTUMN, 1974

PLUS

"ACADEMIC STAFFING SCHEMES RECONSIDERED

- A COMMENT"

by BIRCH, D.W. and CALVERT, J.R.

in EDUCATIONAL ADMINISTRATION BULLETIN

3, 2, SPRING, 1975

Derek W Birch
and
John R Calvert,
University of
Technology,
Loughborough

# A REVIEW OF ACADEMIC STAFFING FORMULAE


## Abstract

A number of recent studies in the UK have developed academic staffing formulae on the basis of the institution's teaching commitment rather than its recruitment of students. We review these formulaea and examine their uses and limitations and conclude that they are useful more as situation analysis tools than as resource allocation devices


## Introduction

The largest single element in most educational budgets is academic staff. Therefore, in the context of the increasing demand for education, the questions of how to calculate the total requirement for academic staff and to allocate this nationally between competing institutions and departments within institutions is of some importance. The traditional academic staff resource allocation and control device in colleges of education and universities is the student staff ratio. Jn further education the complex pattern of student attendance and the high incidence of part time teachers had led to staffing on the basis of student hours at the various levels of work and divisors which reflect the "understandings" on the agreed "class contact" of the various grades of staff appropriate to these levels of work. However, the Pooling Committee has recently recommended staffing norms for advanced further education in the form of student staff ratios.[1]

Lacking any agreement on real output measures educationists have tended to argue that the quality of the learning and teaching process can be measured by the inputs to the system and, in particular, by reference to the largest input - the teaching staff. Intuitively one supposes that small classes are better educationally than large ones, but, whilst some direct and personal

1 "Memorandum from the Pooling Committee on Student/Staff Ratios for Advanced Level Work in Polytechnics and Colleges of Further Education": distributed by Association of Education Committees in August 1972:

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

contact between teacher and student is important, the case for an abundance of small group teaching is not yet proved.

Since a number of items in the college budget seem to be positively correlated with the expenditure on academic staff, supporting an expansion of the service by a constant student staff ratio would tend to result in constant marginal costs. Underlying the debate on educational expenditure, however, is a view that there are economies of scale to be had. No doubt inspired, in part at least, by the possibility of tapping some of these a number of recent studies in the UK have analysed the factors which determine the requirement for teaching staff in higher education.

The Staffing Formulae

All the investigations are agreed that the requirement for academic staff is influenced by (a) the students' tuition load; (b) the teachers' teaching load: and (c) class sizes. One simplification of the relationship would be:-

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

where T = the number of full-time equivalent (fte) staff

s = the number of fte students

g = the average group (class) size

h = the average tuition load (formal time-tabled "teacher contact") hours/week/average group (g) and

t = the notional teaching load (formal time-tabled "class contact") hours/week/fte teacher

whence the student staff ratio (SSR) is defined as:-

$$SSR = \frac{gt}{h} \quad \ldots \quad (2)$$

Equations (1) and (2) form the basis of the Pooling Committee's recommendations on data collection and analysis for further education.[2] They were also the basis on which the Pooling Committee examined the staffing of advanced level

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2 See: V.J. Delany 1971 "Cost Efficiency Indicators in Further Education" Association of Colleges of Further and Higher Education: and "Assessment of Curricular Activity and Utilisation of Staff Resources in Polytechnics and FE Colleges" Councils and Education Press 1972.

(first degree level and above) work in polytechnics and colleges of FE in the Spring Term of 1970 (the results of which presumably supported the student staff ratio "norms" referred to in the first paragraph) and again the Spring Term of 1973.

The parameters h, g and t may be said to define, in part, a college's educational strategy. To some extent t is the result of agreements between the employers and the employees' unions but decisions on h and g are, quite properly, institutional decisions within the province of the academics. Once h, g and t are set, and given s, then T the requirement for teaching staff follows.

Plainly equation (1) is capable of improvement. In higher education at any rate there are occasions in most "course" timetables when the class has no theoretical maximum size - accommodation constraints apart, the "straight lecture can often be delivered as well to 400 or more students as it can to 40 or 4. Consequently the total number of teaching hours provided per week (h) might be divided into hours given in the form of straight lectures (k) and hours given in smaller group situations called, for the sake of a name, seminars (m) i.e. $h = k + m$. The average group size (g) now refers to the seminar group size. Thus with two levels (say undergraduates and postgraduates) equation (1) might be rewritten -

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

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 emphasises the importance of the pattern of a whole range of meeting types - lectures, seminars, tutorials, laboratories, etc.:-

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

where $h_{ij}$ = average number of formal tuition hours/week received by each type of teaching meeting i in the jth year of a programme of study

$s_j$ = number of students enrolled on the jth year of a programme of study and

$g_{ij}$ = maximum size of each type of meeting i in the jth year of a programme of study.

The University of Lancaster CERI-OECD research group (M.G. Simpson et al 1971) developed a model which takes account of lecture and seminar preparation and "post-mortem" time as well as the actual timetabled student-teacher contact time and derived a relationship roughly similar to equation (5):-

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

where $p$ = average preparation time hours/week/lecture

$q$ = average preparation time hours/week/seminar;

$r$ = average number of seminar "repeats"/week/member of staff; and

$u$ = average post-mortem time/student/week.

They experienced difficulty in collecting data on preparation times and conceded that a teachers' 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 (along with administration and research) of the reciprocal of t.

The implications and limitations of the formulae

The student staff ratio suggests that the basis for staffing is the number of students - an increase in students should be followed by a proportionate increase in staff. The staffing formulae described above, on the other hand, suggest that the basis for determining and allocating teaching staff resources should be the timetabled teaching commitment: an increase in students may not lead to a proportionate increase in the timetabled meetings of students and staff, and, therefore, may not necessarily need to be supported by a proportionate increase in staff. For example the Bradford University group (Bottomly et al 1971 p. 125) were able to identify potential economies in academic staff in the ten "courses" examined of between 52% and 82% with an approximate doubling of enrolment. Since the course structure (size, type and frequency of timetabled meetings) was held constant these savings arose largely from taking fuller advantage of the straight lecture.

There is no doubt that the formulae highlight some of the economic consequences of particular learning and teaching strategies so far as these are reflected in the pattern and sizes of formal timetabled meetings, and teaching and tuition loads. A cursory study of equation (1) reveals that we can effect economies in staff by increasing the average size and/or the teachers teaching load and/or by reducing the students' tuition load. However, what the equation does not reveal is what effect this will have on the quality of the process on, say, students' wastage rates, their examination success rates, or their ultimate employability. If we are to maintain the quality of the educational process (so far as this is measurable) how far would savings in teachers have to be balanced by increased expenditure on, say, library spaces and the hardware and software of education technology?

There is a considerable and growing body of opinion which supports the substitution of student initiative for teacher supervision but this does not mean that the teacher is increasingly redundant. What it does mean is that he spends more time thinking about what? how? and when? and less time with "chalk and talk". Professor Ackoff (1968) argues that the objective of education is learning not teaching and "the best way for a student to learn a well defined and recorded body of knowledge is to teach it to another." Therefore, he envisages small groups of students organised into "learning cells" sharing the responsibilities for teaching each other. He did not thereby envisage the faculty disappearing from the campus, rather they would be busy preparing bibliographies and material to be learnt and available like the books on the library shelves for consultation. In sum, savings in the students' tuition load have to be offset by a reduction in the teachers' teaching load consequent upon his being busy with other but equally important things:- the result may be educationally superior but it does not necessarily result in savings in academic staff.

Security of tenure means that in the short run a college's teaching staff is fixed, the institution is, however, able to plan and effect changes in the parameters g, h and t. If we rearrange equation (1) some of the economic consequences of this exercise are identified:-

$$T\left(\frac{gt}{h}\right) = s \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

If in the short run T is constant any manipulation of g, t and h will produce a change in s. From a cost viewpoint presumably the only change we are interested in is an increase in s, i.e equation (6) invites us to maximise the number of student places However, the purpose of education is not just to accommodate students but to bring about some change in them. Ultimately what we need to understand is the relationship, if any, between the various patterns of timetabled meetings of staff and students (and for that matter the other inputs) and the economic, educational, cultural and social "value added" to the students between their entry and exit. The major features of the system are illustrated in Figure 1 (See Page )

Thus far attempts to specify the education production function have concentrated on the inputs and processes. It is not easy to obtain agreement among educationists on their aims and objectives and therefore, on the identification let alone the measurement or weighting of the outputs and benefits. Most progress has been made on the recognition of the economic impacts of education, but few would argue that increasing the students' lifetime earnings or the nation's GNP were the only, or even the major, purposes of further and higher education: the maintenance and enlargement of the stock of knowledge, the advancement of culture and the improvement of the "quality of life" are all claimed as legitimate missions. This being so it is unlikely that we shall ever be able to quantify the system exactly, although in time we may devise plausible weightings and rankings of the outputs and benefits. Meanwhile we must be content with partial and, therefore, possibly sub-optimal answers.

## Conclusions

Plainly academic staffing formulae will give us partial answers since they are concerned with only part of the system. In the short run, as indicated

Components of the Teaching System

FIGURE 1

**OBJECTIVES**
Educational
Economic
Cultural
Social
Political

**INPUTS**

(i) Students: knowledge, skills, aptitudes, attitudes, expectations at entry: socio/economic background.

(ii) Staff: Academic, pedagogical, administrative technical, managerial competence and experience Expectations:

(iii) Physical Facilities:- space, equipment:- learning, teaching, cultural, recreational

**PROCESSES**

(i) The Curriculum/Learning Environment: The pattern of formalised "meetings", teaching and tuition loads pedagogical strategies and tactics - e.g from traditional mix of staff supervised lectures, tutorials and labs at one end of spectrum to student orientated programmed learning and resource centre based environment at the other

(ii) The Assessment/Licensing mechanisms/criteria: assignments, tests, exams etc.

(iii) The "Organisation": Management structure + process, "style", + "ethos", etc.

**OUTCOMES/OUTPUTS**

(i) Immediate: Provision of learning opportunities: "Places" on an organised curriculum. Response=applications → Enrolments

(ii) Short Term: Graduates Students: knowledge, skills, aptitudes, attitudes, expectations at exit

(iii) Longer Term: Impacts on GNP/Life time Earnings: Cultural and Social dimensions.

above, they take one input, academic staff, and then via an analysis of parts of the process (i e the pattern and sizes of timetabled meetings) they determine a second input, student places which is then implicitly defined as an output They ignore the trade-offs between academic staff, on the one hand, and the other inputs - technician and administrative support, space and equipment, on the other, and implicitly, relegate research from a primary to a residual activity. The simple head count of student places, as an index of output, avoids through lack of knowledge the complexities of "value added" measurement but it does recognise some of the "consumption" aspects of the educational process

The Bradford study (Bottomly et al 1971 p 125) strongly recommended the allocation of staff on a teacher commitment rather than a student staff ratio basis. It is possible that this tactic would encourage departments to set up their courses so as to make the maximum use of the teacher inputs and would thus be self-defeating from the point of view of economy in this resource We would have thought it preferable to continue with the allocation of staff on the basis of the student staff ratio In the future it is probable that this ratio will become less favourable in terms of staff provision Faced with these pressures the departments might use the alternative staffing formulae to examine the academic staff cost consequences of various patterns of timetabled meetings i e the formulae are useful more as situation analysis tools than as resource allocation devices Ultimately the "encouragement" to extend the search for alternative ways of achieving the educational objectives (to substitute capital for labour, student initiative for teacher supervision, to re-examine the proposed extension of the option range and so on) comes from a "worsened" student staff ratio rather than the allocation of academic staff on the basis of a teaching commitment.

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D W Birch
and
J R Calvert,
University of
Technology,
Loughborough

Comment

It seems to us that Alan Crispin has missed the point of our argument and, on re-reading our article, we are not at all sure that we succeeded in making it. Our position was, and is, as follows:-

1. We start with the premise that the system is interested in improving efficiency.

2. Improved efficiency is achieved if an institution produces more outputs (graduates, research, public service or whatever) with the same inputs or a less than proportionate increase in inputs or, alternatively, maintains the same outputs with fewer inputs. However, the measurement of output in education is suspect, so the system falls back on a strategy of cost effectiveness: i.e. given two or more ways of achieving an apparently identical output it chooses the least costly method.

3. The major activity of education is teaching: teachers are the largest input to this activity and students its "outcome": ignoring the difficulties of assessing the "quality" of both teachers and students, the cost effectiveness relationship between them is established by the student staff ratio.

4. The centre - be it the Treasury or the DES via the UGC, the Advanced Pool, or individual LEA's - may achieve economies in this activity by operating on the staff student ratio.

5. This does not mean that student number and teaching commitment models are inappropriate in assessing the equity of staff allocations between departments within an institution. On the contrary we believe these formulae (whether expressed algebraically or "sold" via diagrams) may be of great value in helping academic policy makers understand some of the economic implications of their pedagogical strategies and tactics. Nevertheless, so far as the central resource allocation bodies are concerned, we maintain that the staff student ratio remains a simple and effective mechanism for achieving savings in academic staff.

6. We fully endorse Crispin's reservation concerning the application of quantitative analysis "without some overriding qualitative judgements". Education modelling is in its infancy. A great deal remains to be done before we can unscramble the complex relationships between inputs, processes and outputs. 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 peoples' inherent need to bargain their way to a consensus. Nonetheless quantitative data, no matter how partial a representation of the system forms a base from which the political process can start. It is important, however, that this data base is objective and, as far as is possible, beyond dispute. Ranking and weighting systems are, we believe, part of the political process. Ideally they should be debated and agreed by all the parties at the bargaining stage - not built into the formulae by a privileged few. Furthermore, these "fudge factors" are not the tablets brought down from the mountain immutable and unchanging - rather they should be continuously reappraised. Finally, when the academic policy makers have heard the special pleadings and agreed the incidence and extent of subsidies and deprivations, a careful audit of the effects at the quarryface is desirable. The social implications of the application of resource formulae is a potentially fruitful area for research.

We conclude with two sets of questions.

Firstly, let us consider student number schemes, which all lead to the student staff ratio. In polytechnics, further education, and universities, the calculation of students is bedevilled by the complex pattern of attendance. In such circumstances we prefer a straight head count grouped under appropriate headings - full time, sandwich, part time day and so on. The alternative - the FTE concept - involves either a weighting system (see Burnham Reports) or the use of some device such as recommended by the Pooling Committee (1971), i.e.

$$\text{FTE's} = \frac{\text{Total Institutional Curricular Hours}}{\text{Average Curricular Hours of a Full Time Student.}} \quad \ldots\ldots\ldots\ldots 1$$

These sorts of approximations are reasonable when one is considering the total institution but may lead to problems when assessing allocations within the institution. A not untypical situation is that in which a significant amount of service teaching is further complicated by "joint meetings" (i.e. meetings involving more than one course drawn from across departments)* . Suppose for example, the economics department offers service teaching to the engineering departments. Are the average curricular hours of a full time student (equation 1 above) to be those of an average economics student or an average engineering student? We know different disciplines have very different timetable loadings (Fredriksen, 1971).

We approve of the Table of Comparative Staffing employed by Sheffield. It seems to us to be a good point from which to start the annual (and quinquennial) internal debates on resources. But how do they measure students? Is there no service teaching problem at Sheffield? Having coped (somehow!) with the measurement of students the regression lines merely identify existing trends. The intriguing fact about these is the different behaviour of departments below and above size 30 staff. We would have liked more information about this aspect.

So far as Aston's approach is concerned, what is the basis for counting "each hour contributed by service departments to four year sandwich courses... as 1/32nd of a student unit?" Why should undergraduates and postgraduates be weighted differently? Do postgraduates always impose a heavier burden on their teachers? There are a number of examples in our own institution of postgraduates and third year undergraduates attending joint meetings for part of their taught programmes. More importantly who decides these weightings and when? Once imposed are they there for all time?

Secondly, in discussing workload or teaching commitment approaches, Crispin concentrates on a description of a proposed model for an institution which is not named - although it seems familiar to us! He has posed a

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* About 40% of our own departments' teaching is service teaching. At Loughborough in 1972/73 the tuition load without joint meetings would have been 129,980 hours: in the event joint meetings reduced this to 71,251 hours.

number of questions himself - questions we think entirely valid. Therefore, we will content ourselves with just two more:- Firstly, if we amend the model as he suggests to draw the line of "teaching credits" through the origin, how do we decide its slope? Secondly, it is proposed apparently to have several graphs, one for each type of meeting - lecture, tutorial, laboratory: if the approach has any justification at all it seems to us to be the fact that it recognises the size of the student group as an important variable. Hence why should a "lecture" to 20 be credited any differently to a "tutorial" to 20? From the point of view of the teaching techniques likely to be deployed it seems to us that the critical factor is the number of students in the group rather than its timetabled description. We can see no point in reinforcing the myth of a lecture to five and a tutorial to fifty!

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APPENDIX 2.4.

"A PROPOSAL FOR A MANAGEMENT INFORMATION SYSTEM FOR FURTHER EDUCATION"

by BIRCH, D.W. and CALVERT, J.R.

in INFOBANK NO.1195
FURTHER EDUCATION STAFF COLLEGE

Info. Bank No. 1195

# A PROPOSAL FOR
# A MANAGEMENT INFORMATION SYSTEM FOR FURTHER EDUCATION COLLEGES

CONTENTS

SECTIONS



Derek W. Birch
John R. Calvert and
Further Education Staff College.

August, 1976.

I.B.N. 1195

# A PROPOSAL FOR
# A MANAGEMENT INFORMATION SYSTEM FOR FURTHER EDUCATION COLLEGES

## ABSTRACT

1.1 This paper explores the possibilities for developing a Management Information System (MIS) with general applicability to Further Education in England and Wales and with the following objectives:-

a. to facilitate institutional planning and control from 'course' level upwards;

b. to be compatable with LEA and DES data requirements and management needs;

c. to be capable of enhancement i.e. to be a first-stage in a multi-stage development to a total integrated system; and

d. to be amenable (so far as is possible) to 'hand' as well as computer manipulation.

1.2 We begin with a brief review of the 'state of the art', a conceptual framework is then developed and finally a first stage solution is outlined and illustrated.

1.3 For ease of reference the Figures and Exhibits referred to in the text are bound separately in an Appendix.

## THE 'STATE OF THE ART'

2.1 This section is an outline of the state of the art in MIS in North America and Europe. Readers interested in a more comprehensive review are referred to Hussain and Freytag (1973).

2.2 Interest in the development of MIS leading to planning and costing 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.

2.3 CAMPUS (Comprehensive Analytical Methods of Planning in University Systems) has its origin in the work done by Judy and Levine (1965) in simulation in higher education. (Minter and Lawrence 1969). The first operational version CAMPUS V involved a large investment in detailed data collection and was beyond the reach 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 and planning model. What was required, however, was a model 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 is RRPM (Research 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 best seen in the HIS (Hochschule - Informations - Systems) model. (Dettweiler and Frey 1972). HIS was founded in 1969 supported by the Volkswagen Foundation to develop models and operational systems that will be applicable to all institutions of further and higher education in Germany.

2.4 The core of RRPM is shown in Figure I which is, hopefully, self explanatory. CAMPUS and HIS start from a similar base. Predictably this core fastens on to the actual and/or predicted timetable contact between faculty and students as the key to the requirements for resources. Figure I is a simplified version of the actual model. For example, in the original the 'Induced Course Load Matrix' and the 'Induced Work Load Matrix' (their jargon) are drawn up in credit hours* which are subsequently converted to contact hours by an appropriate conversion factor. Nontheless it captures the essence of the logic. The major differences between RRPM on the one hand, and CAMPUS and HIS on the other, lie 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 different stages - undergraduate upper and lower divisions, and post-graduate. Again, the planning variables such as class sizes are more detailed in CAMPUS which allows for maximum and minimum as well as average sizes.

2.5 The determination of the requirement for academic staff in Figure I closely reflects the arguments in Delany (1971, 1972) which will be familiar to readers employed in Further Education in England and Wales viz:

$$SSR = \frac{S}{T} = \frac{ACS \times ALH}{ASH}$$

$$\therefore \; T = \frac{S \times ASH}{ACS \times ALH}$$

where SSR = Student Staff Ratio
S = Full-Time Equivalent Students
T = Full-Time Equivalent Staff
ACS = Average Class Size
ALH = Average Lecturer Hours
ASH = Average Student Hours

(See also Legg 1971; Bottomley et al, 1971; and Simpson et al 1971 for variations on this theme).

*Footnote: 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 program of study are equal to the lecture contact hours in a semester week. However, in the case of laboratories the credit hours tend to be less than the contact hours involved.

2.6 Figure I presents only one module in the information 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 outlined in Figure II. 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 modules still have problems and issues concerned with the calculation, aggregation and stability of the transitional probabilities and the validity of the underlying assumptions.

2.7 Both CAMPUS and HIS calculate space requirements by size and type and CAMPUS also computes and analyses revenue from fees and funding agencies. All three systems can answer "what-if" questions of the following types:-

a. what if the current staffing ratio of support personnel was increased or decreased by 10%?

b. what if there was an X% rise in academic salaries and a Y% rise in non-academic salaries?

c. what if a change is made in the faculty rank mix?

d. what if a change is made in instructional techniques - e.g. substitute capital for labour?

e. what if a new degree programme is added? - or dropped?

f. what would be the effect on X Department if the requirement for maths in course Y was dropped?

g. what if specific changes in the mix of students - discipline or level - is made?

h. what if the institution limits its admission in various fields three years from now?

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

2.8 In summary HIS and CAMPUS are the more detailed in input required and output produced. They are, therefore, more suitable for decision making at the department/course level. The price of such a capability is a larger computer core requirement and higher costs of both development and operations. 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 thus 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.

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*Footnote: There are many theoretical formulations of optimising models in education (See Benard 1973 for an example) but there are none so far operational. Their usefulness must await our ability to identify, measure and weight each output and to specify the exact relationship between inputs and outputs.

## A CONCEPTUAL FRAMEWORK

3.1 Without information management is likely to be a series of reactive gambles not-withstanding that they are carried out with great style and panache. On the other hand 'information overload' may induce paralysis in an otherwise normal human being. The border line between too much and too little is finely drawn and a conclusion that the information system should concentrate on the important merely raises the question - what is important? Answers will be subjective and, therefore, we begin by exposing our prejudices and by stating our view of the purpose and the outputs/ outcomes of further and higher education.

### Objectives

3.2 One view of education is that it is a civilising process whereby the student acquires the behaviour and discipline pattern necessary to appreciate and perpetuate his culture and contribute to society. This approach also embraces the concept that education is a worthwhile end in itself. An alternative view is that of the so called human capital theorists who establish a direct link between education and ultimate productivity and employability. (Schultz 1963, Becker 1964). Further study improves a students' skills level and, therefore, he contributes more to the gross national product and, hence, he earns more. A third approach is now referred to as the filter or screening hypothesis (Arrow 1973, Wiles 1974). This theory suggests that increased lifetime earnings expectations reflect not the productivity enhancing effects of education but merely its effects as a method of signalling ability differences that existed before the education process began i.e. further education is simply a sorting device albeit an expensive one!

3.3 All these views of the education process see it affecting an individual's lifetime chances. 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, on balance, benefits. Moreover education is beneficial to the community at large beyond whatever advantages may be enjoyed by the individual - culture is enriched, political and social institutions enhanced, and productivity improved as a result of these 'externalities'.

3.4 Some of these benefits can be quantified in terms of increased earnings expectations. On the other hand it is contended that education is not undertaken 'primarily for money'. Nevertheless there is information to support the hypothesis that further and higher education does materially improve lifetime earnings. (Selby Smith 1970, Morris and Ziderman 1971). These improvements probably reflect the skills more than the cultural/ social aspects of education but if education is seen to cover the social skills necessary for posts available only to the 'educated' or has no effect on skills levels yet acts as a label conveying some information on the job market (i.e. the filter theory) then it can be argued that the resulting earnings streams signal the effectiveness of the process. Therefore, the maximisation of enhanced earnings expectations is an overall objective which embraces a large part of the aims of further and higher education and our success 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 college level and we must search for more proximate goals.

3.5 The DES has identified the overall aims for Further Education in England and Wales as being broadly:

a. To provide education for those who could benefit from it; and

b. To meet the requirements of society for qualified manpower. (DES 1970).

3.6 The first of these objectives is at a level of generality such as to be beyond dispute. The second aim is more controversial. We subscribe to its sentiments but if it is defined as "organising courses of education so as to match with precision the forecast needs of employers for trained personnel of various types" we remain sceptical as to how it can be effectively deployed in either a macro or micro planning or control context. Nevertheless students may choose to enrol or not in higher education and, having enrolled, the majority of them are aiming for specific qualifications and definite career prospects. Therefore, within a college the following goals might be postulated:

Subject to maintaining academic standards and satisfying cost constraints.

To attain a 'satisfactory' level of:

a. student enrolment

b. pass rates

c. learning gain as measured by some indices of student achievement at entry and exit; and

d. student employability.

Goals (a)(b) and (d) are capable of being defined as targets, i.e. in quantified terms. Learning-gain (c), however, presents problems of definitions and is less susceptible to quantification. To accurately measure learning-gain, we would need to give the students a pre-course and post-course test and allow for outside influences. To compare performance in different institutions we would have to produce standardised tests covering common syllabuses. (Attiyeh and Lumsden 1971 and 1972). If learning-gain is interpreted as being concerned primarily with education rather than attitude culture and social gains or personal consumption it overlaps with the pass rate goal and the latter may serve as a proxy.

Outcomes and Outputs

3.7 As stated above the longer term outputs of education are its impacts on the student's post-college lifetime chances - economic, cultural, social and political - and the spin off from his contribution to society generally - i.e. the 'externalities'. A calculus exists for measuring the economic impacts but its use at the college level is blocked by the paucity of data on alumni careers and age earning profiles.

3.8 Taking a more parochial view, the first teaching task is to provide a variety of learning opportunities in an organised curriculum. This 'course mix' reflects the college's perception of the needs of society. The result may be measured in terms of potential 'places' on a course. Society's response may be assessed in terms of the number of enrolments. Potential places and enrolments are the immediate outcomes of the teaching function. Subsequently teaching takes place in the main in formal meetings between students and academic staff. These student contact hours although not a final output are also an outcome of the teaching process. Ultimately the student either 'drops out' or, as a result of the assessment procedures, fails and repeats or fails and leaves or is successful and moves on to the next stage of the cycle or, in the case of a final student, graduates. Dropouts, failures, repeaters, successes and graduates are all outcomes of various stages of the educational process. The ultimate measurement of these outputs is the value added between entry to and exit from the institution. A reliable practical and accurate calculus for assessing this value-added, embracing attitude change as well as skills and knowledge acquisition, is not available. Consequently the examination system with all its imperfections remains the most important indicator of the degree of success in achieving educational objectives.

Performance Indicators

3.9 Given the college exists to provide a set of learning opportunities subject to satisfying cost constraints two questions may be posed: firstly, what was the response to the provision? and secondly, - how well did the institution manage its resources?

3.10 In line with the objectives suggested above response can be assessed for each course by:-

a. a comparison of enrolment with 'places';

b. success and attrition rates; and

c. graduate employment statistics.

Inherent in the success rate criteria is the view that the institution can rely on teachers 'professionalism' for the maintenance of academic standards. In an ideal world the institution would also run student surveys to monitor the level of satisfaction with curriculum design, syllabus content and teaching methods and assemble longitudinal data on former students' careers to assess value-added rather than learning-gain. This sort of information will be difficult to interpret and costly to collect and is currently not a practical proposition.

3.11 As far as resource management is concerned possible indicators for each course are the relationship of each direct input expressed in quantities and/or monetary terms to:

a. enrolments; and

b. successes.

However, often the important question is not whether but why a particular input/output ratio or unit cost is good or bad. The most popular cost effectiveness measure in the UK is the student staff ratio. As demonstrated elsewhere (Delany op cit 1972, 1972; Bottomley et al op cit 1971; Fredriksen

1971) this ratio is a function of a number of variables and decisions on these are largely within the province of academic staff. Therefore the MIS ought to monitor class size frequencies, tuition loads, and contact hours. This may involve a detailed course profile and timetable analysis such as described below.

Implications for an Information System

3.12 A manager is required to agree objectives; to quantify targets; to specify, evaluate and choose between alternatives; to plan and budget for the resources required; to organise, motivate and direct these resources; and to monitor performance against the plan and to correct adverse deviations. The design and implementation of an information system to support this range of tasks is not a trivial exercise. However, we hold to the view that management is primarily assessed (or ought to be assessed!) in terms of its effectiveness and its efficiency. A manager is effective if he achieves his objectives and he improves his efficiency if either he produces more outputs with a less than proportionate increase in inputs or he attains the same output with fewer resources. Therefore, the information system should concentrate on providing a base for planning and controlling resource utilisation and in monitoring the level and quality of the system's outputs.

3.13 Figure III sets out what we believe to be the major components of a college information system. Given a student flow model (2) a course file (6) and planning parameters (10), a projection of contact hours (11) resources required (12) and, operating and capital budget (13) can be produced. Comparison 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 primarily 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, ideally the model will allow the decision taker to test the sensitivity of the system to variations in these parameters. Boxes (3) (4) (14) and (16) are concerned with monitoring actual events; (5) and (17) compare actual against planned performance and produce reports and indices. This part of the system is concerned with the control function. So much for an ultimate integrated system, but now to a more practical first-stage solution.

## A FIRST-STAGE SOLUTION

Course Analysis

4.1 In this section a system for monitoring existing resource utilisation (staff and space) is developed and illustrated with data from the mythical Blagda College.

4.2 Currently in the majority of cases students enrol on courses 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 this tuition takes place in formal timetabled meetings between students and teachers. Following a course involves studying a number of subject elements and, for each subject element, attending a set of meetings. Some of these meetings may be compulsory, some may be optional, attendance at some will be confined to one course whereas in other cases courses may be combined. Consequently to analyse a set of meetings the following information is required:-

a. The total enrolments for the course (E)

and for each subset of meetings in each subject element of the course:

b. The enrolment from this course (s where $s \leq E$);

c. The total enrolment from all courses attending ($E^*$, where $E^* \geq s$);

d. The department providing the tuition and the type of space utilised - classroom, laboratory etc.

e. The number of groups formed each assigned to one teacher (g);

f. The hours per week attended by a student (h); and

g. The number of weeks per term (or per annum) attended by a student (w).

From this data it is possible to establish for each course, for a departments' courses, and for an institution a number of 'values' of significance in both a planning and control context. (Birch, Calvert, Sizer 1976).

4.3 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 (1), Social Science (2) and Science (3). Course X is located in the Mathematics Department, Y in the Social Science Department and Z in the Science Department. A summary of the weekly teaching pattern is provided in Exhibit 1. You will note that, students enrolled on course X (for example) attend classes for fifteen hours a week in four subject elements - maths A, maths B, social science A and science A. For maths A and science A students from X only attend, but students from all three courses attend maths B, and X and Y are combined for social science A. Maths A and social science A are split into two groups, maths B is taught in four parallel classes but only one group is formed in science A.

4.4 Figure IV sets out the information flow and illustrates the logic of the analysis. At the base of the system are two documents - the 'course teaching analysis document' to be completed for each course, and the 'department teaching commitment document' to be completed for each department. To begin with data collection - each subject element is given a unique code. Details of the enrolment from a course to a subject element is provided by the course administrator to the department providing tuition 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 and/or per annum the subject element will meet (w); the number of groups formed (g); and the total enrolment from all courses attending this subject element ($E^*$). For example in the case of maths A for course X in the Blagda College, and assuming a ten week term and all subjects to be compulsory - $s = 10$, $h = 5$, $w = 10$, $g = 2$ and $E^* = 10$.

4.5 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 his department's requirements for academic staff and space.

4.6 Accordingly the course teaching analysis document identifies for each course:

a. the enrolment to the course = E

b. the notional student contact hours = $\Sigma$ shw;

c. the student contact hours at particular class sizes = $\Sigma$ (shw E*/g;

d. the number of one-hour meetings required if the course were taught entirely separately other variables (such as the number of groups) remaining unchanged = $\Sigma$ hwg

e. the number of actual one hour meetings allocated to the course in the ratio s/E* = $\Sigma \text{(hwg)} \frac{s}{E^*} \longrightarrow \Sigma \frac{\text{(shw)}}{E^*/g}$

f. the number of actual one hour meetings allocated received from 'service departments'.

From this data it is possible to calculate the students average tuition load (ASH in Delany notation), the student's average class size, the degree of 'savings' achieved by combining courses for tuition in some subject elements and the incidence of service teaching. All this seems immensely complicated but the calculations required are in fact very simple. Exhibits 2, 3 and 4 illustrate the process for courses X, Y and Z at the Blagda College and Exhibit 5 summarises the result for the whole college.

4.7 Working from similar basic data the 'department teaching commitment document' Exhibits 6, 7 and 8 identifies:

a. the total one hour meetings to be staffed = $\Sigma$ hwg; and

b. the total notional student contact hours (= $\Sigma$ hwE*) which is one intermediate outcome of the learning opportunities provided by the department.

From this data the average class size provided by the department (ACS in Delany notation) can be calculated. Moreover feeding in the average lecturer's contact hours (ALH in Delany notation and currently about 18 hours per week in further education) the notional staff required can be identified. Again, the calculations are in fact very simple and for Departments (1) (2) and (3) and for the Institution in total in Exhibit 9.

4.8 Further analysis on class sizes and the demands for space can be carried out as is illustrated in Exhibit 10.

## Costing the Teaching Function

4.9 The question of concern here is - how should the costs identified as belonging to the teaching function be allocated to courses and, ultimately, to the students taking these courses? At the moment there is no elegant way of handling the problem - any approach is to some extent arbitrary. Insofar as teaching takes place in meetings between faculty and students, an analysis of timetable data as described above is one basis for cost allocation. Indeed, wherever extensive inter departmental servicing and combined meetings involving more than one course are a feature of the curriculum, a cost allocation on the basis of meetings provided and received may well be more accurate than an allocation on the basis of staff questionnaires/diaries or the multi-regression approach of say Layard and Verry (1975). Specifically if we denote:

allocated meetings from a department to a course by M,
allocated meetings from a department to all courses by $M_T$, and
departmental costs by C - then for a course the cost is given by:-

$$\sum_{\substack{\text{all departments}\\ i}} \left[ \frac{M_i}{M_{Ti}} * C_i \right] = K$$

and the cost per enrolled student by

$$K \; [1/E]$$

where E is the enrolment to a course,
and the cost per successful student (where calculated) is given by:-

$$K \; [1/E_s]$$

where $E_s$ = the students on that course who successfully completed that year of the course.

4.10 Figure V illustrates the logic of this process for the Mathematics Department at Blagda College and the results for the complete Institution are given in Exhibit 11.

4.11 The question of what is the cost per student does not admit of one answer. Therefore, it is prudent to summarise the context in what the unit costs in Exhibit 11 were derived. Firstly, the costs allocated were assumed to be those for the faculty, their administrative technician and 'materials' support - the problems of measuring and assigning capital expenditure and of identifying 'opportunity costs' were thus avoided. Secondly, we have argued that the timetable reflects the 'weights' the institution is implicitly assigning to its courses and that 'allocated meetings' are a fair basis for the assignment of inputs to courses and to students. Thirdly, it has been assumed that colleges are solely teaching establishments. If it is accepted that further education institutions have functions other than teaching, the trade offs between teaching and these other roles need to be examined. If the mix of teaching to non teaching activities is roughly equivalent across departments within institutions and across institutions then student cost comparisons as outlined above provide a reasonable guide to relative effectiveness. On the other hand, if the involvement in non teaching varies significantly from department to department and from institution to institution, then 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.

Performance Indicators

4.12 As indicated above performance indicators can be conveniently classified as being either concerned with effectiveness or with efficiency. Effectiveness is concerned with the achievement of objectives and efficiency with the relationship between inputs and outputs. Supposing that a college exists to attain a 'satisfactory' level of pass rates subject to maintaining academic standards and satisfying cost constraints, we can explore effectiveness in terms of the response to the learning opportunities provided by the institution and efficiency in terms of unit costs.

4.13 Most colleges already maintain individualised student records giving personal details and providing an academic record - Summarised by courses and subjected to some elementary analysis, these would produce the sort of data set out in the 'summary of student file' in Exhibit 12. Add to this the results of the 'summary of course analysis' and 'results of cost analysis' (also Exhibit 12) and we have the basis for an inter-departmental appraisal. At this point consideration has to be given to the mode of reporting. Generally folk are not 'turned on' by statistical data. However, they are more likely to respond favourably if this data is presented pictorially or graphically. For example the data on 'response' and 'resource utilisation' might be 'standardised' (Exhibit 13) and presented in graphical form as in Exhibits 14, 15 and 16.

## SUMMARY

5.1 This paper set out to outline the 'state of the art' in modelling in further and higher education and to develop the framework of a management information system of general applicability to Further Education in England and Wales. A first-stage solution has been described which would facilitate the monitoring of existing resource utilisation and, ultimately, provide a data base from which a planning model could be developed. It has been designed with 'hand operation' in mind but it is not incompatible with computer manipulation. Indeed some aspects of the analysis have already been computerised in research covering the operations of Loughborough University and Lanchester Polytechnic for the academic years 1972/73 and 1973/74. The scheme now requires validation in a number of colleges but it would benefit at this stage from critical (hopefully helpful!) comment on its potential usefulness. It has been suggested (Mason 1973) that 'usefulness' in this context has the following characteristics:-

a. Is the scheme believable? Are the assumptions made at various points in line with potential users perception of reality?

b. Is the scheme relevant? Do the elements and variables identified and high-lighted focus on the problems faced by the decision takers?

c. Is the scheme flexible? Can the system be easily re-defined and restructured to fit changing circumstances?

d. Is the content communicable? Can the potential users participate and do they understand and can they act upon the output at least through an effective interpreter?

Not surprisingly the authors believe the answer to all these questions is "Yes"!

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I.B.N. 1195

APPENDIX TO

A PROPOSAL FOR

A MANAGEMENT INFORMATION SYSTEM FOR FURTHER EDUCATION COLLEGES

CONTENTS

# FIGURE 1.

## Basic Logic for CAMPUS, HIS, RRPM.

ENROLMENTS TO COURSES

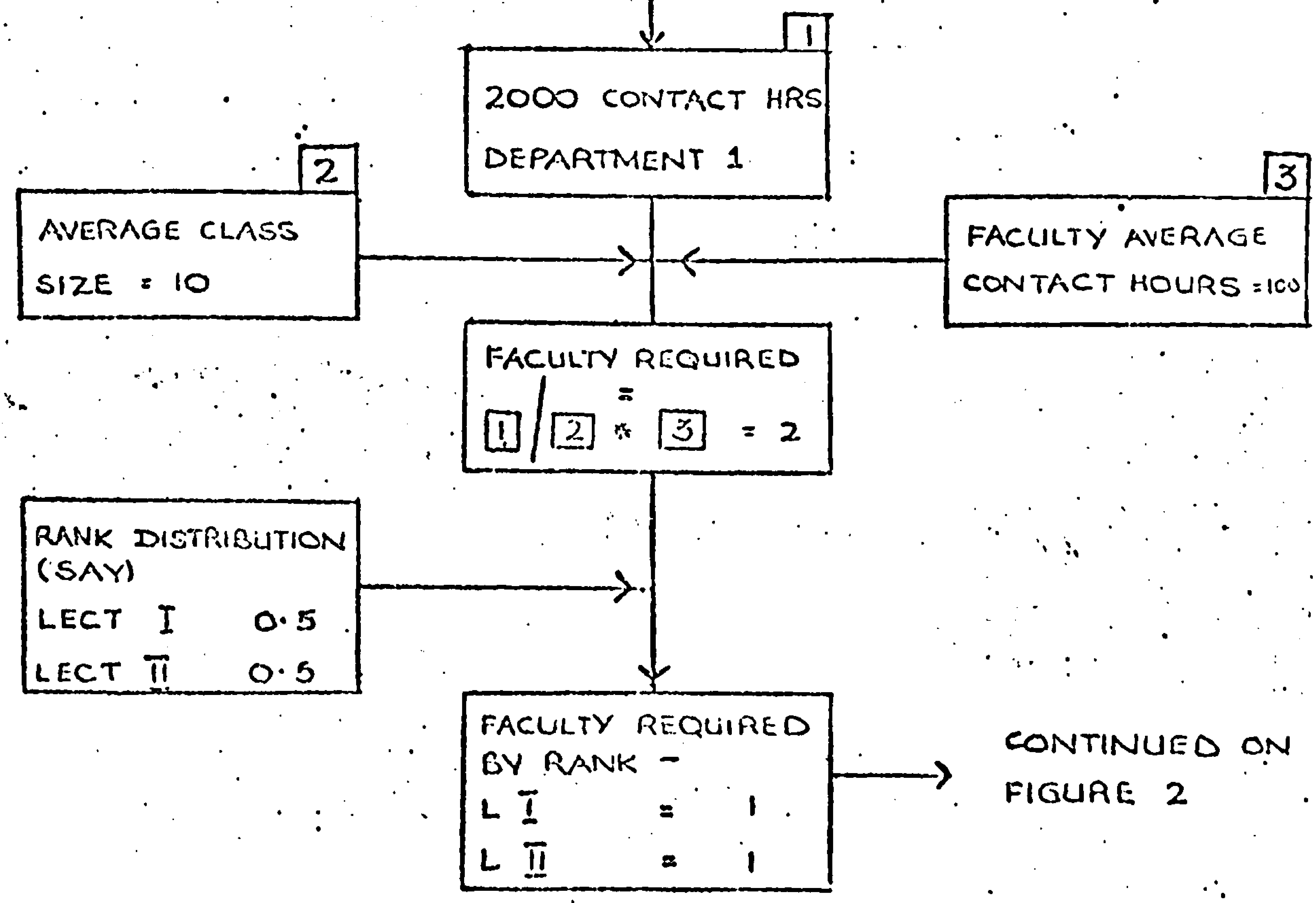
| X | Y | Z |
|---|---|---|
| 10 | 20 | 30 |

| DEPTS. | X | Y | Z |
|---|---|---|---|
| 1 | 70 | 20 | 30 |
| 2 | 40 | 80 | 60 |
| 3 | 40 | 50 | 60 |

= INDUCED COURSE LOAD MATRIX (ICLM) i.e. PATTERN OF DEMAND FOR TIMETABLED TEACHING (Hours) GENERATED BY ONE STUDENT ENROLLED ON A COURSE PER TERM (SAY)

| | X | Y | Z | |
|---|---|---|---|---|
| 1 | 700 | 400 | 900 | 2000 |
| 2 | 400 | 1600 | 1800 | 3800 |
| 3 | 400 | 1000 | 1800 | 3200 |
| | 1500 | 3000 | 4500 | 9000 |

= INSTRUCTIONAL WORK LOAD MATRIX (IWLM) i.e. TOTAL STUDENT HOURS GENERATED BY ENROLLMENTS.




CONTINUED ON FIGURE 2

# FIGURE II

## The Basis of The Costing Module for RRPM

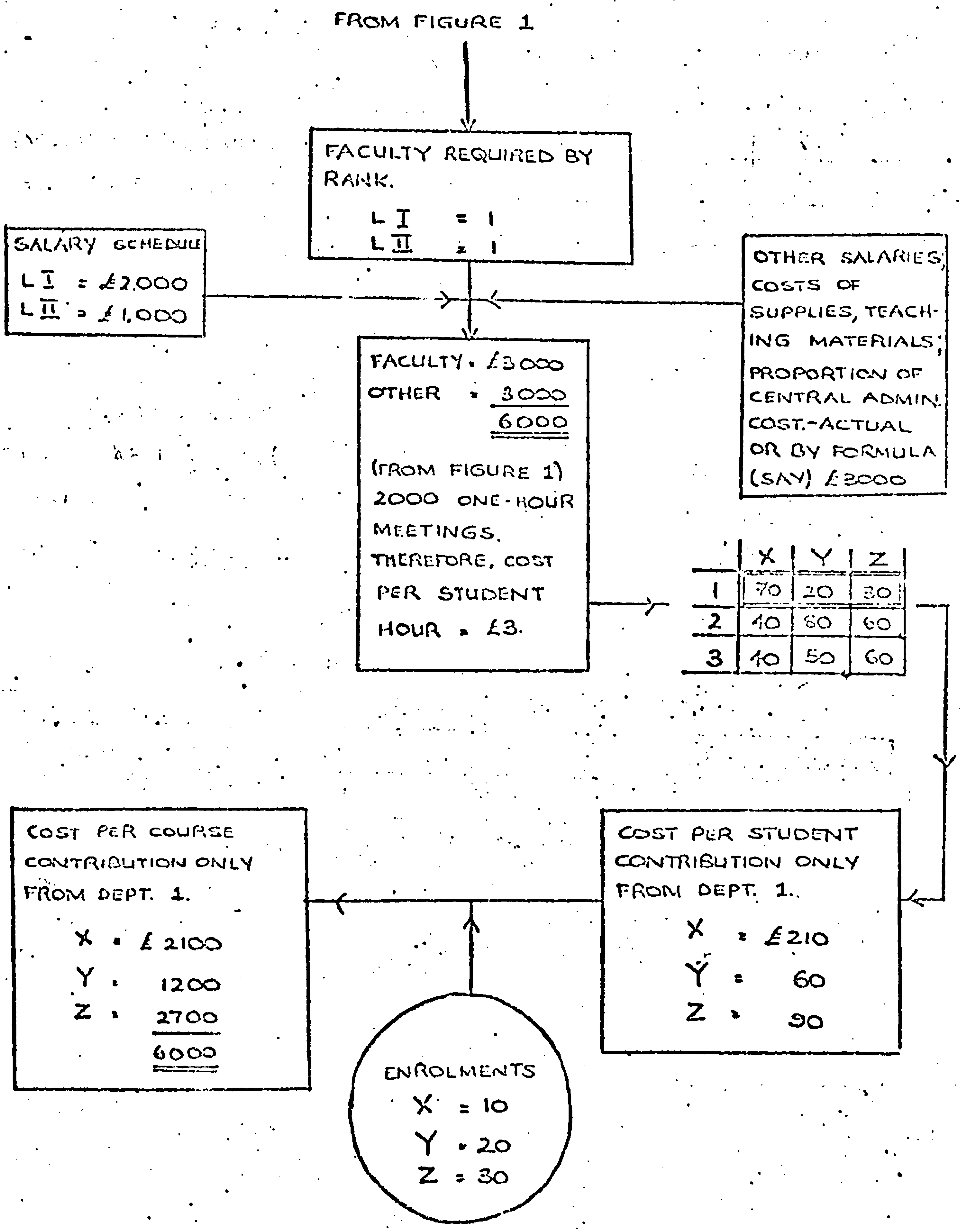
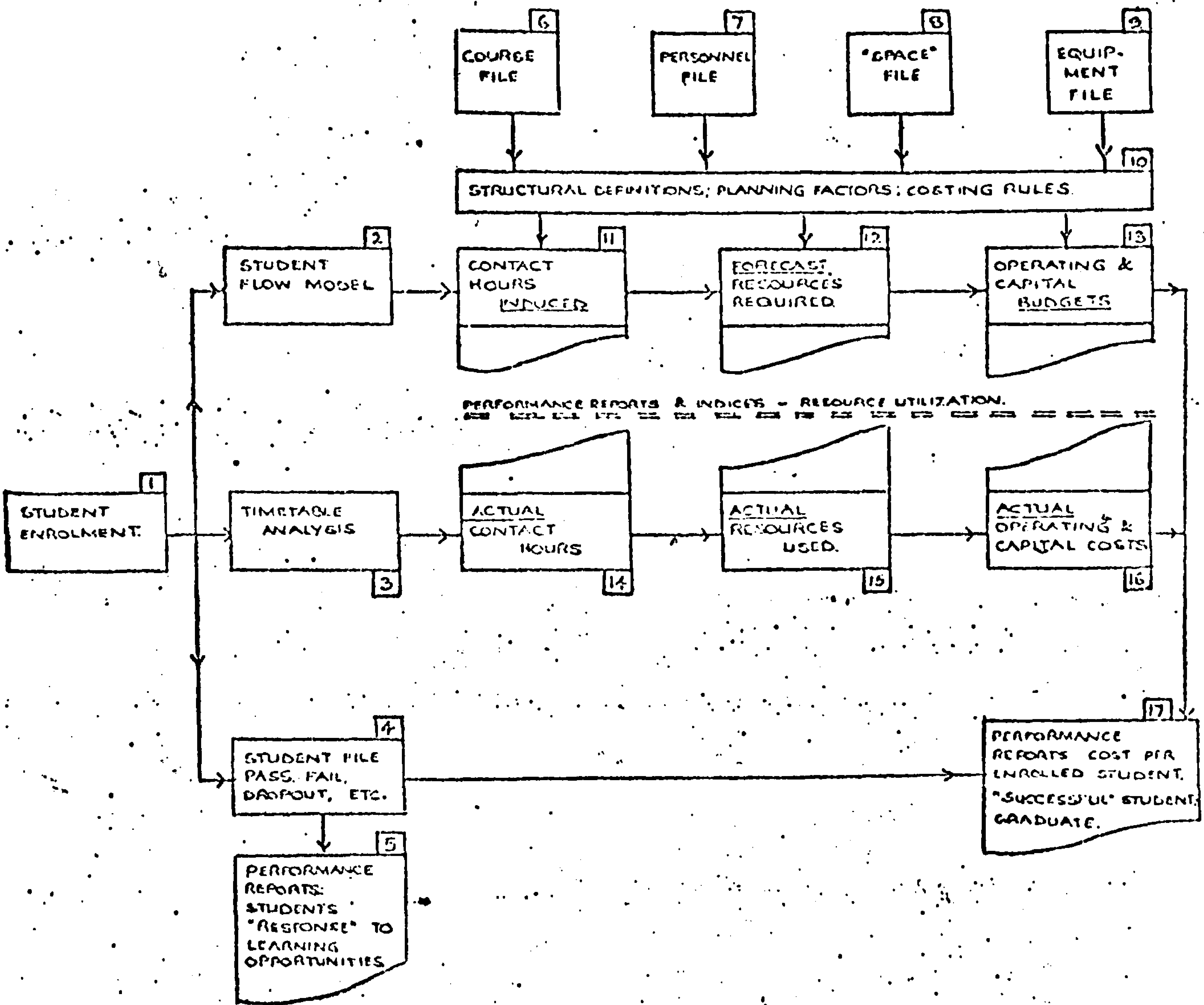


FIGURE III

COMPONENTS OF A COLLEGE MANAGEMENT INFORMATION SYSTEM



# FIGURE IV

Basic Document Data for Monitoring Resource Utilization

## COURSE TEACHING ANALYSIS DOCUMENT

DATA

1. CURRICULUM = Pattern of Subject Elements (unique codes).
2. ENROLMENT = $\boxed{E}$
3. For each subject element
   - A STUDENT'S CONTACT HRS. PER WK. = $\boxed{h}$
   - NUMBER OF WEEKS = $\boxed{w}$
   - NUMBER OF GROUPS = $\boxed{g}$
   - ENROLMENT FROM ALL COURSES = $\boxed{E^*}$
   - ENROLMENT FROM THIS COURSE = s

ANALYSIS

1. STUDENT CONTACT HOURS = $\Sigma shw$ $\boxed{A}$
2. MEETING if course taught entirely separately = $\Sigma hwg$ $\boxed{B}$
3. CLASS SIZE for each subset = $E^*/g$
4. STUDENT CONTACT HOURS AT PARTICULAR CLASS SIZES = $\Sigma(shw)\,E^*/g$ $\boxed{C}$
5. ACTUAL CLASS CONTACT HOURS ALLOCATED TO THIS COURSE i.e. "MEETINGS ALLOCATED" = $\Sigma\frac{(shw)}{E^*/g}$ $\boxed{D}$
6. MEETINGS ALLOCATED FROM "SERVICE" DEPTS. $\boxed{G}$
7. STUDENT'S TUITION LOAD (ASH) = $\boxed{A}/\boxed{E}$
8. STUDENT'S AVERAGE CLASS SIZE = $\boxed{C}/\boxed{A}$
9. PROPORTION OF "SERVICE" ALLOCATED MEETINGS TO TOTAL ALLOCATED MEETINGS = $\boxed{G}/\boxed{D}$
10. PROPORTION OF MEETINGS "SAVED" by COMBINING COURSES = $(\boxed{B}-\boxed{D})/\boxed{B}$

## DEPARTMENT TEACHING COMMITMENT DOCUMENT

DATA

1. SUBJECT ELEMENTS OFFERED (unique codes)
2. TYPE OF SPACE REQUIRED O = ordinary, L = Lab, W = workshop, D = Drawing office.
3. For each subject element.
   - $\boxed{h}$ = A STUDENT'S CONTACT HRS. PER WK.
   - $\boxed{w}$ = NUMBER OF WEEKS
   - $\boxed{g}$ = NUMBER OF GROUPS
   - $\boxed{E^*}$ = ENROLMENT FROM ALL COURSES

② 

① (= $\Sigma s$ from each course taking tuition)

ANALYSIS

1. TOTAL CLASS CONTACT HRS = $\Sigma hwg$ = meetings to be staffed $\boxed{A}$
2. TOTAL STUDENT CONTACT HRS. = $\Sigma hwE^*$ $\boxed{B}$
3. AVERAGE CLASS SIZE PROVIDED = $\boxed{B}/\boxed{A}$
4. NOTIONAL STAFF REQUIRED = $\boxed{A}$ / Average lecturer Contact Hrs.

## COURSE TEACHING ANALYSIS - INSTITUTIONAL SUMMARY

1. ENROLMENT $\boxed{E}$
2. STUDENT CONTACT HRS. $\boxed{A}$
3. MEETINGS TO BE PROVIDED IF COURSES NOT COMBINED $\boxed{B}$
4. STUDENT CONTACT HOURS AT CLASS SIZES $\boxed{C}$
5. MEETINGS ALLOCATED $\boxed{D}$
6. STUDENT'S TUITION LOAD $\boxed{A}/\boxed{E}$
7. STUDENT'S AVERAGE CLASS SIZE $\boxed{C}/\boxed{A}$
8. PROPORTION OF MEETINGS "SAVED" BY COMBINING COURSES $(\boxed{B}-\boxed{D})/\boxed{B}$

## INSTITUTIONAL TEACHING COMMITMENT ANALYSIS.

1. STUDENT CONTACT HOURS $\boxed{B}$
2. CLASS CONTACT HOURS $\boxed{A}$
3. AVERAGE CLASS SIZE PROVIDED = $\boxed{B}/\boxed{A}$
4. NOTIONAL STAFF REQUIRED = $\boxed{A}$ / Average Lecturer Contact Hrs.

FIGURE V

The Basis of Direct Department Costs Allocation at Blagdo College

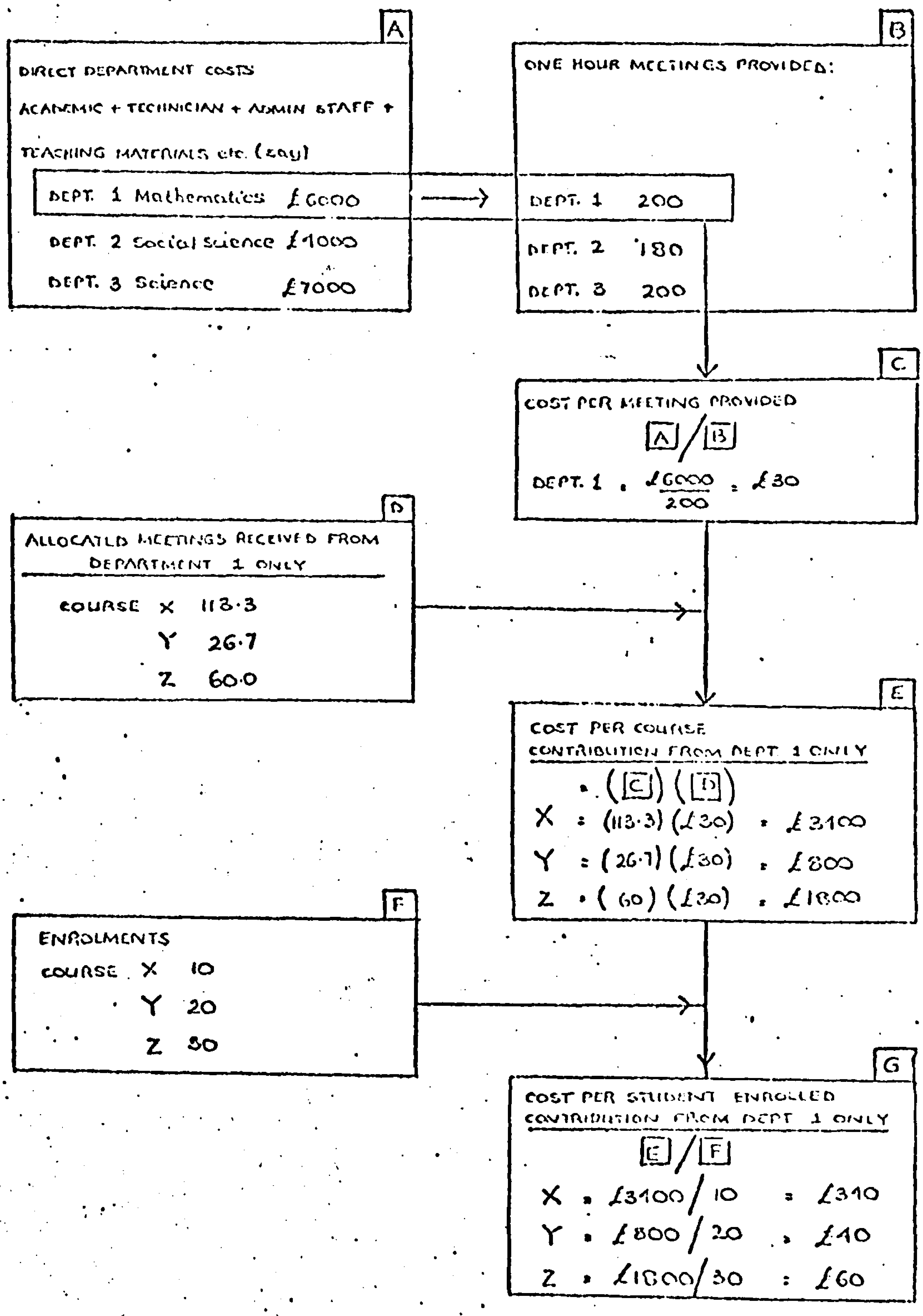


EXHIBIT 1

BIAGDA COLLEGE — SUMMARY OF WEEKLY TEACHING PATTERN

| DEPARTMENT/ SUBJECT | CODE | COURSES X | Y | Z | DETAILS OF COMBINED COURSES AND/OR SPLIT GROUP WORKINGS |
|---|---|---|---|---|---|
| DEPARTMENT 1 | | | | | |
| 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 | |
| DEPARTMENT 2 | | | | | |
| 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 | |
| DEPARTMENT 3 | | | | | |
| 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 | |

## SUMMARY OF TIMETABLE PARAMETERS

| | | Matrix of Enrolments from Courses $\boxed{S}$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Departments | | 1 | | | 2 | | | 3 | | |
| Subject Elements | | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 |
| Enrolments to Courses — Course | $\boxed{E}$ | | | | | | | | | |
| X → | 10 → | 10 | 10 | | 10 | | | 10 | | |
| Y → | 20 → | | 20 | | 20 | 20 | | | 20 | |
| Z → | 30 → | | 30 | 30 | | | 30 | | 30 | 30 |
| Enrolment from all Courses | $\boxed{E^*}$ | 10 | 50 | 30 | 30 | 20 | 30 | 10 | 50 | 30 |
| Number of Groups Formed | $\boxed{g}$ | 2 | 4 | 2 | 2 | 1 | 1 | 1 | 3 | 1 |
| Student's Contact Hours | $\boxed{h}$ | 5 | 2 | 1 | 4 | 4 | 6 | 4 | 5 | 1 |
| Number of Weeks | $\boxed{w}$ | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

# EXHIBIT 2

## COURSE TEACHING ANALYSIS DOCUMENT

Course X Code "Home" Department MATHS

Calendar Pattern: Term 1 Number of weeks: 10

Enrolment [E] 10

Note: Timetable Parameters
- s = enrolment from this course
- h = contact hours per week
- w = number of weeks
- g = number of groups
- E* = enrolment from all courses.

| Subject Element | | Code | Timetable Parameters s | h | w | g | E* | Student Contact Hours s*h*w | Meetings Hours h*w*g | Class Size E*/g | Student Contact Hrs at Class Size (s*h*w)(E*/g) | Meetings Allocated (s*h*w) / E*/g |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maths | A | 1·1 | 10 | 5 | 10 | 2 | 10 | 500 | 100 | 5 | 2500 | 100·0 |
| Maths | B | 1·2 | 10 | 2 | 10 | 4 | 60 | 200 | 80 | 15 | 3000 | 13·3 |
| Social Sci | A | 2·1 | 10 | 4 | 10 | 2 | 30 | 400 | 80 | 15 | 6000 | * 26·7 |
| Science | A | 3·1 | 10 | 4 | 10 | 1 | 10 | 400 | 40 | 10 | 4000 | * 40·0 |
| | | | | | | | TOTALS | 1500 | 300 | | 18500 | 180 |
| | | | | | | | | [A] | [B] | | [C] | [D] |

TOTAL "SERVICE" ALLOCATED MEETINGS: * 66·7 [G]

STUDENT'S TUITION LOAD (ASH) = [A] / [E] 150

STUDENT'S AVERAGE CLASS SIZE = [C] / [A] 10·3

PROPORTION OF "SERVICE" ALLOCATED MEETINGS TO TOTAL ALLOCATED MEETINGS [G] / [D] 0·37

PROPORTION OF MEETINGS "SAVED" BY COMBINING COURSES
= ([B] − [D]) / [B] 0·40

IMPUTED HOURS 3000 (If different from student contact hours add a note of explanation)
- Each student has 15 hours per week private study

# EXHIBIT 3

## COURSE TEACHING ANALYSIS DOCUMENT

Course Y | Code | "Home" Department SOCIAL SCIENCE
Calendar Pattern | Term 1 | Number of weeks: 10

Enrolment [E] 20

Note: Timetable Parameters
s = enrolment from this course
h = contact hours per week
w = number of weeks
g = number of groups
E* = enrolment from all courses.

| Subject Element | | Code | Timetable Parameters s | h | w | g | E* | Student Contact Hours s*h*w | Meetings Hours h*w*g | Class Size E*/g | Student Contact Hrs at Class Size (s*h*w)(E*/g) | Meetings Allocated (s*h*w)/(E*/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maths | B | 1·2 | 20 | 2 | 10 | 4 | 60 | 400 | 80 | 15 | 6000 | * 26·7 |
| Social Sci | A | 2·1 | 20 | 4 | 10 | 2 | 30 | 800 | 80 | 15 | 12000 | 53·3 |
| Social Sci | B | 2·2 | 20 | 4 | 10 | 1 | 20 | 800 | 40 | 20 | 16000 | 40 |
| Science | B | 3·2 | 20 | 5 | 10 | 3 | 50 | 1000 | 150 | 16·7 | 16667 | * 60 |
| TOTALS | | | | | | | | 3000 | 350 | | 50667 | 180 |
| | | | | | | | | [A] | [B] | | [C] | [D] |

TOTAL "SERVICE" ALLOCATED MEETINGS: * 86·7 [G]

STUDENT'S TUITION LOAD (ASH) = [A]/[E] 150

STUDENT'S AVERAGE CLASS SIZE = [C]/[A] 16·9

PROPORTION OF "SERVICE" ALLOCATED MEETINGS TO TOTAL ALLOCATED MEETINGS [G]/[D] 0·48

PROPORTION OF MEETINGS "SAVED" BY COMBINING COURSES
= ([B] − [D])/[B] 0·49

IMPUTED HOURS 6000 (If different from student contact hours add a note of explanation)
*Each student has 15 hours per week private study

# EXHIBIT 4

## COURSE TEACHING ANALYSIS DOCUMENT

Course Z — Code — "Home" Department SCIENCE

Calendar Pattern: Term 1 — Number of weeks: 10

Enrolment [E] 30

Note: Timetable Parameters
s = enrolment from this course
h = contact hours per week
w = number of weeks
g = number of groups
E* = enrolment from all courses.

| Subject Element | | Code | s | h | w | g | E* | Student Contact Hours, s*h*w | Meetings Hours h*w*g | Class Size E*/g | Student Contact Hrs at Class Size (s*h*w)(E*/g) | Meetings Allocated (s*h*w)/(E*/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maths | B | 1·2 | 30 | 2 | 10 | 4 | 60 | 600 | 80 | 15 | 9000 | * 40 |
| Maths | C | 1·3 | 30 | 1 | 10 | 2 | 30 | 300 | 20 | 15 | 4500 | * 20 |
| Social Sci | C | 2·3 | 30 | 6 | 10 | 1 | 30 | 1800 | 60 | 30 | 54000 | * 60 |
| Science | B | 3·2 | 30 | 5 | 10 | 3 | 50 | 1500 | 150 | 16·7 | 25050 | 90 |
| Science | C | 3·3 | 30 | 1 | 10 | 1 | 30 | 300 | 10 | 30 | 9000 | 10 |
| | | | | | | | TOTALS | 4500 [A] | 320 [B] | | 101550 [C] | 220 [D] |

TOTAL "SERVICE" ALLOCATED MEETINGS: * 120 [G]

STUDENT'S TUITION LOAD (ASH) = [A]/[E] 150

STUDENT'S AVERAGE CLASS SIZE = [C]/[A] 22·6

PROPORTION OF "SERVICE" ALLOCATED MEETINGS TO TOTAL ALLOCATED MEETINGS [G]/[D] 0·55

PROPORTION OF MEETINGS "SAVED" BY COMBINING COURSES
= ([B] − [D])/[B] 0·31

IMPUTED HOURS 9000 (If different from student contact hours add a note of explanation)
- Each student has 15 hours per week private study

## EXHIBIT 5

### COURSE TEACHING ANALYSIS - INSTITUTION SUMMARY

Calendar Pattern Term 1 Number of weeks: 10

| Course/Department | Code | Enrolment | Student Contact Hours s * h * w | Meetings Hours h * w * g | Student Contact Hrs at Class Size: (s * h * w)(E*/g) | Meetings Allocated (s * h * w)/E*/g |
|---|---|---|---|---|---|---|
| X (Maths Dept.) | | 10 | 1500 | 300 | 15500 | 180 |
| Y (Social Sci. Dept.) | | 20 | 3000 | 350 | 50667 | 180 |
| Z (Science Dept.) | | 30 | 4500 | 320 | 101550 | 220 |
| TOTALS | | 60 | 9000 | 970 | 167717 | 580 |
| | | $\boxed{E}$ | $\boxed{A}$ | $\boxed{B}$ | $\boxed{C}$ | $\boxed{D}$ |

STUDENT'S TUITION LOAD (ASH) $\boxed{A}/\boxed{E}$ $\boxed{150}$

STUDENT'S AVERAGE CLASS SIZE $\boxed{C}/\boxed{A}$ $\boxed{18{\cdot}6}$

PROPORTION OF MEETINGS 'SAVED' BY COMBINING COURSES

$= (\boxed{B} - \boxed{D}) / \boxed{B}$ $\boxed{0{\cdot}40}$

# EXHIBIT 6

## DEPARTMENT TEACHING COMMITMENT DOCUMENT

Department: MATHS  Code 1

Calendar Pattern: Term 1  Number of weeks 10

Note

Space O = Ordinary  Timetable Parameters h = hours
L = Laboratory  w = weeks
W = Workshop  g = groups
D = Drawing Office  E* = total enrollment.

| Subject Element | Code | Space | | | | Timetable Parameters | | | | Class contact Hrs. | Student Contact Hrs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | L | W | D | h | w | g | E* | h * w * g | h * w * E* |
| Maths A | 1·1 | ✓ | | | | 5 | 10 | 2 | 10 | 100 | 500 |
| Maths B | 1·2 | ✓ | | | | 2 | 10 | 4 | 60 | 80 | 1200 |
| Maths C | 1·3 | ✓ | | | | 1 | 10 | 2 | 30 | 20 | 300 |
| | | | | | | | | | | 200 | 2000 |
| | | | | | | | | | | A | B |

AVERAGE CLASS SIZE (ACS) provided by Department B/A  10·0

NOTIONAL STAFF REQUIRED = A/Average Lecturer Contact Hours (say) 100 = 2·0

ACTUAL STAFF (say)  2·0

# EXHIBIT 7

## DEPARTMENT TEACHING COMMITMENT DOCUMENT

Department: SOCIAL SCIENCE          Code 2

Calendar Pattern:   Term 1          Number of weeks: 10

Note

Space O = Ordinary          Timetable Parameters h = hours
L = Laboratory          w = weeks
W = Workshop          g = groups
D = Drawing Office          E* = total enrollment.

| Subject Element | Code | Space | | | | Timetable Parameters | | | | Class Contact Hrs. | Student Contact Hrs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | L | W | D | h | w | g | E* | h * w * g | h * w * E* |
| Social Sci A. | 2·1 | ✓ | | | | 4 | 10 | 2 | 30 | 80 | 1200 |
| Social Sci B. | 2·2 | ✓ | | | | 4 | 10 | 1 | 20 | 40 | 800 |
| Social Sci C. | 2·3 | ✓ | | | | 6 | 10 | 1 | 30 | 60 | 1800 |
| | | | | | | | | | | 180 | 3800 |
| | | | | | | | | | | A | B |

AVERAGE CLASS SIZE (ACS) provided by Department B/A          21·1

NOTIONAL STAFF REQUIRED = A /Average Lecturer Contact Hours (say) 100 =          1·8

ACTUAL STAFF (say)          2·0

# EXHIBIT 8

## DEPARTMENT TEACHING COMMITMENT DOCUMENT

Department: SCIENCE Code 3

Calendar Pattern: Term 1 Number of weeks: 10

Note

Space O = Ordinary Timetable Parameters h = hours

L = Laboratory w = weeks

W = Workshop g = groups

D = Drawing Office E* = total enrollment

| Subject Element | Code | Space | | | | Timetable Parameters | | | | Class Contact Hrs | Student Contact Hrs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | O | L | W | D | h | w | g | E* | h * w * g | h * w * E* |
| Science A | 3·1 | ✓ | | | | 4 | 10 | 1 | 10 | 40 | 400 |
| Science B | 3·2 | ✓ | | | | 5 | 10 | 3 | 50 | 150 | 2500 |
| Science C | 3·3 | | ✓ | | | 1 | 10 | 1 | 30 | 10 | 300 |
| | | | | | | | | | | 200 | 3200 |
| | | | | | | | | | | $\boxed{A}$ | $\boxed{B}$ |

AVERAGE CLASS SIZE (ACS) provided by Department $\boxed{B}/\boxed{A}$ 16·0

NOTIONAL STAFF REQUIRED = $\boxed{A}$/Average Lecturer Contact Hours (say) 100 = 2·0

ACTUAL STAFF (say) 2·0

# EXHIBIT 9

## INSTITUTIONAL TEACHING COMMITMENT ANALYSIS

Calendar Pattern: Term 1 Number of weeks: 10

| Department | Code | Class Contact Hrs. | Student Contact Hrs. |
|---|---|---|---|
| Mathematics | 1. | 200 | 2000 |
| Social Science | 2. | 180 | 3800 |
| Science | 3. | 200 | 3200 |
| TOTALS | | 580 | 9000 |
| | | $\boxed{A}$ | $\boxed{B}$ |

AVERAGE CLASS SIZE (ACS)
PROVIDED BY INSTITUTION $\boxed{B}/\boxed{A}$ 15·5

*NOTIONAL STAFF REQUIRED =
$\boxed{A}$/ Average Lecturer Contact Hrs. (say) 100 5·8

ACTUAL STAFF (say) 6·0

*Note: Notional Staff Required by Delany Formula = T

$$= \frac{S/ACS * ASH}{ALH} \quad \text{where } S = \text{fte students}$$

$$= \frac{60/15.5 * 150}{10} = 5.8$$

## EXHIBIT 10

### INSTITUTIONAL GROUP SIZE - FREQUENCY DISTRIBUTION

| Group Size | Cumulative Meetings (hrs.) | Cumulative Meetings (%) |
|---|---|---|
| 5 | 100 | 17 |
| 10 | 140 | 24 |
| 15 | 320 | 55 |
| 20 | 510 | 88 |
| 30 | 580 | 100 |

Average Group Size Provided is 15·5

### STUDENT'S GROUP SIZE - COURSE VALUES

| | Average | Standard Deviation |
|---|---|---|
| Course X | 10·33 | 4·27 |
| Course Y | 16·89 | 2·01 |
| Course Z | 22·56 | 6·99 |
| Total Institution | 18·63 | 7·00 |

EXHIBIT II

## COST ANALYSIS TERM 1

| | | Maths 1 | Social Sci 2. | Science 3 | Totals |
|---|---|---|---|---|---|
| | | Department | | | |
| Academic Salaries (say) | £ | 3000 | 3000 | 3000 | 9000 |
| Other Direct Deptl. Costs (say) | £ | 3000 | 1000 | 4000 | 8000 |
| Total Direct Costs | £ | 6000 | 4000 | 7000 | 17000 |
| Meetings Provided | | 200 | 180 | 200 | 580 |
| Cost per Meeting | £ | 30.0 | 22.2 | 35.0 | 29.3 |

Allocated Meetings Received (See Course Analysis)

| Course | Department: Maths 1 | Social Sci.2 | Science 3 | Totals |
|---|---|---|---|---|
| X | 113.3 | 26.7 | 40.0 | 180.0 |
| Y | 26.7 | 93.3 | 60.0 | 180.0 |
| Z | 60.0 | 60.0 | 100.0 | 220.0 |
| Total | 200.0 | 180.0 | 200.0 | 580.0 |

Costs Allocated (= Cost per Meeting × meetings allocated)

| Course | Department: Maths 1 | Social Sci 2 | Science 3 | Totals |
|---|---|---|---|---|
| X | 3400 | 593 | 1400 | 5393 |
| Y | 800 | 2074 | 2100 | 4974 |
| Z | 1800 | 1333 | 3500 | 6633 |
| Total | 6000 | 4000 | 7000 | 17000 |

Unit Costs (= cost allocated to course / enrolment.)

| Course | Department: Maths 1 | Social Sci 2 | Science 3 | Totals |
|---|---|---|---|---|
| X | 340.0 | 59.3 | 140.0 | 539.3 |
| Y | 40.0 | 103.7 | 1050.0 | 248.7 |
| Z | 60.0 | 44.4 | 116.7 | 221.1 |

# EXHIBIT 12

## SUMMARY OF STUDENT FILE

| | Course X | Course Y | Course Z | Average of 3 courses | Standard Deviation (of 3) |
|---|---|---|---|---|---|
| Enrolments | 10 | 20 | 30 | 20 | 8·16 |
| Pass rate (%) | 90 | 70 | 83·33 | 81·11 | 8·31 |
| Fail rate (%) | 10 | 15 | 13·33 | 12·78 | 2·08 |
| Dropout rate (%) | 0 | 15 | 3·33 | 6·11 | 6·43 |
| Average Exam Mark | 55 | 50 | 53 | 52·67 | 2·05 |
| Coefficient of Variation of Exam Marks (%) | 18·20 | 16·00 | 20·75 | 18·32 | 1·94 |

## SUMMARY OF COURSE ANALYSIS

| | Course X | Course Y | Course Z | Average of 3 courses | Standard Deviation (of 3) |
|---|---|---|---|---|---|
| Student's Tuition Load | 150 | 150 | 150 | 150 | 0 |
| Student's Average Group Size | 10·33 | 16·89 | 22·56 | 16·59 | 5·00 |
| Standard Deviation of Std's Gp. Size | 4·27 | 2·01 | 6·99 | 4·42 | 2·04 |
| Percentage of Meetings Saved | 40·00 | 48·57 | 31·25 | 39·94 | 7·07 |
| Percentage of Meetings Serviced | 37·06 | 48·17 | 54·55 | 46·59 | 7·23 |

## RESULTS OF COST ANALYSIS

| | Course X | Course Y | Course Z | Average of 3 courses | Standard Deviation (of 3) |
|---|---|---|---|---|---|
| Total Direct Cost per student £ | 539·3 | 248·7 | 221·1 | 336·4 | 143·9 |

# EXHIBIT 13

## STANDARDISED COURSE PARAMETERS

| | Course | | |
|---|---|---|---|
| | X | Y | Z |
| Enrolments | -1·23 | 0 | +1·23 |
| Pass rate | +1·07 | -1·34 | +0·27 |
| Fail rate | -1·34 | +1·07 | +0·26 |
| Dropout rate | -0·95 | +1·38 | -0·43 |
| Average Exam Mark | +1·14 | -1·30 | +0·16 |
| Coeff. of Var. of Exam Marks | -0·06 | -1·20 | +1·25 |
| Student's Tuition Load | 0 | 0 | 0 |
| Student's Average Group Size | -1·25 | +0·06 | +1·19 |
| Standard Deviation of Stdts. Gp. Size | -0·07 | -1·18 | +1·26 |
| Percentage of Meetings Saved | 0 | +1·22 | -1·22 |
| Percentage of Meetings Serviced | -1·32 | +0·22 | +1·11 |
| Total Direct Cost per Student | +1·41 | -0·61 | -0·80 |

Each entry equals (value of a parameter for a course minus average of the 3 values of that parameter) divided by the standard deviation of the 3 values of that parameter.

## EXHIBIT 14

### STANDARDISED COURSE PARAMETERS - Course X

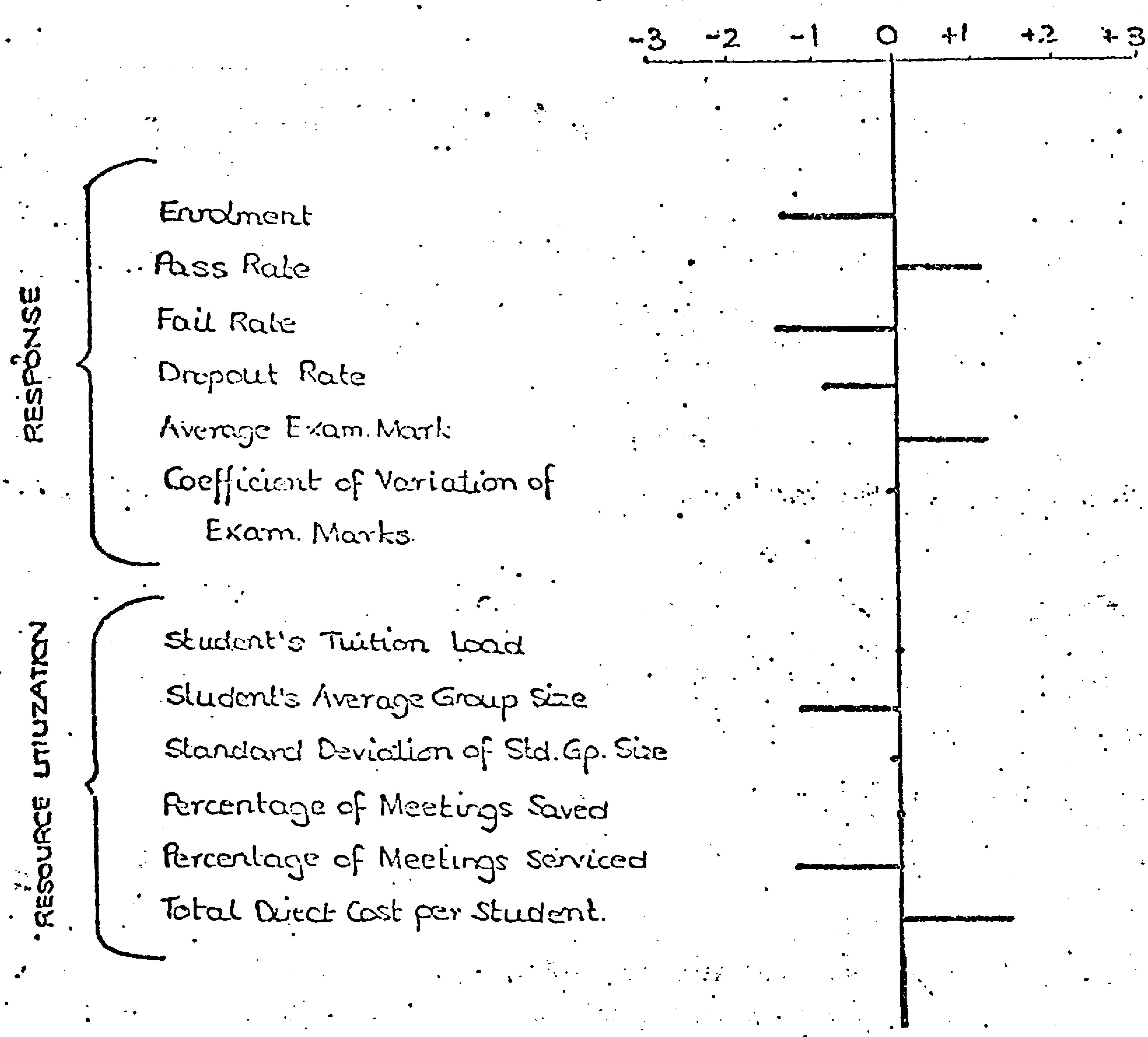
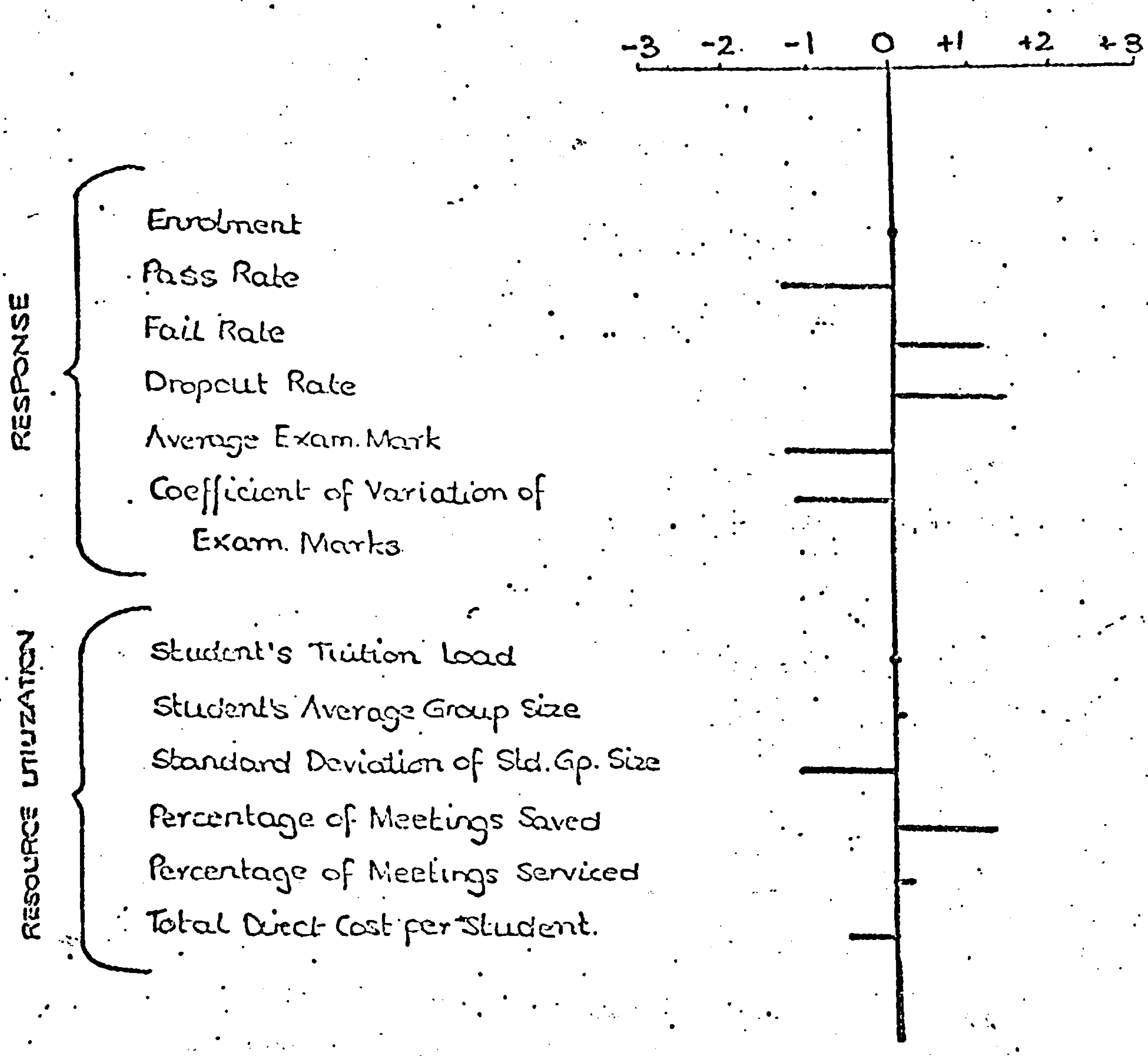


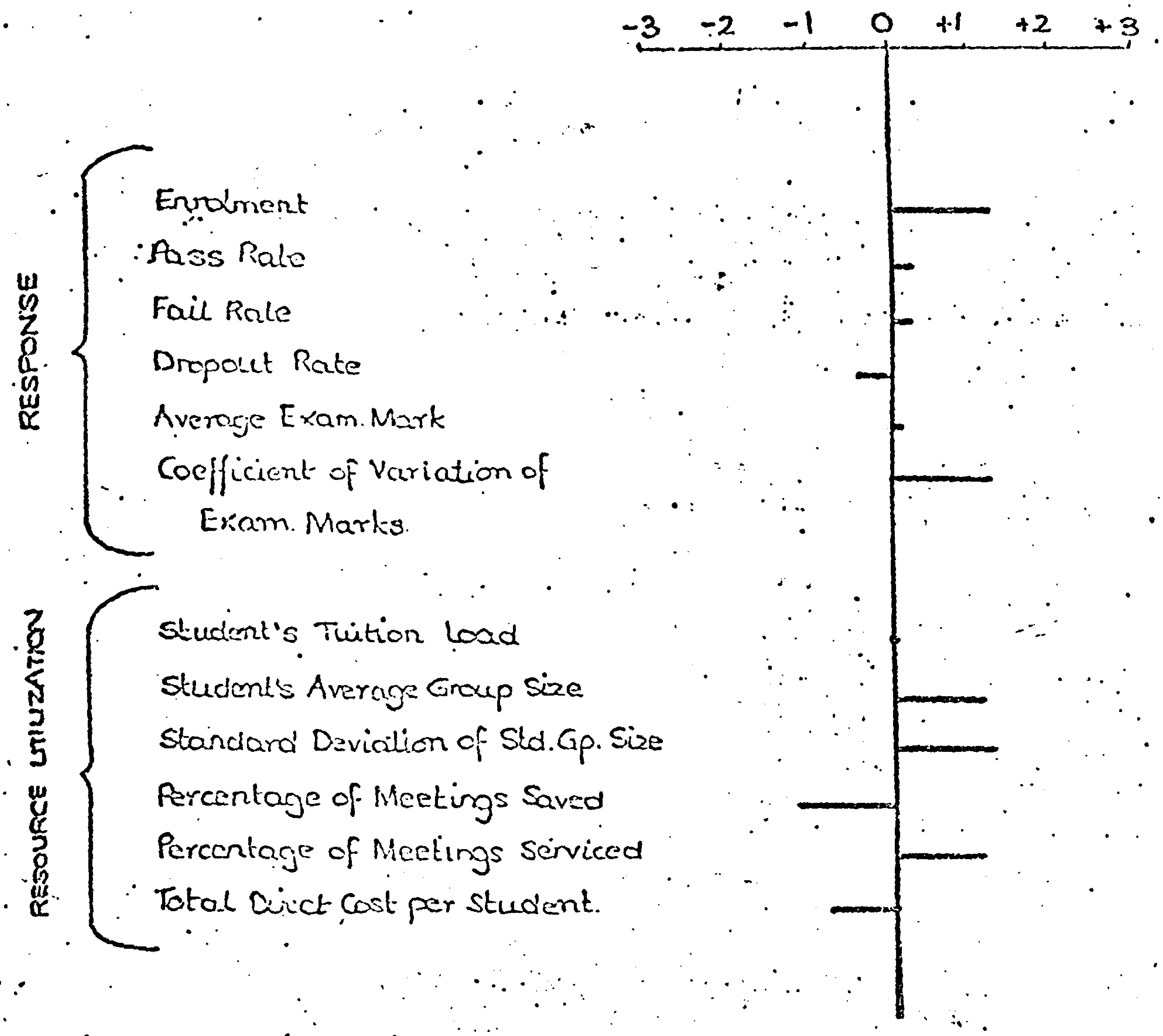
EXHIBIT 15

STANDARDISED COURSE PARAMETERS - Course Y



## EXHIBIT 15

## STANDARDISED COURSE PARAMETERS - Course Z



APPENDIX 2.5.

"IDENTIFICATION OF PERFORMANCE INDICES FOR TEACHING ACTIVITIES"

by BIRCH, D.W., CALVERT, J.R., DOCKERILL, J. and SIZER, J.

in PROCEEDINGS OF THE SECOND GENERAL CONFERENCE OF THE OECD/CERI/IMHE PROGRAMME, OECD, PARIS, JANUARY 1975

ORGANISATION FOR ECONOMIC
CO-OPERATION AND DEVELOPMENT

Centre for Educational Research
and Innovation

Paris, 18th December, 1974
Or. Engl.

IMHE/GC/74.42

Programme on Institutional Management
in Higher Education

# The Development of Performance Indices for the Teaching Function in Higher Education

D.W. Birch
J.R. Calvert
J. Dockerill
J. Sizer

Second General Conference of Member Institutions
(Paris 20-22 January 1975)

10.134

CONTENTS

# I

## NOTE BY THE SECRETARIAT

At any given point in time, the research groups of OECD's Programme on Institutional Management in Higher Education are in varying stages of advancement, since each has its own predetermined starting date and duration. On the occasion of the programme's Second General Conference of Member Institutions, final reports on the findings of three research groups which completed their work during 1974 are being presented. In addition, however, the Conference provides an opportunity for representatives of all the Member institutions to become acquainted with investigations in progress by other research groups participating in the programme. Thus, invitations have been extended to five on-going groups to present progress reports at the Conference. The topics included are :

- Identification of indices of performance for teaching activities;

- Identification of indices of performance for service activities;

- The use of cost-effectiveness and cost-benefit techniques in planning courses of study for new higher educational institutions;

- The costing and management of university grants and contracts; and

- Economic and pedagogical aspects for managing new communication technologies in higher education.

Of the above listed topics, the first three are the subject of full-scale investigations to be carried out over a two-year time span. By contrast, feasibility studies of a relatively limited scope have been carried out in the case of each of the last two topics and it is expected that these feasibility studies will lead to the formulation and implementation of full-scale projects in a second stage.

The objectives of this project are to move towards a clearer understanding and specification of the teaching function in higher education and to permit an improved budgetary planning and control system as well as comparisons across universities and polytechnics. To achieve this purpose the following steps were set out :

(i) identification and definition of inputs, outcomes and processes of the teaching function;

(ii) data collection and measurement of the variables and parameters identified; and

(iii) establishment of a set of performance indicators and investigation of their uses in varying budgeting and control strategies.

The Centre for Educational Research and Innovation wishes to express its sincerest thanks to the members of the U.K. research group for providing us with the attached report on the progress being made on this project, which will continue during 1975.

"The Development of Performance Indices for the Teaching Function in Higher Education"

1.01. Preamble

At a meeting concerned with OECD-CERI Program on Institutional Management in Higher Education held in London on 15th November 1972 a number of Universities and Polytechnics declared their interest in collaborating on an investigation into "performance indicators such as the use of staff time, capacity utilisation and staff student ratios" in their institutions.

1.02.

At the request of CERI a formal proposal of research into this area was drafted and three areas of research activity were defined - teaching, central services and research - and the institutions were asked to state their preferred areas. Loughborough University and Lanchester Polytechnic opted to seek funding to undertake a joint investigation into the teaching function and a preliminary presentation of the proposal was made at the OECD-CERI Conference in Paris on January 8-10,1973.

1.03.

Subsequently a research contract was signed with the Department of Education and Science to take effect from 1 December 1974. The main responsibility for carrying out the investigation would rest with Loughborough and Lanchester but once a framework had been developed and tested within these two institutions data would be collected from associated universities and polytechnics. At the same time Leeds University and Huddersfield Polytechnic agreed to lead an investigation into performance indices for central services and Bath University undertook a pilot study on the costing of research contracts.

2.01. Project Objectives

The broad objectives of this project are "to move towards a clearer understanding and specification of the teaching function in higher education and, hence, to permit an improved budgetary planning and control system and also comparisons across universities and polytechnics". To achieve this purpose the following steps were set out:

(i) Identify and define the inputs, outcomes and processes of the teaching function;

(ii) Collect data and measure (as far as is possible) the variables and parameters identified in (i); and

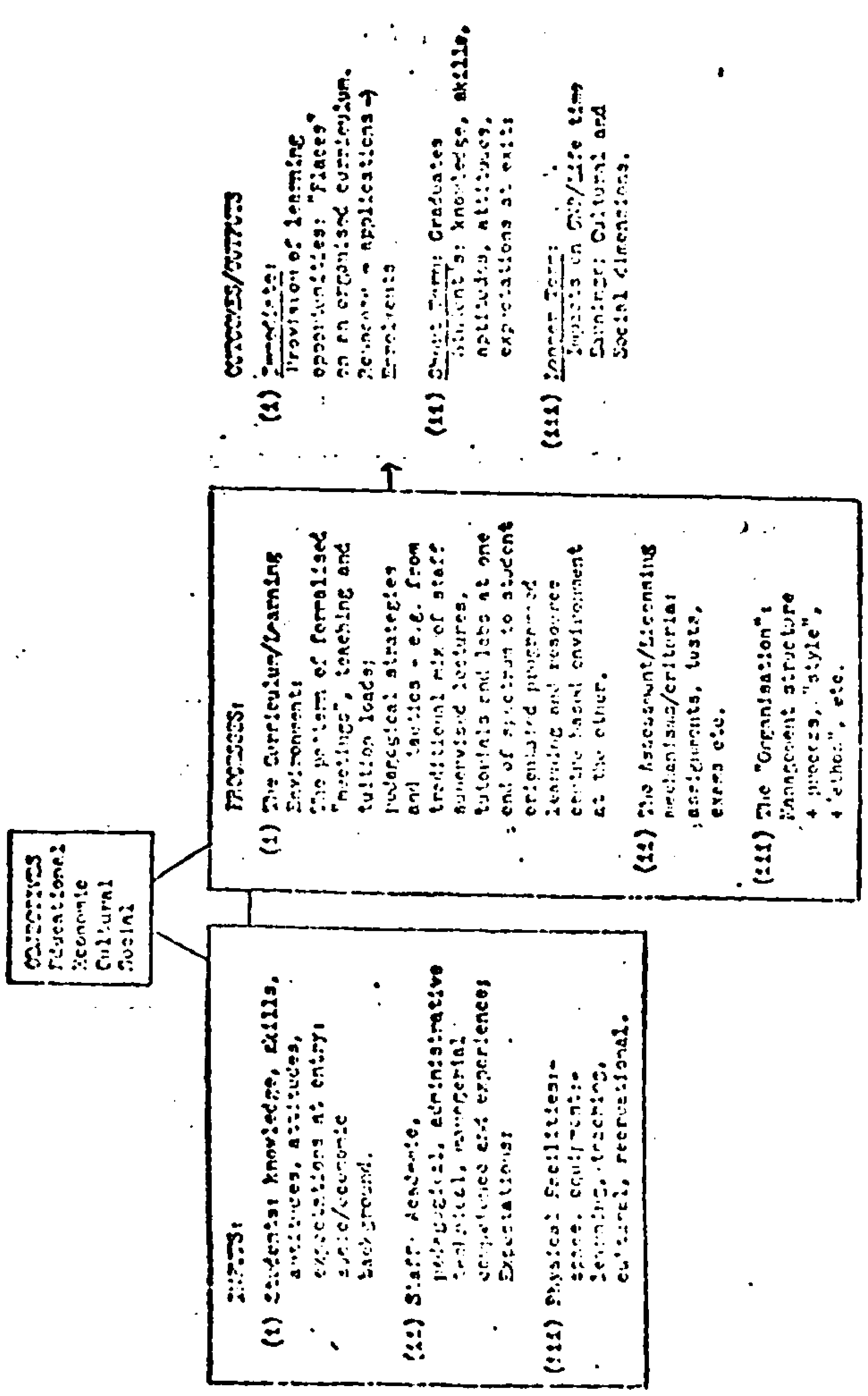
(iii) Establish a set of performance indicators and investigate their use in varying budgeting and control strategies.

2.02.

Figure I below identifies what we believe to be the major internal components of the teaching function. Within the constraints of the projects' modest budget and two year time scale it is not possible to collect and to analyse data on all the components identified. Accordingly we are concentrating on those aspects for which data is most readily available and quantifiable and have made assumptions as to institutional objectives and targets.

FIGURE 1

Components of the Teaching System



2.03.

We have decided not to collect data on:

(i) The students' socio-economic backgrounds or their attitudes and expectations at entry and exit;

(ii) The 'quality', expectations and values of the staff;

(iii) The management structure and process; and

(iv) The long term impacts of higher education.

We believe these variables to be significant but the collection and analysis of data on each would be an heroic exercise in itself and is not possible within the projects' budgeting and time constraints. However, the present investigation was conceived as a preliminary exercise which hopefully would lead on to further research into these less easily quantified more behavioural aspects.

2.04.

So far as institutional objectives are concerned the project accepts the Department of Education and Science's statement of overall aims for the teaching function in higher education as being: "To provide higher education for those who could benefit from it. To meet the requirements of society for qualified manpower". Students may choose to enrol or not in higher education and, having enrolled, the majority of them are aiming for specific qualifications and career prospects. Consequently within each institution the following more proximate goals might be postulated:

Subject to maintaining academic standards and satisfactory cost constraints:

(i) To optimise the student intake "potential";

(ii) To optimise the pass rates;

(iii) To optimise the learning gain as measured by some index of student achievement at entry and exit; and

(iv) To optimise student employability.

2.05.

Arising out of this set of institutional objectives the following performance measures were tentatively agreed by the projects' Steering Committee:

(i) At the beginning of a study program:

The average A level points score of enrolments compared with the average A level points score anticipated or some similar measures of the 'quality' of client response. *

*The normal minimum entry qualifications for a University/Polytechnic undergraduate program are two subjects at Advanced Level (A-Level) of the General Certificate of Education and/or (less usually) the appropriate Ordinary National Certificate (ONC) or Ordinary National Diploma (OND).

(ii) <u>At the end of each year of a study program</u>

The ratio of successes, failures and dropouts to enrolments;

The learning gain; and

The relationship of each direct input (academic staff, teaching spaces, departmental administration and technician support, consumables and equipment) to enrolments, successes, and learning gain.

(iii) <u>At the end of the final year of a study program</u>

(i) and (ii) to be computed for the complete study program cycle; and

feedback on graduates' initial employment and salaries.

2.06.

Since December 1973 we have been collecting the information and writing and proving the computer programs necessary to establish the data base implied in 2.05 for the academic year 1972/73 for Lanchester and Loughborough. This work is now almost completed but our original time schedules have proved optimistic and it is clear that the search in the associated institutions within the two year span of the project will be limited to some of the undergraduate programs in the more popular discipline areas.

2.07.

It became apparent very soon into the investigation that the timetable analysis and the students' academic record would make heavy demand on the time of the project team. The timetable analysis was difficult because of the complexity of the pattern of meetings at Loughborough: the student record presented problems because at Lanchester the data system is in its infancy, handwritten and, in parts, incomplete. However, this part of the project is now well advanced and discussed below.

3.01. <u>The Lanchester and Loughborough contexts</u>

Before reviewing what has been achieved to date it is appropriate to outline the Lanchester and Loughborough contexts.

3.02.

Lanchester Polytechnic was designated on 1 January 1970 and 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.

3.03.

The enrolment in 1972/73 was over 5000 of which over 3000 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 1972/73 of 929, 688, 1204 and 267 respectively. The majority are registered for first degrees awarded by the Council for National Academic Awards although the Polytechnic offers a range of study programs from sub degree to postgraduate level.

3.04.

In 1972/73 over 40 independent degree programs, in the main separately timetabled, were offered. More recently the Polytechnic has rationalised its course pattern by introducing two modular degree programs and is planning to develop this particular provision of education in the next few years.

3.05.

Loughborough University of Technology received its charter in April 1966 the first of the former Colleges of Advanced Technology to achieve university status. Its predecessor, Loughborough College, introduced full time advanced courses in science and technology in 1918. One of the distinguishing features of the earliest courses was the sandwich principle, the integration of practical training with academic studies, and this has been maintained.

3.06.

The enrolment in 1972/73 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 1972/73 of 1250, 738, 461 and 92 undergraduates respectively.

TABLE 1

1972/73 ENROLMENTS TO STUDY PROGRAMS INCLUDED IN PROJECT SURVEY

| | LANCHESTER | | | | | | LOUGHBOROUGH | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DISCIPLINE: | A | B | C | D | TOTAL | % | A | B | C | TOTAL | % |
| **Sandwich** | | | | | | | | | | | |
| Education | - | - | - | - | - | - | 22 | 7 | 2 | 31 | 1.2 |
| Technology & Engineering | 270 | 234 | 212 | - | 716 | 31.1 | 549 | 313 | 257 | 1119 | 44.3 |
| Science & Applied Science | 72 | 60 | 49 | - | 181 | 7.8 | 87 | 84 | 64 | 235 | 9.3 |
| Social & Business Studies | 133 | 130 | 127 | 8 | 398 | 17.3 | 72 | 24 | 29 | 125 | 5.0 |
| Urban & Regional Planning | 24 | 23 | 19 | 21 | 87 | 3.8 | - | - | - | - | - |
| Librarianship | - | - | - | - | - | - | - | - | - | - | - |
| Languages Studies | - | - | - | - | - | - | - | - | - | - | - |
| TOTAL | 499 | 447 | 407 | 29 | 1382 | 60.0 | 730 | 428 | 352 | 1510 | 59.8 |
| **Full time** | | | | | | | | | | | |
| Education | - | - | - | - | - | - | - | - | - | - | - |
| Technology & Engineering | - | - | - | - | - | - | 148 | 100 | 94 | 342 | 13.5 |
| Science & Applied Science | 150 | 103 | 108 | - | 361 | 15.7 | 127 | 108 | 97 | 332 | 13.1 |
| Social & Business Studies | 182 | 147 | 129 | - | 458 | 19.9 | 103 | 56 | 33 | 192 | 7.6 |
| Urban & Regional Planning | - | - | - | - | - | - | - | - | - | - | - |
| Librarianship | - | - | - | - | - | - | 29 | 21 | 15 | 65 | 2.6 |
| Languages Studies | 38 | 33 | 30 | - | 101 | 4.4 | 39 | 19 | 27 | 85 | 3.4 |
| TOTAL | 370 | 283 | 265 | - | 920 | 40.0 | 446 | 304 | 266 | 1016 | 40.2 |
| OVERALL | 869 | 730 | 674 | 29 | 2302 | 100.0 | 1176 | 732 | 618 | 2526 | 100.0 |

3.06.

Table 1 gives details of the numbers of students enrolled on study programs included in the investigation. Sandwich students on these courses who spent the whole of the academic year 1972/73 out of college at practical training are omitted. The total numbers involved in each institution are very similar 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 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, whilst at Lanchester there is a more equal balance between engineering and technology (31%) social and business studies (37%) and pure and applied science (24%).

4.01. The Timetable Analysis

Teaching (unlike learning!) is an activity which takes place for the most part in formal meetings between students and academic staff. The pattern of meetings is set down in the timetable and we consider that any attempt to explain the teaching process must begin here. Timetables are not one hundred per cent accurate but as a data source we believe them to be at least as accurate as the staff and/or student diary.

4.02.

Currently the lowest teaching administrative unit in the majority of institutions of higher education in the UK appears to be the study program ("course"). In our analysis of a study program we have broken it down into sets of meetings where a meeting is defined as a timetabled hour of contact between academic staff and students. A meeting may be described as a lecture, a seminar, a tutorial, a laboratory, an exercise class or whatever. Nevertheless we decided that the important differences between meetings lay in:

(i) the number of students involved;

(ii) the department providing the teacher; and

(iii) the type of space utilised i.e. specialist (laboratory, workshop, drawing office) or non specialist.

From the point of view of the pedagogical techniques likely to be deployed, the critical variable seemed to us to be the number of students in the group rather than its timetabled description. We saw no point in perpetuating the myth of a "lecture" to five and the "tutorial" to fifty.

4.03.

The basic unit of analysis, therefore, was the meeting. A study program constitutes a set of meetings. This 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. For a particular study program this subset of meetings might be compulsory or optional, could be taught to a single study program or might involve a number of study programs.

Consequently to analyse a set of meetings the following information was required:

(i) Total enrolment to a study program (denote by E)

(ii) The enrolment from a study program to a particular subset of meetings (denote by s where s $\gtrsim$ E);

(iii) The total enrolment from all programs of study attending a subset of meetings (denote by $E^*$ where $E^* \geq$ s);

(iv) The department providing the tuition for a subset of meetings;

(v) The type of space utilised - specialist and non specialist - by a subset of meetings;

(vi) The number of student groups each assigned to one teacher formed in a subset of meetings (denote by g); and

(vii) The total number of hours attended by a student in a particular subset of meetings of a particular group size (denote by h).

This information was collected for all the undergraduate programs in operation in 1972/73 at Loughborough and Lanchester (except art and design). (Identical data on the postgraduate taught programs at Loughborough has also been collected but not yet analysed).

4.04.

Given the above information we were able to establish for each year of a study program, for a department's programs, for discipline areas and for the institution the following values:

(i) Student load: this is the average hours of timetabled contact that the student received i.e.

$$\text{student load} = \frac{\sum(h.s)}{E}$$

(ii) Total Meetings timetabled for a particular study program:

$$\sum(h.g)$$

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

(iii) Allocatable Meetings: where several study programs attend the same set of meetings (i.e. E* > s) the teaching hours were allocated pro rata to the number of students attending from a study program i.e.

$$\text{allocatable meetings} = \sum(h.g.\frac{s}{E*});$$

(iv) Group Size: This is the size of meeting the student actually attended i.e.

group size = $\frac{E^*}{g}$

(v) Average group size attended by the student i.e.

$$\frac{\sum \frac{E^*}{g} \cdot \left(\frac{h.s}{E}\right)}{\sum \left(\frac{h.s}{E}\right)} \text{ ; and}$$

(vii) The average group size provided by the institution i.e. :

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

From (v) and (vi) it is possible to derive two frequency distributions: (v) shows the range of group sizes an average student attends and can be summed for a study program, department, discipline or institution; whereas the frequency distribution derived from (vi) shows the range of group sizes provided and because of the possibility of joint meetings crossing department or discipline boundaries may be meaningful only when summed for the whole institution.

4.05.

All study programs are based in a particular department and, therefore, discipline area and for a department or discipline area it is important to know whether the demand is from one's own study programs, or from some other departments' and whether it requires specialist space or not. Accordingly, we have analysed the totals of the values in 4.04 for study programs to reveal for each department and discipline area:-

(i) Own teaching in non specialist space;
(ii) Own teaching in specialist space;
(iii) Total own teaching;
(iv) Service teaching in non specialist space;
(v) Service teaching in specialist space;
(vi) Total service teaching;
(vii) Total teaching in non specialist space;
(viii) Total teaching in specialist space; and
(ix) Total teaching to the program.

4.06.

Some of the results of this analysis by discipline are presented in Appendix 1 but for convenience the overall results for the two institutions are given below in Tables 2, 3, and 4.

TABLE 2

SOME TIMETABLE STATISTICS 1972/73

| | LANCHESTER | | | | LOUGHBOROUGH | | |
|---|---|---|---|---|---|---|---|
| PARTS | A | B | C | D | A | B | C |
| Enrolment | 845 | 730 | 674 | 29 | 963 | 731 | 618 |
| Student Load (hrs) | 655 | 692 | 584 | 378 | 578 | 593 | 441 |
| Meetings | 42459 | 51C72 | 51964 | 1864 | 46368 | 41046 | 31054 |
| Allocatable Meetings | 40794 | 50349 | 50473 | 1864 | 20443 | 22623 | 19352 |
| Students' Average Group size | 31.4 | 19.6 | 18.2 | 16.2 | 66.9 | 46.2 | 28.6 |
| (Standard Deviation) | (27.3) | (22.4) | (22.7) | (7.7) | (61.9) | (28.5) | (22.3) |
| Institutions' Average Group Size | 13.6 | 10.0 | 7.8 | 5.9 | 27.2 | 19.1 | 14.1 |
| (Standard Deviation) | (15.5) | (9.8) | (9.0) | (7.8) | (32.8) | (22.7) | (14.3) |

TABLE 3

FREQUENCY DISTRIBUTION OF AVERAGE STUDENTS' GROUP SIZES (HRS)

| | | LANCHESTER | | | | LOUGHBOROUGH | | |
|---|---|---|---|---|---|---|---|---|
| PARTS | | A | B | C | D | A | B | C |
| Group Sizes | 1 | 10 | 10 | 18 | 39 | 0 | 0 | 5 |
| | 2-5 | 26 | 37 | 78 | 15 | 7 | 19 | 18 |
| | 6-10 | 100 | 196 | 166 | 55 | 31 | 50 | 45 |
| | 11-15 | 135 | 181 | 95 | 0 | 64 | 71 | 64 |
| | 16-20 | 60 | 90 | 75 | 0 | 53 | 73 | 73 |
| | 21-30 | 74 | 47 | 72 | 267 | 77 | 59 | 76 |
| | 31-40 | 76 | 63 | 26 | 0 | 24 | 69 | 54 |
| | 41-60 | 66 | 43 | 42 | 0 | 85 | 90 | 66 |
| | 61-80 | 56 | 13 | 0 | 0 | 47 | 96 | 34 |
| | 81-100 | 37 | 0 | 0 | 0 | 52 | 14 | 0 |
| | 101-125 | 8 | 0 | 0 | 0 | 40 | 3 | 0 |
| | 126-150 | 0 | 0 | 0 | 0 | 25 | 15 | 0 |
| | 151-175 | 0 | 0 | 0 | 0 | 10 | 7 | 0 |
| | 176-200 | 0 | 7 | 7 | 0 | 39 | 13 | 0 |
| | 200+ | 0 | 0 | 0 | 0 | 17 | 6 | 1 |

4.07.

The 'Parts' referred to in The Tables correspond to all intents and purposes with academic years. The normal college attendance for first degrees is three years but in two study programs at Lanchester (Urban and Regional Planning and Social Work) the in-college study covers four years.

4.08.

From Tables 2 and 3 it would appear on the basis of the 1972/73 timetables that over the normal three year cycle an undergraduate at Lanchester received 1931 hours of timetabled tuition as compared with 1612 hours at Loughborough. In both cases the student found himself in group sizes varying from 1 to 60. However, the Loughborough undergraduates spent far more time in groups in excess of 60 and on average could expect to spend 24 hours over the three years in classes in excess of 200 students.

4.09.

The greatest divergence between the two institutions lay in the difference between the "meetings" and "allocatable meetings". The "meetings" are those formal academic staff/student contact hours per annum that would need to be provided if each study program is timetabled independently: the "allocatable meetings" summed over the whole institution are the meeting hours actually provided: any difference arises out of "joint" classes involving more than one study program. The economic possibilities of joint meetings are clearly demonstrated in the case of Loughborough where savings in undergraduate demands for tuition of about 47% were achieved in 1972/73 as compared with 3% for Lanchester. An index of undergraduate tuition demands in hours per annum per student enrolled in college is given by:-

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

For the 72/73 data this index is as follows:-

| PARTS | LANCHESTER | LOUGHBOROUGH |
|---|---|---|
| A | 48 | 21 |
| B | 69 | 31 |
| C | 75 | 31 |
| D | 64 | - |

4.10.

It is important to appreciate the distinction between the students' average group size and the institutions' average group size. The former derived from value (v) in paragraph 4.04 identifies the average group size in which the average student finds himself i.e. his typical learning environment. The latter derived from value (vi) paragraph 4.04 identifies the average group size which the institution needs to provide. For example in the case of 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 group of 20, the students' average group size is 11.7. The institution, on the other hand, provides four hours of group size 5, two hours of group size 10 and one hour of group size 20 i.e. the institutions' average group size is 8.6. The institutions' average group size corresponds directly with the Pooling Committee's "average class size" familiar to the British polytechnic reader. Joint meetings rather than the number of enrolments to particular study programs are the major reason for the higher students' class size achieved at Loughborough.

TABLE 4

FREQUENCY DISTRIBUTION OF DEMAND FOR TEACHING SPACE (HRS)

| GROUP SIZE | LANCHESTER A | B | C | D | TOTAL | CUM % | LOUGHBOROUGH A | B | C | TOTAL | CUM % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8450 | 7660 | 12405 | 1135 | 29650 | 20.6 | 392 | 156 | 3346 | 3894 | 6.2 |
| 2-5 | 4524 | 6521 | 13582 | 128 | 24755 | 37.9 | 1932 | 4915 | 2772 | 9619 | 21.6 |
| 6-10 | 9661 | 18268 | 13522 | 231 | 41682 | 66.9 | 3589 | 4676 | 3654 | 11919 | 40.7 |
| 11-15 | 8807 | 10388 | 4975 | 0 | 24170 | 83.8 | 4442 | 4019 | 3225 | 11686 | 59.4 |
| 16-20 | 2697 | 3824 | 2888 | 0 | 9409 | 90.4 | 2929 | 2977 | 2528 | 8434 | 72.9 |
| 21-30 | 2647 | 1564 | 1953 | 370 | 6534 | 95.0 | 2837 | 1836 | 1789 | 6462 | 83.2 |
| 31-40 | 1800 | 1332 | 511 | 0 | 3643 | 97.5 | 673 | 1435 | 922 | 3030 | 88.1 |
| 41-60 | 1082 | 612 | 608 | 0 | 2302 | 99.1 | 1605 | 1374 | 842 | 3821 | 94.2 |
| 61-80 | 689 | 150 | 0 | 0 | 839 | 99.7 | 651 | 951 | 306 | 1908 | 97.2 |
| 81-100 | 375 | 0 | 0 | 0 | 375 | 99.9 | 557 | 117 | 0 | 674 | 98.3 |
| 101-125 | 60 | 0 | 0 | 0 | 60 | 99.9 | 348 | 21 | 0 | 369 | 98.9 |
| 126-150 | 0 | 0 | 0 | 0 | 0 | 99.9 | 173 | 83 | 0 | 256 | 99.3 |
| 151-175 | 0 | 0 | 0 | 0 | 0 | 99.9 | 56 | 32 | 0 | 88 | 99.4 |
| 176-200 | 0 | 30 | 29 | 0 | 59 | 99.9 | 208 | 54 | 0 | 262 | 99.8 |
| 200+ | 3 | 0 | 0 | 0 | 3 | 100.0 | 79 | 24 | 4 | 107 | 100.0 |

4.11.

Table 4 sets out the total demands in 1972/73 in each institution for teaching space by various group sizes. The pattern of demand is typified at the ends of the distribution. Almost 21% of the demand at Lanchester was for individual tutorials as compared with 6% at Loughborough: on the other hand 17% of the demand at Loughborough was for groups greater than size 30 whilst at Lanchester only 5% of the demand was for groups of 30+ students. At Lanchester 28% of the total demand was for specialist teaching space as compared with 21% at Loughborough. The institution's average group size (and standard deviation) in specialist space was as follows:-

| Parts | Lanchester | Loughborough |
|---|---|---|
| A | 12.5 (8.0) | 21.5 (11.8) |
| B | 8.6 (5.5) | 14.3 ( 8.7) |
| C | 6.2 (5.0) | 10.7 ( 5.8) |
| D | 21.0 (0.0) | - |

5.01. Student's Record

The following data on all undergraduate and taught postgraduate students at Loughborough and for most undergraduate students at Lanchester enrolled in 1972/73 has been collected:

(i) Year of entry, sex, marital status, date of birth, home or overseas;

(ii) Entry qualifications - examination boards and grades;

(iii) Subsequent academic record: study programs, parts, marks, grades; and, where it was available.

(iv) Details of first employer and initial salary.

Some of this information has been analysed and the results for discipline areas are presented in Appendix 2. For convenience the overall results for both institutions are presented below:

TABLE 5

SOME UNDERGRADUATE STATISTICS 1972/73

| | LANCHESTER | | | | LOUGHBOROUGH | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C |
| **A-LEVEL ENTRY** | | | | | | | |
| MEAN | 2.13 | 2.21 | 2.24 | 2.83 | 2.90 | 2.93 | 2.99 |
| STANDARD DEVIATION | 0.82 | 0.83 | 0.81 | 0.62 | 0.79 | 0.82 | 0.82 |
| **% ENROLMENTS** | | | | | | | |
| PASS | 0.60 | 0.88 | 0.97 | 0.86 | 0.82 | 0.85 | 0.95 |
| TO ORD | 0.11 | 0.01 | 0.00 | 0.00 | 0.04 | 0.04 | 0.00 |
| | 0.71 | 0.89 | 0.97 | 0.86 | 0.86 | 0.89 | 0.95 |
| FAIL | 0.22 | 0.09 | 0.03 | 0.03 | 0.09 | 0.09 | 0.03 |
| NOT TAKEN | 0.07 | 0.02 | 0.00 | 0.10 | 0.06 | 0.03 | 0.02 |
| MEAN MARKS | 51.79 | 55.27 | 58.40 | 60.38 | 53.33 | 54.29 | 58.15 |
| STANDARD DEVIATION | 10.19 | 8.19 | 7.47 | 5.14 | 10.81 | 10.89 | 9.69 |
| **CORRELATIONS** | | | | | | | |
| RESULTS v A-LEVELS | +.15 | +.05 | +.14 | -.24 | +.29 | +.27 | +.15 |
| B v A | | +.46 | | | | +.63 | |
| C v B | | | +.68 | | | | +.71 |
| D v C | | | | +.53 | | | |

5.02.

The A level grades have been calculated on the normal UCCA basis of A = 5, B = 4, C = 3, D = 2 and E = 1. In both institutions there is some evidence that the "quality" of the student intake as measured by mean A level grades has fallen very slightly over the years. However, this apparent fall in entry standards might be explained by the "weeding out" process of examinations. For the comparable Parts A, B and C the average Loughborough student with a mean A level of just below C was about three quarters of a grade above his Lanchester counterpart.

5.03.

Apart from Part A the pass, failure and "not taken" (wastage?) rates were similar in both institutions. The higher failure rate in Part A at Lanchester might be ascribed to the lower A level entry, but the low correlation between A levels and Part examinations suggest this explanation be treated with caution.

5.04.

There is a consistent and remarkably similar improvement in mean marks for Parts A to C in both institutions. This trend is accompanied by a tightening of the distribution of marks as the Parts proceed particularly at Lanchester.

This phenomena may be evidence of learning gain. On the other hand it may be merely illustrative of a tendency for examiners to fulfill their original "labelling" prophecies!

5.05.

The large sample sizes mean that the correlation coefficients for both institutions for Part A, B and C are significant. The correlation of A level grades with subsequent degree examination performance is consistently higher at Loughborough but even here A levels explain less than 9% of subsequent degree examination performance. The correlation between A levels and degree examinations was not materially affected by alternative measurements of A level such as "mean of best three A levels" or "number of A levels".

5.06.

The relationship between one Part and the preceding Part examination results is again stronger at Loughborough. In both institutions the correlation is increased as the Parts proceed. At Lanchester the Part A results explain just over 20% of the Part B results whilst Part B results explain about 45% of Part C results. At Loughborough the comparable percentages are 40 and 60.

5.07.

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

| Part | Lanchester | | Loughborough | |
|---|---|---|---|---|
| | N | r | N | r |
| A | 69 | +.40 | 93 | +.44 |
| B | 75 | +.29 | 66 | +.37 |
| C | 50 | +.31 | 65 | +.27 |

In all cases the coefficients are somewhat higher than the A level correlations and explain about 10% of Part A results. This stronger correlation may be accounted for by the higher probability of a good "match" between ONC/OND material and degree syllabuses.

5.08.

TABLE 6

FIRST SALARY DATA GRADUATES 1972/73 £ AND CORRELATION WITH FINAL MARK

| DISCIPLINE | LANCHESTER | | | | LOUGHBOROUGH | | | |
|---|---|---|---|---|---|---|---|---|
| | N | M £ | SD | r | N | M £ | SD | r |
| 3 | 56 | 1778 | 286 | -.10 | 190 | 1725 | 388 | +.17+ |
| 5 | 32 | 1523 | 364 | +.13 | 83 | 1503 | 279 | +.02 |
| 6 | 51 | 1696 | 359 | -.01 | 26 | 1756 | 346 | +.55* |
| 7a | - | - | - | - | - | - | - | - |
| 7b | - | - | - | - | 11 | 1466 | 166 | +.14 |
| 8 | 6 | 1488 | 302 | +.47 | 8 | 1396 | 102 | +.07 |
| All | 145 | 1681 | 347 | +.03 | 318 | 1654 | 365 | +.19* |

* Significant at the 5% level.

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

5.09. Postscript

The team is currently working on a number of problem areas: the measurement of "learning gain"; the development of a rationale for the allocation of administrators, technicians, consumables and equipment to study programs. It will be appreciated that our objective is not to undertake a comparison between Loughborough and Lanchester but to develop a methodology for accounting for inputs and outputs. However, it seemed preferable to establish the significance and sensitivity of our measurements in the Loughborough/Lanchester context before involving the associated institutions in a demanding data collection exercise.

6.00.

The project team have benefitted greatly from the advice and comments from the members of the Steering Committee, the members of which are given in Appendix 3.

17.

## Appendix 1

### Timetable Analysis

Some results for Lanchester and Loughborough 1972/73 analysed by discipline.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| I | Part A | Enrolments, | Student Load, | Meetings, | Allocatable Meetings, | Group Sizes. | | |
| II | Part B | " | " | " | " | " | " | " |
| III | Part C | " | " | " | " | " | " | " |
| IV | Part D | " | " | " | " | " | " | " |
| V | Lanchester Frequency Distribution (Hrs/Annum) Students' Group Sizes. | | | | | | | |
| VI | Loughborough | " | " | " | " | " | " | |

| | 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 manufacture e.g. 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 - architecture and town and country planning | Architecture, town and country planning. |
| 7b | Vocational - other | Catering, institutional management, home economics, Librarianship, nautical studies, transport. |
| 8 | Languages (literature and area) studies | |
| 9 | Arts (other than Languages) | History, archaeology, philosophy. |
| 10 | Art and Design | Art and design, drama, music. |

I

PART A ENROLMENTS, STUDENT LOAD, MEETINGS, ALLOCATABLE MEETINGS, GROUP SIZES BY DISCIPLINE

| DISCIPLINE | ENROLMENTS | STUDENT LOAD (HRS) | MEETINGS (HRS) | ALLOCATABLE MEETINGS (HRS) | STUDENTS' AVERAGE GROUP SIZE (STANDARD DEVIATION) | INSTITUTIONS' AVERAGE GROUP SIZE (STANDARD DEVIATION) |
|---|---|---|---|---|---|---|
| LANCHESTER | | | | | | |
| 3 | 246 | 796 | 16741 | 16625 | 21.2 (14.9) | 11.8 (10.5) |
| 5 | 222 | 789 | 11750 | 11750 | 36.2 (32.6) | 14.9 (17.8) |
| 6 | 315 | 468 | 11690 | 10646 | 39.2 (31.5) | 13.9 (18.7) |
| 7a | 24 | 510 | 740 | 740 | 23.6 (3.2) | 16.5 (10.8) |
| 8 | 38 | 589 | 1529 | 1023 | 36.1 (7.3) | 21.9 (17.6) |
| TOTAL | 845 | 654 | 42459 | 40784 | 31.4 (27.3) | 13.6 (15.5) |
| LOUGHBOROUGH | | | | | | |
| 1 | 22 | 490 | 1590 | 573 | 53.0 (48.8) | 18.7 (25.2) |
| 3 | 485 | 620 | 17666 | 10391 | 70.9 (64.8) | 28.9 (34.8) |
| 5 | 214 | 582 | 14357 | 4469 | 59.4 (49.5) | 27.8 (29.5) |
| 6 | 174 | 498 | 10255 | 2802 | 77.5 (54.7) | 30.8 (37.9) |
| 7b | 29 | 567 | 1390 | 1180 | 27.7 (41.0) | 13.9 (13.8) |
| 8 | 39 | 455 | 1110 | 1028 | 45.5 (57.1) | 17.2 (22.0) |
| TOTAL | 963 | 578 | 46368 | 20443 | 66.9 (61.9) | 27.2 (32.8) |

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II

PART B ENROLMENTS, STUDENT LOAD, MEETINGS, ALLOCATABLE MEETINGS, GROUP SIZES, BY DISCIPLINE

| DISCIPLINE | ENROLMENTS | STUDENT LOAD (HRS) | MEETINGS (HRS) | ALLOCATABLE MEETINGS (HRS) | STUDENTS' AVERAGE GROUP SIZE (STANDARD DEVIATION) | INSTITUTIONS' AVERAGE GROUP SIZE (STANDARD DEVIATION) |
|---|---|---|---|---|---|---|
| LANCHESTER | | | | | | |
| 3 | 234 | 831 | 22183 | 22183 | 11.6 (4.8) | 8.8 (4.9) |
| 5 | 163 | 941 | 15255 | 15255 | 14.5 (9.2) | 10.1 (6.7) |
| 6 | 277 | 453 | 12089 | 11214 | 36.1 (38.1) | 11.2 (16.7) |
| 7a | 23 | 500 | 720 | 720 | 22.6 (3.1) | 16.0 (10.3) |
| 8 | 33 | 625 | 1425 | 977 | 31.4 (5.2) | 21.1 (14.7) |
| TOTAL | 730 | 692 | 51672 | 50349 | 19.6 (22.4) | 10.0 (9.8) |
| LOUGHBOROUGH | | | | | | |
| 1 | 7 | 527 | 1185 | 397 | 37.4 (44.3) | 9.1 (15.6) |
| 3 | 413 | 632 | 18874 | 12751 | 54.8 (46.7) | 20.4 (26.5) |
| 5 | 192 | 599 | 8697 | 5470 | 36.7 (29.7) | 20.8 (18.1) |
| 6 | 80 | 435 | 9500 | 2294 | 29.2 (30.3) | 15.1 (14.5) |
| 7b | 21 | 497 | 1710 | 974 | 15.8 (11.3) | 10.7 (7.4) |
| 8 | 19 | 480 | 1080 | 737 | 21.8 (17.4) | 12.4 (10.8) |
| TOTAL | 732 | 593 | 41046 | 22623 | 46.2 (28.5) | 19.1 (22.7) |

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PART C ENROLMENTS, STUDENTS' LOAD, MEETINGS, ALLOCATABLE MEETINGS, GROUP SIZES, BY DISCIPLINE

| DISCIPLINE | ENROLMENTS | STUDENT LOAD (HRS) | MEETINGS (HRS) | ALLOCATABLE MEETINGS (HRS) | STUDENTS' AVERAGE GROUP SIZE (STANDARD DEVIATION) | INSTITUTIONS' AVERAGE GROUP SIZE (STANDARD DEVIATION) |
|---|---|---|---|---|---|---|
| **LANCHESTER** | | | | | | |
| 3 | 212 | 702 | 23293 | 23293 | 11.6 (7.7) | 5.4 (5.8) |
| 5 | 157 | 741 | 17062 | 17062 | 11.5 (7.9) | 6.8 (5.6) |
| 6 | 256 | 401 | 9599 | 8603 | 33.5 (38.0) | 12.0 (16.1) |
| 7a | 19 | 480 | 660 | 660 | 18.6 (2.6) | 13.8 (8.2) |
| 8 | 30 | 520 | 1350 | 848 | 28.1 (5.3) | 18.4 (13.4) |
| TOTAL | 674 | 584 | 51964 | 50173 | 18.2 (22.7) | 7.8 (9.0) |
| **LOUGHBOROUGH** | | | | | | |
| 1 | 2 | 100 | 120 | 30 | 18.5 (14.9) | 6.4 (8.6) |
| 3 | 351 | 433 | 13854 | 8848 | 35.2 (25.8) | 17.2 (17.6) |
| 5 | 161 | 507 | 9830 | 7048 | 20.9 (13.0) | 11.6 (10.4) |
| 6 | 62 | 373 | 5720 | 1993 | 19.8 (10.9) | 11.6 (9.7) |
| 7b | 15 | 332 | 720 | 720 | 8.3 (3.5) | 6.9 (3.0) |
| 8 | 27 | 390 | 810 | 713 | 23.3 (13.7) | 14.7 (11.2) |
| TOTAL | 618 | 441 | 31054 | 19352 | 28.6 (22.3) | 14.1 (14.3) |

IV

PART D ENROLMENTS, STUDENTS' LOAD, MEETINGS, ALLOCATABLE MEETINGS, GROUP SIZES BY DISCIPLINE

| DISCIPLINE | ENROLMENTS | STUDENTS' LOAD (HRS) | MEETINGS (HRS) | ALLOCATABLE MEETINGS (HRS) | STUDENTS' AVERAGE GROUP SIZE (STANDARD DEVIATION) | INSTITUTIONS' AVERAGE GROUP SIZE (STANDARD DEVIATION) |
|---|---|---|---|---|---|---|
| LANCHESTER | | | | | | |
| 3 | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - |
| 6 | 8 | 308 | 759 | 759 | 5.4 (2.3) | 3.3 (2.7) |
| 7a | 21 | 405 | 1105 | 1105 | 19.3 (5.6) | 7.7 (9.4) |
| 8 | - | - | - | - | - | - |
| TOTAL | 29 | 378 | 1864 | 1864 | 16.2 (7.7) | 5.9 (7.8) |

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KEY TO GROUP SIZES.

| | |
|---|---|
| 1 | 1 |
| 2 | 2-5 |
| 3 | 6-10 |
| 4 | 11-15 |
| 5 | 16-20 |
| 6 | 21-30 |
| 7 | 31-40 |
| 8 | 41-60 |
| 9 | 61-80 |
| 10 | 81-100 |
| 11 | 101-125 |
| 12 | 126-150 |
| 13 | 151-175 |
| 14 | 176-200 |
| 15 | 201+ |

LANCHESTER

FREQUENCY DISTRIBUTION (HOURS/ANNUM) OF STUDENTS' GROUP SIZES BY DISCIPLINE 1972/73

| DISCIPLINE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PART A | | | | | | | | | | | | | | | |
| 3 | 10 | 75 | 103 | 196 | 150 | 71 | 109 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 10 | 15 | 103 | 180 | 43 | 138 | 74 | 46 | 71 | 72 | 33 | 0 | 0 | 0 | 0 |
| 6 | 10 | 1 | 116 | 78 | 13 | 9 | 0 | 85 | 100 | 50 | 0 | 0 | 0 | 0 | 0 |
| 7a | 10 | 0 | 0 | 0 | 0 | 500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 10 | 0 | 0 | 30 | 0 | 0 | 549 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ALL | 10 | 26 | 100 | 135 | 60 | 74 | 76 | 66 | 56 | 37 | 8 | 0 | 0 | 0 | 0 |
| PART B | | | | | | | | | | | | | | | |
| 3 | 10 | 75 | 314 | 237 | 145 | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 10 | 33 | 285 | 357 | 136 | 16 | 81 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 11 | 11 | 15 | 83 | 66 | 35 | 25 | 53 | 104 | 36 | 0 | 0 | 0 | 20 | 0 |
| 7a | 10 | 0 | 0 | 0 | 490 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 10 | 0 | 0 | 0 | 0 | 60 | 555 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ALL | 10 | 37 | 196 | 181 | 90 | 47 | 63 | 43 | 13 | 0 | 0 | 0 | 0 | 7 | 0 |
| PART C | | | | | | | | | | | | | | | |
| 3 | 26 | 139 | 212 | 134 | 92 | 56 | 38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 22 | 131 | 267 | 146 | 106 | 49 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 10 | 8 | 98 | 49 | 14 | 62 | 38 | 101 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| 7a | 10 | 0 | 0 | 0 | 470 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 10 | 0 | 0 | 0 | 60 | 0 | 450 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ALL | 18 | 78 | 166 | 95 | 75 | 72 | 26 | 42 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |
| PART D | | | | | | | | | | | | | | | |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | 50 | 56 | 202 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7a | 35 | 0 | 0 | 0 | 0 | 370 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ALL | 39 | 15 | 55 | 0 | 0 | 267 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

LOUGHBOROUGH

FREQUENCY DISTRIBUTIONS (HOURS/ANNUM) OF STUDENTS' GROUP SIZES BY DISCIPLINE 1972/73

| DISCIPLINE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PART "A" | | | | | | | | | | | | | | | |
| 1 | 4 | 0 | 56 | 90 | 0 | 104 | 0 | 70 | 0 | 83 | 38 | 19 | 19 | 1 | 3 |
| 3 | 0 | 6 | 27 | 58 | 71 | 78 | 25 | 83 | 75 | 31 | 49 | 16 | 1 | 72 | 22 |
| 5 | 0 | 19 | 0 | 47 | 48 | 143 | 42 | 68 | 29 | 109 | 3 | 45 | 0 | 4 | 18 |
| 6 | 0 | 0 | 53 | 28 | 11 | 22 | 12 | 146 | 15 | 41 | 71 | 35 | 35 | 13 | 11 |
| 7b | 0 | 0 | 166 | 270 | 64 | 0 | 1 | 1 | 0 | 0 | 20 | 20 | 20 | 0 | 0 |
| 8 | 0 | 0 | 35 | 240 | 60 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 60 | 0 | 0 |
| All | 0 | 7 | 31 | 64 | 53 | 77 | 24 | 85 | 47 | 52 | 40 | 25 | 10 | 39 | 17 |
| PART "B" | | | | | | | | | | | | | | | |
| 1 | 0 | 112 | 98 | 7 | 105 | 32 | 0 | 28 | 17 | 100 | 8 | 0 | 0 | 11 | 5 |
| 3 | 0 | 24 | 32 | 49 | 86 | 72 | 59 | 79 | 128 | 21 | 6 | 25 | 12 | 21 | 10 |
| 5 | 0 | 2 | 50 | 121 | 45 | 60 | 76 | 139 | 90 | 4 | 0 | 0 | 0 | 3 | 3 |
| 6 | 0 | 19 | 87 | 39 | 92 | 23 | 101 | 52 | 0 | 0 | 0 | 7 | 4 | 5 | 0 |
| 7b | 0 | 50 | 45 | 242 | 68 | 0 | 69 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 30 | 270 | 0 | 0 | 0 | 90 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All | 0 | 19 | 50 | 71 | 73 | 59 | 69 | 90 | 96 | 14 | 3 | 15 | 7 | 13 | 6 |
| PART "C" | | | | | | | | | | | | | | | |
| 1 | 0 | 25 | 20 | 5 | 0 | 30 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 3 | 11 | 33 | 44 | 47 | 67 | 62 | 95 | 59 | 0 | 0 | 0 | 0 | 0 | 2 |
| 5 | 11 | 15 | 43 | 123 | 151 | 60 | 66 | 23 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 4 | 44 | 53 | 26 | 70 | 139 | 12 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7b | 0 | 150 | 82 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 122 | 27 | 0 | 180 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All | 5 | 18 | 45 | 64 | 73 | 73 | 54 | 63 | 34 | 0 | 0 | 0 | 0 | 0 | 1 |

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## Appendix 2

### Student Record

Some results for Lanchester and Loughborough 1972/73 analysed by discipline.

| | |
|---|---|
| I | Part A Undergraduate Results |
| II | Part B Undergraduate Results |
| III | Part C Undergraduate Results |
| IV | Part D Undergraduate Results |
| V | Mean A level Scores |
| VI | Correlation of Mean A level Scores with Parts |
| VII | Correlation Part with Preceding Part Results |
| VIII | Correlation of Mean ONC/OND Scores with Parts |

| 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 manufacture e.g. 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 - architecture and town and country planning | Architecture, town and country planning. |
| 7b Vocational - other | Catering, institutional management, home economics, Librarianship, nautical studies, transport. |
| 8 Languages (literature and area) studies | |
| 9 Arts (other than Languages) | History, archaeology, philosophy. |
| 10 Art and Design | Art and design, drama, music. |

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I

1972/73 PART A UNDERGRADUATE RESULTS BY DISCIPLINE

| DISCIPLINE | ENROL | PASS | TO ORD | FAIL | NOT TAKEN | MEAN MARK | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| LANCHESTER | | | | | | | |
| 3 | 270 | 131 (0.49) | 46 (0.17) | 70 (0.26) | 23 (0.08) | 53.68 | 11.19 |
| 5 | 222 | 102 (0.46) | 39 (0.18) | 65 (0.29) | 16 (0.07) | 50.77 | 10.50 |
| 6 | 316 | 245 (0.78) | 11 (0.03) | 43 (0.14) | 16 (0.05) | 50.36 | 9.11 |
| 7a | 24 | 21 (0.88) | 0 (0.00) | 2 (0.08) | 1 (0.04) | 58.09 | 4.09 |
| 8 | 38 | 24 (0.63) | 0 (0.00) | 8 (0.21) | 6 (0.16) | 52.66 | 8.53 |
| TOTAL | 869 | 523 (0.60) | 96 (0.11) | 188 (0.22) | 62 (0.07) | 51.79 | 10.19 |
| LOUGHBOROUGH | | | | | | | |
| 1 | 22 | 19 (0.86) | 0 (0.00) | 3 (0.14) | 0 (0.00) | 51.77 | 10.65 |
| 3 | 697 | 567 (0.81) | 27 (0.04) | 68 (0.10) | 35 (0.06) | 53.60 | 11.26 |
| 5 | 214 | 165 (0.77) | 13 (0.06) | 17 (0.08) | 19 (0.09) | 51.55 | 12.30 |
| 6 | 175 | 151 (0.86) | 4 (0.02) | 9 (0.05) | 11 (0.06) | 54.14 | 8.07 |
| 7b | 29 | 28 (0.97) | 0 (0.00) | 1 (0.03) | 0 (0.00) | 55.55 | 6.68 |
| 8 | 39 | 34 (0.87) | 0 (0.00) | 5 (0.11) | 0 (0.00) | 53.34 | 5.23 |
| TOTAL | 1176 | 964 (0.82) | 44 (0.04) | 103 (0.09) | 65 (0.06) | 53.33 | 10.81 |

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II

## 1972/73 PART B UNDERGRADUATE RESULTS BY DISCIPLINE

| DISCIPLINE | ENROL | PASS | TO ORD | FAIL | NOT TAKEN | MEAN MARK | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| **LANCHESTER** | | | | | | | |
| 3 | 234 | 195 (0.83) | 3 (0.01) | 35 (0.15) | 1 (0.00) | 56.56 | 9.26 |
| 5 | 163 | 136 (0.83) | 3 (0.02) | 20 (0.12) | 4 (0.02) | 55.66 | 9.66 |
| 6 | 277 | 259 (0.94) | 1 (0.00) | 13 (0.05) | 4 (0.01) | 54.15 | 6.38 |
| 7a | 23 | 23 (1.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 53.09 | 5.35 |
| 8 | 33 | 29 (0.88) | 0 (0.00) | 1 (0.03) | 3 (0.09) | 55.03 | 4.91 |
| TOTAL | 730 | 642 (0.88) | 7 (0.01) | 69 (0.09) | 12 (0.02) | 55.27 | 8.19 |
| **LOUGHBOROUGH** | | | | | | | |
| 1 | 7 | 5 (0.71) | 0 (0.00) | 1 (0.14) | 1 (0.14) | 51.67 | 5.59 |
| 3 | 413 | 341 (0.83) | 26 (0.06) | 40 (0.10) | 6 (0.01) | 54.75 | 11.36 |
| 5 | 192 | 170 (0.89) | 0 (0.00) | 16 (0.08) | 6 (0.03) | 53.22 | 11.46 |
| 6 | 80 | 71 (0.89) | 0 (0.00) | 5 (0.06) | 4 (0.05) | 54.38 | 8.29 |
| 7b | 21 | 19 (0.90) | 0 (0.00) | 0 (0.00) | 2 (0.10) | 58.84 | 5.13 |
| 8 | 19 | 16 (0.84) | 0 (0.00) | 3 (0.16) | 0 (0.00) | 50.58 | 6.22 |
| TOTAL | 732 | 622 (0.85) | 26 (0.04) | 65 (0.09) | 19 (0.03) | 54.29 | 10.89 |

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III

1972/73 PART C UNDERGRADUATE RESULTS BY DISCIPLINE

| DISCIPLINE | ENROL | PASS | TO ORD | FAIL | NOT TAKEN | MEAN MARK | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| LANCHESTER | | | | | | | |
| 3 | 212 | 208 (0.98) | 0 (0.00) | 4 (0.02) | 0 (0.00) | 62.41 | 7.52 |
| 5 | 157 | 148 (0.94) | 0 (0.00) | 9 (0.06) | 0 (0.00) | 57.88 | 8.36 |
| 6 | 256 | 250 (0.98) | 0 (0.00) | 4 (0.02) | 2 (0.01) | 55.69 | 5.88 |
| 7a | 19 | 18 (0.95) | 0 (0.00) | 0 (0.00) | 1 (0.05) | 57.44 | 4.70 |
| 8 | 30 | 30 (1.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 56.00 | 4.68 |
| TOTAL | 674 | 654 (0.97) | 0 (0.00) | 17 (0.03) | 3 (0.00) | 58.40 | 7.47 |
| LOUGHBOROUGH | | | | | | | |
| 1 | 2 | 2 (1.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 51.00 | 7.00 |
| 3 | 351 | 331 (0.94) | 0 (0.00) | 13 (0.04) | 7 (0.02) | 59.65 | 9.52 |
| 5 | 161 | 152 (0.94) | 0 (0.00) | 7 (0.04) | 2 (0.01) | 56.14 | 10.66 |
| 6 | 62 | 62 (0.98) | 0 (0.00) | 1 (0.02) | 0 (0.00) | 55.42 | 7.34 |
| 7b | 15 | 15 (1.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 61.93 | 9.30 |
| 8 | 27 | 27 (1.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 55.56 | 5.82 |
| TOTAL | 618 | 588 (0.95) | 0 (0.00) | 21 (0.03) | 0 (0.00) | 58.15 | 9.69 |

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IV

1972/73 PART D UNDERGRADUATE RESULTS BY DISCIPLINE

| DISCIPLINE | ENROL | PASS | TO ORD | FAIL | NOT TAKEN | MEAN MARK | STANDARD DEVIATION |
|---|---|---|---|---|---|---|---|
| 3 | | - | - | | - | - | - |
| 5 | | - | - | - | - | - | - |
| 6 | 8 | 8 (1.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 64.00 | 4.72 |
| 7a | 21 | 17 (0.81) | 0 (0.00) | 1 (0.05) | 3 (0.14) | 58.78 | 4.46 |
| 8 | - | - | - | - | - | - | - |
| TOTAL | 29 | 25 (0.86) | 0 (0.00) | 1 (0.03) | 3 (0.10) | 60.38 | 5.14 |

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V

MEAN A-LEVEL SCORES FOR UNDERGRADUATES ENROLLED 1972/73
BY DISCIPLINE

| DISCIPLINE | PART A | | | PART B | | | PART C | | | PART D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LANCHESTER | N | M | SD | N | M | SD | N | M | SD | N | M | SD |
| 3 | 178 | 1.95 | 0.84 | 100 | 1.91 | 0.85 | 85 | 2.01 | 0.79 | - | - | - |
| 5 | 194 | 1.80 | 0.72 | 124 | 1.80 | 0.70 | 112 | 1.83 | 0.89 | - | - | - |
| 6 | 295 | 2.34 | 0.77 | 242 | 2.42 | 0.73 | 224 | 2.44 | 0.67 | 6 | 2.73 | 0.40 |
| 7a | 24 | 2.84 | 0.73 | 19 | 2.59 | 0.91 | 19 | 2.95 | 0.68 | 16 | 2.87 | 0.68 |
| 8 | 34 | 2.54 | 0.78 | 31 | 3.02 | 0.75 | 29 | 2.57 | 0.63 | - | - | - |
| TOTAL | 725 | 2.13 | 0.82 | 516 | 2.21 | 0.83 | 469 | 2.24 | 0.81 | 22 | 2.83 | 0.62 |
| LOUGHBOROUGH | | | | | | | | | | | | |
| 1 | 21 | 2.55 | 0.73 | 5 | 3.14 | 0.47 | 1 | 1.70 | 0.00 | - | - | - |
| 3 | 545 | 2.96 | 0.81 | 329 | 3.00 | 0.82 | 269 | 2.98 | 0.77 | - | - | - |
| 5 | 205 | 2.79 | 0.80 | 185 | 2.86 | 0.82 | 150 | 3.07 | 0.81 | - | - | - |
| 6 | 166 | 2.77 | 0.69 | 65 | 2.66 | 0.70 | 54 | 2.68 | 0.96 | - | - | - |
| 7b | 29 | 2.98 | 0.76 | 21 | 2.90 | 0.75 | 15 | 2.83 | 0.85 | - | - | - |
| 8 | 39 | 3.45 | 0.59 | 19 | 3.36 | 0.89 | 27 | 3.34 | 0.72 | - | - | - |
| TOTAL | 1005 | 2.90 | 0.79 | 624 | 2.93 | 0.82 | 516 | 2.99 | 0.82 | - | - | - |

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VI

CORRELATION: MEAN A-LEVEL SCORES WITH PARTS UNDERGRADUATES 1972/73

| DISCIPLINE | A | | B | | C | | D | |
|---|---|---|---|---|---|---|---|---|
| LANCHESTER | N | r | N | r | N | r | N | r |
| 3 | 158 | +.22 | 100 | +.10 | 85 | +.19 | - | - |
| 5 | 182 | +.00 | 121 | -.01 | 111 | +.38 | - | - |
| 6 | 281 | +.20 | 239 | +.18 | 221 | +.12 | 6 | +.42 |
| 7a | 23 | +.12 | 19 | -.30 | 18 | +.36 | 15 | -.40 |
| 8 | 30 | +.31 | 28 | +.43 | 29 | +.44 | - | - |
| TOTAL | 674 | +.15 | 507 | +.05 | 464 | +.14 | 21 | -.24 |

| LOUGHBOROUGH | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 21 | +.38 | 5 | -.68 | 1 | - | - | - |
| 3 | 518 | +.31 | 320 | +.31 | 264 | +.10 | - | - |
| 5 | 188 | +.33 | 176 | +.28 | 147 | +.26 | - | - |
| 6 | 155 | +.22 | 61 | -.07 | 53 | -.10 | - | - |
| 7b | 29 | +.00 | 19 | +.36 | 15 | +.47 | - | - |
| 8 | 38 | +.45 | 19 | +.64 | 27 | +.31 | - | - |
| TOTAL | 949 | +.29 | 600 | +.27 | 507 | +.15 | - | - |

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VII

CORRELATION PART WITH PRECEDING PART RESULTS UNDERGRADUATES 1972/73

| DISCIPLINE | B v A | | C v B | | D v C | |
|---|---|---|---|---|---|---|
| LANCHESTER | N | r | N | r | N | r |
| 3 | 198 | +.48 | 211 | +.62 | - | - |
| 5 | 152 | +.39 | 156 | +.68 | - | - |
| 6 | 273 | +.39 | 252 | +.59 | 8 | +.88 |
| 7a | 23 | +.40 | 18 | +.73 | 18 | +.30 |
| 8 | 30 | +.72 | 30 | +.71 | - | - |
| TOTAL | 676 | +.46 | 667 | +.68 | 26 | +.53 |
| LOUGHBOROUGH | | | | | | |
| 1 | 6 | +.72 | 2 | -1.00 | - | - |
| 3 | 400 | +.67 | 343 | +.70 | - | - |
| 5 | 182 | +.62 | 156 | +.77 | - | - |
| 6 | 76 | +.27 | 62 | +.50 | - | - |
| 7b | 18 | +.75 | 15 | +.75 | - | - |
| 8 | 19 | +.70 | 27 | +.74 | - | - |
| TOTAL | 701 | +.63 | 605 | +.71 | - | - |

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VIII

CORRELATION MEAN ONC/OND SCORES WITH PARTS 1972/73 BY DISCIPLINE

| DISCIPLINE | A | | B | | C | |
|---|---|---|---|---|---|---|
| LANCHESTER | N | r | N | r | N | r |
| 3 | 52 | +.25 | 54 | +.23 | 32 | +.06 |
| 5 | 8 | +.78 | 11 | +.02 | 8 | -.05 |
| 6 | 9 | +.43 | 10 | +.43 | 9 | +.75 |
| 7a | - | - | - | - | - | - |
| 8 | - | - | - | - | 1 | - |
| TOTAL | 69 | +.40 | 75 | +.29 | 50 | +.31 |
| LOUGHBOROUGH | | | | | | |
| 1 | 1 | - | 1 | - | 1 | - |
| 3 | 87 | +.44 | 58 | +.35 | 57 | +.15 |
| 5 | 3 | +.96 | 2 | +1.00 | 6 | +.73 |
| 6 | 2 | +1.00 | 5 | +.74 | 1 | - |
| 7b | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - |
| TOTAL | 93 | +.44 | 66 | +.37 | 65 | +.25 |

## Appendix 3

### Steering Committee

| | |
|---|---|
| J.R. Calvert | Loughborough University of Technology (Secretary to the Committee) |
| Prof. L. Cantor | Loughborough University of Technology |
| P. Cordle | Assistant Treasurer, West Midlands Metropolitan Authority |
| Dr. Legg | Lanchester Polytechnic, (Chairman of the Committee) |
| K. Houghton | Polytechnic of Central London |
| A.F. Nightingale | Polytechnic, Huddersfield |
| Dr. W. Palmer | Lanchester Polytechnic |
| Dr. F. Pearson | Lanchester Polytechnic |
| F.L. Roberts | Registrar, Loughborough University of Technology |
| B. Rodmell | Senior Economic Adviser, Department of Education and Science, London. |
| Prof. P. Rivett | Sussex University |
| Prof. J. Sizer | Loughborough University of Technology |

### Project Team

| | |
|---|---|
| Prof. J. Sizer | Project Director |
| D.W. Birch | Loughborough University of Technology, (Deputy Project Director) |
| J. Calvert | Loughborough University of Technology |
| J. Dockerill | Lanchester Polytechnic |
| J. Greenwood | Loughborough University of Technology, (Research Assistant) |
| B. Wardell | Lanchester Polytechnic, (Part-time Clerk) |
| C.E. Hann | Loughborough University of Technology, (Part-time Clerk) |

APPENDIX 2.6.

"A STUDY OF SOME PERFORMANCE INDICATORS IN HIGHER EDUCATION WITH PARTICULAR REFERENCE TO LOUGHBOROUGH UNIVERSITY AND LANCHESTER POLYTECHNIC"

by BIRCH, D.W., CALVERT, J.R. and SIZER, J.

in PROCEEDINGS OF THE THIRD GENERAL CONFERENCE OF THE OECD/CERI/IMHE PROGRAMME, OECD, PARIS, SEPTEMBER 1976

Organisation for Economic Co-operation and Development

CENTRE FOR EDUCATIONAL RESEARCH AND INNOVATION

PROGRAMME ON INSTITUTIONAL MANAGEMENT IN HIGHER EDUCATION

# "A STUDY OF SOME PERFORMANCE INDICATORS IN HIGHER EDUCATION WITH PARTICULAR REFERENCE TO LANCHESTER POLYTECHNIC AND LOUGHBOROUGH UNIVERSITY"

D. W. BIRCH, J. R. CALVERT & J. SIZER

A Report to be presented to the Third General Conference of Member Institutions of the Programme on Institutional Management in Higher Education, Paris, 13th-16th September 1976.

# A STUDY OF SOME PERFORMANCE INDICATORS IN HIGHER EDUCATION WITH PARTICULAR REFERENCE TO LANCHESTER POLYTECHNIC AND LOUGHBOROUGH UNIVERSITY

## PREAMBLE

This case study is the result of an investigation undertaken jointly by Lanchester Polytechnic and Loughborough University of Technology. It has been partly financed by the United Kingdom Department of Education and Science and sponsored by the Institutional Management in Higher Education Programme of OECD/CERI.

The purpose of the study was to examine the potential for performance indicators for the teaching activities in higher education in the UK where "teaching" is defined as:-

- The recruitment and selection of the student body;
- The creation of a learning environment leading to the transmission of knowledge and skills and the development of creative, analytical and critical abilities; and
- The verificiation and certification of the learning processes.

In addition to their teaching role institutions of higher education pursue research and scholarship and public service and these latter activities also contribute directly and indirectly to the teaching function. The multi missions of higher education give rise to joint costs and products which it will often be impossible to precisely unscramble. However, a consideration of research and scholarship and public service was outside the project's remit and for the purpose of this study they are treated as residual activities.

The broad objectives of the project were set as being "to move towards a clearer understanding of the teaching function in higher education and, hence, to permit an improved budgetary planning and control system and also comparisons across UK universities and polytechnics". To achieve this the following steps were identified:

(i) Identify and define the inputs, outcomes and processes of the teaching functions:

(ii) Collect data and measure (as far as is possible) the variables and parameters identified in (1); and

(iii) Establish a set of performance indicators and investigate their significance with data from the undergraduate programmes at Lanchester Polytechnic and Loughborough University for the academic years 1972/73 and 1973/74.

## COMPONENTS OF THE TEACHING FUNCTION

Figure 1 below identifies what we believe to be the major internal components of the teaching function. Within the constraints of the project's budget and time-scale it was not possible to collect and analyse data on all the variables identified. Accordingly we have concentrated on these aspects for which data was most readily available and quantifiable. Thus data was not collected on

- The students' socio-economic backgrounds or their attitudes and expectations at entry and exit;
- The 'quality', expectations and values of the staff;
- The management structure and process; and
- The long term impacts of higher education.

FIGURE 1



SOME COMPONENTS OF THE TEACHING FUNCTION IN HIGHER EDUCATION

**OBJECTIVES**

Educational
Economic
Cultural
Social
Political

**INPUTS**

) STUDENTS
knowledge, skills, aptitudes, attitudes, expectations at entry: Socio-economic background.

) STAFF: Academic, Technician, Administrative, Pedagogical, Technical, managerial
Competence and experience:
Expectations and values

) PHYSICAL FACILITIES & RESOURCES
Space, equipment, materials for learning/teaching cultural and recreational activities.

**PROCESSES**

(i) LEARNING ENVIRONMENT
The Curriculum: The timetable - the pattern of formal meetings, tuition and teaching loads:
Pedagogical strategies and tactics - from traditional mix of staff supervised lectures, tutorials and laboratories at one end of the spectrum to student orientated programmed learning and resource centre based environment on the other.

(ii) ASSESSMENT/LICENSING MECHANISMS & CRITERIA
Assignments, tests, examinations etc.

(iii) "ORGANISATION"
Management structure and Process;
Management "style";
Institutional ethos etc.

**OUTCOMES/OUTPUTS**

(i) IMMEDIATE
The provision of learning opportunities i.e. "Places" on an organised curriculum:
Response = initially "applications" ultimately "enrolments".

(ii) SHORT TERM
Graduates: Students' knowledge, skills, aptitudes, attitudes, expectations at exit

(iii) LONGER TERM
Impacts on Gross National Product/Life-time earnings and cultural and social dimensions.

We believe these variables to be significant but the investigation of each would be an heroic task. They remain potentially fruitful areas for further research.

## The Objectives of Higher Education

One view of education is that it is a civilising process whereby the student acquires the behaviour and discipline patterns necessary to appreciate and perpetuate 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 these which the production of material wealth can be made to subserve" (Marshall 1890).

An alternative view is that of the human capital theorists who establish a direct link between education and a student's productivity and marketability. (Becker 1964, Schultz 1963). University study improves a student skills level therefore he can contribute more to the gross national product and consequently he earns more.

A third approach is referred to as the filter or screening hypothesis. (Arrow 1973, Wiles 1974). This theory 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 - i.e. higher education is simply a sorting device, a filter.

All these views of the education process see it affecting an individual's lifetime chances. 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 enhanced, and productivity improved by the more efficient use of resources within existing knowledge and by the development of new technologies pushing the production possibility curve outwards.

Some of these benefits can be quantified in terms of increased earnings expectations. On the other hand, it might be contended that higher education is not undertaken "just for money" or "primarily for money". Nevertheless there is now sufficient information available in the UK to support the hypothesis that higher education does materially improve lifetime earnings expectations (Morris and Ziderman 1971, Ziderman 1973). These improvements probably reflect the vocational (skills) more than the general (cultural) aspects of higher education but if general education is seen to cover the social skills necessary for posts available only to graduates, or has no effect on skills levels yet acts as a label conveying some information on the job market (as according to the filter theory), then it can be argued that the resulting earnings streams signal the effectiveness of the 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 total systems 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 institutional level.

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 5th or 10th 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;
proportions holding elected office;
rate of participation in local affairs;
drunkeness, 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 higher 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.

The Department of Education and Science has identified the overall aims for the teaching function in higher education in the UK as being:

> To provide higher education for those who could benefit from it; and
> To meet the requirements of society for qualified manpower. (DES 1970).

The first of these objectives is at a level of generality such as to be beyond dispute. The second aim, is more controversial - we subscribe to its sentiments but if it is defined as "organising courses of education so as to match with precision the forecast needs of employers for trained personnel of various types" we remain sceptical as to how it can be effectively deployed in either a macro or micro planning or control context. Nevertheless, students may choose to enrol or not in higher education and, having enrolled, the majority of them are aiming for specific qualifications and definite career prospects. The major reason for going to university by the largest groups in Startup's survey (1972) were occupational in nature. They believed that a degree would give them access to a wider range of better paid and more interesting jobs. This phenomenon applied particularly to applied science and science students (Startup and Birk 1975). Therefore, within an institution the following goals might be postulated:

> Subject to maintaining academic standards
> and satisfying cost constraints -
>
> To attain a "satisfactory" level of:

(i) student intake "potential"

(ii) pass rates;

(iii) learning gain as measured by some index of student achievement at entry and exit; and

(iv) student employability.

Goals (i), (ii) and (iv) are capable of being defined as targets i.e. in quantified terms. "Learning gain" however, presents problems of definition and is less susceptible to quantification: if it is interpreted as being concerned primarily with educational rather than say experiential attitudinal, cultural and social gains or personal consumption then it overlaps with the pass-rate goal and the latter may serve as a proxy. To accurately measure learning gain we would need to give the students a pre course and post course test and allow for outside influences. To compare performance in different institutions we would have to produce standardised tests covering common syllabuses. (Attiyeh and Lumsden 1971 and 1972). This formidable task has not been pursued here.

The above list of goals is by no means exhaustive. Attempts to obtain agreement among educators as to their objectives in terms precise enough to permit an exact specification of institutional outputs and hence permit the effective monitoring of performance have not been particularly successful. It has been argued (Cohen and March 1974) that university objectives are not only ambiguous but are destined to remain so, since many administrative and faculty feel this to be desirable and even beneficial. (Fielden and Lockwood 1973).

## Outcomes and Outputs

The longer term outputs of the teaching process are its impacts on the student's post institution lifetime chances - economic, social, cultural and political - and the spin off from their individual contributions to society generally i.e. the "externalities". As indicated above a calculus for assessing the economic effects exists but its effective use at the level of institutional management is blocked by the paucity of data on alumni careers and age earnings profiles. Information on students' initial employments is less difficult to assemble and is essential feedback for an institution which has agreed objectives in terms of satisfying manpower needs.

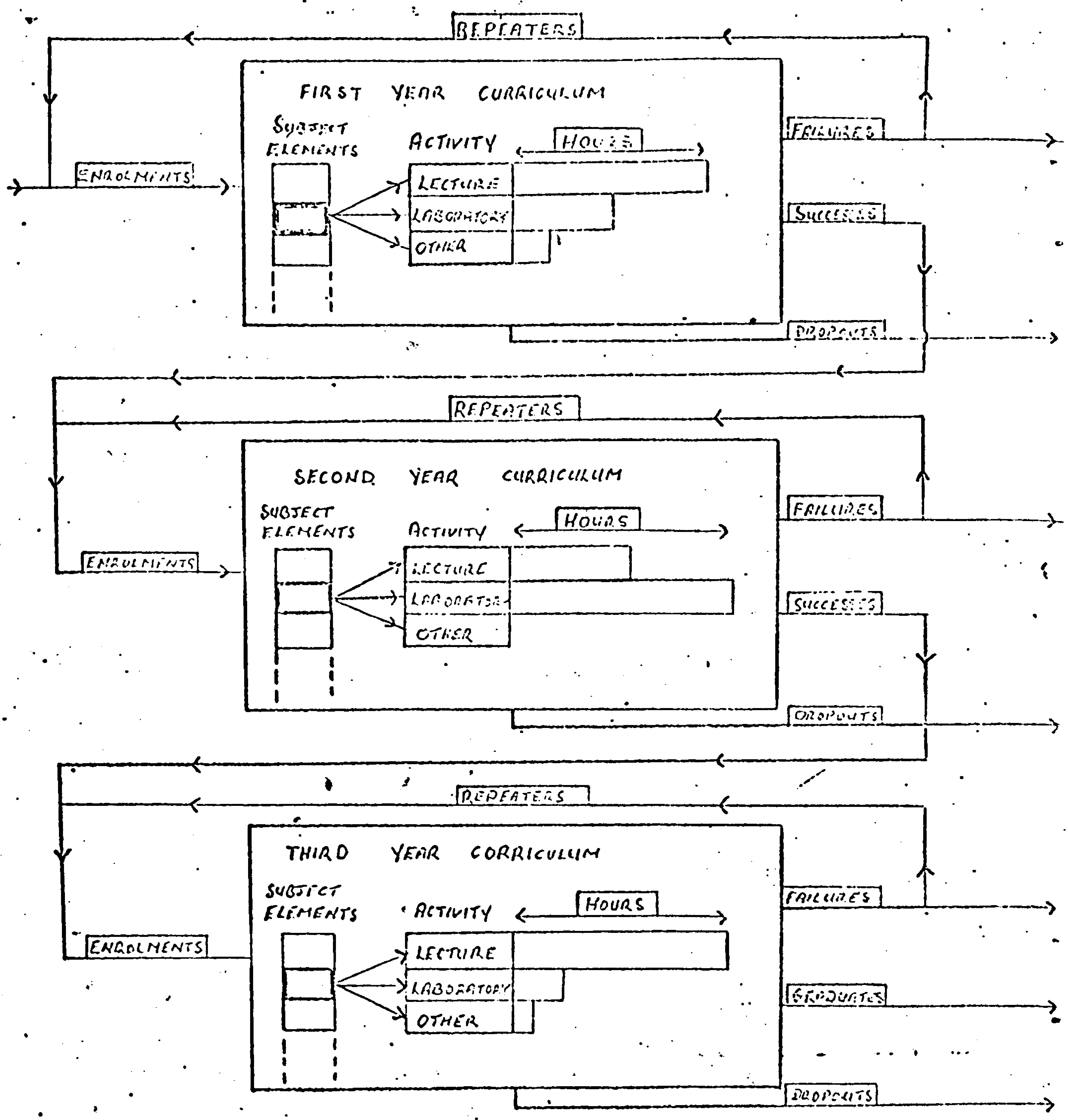
The first teaching task is to provide a variety of learning opportunities in an organised curriculum. This "course mix" reflects the institutions perception of the needs of society. The result may be quantified in terms of potential student "places" on a course. Society's response may be assessed by the number and quality (as measured, say, by entry qualifications) of enrolments. Potential places and enrolments are the immediate outcomes of the teaching function.

Teaching (unlike learning!) takes place in meetings between faculty and students the large majority of these meetings are set down in the timetable. These tuition hours, although not a final output, are also an outcome of the teaching process.

Subsequently the student either 'drops out' or, as a result of the assessment procedure, fails and repeats or leaves the system, or is successful and moves on to the next stage of the cycle or, in the case of final year students, graduates. As indicated in Figure 2 below - dropouts, failures, repeaters, successes and graduates are all outcomes of various stages of the educational process.

FIGURE 2

SOME OUTCOMES/OUTPUTS OF THE UNDERGRADUATE TEACHING PROCESS



The ultimate measurement of these outputs is the value added plus the students' personal "consumption" between entry to, and final exit from the institution. A reliable and accurate calculus for assessing this value added embracing attitudinal change as well as skills and knowledge acquisition was well beyond the scope of this project. A large part of the output may not be susceptible to quantification in the formal sense but future studies may demonstrate how subjective judgements may be ordered and categorised in this context even when they cannot be placed on a calibrated scale. Meanwhile for a large part of higher education the examination system, imperfect though it is, remains the most important method for assessing the level of success in achieving educational objectives.

It is difficult to assess what a student who fails an examination and/or drops out gains from higher education. To paraphrase it may be better to have tried and failed than never to have tried at all. There is some evidence that a failed or drop-out student has a lifetime earnings pattern not very different from what it would have been if he had not attended higher education. It also seem reasonable to assume that there is some psychic cost. Attrition rates may signal a failure in the institution as well as in the student initially in terms of inadequate selection and subsequently in terms of inadequate teaching or counselling. The taxpayer will tolerate attrition rates only so long as he values the opportunity to try higher than the cost of providing the educational exposure.

## PERFORMANCE INDICATORS

Given that an institution of higher education in its teaching role exists to provide a set of learning opportunities subject to satisfying cost constraints two questions may be posed: firstly, what was the response to the provision? and secondly, how well did the institution manage its resources?

In line with the objectives postulated above response can be assessed for each course by:

- a comparison of enrolments with places;
- the monitoring of the 'quality' of new students as measured say by A level points scores;
- success and attrition rates; and
- graduate initial employment statistics.

Inherent in the success rate criteria is the view that the institution can rely on teachers "professionalism" for the maintenance of academic standards. To an extent this is ensured by the system of external assessors and examiners. However, some doubts have been cast on the comparability of degree standards in the UK even within the same subject groups (Nevin 1972).

In an ideal world the institution would also run student surveys to monitor the level of satisfaction with curriculum design, syllabus content and teaching methods and assemble longitudinal data on former students' careers in order to assess value added rather than learning gain. This sort of information will be difficult to interpret and costly to collect and was beyond the scope of this project.

So far as resource management is concerned possible indicators for each course are:

- the relationship of each direct input expressed in quantities and/or monetary terms to a) enrolments and b) successes;
- the relationship of each direct input over the complete course cycle expressed in quantities and/or monetary terms to graduates.

Often the important question is not whether but why a particular input/output ratio or unit cost is good, bad or indifferent. The most popular cost effectiveness measure in the UK is the student staff ratio. As has been demonstrated elsewhere (Bottomley et al 1971, Delany 1971, 1972 Fredriksen 1971, Legg 1971, Simpson et al 1971) this ratio is a function of a number of variables and decisions on these are largely within the province of the academic staff. Therefore, the management information system ought to monitor class size frequencies, tuition loads and contact hours. (Delany op cit 1971, 1972). Depending on the complexity of the curriculum this may involve a detailed timetable analysis such as that described below.

## LANCHESTER AND LOUGHBOROUGH CONTEXTS AND RESULTS

The information required to construct the performance indicators discussed above has been collected from the student record and an analysis of the timetables at Lanchester Polytechnic and Loughborough University for the academic years 1972/73 and 1973/74. For ease of reference the Tables referred to in the following text are provided in a separately bound Appendix.

Lanchester Polytechnic was designated on 1 January 1970 and was formed from three institutions of higher education - Lanchester College of Technology, Rugby College of Engineering Technology and Coventry College of Art. The Polytechnic has four faculties - Engineering, Applied Science, Social Science and Art and Design - and offers a range of courses from sub degree to postgraduate. In 1972/73 the total enrolment was over 5000 of which over 3000 were full time and sandwich students and the majority of these were studying for first degrees awarded by the Council for National Academic Awards.

Loughborough University of Technology received its charter in April 1966 the first of the former Colleges of Advanced Technology to achieve university status. Its predecessor, Loughborough College introduced full time advanced courses in science and technology in 1918. The university has four schools - Engineering, Pure and Applied Science, Human and Environmental Studies and Educational Studies and the enrolment in 1972/73 was over 3000.

Tables 1 and 2 provide details of the numbers of students enrolled on courses included in the survey. Sandwich students who spent the whole of the relevant academic year out of college on industrial/professional training are omitted. The normal 'in college' attendance for a first degree in the UK is three years but in two courses at Lanchester (Urban and Regional Planning and Social Work) the study covers four years.

The total number of undergraduates in both institutions is similar and the split between sandwich and full time students in each institution is virtually identical. In both institutions over 90% of the students are to be found in technology and engineering, pure and applied science, or social and business studies. However, within these areas the mix is different:- engineering and technology is clearly the dominant discipline at Loughborough reflecting the institution's original raison d'être; at Lanchester there is a more equal balance between engineering and technology social and business studies and pure and applied science.

The level of "Response"

Some indication of society's initial response to the institution's provision is given by the take up of places and the 'quality' of the student entry. Both institutions claimed to have attained or exceeded their enrolment targets for both years reviewed but information on 'places' per course was in some cases suspect and in others not available.

Consequently a comparison of first year enrolments against places has not been made. Over the two years examined there was a 7% decline at Loughborough and at Lanchester a 4% increase in first year undergraduate enrolments.

The normal minimum entry qualification for an undergraduate programme in the UK are two subjects at Advanced Level (A-Level) of the General Certificate of Education and/or (less usually) the appropriate Ordinary National Certificate (ONC) or Ordinary National Diploma (OND). A-levels are graded and some indication of the 'quality' in terms of educational attainment can be had by monitoring this data where the pass grades A, B, C, D and E are weighted 5, 4, 3, 2 and 1 respectively. Table 3 sets out the mean A-level scores for "fresher" undergraduates overall and for the three major and comparable discipline areas. In both years studied the average Loughborough student with a mean A level grade of just under 3=C was about 3/4 of a grade above his Lanchester equivalent. A higher proportion of the undergraduate intake qualifies by the A-level route and the average grade 'advantage' is higher at Loughborough in all disciplines for both years.

A-level grades are not good predictors of subsequent degree examination performance and, therefore, their efficiency as 'quality' indicators is open to question. However, they are better predictors than any of the major alternatives so far tested (Enwistle and Percy 1973). From Table 4 we note that the correlation coefficients are higher at Loughborough for each of the three years of the normal first degree course but even here at best A level scores only "explain" about 9% to 12% of first year degree examination results.

Table 5 summarises the pass, fail and dropout rates and Table 6 the examination mean marks and standard deviations for the undergraduate programmes overall and for the three major comparable discipline areas. Apart from the first year results at Lanchester the pass rates are reasonably stable over time and slightly higher overall at Loughborough. In both institutions the failure rates in the social sciences are generally lower than in engineering or science.

The examination marks are very similar across the two institutions in both years. There is some evidence of an improvement in mean marks and a tightening of the distribution around these means in all disciplines but this is most marked in engineering. At this level of aggregation there is apparently little difference between the two institutions in "response" as indicated by examination marks.

One indicator of society's response to the final outputs of the institution is the initial employments of graduates and their starting salaries. In neither institution was this data available for all the graduates. However, information on starting salaries was collected for just over 20% of the graduates at Lanchester in 1972/73 and 50% and 47% of the graduates at Loughborough in 1972/73 and 1973/74 respectively and is set out in Table 7. It appears that discipline area rather than institution is a more important determinant of initial salary and that the correlation between starting salary and final examination mark although positive in the majority of cases is by no means strong.

Timetable Analysis

The pattern of formal meetings between academic staff and students is set down in the timetable which defines what, where, by whom and for whom. The systematic collection and analysis of timetable data is one way of identifying the direction and intensity of an institutions' teaching efforts. Doubts may be cast on the absolute accuracy of timetables but the information they contain is at least as reliable as that obtained by student/faculty questionnaires or diaries.

Teaching requires faculty commitment not only to formal classroom time but also to preparation, the correction and feedback 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 at least partly subjective and, therefore, suspect. (Simpson et al 1971) op cit pp. 45-48). Preparation time is likely to be a function of the experience of the lecturer and the level of work whilst marking time is likely to be a function of class size. A survey of a representative sample of faculty timetable commitments in both institutions suggested that the typical member of the faculty had a mix of class sizes and levels which did not diverge greatly from his department's average. Consequently class contact may be a reasonably accurate proxy for total teaching commitments.

Formally - a course constitutes a set of meetings where a meeting is a timetabled hour of contact between academic staff and students. This set can be broken down into subsets on the basis of the department providing the tuition 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. Consequently to analyse a set of meetings the following information is required:-

(i) total enrolment to a course (E);

(ii) the enrolment from a course to a particular subset of meetings (s, where $s \leq E$);

(iii) the total enrolment from all courses attending this particular subset of meetings ($E^*$ where $E^* \geq s$);

(iv) the department providing the tuition for this particular subset of meetings;

(v) the number of classes formed each assigned to one teacher formed in this particular subset of meetings (g); and

(vi) the hours per annum attended by a student in this particular subset of meetings (h) of a particular group size ($E^*/g$).

From this data it is possible to establish for each year of a study programme, for a department's courses, for discipline areas and for each institution the following "values" where the summations are made over the relevant subsets:-

1. Students Tuition Load This is the hours of timetabled contact with faculty that the student on average received -

$$\frac{\sum (h \cdot s)}{E} \quad ;$$

2. Total Meetings timetabled -

$$\sum (h \cdot g) \quad ;$$

3. Summed over a department or discipline area or an institution the statistic "Total Meetings" counts joint meetings (i.e. meetings involving two or more courses) several times. Therefore, where several courses attend the same subset of meetings the timetabled hours are allocated pro rata to the number of students attending from a course:-

$$\text{Allocated Meetings} = \sum \left(h \cdot g \cdot \frac{s}{E^{\bullet}}\right) \quad ;$$

4. Average Group Size Attended by the Student -

$$\sum \frac{E^{\bullet}}{g} \left(\frac{h \cdot s}{E}\right); \quad \text{and}$$

5. Average Group Size Provided by the Institution -

$$\frac{\sum \frac{E^{\bullet}}{g} \left(h \cdot g \cdot \frac{s}{E^{\bullet}}\right)}{\sum \left(h \cdot g \cdot \frac{s}{E^{\bullet}}\right)}$$

An illustration of the calculation of these values is given at the end of the Appendix.

Table 8 presents the overall results of the timetable analysis for each year of the normal three year undergraduate cycle for 1972/73 and 1973/74. Table 9 summarises the "average tuition load" the "meetings" and "allocated meetings" for the whole undergraduate cycle by discipline area.

The average undergraduate at Lanchester received an extra 328 hours of formal tuition compared with his Loughborough equivalent. In every discipline the Lanchester student had a tuition load greater than his Loughborough counterpart. This difference ranged from 932 hours for science (1973/74) to 19 hours social studies (1972/73. Engineering and science students in both institutions had more formal teacher contact than their social science colleagues (cf. B. Frederiksen 1971) but at Lanchester this difference was over 1000 hours in most cases compared with less than 400 hours at Loughborough.

The most significant divergence between the two institutions lies in the difference between the meetings and allocated meetings. It will be recalled that meetings are the formal teacher/student contact hours per annum that would be required if each course was timetabled independently: the allocated meetings are the formal teacher/student contact hours actually provided: any difference arises out of "joint classes" involving more than one course. For example in social studies at Lanchester in 1972/73 joint meetings reduced the class contact which had to be provided from 33378 to 30469 hours whereas at Loughborough the reduction was from 25475 to 7089 hours.

Table 10 provides details of the students' average group size and Tables 11 and 12 are relative frequency distributions of the average students class sizes in 1972/73 and 1973/74 respectively. In both years the Loughborough undergraduate experienced a wider range of class sizes and found himself on average in larger classes than his Lanchester equivalent. This difference is most evident in engineering and least marked in social studies.

The "student's average class size" identifies the student's typical formal teaching environment. The "institution's average class size" on the other hand identifies the class size the institution on average is required to provide. Information on this statistic are provided in Table 13. The cumulative relative frequency distribution of the demands for teaching space are presented in Table 14. About 20% of the demands at Lanchester were for individual tutorials compared with 6% at Loughborough. On the other hand, about 16% of the demands at Loughborough were for classes greater than 30 whereas at Lanchester only 5% of the demands were for groups of 30+ students.

## Some Economic Implications

By comparison with the Loughborough undergraduate, the Lanchester student is, on average timetabled for 20% more hours in classes of approximately half the size composed almost exclusively of students from his own course. Higher tuition loads, smaller groups and a lower incidence of joint meetings are 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:-

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

For the years for which data was collected this statistic is as follows:-

| | Lanchester | | Loughborough | |
|---|---|---|---|---|
| | 1972/73 | 1973/74 | 1972/73 | 1973/74 |
| Engineering | 0.2 | 0.0 | 36.5 | 33.9 |
| Science | 0.0 | 0.0 | 48.3 | 46.6 |
| Social Studies | 8.7 | 13.0 | 72.2 | 64.1 |
| All Undergraduates | 3.1 | 4.5 | 47.3 | 43.2 |

The economic possibilities of joint meetings are most clearly demonstrated in social studies at Loughborough but the incidence of multi-course meetings is higher at Loughborough in all disciplines resulting in an overall reduction in tuition demands of 47% in 1972/73 and 43% in 1973/74 compared with 3% and 4.5% respectively at Lanchester.

Apart from joint meetings 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 the years studied this ratio of undergraduate tuition demands in hours per annum per student enrolled was as follows:-

| | Lanchester | | Loughborough | |
|---|---|---|---|---|
| | 1972/73 | 1973/74 | 1972/73 | 1973/74 |
| Engineering | 87 | 88 | 22 | 23 |
| Science | 81 | 83 | 30 | 31 |
| Social Studies | 36 | 35 | 22 | 23 |
| All Undergraduates | 62 | 60 | 25 | 26 |

Thus the average undergraduate at Lanchester made over double the tuition demands of his Loughborough colleague. If the teaching load (class contact) of the average fte teacher and his salary had been equivalent across the two institutions the academic staff cost per undergraduate in 1972/73 and 1973/74 at Loughborough would have been less than half that at Lanchester. Alternatively the average Loughborough lecturer had half the timetable commitment, hopefully devoted more time to research and the teacher unit costs were approximately the same in both institutions.

## Costing the Teaching Function

The usual starting point in the search for an historical cost is actual expenditure 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 thought 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 in the UK, 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 way of forecasting and ranking all these alternatives and, therefore, no way of identifying the economic cost. Nevertheless some foregone opportunities may be recognised and accounted for: the common examples in higher education cost studies being the loss by the economy of the student's contribution to GNP as a result of his withdrawal from paid employment. Once we move from actual recorded cash flows to concepts of depreciation and of opportunity cost we move from a matter of fact to a matter of opinion.

For the purposes of this project outlays on teaching in higher education 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 in teaching. Outlays under these heads account for between 60% to 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. Ultimately these outlays have to be set against the outputs of the enterprise. In the case of a homogeneous product the resulting averaging process is not controversial but the outputs of education are not homogeneous: staff used for teaching are also employed on research; students vary by level, year, discipline pattern of attendance and not all of them survive to graduation. Consequently, unit costs in education are never clear cut. We shall proceed on the basis that: firstly, universities and polytechnics are predominantly teaching institutions, and secondly, that the teaching efforts of an institution of higher education are directly related to its timetable. These are maybe gross simplifications but the road to most costs is littered with assumptions and pot-holed by value judgements.

Academic staff salaries account for over 50% of most polytechnic budgets and the questions of concern are, firstly, how should this expenditure be apportioned between research and teaching: and, secondly, how should that part identified as belonging to the teaching function be allocated to courses and ultimately to students taking these courses?

At the moment there is no 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 (FAA) Programme NCHEMS at WICHE (1971, 1973 and 1974). Succintly the objectives which can be raised to this questionnaire/diary solution are concerned with time-scales, the validity of the data and the cost of collection. Typically the academic's workload is largely unprogrammed and variable with significant peaks and troughs. Hence - when should the survey be conducted? Over what time scale should it relate? How frequently should it be administered? - 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 M.G. et al 1971 p.48). Questionnaires rely heavily on the goodwill and co-operation of staff and involve a significant investment of their time. Thus "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 1971 p.45).

Given a complex situation of joint meetings such as found at Loughborough and an assumption that the pattern of formal meetings set down in the timetable reflects the direction and intensity of the institution's teaching efforts a timetable analysis such as described above offers an alternative basis for the allocation of faculty costs. On the other hand, some part of this cost may relate more directly to enrolments - student recruitment for example. In the absence of other objective criteria there seems no reason why other 'direct' inputs should not be allocated similarly. It might be argued that a greater proportion of administrative staff costs should be assigned in line with enrolments or that technician staff cost is better apportioned by references to 'laboratory meetings'. The objective was to construct a formula which was relatively simple but flexible enough to accommodate these sorts of subjective decision.

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 from a department to a course by $M$;
allocated meetings from a department to all courses by $M_T$;
the proportion of cost allocated to a department's students on the basis of enrolment by $\alpha$;
the proportion of cost allocated on the basis of allocated meetings by $\beta$;

polytechnics (if not universities!) are primarily teaching institutions and that the teaching function should bear the full costs of faculty 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 results by the agreed proportion.

Table 17 sets out the costs per enrolled student for the major teaching levels in both institutions in 1972/73 and also identifies these unit costs for the major undergraduate discipline areas. In this and the following tables concerned with costs the costs per course on an enrolment basis or a meetings basis have been summed over the relevant discipline area or level and divided by the enrolments to these courses.

An allocation solely by 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 allocating a small proportion of the total cost (or maybe a larger proportion of the administrative staff cost) by this method. However, it is believed an allocation on the basis of allocated meetings is a fairer reflection of the institution's commitments to its teaching role since these 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 and accounted for about 75% of the total first degree enrolment at Loughborough compared with about 55% at Lanchester. Therefore, if a discipline mix adjustment had been attempted, the apparent undergraduate cost advantage of Loughborough would have been enhanced. Whichever method of cost allocation is used the difference in costs between the major disciplines was smaller at Loughborough: because of the high incidence of joint meetings across disciplines.

Predictably the average undergraduate costs per enrolled student allocated on a meetings basis increase as the years of study proceed (Table 17) at Lanchester in 1972/73 from £572 for first year undergraduates to £887 for third year students, and at Loughborough from £310 to £451. Hence in both institutions the final year undergraduate costs about half as much again as the "fresher". This result reflects the fact that although in both institutions the finalist had a lower tuition load this was out weighed by much reduced average class sizes and, in the case of Loughborough, fewer joint meetings.

The components of the cost per student enrolled in 1972/73 allocated on a meetings basis are given in Table 18. 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 differences between the two institutions was in academic staff which was higher at Lanchester irrespective of the basis of allocation.

Tables 19 and 20 provide details of the cost per "successful" students and of a "graduate" in each broad discipline area. Given the slightly higher failure rate (i.e. $1 - (\alpha + \beta)$ is the proportion of cost assigned to research and other activities not associated with the teaching function)

then for a course the cost is given by:

$$\alpha \left[ \frac{E}{E_D} \cdot C \right] + \beta \left[ \frac{M}{M_T} \cdot C \right] + \left[ \sum_{\substack{\text{other}\\\text{departments}}} \beta' \frac{M'}{M'_T} \cdot C' \right]$$

and if $\beta$ is the same for all departments by

$$\alpha \left[ \frac{E}{E_D} \cdot C \right] + \beta \left[ \sum_{\substack{\text{all}\\\text{departments}\\ i}} \frac{M_i}{M_{Ti}} \cdot C_i \right]$$

and the cost per student enrolled by:

$$\alpha \left[ \frac{E}{E_D} \cdot C \right] + \beta \left[ \sum_{\substack{\text{all}\\\text{departments}\\ i}} \frac{M_i}{M_{Ti}} \cdot C_i \right] \left[ \frac{1}{E} \right]$$

Details of the costs to be apportioned in 1972/73 and data on enrolments and allocated meetings (the possible bases for apportionment) are given in Tables 15 and 16 respectively.

The costs have been allocated firstly on the basis of enrolments (i.e. $\alpha = 1$; $\beta = 0$) and, secondly, on the basis of allocated meetings (i.e. $\alpha = 0$; $\beta = 1$) In the latter case it has been assumed that $\beta$ is the same for all departments. No apportionment to non teaching activities has been made.

The results of the 1971 "Enquiry into the use of Academic Staff Time" commissioned by the Committee of Vice Chancellors and Principals supports an allocation of 20% to 30% to non teaching activities. However it has been argued that at Lanchester the economic advantage of Loughborough is widened at this stage of costing. On the other hand, the Lanchester students start from a lower base (A level score) and hence the learning gain may be higher.

In times of stringency and in the absence of an accurate specification of cause and effect in education attention inevitably focusses on cost effectiveness. In assessing performance a range of criteria ought to be taken into account. The cultural and social implications of the teaching strategies deployed at Lanchester and Loughborough was outside the scope of this project but the relationships between average exit marks and the relevant unit costs, timetable parameters and student characteristics for each year of each course were examined. The results are summarised in Table 21. The consistency of the directions of the correlation coefficients across the two institutions and within each institution across discipline areas lends some support to the argument that the economic advantages of large classes and joint meetings are matched by some educational disadvantages.

SUMMARY

The purpose of this study was to examine the potential for performance indicators for the teaching activities in higher education. Performance can be assessed in terms of "effectiveness" and of "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 maximising students' employability subject to maintaining academic standards this project has explored "effectiveness" in terms of society's 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 important input and process variables and by concentrating on the more easily quantified outcomes and outputs.

Using data for the undergraduate programmes at Lanchester and Loughborough for the academic years 1972/73 and 1973/74 some significant differences in response in terms of pre entry scores (A-level grades) and first year failure rates have been isolated. However, at a discipline level of aggregation outcomes defined as examination marks or second and third year pass rates or initial salary levels proved to be remarkably similar across the two institutions.

A detailed timetable analysis has revealed a number of differences in the formal (i.e. timetabled) learning/ teaching environments. Larger classes, lower students' tuition loads and a much greater incidence of "joint meetings" (i.e. involving more than one course) were consistently observed at Loughborough. The economic implications of this strategy have been examined by calculating the unit costs which proved to be much lower in all disciplines at Loughborough. The question of what is the cost per student does not admit of one answer. Therefore, 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 thus avoided. Secondly it was assumed that polytechnics and universities are solely teaching establishments. Finally it was assumed that the timetable reflects the direction and intensity of an institutions teaching efforts and is a fair basis for the allocation of expenditures.

An accurate identification of output would involve the measurement of the - cultural,social, educational and economic value added to the students by the institution between entry and exit. This is not a practical possibility now nor in the foreseeable future. Consequently 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 proportional increase in costs but the value added to the extra students may be outweighed by the decline in value added to the existing students.

The project's terms of reference specifically excluded a consideration of research and other non teaching activities. If we accept that institutions of higher education have functions other than teaching then in assessing overall performance consideration has to be given to the trade-offs between teaching and these other roles. Pedagogical innovation may improve the efficiency of the teaching function but prove to be detrimental to research and hence to reduce overall efficiency. Various measures of research output have been suggested but peer evaluation seems to find most support and thus assessment may only be possible in a qualitative manner. Todays' practical solution seems to be to measure research output by counting the inputs. If we can be reasonably sure that the mix of teaching to non teaching activities is roughly equivalent across institutions then student cost comparisons provide a 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 difficult. (For that matter so was putting a man on the moon!) 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 inter institutional comparisons but to produce a range of indicators which would identify changes in direction within an institution and focus attention on adverse trends. Ideally these measures should not only indicate what is happening but also give a lead on why it is happening: the timetable analysis described above is an example. In the interests of preserving some anonymity the data we have published has been aggregated to the level of broad discipline areas and at this level of aggregation the results proved to be reasonably stable over time. At the level of courses significant divergencies in response and costs were discovered within discipline areas in each institution and hopefully these would have prompted "discerning questions".

The fact that a large part of education can only be assessed qualitatively is not a good reason for failing to systematically monitor that part which is quantifiable. The data base to construct the sort of indicators outlined above already exists in some form or another in most institutions. Regular reports at the course level on "response" and "efficiency" if necessary defined to meet peculiar institutional characteristics would facilitate internal "management by exception". The case for course budgets based at least in part on past "effectiveness" and "efficiency" is not without support. However, at some point account would have to be taken of subjective judgements on the qualitative aspects. The usefulness of cross institutional comparisons would depend on the agreement of data elements and upon a reasonable degree of homogenity in role-mix in the institutions involved. At this moment in time the dissimilarity in the proportion invested in research and in the 'quality' of student input would seem to militate against meaningful polytechnic/university comparisons in the UK. However, the comparison of polytechnic with polytechnic and university with university seems entirely viable.

BIRCH, D.W., CALVERT, J.R., SIZER, J.
Loughborough June 1976

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"A STUDY OF SOME PERFORMANCE INDICATORS IN HIGHER EDUCATION WITH PARTICULAR REFERENCE TO LANCHESTER POLYTECHNIC AND LOUGHBOROUGH UNIVERSITY"

D. W. BIRCH, J. R. CALVERT, & J. SIZER

## T A B L E S

TABLE 1

ENROLMENTS TO UNDERGRADUATE PROGRAMMES INCLUDED IN PROJECT STUDY

LANCHESTER

| Discipline | Years: | 1972/73 1 | 2 | 3 | 4 | Total | % | 1973/74 1 | 2 | 3 | 4 | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SANDWICH | | | | | | | | | | | | | |
| Engineering | | 270 | 234 | 212 | - | 716 | 31.1 | 287 | 197 | 196 | - | 680 | 30.5 |
| Science | | 72 | 60 | 49 | - | 181 | 7.8 | 67 | 47 | 47 | - | 161 | 7.2 |
| Social Studies | | 133 | 130 | 127 | 8 | 398 | 17.3 | 152 | 116 | 122 | 13 | 403 | 18.1 |
| Urban Planning | | 24 | 23 | 19 | 21 | 87 | 3.8 | 17 | 20 | 23 | 17 | 77 | 3.5 |
| TOTAL | | 499 | 447 | 407 | 29 | 1382 | 60.0 | 523 | 380 | 388 | 30 | 1321 | 59.3 |
| FULL TIME | | | | | | | | | | | | | |
| Science | | 150 | 103 | 108 | - | 361 | 15.7 | 123 | 90 | 88 | - | 301 | 13.5 |
| Social Studies | | 182 | 147 | 129 | - | 458 | 19.9 | 209 | 149 | 142 | - | 500 | 22.4 |
| Languages | | 38 | 33 | 30 | - | 101 | 4.4 | 53 | 22 | 31 | - | 106 | 4.8 |
| TOTAL | | 370 | 283 | 267 | - | 920 | 40.0 | 385 | 261 | 261 | - | 907 | 40.7 |
| OVERALL | | 869 | 730 | 674 | 29 | 2302 | 100.0 | 908 | 641 | 649 | 30 | 2228 | 100.0 |

TABLE 2

ENROLMENTS TO UNDERGRADUATE PROGRAMMES INCLUDED IN PROJECT STUDY

LOUGHBOROUGH

| Discipline | Years: | 1972/73 1 | 2 | 3 | Total | % | 1973/74 1 | 2 | 3 | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SANDWICH | | | | | | | | | | | |
| Education | | 22 | 7 | 2 | 31 | 1.2 | 24 | 19 | 4 | 47 | 1.8 |
| Engineering | | 549 | 313 | 257 | 1119 | 44.3 | 534 | 322 | 249 | 1105 | 43.0 |
| Science | | 87 | 84 | 64 | 235 | 9.3 | 75 | 79 | 74 | 228 | 8.9 |
| Social Studies | | 72 | 24 | 29 | 123 | 5.0 | 66 | 59 | 24 | 149 | 5.8 |
| TOTAL | | 730 | 428 | 352 | 1510 | 59.8 | 699 | 479 | 351 | 1529 | 59.6 |
| FULL TIME | | | | | | | | | | | |
| Engineering | | 148 | 100 | 94 | 342 | 13.5 | 135 | 127 | 76 | 388 | 13.2 |
| Science | | 127 | 108 | 97 | 332 | 13.1 | 99 | 106 | 91 | 296 | 11.5 |
| Social Studies | | 103 | 56 | 33 | 192 | 7.6 | 81 | 96 | 50 | 227 | 8.8 |
| Librarianship | | 29 | 21 | 15 | 65 | 2.6 | 53 | 28 | 19 | 100 | 3.9 |
| Languages | | 39 | 19 | 27 | 85 | 3.4 | 27 | 33 | 17 | 77 | 3.0 |
| TOTAL | | 446 | 304 | 266 | 1016 | 40.2 | 395 | 390 | 253 | 1038 | 40.4 |
| OVERALL | | 1176 | 732 | 618 | 2526 | 100.0 | 1094 | 869 | 604 | 2567 | 100.0 |

TABLE 3

MEAN A-LEVEL SCORES FOR FIRST YEAR UNDERGRADUATES

| | Lanchester | | | | | | Loughborough | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 72/73 | | | 73/74 | | | 72/73 | | | 73/74 | | |
| Discipline | N | M | SD | N | M | SD | N | M | SD | N | M | SD |
| Engineering | 178 | 2.0 | .8 | 208 | 2.0 | .9 | 545 | 3.0 | .8 | 521 | 3.0 | .9 |
| Science | 194 | 1.8 | .7 | 156 | 1.8 | .7 | 205 | 2.8 | .8 | 161 | 2.7 | .9 |
| Social Studies | 295 | 2.3 | .8 | 337 | 2.3 | .8 | 166 | 2.8 | .7 | 138 | 2.7 | .9 |
| Overall | 725 | 2.1 | .8 | 768 | 2.1 | .8 | 1005 | 2.9 | .8 | 913 | 2.9 | .9 |

N = Number of observations

M = Mean Score

SD = Standard Deviation

TABLE 4

CORRELATION COEFFICIENTS MEAN A-LEVEL GRADES v FIRST DEGREE EXAMINATION RESULTS

| Degree Examinations Year | Lanchester 72/73 | Lanchester 73/74 | Loughborough 72/73 | Loughborough 73/74 |
|---|---|---|---|---|
| 1 | +.15 | +.20 | +.29 | +.35 |
| 2 | +.05 | +.05 | +.27 | +.25 |
| 3 | +.14 | +.07 | +.15 | +.14 |

Footnote:

A comparison of mean ONC/OND marks and degree examinations resulted in the following correlations:

| Degree Examinations | Loughborough 1972/73 | | Loughborough 1973/74 | | Lanchester 1972/73 | | Lanchester 1973/74 | |
|---|---|---|---|---|---|---|---|---|
| Year: | N | r | N | r | N | r | N | r |
| 1 | 69 | +.40 | 75 | +.33 | 93 | .44 | 95 | +.38 |
| 2 | 75 | +.29 | 56 | +.33 | 66 | +.37 | 68 | +.10 |
| 3 | 50 | +.31 | 67 | +.17 | 65 | +.27 | 71 | + -05 |

N = Number of observations   r = correlation coefficient

These correlations are in most cases higher than for A level versus degree examinations. This improvement is probably explained by the higher probability of overlap in the subject matter.

TABLE 5

UNDERGRADUATE PASS, FAIL AND 'DROPOUT' RATES (PERCENTAGES OF ENROLMENTS)

| Years:- | 1 | | | 2 | | | 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pass | Fail | Dropout | Pass | Fail | Dropout | Pass | Fail | Dropout |
| LANCHESTER 1972/73 | | | | | | | | | |
| Engineering | 66 | 26 | 8 | 85 | 15 | 0 | 98 | 2 | 0 |
| Science | 64 | 29 | 7 | 85 | 13 | 2 | 94 | 6 | 0 |
| Social Studies | 81 | 14 | 5 | 94 | 5 | 1 | 98 | 1 | 1 |
| Overall | 71 | 22 | 7 | 89 | 9 | 2 | 97 | 3 | 0 |
| 1973/74 | | | | | | | | | |
| Engineering | 74 | 17 | 9 | 86 | 13 | 1 | 97 | 2 | 1 |
| Science | 84 | 10 | 6 | 87 | 10 | 3 | 93 | 6 | 1 |
| Social Studies | 84 | 10 | 6 | 89 | 8 | 3 | 97 | 3 | 0 |
| Overall | 81 | 12 | 7 | 88 | 10 | 2 | 96 | 3 | 1 |
| LOUGHBOROUGH 1972/73 | | | | | | | | | |
| Engineering | 85 | 10 | 5 | 89 | 10 | 1 | 94 | 4 | 2 |
| Science | 83 | 8 | 9 | 89 | 8 | 3 | 95 | 4 | 1 |
| Social Studies | 89 | 5 | 6 | 89 | 6 | 5 | 98 | 2 | 0 |
| Overall | 85 | 9 | 6 | 89 | 8 | 3 | 96 | 3 | 1 |
| 1973/74 | | | | | | | | | |
| Engineering | 84 | 8 | 8 | 88 | 10 | 2 | 95 | 3 | 2 |
| Science | 89 | 7 | 4 | 91 | 4 | 5 | 98 | 1 | 1 |
| Social Studies | 86 | 3 | 11 | 94 | 1 | 5 | 95 | 1 | 4 |
| Overall | 85 | 7 | 8 | 90 | 6 | 4 | 96 | 2 | 2 |

TABLE 6

UNDERGRADUATE EXAMINATION RESULTS MEAN MARKS % (STANDARD DEVIATION)

| Years:- | 1 | 2 | 3 |
|---|---|---|---|
| LANCHESTER 1972/73 | | | |
| Engineering | 54(11) | 57(9) | 62(8) |
| Science | 51(11) | 56(10) | 58(8) |
| Social Studies | 50(9) | 54(6) | 56(6) |
| Overall | 52(10) | 55(8) | 58(7) |
| 1973/74 | | | |
| Engineering | 54(13) | 56(9) | 61(7) |
| Science | 54(9) | 54(8) | 55(8) |
| Social Studies | 58(8) | 52(7) | 53(7) |
| Overall | 53(10) | 54(8) | 56(8) |
| LOUGHBOROUGH 1972/73 | | | |
| Engineering | 54(11) | 55(11) | 60(10) |
| Science | 52(12) | 53(11) | 56(11) |
| Social Studies | 54(8) | 54(8) | 55(4) |
| Overall | 53(11) | 54(11) | 58(10) |
| 1973/74 | | | |
| Engineering | 56(13) | 55(12) | 60(10) |
| Science | 55(12) | 54(11) | 57(9) |
| Social Studies | 56(7) | 55(6) | 57(7) |
| Overall | 56(12) | 55(11) | 59(9) |

TABLE 7

FIRST SALARY DATA FOR GRADUATES AND CORRELATION WITH FINAL MARK

| | 1972/73 | | | | 1973/74 | | | |
|---|---|---|---|---|---|---|---|---|
| | Observations | Mean £ | Standard Deviation | Correlation Coefficient | Observations | Mean £ | Standard Deviation | Correlation Coefficient |
| LANCHESTER | | | | | | | | |
| Engineering | 56 | 1778 | 286 | -.10 | | | | |
| Science | 32 | 1523 | 364 | +.13 | | Not | | |
| Social Studies | 51 | 1696 | 359 | -.01 | | Available | | |
| Overall | 145 | 1681 | 347 | +.03 | | | | |
| LOUGHBOROUGH | | | | | | | | |
| Engineering | 190 | 1725 | 388 | +.17 | 157 | 2039 | 586 | +.08 |
| Science | 83 | 1503 | 279 | +.02 | 86 | 1772 | 282 | +.08 |
| Social Studies | 26 | 1756 | 346 | +.55 | 22 | 1761 | 248 | -.35 |
| Overall | 318 | 1654 | 365 | +.19 | 285 | 1916 | 488 | +.10 |

TABLE 8

SOME UNDERGRADUATE TIMETABLE STATISTICS

| | Lanchester | | | Loughborough | | |
|---|---|---|---|---|---|---|
| Years:- | 1 | 2 | 3 | 1 | 2 | 3 |
| **1972/73** | | | | | | |
| Tuition Load (Hours) | 654 | 692 | 584 | 578 | 593 | 441 |
| Meetings (Hours) | 42,459 | 51 672 | 51 964 | 46,368 | 41 046 | 31 051 |
| Allocated Meetings (Hours) | 40 784 | 50 349 | 50 473 | 20 443 | 22 623 | 19 352 |
| Students' Average Class Size | 31 | 20 | 18 | 67 | 46 | 29 |
| (Standard Deviation) | (27) | (22) | (23) | (62) | (29) | (22) |
| Institution's Average Class Size | 14 | 10 | 8 | 27 | 19 | 14 |
| (Standard Deviation) | (16) | (10) | (9) | (33) | (23) | (14) |
| **1973/74** | | | | | | |
| Tuition Load (Hours) | 643 | 687 | 570 | 589 | 565 | 417 |
| Meetings (Hours) | 42 607 | 46 496 | 51 955 | 41 837 | 42 991 | 30 782 |
| Allocated Meetings (Hours) | 40 855 | 44 095 | 49 794 | 20 414 | 26 105 | 19 190 |
| Students' Average Class Size | 33 | 18 | 16 | 56 | 45 | 25 |
| (Standard Deviation) | (26) | (15) | (13) | (48) | (12) | (23) |
| Institutions Average Class Size | 14 | 10 | 7 | 26 | 19 | 13 |
| (Standard Deviation) | (16) | (9) | (8) | (28) | (22) | (13) |

TABLE 9

TUITION LOAD, MEETINGS, ALLOCATED MEETINGS (HRS) 3-YEAR UNDERGRADUATE CYCLE

| | Lanchester | | | Loughborough | | |
|---|---|---|---|---|---|---|
| | Tuition Load | Meetings | Allocated Meetings | Tuition Load | Meetings | Allocated Meetings |
| **1972/73** | | | | | | |
| Engineering | 2329 | 62217 | 62102 | 1685 | 50394 | 31990 |
| Science | 2471 | 44067 | 44067 | 1688 | 32884 | 16987 |
| Social Studies | 1325 | 33378 | 30469 | 1306 | 25475 | 7089 |
| All undergraduates | 1930 | 146606 | 141606 | 1612 | 118468 | 62418 |
| **1973/74** | | | | | | |
| Engineering | 2303 | 59658 | 59567 | 1667 | 51172 | 33848 |
| Science | 2522 | 38420 | 38420 | 1590 | 30534 | 16302 |
| Social Studies | 1342 | 36596 | 31851 | 1314 | 23969 | 8605 |
| All undergraduates | 1900 | 141058 | 134744 | 1571 | 115610 | 65709 |

TABLE 10

UNDERGRADUATE STUDENTS' AVERAGE GROUP SIZE

| | Lanchester | | | Loughborough | | |
|---|---|---|---|---|---|---|
| Years: | 1 | 2 | 3 | 1 | 2 | 3 |
| 1972/73 | | | | | | |
| Engineering | 21 | 12 | 12 | 71 | 55 | 35 |
| Science | 36 | 15 | 12 | 59 | 37 | 21 |
| Social Studies | 39 | 36 | 34 | 78 | 39 | 20 |
| All undergraduates | 31 | 20 | 18 | 67 | 46 | 29 |
| 1973/74 | | | | | | |
| Engineering | 22 | 14 | 9 | 63 | 52 | 31 |
| Science | 32 | 14 | 10 | 39 | 35 | 21 |
| Social Studies | 46 | 29 | 26 | 66 | 41 | 19 |
| All undergraduates | 33 | 18 | 16 | 56 | 45 | 26 |

TABLE 11

RELATIVE FREQUENCY DISTRIBUTION OF AVERAGE UNDERGRADUATE STUDENTS CLASS SIZES 1972/73

| Class Sizes:- | 1-10 | 11-20 | 21-30 | 31-40 | 41-60 | 61-80 | 81-100 | 101-150 | 151-200 | 200+ |
|---|---|---|---|---|---|---|---|---|---|---|
| <u>Engineering</u> | | | | | | | | | | |
| Lanchester | 41 | 42 | 8 | 6 | 3 | - | - | - | - | - |
| Loughborough | 8 | 21 | 13 | 9 | 16 | 16 | 3 | 5 | 7 | 2 |
| <u>Science</u> | | | | | | | | | | |
| Lanchester | 36 | 40 | 8 | 6 | 3 | 3 | 3 | 1 | - | - |
| Loughborough | 9 | 33 | 16 | 11 | 14 | 7 | 6 | 3 | - | 1 |
| <u>Social Studies</u> | | | | | | | | | | |
| Lanchester | 21 | 23 | 8 | 5 | 19 | 16 | 7 | - | 1 | - |
| Loughborough | 20 | 20 | 15 | 10 | 17 | 1 | 3 | 9 | 4 | 1 |
| <u>All Undergraduates</u> | | | | | | | | | | |
| Lanchester | 33 | 33 | 10 | 9 | 8 | 4 | 2 | - | 1 | - |
| Loughborough | 11 | 24 | 14 | 9 | 15 | 11 | 4 | 6 | 4 | 2 |

TABLE 12

RELATIVE FREQUENCY DISTRIBUTION OF AVERAGE UNDERGRADUATE STUDENTS CLASS SIZES 1973/74

| Class Sizes:- | 1-10 | 11-20 | 21-30 | 31-40 | 41-60 | 61-80 | 81-100 | 101-150 | 151-200 | 200+ |
|---|---|---|---|---|---|---|---|---|---|---|
| Engineering | | | | | | | | | | |
| Lanchester | 43 | 33 | 15 | 2 | 7 | - | - | - | - | - |
| Loughborough | 10 | 17 | 18 | 8 | 14 | 13 | 8 | 7 | 4 | 1 |
| Science | | | | | | | | | | |
| Lanchester | 43 | 30 | 12 | 7 | 3 | 4 | 1 | - | - | - |
| Loughborough | 11 | 26 | 25 | 9 | 12 | 13 | - | 4 | - | - |
| Social Studies | | | | | | | | | | |
| Lanchester | 21 | 25 | 10 | 9 | 22 | 3 | 4 | 6 | - | - |
| Loughborough | 20 | 12 | 18 | 10 | 9 | 14 | 9 | 5 | 3 | - |
| All Undergraduates | | | | | | | | | | |
| Lanchester | 34 | 30 | 14 | 6 | 12 | 2 | 1 | 1 | - | - |
| Loughborough | 13 | 21 | 19 | 8 | 12 | 12 | 6 | 6 | 3 | - |

TABLE 13

INSTITUTIONS' AVERAGE GROUP SIZE

| | Lanchester | | | Loughborough | | |
|---|---|---|---|---|---|---|
| Years: | 1 | 2 | 3 | 1 | 2 | 3 |
| <u>1972/73</u> | | | | | | |
| Engineering | 12 | 9 | 6 | 29 | 20 | 17 |
| Science | 15 | 10 | 7 | 28 | 21 | 12 |
| Social Studies | 14 | 11 | 12 | 31 | 15 | 12 |
| All Undergraduates | 14 | 10 | 8 | 27 | 19 | 14 |
| <u>1973/74</u> | | | | | | |
| Engineering | 12 | 9 | 6 | 28 | 20 | 15 |
| Science | 16 | 9 | 6 | 22 | 19 | 12 |
| Social Studies | 15 | 11 | 12 | 29 | 18 | 12 |
| All Undergraduates | 14 | 10 | 7 | 26 | 19 | 13 |

TABLE 14

CUMULATIVE RELATIVE FREQUENCY DISTRIBUTION OF THE UNDERGRADUATE DEMAND FOR TEACHING SPACE

| Class Size | Lanchester 1972/73 Cum.% | Lanchester 1973/74 Cum.% | Loughborough 1972/73 Cum.% | Loughborough 1973/74 Cum.% |
|---|---|---|---|---|
| 1-10 | 66.9 | 66.8 | 40.7 | 42.8 |
| 11-20 | 90.4 | 89.0 | 72.9 | 69.1 |
| 21-30 | 95.0 | 94.7 | 83.2 | 84.2 |
| 31-40 | 97.5 | 96.7 | 88.1 | 88.7 |
| 41-60 | 99.1 | 99.3 | 94.2 | 93.6 |
| 61-80 | 99.7 | 99.6 | 97.2 | 97.1 |
| 81-100 | 99.9 | 99.8 | 98.3 | 98.6 |
| 101-150 | 99.9 | 100.0 | 99.3 | 99.6 |
| 151-200 | 99.9 | | 99.8 | 99.95 |
| 200+ | 100.0 | | 100.0 | 100.0 |
| Total Hours:- | 141 606 | 134 744 | 62 418 | 65 709 |

TABLE 15

TEACHING INPUTS £'000s 1972/73

| | Lanchester | Loughborough |
|---|---|---|
| Academic Staff | 1830 | 1284 |
| Administrative Staff | 60 | 120 |
| Technician Staff | 294 | 323 |
| Departmental Recurrent Expenditure | 170 | 154 |
| Total | 2354 | 1881 |

Notes:

(i) The costs for full time staff have been established by reference to salary scale mid points in 1972/73 plus employers' contribution to superannuation (10% university, 6% polytechnic) plus employers' social security on the assumption of "all male contracted out" i.e. £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 have been excluded.

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

(v) Recurrent expenditure covers teaching materials, the maintenance and hire of teaching equipment, the cost of short courses and field work and staff travel and subsistence.

(vi) The amounts identified are total institutional inputs under these heads and not the amounts concerned with the undergraduate population.

TABLE 16

TOTAL ENROLMENTS AND ALLOCATED MEETINGS 1972/73

| | Undergraduate | Postgraduate | "Other" | Short Courses | Total |
|---|---|---|---|---|---|
| ENROLMENTS | | | | | |
| Lanchester | 2599 | 35 | 2150 | 996 | 5780 |
| Loughborough | 2660 | 574 | - | 1238 | 4472 |
| ALLOCATED MEETINGS | | | | | |
| Lanchester | 137 731 | 1963 | 63 581 | 1256 | 204 531 |
| Loughborough | 65 862 | 52 697 | - | 14 611 | 133 170 |

Notes:

(i) In calculating the "allocated meetings"

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

(b) 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.

TABLE 17

COSTS £'s PER UNDERGRADUATE STUDENT ENROLLED PER ANNUM 1972/73

| | Enrolment Basis | | | | Allocated Meetings Basis | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | Average | 1 | 2 | 3 | Average |
| **Engineering** | | | | | | | | |
| Lanchester | 442 | 480 | 520 | 476 | 851 | 1161 | 1405 | 930 |
| Loughborough | 362 | 367 | 375 | 375 | 330 | 448 | 380 | 411 |
| **Science** | | | | | | | | |
| Lanchester | 527 | 596 | 571 | 575 | 555 | 966 | 1107 | 773 |
| Loughborough | 510 | 495 | 466 | 489 | 291 | 384 | 592 | 381 |
| **Social Studies** | | | | | | | | |
| Lanchester | 349 | 337 | 324 | 328 | 364 | 430 | 372 | 380 |
| Loughborough | 501 | 455 | 496 | 489 | 215 | 379 | 460 | 313 |
| **All Undergraduates** | | | | | | | | |
| Lanchester | 441 | 460 | 463 | 457 | 572 | 797 | 887 | 667 |
| Loughborough | 442 | 426 | 421 | 430 | 310 | 438 | 451 | 399 |

TABLE 18

COMPONENTS OF COST PER ENROLLED UNDERGRADUATE STUDENT £'s 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 |

TABLE 19

COST PER SUCCESSFUL* UNDERGRADUATE STUDENT PER ANNUM £'s 1972/73

| | Enrolment Basis | | | Allocated Meetings Basis | | |
|---|---|---|---|---|---|---|
| Year: | 1 | 2 | 3 | 1 | 2 | 3 |
| Engineering | | | | | | |
| Lanchester | 648 | 567 | 530 | 1246 | 1372 | 1432 |
| Loughborough | 410 | 415 | 395 | 374 | 507 | 401 |
| Science | | | | | | |
| Lanchester | 830 | 699 | 605 | 873 | 1133 | 1173 |
| Loughborough | 614 | 557 | 493 | 350 | 431 | 627 |
| Social Science | | | | | | |
| Lanchester | 429 | 359 | 332 | 448 | 458 | 381 |
| Loughborough | 563 | 512 | 504 | 241 | 427 | 468 |
| All Undergraduates | | | | | | |
| Lanchester | 611 | 517 | 477 | 792 | 896 | 914 |
| Loughborough | 533 | 482 | 441 | 374 | 496 | 472 |

where "successful" = the students who successfully sat the examinations in that year

TABLE 20

COST £ PER GRADUATE 1972/73

| | Lanchester | | Loughborough | |
|---|---|---|---|---|
| | Enrolments Basis | Meetings Basis | Enrolments Basis | Meetings Basis |
| Engineering | 2114 | 4667 | 1435 | 1445 |
| Science | 2682 | 3989 | 1621 | 1513 |
| Social Studies | 1287 | 1306 | 1809 | 1201 |

Cost per Graduate = Cost per eventually successful third year (final) student

+

Cost per eventually successful second year student/$P_C$

+

Cost per eventually successful first year student/$P_C \cdot P_B$

where $P_C$ = Proportion of eventually successful final year students

$P_B$ = Proportion of eventually successful second year students (i.e. proportion that eventually reach final year)

TABLE 21

SOME CORRELATIONS WITH AVERAGE EXIT MARK PER COURSE

| | Both Institutions | Lanchester All disciplines | Loughborough All disciplines | Lanchester | | | Loughborough | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Engineering | Science | Social Science | Engineering | Science | Social Science |
| Academic Unit Cost based on meetings | 31* | 31* | 21* | 34 | 30 | -41 | 16 | 19 | 36 |
| Administrative Unit cost based on meetings | 12 | 27* | 15 | 40* | 17 | -36 | 35* | 34* | 34 |
| Technician Unit Cost based on meetings | 30* | 44* | 07 | 41* | 31 | 24 | 24 | -01 | 16 |
| Total Unit Cost based on meetings | 33* | 37* | 19* | 38* | 32 | -40 | 20 | 13 | 36 |
| Students Tuition Load | 15* | 12 | 05 | -22 | -22 | -10 | -24 | 39* | 22 |
| Students Average Group Size | -23* | -32* | -11 | -47* | -26 | 05 | -06 | -15 | -32 |
| Standard deviation of Students' Group Size | -20* | -26* | -07 | -40* | -19 | 03 | -09 | -08 | -19 |
| Allocated Meetings/Meetings | 32* | 33* | 31* | 11 | 00 | 63* | 36* | 22 | 39* |
| "Service" Allocated Meetings/Total Allocated Meetings | -20* | -37* | -09 | -47* | -40* | -16 | -38* | -02 | -08 |
| Average Entry Mark | 57* | 63* | 51* | 59* | 63* | 68* | 52* | 59* | 17 |
| Proportion Female | -03 | -22* | 08 | -19 | -17 | 21 | -15 | 40* | -19 |
| Proportion Married | 16* | 10 | 25* | 00 | 21 | 53* | 27* | 28* | 38* |
| Proportion Overseas | 03 | +22* | -07 | 06 | 43* | -26 | -07 | -08 | -30 |
| Proportion not A-level | 25* | 34* | 10 | 26 | 17 | 07 | 08 | 00 | 26 |

*Significant at 95% level - two tailed test.

(All the correlation coefficients have been multiplied by 100)

## An Illustration of the Calculation of Timetable "Values"

Consider two courses A and B with enrolments of 30 and 20 respectively. Students on course A read subject elements L and N and also have the option of attending subject elements M or O or none. Students on course B read subject elements N, O and P and may also opt to follow subject M. The enrolment to subject elements, the number of groups and the hours per annum attended in each subject are as follows:-

| | Subject Elements L | M | N | O | P |
|---|---|---|---|---|---|
| A $E = 30$ | 30 | 20 | 30 | 5 | – |
| B $E = 20$ | – | 5 | 20 | 20 | 20 |
| $E^* =$ | 30 | 25 | 50 | 25 | 20 |
| $g =$ | 2 | 1 | 1 | 1 | 2 |
| $h =$ | 20 | 15 | 30 | 20 | 20 |

*Average Tuition Load.* $\frac{\sum h.s}{E}$

$$A = \frac{(20)(30) + (15)(20) + (30)(30) + (20)(5)}{30} = \underline{63.3}$$

$$B = \frac{(15)(15) + (30)(20) + (20)(20) + (20)(20)}{20} = \underline{73.75}$$

MEETINGS $\sum h.g$

$$A = (20)(2) + (15)(1) + (30)(1) + (20)(1) = \underline{105}$$

$$B = (15)(1) + (30)(1) + (20)(1) + (40)(1) = \underline{105}$$

ALLOCATABLE MEETINGS $\sum (h.g.\frac{s}{E^*})$

$$A = (20)(2)(30/30) + (15)(1)(20/25) + (30)(1)(30/50) + (20)(1)(5/25) = \underline{74}$$

$$B = (15)(1)(5/25) + (30)(1)(20/50) + (20)(1)(20/25) + (20)(2)(20/20) = \underline{71}$$

STUDENTS' AVERAGE GROUP SIZE $\dfrac{\sum E^{*}/g \ \frac{(h.s)}{E}}{\sum \frac{(h.s)}{E}}$

$$A = \frac{(30/2)\left(\frac{(20)(30)}{30}\right) + (25/1)\left(\frac{(15)(20)}{30}\right) + (50/1)\left(\frac{(30)(30)}{30}\right) + (25/1)\left(\frac{(20)(5)}{30}\right)}{63.3} = \underline{33.68}$$

$$B = \frac{(25/1)\left(\frac{(15)(15)}{20}\right) + (50/1)\left(\frac{(30)(20)}{20}\right) + (25/1)\left(\frac{(20)(20)}{20}\right) + (20/2)\left(\frac{(20)(20)}{20}\right)}{73.35} = \underline{31.1}$$

INSTITUTION'S AVERAGE GROUP SIZE $\dfrac{\sum \frac{E^{*}}{g}\left(\frac{h.g.s}{E^{*}}\right)}{\sum\left(\frac{h.g.s.}{E^{*}}\right)}$

$$(30/2)\left((20)(2)\ (30/30)\right) + (25/1)\left((15)(1)\ (20/25)\right) + (50/1)\left((30)(1)(30/50)\right) + (25/1)\left((20)(1)\ (5/25)\right)$$

$$+ (25/1)\left((15)(1)(5/25)\right) + (50/1)\left((30)(1)\ (20/50)\right) + (25/1)\left((20)(1)\ (20/25)\right) + (20/2)\left((20)(2)\ (20/20)\right) \Big/ 74 + 71$$

$$= \underline{23.28}$$

APPENDIX 2.7.

"A COMPARATIVE TIMETABLE ANALYSIS FOR UNDERGRADUATE PROGRAMMES IN A POLYTECHNIC AND A UNIVERSITY"

by BIRCH, D.W. and CALVERT, J.R.

in HIGHER EDUCATION REVIEW, 8, 3, SUMMER 1976

# A comparative timetable analysis for undergraduate programmes in a polytechnic and a university

Derek Birch and John Calvert

Teaching (unlike learning) takes place in meetings between students and academic staff. The timetable is a written record of these meetings which may be defined in terms of time, place, discipline and group size. The systematic collection and analysis of timetable data is one approach to an improved understanding of the teaching process. Doubts may be cast on the absolute accuracy of timetables but the information they contain is at least as reliable as that obtained by student/faculty questionnaires or diaries. Teaching requires academic staff commitment not only to formal classroom time but also to preparation, the correction and feedback of students' assignments, the preparation and marking of examinations and other 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. If we assume that a teacher will have a mix of levels, of 'new courses', and of group sizes which does not diverge greatly from the average for his institution then the timetable provides information on faculty teaching loads. More importantly from the point of view of this paper the timetable also defines the pattern of demand for teaching space and specifies aspects of the students' formal learning environment.

The timetable analysis described below is part of an investigation into performance indices in higher education sponsored by the OECD Institutional Management in Higher Education Programme and financed by the Department of Education and Science. The study has involved *inter alia* an examination of student timetables at Lanchester Polytechnic and Loughborough University for the whole of the academic year 1972–73 for all undergraduate courses (except art at Lanchester). An analysis of who was taught, by whom and for how long has revealed some large differences between the two institutions which may have educational, cultural and social implications. Some of the economic consequences are explored below

**TABLE 1**

*1972 enrolments to first degree courses included in the study*

| | Lanchester | Per cent | Loughborough | Percent |
|---|---|---|---|---|
| **Sandwich** | | | | |
| Engineering and technology | 716 | 31 | 1119 | 44 |
| Science | 181 | 8 | 235 | 9 |
| Social and Business studies | 398 | 17 | 125 | 5 |
| Other | 87 | 4 | 31 | 1 |
| **Full–time** | | | | |
| Engineering and technology | – | – | 342 | 14 |
| Science | 361 | 16 | 332 | 13 |
| Social and business studies | 458 | 20 | 192 | 8 |
| Other | 101 | 4 | 150 | 6 |
| Total | 2302 | 100 | 2526 | 100 |

Source: see text

In 1972–3 the first degree populations at Lanchester and Loughborough were very similar, and the split between sandwich and full-time students in each institution was virtually identical (see Table 1). In both institutions over 90 per cent of the undergraduates were reading for degrees in engineering and technology, pure and applied science, or social and business studies. Within these three broad discipline areas, however the mix was different – engineering and technology (58 per cent was the dominant discipline at Loughborough, whereas at Lanchester there was a more equal balance between engineering and technology (31 per cent), social and business studies (37 per cent) and pure and applied science (24 per cent).

**Timetable Parameters**

Previous studies have identified average class size, average teaching load, average tuition load,[1] the mix between lectures (comparatively open–ended in terms of potential student accommodation) and small group situations (with critical maximum class sizes),[2,3] and preparation and postmortem time[4] as important variables to be included in academic staffing formulae. However, so far as we understand them these formulae have been concerned with analysis at the level of the institution and/or have viewed the 'course' as self–contained and timetabled independently. In the event, the situation particularly at Loughborough, proved to be more complex, approximating to the 'modular' structure represented in the matrix in Fig.1. In this figure, the columns represent courses and the rows subject elements. If a subject element is compulsory then the upper limit of a class size is the sum of the total enrolments to the courses taking that particular topic – for example, courses 1 and 3 for subject element A in the matrix. If a subject element is optional the enrolments to meetings in that topic will be equal to or less than the total enrolments to the courses participating.

Courses

| Subject Elements | | 1 | 2 | 3 |
|---|---|---|---|---|
| | A | x | | x |
| | B | x | x | |
| | C | | x | x |

*Figure 1: Diagrammatic course structure at Loughborough University*

Thus a course consitutes a set of 'meetings' where a meeting is a timetabled hour of contact between academic staff and students. This 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 assigned to each teacher. 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. Consequently, to analyse a set of meetings the following information is required:

Total enrolment to a course (denote by E)
The enrolment from a course to a particular subset of meetings (denote by s where $s \leqslant E$);
The total enrolment from all courses attending this particular subset of meetings (denote by $E^*$ where $E^* \geqslant s$);
The department providing the tuition for this particular subset of meetings;
The number of student groups each assigned to *one* teacher formed in this particular subset of meetings (denote by g); and
The total number of hours attended by a student in this particular subset of meeting(denote by h) of a particular group size ($E^*/g$).

From these data it is possible to define for each year of a course, for a department's courses, for discipline areas and for each institution the following values where, in each case, the summations are made over the relevant subsets.
Student's tuition load = Hours of timetabled contact with faculty that the student on average received = $\Sigma[(h)(s)]/E$
Meetings (hours) timetabled for a course = $\Sigma[(h)(g)]$
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, where 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 meetings = $\Sigma[(h)(g)(s/E^*)]$

$$\text{Students' average group size} = \frac{\Sigma[E^*/g]\ [\frac{(h)(s)}{E}]}{\Sigma[\frac{(h)(s)}{E}]}$$

$$\text{Institution's average group size} = \frac{\Sigma[E^*/g]\ [(h)(g)(s/E^*)]}{\Sigma[(h)(g)(s/E^*)]}.$$

TABLE 2

*Summary of timetable parameters for three year undergraduate cycle 1972–73*

| | All disciplines | | Engineering & technology | | Science | | Social and business | |
|---|---|---|---|---|---|---|---|---|
| | Lan | Lou | Lan | Lou | Lan | Lou | Lan | Lou |
| Students tuition Load (hrs) | 1,930 | 1,612 | 2,329 | 1,685 | 2,471 | 1,688 | 1,325 | 1.306 |
| Meetings (hrs) | 146,086 | 118,468 | 62,217 | 50,394 | 44,067 | 32,884 | 33,378 | 25,475 |
| Allocated meetings (hrs) | 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 |

Source: see text

## The results

Tables 2, 3 and 4 summarise the timetable parameters over the normal three year undergraduate cycle, the relative frequency distribution of the average students' group size and the pattern of demand for teaching space respectively.

For all the major comparable disciplines the Lanchester student had a tuition load greater than his Loughborough counterpart. The difference ranged from 783 hours over three years for science and applied science to 19 hours for social and business studies. Engineering and science and applied science students in both institutions had more teacher contact than their social sciences and humanities colleagues: a phenomenon identified by Frederickson[5] for a larger and wider sample in Europe. At Lanchester this difference 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 meetings. Meetings are the formal academic staff/student contact hours per annum that would be provided if each course was self–contained and timetabled independently: allocated meetings are the meeting hours actually provided: any difference arises out of joint classes involving more than one course. For example, in Social and Business Studies at Lanchester joint meetings reduced the one hour classes required from 33, 378 to 30, 469, whereas at Loughborough the reduction was from 25, 475 to 7, 089.

Partly as a result of joint meetings, the Loughborough undergraduate found himself in much larger groups on average than his Lanchester counterpart and experienced a wider variation 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 ten per cent of his timetable in groups of ten or below (Table 3). However, at Lanchester 66 per cent of the student's formal teacher contact was in groups of 20 or less compared with only 36 per cent at Loughborough. At Lanchester only seven per cent of the timetabled contact was in groups larger than 60; at Loughborough 26 per cent was in groups larger than 60 and 11 per cent in classes of 100 or more.

It is important to appreciate the distinction between the students' average group size (Table 2). The former identifies the average group size in which the average student finds himself, ie his typical learning environment. The latter identifies the group size the institution on average is required to provide. For example, an enrolment of 20

**TABLE 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 |

Source: see text

students receiving one hour in a group of five, one hour in a group of ten and one hour in a group of 20 has a students' average group size of 11.7. The institution, on the other hand, provides four hours of group size five, two hours of group size ten and one hour of group size 20, ie the institution's average group size is 8.6. It is the institution's average group size which forms part of the base for the Pooling Committee's student/staff norms.

Almost 67 per cent of the demand for teaching space at Lanchester was for groups of ten or below compared with 41 per cent at Loughborough (Table 4). On the other hand, 12 per cent of the demand at Loughborough was for groups greater than 40 whereas at Lanchester only two per cent of the demand was for groups of 40+ students.[6]

**TABLE 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 |

Source: See text

## 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 five 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 Committe [7] on minimum class sizes 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 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 Business 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. In the event the first of these possibilities proved to be more the case.

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.[8] 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; the organisation structure and managerial climate. We have not collected information on these variables but we have collected data on A level and other entrance examination scores and subsequent examination performance. A summary of the A level scores and internal examination results for 1972–73 for both institutions has been published elsewhere.[9] Briefly, the average Loughborough student with a mean A level score of just below C was about three quarters of a grade above his Lanchester counterpart – which may be some explanation of the difference in timetables. Apart from first year failure rates (Lanchester 22 per cent, Loughborough 9 per cent), pass and wastage rates in 1972–73 were virtually identical for both institutions, and there was a consistent and similar improvement in mean scores accompanied by a tightening of the distribution of marks from second to third year studies

If differences in educational outcomes prove to be not statistically significant, the emphasis shifts from cost benefit to cost effectiveness in assessing institutional performance. In such circumstances the deployment of students and staff outlined in the timetable becomes more critical. Cross institution comparisons apart, a timetable analysis identifies some of the resource implications of alternative educational strategies and it is an obvious aid in the internal resource allocation process. The economic advantages of lower tuition loads and joint meetings leading to larger groups are easily demonstrated. The questions of the educational and cultural 'costs' involved in these teaching strategies are more demanding. We are exploring some of the educational outcomes – the effects on the ethos and social climate of the institution remain a potentially fruitful area for research.

## Notes

1 Delany, V J (1971), *Cost Efficiency Indicators in Further Education*, The Association of Colleges of Further and Higher Education.

2 Bottomley, J A et al (1972), *Costs and Potential Economies*, OECD/CERI/IMHE, Paris.

3 Legg, K (1971), *Comparative Studies in Costs and Resource Requirements for Universities*, OECD/CERI/IMHE, Paris.

4 Simpson, M G et al (1971), *Planning University Development*, OECD/CERI/IMHE, Paris.

5 Frederiksen, B (1971), *Subject Field and Regional Variations in Student/Staff Ratios. Academic Programme and Recurrent Expenditures*, OECD/CERI/IMHE, Paris.

6 We have also collected and analysed data for both institutions for the academic year 1973–74. There were no significant changes between the 1972–73 and 1973–74 timetables.

7 Pilkington Committee on the More Effective Use of Technical College Resources (1966), *Size of Classes and Approval of F E Courses*, HMSO.

8 See Birch, D W, Calvert, J R and Sizer J, 'A Note on Costing The Teaching Activity in Higher Education', to be published in forthcoming edition of *Higher Education*.

9 Birch D W, Calvert, J R and Sizer, J (1976), 'A Study of Some Performance Indicators in Higher Education with Particular Reference to Lanchester Polytechnic and Loughborough University', a paper presented to the Third General Assembly of Member Institutions IMHE/CERI/OECD, Paris. Mimeographed, available from the authors.

APPENDIX 2.8.

"A CASE STUDY OF SOME PERFORMANCE INDICATORS IN HIGHER EDUCATION IN THE UK"

by BIRCH, D.W., CALVERT, J.R. and SIZER, J.

in INTERNATIONAL JOURNAL OF INSTITUTIONAL MANAGEMENT IN HIGHER EDUCATION, 1, 2, AUTUMN, 1977

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RESEARCH REPORT

# A CASE STUDY OF SOME PERFORMANCE INDICATORS IN HIGHER EDUCATION IN THE UNITED KINGDOM

D.W. Birch, J.R. Calvert, J. Sizer,
Loughborough University of Technology,
Loughborough, United Kingdom

## ABSTRACT

*The major purpose of this case study was to explore the potential for performance indicators for the teaching function in higher education. A framework for performance assessment in terms of "response" to the learning opportunities provided and "resource utilisation" is developed and tested on data from Lanchester Polytechnic and Loughborough University for the academic year 1972/73. At a "discipline" level of aggregation few significant differences in response but quite different patterns of instruction leading to very different unit costs are identified. The study concludes that there is a case for the systematic collection of data on instruction and resource utilisation patterns within and across institutions. However, in the absence of an accurate specification of cause and effect such a data base would require careful and sympathetic interpretation pending the development of finer measurements of outcome.*

## INTRODUCTION

Universities and Polytechnics pursue a number of objectives other than teaching but a consideration of research and scholarship and public service was outside the project's remit. Moreover, the research was constrained to take account of only those aspects which could be "easily quantified" and for which information was "readily available".

The data base for the case was formed from the undergraduate courses at Lanchester Polytechnic and Loughborough University of Technology for the academic year 1972/73. In that year the total first degree population at Lanchester and Loughborough was similar and the split between sandwich and full-time students in each institution was virtually identical. In both institutions over 90% of the undergraduates were reading for degrees in either engineering and technology, pure and applied science, or social and business studies. Within these three broad discipline areas, however, the mix was different - engineering and technology (58%) was the dominant discipline at Loughborough whereas at Lanchester there was a more equal balance with the highest recruitment to social and business studies (37%) (Birch, Calvert, Sizer, 1976).

## A FRAMEWORK FOR PERFORMANCE ASSESSMENT

An organisation is effective if it achieves its objectives; it improves its efficiency if it achieves these objectives with fewer resources. Hence performance assessment involves (inter alia) firstly, comparing the level and quality of outcomes with objectives and, secondly, examining input-output relationships. (An institution may be internally effective yet externally ineffective if its objectives are not congruent with the needs of society.)

So apparently, the first critical task is to establish a set of objectives, but 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). One problem is the lag between the process and its effects, another is the uncertainty about the nature of the connection. Whether 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 a filtering device signalling ability differences which existed before the process began (Arrow, 1973) its ultimate impacts are long term and obscure. Institutional performance assessment requires more proximate objectives.

All is not lost however if we accept the inevitability of the generality and vagueness of objectives in education. It is possible to move directly to the measurement of "outputs" or (perhaps more exactly) "outcomes" and, hopefully, the evidence collected will lead to an improved understanding of, and sensitivity to, the sophistication of the educational process.

Given that institutions of higher education exist in their teaching roles to provide sets of learning opportunities and that students may choose to enrol or not, the first indication of success is provided by the numbers and "quality" of students actually enrolled. Subsequently institutions hope to progress their students successfully through the system and ultimately to have their graduates accepted by the economy. Hence, dropouts, failures, repeaters, successes, graduates and the initial employments of graduates are all outcomes of various stages of the educational process and a careful monitoring of these is indicated. Inherent in the success rate criteria is the view that the institution may rely on academic "professionalism" for the maintenance of academic standards. To an extent this is ensured in the United Kingdom by the system of external assessors and examiners but some doubts have been cast on the comparability of degree standards even within the same subject group (Nevin, 1972).

A more sophisticated measure of output is the "value added" to the students between entry to and exit from the institution. This concept presents problems of definition and is less susceptible to quantification. If it is interpreted as being concerned primarily with knowledge and skills acquisition rather than experiential, attitudinal, cultural and social gains plus personal consumption, then it overlaps with the pass rate criteria and the latter may serve as a proxy. However, to accurately measure and compare this "learning gain" standardised pre-course and post-course tests covering common syllabi would be required

(Attiyeh and Lumsden, 1971 and 1972). This solution was not used in this case.

Enrolments, pass and attrition rates and information on graduate employment by course are all indicators of society's response to the institution's provision of learning opportunities, i.e. they are outcome measures. Now to the question of efficiency. Usually the input-output relationship is summarised in the form of a unit cost but in the United Kingdom the popular approximation is the student staff ratio. This ratio is a function of a number of variables (Delany, 1971; Legg, 1971; Bottomley et al, 1972; Simpson et al, 1972) and an examination of resource utilisation at the institutional level should take account of them. Depending on the complexity of the curriculum this may involve a detailed timetable analysis such as is outlined below.

Consider a college with two departments X and Y with two courses A and B (Figure 1); course A is administered by Department X and course B by Department Y. There are 30 enrolments to course A and 20 to course B. Courses receive and departments provide tuition. Department X provides tuition in subject elements L, M and N whilst Department Y offers subjects O and P. Following a course involves the student reading a number of subject elements and attending a set of meetings with teachers. These meetings (class hours) may be compulsory or optional, involve just one course or be joint with other courses. 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 are "joint meetings" involving both courses A and B.

Therefore, to analyse a set of meetings the following information is required:

- for a year of a course ("course year")
  total enrolment = E
- for a particular subset of meetings for a subject element
  enrolment from a particular "course year" = S
  enrolment from all "course years" of all courses = E *
  number of groups formed each assigned to one teacher = g
  hours per annum attended by the student = h

and the department providing the tuition and the type of space used.

*Figure 1*

Timetable Parameters

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Department | X | | | Y | |
| | | Subject Elements | L | M | N | O | P |
| | $\boxed{g}$ | No. of Groups Formed | 2 | 1 | 1 | 1 | 2 |
| | $\boxed{h}$ | Students' Contact Hours | 20 | 15 | 30 | 20 | 20 |
| Course | $\boxed{E}$ | Enrolment | $\boxed{S}$ = Enrolments to Subject Elements | | | | |
| A | | 30 | 30 | 20 | 30 | 5 | |
| B | | 20 | | 5 | 20 | 20 | 20 |
| | $\boxed{E*}$ | Enrolment from all courses | 30 | 25 | 50 | 25 | 20 |

From this data the meetings provided by each department can be identified and distributed to those courses receiving tuition in the proportion:

$$\frac{\text{Students enrolled from this course year}}{\text{Students enrolled from all course years}} = \frac{S}{E*}$$

The analysis of the meetings provided by Department X and the logic of the subsequent cost allocation is set out in Figure 2.

As a byproduct a number of "values" of significance in the internal management of resources may be derived (Figure 3). These provide inter alia details of teaching loads, students' tuition loads, class sizes - both those typically received by the students and those provided by the institution - and data on the frequency of demand for teaching space of various types and capacities.

## THE CASE RESULTS

Figure 4 summarises the course-year parameters for the response dimension. At this level of aggregation the pattern of pass and attrition rates were remarkably similar overall and by discipline area across the two institutions. The significant differences in response in 1972/73 lay in enrolments per course (higher at Lanchester except in engineering), the percentage without A-level (higher at Lanchester except in social science), and average A-level scores (overall just below 3 = Grade 'C' at Loughborough and just above 2 = Grade 'D' at Lanchester) and the coefficient of variation of A-level (higher at Lanchester). Thus it would appear that in 1972/73 the normal pre-entry to institution quality as measured by A-level scores was consistently higher and less variable at Loughborough. Subsequently, however, mean internal examination scores were lower and more variable at Loughborough although not significantly so.

As suggested above, one indicator of society's response to the final outputs of an institution is the initial employment of graduates and their starting salaries. In 1972/73 this information was only available for 20% of the graduates at Lanchester and 50% of the graduates at Loughborough. From this sample it seemed that discipline area rather than institution was the more important determinant of initial salary and the correlation between starting salary and examination mark although positive in the majority of cases was by no means strong.

The pattern of resource utilisation (Figure 5) is quite different across the two institutions. Lower tuition loads (except social science), larger classes, a higher incidence of tuition from "service" departments (except science) and much larger "savings" in tuition demands through joint meetings were consistently observed at Loughborough. Of these differences the most striking was the incidence of classes involving more than one course which was far higher in all disciplines at Loughborough. Typically, the Lanchester undergraduate found himself in classes comprised almost entirely (97%) of students from his own courses whereas the Loughborough student experienced classes in which 40% of the students were from courses other than his own. The sizes of seminars and tutorials are constrained by what the academics consider to be effective learning/teaching situations and joint meetings will not alter these constraints. However, lecturing to one hundred is often as effective as lecturing to ten and it is in this - the lecture content of the curriculum - that joint meetings have their economic impact. As a consequence of larger classes and joint meetings undergraduate unit

*Figure 2*

The Logic of a Department Cost Allocation on a Meetings Basis

| | | | | |
|---|---|---|---|---|
| Department | | | X | |
| Subject Elements | | L | M | N |
| Groups formed | $\boxed{g}$ | 2 | 1 | 1 |
| Students' Contact Hours | $\boxed{h}$ | 20 | 15 | 30 |

| Course | Enrolment $\boxed{E}$ | Enrolment to Subject Elements $\boxed{S}$ | | |
|---|---|---|---|---|
| A | 30 | 30 | 20 | 30 |
| B | 20 | | 5 | 20 |

| | | | | |
|---|---|---|---|---|
| $\boxed{E*}$ 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 | → Total = 15 |

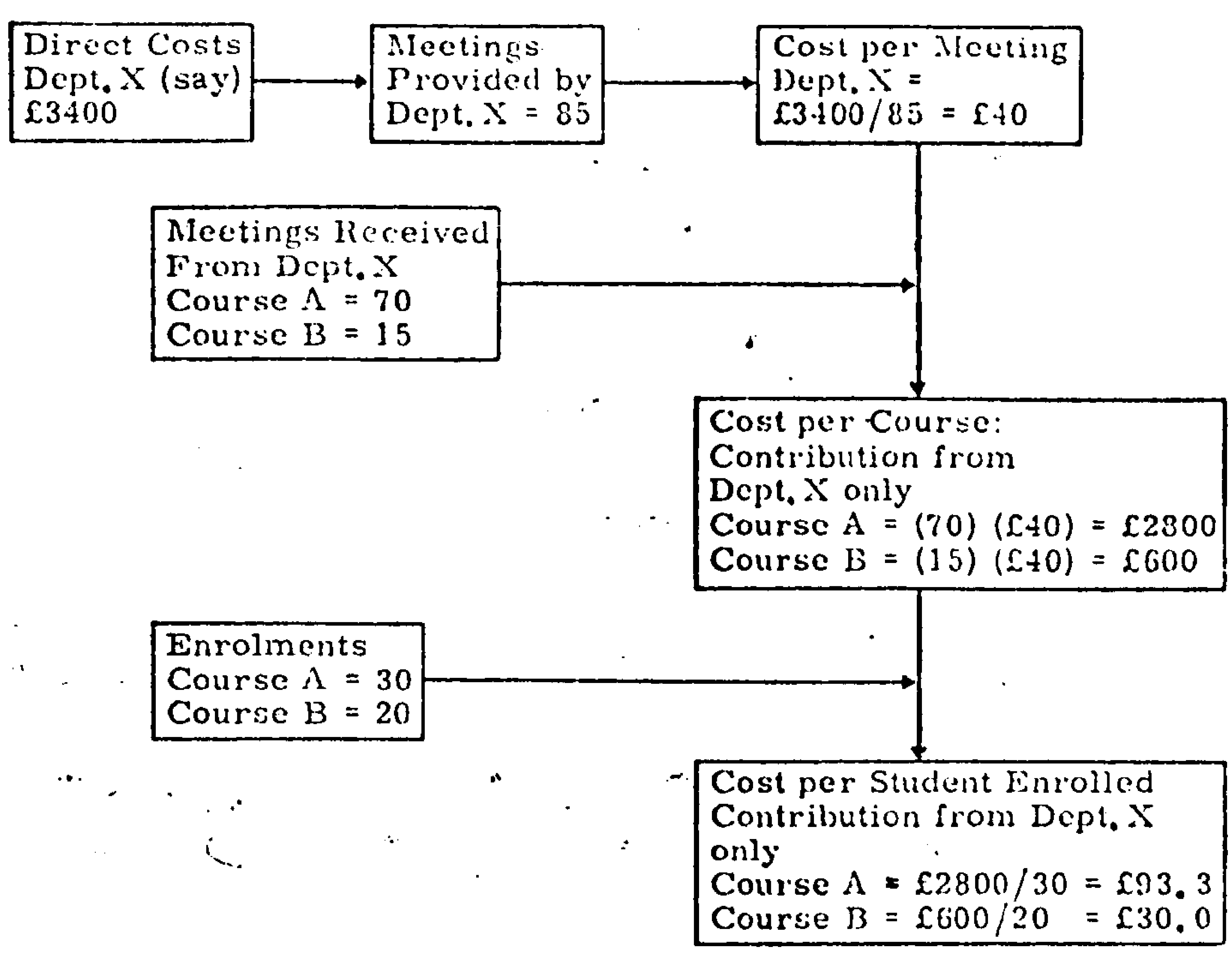

*Figure 3*

Timetable Parameters

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 $E^*_k$

$$= \sum_i \sum_j S_{ijk}$$

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 $= \sum_k \left[(h_k)\ (g_k)\right] = \alpha$

3 Summed over a department or discipline area or for the institution the statistic "Meetings" counts joint meetings (i.e. 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, i.e.

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

4 Hence CLASS HOURS "SAVED" $= \alpha - \beta$

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

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

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

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

*Figure 4*

**Summary of Average "Course-Year" Response Parameters 1972/73 (1)**

| | All Disciplines | | | Engineering | | Science | | Social Science | |
|---|---|---|---|---|---|---|---|---|---|
| | Both | LAN.* | LOU.** | LAN.* | LOU.** | LAN.* | LOU.** | LAN.* | LOU.** |
| Number of "Course Years" | 226 | 88 | 138 | | | | | | |
| RESPONSE | | | | | | | | | |
| Enrolment | 20 | 25 | 17 | 18 | 21 | 19 | 14 | 43 | 12 |
| A-Level Score (2) | 2.51 | 2.06 | 2.80 | 1.91 | 2.87 | 1.82 | 2.79 | 2.38 | 2.64 |
| Coefficient of Variation of A-Level | 0.27 | 0.33 | 0.22 | 0.37 | 0.23 | 0.35 | 0.24 | 0.28 | 0.18 |
| Percentage without A-Level | 20 | 27 | 15 | 42 | 22 | 25 | 5 | 12 | 16 |
| Entry Mark | 54.6 | 55.9 | 53.8 | 57.2 | 54.6 | 55.4 | 53.0 | 54.3 | 53.2 |
| Coefficient of Variation of Entry Mark | 0.13 | 0.11 | 0.15 | 0.11 | 0.15 | 0.12 | 0.16 | 0.10 | 0.12 |
| Exit Mark | 54.8 | 56.2 | 54.0 | 58.4 | 54.6 | 55.8 | 52.9 | 53.2 | 54.2 |
| Coefficient of Variation of Exit Mark | 0.15 | 0.14 | 0.16 | 0.14 | 0.17 | 0.16 | 0.18 | 0.13 | 0.12 |
| Pass Percentage | 87 | 86 | 88 | 85 | 87 | 85 | 87 | 90 | 89 |
| Fail Percentage | 10 | 11 | 9 | 14 | 10 | 12 | 9 | 8 | 6 |
| Drop Out Percentage | 3 | 3 | 3 | 1 | 2 | 3 | 4 | 2 | 5 |

Notes:

1. The normal duration of undergraduate programmes in the United Kingdom is <u>three</u> "course-years".
2. A-Level is the normal qualification for undergraduate programmes. The A-level scores were calculated as follows: 'A' = 5; 'B' = 4; 'C' = 3; 'D' = 2; 'E' = 1.

* LAN.: Lanchester    ** LOU.: Loughborough

*Figure 5*

Summary of Average "Course-Year" Resource Utilisation Parameters 1972/73

| | All Disciplines | | | Engineering | | Science | | Social Science | |
|---|---|---|---|---|---|---|---|---|---|
| | Both | LAN.* | LOU.** | LAN.* | LOU.** | LAN.* | LOU.** | LAN.* | LOU.** |
| Number of "Course Years" | 226 | 88 | 138 | | | | | | |
| RESOURCE UTILISATION | | | | | | | | | |
| Students' Tuition Load (Hours) | 534 | 668 | 529 | 773 | 561 | 764 | 561 | 425 | 448 |
| Students' Class Size | 33 | 18 | 43 | 13 | 49 | 12 | 37 | 30 | 41 |
| Standard Deviation of Students' Class Size | 24 | 9 | 34 | 6 | 41 | 5 | 29 | 24 | 28 |
| Percentage of Class Hours Provided by "Service" Departments | 31 | 28 | 32 | 24 | 30 | 36 | 21 | 29 | 46 |
| Percentage of Class Hours "Saved" | 37 | 3 | 59 | 0 | 57 | 0 | 59 | 9 | 71 |
| Cost per student enrolled £ (1) | 635 | 940 | 441 | 1126 | 412 | 1150 | 486 | 445 | 399 |

Note:

1. The costs allocated include the salaries, superannuation and national insurance of academic, technician and administrative staff deployed at the level of departments together with recurrent expenditure on teaching materials, the maintenance and hire of teaching equipment, and the cost of short courses and field work. The costs of the full-time staff were established by reference to salary scale mid-points in 1972/73; the costs for part-time staff were "actual" in 1972/73.

* LAN.: Lanchester ** LOU.: Loughborough

costs per annum although reasonably close in social science were in engineering and science and overall significantly lower at Loughborough.

## CONCLUSIONS

In the present climate of concern with the proportion of GNP allocated to higher education and in the absence of an accurate specification of cause and effect in education attention inevitably focuses on cost effectiveness. At a discipline level of aggregation the Lanchester-Loughborough case apparently provides the sort of intelligence which central budget allocators seek, i.e. few significant differences in "response" but quite different patterns of instruction leading to very different unit costs. There were examples in both institutions of courses with response and resource utilisation patterns significantly different from the norms for their institution and discipline. The monitoring of these divergencies would have prompted discerning questions the answers to which might have helped the decision takers to isolate and to support the genuine cases of development and diversity. It is to be hoped that whatever "standardising tendencies" emerge through the increasing role of central planning authorities and agencies (Trow, 1974) there will remain scope for the exercise of subjective judgments at the sharp end. However the case for internal resource allocation based in part on past effectiveness and efficiency is not without support.

Further research is required firstly, to replicate the Lanchester-Loughborough study in a variety of settings selected for their diversity and supposed similarity; and secondly to develop accurate and reliable measures of outcome initially of learning gain and ultimately of the value-added type. This second task is formidable and the probability is that it will require efforts on the part of many investigators and will proceed only slowly. Meanwhile the system will rely on existing examining arrangements and on the comparability of academic standards within and across institutions. In these circumstances improvements in cost effectiveness may prove to be misleading: more students may pass through the system at the same or with a less than proportional increase in costs but the value added to the additional students may be outweighed by the decline in value added to the existing students. Nevertheless, a move towards the systematic collection and analysis of data on institutional outcomes and resource utilisation is overdue. Regular reports at the course level would facilitate internal "management by exception" and establish a data base and prompt the research from which a greater understanding of the teaching/learning process might be achieved.

## ACKNOWLEDGEMENTS

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APPENDIX 2.9.

"A NOTE ON COSTING THE TEACHING ACTIVITY IN HIGHER EDUCATION"

by BIRCH, D.W., CALVERT, J.R. and SIZER, J.

in HIGHER EDUCATION, 7, 1977

*Higher Education* 7 (1977) 67–74


# A NOTE ON COSTING THE TEACHING ACTIVITY IN HIGHER EDUCATION

D. W. BIRCH, J. R. CALVERT and J. SIZER

*Department of Management Studies, University of Technology, Loughborough, Leicestershire LE11 3TU, England*

**ABSTRACT**

This note explains one method of calculating unit costs for the teaching function in higher education. A formula is developed for allocating expenditures on the basis of a timetable analysis and tested on data from Lanchester Polytechnic and Loughborough University for the academic year 1972/73.

## Introduction

This note arises out of an investigation into performance indicators in higher education sponsored by the Institutional Management in Higher Education Programme of OECD and partly financed by the Department of Education and Science. The data base for the case study is formed from the undergraduate courses (except art) at Lanchester Polytechnic and Loughborough University for the academic year 1972/73.

In 1972/73 the total undergraduate population at Lanchester and Loughborough was very similar and the split between sandwich and full-time students in each institution was virtually identical. In both institutions over 90% of the students were reading for degrees in either engineering and technology, pure and applied science or social and business studies. However within these three discipline areas the mix was different: engineering and technology (58%) was the dominant discipline at Loughborough reflecting the university's original raison d'être; at Lanchester there was a more equal balance between engineering and technology (31%) social and business studies (37%) and pure and applied science (24%).

## A Timetable Analysis

The question of concern here is: How should the costs identified as belonging to the teaching function be allocated to courses, and ultimately, to the students taking these courses?

At the moment there is no elegant way of handling the problem – any approach is to some extent arbitrary. The largest input is invariably academic staff and a case can be made for having the allocations done by the academics themselves (NCHEMS at Wiche, 1971). Succinctly the objections that can be raised to this questionnaire/diary solution are concerned with time scales, the validity of the data and the costs of collection. Questionnaires rely heavily on the goodwill and co-operation of staff 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, p. 45).

Teaching takes place in meetings between faculty and students. The large majority of these meetings are set down in the timetable which thus defines what? when? where? by whom? and for whom? The analysis of timetable data is an alternative method of identifying the direction and intensity of an institution's teaching efforts and, therefore, an alternative basis for cost allocation. (Bottomley et al., 1972; Delany, 1971).

Specifically, a course constitutes a set of meetings where a meeting is a timetabled *hour* of contact between academic staff and students. This set can be broken down into subsets on the basis of the department providing the tuition and the size of the classes each assigned to one teacher. 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. Consequently to analyse a set of meetings the following information is required:

- total enrolment to a course (denote by $E$);
- the enrolment from a course to a particular subset of meetings (denote by $s$, where $s \leqslant E$);
- the total enrolment from all courses attending this particular subset of meetings (denote by $E^*$, where $E^* \geqslant s$);
- the department providing the tuition for this particular subset of meetings;
- the number of groups each assigned to one teacher formed in this particular subset of meetings (denote by $g$); and
- the hours per annum attended by a student in this particular subset of meetings (denote by $h$).

Table I gives the overall results of a timetable analysis for each year of the normal three year undergraduate cycle at Lanchester and Loughborough in 1972/73.

Briefly, by comparison with the Loughborough undergraduate the Lanchester student was on average timetabled for 20% more hours invariably

TABLE I

Some Undergraduate Timetable Statistics 1972/73

| | Lanchester | | | Loughborough | | |
|---|---|---|---|---|---|---|
| Year of Study | 1 | 2 | 3 | 1 | 2 | 3 |
| Student's Tuition Load (Hours)[1] | 654 | 692 | 584 | 578 | 593 | 441 |
| Meetings (Hours)[2] | 42 459 | 51 672 | 51 964 | 46 368 | 41 046 | 31 051 |
| Allocated Meetings (Hours)[3] | 40 784 | 50 349 | 50 473 | 20 443 | 22 623 | 19 352 |
| Student's Average Class Size[4] | 31 | 20 | 18 | 67 | 46 | 29 |
| Institution's Average Class Size[5] | 14 | 10 | 8 | 27 | 19 | 14 |

1 Student's Tuition Load: the hours of timetabled contact with faculty that the student on average received = $(h \cdot s)/E$

2 Meetings timetabled for a course = $\Sigma\,(h \cdot g)$;

3 Summed over a department or discipline area or for the institution the statistic "Meetings" counts joint meetings (i.e. meetings involving two or more courses) several times. Hence where 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; thus Allocated Meetings = $\Sigma\,(h \cdot g \cdot s/E^{*})$;

4 Student's Average Group Size = $$\frac{\sum E^{*}/g \left[\dfrac{h \cdot s}{E}\right]}{\sum \left[\dfrac{h \cdot s}{E}\right]}$$

5 Institution's Average Group Size = $$\frac{\sum E^{*}/g \left[\dfrac{h \cdot g \cdot s}{E^{*}}\right]}{\sum \left[\dfrac{h \cdot g \cdot s}{E^{*}}\right]}$$

In each case the summations are made over the relevant subsets.

with students from his own course in classes of approximately half the size. Higher tuition loads, smaller classes and a lower incidence of joint meetings was consistently observed at Lanchester in all disciplines. However, the greatest divergence between the two institutions lay in the difference between "meetings" and "allocated meetings". The meetings are the staff-student contact hours per annum that would have to be provided if each course was timetabled independently; the allocated meetings are the class hours actually provided: any difference arises out of joint meetings involving more than one course.

What are the economic implications of these differences? A measure which summarises the cumulative effects of tuition loads, class size and the incidence of joint meetings is:

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

In 1972/73 this ratio of undergraduate timetable demands in hours per annum per student enrolled in each discipline area was:

| | Lanchester | Loughborough |
|---|---|---|
| Engineering and Technology | 87 | 22 |
| Pure and Applied Science | 81 | 30 |
| Social and Business Studies | 36 | 22 |
| All undergraduates | 62 | 25 |

Thus the average undergraduate at Lanchester made over double the tuition demands of his Loughborough counterpart. If the class contact of the average teacher and his salary had been equivalent across the two institutions the academic staff cost per undergraduate at Loughborough would have been less than half that at Lanchester. Alternatively, the average Loughborough lecturer had half the timetable commitment, hopefully devoted more time to research and the teacher unit costs were approximately the same in both institutions.

## Unit Costs

To recap, an analysis of the timetable such as described above offers an alternative and, wherever extensive inter-departmental "servicing" and joint meetings are a feature, maybe a more accurate method of allocating costs to courses than a questionnaire/diary approach or a multi-regression approach such as that of Layard and Verry (1975). Specifically if we denote:

allocated meetings from a department to a course by $M$; and
allocated meetings from a department to all courses by $M_T$; and
departmental costs by $C$;

then for a course the cost is given by:

$$\sum_{\substack{\text{all departments}\\ i}} \left[ \frac{M_i}{M_{Ti}} \cdot C_i \right] = K$$

and unit cost by $K\,[1/E]$
where $E$ is the enrolment to the course.

In the following tables the costs allocated 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 recurrent expenditure on teaching materials, the maintenance and hire of teaching equipment, and the cost of short courses and field work. The costs for the full-time staff have been established by reference to salary scale mid points in 1972/73; the costs for part-time staff are actual. Full-time research workers financed wholly by research grants and contracts have been excluded. In the case of Lanchester the permanent Deans' salaries have been apportioned equally between the departments for which they were responsible.

Table II sets out the costs per enrolled student in 1972/73 for the major undergraduate discipline areas. In Tables II, III and IV the costs per course have been summed over the relevant discipline area and level and divided by the total enrolments to the courses in this discipline and level.

TABLE II

Costs in £'s per Undergraduate Enrolled 1972/73

| Year of Study | 1 | 2 | 3 | Average |
|---|---|---|---|---|
| *Engineering and Technology* | | | | |
| 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 |

When comparing average costs across institutions some adjustment for discipline mix should be made. Engineering and science were the most expensive disciplines in both institutions and accounted for about 75% of the total first degree enrolments at Loughborough compared with about 55% at Lanchester. Therefore if a discipline mix adjustment had been attempted the apparent undergraduate cost advantage of Loughborough would have been enhanced. The difference between the disciplines was smaller at Loughborough because of the high incidence of joint meetings across disciplines. Predictably the costs per enrolled student increase as the years of study proceed at Lanchester from £572 for first year undergraduates to

£887 for third year students, at Loughborough from £310 to £451. Hence in both institutions the final year undergraduate costs about half as much again as the "fresher". This reflects the fact that although in both institutions the finalist had a lower tuition load this was outweighed by much reduced class sizes, and in the case of Loughborough, fewer joint meetings. In both institutions there was some evidence that resources were being channeled to the higher level courses, at Loughborough the average annual cost per postgraduate on a meetings basis was £1147 and at Lanchester the cost per student enrolled on a sub degree course was £264.

The components of the average cost per student enrolled in 1972/73

TABLE III

Components of Cost per Enrolled Undergraduate in £'s

| | Lanchester | (%) | Loughborough | (%) |
|---|---|---|---|---|
| Academic Staff | 519 | 78 | 273 | 68 |
| Administrative Staff | 16 | 2 | 26 | 7 |
| Technician Staff | 85 | 13 | 67 | 17 |
| Recurrent Expenditure | 47 | 7 | 33 | 8 |
| Total | 667 | 100 | 399 | 100 |

TABLE IV

Cost per "Successful"* Undergraduate in £'s

| Year of Study | 1 | 2 | 3 |
|---|---|---|---|
| *Engineering and Technology* | | | |
| 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 the given year.

are presented in Table III. 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.

Table IV provides details of the cost per "successful" undergraduate in each year of the three year cycle by discipline area. Given a somewhat higher attrition rate at Lanchester the economic advantage of Loughborough is widened at this stage of costing. On the other hand the Lanchester students started from a lower pre-entry (A-level) score on average and the learning gain there may be higher.

## Summary

The question of what is the cost per student does not admit of a single answer. Therefore it is prudent to summarise the context in which the unit costs above 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 thus avoided. Secondly it was argued that the timetable reflects the "weights" the institution is implicitly assigning to its courses and that "allocated meetings" are a fair basis for the assignment of inputs to courses and to students. Thirdly, it was assumed that polytechnics and universities are solely teaching establishments. If it is accepted that higher education institutions have functions other than teaching, the trade-offs between teaching and these other roles need to be examined. If the mix of teaching to non-teaching activities is roughly equivalent across institutions then student cost comparisons as outlined above provide a reasonable guide to relative effectiveness. On the other hand, if the involvement in non-teaching varies significantly from institution to institution then 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.

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APPENDIX 2.10

"PERFORMANCE INDICATORS IN HIGHER EDUCATION:
A COMPARATIVE STUDY"

by BIRCH, D.W. and CALVERT, J.R.

in EDUCATIONAL ADMINISTRATION, 5, 2, SPRING 1976

Derek W Birch and
John R Calvert,
Department of
Management Studies,
Loughborough University

# PERFORMANCE INDICATORS IN HIGHER EDUCATION: A COMPARATIVE STUDY

## Introduction

This note reports some of the findings of an investigation sponsored by the Institutional Management in Higher Education Programme of OECD and financed by the Department of Education and Science. The purpose of the study was to examine the potential for performance indicators for the teaching function in higher education. In addition to their teaching roles institutions of higher education pursue research and scholarship and render public service and these latter activities contribute directly and indirectly to the teaching function. It is impossible precisely to unscramble the joint costs and products arising from these multi-missions. However, a consideration of research, scholarship and public service was outside the project's remit and for the purpose of this case study they are treated as residual activities. Furthermore the project was constrained to consider those aspects which could be "easily quantified" and for which information was "readily available".

The data base for the results set out below was formed from the undergraduate courses (except Art) at Lanchester Polytechnic and Loughborough University for the academic year 1972/73. In that year the total first degree population at Lanchester and Loughborough was very similar and the split between sandwich and full-time students in each institution was virtually identical. In both institutions over 90% of the undergraduates were reading for degrees in either engineering and technology, pure and applied science or social and business studies. Within these three broad discipline areas, however, the mix was different - engineering and technology (58%) was the dominant discipline at Loughborough whereas at Lanchester there was a more equal balance between engineering and technology (31%), social and business studies (37%), and pure and applied science (24%).

## The Framework for Institutional Performance Assessment

The case study 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 quality of an institution's outcomes with its objectives and, secondly, examining input-output (i.e. cost-benefit) relationships. If an institution's objectives are not in line with those that society has set for it, it may be internally effective and efficient and yet be ineffective and, hence, inefficient externally.

So the first 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 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.

The Department of Education and Science has ventured the following overall objectives for the teaching function in higher education:

> "To provide higher education for those who could benefit from it, and to meet the requirements of society for qualified manpower."
>
> (DES, 1970)

The first of these aims is at the level of a bromide and is beyond dispute. The second aim is more controversial but 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).

In the event the following objectives were agreed by the project's Steering Committee which was composed of a number of interests - academic and administrative - from within and without Lanchester and Loughborough:

> "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."

The form of words accords nicely with the "satisficing" phenomenon of Simon (1957). Nevertheless goals 1, 2 and 4 are capable of being defined as targets, i.e. 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 (i.e. knowledge and skills acquisition) rather than 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-course and post-course tests covering common syllabi would be required (Attiyeh and Lumsden, 1971 and 1972).

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 "outputs" or (perhaps more exactly) "outcomes" in education and we hope that over time the evidence collected by this sort of exercise will lead to an improved understanding of, and sensitivity to, the sophistication of the educational process.

Given that an institution of higher education exists in its teaching role to provide a set of learning opportunities and that students may choose to enrol or not, the first indication of success is provided by the numbers and quality of students actually enrolled. Subsequently the institution hopes to progress its students successfully through the system and ultimately to have its graduates 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 together with the collection of data on the initial employments of graduates is indicated. Inherent in the success rate criteria is the view that the institution may rely on teachers' "professionalism" for the maintenance of academic standards. To an extent this is ensured by the system of external assessors and examiners but some doubts have been cast on the comparability of degree standards in the UK even within the same subject groups (Nevin, 1972).

So much for society's response, now to the question of how the institution deployed its resources in providing the learning opportunities. Usually this input output relationship is summarised in the form of a unit cost but in the UK the popular approximation is the student staff ratio. This ratio is a function of a number of variables and decisions on these are largely within the province of the academic staff (Bottomley et al 1971; Delany 1971; Simpson et al 1971). These variables are significant in determining the costs of instruction and an examination of resource utilisation at the micro-level should take account of them. Depending on the complexity of the curriculum this may involve a detailed timetable analysis such as outlined in Exhibit 1.

**Exhibit 1**

**Timetable Parameters**

| | | | | | | |
|---|---|---|---|---|---|---|
| | Department | | X | | Y | |
| | Subject Elements | L | M | N | O | P |
| $\boxed{g}$ | No. of Groups Formed | 2 | 1 | 1 | 1 | 2 |
| $\boxed{h}$ | Students' Contact Hours | 20 | 15 | 30 | 20 | 20 |
| Course $\boxed{E}$ | = Enrolment | $\boxed{S}$ Enrolments to Subject Elements | | | | |
| A | 30 | 30 | 20 | 30 | 5 | |
| B | 20 | - | 5 | 20 | 20 | 20 |
| $\boxed{E*}$ | 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

Enrolment 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

Consider an institution with two departments X and Y with two courses A and B (Exhibit 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 reading a number of subject elements and attending a set of meetings with academic staff. These meetings may be compulsory or optional, involve just one course or be joint with other courses. 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 and h (Exhibit 1) is required. From these parameters a number of 'values' of significance in the students' formal learning environment may be derived (Exhibit 2).

**Exhibit 2**

**Timetable Parameters**

1 STUDENT'S TUITION LOAD = Hours of timetabled contact with faculty that the student on average received

$$= \sum \left[(h)(S)\right] / E$$

2 MEETINGS timetabled for a course

$$= \sum \left[(h)(g)\right] = \alpha$$

3 Summed over a department or discipline area or for the institution the statistic "Meetings" counts joint meetings (i.e. meetings involving two or more courses) several times. Therefore, where 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, i.e.:

ALLOCATED MEETINGS $= \sum \left[(h)(g)(S/E^*)\right] = \beta$

4 Hence MEETINGS "SAVED" $= \alpha - \beta$

5 STUDENTS' AVERAGE GROUP SIZE

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

N.B. In each case the summations are made over the relevant subsets.

See Note 1 at the end of the text for a precise definition of the formulae.

The economic implication of tuition loads, class sizes and the extent of joint meetings may be summarised in a unit cost. The unit costs used in the Lanchester Loughborough case were constructed by allocating direct departmental inputs (i.e. academic staff plus their technician, administrative and 'materials' support) to courses and thence to students on the basis of "allocated meetings". The arguments for an allocation on this basis have been rehearsed elsewhere (Birch, Calvert, Sizer, 1977) but the basic logic of the calculation is set out in Exhibit 3. (See Page 21 ).

## The Results

Table I (see Page 22 ) summarises the course parameters by discipline (see Birch, Calvert, Sizer, 1976 for a more detailed report). At this level of aggregation the pattern of pass and attrition rates, and the mean and the coefficient of variation of examination marks were remarkably similar overall and by discipline area across the two institutions. The significant differences in response lay in enrolments per course (higher at Lanchester except in engineering), the percentage without A level (higher at Lanchester except in social science and business studies), and average A level scores (overall just below 3 = 'C' at Loughborough and just above 2 = 'D' at Lanchester).

However the pattern of resource utilisation is quite different across the two institutions. Lower tuition loads (except social science and business studies), larger classes, a higher incidence of tuition from "service departments" (except science) and much larger savings in tuition demands through joint meetings were consistently observed at Loughborough. Of these differences the most striking was the incidence of meetings involving more than one course which was far higher in all disciplines at Loughborough. As a consequence undergraduate unit costs although reasonably close in social science and business studies were in engineering and science and overall significantly lower at Loughborough.

As suggested above, one indicator of society's response to the final outputs of an institution is the initial employments of graduates and their starting salaries. In 1972/73 this information was only available for 20% of the graduates at Lanchester and 50% of the graduates at Loughborough. From this sample it seemed that discipline area rather than institution was the more important determinant of initial salary and the correlation between starting salary and examination mark although positive in the majority of cases was by no means strong.

## Conclusions

In the present economic climate and in the absence of an accurate specification of cause and effect in education attention inevitably focuses on cost effectiveness. At a discipline level of aggregation the Lanchester-Loughborough

**Exhibit 3**

| | | | | | |
|---|---|---|---|---|---|
| | 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 | Total = 15 |

THE LOGIC OF A DEPARTMENT COST ALLOCATION ON A MEETINGS BASIS

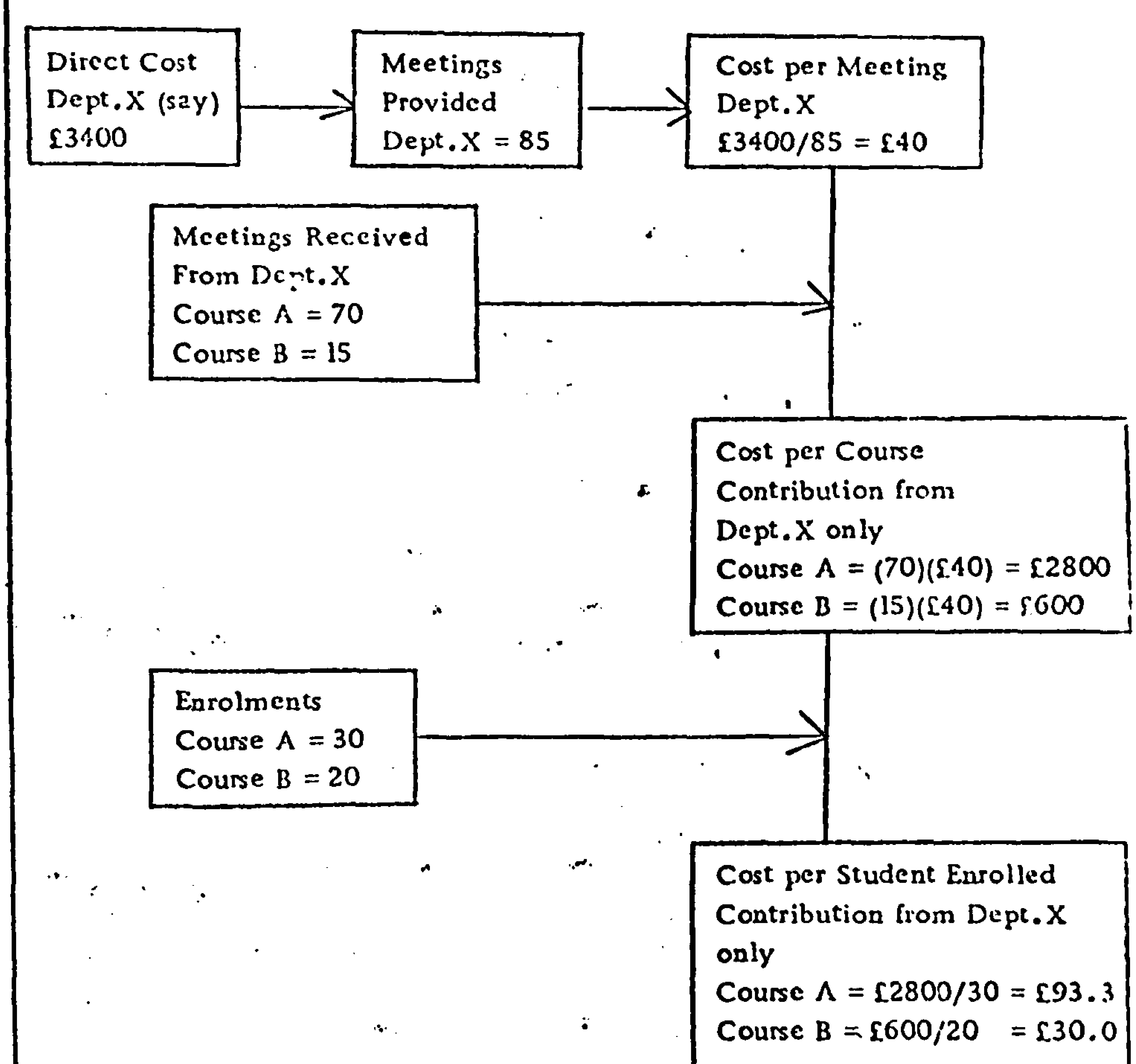

Table I

Summary of Course Parameters 1972/73

| | All Disciplines | | | Engineering | | Science | | Social Studies | |
|---|---|---|---|---|---|---|---|---|---|
| | BOTH | LAN | LOU | LAN | LOU | LAN | LOU | LAN | LOU |
| **"Response"** | | | | | | | | | |
| Average A-level Score (+) | 2.51 | 2.06 | 2.80 | 1.91 | 2.87 | 1.82 | 2.79 | 2.38 | 2.64 |
| Percentage without A-level | 20 | 27 | 15 | 42 | 22 | 25 | 5 | 12 | 16 |
| Enrolment per Course | 20 | 25 | 17 | 18 | 21 | 19 | 14 | 43 | 12 |
| Pass Rate Percentage | 87 | 86 | 88 | 85 | 87 | 85 | 87 | 90 | 89 |
| Fail Rate Percentage | 10 | 11 | 9 | 14 | 10 | 12 | 9 | 8 | 6 |
| 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 | 13 | 13 | 12 |
| **Resource Utilisation** | | | | | | | | | |
| 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 |
| Percentage Meetings "Saved" | 37 | 3 | 59 | 0 | 57 | 0 | 59 | 9 | 71 |
| Percentage Meetings "Serviced" | 31 | 28 | 32 | 24 | 30 | 36 | 21 | 29 | 46 |
| Total Direct Cost Per Student Enrolled £ | 635 | 939 | 441 | 1126 | 411 | 1150 | 486 | 445 | 399 |

(+) 'A' = 5; 'B' = 4; 'C' = 3; 'D' = 2; 'E' = 1 case apparently provides the sort of intelligence which central budget allocators avidly seek, viz: few differences apparently in response but quite different patterns of instruction leading to very different unit costs. Certainly the case for internal resource allocation based in part on past effectiveness and efficienc is not without support. There were examples in both institutions of "rogue-elephant" courses with outcome and resource utilisation patterns significantly different from the norms for their institutions and discipline. Had these divergencies been monitored they would have prompted "discerning questions". The answers might have helped the authorities to isolate and to support the genuine cases of development and diversity. However, 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) there will remain scope for the exercise of subjective judgements at the sharp end.

The cultural and social implications of the teaching strategies deployed were outside the scope of the Lanchester Loughborough exercise, but the relationship between average exit marks for each course and the relevant timetable parameters, unit costs and a proxy for student quality (A-level score for first year level courses and previous examination marks for second and third year levels) were tested. The results are set out in Table 11. (See Page 24 ) Entry marks were the most strongly correlated "explaining" about one third of the exit marks - a result which accords with the findings of Entwistle and Percy (1974). 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 advantage of large classes and joint meetings are matched by some educational disadvantages.

Further research is required firstly, to replicate the Lanchester Loughborough study in a variety of settings selected for their diversity and supposed similarity; and, secondly, to develop accurate and reliable measures of outcome initially of learning gain and ultimately of the value-added type. This second task is formidable and the chances are it will require efforts on the part of many investigators and will proceed only slowly. Meanwhile we shall continue to rely on existing examining arrangements and the comparability of degree standards. 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 proportional increase in costs, but the value-added to the extra students may be outweighed by the decline in value-added to the existing students. However, a move towards a more systematic collection and analysis of data on institutional outcomes and the processes of instruction is overdue. Regular reports at the course level on response and resource utilisation, if necessary defined to meet peculiar institutional characteristics, would facilitate internal "management by exception" and establish a data base and prompt the research from which a greater understanding of the educational process might be achieved.

**Table II**

**Some Correlations with Average Exit Mark Per Course**

| | All Disciplines | | | Engineering | | Science | | Social Studies | |
|---|---|---|---|---|---|---|---|---|---|
| | BOTH | LAN | LOU | LAN | LOU | LAN | LOU | LAN | LOU |
| Percentage without A-Level | 25* | 34* | 10 | 26 | 8 | 17 | 0 | 7 | 26 |
| Average entry mark | 57* | 63* | 51* | 59* | 52* | 63* | 59* | 68* | 17 |
| Student's Tuition Load | 15* | 12 | 5 | -22 | -24 | -22 | 39* | -10 | 22 |
| Student's Average Group Size | -23* | -32* | -11 | -47* | - 6 | -26 | -15 | 5 | -32 |
| Standard Deviation of Student's Group 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 |
| Total Direct Cost per Student Enrolled | 33* | 37* | 19* | 38* | 20 | 32 | 13 | -40 | 36 |

Note: * = Significant at 95% level - two tailed test

All the correlations have been multiplied by 100

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NOTE 1

In precise mathematical terms:

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

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 one teacher is $g_k$.

Hours per annum attended by a student involved in this set of meetings is $h_k$

Then for course-year (i, j)

STUDENT LOAD $= \sum_k \left((h_k)(S_{ijk})\right)/E_{ij}$

ALLOCATED MEETINGS $= \sum_k \left((h_k)(g_k)(S_{ijk}/E^*_k)\right)$

STUDENTS' AVERAGE GROUP SIZE

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

For the Institution

Institution's Average Group Size

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

$$= \frac{\sum_k h_k E^*_k}{\sum_k h_k g_k}$$

APPENDIX 2.11.

"TRACING THE EFFICIENT FRONTIER IN BRITISH UNIVERSITIES"

by CALVERT, J.R, and BIRCH, D.W.

DEPARTMENT OF MANAGEMENT STUDIES, LOUGHBOROUGH

UNIVERSITY OF TECHNOLOGY, 1978

# TRACING THE EFFICIENT FRONTIER
# IN BRITISH UNIVERSITIES

John Calvert, Lecturer in Management Science
Derek Birch, Senior Lecturer in Financial Management

Department of Management Studies
University of Technology
Loughborough, Leics.

1978

# TRACING THE EFFICIENT FRONTIER IN BRITISH UNIVERSITIES

John Calvert
Derek Birch

Loughborough University

## ABSTRACT

This paper considers the feasibility of finding an overall measure of efficiency for institutions in higher education given that they are 'consumers' of staff time, materials and money, and 'producers' of graduates, postgraduates and research. It does this by identifying a group of 'technically more efficient' institutions which are used as benchmarks for the rest. For illustrative purposes the approach is applied to UK Universities in the years 1972-3 and 1973-4.

TABLE OF CONTENTS

## 1 - OECD/CERI/IMHE PROJECT

From 1 August 1973 to 1 December 1975 J. R. Calvert and D. W. Birch, with others, were engaged on a D.E.S.-financed and OECD/CERI/IMHE-approved study to develop performance indices for the teaching function in higher education, in the UK, by means of a detailed study of Loughborough University and Lanchester Polytechnic. The Steering Committee included Polytechnic and University Administrators and a representative of the D.E.S. The main results of the study were the identification of various measures of input and output and the idea of a performance profile rather than a single measure of performance.

## 2 - OBJECTIVES OF THE RESEARCH AND THE PROBLEM IT CONSIDERS

At various points members of the OECD/CERI/IMHE Project Steering Committee and outside commentators raised the question of the possibility of constructing an overall efficiency rating for an institution or department. This is the problem that the research sets out to examine.

Its objectives are two-fold. Firstly, using fairly crude measures of input and putput, the aim is to develop an interpret a model capable of mapping technical efficiency in the use of inputs and production of outputs in higher education across and within institutions.

Secondly, the aim is to derive more realistic measures of input and output to which the model could be applied so as to indicate in which directions institutions or departments should move if they wish to attain a more "technically efficient" position.

During the OECD/CERI/IMHE project a considerable database for the two institutions was established and this database, although now outdated, would constitute a viable "test-base" for any within institutional measures of performance which the proposed project would throw up.

## 3 - CONCEPTUAL FRAMEWORK

### 3.1. Activities of an Educational Institution

Most educational systems have a number of objectives which not infrequently are inconsistent. 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", and so on. It is difficult to disagree with any common understanding of such bromides and equally difficult to deploy them usefully in a management context. The more detailed the list of 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 programmes for higher education - instruction (or the transmission of knowledge) ... and research (or the acquisition of knowledge).

Now Figure 1 outlines the components of the teaching function and illustrates that since education has a lifelong impact the choice of inputs and outputs depends on which part of the system is examined. If one considers the allocation of funds to provide teaching opportunities then the output is the places provided. But if the system is taken to include the provision of graduates then the output includes the number and quality of graduates.

## Components of the Teaching System

FIGURE 1

**OBJECTIVES**
Educational
Economic
Cultural
Social
Political

**INPUTS**

(i) Students: knowledge, skills, aptitudes, attitudes, expectations at entry: socio/economic background.

(ii) Staff: Academic, pedagogical, administrative technical, managerial competence and experience Expectations:

(iii) Physical Facilities: - space, equipment: - learning, teaching, cultural, recreational

**PROCESSES**

(i) The Curriculum/Learning Environment:
The pattern of formalised "meetings", teaching and tuition loads pedagogical strategies and tactics - e.g from traditional mix of staff supervised lectures, tutorials and labs at one end of spectrum to student orientated programmed learning and resource centre based environment at the other

(ii) The Assessment/Licensing mechanisms/criteria: assignments, tests, exams etc.

(iii) The "Organisation": Management structure + process, "style", + "ethos", etc.

**OUTCOMES/OUTPUTS**

(i) Immediate:
Provision of learning opportunities. "Places" on an organised curriculum. Response=applications → Enrolments

(ii) Short Term: Graduates
Students: knowledge, skills, aptitudes, attitudes, expectations at exit:

(iii) Longer Term:
Impacts on GNP/Life time Earnings: Cultural and Social dimensions.

## 3.2. Crude Measures of Input and Output

### 3.2.1. Teaching Outputs

There are at least two schools of thought on how to conceptualise the outcomes of the teaching function: firstly, the changes in students' characteristics associated with various institutional input and process variables; and secondly, the characteristics of the learning opportunities made available. The changes wrought in students' skills, knowledge, attitudes and values between entry to, and exit from, university reflect their learning functions and are only indirectly related to the institution's production function. The outcomes attributable to the institution (and the institution alone) are the magnitude and quality of the services made available. Initially it is assumed that student enrolments on undergraduate and postgraduate programmes are an adequate proxy for the magnitude of teaching services made available. This assumes that the 'quality' of the places provided on an organised curriculum both within and across institutions is comparable.

### 3.2.2. Research Outputs

The measurement of research output is immensely difficult. Various processes have been suggested - a weighted sum of the publications produced, the level of research funds attracted or the quality weighted hours spent on personal research (Cartter (1965), Layard and Verry (1973)). Initially expenditures from research grants is the chosen proxy. Of course, this is essentially an input measure and its use can only be justified as an attempt to obtain a more realistic mapping of the teaching outcomes.

### 3.2.3. Inputs

The measurement of inputs is not quite so difficult but still causes problems. One can count academic staff or total their salaries, but it is infinitely more difficult to bring in a quality measure. Similarly, one can count money spent on equipment etc., but not easily establish the input that equipment has into the teaching or research activity. Initially the project would use money values for inputs but also incorporate the number of academic staff in case some institutions have the "right" number of staff but at the "wrong" salary levels or vice versa.

## 3.3. Input/Output Profile and its Geometrical Interpretation

An educational institution has many inputs and outputs so unless these are converted to monetary 'equivalents' as in a cost-benefit analysis or weighted together as in a utility approach, the institution or department can only be described by an input/output profile.

However, if we think of the input/output profile as a vector it defines a point in multi-dimensional space and so one can consider any collection of institutions or departments as a collection of points. This collection of points will have a boundary and intuitively some of the boundary institutions will be more efficient than some not on the boundary.

### 3.4. Concepts of Efficiency

The theory of the firm in neoclassical economics assumes the existence of a production function which defines the relationship between inputs and outputs. Consider an industry where two factors of production are employed to produce a single output under conditions of constant returns to scale. Firms operating in this industry can be plotted on a graph (*Figure* 2) against their unit-output values.

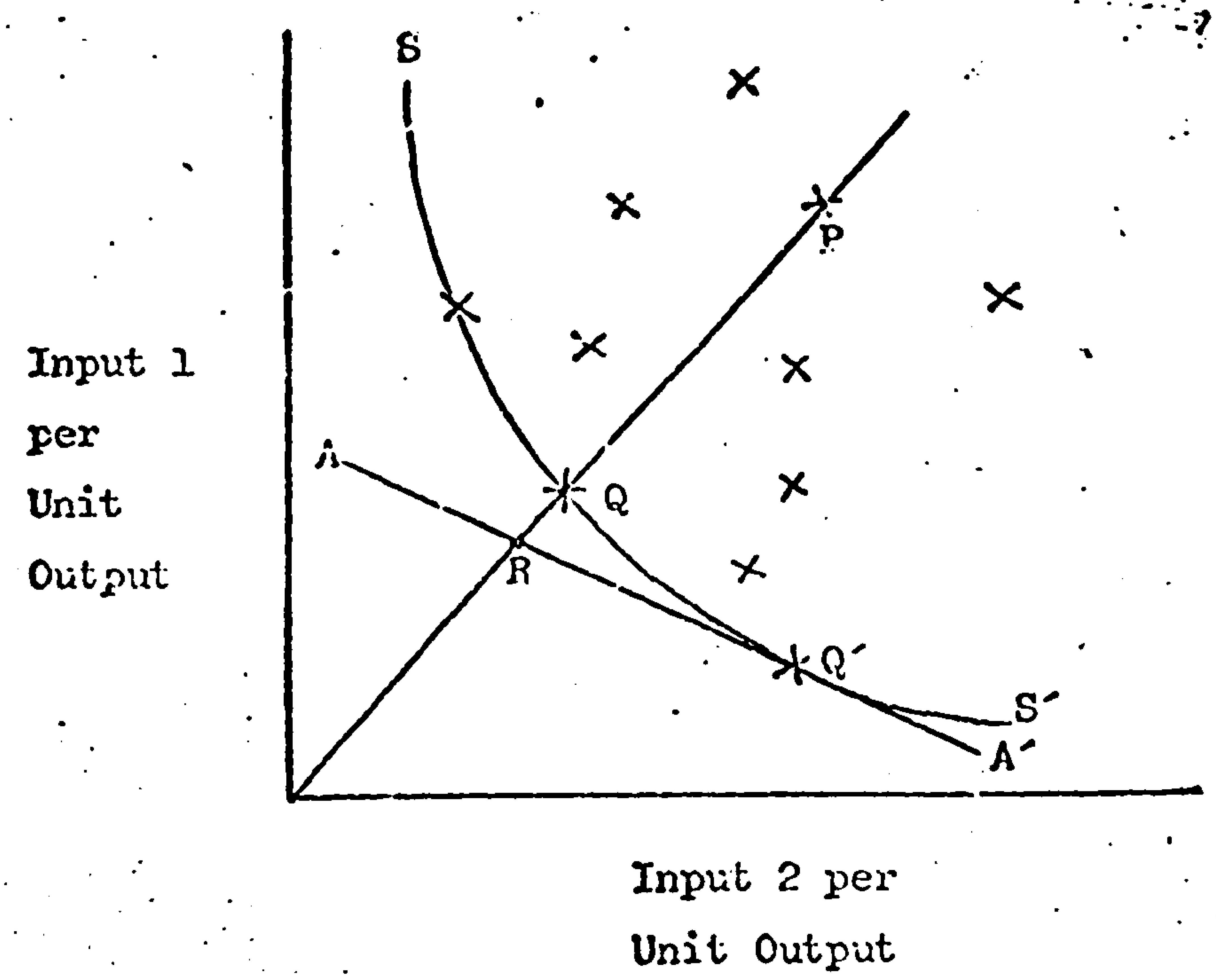



Figure 2

Farrell (1957) has used this diagram to measure and distinguish between a firm's *technical* efficiency and its *price* efficiency. SS´ is the envelope of the observations for all firms. No firm is able to produce a unit of output with an input ratio to the South-West of SS´, ie: SS´ represents the production frontier. Consider firm P. Point Q represents a (perhaps hypothetical) firm which is more efficient than P although using the same ratio of inputs. If the straight line AA´ tangential to SS´ at Q´ is the iso-cost line based on the input-price ratio then firm Q´ is less costly than Q and, therefore, point R represents a less costly situation than Q (and hence of P) but with the same input ratio. Therefore:

$\frac{OQ}{OP}$ represents the technical efficiency of P;

$\frac{OR}{OQ}$ represents the price efficiency of Q; and

$\frac{OR}{OP}$ represents the overall efficiency of P.

In the rest of this submission we are concerned solely with "technical efficiency". Indeed, if we compare two or more firms with the same input mix they have the same "price efficiency". (Note 1)

In Educational Management the price or value of many of the inputs and outputs is not readily available and so the idea of comparing an institution with a hypothetical one with the same mix of inputs but different levels of output has some attractions. It delays the attachment of weights or subjective values to inputs or outputs until the actual comparison is made and means that the analysis for the most part is not carried out in "funny money" but in actual numbers of students or pounds sterling spent, and so on.

### 3.5. The Production Frontier (Is it near the boundary or near the average?)

Intuitively if there is a true production frontier relating the efficient use of inputs to produce outputs then given a set of points some of the boundary points should be nearer to it than any of the non-boundary points, and hence it would seem that the best estimate of the production frontier is one based on part of the boundary of the set of points.

However, as Timmer (1971) has pointed out, since only extreme observations would be used to estimate the frontier the estimation is highly subject to errors in the data. If one assumes that some of the extreme points are random outliers and not truly efficient then the 'true' frontier runs through the set and so he suggests that one can either reject some of these outliers and look for a stable frontier or use the set as a whole and fit to the average. However, he comments that the frontier based on the boundary points of the observed set may not be a neutral transformation of the frontier based on an average so one has to make a choice one way or the other. He randomly deletes extreme points and looks at the changes in the frontier estimates. On the other hand Levin (1974) does a comparison of average and boundary estimates, but to do this he has to assume a shape for the fitted function (Cobb Douglas type). He still found great differences between the two methods.

In conclusion, the choice seems simple - either one specifies a function for the production frontier and then fits it to all the data, or one estimates the frontier by finding the boundary points of the observed set. The research uses the latter since it is very difficult to specify a function for the production frontier in a multi-input/multi-output situation. The simplest form of such a function would be an input/output matrix.

## 4 - ESTIMATING THE PRODUCTION FRONTIER FROM OBSERVED DATA

### 4.1. Mathematical Procedure

We can estimate the production frontier as a series of line segments from observed data if we assume that the frontier is convex (i.e. if two points are attainable in practice a point representing a weighted average of the two is also obtainable in practice). This is because the set of observations then makes up a convex set and then each observation can be written as a linear combination of some of the boundary points. Any line segment joining two observations is defined by linear combinations of the two points.

However, the points which are used to estimate the frontier are not simply on the boundary, they must be more "efficient" than the others. So when looking at inputs a line segment should be nearer the origin than other points and when looking at outputs it should lie further away than other points. The method of finding the frontier points is, therefore, to find the line segments which lie to the right side of every point with respect to the origin. In the two input one output case with constant returns this is straightforward using a graphical approach (Note 2). However, in the multi-input multi-output case the concept of 'nearer to the origin' is more difficult to pin down. However, Carlson has suggested one approach as outlined in the next section.

## .2. A Linear Programming Approach

There are several methods available for identifying frontier observations but the most general and least sensitive to prior specification of the form of the production function is the linear programming techniques. The LP approach was originally suggested by Farrell (1957, *op.cit.*) and later deployed in the measurement of educational production by Carlson (1972, 1975) and Levin (1974). Briefly, the approach requires the identification of the input and output variables of all the institutions in the population where all the institutions are judged to have comparable quality outcomes (or where one or more measures of quality are explicitly included as characteristic variables). LP is then used to maximise one output, subject to satisfying other output and input constraints. The result of this is a production efficiency index that will be 1.0 for all institutions on the frontier and less than 1.0 for all other institutions for that output.

Consider the boundary and a point $P_k$. If $P_k$ is not on the boundary we can move from $P_k$ in the direction of increasing output 1 or output 2 until we reach a boundary point which will be a linear combination of the frontier points (*Figures 3 and 4*).

Figure 3

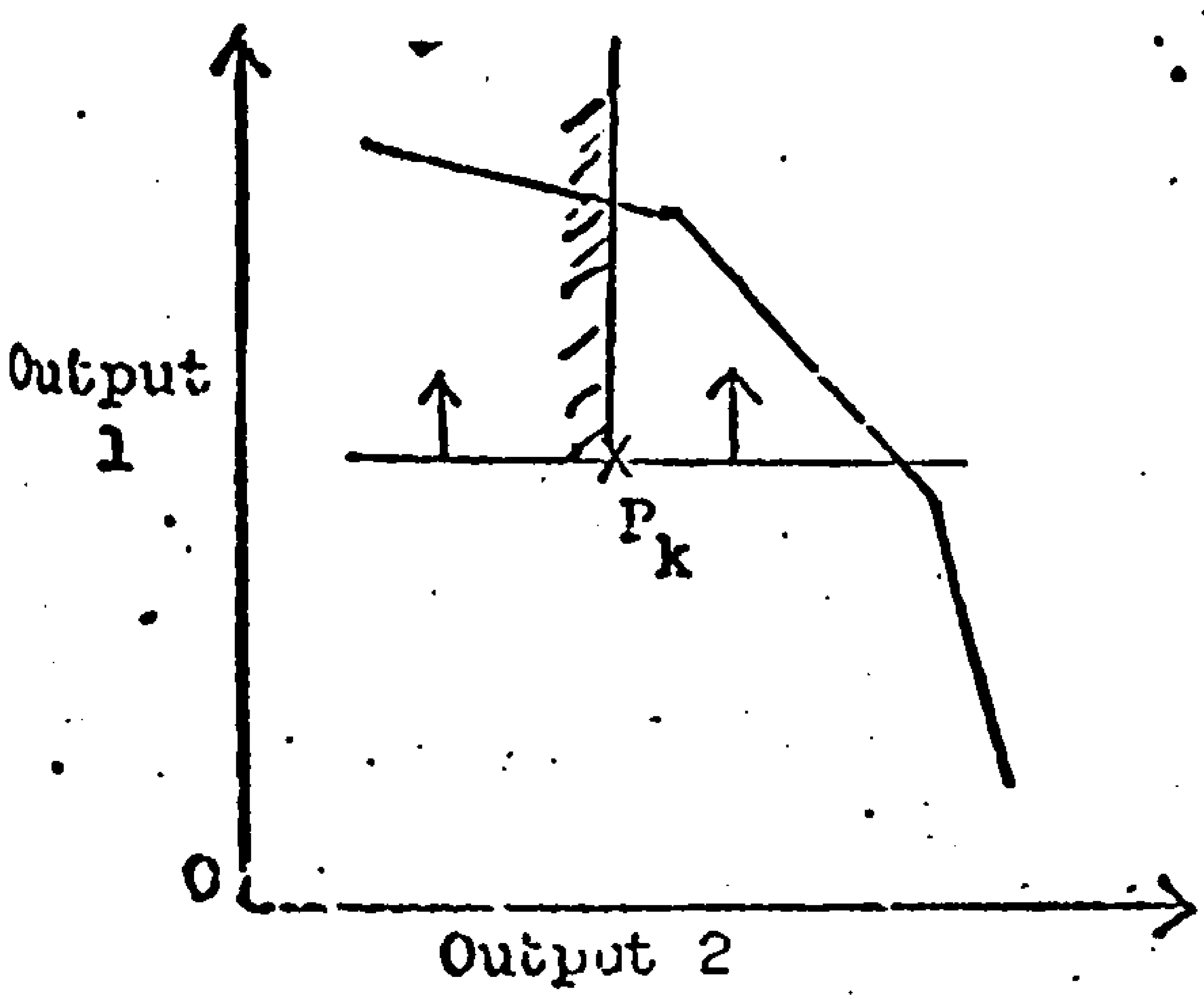
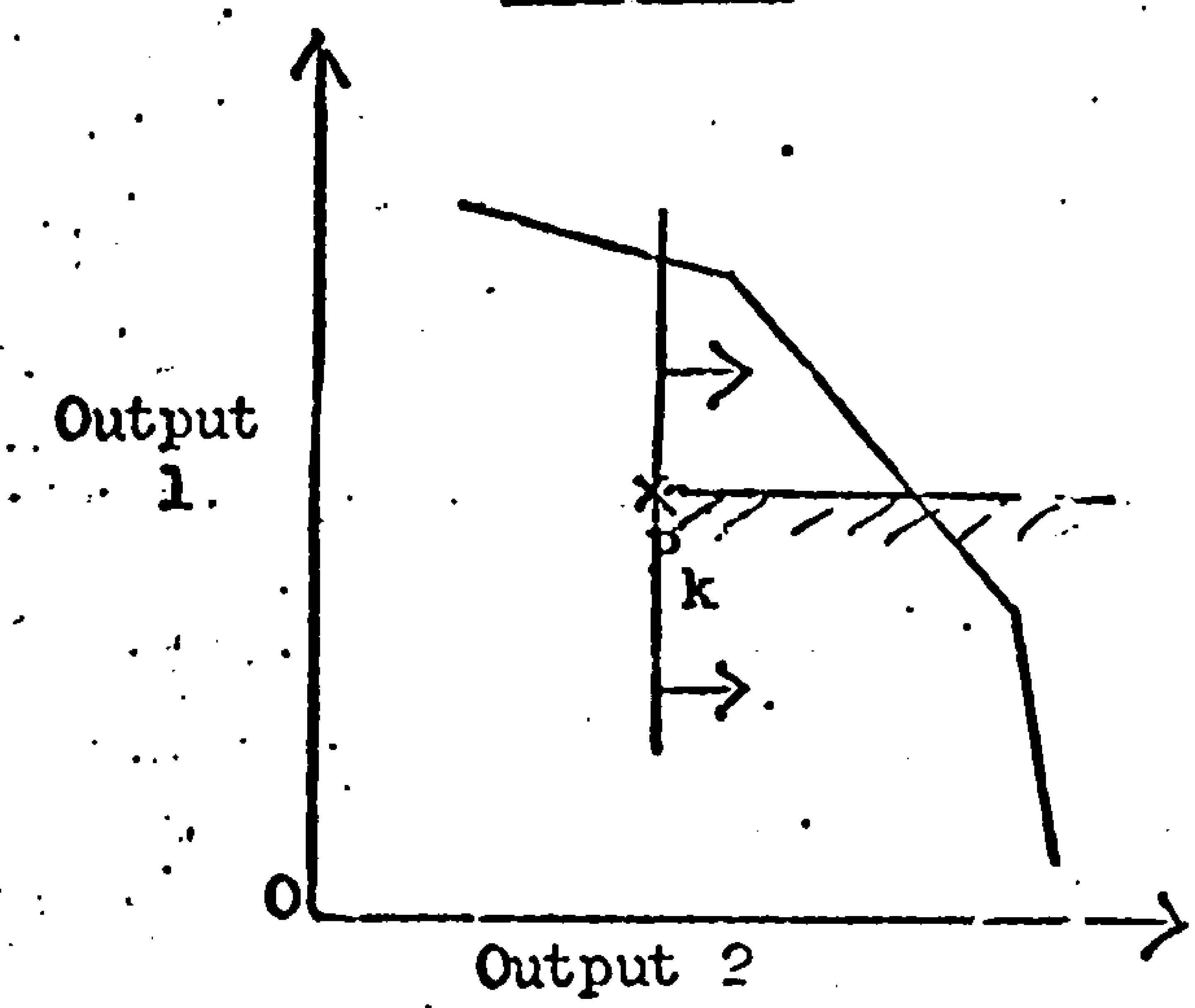



Figure 4




Thus, if we select a point in the set and one of the outputs we can find the boundary in one direction and at the same time identify some of the frontier points. To accomplish this for institution S and output r we formulate a linear programming problem as follows:

If $X_{it}$ = the quantity of the ith resource used by institution t,

and $Y_{jt}$ = the quantity of the jth output produced by institution t,

then the point on the frontier in the direction (starting from institution s) of increasing output r is given by $z_1, \ldots\ldots, z_t$

where we:

$$\max \sum_{t=1}^{T} z_t \, Y_{rt}$$

$$\text{subject to} \quad \sum_{t=1}^{T} z_t \, X_{it} \leqslant X_{is} \quad i = 1, \ldots\ldots N$$

$$\sum_{t=1}^{T} z_t \, Y_{jt} \geqslant Y_{js} \quad j = 1, \ldots . r-1, r+1, \ldots . m$$

$$z_t \geqslant 0 \quad t = 1, \ldots . T$$

The optimal solution to this linear program will identify some of the frontier points, ie: the points with non-zero weights. Hence we can identify all the frontier institutions if we solve the linear program for every institution S for each of the outputs r. For any one output we can measure how near an institution is to the frontier by the ratio of its output to the value of the objective function at optimal, ie: "efficiency" in *one* direction (rth output) is given by $Y_{rs}/\sum z_t Y_{rt}$. This approach assumes a consistent slope of the frontier (either positive or negative) but does not insist on constant returns to scale (ie: does not include the origin in the set of points).

4.2.1. <u>An Illustration</u>

<u>Frontier Universities in the UK 1972/73 and 1973/74</u>

Information on the following variables for the academic years 1972/73 and 1973/74 was collected from DES published statistics for all the UK universities except the London Graduate School of Business, the Manchester Business School, the Welsh National School of Medicine and St. David's Lampeter:

Outputs 1 Undergraduate enrolment - full-time;

2 Undergraduate enrolment - full-time plus part-time;

3 Postgraduate enrolment - full-time;

4 Postgraduate enrolment - full-time plus part-time; and

5 Expenditure from research grants (a proxy for research involvement).

Inputs i Total full-time teaching and research staff paid directly from university funds;

ii Salaries of teaching and research staff;

iii Other departmental salaries and wages;

iv Departmental and laboratory expenditure; and

v Total expenditure.

The institutions identified as being on the frontier are listed in *Table 1*. The complete results of the analysis (ie: "efficiency" index equals 1.0 for frontier institutions and less than 1.0 for other institutions) for each of the outputs 1 to 5 is provided in *Appendices A and B*. By definition, if an institution is on the boundary in one direction it is on the boundary. The index produced is a measure of "efficiency" on that output programme given the need to satisfy all other output and input constraints.

Out of the total sample of 49 institutions 24 are identified as "efficient" in one or the other or both of the academic years examined. Sixteen universities/university colleges appear as boundary institutions in both years. The eight institutions listed as on the boundary in only one of the two years, achieve at least one high index on the five output programmes examined in the year in which they are not on the boundary. Hence, the "efficiency" ranking appears to be reasonably stable over time.

An examination of the equality constraints in the optimum solutions revealed "staff numbers" and "recurrent departmental and laboratory expenditure" as the critical constraining variables. It is on these variables that the majority of non-boundary institutions would have to operate if they wished to move towards the frontier. (*Note* 3)

Table 1

Frontier Universities 1972/73 and 1973/74

| | 1972/73 | 1973/74 |
|---|---|---|
| | 2 | - |
| | - | 3 |
| | 7 | 7 |
| | 11 | 11 |
| | 12 | 12 |
| | - | 14 |
| | 15 | 15 |
| | 16 | 16 |
| | 17 | - |
| | - | 18 |
| | 20 | 20 |
| | 23 | - |
| | 26 | 26 |
| | 32 | 32 |
| | 33 | 33 |
| | 34 | 34 |
| | 35 | 35 |
| | 36 | 36 |
| | 37 | 37 |
| | 38 | 38 |
| | 44 | 44 |
| | 45 | 45 |
| | 46 | - |
| | 48 | - |
| Boundary Institutions; | 21 | 19 |
| Total Sample; | 49 | |

## 4.3. Farrell's Formulation to Find Measures of Efficiency for Non-Frontier Points

Farrell (1957) suggests that the frontier should:

(a) observe constant returns to scale, and that

(b) nowhere has a positive slope (i.e. extra inputs always produce extra outputs, however small).

One way to ensure that the production frontier nowhere has a positive slope is to add points at infinity $(0, \infty)$, $(\infty, 0)$. The establishment of a line segment parallel to the axes can also be achieved using $(\max_1 \min_2)$ $(\min_1 \max_2)$ with easier computation in a one-output case. He does this so that the two input one output case can be generalised to a many input many output case as follows.

4.3.1. Two Inputs One Output.

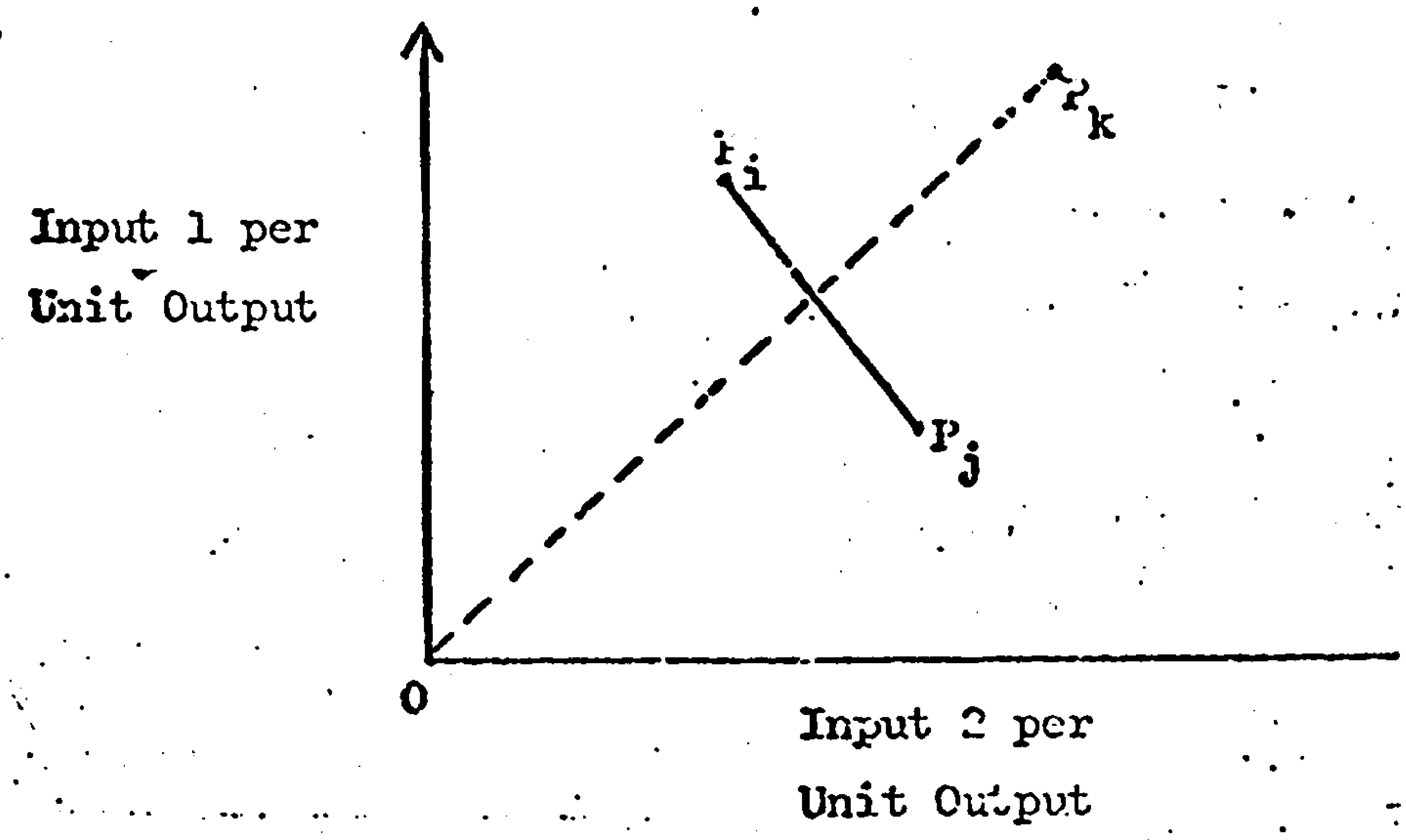



Figure 2

Consider points $P_i$ and $P_j$ which are adjacent frontier points, and point $P_k$ the firm under examination (*Figure 2*). The co-ordinates of $P_i$, $P_j$ and $P_k$ are $\underline{P}_i$, $\underline{P}_j$ and $\underline{P}_k$.

Let $\lambda_{ijk}$, $\mu_{ijk}$ be the solutions of:

$$\lambda\underline{P}_i + \mu\underline{P}_j = \underline{P}_k$$

Any point $P_l$ on the line through $P_i$ and $P_j$ has $\lambda_{ijl} + \mu_{ijl} = 1$. For any point $P_m$ for which $OP_m$ cuts $P_i$, $P_j$ internally $\lambda_{ijm}$ and $\mu_{ijm}$ are both positive. Hence if $P_i$, $P_j$ lies between $P_k$ and the origin, $\lambda_{ijk} + \mu_{ijk} \geqslant 1$ and $\lambda_{ijk}$ and $\mu_{ijk}$ are both positive. Therefore, the line joining $P_i$, $P_j$ is part of the frontier if, and only if, $\lambda_{ijk} + \mu_{ijk} \geqslant 1$ for all points in the set. Thus we can establish the production frontier as a set of linked points and the technical efficiency of any $P_k$ is equal to the maximum of $1/(\lambda_{ijk} + \mu_{ijk})$ for all frontier segments $P_i$, $P_j$. Since the frontier is assumed to be convex this maximum will be attained when $\lambda_{ijk}$ and $\mu_{ijk}$ are both positive. So we can compare a $P_k$ with that point where $OP_k$ cuts the frontier which although hypothetical is theoretically obtainable since it is a weighted average of two frontier points. It will have the same input ratio as $P_k$ but will be using fewer inputs to produce unit output. (*Note 4*)

### 4.3.2. Many Input Many Output Case



If we generalise to n inputs and m outputs but retain the assumption of constant returns each institution now has an input vector $\underline{X}$, and an output vector $\underline{Y}$, and can be represented as a point in m + n dimensional space (ie: $\underline{P}_i = (\underline{X}_i', \underline{Y}_i')$). The set of points is extended to include points at infinity as before. Since there are constant returns if $\underline{P}_i = (\underline{X}_i, \underline{Y}_i)$ is efficient then $(\frac{1}{2}\underline{X}_i, \frac{1}{2}\underline{Y}_i)$ must be efficient also and hence the origin must be added to the set as a frontier point. Instead of lines and line segments we now have hyperplanes and *facets*. A facet is the part of the hyperplane whose whose points can be represented as weighted averages with non-negative weights (except for the origin) of the m + n defining points. The frontier is now a surface in m + n dimensional space made up entirely of such facets.

To compare a point $P_k$ with a hypothetical point on the boundary we need to compare $P_k$ with a linear combination of (m + n) frontier points including the origin. Farrell suggests matching the inputs of $P_k$ and exceeding the outputs of $P_k$ by the same ratio for each output. This ratio represents the technical efficiency.

Thus, we have that if $\underline{\delta}$ is the solution of:

$$(\underline{Y}_i, \underline{Y}_{i+1}, \ldots \underline{Y}_{i+m+n-2}, \underline{0})\,\underline{\delta} = (\sum_{1} \delta_j)\,\underline{Y}_k$$

$$(\underline{X}_i, \underline{X}_{i+1}, \ldots \underline{X}_{i+m+n-2}, \underline{0})\,\underline{\delta} = \underline{X}_k$$

then the facet defined by $\underline{P}_i \ldots \underline{P}_{i+m+n-2}$ and $\underline{0}$ is part of the frontier if, and only if, $\sum \delta_1 \geqslant 1$ for all $\underline{P}_k$ in the set. The technical efficiency of $\underline{P}_k$ is (as before) the maximum of $1/\sum \delta_j$. Therefore an efficient institution can produce $\underline{Y}_k$ outputs from $1/\sum \delta_j \underline{X}_k$ inputs (ie: less inputs than $\underline{P}_k$) and, given constant returns to scale, $\sum \delta_j \underline{Y}_k$ outputs from $\underline{X}_k$ inputs (ie: more outputs

## 5 - USING THE ESTIMATED FRONTIER

### 5.1 Moving Along the Frontier

Using the approach outlined above and illustrated on a small example it seems possible to split a set of institutions into frontier and non-frontier institutions. However, an institution "on the frontier" is there because no other is "nearer" the true frontier but that may be because the institution is very economical in its use of one or two inputs for example, and not necessarily because it is economical across a majority of inputs and outputs.

This means that a frontier institution may wish to move along the frontier to get a different output and input mix. If one attaches relative values or weights to the inputs or outputs this can easily be done (Goal Programming, for example). Otherwise one has to compare an institution with 'adjacent' ones and compare differences. Further researchwill, it is hoped, provide a mechanism for finding 'adjacent' institutions and also indicate why certain institutions are on the frontier.

### 5.2 Moving Towards the Frontier

Institutions that are not on the frontier, if they wished, could move towards it in several ways. They could become more efficient in the Farrell sense by producing the same output mix with less inputs, or use the same input mix to produce more outputs. Alternatively, they could move towards a frontier point representing different inputs and output mix. Again, if one attaches relative weights to the inputs and outputs this is easily done. Otherwise one has to proceed towards the frontier with the same input mix or the same output mix or by heading for the nearest part of the frontier. Further research, it is hoped, will provide a mechanism for doing this simply.

## 6. Further Work

Once the approach has been thoroughly tested on the sample set of crude measures of input and output of institutions it is hoped to carry out the following activities.

### 6.1. Test the Validity of Partitioning the Sample

From the sample data, albeit crude, it is obvious that certain institutions are in a class of their own and hence end up on the frontier because there is no other to compare them with (e.g. London). This leads one to the idea that the sample could be split into redbrick ex-cat. etc., and frontiers found for each sub-set to see what differences there are between these and the total frontier.

### 6.2. Test the Stability of the Frontier

Timmer (1971 ) has suggested that since the estimated frontier is calculated from extreme observations only it is vulnerable to errors in the data. He suggests that some of the frontier points should be discarded and the frontier recalculated until the stability is achieved. Hence, if it is possible to identify institutions that are only 'just on the frontier' the sample set will be reduced and the frontier examined for stability. It is hoped that the research will provide a technique for carrying this out easily.

### 6.3. Look for Better Measures of Input and Output at the Institutional level

It is obvious from the example that some of the proxy measures are inadequate but it is also semi-evident that the seeming contradictions in the choice of frontier institutions indicate what is wrong with some of the measures. In any event, part of the project time will be spent on examining the measures available and hopefully considering new ones.

(For example, the average class size experienced by a student [OECD/CERI study referred to earlier] as a measure of teaching environment provided.)

## 6.4. Test the Approach within the Institution

Quite often in education the provision of funds and sometimes the level of student applications are outside the control of the institution and the problems arise in the allocation of resources within the institution. There is a need, therefore, to examine the possibility of utilising the approach outlined above within an institution, say at departmental level. The research, therefore, will incorporate an analysis, based on the Loughborough Lanchester data base of within institutional efficiency which will identify frontier departments, indicate how to move along the frontier or towards it as well as identify its stability.

## 6.5. Identify Useful Measures of Input and Output within the Institution

In the same way that the research will involve examination of better measures at the institutional level, it is hoped that the analysis will indicate which measures at the departmental level are most inadequate. The research will, therefore, include an examination of possibly better measures of input or output at the departmental level with a view to incorporating them in the approach being utilised.

## 7. USE OF THE RESULTS

Truehart and Weathersby (1977) have tried a similar approach on black colleges in the USA but only in a one output situation. This, of course, lends itself to applying regression analysis to the frontier institutions to fit a specified production function. However, in our case, where there are many inputs and many outputs, the establishment of the production function as anything more than an empirically found set of defining points must await further research, more recent data, and preferably better measures of input and output than those used for the initial study. (The simplest form of production function for the multi-input/multi-output case is the input/output matrix).

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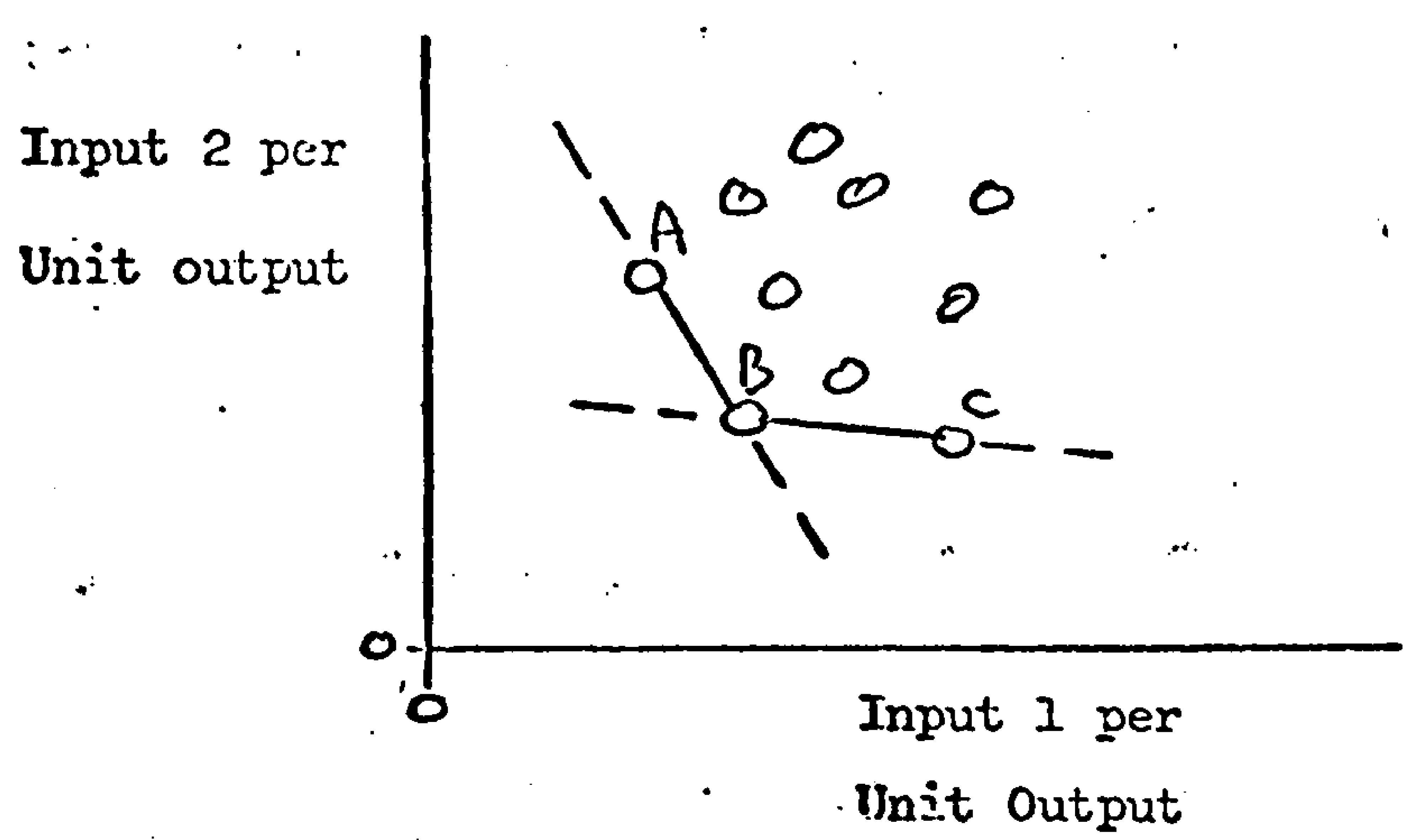
## NOTES

### Note 1

There is one other concept of efficiency from the neoclassical theory of the firm - "preference efficiency" - which describes the utility maximising mix of multiple outputs. Leibenstein (1976) suggests a fourth type of efficiency - "X-efficiency" - which describes managerial ability and willingness to enable organisations to accomplish their objectives.

### Note 2

Consider the two input one output case. If there is constant returns we can compare inputs per unit output and plot each institution or department as a point in two-dimensional space, as follows:




Points A, B and C obviously define two line segments that lie between the rest of the points and the origin and hence are more technically efficient than many of the other members of the set of points.

Note 3

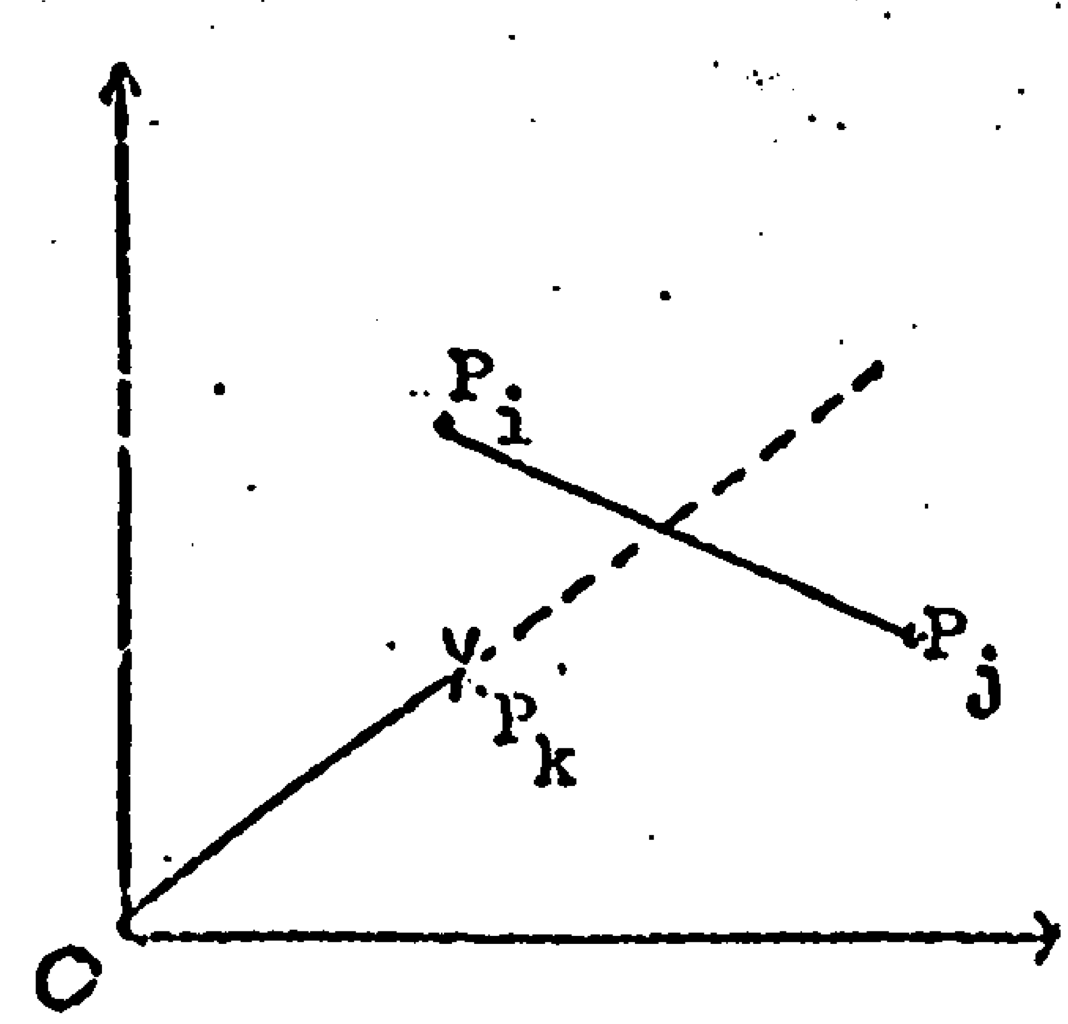
In brief the procedure involves:

1. For each university, trying to identify a hypothetical institution which produces equal or more outputs with less than or equal inputs.
2. This hypothetical institution will be a linear combination of several frontier institutions (or a proportion of one frontier institution).
3. In the optimum solution to the LP some constraints will be equalities.
4. It is on these equality constraints that the university under examination would have to operate if it wished to move towards the hypothetical boundary institution since if the inequality constraints are altered the basic solution is unaltered and the index of "efficiency" is unaltered.

Note 4

We can adapt the same approach to two outputs and one input. The assumptions now are that the production frontier is concave to the origin and nowhere has a positive slope. So to close the boundary we need to extend the set to include $(max_1,0)(0, max_2)$ or simply $(max_1\ min_2)(min_1\ max_2)$ as before.

Output 1 per Unit input




Output 2 per Unit input

Let $\lambda^*_{ijk}$, $\mu^*_{ijk}$ be the solutions of $\underline{\lambda}^*_{ijk} \underline{P}_i + \underline{\mu}^*_{ijk} \underline{P}_j = P_k$.
Any point on the line through $P_i$ and $P_j$ has $\lambda^*_{ijk} + \mu^*_{ijk} = 1$.
Hence if $P_k$ lies between the origin and the segment $P_i P_j$, $\lambda^*_{ijk} + \mu^*_{ijk} \leqslant 1$ and if $OP_k$ cuts $P_i P_j$ internally $\lambda^*_{ijk}$, $\mu^*_{ijk}$ are both $\geqslant 0$. Therefore the line joining $P_i$ and $P_j$ is part of the frontier if, and only if, $\lambda^*_{ijk} + \mu^*_{ijk} \leqslant 1$ for all $P_k$ in the set and the technical efficiency of $P_k$ is the maximum of $\lambda^*_{ijk} + \mu^*_{ijk}$ for all segments of the boundary. The concavity of the boundary ensures that at the maximum $\lambda^*_{ijk}$ and $\mu^*_{ijk}$ are both positive.

## Appendix A

### Efficiency Ratings 1972/73

| | Output 1 | Output 2 | Output 3 | Output 4 | Output 5 |
|---|---|---|---|---|---|
| 1 | 0.86 | 0.86 | 0.81 | 0.85 | 0.24 |
| 2 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 3 | 0.80 | 0.80 | 0.93 | 0.97 | 0.89 |
| 4 | 0.79 | 0.79 | 0.60 | 0.74 | 0.33 |
| 5 | 0.76 | 0.75 | 0.56 | 0.57 | 0.53 |
| 6 | 0.91 | 0.91 | 0.54 | 0.94 | 0.37 |
| 7 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 8 | 0.66 | 0.65 | 0.41 | 0.65 | 0.26 |
| 9 | 0.94 | 0.94 | 0.82 | 0.89 | 0.39 |
| 10 | 0.97 | 0.97 | 0.69 | 0.72 | 0.55 |
| 11 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 12 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 13 | 0.91 | 0.91 | 0.75 | 0.78 | 0.39 |
| 14 | 0.89 | 0.89 | 0.71 | 0.88 | 0.51 |
| 15 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 16 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 17 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 18 | 0.99 | 0.99 | 0.95 | 0.98 | 0.56 |
| 19 | 0.78 | 0.78 | 0.64 | 0.69 | 0.55 |
| 20 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 21 | 0.92 | 0.90 | 0.57 | 0.72 | 0.66 |
| 22 | 0.67 | 0.67 | 0.68 | 0.75 | 0.40 |
| 23 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 24 | 0.75 | 0.75 | 0.58 | 0.58 | 0.63 |
| 25 | 0.93 | 0.93 | 0.74 | 0.95 | 0.67 |
| 26 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 27 | 0.83 | 0.83 | 0.86 | 0.90 | 0.45 |
| 28 | 0.75 | 0.75 | 0.52 | 0.76 | 0.26 |
| 29 | 0.74 | 0.74 | 0.68 | 0.70 | 0.36 |
| 30 | 0.85 | 0.85 | 0.83 | 0.83 | 0.85 |
| 31 | 0.80 | 0.79 | 0.56 | 0.71 | 0.38 |
| 32 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 33 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 34 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 35 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*Appendix A continued*

| | Output 1 | Output 2 | Output 3 | Output 4 | Output 5 |
|---|---|---|---|---|---|
| 36 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 37 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 38 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 39 | 0.83 | 0.85 | 0.63 | 0.63 | 0.31 |
| 40 | 0.80 | 0.79 | 0.36 | 0.37 | 0.27 |
| 41 | 0.73 | 0.72 | 0.48 | 0.52 | 0.46 |
| 42 | 0.86 | 0.86 | 0.59 | 0.74 | 0.82 |
| 43 | 0.74 | 0.75 | 0.34 | 0.47 | 0.48 |
| 44 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 45 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 46 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 47 | 0.86 | 0.86 | 0.65 | 0.78 | 0.56 |
| 48 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 49 | 0.85 | 0.87 | 0.38 | 0.37 | 0.13 |

## Appendix B

## Efficiency Ratings 1973/74

| | Output 1 | Output 2 | Output 3 | Output 4 | Output 5 |
|---|---|---|---|---|---|
| 1 | 0.86 | 0.86 | 0.77 | 0.82 | 0.23 |
| 2 | 0.96 | 0.95 | 0.83 | 0.91 | 0.44 |
| 3 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 4 | 0.78 | 0.78 | 0.61 | 0.74 | 0.38 |
| 5 | 0.76 | 0.76 | 0.55 | 0.54 | 0.59 |
| 6 | 0.90 | 0.90 | 0.59 | 0.95 | 0.40 |
| 7 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 8 | 0.66 | 0.66 | 0.40 | 0.60 | 0.28 |
| 9 | 0.91 | 0.91 | 0.86 | 0.86 | 0.42 |
| 10 | 0.94 | 0.94 | 0.74 | 0.72 | 0.45 |
| 11 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 12 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 13 | 0.86 | 0.86 | 0.65 | 0.65 | 0.25 |
| 14 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 15 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 16 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 17 | 0.91 | 0.91 | 0.93 | 0.95 | 0.43 |
| 18 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 19 | 0.73 | 0.73 | 0.64 | 0.67 | 0.49 |
| 20 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 21 | 0.89 | 0.89 | 0.72 | 0.78 | 0.61 |
| 22 | 0.74 | 0.73 | 0.75 | 0.77 | 0.46 |
| 23 | 0.56 | 0.56 | 0.83 | 0.81 | 0.40 |
| 24 | 0.76 | 0.78 | 0.64 | 0.62 | 0.61 |
| 25 | 0.92 | 0.92 | 0.79 | 0.90 | 0.64 |
| 26 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 27 | 0.85 | 0.85 | 0.87 | 0.83 | 0.50 |
| 28 | 0.76 | 0.76 | 0.48 | 0.66 | 0.31 |
| 29 | 0.74 | 0.74 | 0.64 | 0.65 | 0.42 |
| 30 | 0.87 | 0.87 | 0.77 | 0.76 | 0.88 |
| 31 | 0.80 | 0.81 | 0.60 | 0.73 | 0.47 |
| 32 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 33 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 34 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 35 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

*Appendix B continued*

| | Output 1 | Output 2 | Output 3 | Output 4 | Output 5 |
|---|---|---|---|---|---|
| 36 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 37 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 38 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 39 | 0.79 | 0.81 | 0.50 | 0.93 | 0.35 |
| 40 | 0.73 | 0.73 | 0.35 | 0.33 | 0.24 |
| 41 | 0.74 | 0.73 | 0.47 | 0.49 | 0.49 |
| 42 | 0.96 | 0.96 | 0.60 | 0.78 | 0.96 |
| 43 | 0.75 | 0.77 | 0.31 | 0.43 | 0.57 |
| 44 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 45 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 46 | 0.93 | 0.94 | 0.45 | 0.50 | 0.45 |
| 47 | 0.88 | 0.88 | 0.72 | 0.85 | 0.57 |
| 48 | 0.94 | 0.96 | 0.68 | 0.82 | 0.54 |
| 49 | 0.82 | 0.83 | 0.43 | 0.52 | 0.16 |

APPENDIX 2.12.

"ASSESSING INSTITUTIONAL PERFORMANCE: THE EFFICIENT FRONTIER"

by CALVERT, J.R.

in PROCEEDINGS OF THE FOURTH GENERAL CONFERENCE OF THE OECD/CERI/IMHE PROGRAMME, OECD, PARIS, SEPTEMBER 1978

ORGANISATION FOR ECONOMIC
CO-OPERATION AND DEVELOPMENT

CENTRE FOR EDUCATIONAL
RESEARCH AND INNOVATION

PROGRAMME ON INSTITUTIONAL MANAGEMENT IN
HIGHER EDUCATION

Fourth General Conference of Member Institutions

MANAGING UNIVERSITIES IN THE 1980's

(Paris 11-13 September 1978)

WORKSHOP PAPER

"Assessing Institutional Performance: The Efficient Frontier"

John Calvert
Lecturer in Management Science
Department of Management Studies
University of Technology
Loughborough

# ASSESSING INSTITUTIONAL PERFORMANCE: THE EFFICIENT FRONTIER

John Calvert

Lecturer in Management Science
Department of Management Studies
University of Technology
Loughborough

ABSTRACT

The paper considers the feasibility of finding an overall measure of efficiency for institutions in higher education given that they are "consumers" of staff time, materials and money, and "producers" of graduates, postgraduates and research. It does this by identifying a group of "technically more efficient" institutions which are used as benchmarks for the rest. For illustrative purposes the approach is applied to UK Universities in the years 1972-73 and 1973-74.

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THE PROBLEM

From 1 August 1973 to 1 December 1975 the Author, with others, was engaged on a D.E.S.-financed and OECD/CERI/IMHE-approved study to develop performance indicators for the teaching function, in higher education, in the UK, by means of a detailed study of Loughborough University and Lanchester Polytechnic. (Birch, Calvert and Sizer, 1977).

The Steering Committee included Polytechnic and University Administrators and a representative of the D.E.S. The main results of the study included the identification of various measures of input and output and the idea of a performance profile rather than the choice of a single measure of performance. However, at various points members of the Steering Committee and outside commentators raised the question of the possibility of constructing an overall efficiency rating for an institution or a department from the available measures of performance. It is this problem that this paper and the related research sets out to examine.

THE OBJECTIVES OF THE RESEARCH

Firstly, using fairly crude measures of input and output, the aim is to develop and interpret a model capable of mapping technical efficiency in the use of inputs and production outputs in higher education across and within institutions.

Secondly, the aim is to derive more realistic measures of input and output to which the model could be applied so as to indicate in which directions institutions or departments should move if they wish to attain a more "technically efficient" position.

During the OECD/CERI/IMHE project a considerable database for the two institutions was established and this database, although now outdated, would constitute a viable "test-base" for any within-institutional measures of performance which the research would throw up.

## THE APPROACH

Most educational systems have a number of objectives which not infrequently are inconsistent. 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", and so on. It is difficult to disagree with any common understanding of such bromides and equally difficult to deploy them usefully in a management context. The more detailed the list of 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 programmes for higher education – instruction (or the transmission of knowledge) and research (or the acquisition of knowledge).

### Crude Measures of Input and Output

There are at least two schools of thought on how to conceptualise the outcomes of the teaching function: firstly, the changes in students' characteristics associated with various institutional input and process variables; and secondly, the characteristics of the learning opportunities made available. The changes wrought in students' skills, knowledge, attitudes and values between entry to, and exit from, university reflect <u>their</u> learning functions and are only indirectly related to the institution's production function. The outcomes attributable to the institution (and the institution alone) are the magnitude and quality of the services made available. Therefore, the student enrolment on undergraduate and postgraduate programmes is a crude proxy for the magnitude of teaching services made available. This assumes that the quality of the places provided on an organised curriculum is comparable both within and across institutions.

The measurement of research output is immensely difficult. Various processes have been suggested - a weighted sum of the publications produced, the level of research funds attracted, or the quality-weighted hours spent on personal research (Cartter (1965), Layard and Verry (1973)). A crude measure of research output is the expenditure from research grants in a given period. Of course, this is essentially an input measure and its use can only be justified as an attempt to obtain a more realistic mapping of the teaching outcomes.

The measures of inputs is not quite so difficult but still causes problems. One can count academic staff or total their salaries, but it is infinitely more difficult to bring in a quality measure. Similarly, one can count money spent on equipment etc., but not easily establish the input that equipment has into the teaching or research activity. Initially it is useful to use money values for inputs but also it is useful to incorporate the number of academic staff in case some institutions have the "right" number of staff but at the "wrong" salary levels or vice versa.

## The Efficiency Frontier

Educational institutions, like other organisations, consume a range of inputs and produce a range of outputs. However, some will do this more efficiently than others. If their performance is to be examined it seems feasible to first identify the "technically more efficient" institutions and then use those as benchmarks against which the rest can be compared. If all the inputs and outputs are considered then intuitively these technically more efficient institutions will be on the boundary of the set of institutions considered. The term "efficiency frontier" refers to the part of the boundary determined by these technically more efficient institutions. (see Figure 1.

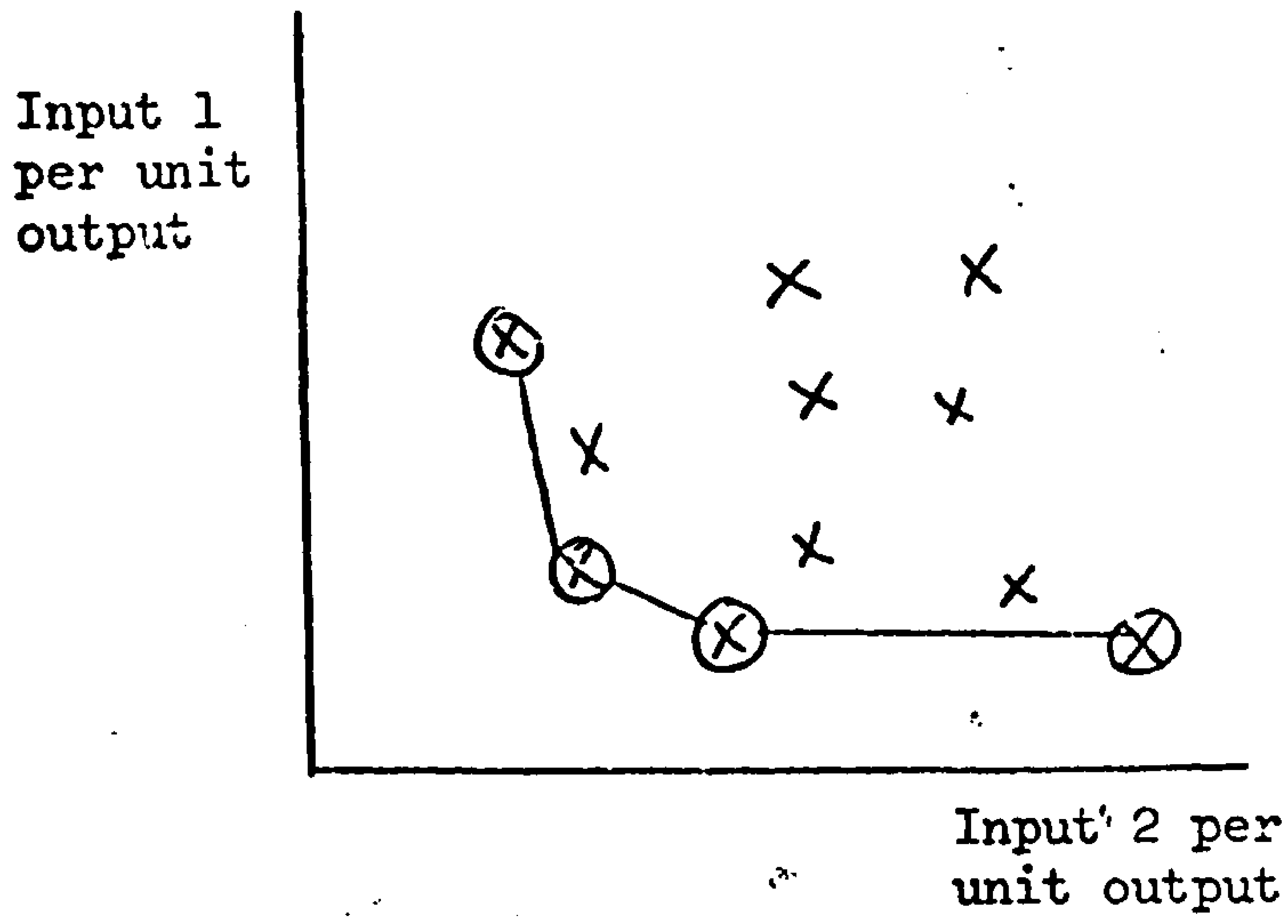


Figure 1

In practice more than two inputs and one output are involved and so the efficient frontier has to be found mathematically using a technique such as Linear Programming (Calvert and Birch (1978)).

Non-Frontier Institutions

Once the frontier institutions have been identified and the efficient frontier specified it is possible to compare a non-frontier institution with one on the boundary. The ideal method is to compare two institutions with the same mixed inputs but different levels of outputs (Farrell (1957)). This delays the attachment of weights or subjective values to inputs or outputs until the actual comparison is made and means that the analysis, for the most part, is not carried out in "funny money" but in actual numbers of students or pounds sterling spent, and so on. This is particularly relevant in Educational Management where the price or value of many of the inputs and outputs is not readily available.

AN ILLUSTRATION

The approach outlined above has, for the purposes of illustration only, been applied to the UK Universities in 1972-73 and 1973-74 (Calvert and Birch (1978)). The D.E.S. published statistics allowed the following variables to be used:

| | |
|---|---|
| Outputs | Undergraduate enrolment - full-time |
| | Undergraduate enrolment - full-time plus part-time |
| | Postgraduate enrolment - full-time |
| | Postgraduate enrolment - full-time plus part-time |
| | Expenditure in the academic year from research grants (a proxy for research involvement) |
| Inputs | Total full-time teaching and research staff paid directly from University funds |
| | Salaries of teaching and research staff |
| | Other departmental salaries and wages |
| | Departmental and Laboratory expenditure |
| | Total expenditure |

Out of the total sample of 49 institutions, 24 are identified as "more efficient" in one or the other, or both, of the academic years examined; of these 16 appear on the frontier in both years, and the other 8 have a high ranking on at least one of the 5 output programmes examined in the year in which they were not on the boundary. Hence the efficiency frontier appears to be reasonably stable over the two years. An examination of the non-frontier institutions revealed "staff numbers" and "recurrent departmental and laboratory expenditure" as the critical constraining variables. It is on these variables that the majority of non-boundary institutions would have to operate *if* they wished to move towards the frontier.

FURTHER WORK

Once the approach has been thoroughly tested on the sample set of crude measures of input and output of institutions it is hoped to carry out the following activities:

1. Partition the sample into "Oxbridge", "Red-brick", "Ex-CAT" and so on, so that like is being compared with like.
2. Test the approach within the institution using the Loughborough-Lanchester data.
3. Look for better measures of input and output across and within institutions in the light of the results of using the crude measures outlined above.

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