TR/06/89 JUNE 1989

THE NECESSITY FOR INNOVATION IN UNDERGRADUATE COURSE DESIGN

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Z1641994

ABSTRACT

Major changes are taking place in the general "marketplace" for universities' undergraduate courses. There are unfavourable demographic trends; perhaps even more importantly, substantial innovations are occuring in the structure and style of school examinations; there are general moves towards widening access to university education; the requirements of employers of the graduates are being seen as of increased importance; and there are political pressures for change .

It is argued that all these changes provide both an opportunity and the necessity for major innovation in undergraduate course design. Attention is particularly focussed on mathematics, where the highly sequential nature of the subject causes the problems to be more acute - but the opportunities to be that much greater .

This paper is an adaptation of the author's MBA dissertation (Goodall, 1988), which considered also issues of the general management of innovation and the management of universities. Most of this discussion has been removed from the present paper.

The work was completed in the autumn of 1988, and has already been overtaken by events in some areas. The concluding chapter provides a brief discussion of these further changes.

CHAPTER 1

PRELIMINARIES

1.1 INTRODUCTION

This paper is concerned with the development and provision of undergraduate courses by universities at a time of major and challenging changes. The changes are at least four-fold. Demographically, there will be a major decline over the next several years in the number of 18-year-olds in the population, this being of course the normal age for entering university. Academically, substantial changes are taking place in the school examination system, so that candidates for university education will be coming forward with a rather different kind of background. At the same time, the feeling is quite generally abroad that access to university education should be very substantially broadened, not only in respect of encouraging more young people of school-leaving age to proceed to university but also in opening university education to people in wholly different age-groups and with wholly different backgrounds. And finally there are political pressures for change - the desire by government that university education should serve the "national interest" (however defined), perhaps more clearly articulated in terms of the skills sought by employers of graduates.

The scale and rapidity of these changes present a picture of major uncertainty, and have been the cause of much worry in universities. The paper will however argue that the changes should be seen instead as providing opportunities, for universities to introduce real and useful innovations in education, to the benefit of the public in general and of themselves.

It will be argued that such innovations in fact must be made; and that, to make them, universities will have to attach a new importance to the management of teaching.

The author will also argue, in part, for a marketing approach to these innovations. The author is aware that this will beget some hostility! But the author intends to show that, in these times of rapid and very major change, there is no viable medium-term alternative to what is, in a broad sense, a marketing approach - find out what it is that the "customers" (students) wish to "purchase" (study), and then see how resources can be mobilised to provide it. Always, of course, maintaining complete academic integrity.

The paper will focus in particular on Brunel University and on the subject of mathematics. Many of the ideas to be developed will be of wide currency among all universities and for all subjects. However, it will be shown that both Brunel as a university and mathematics as a subject area face peculiar problems - which, with sufficient vision, can be translated into peculiar opportunities.

Little overt reference will be made to polytechnics and other non-university institutions of higher education, though these do of course face all the same major changes. However, while some of the ideas of this paper will no doubt be transferable to the non-university sector, that sector undoubtedly is in some ways different, and really needs a study of its own.

CHAPTER 2

UNIVERSITIES AND COURSES

2 .1 INTRODUCTION

It will not be necessary, in a Technical Report designed for internal university use, to review at any length either the arrangements by which universities receive government funding or the universities' own internal management systems.

Suffice it to say that universities receive government grant through an intermediary body, which at the time this paper was prepared was the University Grants Committee (UGC). The UGC distibutes grant to the universities, with "advice", of varying degrees of specifity, as to how the money shall be used. Further public money comes to universities through the Research Councils as support for particular research projects. Broadly speaking, about two-thirds of the grant money is awarded in terms of teaching-based criteria, about one-third in terms of research-based criteria. The teaching-based criteria consist of little more than crude counts of student numbers. Because of this, UGC "guidelines" rapidly assume the status of highly important "targets" that universities must reach in order to maintain their teaching-based funding. On the research side, there has been a substantial increase in selectivity in recent years, a trend which seems certain to continue.

Much management effort has been invested by universities in the management of research. This is as it should be; it is a peculiar province of universities to engage in research, and the close involvement of top management in this activity can do nothing but good. In contrast, there has often been little institutional involvement in the management of teaching. Courses have evolved, apparently successfully in terms of academic structure and in terms of recruitment; but institutional attitudes are often largely "laissez-faire". It is an argument of this paper that current changes in the teaching situation are so major that proper management attention must be devoted to them.

2.2 COURSES

As has been described, about two-thirds of universities' income is related to teaching-based criteria, essentially little more than counts of student numbers. The maintenance of student numbers ought therefore to be of paramount importance. As has already been mentioned, UGC "guidelines" rapidly become important "targets".

The range of undergraduate courses offered at universities, both as single-subject specialisms and as joint courses combining two or more subjects, is staggering. Even though not all universities cover all subjects, it remains true that virtually any academic subject can be studied, either by itself or in combination with others, at a substantial number of institutions. The number of courses offered has tended to increase over the years, with major new developments particularly in areas associated with computing and with some increased attention to "vocational" subjects such as accountancy and

finance; though on the other hand it has to be recorded that many universities have withdrawn some subjects. But it remains true that the variety is almost endless.

It also remains true that, overall, there are far more candidates than can be admitted; every year, large numbers are turned away, and though many of these have only reached very modest attainments in school examinations, a sizeable proportion have very respectable achievements behind them. But the pressure on places is not uniformly distributed over all subjects. In some, the shortfall of places is both chronic and acute (an analogy particularly well suited to what is probably the most extreme case, medicine), whereas in others universities may not even be able to reach their targets.

Nevertheless, looked at in the large, it would appear that universities have been very successful in offering a wide diversity of popular and heavily-subscribed courses. A "marketing man" would be very happy to conclude that this is the result of a deliberate and highly-tuned policy of market segmentation.

Unfortunately, this is not the case. On the contrary, the situation is almost entirely one of product differentiation rather than market segmentation. To the extent that analogy with manufacturing industry can be made, the situation is almost exclusively production-dominated. A wide variety of courses is indeed offered, but this is because the producers, i.e. the academics, wish it to be so - they are so convinced of the importance of their numerous individual subjects that they are absolutely certain that students will queue up for the opportunity to study them.

And for many years, and for most subjects, they have been right. Courses have in general been over-subscribed. Any thought that it might be necessary to ask students what they would really like to study has appeared wholly irrelevant, as well as being almost heretical academically. There appeared no need for marketing, and to most academics it was anathema anyway.

There have, of course, been some partial exceptions. The more vocationally-oriented courses have to some extent been driven by the market, though perhaps the market for graduate employment rather than the market of initial "customers" for courses. And there are some other specific instances of courses that have been developed because of a perception of a clear student demand for them (the author would beg to suggest that a particular course at Brunel with which he is well known to be closely associated is precisely of this kind). But hitherto such cases have very much been the exceptions.

Chapter 4 will highlight the demographic changes facing universities. In view of these, the author is convinced that much more attention will simply have to be given by the universities to the general marketing of their courses. The targets of student numbers are absolutely vital - there would seem to be far more money to be lost through consistent failure to meet these targets than could possibly be gained by selective funding of research. But in most cases these targets have been achieved, and usually fairly easily, for years; and with the general laissez-faire attitude to teaching, university managements have shown little or no interest in knowing how these targets are achieved, or in ensuring that this happy state of affairs

will continue. But suddenly demography has caught up; and a certain amount of panic is setting in. It has abruptly become necessary to manage tomorrow; but most managements have little real idea about what is happening today.

2.3 PARALLELS FROM ABROAD

There are often very great and very real differences in the histories, general cultures, and present positions of universities in different countries. It is therefore unwise to go too far down the path of looking for parallels to the British situation in other countries. Nevertheless, we all have something to learn from each other, and in this spirit a few remarks are included here about the situations in America and in Japan.

The American situation is energetically treated by Keller (1983). Before reviewing his arguments, it is necessary to emphasise the differences between the American and British systems: in America there are vastly more universities and they are vastly more varied, and private rather than state funding is often paramount. But there are huge similarities too: universities in both countries are facing cut-backs in funding, greater selectivity, and unfavourable demographic trends.

Keller spends much time bemoaning, on the one hand, academics who promote themselves as individuals rather than the corporate good and, on the other hand, college presidents (the American equivalent of the vice-chancellors) who are genial amateur mediators, not managers. While such a situation might have been tolerable in times of expansion, it is useless for dealing with contraction. He argues that there needs to be a general central direction of a university's activities - but this direction must be visionary, tolerant, genuinely concerned with nothing but the well-being of the institution as a whole, and always open to rational argument and debate by the academics.

Thus far, this is likely to be acceptable, at least as an ideal, to British universities. But Keller goes on to place much importance on the management of teaching. He complains strongly that for many years teaching has been very much secondary to research, and he is pleased to see that, nowadays, "campus domination by exclusively research-oriented academics is being leached out". A greater contrast with the contemporary situation in Britain could hardly be imagined.

Keller argues that American universities have been impelled to take a much more positive attitude to teaching because of changes in the market of potential students. Demographically, there are fewer of them; probably more important, they increasingly want to study what they want to study, subjects that are seen as useful and career-oriented, rather than just sign on for what institutions care to offer. So Keller draws attention to the urgent necessity for genuine marketing of courses - find out what it is that students actually want to study, and then see how academically sound courses can be designed to meet those desires. And he shows that many American universities have made considerable strides in this direction, and that these universities have benefited by achieving strong enrolments of enthusiastic and committed students.

There are many parallels here with the developing situation in Britain, and these parallels will be uncomfortable to most British university managements. The demographic situation is similar; and British students also are increasingly turning towards "useful", vocational, subjects. Keller states that, in America, universities are entering "a period of consumer sovereignty, one which will require a great many adjustments in institutional behaviour". Something like this seems likely to occur in Britain too - and will most certainly require changes in institutional behaviour ! Opportunities for innovation will be there - if only institutions look out for them, and seize them.

For a very different view from abroad, a brief portrait of the situation in Japan has recently been provided by a senior British industrialist who travelled there to compare education and training, particularly of technicians and engineers, with that in the UK (Lorriman, 1988). He deals primarily with engineering education, including the necessary mathematics, but no doubt his remarks have considerable general currency. The situation shows marked differences from that in the UK. A large number of universities produce vastly more graduates per head of population. Undergraduate courses are four years long, and are on the whole perhaps rather relaxed compared with a very high pressure schools system. The ethos of the university courses is to be broad; even within engineering, a broad engineering and general educational background is deliberately provided. This coincides with the system in many other countries (notably, and famously, in Germany), but is in marked contrast to most British engineering degrees which are narrow, technology-specific, and have little or no contact with subjects that are not immediately central to one particular aspect of engineering. In Japan, technology-specific education is provided as part of training at work; it is seen as part of the natural, normal and necessary duties of managers to develop their subordinates in this way. As Lorriman says, the contrast is perhaps best summed up by the acronym OJT : in Britain, this means "off-the-job training", but in Japan it means "on-the-job training".

What lessons can be drawn from this? The Japanese are, of course, not noted for original inventions; partly this is bound up with a culture of corporateness and systematicity - individual enterprise without consultation is rather contrary to the culture. But the Japanese are famed for bringing innovations to commercial success, for superb manufacturing management, for virtual obsession with quality, for taking long-term views, and for brilliant marketing. Much of this is based on the breadth of education - engineers are taught about business and commerce, about marketing and strategic planning, in a way that nearly all British engineers are not. And no-one can deny the phenomenal success of Japanese industry. In contrast, there is more than an element of truth in the stereotype of the British inventor turning out innovation after innovation all of which fail utterly to be brought to success in the market. So perhaps British education again needs to become more attuned to the needs of its market; not, this time, the market of its immediate customers, the students, but the market of the employers of its graduates - who seem to need more people with a broad view of the totality of industry, business and commerce, and not merely more and more specialised technocrats.

2.4 BRUNEL, UNIVERSITY

In the same vein as the opening remarks of section 2.1, it will not be necessary to devote much space to describing the particular characteristics of Brunel University. Suffice to say, for the sake of external readers, that Brunel is a technological university and has remained comparatively small (student population of order 2500); it concentrates on science and engineering subjects, with some involvement in the social sciences too.

The smallness of Brunel brings some financial disadvantages. "Overhead costs" in the provision of central services (library, computer, refectory, etc.) still exist, and it is harder to enjoy economies of scale in respect of them; but there are not so many places among which this overhead may be shared. However, smallness brings, or at least ought to bring, the huge advantage of flexibility. It should be easily possible to establish the lateral inter-departmental contacts that are all-important in overcoming the strong tendency to compartmentalise into separate professional disciplines. Developments - whether in teaching, research, or whatever - should be able to be readily pursued through local initiatives by enthusiastic individuals. The university management should find little need to establish layers of hierarchy or other rigidities in any system for management control. It will be argued later that enthusiastic local initiative is vital for the development of the university's courses, and that flexibility of management is necessary for this to happen.

It is requisite to devote space here to a further uniquely distinguishing feature of Brunel University that brings some problems but also vast opportunities - the fact that all its undergraduate courses are organised on the "thin-sandwich" basis. First, the problems. The courses are four years long, and are therefore inevitably more costly (though not by a factor of four-thirds) than a conventional three-year course. The university has to continually manage its contacts with industry, business and commerce to ensure that industrial training places for its students are sufficient in number and quality. And it is difficult for the university to attract overseas undergraduate students {very lucrative because "full-cost fees" can be charged), partly because such students would have to fund themselves for four years at Brunel rather than three years elsewhere and partly because for various reasons, good and bad, it can be particularly difficult to place overseas students for industrial training.

It is easy to take a gloomy view of the problems caused by the 100% adherence to the thin sandwich system. Yes, it is more costly. Yes, continual vigilance concerning the placements is necessary. Yes, it would be good to have more foreign students (very much from a cultural point of view, as well as financially). It seems clear that the view of the university's top management is that these problems are paramount; there have been frequent suggestions that the university should move away from total adherence.

But what of the opportunities? Top management seem to have no vision for two key features. First, and here and now, total adherence to thin sandwiches gives Brunel an absolutely unique marketing advantage. Not all prospective students will be attracted by such

courses, but those that are will know that Brunel is the one and only university that specialises in them, and can therefore be expected to do a good job. So the university can market itself to this segment of the total student population, and can take many steps to develop and expand the segment. In contrast, if Brunel became a small university doing much the same as all the other universities, it is very difficult to see how it could distinguish itself in such a way a-3 to continue to attract a worthwhile number of students. Secondly, the sandwich system means that Brunel inevitably has a multiplicity of contacts with industry and commerce - giving it a splendid opportunity to design its courses with the real needs of employers of graduates in mind, and to be innovatory in designing new courses in the closest co-operation with business. Therefore, in the particular situation of Brunel, none of the innovations to be discussed in chapter 6 will involve any dilution of the sandwich system.

CHAPTER 3

MATHEMATICS

3.1 MATHEMATICS - A SEQUENTIAL SUBJECT

Mathematics differs from all other subjects in the highly sequential nature of its development. At all levels of the subject, each level is strongly dependent on those that have gone before; and therefore students of the subject cannot really be expected, required or allowed to proceed to a new level unless they have achieved a reasonable competency in their earlier work. This applies throughout the subject, from primary school right through to the highest post-doctoral and research levels.

While obviously something of the sort is true for other subjects, nevertheless no other subject rivals mathematics in the universality of its sequaciousness. The nearest approach is probably physics, but even this falls some way behind. Other subjects tend to either "start again" at various levels or to simply start at a fairly high level without really having existed at all up to that point. An example of the latter is provided by the study of economics at school -large numbers of pupils take A-level in economics without any formal study of the subject previously. Some other social science disciplines hardly exist at all at schools and yet are popular subjects at universities. As an example of "starting again", one can consider the subject of English; for many (admittedly not all) pupils this means the study of 'English language' up to O-level/CSE/GCSE stage and a fairly major change to 'English literature' thereafter. In the science subjects, one might look at chemistry, where often A-level courses are so markedly different from earlier work as to render the earlier studies at least partly redundant.

Of course this is an argument that cannot be pursued to any ultimate end. In the case of economics, for instance, it is immediately evident that a general educational background and some sort of mature contact with world affairs are necessary pre-requisites to formal study of the subject. In the case of English, the richness of literature cannot be properly appreciated without some knowledge of the structure of language. But there is hardly any comparison with the situation in mathematics, where each and every stage depends directly and unequivocally on the preceding one and itself leads equally directly and unequivocally into the next.

Designers of courses in mathematics, at any level, therefore face special constraints. They must be explicitly aware of the content of courses at other levels. The constraints work both ways. Designers of school courses have for decades complained that they are required to work pupils up to a level considered adequate by universities - a level that may be too hard, and will almost certainly be inappropriate in content, for the large majority of their pupils who will not be proceeding to mathematical study in higher education. Universities, on the other hand, complain that the content of their first year courses is continually having to be modified (usually downwards!) to take account of the level of mathematical education reached by school-leavers. Both these arguments would appear to some

extent in other subjects; but neither would matter so much.

Translating these problems into opportunities for innovation cannot really be discussed until after a study, in chapter 5, of the major changes now taking place in the examination system in schools.

3.2 MATHEMATICS AS A SPECIALIST SUBJECT

Undergraduate courses in mathematics as a main subject for its own sake are widely available at universities. There are several different flavours of these courses. They are regarded here as including both those in which mathematics is a single subject specialism and those in which mathematics is combined as a main subject with some other discipline. The former category encompasses a broad spectrum from pure mathematics to various kinds of applied mathematics, and under the latter heading should be thought of as covering several courses whose title is or refers to 'statistics' and probably a few in the area of 'mathematical physics' as well. In the latter category, there are a large number of courses in which mathematics is a major component coupled with another subject as a minor component (a frequently-occurring example of such a minor component is computer science), and also many where mathematics and the other subject each occupy half the total course; often these combinations combine mathematics with some other subject with which it would appear to have little direct connection, for instance foreign languages.

All such courses will be considered in this paper as being "mathematics-for-its-own-sake" courses. Students take such courses first and foremost because they wish to study mathematics, possibly coupled with another subject as well. From the management point of view, such courses occupy a fairly simple position, being clearly and unequivocally a prime responsibility of the university's department of mathematics (in some institutions, this department will be known by another name, and may be more than one department (e.g. of pure mathematics and of applied mathematics); but the import is always absolutely clear). There is some complication in the case of the joint courses with other subjects; sometimes such courses remain entirely the management responsibility of the mathematicians, sometimes there is also a management input (which may be of equal standing) from the other department. But it remains true that the mathematicians have essential control over these courses; if there is any collaboration with another department, it will usually be very close and very amicable.

This means that developments in "mathematics-for-its-own-sake" courses can be pursued by the mathematicians themselves in a proactive way. The opportunity and the responsibility for innovation lie at their own door.

3.3 MATHEMATICS AS A SERVICE SUBJECT

Another aspect of mathematics, however, is vastly more complicated. This is its use as a "service subject" in a large number of other disciplines.

All the science subjects and all the engineering subjects depend to some extent on mathematics. The extent of this dependence varies from subject to subject; for instance, biology has traditionally been thought of as being less dependent on mathematics than, say, physics, though it is arguable that this stereotyped view is rapidly becoming wholly out of date with exciting advances in mathematical biology. Also, the various other subjects are dependent in detail on different parts of mathematics; for instance, the requirements of the electrical engineer are markedly different from those of the civil engineer. Nevertheless, a quite strong mathematical background is essential for everyone in these disciplines.

Neither does the need for mathematics stop with the scientists and technologists. Some social science disciplines are surprisingly heavily mathematical - certainly economics, and as another example, though perhaps depending somewhat on how the subject is treated, psychology. It may be that a different sort of mathematics is needed in these disciplines compared with science and engineering, but nevertheless it is mathematics, of some kind, that is required. And in no way has the list of subjects that require a mathematical background been exhausted by those quoted here.

This leads to academic problems, and political problems.

The academic problems are related to the sequential nature of mathematics, discussed above. It is natural for the other disciplines to want to include in their courses only those parts of mathematics that are immediately relevant. But often it will be impossible to impart any sensible understanding without a great deal of preliminary and related work. It will quite frequently be possible to put over the required mathematics in a "cook-book" style of "this is what you do, never mind why"; but it has to be most seriously questioned whether this is really the proper way to go about education, any in any case it is often not possible to realistically do even that.

Very careful thought has therefore to be given to the real mathematical requirements of these other disciplines. In designing courses, there ought to be close co-operation between subject specialists (preferably those who are well acquainted with mathematics) and mathematicians (preferably those with knowledge of the other discipline). The subject specialists will naturally be concerned that time spent in teaching mathematics is less time that can be devoted to teaching the discipline itself. It is very important, and very difficult, to get a good balance between, on the one hand, doing enough mathematics to achieve a reasonable understanding of what is required and, on the other hand, not losing sight of the fact that the mathematics is there to service the other discipline, not to dominate it.

It would be quite difficult enough to address these problems if they could be tackled purely in academic terms. But they have to be seen in political and financial terms as well. In a nutshell, the question to be faced is: who owns the mathematics?

Although there are many exceptions where mathematics is taught "in-house" by the other department, the accepted norm hitherto has always been for service teaching of mathematics to be done by

mathematicians based in the department of mathematics. The impeccable academic argument for this is that any subject ought to be taught by persons who are full members of the "community" of that subject and therefore up-to-date with developments in it. University mathematics departments are usually very heavily involved in service teaching, and may well receive up to as much as about a half of their teaching-based income from internal accounting procedures for this activity.

Which means that the departments being serviced are collectively paying out, through the internal procedures, substantial sums of money to the mathematics department. With increasing financial stringencies, these departments have naturally looked to doing the mathematics teaching themselves instead of, as it were, contracting it out to the mathematicians. And another entirely respectable academic argument comes into play - that teachers of, say, mathematics for electrical engineering should actually be electrical engineers so that they know what the mathematics is being used for.

The argument rages, and is the cause of much organisational conflict within universities. The collective professional views of mathematicians and (particularly) engineers are almost diametrically opposite, as may be seen for example in submissions on the question to the UGC by the respective committees of professors. And while it might be the academic arguments that are openly discussed, no-one has any doubt that the real driving-force behind the debate is political. Perhaps at some stage the UGC will actually have to rule on the matter (if, for example, it found in favour of the mathematicians, it could do so by refusing to fund any posts for mathematicians in other departments). In the meantime, the individual universities themselves have somehow to arbitrate between the very independent and very powerful professional groups.

What all this means for innovation in a service-teaching context is that the background climate is fairly hostile. The atmosphere is one of a certain amount of professional mistrust, and this has a tendency to beget risk-aversion. It remains fundamentally true that whenever there are problems there are opportunities, and these will be referred to in chapter 6. But the danger here is that genuine innovation may all too readily be misconstrued as political manoeuvring.

CHAPTER 4

DEMOGRAPHY

4.1 INTRODUCTION

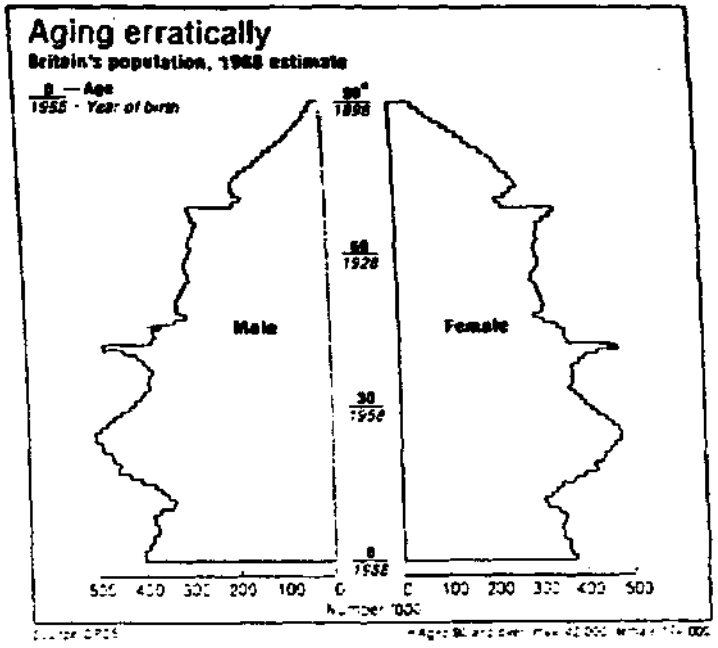
Demography is the study of population statistics - in particular in the present context the study of changes in the population, its total size, its age structure, its composition, its educational achievements, its employment, and so on.

Demography is fundamentally important in all marketing situations, and receives its due treatment in all serious marketing texts; see, for instance. Baker (1985) for a fairly general treatment, or Drucker (1985) for extended consideration more especially in the context of innovation. Changes in the demographic situation are usually highly visible, and underlying trends can be predicted with a high degree of certainty many years in advance; for example, an upper bound on the total number of 18-year-olds in Britain was known 18 years ago, leaving aside questions of immigration. But failures to take due account of demographic trends abound; some particularly scathing remarks about this can be found in Drucker.

Drucker attributes the failures not to ignorance of the basic trends but to beliefs that the changes take place so slowly and over such long time spans as to be of little practical concern in day-to-day situations. He argues that this is a dangerous error. Major, sudden and unpredictable changes do occur, and indeed always have occurred throughout history- But they do usually have long lead times before impact, and this gives opportunities for alert organisations to plan accordingly and to have appropriate policies in place at the right time.

4.2 THE POPULATION STRUCTURE IN BRITAIN

The age structure of the British population shows major fluctuations in the sizes of successive age groups. This is largely due to the post-war "bulge" in births which itself begat a further "bulge" in the 1960s, with major "troughs" between these two bulges and after the second. In addition, there is still some effect from the 1914-1918 war working through the age structure. The chart (extracted with slight modification from 'The Economist' of 6 August 1988) nicely displays the present age structure.



These fluctuations have major implications throughout the economy. Universities will be centrally interested in the sizes of successive cohorts of 18-year-olds, as this is the normal age for entering university. It is clear from the chart that a major decline is just starting. Reliable estimates and projections of the size of the 18-year-old population are readily available from U.K. official statistics; the prediction is of a "trough" of around 600,000 in the mid-1990s, from a "peak" of well over 800,000 in 1984. Turning these estimates into projections of actual student numbers at universities has absorbed a great deal of time of many groups of people, and has also been the source of much controversy.

4.3 PROJECTIONS OF STUDENT NUMBERS

The story starts in 1983, with the Department of Education and Science's Report on Education No.99 (DES 1983), which predicted very heavy drops in student numbers. As well as massive dissent from the universities themselves, serious objections were raised by the statistical community, on the grounds that the methodology used was, to say the least, open to question and that the many assumptions that must have gone into the projections had not been made public. The issues are discussed at length in Royal Statistical Society (1985).

Evidently the serious statistical objections were taken on board, for various new official projections have been made in which the prognosis is far less gloomy. See DES (1986), Secretaries of State (1987).

This latter reference, referred to hereafter by its short title of Cmnd 114, states that "the Government will plan for student numbers to increase in the next few years, to return to present levels in the mid-1990s and then to grow again". Its projections assume that a higher proportion of young people will attain traditional university entrance qualifications, due to continuation of a long-running trend of girls catching up with boys in this regard, to "changes in the social/occupational mix of the population", and to general improvement in the standard of school education. Its more optimistic projections make a further assumption that "there will be a significant increase in the proportion of qualified young people who enter higher education". It is interesting that Cmnd 114 only adds this last assumption when calculating "optimistic" projections; it does not form part of the base assumptions from which standard projections are calculated.

The assumptions about girls catching up with boys and about the social/occupational mix of the population are important. Any assumptions in these areas are of course to a large extent arbitrary, but it seems that the assumptions are now informed by some serious research, which was probably not the case with those made in DES (1983). The point about girls catching up with boys is fairly simple; as stated above, this is a long-running trend, and the only features to discuss are how fast and how far it will go. The point concerning the social/occupational mix is much more complicated.

A lengthy article by Rudd (1987) reports on a study of the educational qualifications and social class of the parents of a sizeable sample of undergraduates who commenced their courses in

1984. He finds strong evidence that entry of children to university is related not only to the social class of their parents but also, and independently, to whether the parents proceeded to some form of higher education. This phenomenon is also found by Redpath and Harvey (1987) in a large survey for OPCS. Rudd regards it as a new kind of transmission of values: "those who have themselves received more education than most pass on a belief in its value to their children. It seems that if we educate one generation we make a good start on the education of the next". He stresses that it is independent of social class, without denying that social class is an important variable. It is well known that the different social classes display different propensities to participate in higher education, but perhaps this work shows a new feature that can operate to universities' advantage: for there was a "boom" in graduates in the mid-1960s, and many of these people now have children of student age who may themselves now show a high propensity to proceed to university.

4.4 CHANGING PATTERNS OF DEMAND WITHIN HIGHER EDUCATION

It is perhaps an extension of the meaning of the word 'demography' to include under it a discussion of changes in the relative demands for particular subject areas, but this does seem to be a convenient place to carry out this discussion.

Some attention has already been drawn in section 2.2 to changes in the courses provided by universities - increase in areas associated with computing, more attention to vocational subjects, some reduction elsewhere. But it was also pointed out in that section that these changes have only in part been demand-led; rather, changes are often impelled much more by "production decisions" taken by the universities.

In strict economic terms it may not be formally possible to talk about the "demand" for various subjects since there is, to the consumer, no real concept of a price for education in any particular subject and certainly no differe ntiation in price between different subjects. Nevertheless, it is clear that there is a meaningful concept of "demand", registering in some sense students' tastes for different subjects.

But this is remarkably difficult to actually measure. The Universities Central Council on Admissions produces each year copious statistics on numbers of applicants for and admissions to courses in different subjects, but these data do not quite capture what one is really trying to measure.

Certainly numbers admitted are an inadequate proxy for demand. At a fairly philosophical level, there is the problem discussed in section 2.2, that courses tend to be production-led rather than demand-led; so, to some extent, students have to study what is provided, not necessarily what they would actually choose to study. There are also deep points to be made about "perfect information" in this "market" - there are so many universities and so many courses (and publicity is often woefully bad) that students are likely to have only very limited information as to what is available- But there are also problems of a much more practical nature. Numbers admitted to each

course are strongly constrained by the university authorities, in the light of "advice" from the UGC. Obviously there is some flexibility, and obviously some attention is paid to relative levels of demand; but, basically, numbers admitted are determined by the supply side, not the demand.

One can have much more confidence in turning to statistics of the numbers of applicants for different subjects, but here again there are serious problems. One difficulty is that the pattern of applications is, to some extent, conditioned by the constraints that candidates know to exist on the supply side; so the data do not provide a picture of what the relative demands would be if there were complete freedom of choice. A second difficulty is in defining exactly what is the population whose demand is being measured. Is this population to consist of all those applicants who stand a reasonable chance of meeting entrance requirements? If so, the published statistics cannot suffice, for they also cover large numbers of applicants who (regrettably) stand no chance of getting anywhere near the levels of attainment currently required. It could, on the other hand, be argued that this does not matter at the present time, if widening the access base to universities really does include opening the doors to candidates with less than the present level of entry qualification. But this argument can then be taken forward to the supposition that large numbers of potential students simply do not apply nowadays because they believe they stand no chance of admission, and so the current statistics obviously cannot measure this latent demand.

With all these caveats, there is nevertheless some information to be gained from the national statistics of applicants for various subject areas. The list is completely dominated by law and medicine - far and away the most popular subjects. {And therein lies another major drawback of the data. Many applicants for these subjects, particularly medicine, knowing of the extreme competition for places, will have a "fall-back position" of another subject they would wish to study should they be unsuccessful in gaining a place; no quantitative information on this fall-back position exists.) Some way behind, but fairly close together, comes a batch consisting of English, management studies, history, economics, geography and psychology. Only after another noticeable gap do computer studies and mathematics appear.

The author is frankly surprised by some of the subjects in this list, which seem very non-vocational and not directly career-oriented (except of course in the sense that many organisations are happy to recruit graduates in any discipline). The author would further take some issue with a comment in the 'Financial Times' for 9 January 1988: "the trend of demand, which is increasingly for work-related courses, is combined with a fall in the UK's teenage population to cut applications for less vocation-oriented studies such as mathematics, French, biology and physics". Obviously it all depends what one means by vocational! What the marketer wants to know is what the customers mean by vocational; and as far as can be judged from the imperfect information that is available, the outlook for mathematics is not good.

CHAPTER 5

SCHOOL EXAMINATIONS AND THE UNIVERSITY INTERFACE

5.l THE SCHOOL EXAMINATION SYSTEM

Part of the school examination structure in England and Wales (and Northern Ireland, where the same system is used) has just undergone a major upheaval. Indeed, for many years there has been much talk of the necessity for major reforms. Perhaps the most startling thing about the present change is that it actually happened. And there is much continuing discussion about the need for further changes; weighty reports come out at frequent intervals.

For some thirty years, the examination structure has consisted of General Certificate of Education (GCE) examinations at Ordinary Level (O-level), normally taken at about age 16, and Advanced Level (A-level), normally taken at age 18. The spectrum of examinations at about age 16 was widened by the introduction of Certificate of Secondary Education (CSE) examinations, broadly speaking intended for children who were less academically strong; a deliberate overlap was created between CSE and O-level, whereby the highest level of classification in CSE examinations was regarded in every way as equivalent to an O-level pass. An assortment of examinations also evolved, though without too much structure, to partially fill the gap between O-level/CSE and A-level. With compulsory education extending to age 16, all children had the opportunity, and were expected, to be examined at O-level or CSE in a quite wide range of subjects. Those who went on to A-level, however, carried forward only a very restricted number of subjects; it became unusual even to take as many as four subjects at A-level. Not only were A-level choices restricted in number, but also they were usually very restricted in variety; the majority of children concentrated either entirely on science subjects or entirely on arts subjects or entirely on social science subjects.

In the 1970s, all the attention appeared to be on the A-level end of the structure. Strenuous efforts were made to devise and implement a system where the basic diet would consist of a larger number and wider range of subjects studied to a somewhat lower level. But all these attempts fell by the wayside. The only saving grace was some increasing diversity of choice within the traditional A-level structure; but this was in no sense "managed", it just happened. More children began to look for diversity in their studies, and more teachers began to see that rigid compartmentalisation of disciplines was not necessary. But these moves were only quite small; specialisation of studies continued to be the norm at this level. However, in the 1980s there was a major change in the direction of the attack on the system; attention was focussed on the O-level/CSE part of the structure.

5.2 GCSE - THE NEW 16+ EXAMINATION

An entirely new examination, the General Certificate of Secondary Education (GCSE), has been created to replace both the former O-level and the CSE. From the outset, it has been designed with a graded

structure so as to be accessible to children of all abilities. It also integrally features assessed coursework and projects, and does not rely wholly on an examination at the end of the course. The concept has been generally welcomed educationally, but, as already mentioned, perhaps the really surprising thing is that it has been actually vigorously pushed forward into implementation. Clearly it has had a great deal of political willpower behind it. And while there have been some complaints that it has in fact been implemented too quickly, there appears to be general satisfaction with it, and there will certainly be no going back to the old system.

It is important to realise that GCSE is substantially different from O-level/CSE. Syllabuses in general are more broadly drawn, and where possible try to attach themselves to general educational aims as well as the development of the particular subject. The inclusion of formal assessed coursework, which is a major innovation in public examinations at this level, is meant partly to reduce the pressure caused by having an artificial all-important final examination, and partly as a vehicle for children to become genuinely interested in the wider aspects of their studies. (In passing, it might be noted that some schools have taken the coursework on board with great enthusiasm; but others, more conservative, more timid, or less confident of their own teaching abilities, have availed themselves of dispensations to omit coursework for the first year or two of the new system. But there is no doubt whatsoever that coursework has come, and has come to stay.)

It needs to be mentioned that no sooner has GCSE been introduced than a further major new development has been set in train that may overtake or subsume it. This is the development of a "national curriculum" in key subjects for all children at all ages from 5 to 16. National syllabuses will be laid down, with varying degrees of specifity in different subjects, that all schools will be required to teach to. There will be compulsory testing, according to nationwide schemes, at ages 7, 11, 14 and 16. All this is contained in the current Education Reform Act, and is being vigorously pushed forward into implementation, again with the utmost political willpower behind it. Strictly speaking, it applies only to the maintained sector, but schools in the private sector will not be able to ignore it.

The role of the existing Examining Boards in this is not clear. Possibly they will win "contracts" to conduct the new compulsory tests, in which case there may be some shades-of-emphasis variations in testing procedures. Even more unclear is the medium-term position of GCSE. In the mid-1990s, 16-year-olds having come up through the national curriculum will for the first time be taking the age-16 compulsory test. Will there be any point in having GCSE examinations as well?

Though these issues will become of profound importance in education generally, they do not appear to matter too much for the present study. The national curriculum itself is fairly broadly drawn, and it can safely be assumed that its testing procedures will involve substantial elements of project-type work rather than just rely on traditional examinations. Educationalists are not going to allow the advances in this direction, very gradually won over many years and now suddenly strongly reinforced in GCSE, to be lost again. Consequently, from the viewpoint of universities, children who have come

up through the national curriculum will probably not look very different from those who are "pure GCSE". Indeed, there may be an advantage, in that with a national curriculum and national testing one should be able to be quite confident about what children will have studied and how good they are at it. To be set against this, there is of course the very real danger of the stultifying effect of uniformity, particularly for any lower-calibre schools which decline to do any teaching outside the strict confines of the national scheme.

5.3 **THE INTERFACE TO AGES 16-18**

The developments outlined in the previous section are in hand; GCSE, indeed, has now actually happened. Up to age 16, schools are acting as a reasonably coherent group, reacting to a new examination system largely imposed on them by deliberate government intervention. The schools, of course, have had to do this; they really have no choice.

The implications for the next stage of school education, ages 16-18, are profound - and have so far to a large extent been deliberately ignored. The GCSE curriculum is, deliberately and successfully, broader than what went before; time being finite, this necessarily means that individual subjects are pursued to less depth than was previously the case. More subtly, but arguably more importantly, GCSE candidates are beginning to experience a different style of teaching, with more emphasis on the coursework and on learning through group and individual project work. Inevitably, therefore, the syllabus content of the A-level work undertaken post-GCSE needs to be throughly reviewed; but so also does the whole general style of A-levels, so as to match the new, and in many respects enhanced, educational experiences of the GCSE candidates.

The traditional British approach to problems is to set up a Committee of Inquiry. This was duly gone through. The Higginson Committee, so named after its chairman, produced its report in 1988. It was immediately rejected outright by the government. Probably it deserved it. Higginson was aware that, while A-levels have their critics, they also have their staunch political defenders as being the last bastion of traditional academic excellence in the school system. But Higginson failed to grasp the nettle, and really ducked the issue. A rather severe, but nevertheless valid, judgement appeared in 'The Economist' of 10 September 1988: Higginson was a "clumsy attempt to appease both the critics and defenders of A-levels" by making "the unrealistic recommendation that pupils should study more subjects without any change in standards".

Nevertheless, it is clear that, despite their political support, A-levels in their present form are indefensible. The GCSE candidates will be improperly prepared for them. The first few cohorts of GCSE candidates will be in a most unenviable position, in trying to go forward into traditional A-levels from a GCSE base. Pressure for change in A-levels will become irresistible; to try to maintain the present system will be an unsustainable position. Indeed, some syllabus-review activity can already be seen; the author would guess about 1993 for fairly major changes in A-levels, to bring them more into line with the philosophy of GCSE. The mis-match, indeed the

incipient yawning gap, at age 16 will be attended to, and sooner rather than later.

5.4 AS-LEVELS

It is necessary to divert sideways at this point to consider a new development that is appearing within the existing structure. This is the AS-level ("Advanced Supplementary") examination, which is to be available for the first time in 1989. The long-term position of this is extremely unclear; it could well be that it will turn out to be a sideline, an irrelevance, a distraction from the main effort of fundamentally reforming A-levels. Or, it could be something for which there is a real niche in the examining system. The politicians certainly attach great importance to it.

The idea is to break the excessively specialised mould of A-levels by providing an additional examination, to be taken alongside A-levels, consisting of "half subjects" but where the "half" is a "vertical slice" (i.e. some topics pursued all the way) rather than a "horizontal slice" (i.e. just the easier parts) of an A-level course. Something like this had been seen in the proposals of the 1970s. As with GCSE, it seems amazing that AS-levels have actually come into existence; even though they have been welcomed on general educational grounds, their actual birth was really only due to great political pressure. The intention, or perhaps one should say the hope, is that candidates will take AS-levels in subjects that are different from those of their main A-level studies; either subjects that are a complete contrast (for example, a language for candidates specialising in the sciences, or mathematics for an arts-based candidate) or subjects that are in some way complementary to the main studies (as for instance statistics might be for a candidate specialising in the social sciences). The qualification is to be worth "half an A-level" in every respect.

As mentioned above, it very much remains to be seen whether this new examination really will prove to be a valuable addition to the menu.

5.5 THE INTERFACE TO UNIVERSITY

First, let it be stressed that A-level examinations, in whatever guise, are not there solely to provide an entrance qualification for higher education. On the contrary, universities are only a "minority customer" for the product. For many decades, universities have tended to forget this, and have sought, generally successfully, to exert major influence over the design of the examinations. As explained in sections 5.2 and 5.3, this is changing. Frankly, the author welcomes the change. Educationally, the final examination of one's school career should be driven primarily by what happens at school, not by the requirements of something that may or may not happen post-school. Trying to look at the situation from a marketing standpoint, in one sense the "customers" of the examinations are the pupils themselves, and they will surely likewise wish to be examined *on* the basis of what has actually happened at school (assuming, idealistically, that the pupils wish to be examined at all!?). Alternatively, "customers" could be thought of as the "employers" of 18-year-olds, and higher education is only one of many such

"employers"; the needs of others are likely to be very different.

This is not to deny that qualification for higher study is an important use of A-levels; it merely points out that this use is but one of many. It is undoubtedly an important use, and it is entirely reasonable that its requirements should exert some influence over the examinations. But it is entirely unreasonable that it should be the only influence.

Higher education in general (and, for the purposes of this study, universities in particular) will therefore have to learn to live with whatever changes take place in A-level examinations. Attempts to influence these changes can, will, and should be made. But it must be realised that the pendulum has swung away, and other influences are now regarded as also being important. So it becomes necessary to try to anticipate changes, and position oneself accordingly.

The transition from school to university through the present A-level system is deemed almost as an act of faith to be reasonably easy. A sufficiently good performance at A-level can be expected, is expected, to be adequate to enable the first year at university to be properly tackled. Of course everyone knows there are real problems and difficulties, but, formally at least, these are not ascribed to major deficiencies in the A-level examining system {they may well be ascribed by universities to bad teaching at schools, but that is a rather different matter). At present, there is not really a major mis-match at age 18 for students who are sufficiently intelligent and sufficiently committed.

As explained in section 5.3, a mis-match is beginning to occur at age 16. But, as has been pointed out, this will be attended to. Inevitably, then, a gap will appear at age 18. If universities do not make any significant alterations to the initial stages of their courses, there are going to be very serious problems for new students coming up through the new-style GCSE/A-level route.

Dealing with this interface will require positive management by universities. A laissez-faire attitude that the existing courses will suffice just will not do. The problem is certainly worse in mathematics, and in subjects such as engineering with a strong mathematics element, because of the sequential nature of the subject, discussed in chapter 3. But this is something to which the mathematicians absolutely must give attention. Mathematics is already widely perceived as being a difficult subject. If it is further seen that there are large problems in making the transition from school to university in mathematics, then students will vote with their feet into other disciplines. So mathematics departments will suffer by having fewer students; and eventually the "national interest" will suffer as well, by having fewer highly trained mathematics specialists. And any lack of interest in mathematics in current cohorts is likely to feed on itself in future cohorts and thus get worse.

5.6 ACCESS

Much attention is currently being given to the general issues of "access" to universities. The debate subsumes both the interface

with the changing A-level system and the development of new routes for entry to university.

General government policy is, on the face of it, strongly supportive of moves to introduce new entry routes. In a further quotation from Cmnd 114 (Secretaries of State, 1987), universities are enjoined to "accommodate students with a wider range of academic and practical experience than before, many of whom will not have the traditional qualifications for entry", and to "adapt teaching methods and design of courses to accommodate new types of student".

However, it is immediately added that all thismust be "not at theexpense of academic excellence"!! As well asthe usual desire of politicians to both have their cake and eat it, there is the serious conclusion to be drawn that the consequences ofwidening access just have not been thought through at this level.

Within the universities, there seems to be a degree of unanimity on the general need to widen access. Undoubtedly this is mainly impelled by demographic necessity. It is also, and genuinely, seen as a matter of social justice and as a response to the likely future demand for graduates, but nevertheless if it were not for the demographic situation there is little doubt that there would be much less interest in it. Still, for whatever reason, the interest is there, and is to be welcomed.

It should be said that other routes to university than A-levels have always existed. For instance, a quite popular route in the past, but which has now largely disappeared, was via Ordinary and Higher National Certificates and Diplomas (ONC/OND/HNC/HND); and nowadays fairly wide use is made of courses run under the aegis of the Business and Technician Education Council (BTEC). But these other routes have always been more important in some subject areas than others. Within the particular context of mathematics, they have been uncommon; the traditional 0-level/A-level route has been all- important. Mainly this is a reflection yet again of the sequential nature of mathematics as a subject.

This last problem surfaces also in universities' reactions to the AS-levels discussed in section 5.4. Universities have welcomed AS-levels in principle, and will undoubtedly also welcome them in practice if they mean that candidates will study more than would otherwise have been the case. But what about candidates who use an AS-level as a substitute for a full A-level? There is a lurking problem here, particularly in mathematics. For it seems likely that many candidates who currently take mathematics as what might be called their "third subject" at A-level may choose, or be directed by their schools, to take only an AS-level in mathematics (possibly as one of two AS-levels replacing the third A-level). But such candidates would not then have an A-level qualification in mathematics and so would not, on present terms, qualify for admission to any mathematics-based degree course (including most engineering and many science subjects). Hence the "broadening" AS-levels may actually serve to restrict students' choices!

AS-levels may prove unpopular, or otherwise short-lived, but there remains of course the real problem of trying to define entry requirements for candidates who have not come up by the conventional

route. Universities are just beginning to realise that new requirements and new procedures will be needed; that better liaison with schools and colleges will be essential; and that there might actually be something to be learnt from the polytechnics. As is discussed in chapter 2, these realisations require university managements to attach a new importance to the management of teaching; demographic necessity compels this change of attitude.

The universities are genuinely concerned about the effect wider access is likely to have on academic standards. The high-level, high-pressure, and usually highly-specialised three-year under-graduate degree is, justifiably, a matter of considerable pride. But is it sacrosanct? Is it too specialised? Perhaps the moves to less specialisation in schools, coupled with realisation that less-specialised systems of university education such as are normal abroad are in many ways actually superior as a general education, will force universities to begin to re-consider entire attitudes to course structure, though any such considerations would (or should) need to be informed by genuine knowledge about the real requirements of employers of graduates.

Some moves have already been made. "Access courses" are appearing in many local technical colleges. Such a course is typically of one year's duration, and is designed by the college in close collaboration with a particular university to prepare students for entry to some of that university's courses; successful completion of the "access course" will guarantee a place at the university. The resulting somewhat incestuous relationship between a college and a university is clearly not quite what the government is looking for; Cmnd 114 commends "access courses", but seeks a comprehensive framework of well-devised courses that will give fairly wide access to several universities, not just to one institution. There is little evidence yet of universities co-operating in this way (except for long-established arrangements, mainly for mature entrants, for teacher training and for social work training), but it might well be that enterprising colleges could find a useful market niche here.

But it must immediately be noted that "access courses" are designed to give access to universities' existing courses. Viewed cynically, they could be seen as the universities ' method of retaining their status quo and pushing the onus of preparing candidates on to another sector of education. The universities have not grasped the nettle of fundamentally reviewing their own courses.

To be fair, it must at once be added that the universities' position is genuinely very difficult. Most problems could readily be overcome if proper funding, and proper arrangements for student support, were made available for the universities themselves to run "preliminary years", thus making the normal degree course four years long (or five years in the "sandwich" universities like Brunel). The preliminary year could be used not only for bringing the students "up to scratch" for their specialised studies, but also for broad-educational aims. There are precedents for this - in Scotland, as described in the next section, and also something of the kind is done at the University of Keele. But, most regrettably, it seems that the idea is a complete non-starter; government funding for any such extra year simply would not be made available.

Except that just a few instances of doing it are actually visible. Brunel, for instance, has in the current year about a dozen students taking a "Foundations of Engineering" course which starts with what is precisely a preliminary year and for which the usual entry qualifications for engineering courses (notably, a good level of mathematics) do not apply. These students are fully funded through the UGC via the normal mechanisms. It is in fact all part of a general initiative to improve engineering education. There is surely no academic reason why such an initiative should apply only to engineering, or why it should be limited to very small numbers. But it still has to be concluded that, in the current political and financial climate, this is most unlikely to be a small acorn from which a great oak will grow.

After such a preliminary year, the rest of the course can be exactly what is currently offered to candidates with the conventional entrance qualifications. So the arrangement actually avoids any necessity for a fundamental re-think of the existing courses. Perhaps, however, such a re-think is really what is needed. The courses need to be academically sound, and this is of course paramount. But they do need also to consider the educational backgrounds, the different kinds of learning skills, the levels of attainment and the hopes, aspirations and interests of the students. Not forgetting, too, the needs of the employers of the graduates.

5.7 SCOTLAND

One need look no further than Scotland to find a rather different philosophy of course structure, and indeed a generally broader approach to education at all levels. The Scottish system has always been different from that in England and Wales; and few would deny that it has been entirely successful in producing well-educated people, adequately skilled and trained in all the various specialisms, but also with a most welcome breadth of general educational vision.

Going straight to the 16-18 stage, the Scottish system strongly encourages sixth-formers to study several subjects. The examination col l oqually known as "highers" is typically taken in up to five subjects at age 17 after a one-year course. Candidates may stay on for a further year at school, taking the Scottish Certificate of Sixth Year Studies, a more advanced examination which often includes a large element of project work; or they may proceed direct to a Scottish university, where courses are normally four years long instead of the three years in England and Wales, and where the first year acts as a kind of general preliminary year. The breadth of education thus gained really is in marked contrast to the narrow specialisation that is normal South of the border.

There is no restriction on A-level candidates applying for places at Scottish universities, and likewise the Scottish qualifications are, formally, an acceptable entry requirement for English and Welsh universities. However, it has to be said that English and Welsh universities have always tended to be suspicious of candidates from the Scottish system, fearing that they will not properly be able to cope with their very specialised degree courses. It will be argued in chapter 6, and indeed has already been argued in this chapter,

that this is the sort of attitude that will just have to change; it will no longer be acceptable, or even possible, to insist on a high level of narrow specialisation in university applicants. Course structures, and admission procedures, will have to evolve to take account of students with a much greater breadth of vision at the expense of ultimate depth of knowledge in individual subjects.

5.8 SUMMARY

It is clear from the preliminary sections above that the situation in the school examination system is one of major change - indeed, perhaps turmoil would not be too strong a word! The GCSE examination will produce, is producing, children with a broader general education than before, inevitably at the expense of some depth of knowledge; and children who are used to learning in an investigative project-based sort of way. Initially, the A-level system is trying to resist these changes, but this position is obviously unsustainable and before long similar changes will take place in A-levels.

This will create a major mis-match between A-level and university education unless universities look very fundamentally at the nature and style of their courses. The evidence is that the universities are not doing this in any coherent way, though there is considerable activity in shifting the problem sideways by negotiating the provision of "access courses" in local colleges. However, this does not address the heart of the problem. The problem is an exceedingly difficult one because of its immediate implications for funding and financial support. But this makes it all the more important that it be tackled properly, for it is a problem that will not go away. The academic attainments of students entering university are beginning to slip downwards and sideways away from the traditional highly specialised entry requirements that have obtained hitherto. What universities need to do is to see whether their own very specialised courses might themselves actually be enhanced by slipping "downwards and outwards" a bit.

CHAPTER 6

INNOVATION IN UNIVERSITY COURSES

6.1 INTRODUCTION

Earlier chapters have outlined the major changes that are taking place in many facets of the "market" of potential undergraduate university students. It seems to the author that change must now be regarded as the norm in this situation; maybe stability will at some time return, but not for several years. However, major changes beget major opportunities - if only there exists the will to grasp them.

These opportunities can, should and must be used to benefit both the universities and the public. The universities have to protect themselves from the inescapable demographic trends of the next several years; they should look for ways of doing this creatively, so as to enhance the whole quality of education at this level. And it is nothing less than a social duty for universities to look towards benefiting the public as well, all the more so if it is indeed true (see section 4.3) that a greater proportion of 18-year-olds will qualify for higher education and that a greater proportion of those who qualify will actually wish to take it up. Further, universities ought to look towards the whole process of "continuing education", designing courses that are relevant, attractive and accessible to mature students as part of a general culture of continuous re-training.

6.2 OPTIONS FOR "PRODUCT" POLICY

First, it needs to be stated that analytic management tools that have been developed largely in the context of manufacturing industry can be applied with little if any formal alteration to service industries; and that, in this regard, the provision of courses by universities can be seen formally as being just like any other service industry. As an example of how analogies can be made, the design of courses that are suitable for what is really a different kind of student can be very strongly likened to new product development in the face of a different quality of raw material.

General guidelines for business strategy can be applied at corporate level and at business unit level. In the university context, these equate to University level and Department level, as it is the Department that is the fundamental management unit. It will become clear that the author strongly prefers the latter.

A simple but effective analytic tool, and one that has certainly stood the test of time, is the well-known Ansoff matrix. This first appeared in the September/October 1957 issue of the 'Harvard Business Review' , and has been widely adopted and discussed by numerous authors ever since; see, for instance, Baker (1985). The idea is to make a simple and basic, yet very powerful, statement of the strategic alternatives open to a firm based on joint consideration of changes in the firm's product(s) and/or in the market{s) it faces. The four basic strategies are collected in matrix form thus:-

	product: present	product: new
market: present	market penetration	product development
market: new	market development	diversification

Market penetration consists of the company trying to obtain increased sales for its present products in its present markets, by more aggressive promotion and distribution; market development consists of the firm taking its existing products into new markets (often by attacking new segments of the existing market rather than by moving into wholly new areas); product development consists of developing new improved products for the existing markets; and diversification consists of developing new products for new markets.

How does this relate to universities and courses? First, as already discussed in section 2.4, Brunel ought to see itself as being in a unique position to grow, or at least survive, by market penetration in respect of its "thin-sandwich" courses; and the author repeats that he will eschew all thoughts of "new product development" of non-sandwich courses as this would destroy Brunel's one clear, unique and unequivocal marketing advantage. More generally for all universities, the "access course" route fits into the bottom-left corner of the matrix in the sense that it is adapting the market to the product; this will be discussed at length in the next section. Section 6.4, however, will look at the route the author would prefer - adapting the product to the market, roughly the equivalent of the top-right corner of the matrix.

Could it even be that universities should consider going all the way, into the bottom-right corner? This is usually the riskiest position, and as such is unlikely to appeal to what are essentially conservative institutions. Really it depends on what one means by "diversification". The development of post-experience courses could be considered as such, and such development is to be welcomed; but sections 6.4 and 6.6 will attempt to position this, at least in part, in the top-right corner.

6.3 FITTING THE MARKET TO THE PRODUCT

This is what universities have, in effect, always done - though not, sadly, through any proactive ideas of market segmentation, but rather through an attitude that the courses in their existing form are sacrosanct and that it must therefore be ensured that the students are properly prepared to take them. Witness, thus, the universities' long-standing gross interference in school examinations (see section 5.5); and their frequent disdain for non-standard qualifications, exemplified by the discussions concerning Scottish qualifications in section 5.7.

The idea is, quite simply and quite firmly, that the existing courses

shall remain unchanged, except, possibly, for just a little tinkering.

Which would be absolutely fine if only universities could have their own preliminary year (though one would most earnestly hope that some general "broadening" activity would be included, as well as direct preparation for specialised study). But, as discussed in section 5.6, this is (almost certainly) an unrealistic dream. It is a splendid ideal to aim for - but it would require a complete change in government policy in regard of the funding arrangements, and there is absolutely no sign of such a complete change occurring. The initiative in engineering education, discussed earlier, offers perhaps the very slightest suspicion of a chink of light; and there have been some tentative steps towards preliminary years by the most prestigious British universities, which may perhaps be considered sufficiently "special cases" to warrant a modicum of special treatment. But, viewed overall, the author sees such a miniscule prospect of preliminary years being funded that planning absolutely has to be directed elsewhere.

"Access courses" are certainly a way of fitting the market to the existing product, and these are already in place and operational (see section 5.6). Arguments can indeed be made in favour of access courses rather than preliminary years, on the grounds that the Colleges running the access courses are likely to be more in tune with the "input" of students at that level. There is however the serious danger that access courses will be very strongly driven by the universities' academic requirements, even worse in fact than conventional A-levels, so that prospects for general broadening may be bleak. Nevertheless, the better Colleges can be expected to make a good job of running access courses; and these courses might well become very important to the colleges in their general portfolios of courses, for the colleges also are faced with problems of keeping numbers up .

A further point in favour of access courses is that they might ease the "cultural shock" of transition to university. It certainly seems that Sixth-Form Colleges can do this, with their relatively relaxed and informal atmosphere in comparison with what often obtains at schools. But care must be taken that the access courses do not become very regimented and even somewhat remote in their teaching, or precisely the opposite effect is likely to occur!

Whatever the virtues of access courses, it is probably unrealistic to expect many candidates to choose this route to university. In the case of pupils of school age, surely A-levels (in whatever form they evolve) will usually be a more natural route. Post-experience candidates can already often obtain direct admission to universities as mature students - and most surely this should not be restricted in any way - though some may choose to prepare themselves by spending a year taking an access course. But the author really cannot see large numbers coming forward to universities via access.

In any case, access courses do not touch the classic A-level intake, which will surely remain the vast bulk. As has been explained, the days of fitting the market to the product by virtual control of A-level syllabuses are now on the way out. A process of "tinkering round the edges" of university courses will be nowhere near enough to

bridge the gap that will develop as A-levels move "downwards and outwards" away from their present position. Tinkering of this nature really ignores the main problem; and, as explained in section 5.5, this is a problem that will become more severe.

And, returning to chapter 3, the problem is far worse in sequential subjects (notably, mathematics!) than in subjects that are to a large extent non-sequential. Some tinkering might in fact go quite a long way in some non-sequential subjects. But for the sequential subjects, it really is adopting the pose traditionally though highly unfairly associated with the ostrich.

But this should not be a cause for despair. Be bold, and go forward.

6.4 FITTING THE PRODUCT TO THE MARKET

It is in this area that the author argues for real innovations in course design.

Universities' courses will increasingly need to be marketed. This is already very evident in America, as is often brought out by Keller (1983). It will more and more be necessary in Britain - demographics will impel it, and student choice will become more important. Many old-fashioned academics will be horrified, but the marketing will just have to be done, or many courses will wither away. This being the case, marketing should be adopted with enthusiasm, and used proactively in designing courses that are absolutely sound academically but that also attach themselves to the real desires of the students.

And to the real needs of employers of graduates. The author has, in a rather casual way, been using some of Brunel's industrial contacts to enquire what the true requirements of employers are. This has not been done by any structured formal questionnaire approach, and so it may be objected that the evidence is anecdotal. Also, some employers have indicated that they would prefer not to be identified, and this can only be honourably achieved by not identifying any. But despite these shortcomings, the message is absolutely clear. The message comes from a wide spectrum of industry, business and commerce - from heavy manufacturing industry right across to financial services. The message is breadth. Employers, on the whole, do not very much want specialised technocrats (see also the earlier discussion in section 2.3 concerning Japan). They want bright, able, committed, intelligent and widely-skilled people, who can readily pick up the required specialised skills as they go along.

There are some exceptions. Perhaps inevitably, the exceptions tend to be particularly in mathematics and closely related disciplines, where there is some demand (but in no sense an overwhelming demand) for a high level of technical competence. Also, of course, highly specialised skills are demanded of those who would enter the academic profession, and of those who seek what might be called "quasi-academic" jobs - for instance as scientists in key research units.

These exceptions are important. But they are only exceptions. There seems to be a danger of repetition at the graduate-employment level

of the situation where the university tail wags the A-level dog. The suitability of graduates for most areas of employment must not be compromised by the perceived requirements of a very small area. Perhaps it will have to be accepted that where very highly-developed specialised skills are required some further training (e.g. a Master's Degree) is necessary. And maybe it will then begin to be thought that the development of such highly-specialised skills before entering employment is not in fact quite so necessary after all.

At the employment end, then, the market wants breadth. And at the input end, there will inevitably be greater breadth, and not so much depth, in the students than now. This state of affairs should be used, embraced, as the opportunity for a really fundamental look at courses.

Thus, all courses that are sequentially dependent on A-level knowledge will have to start at a somewhat lower level merely because A-levels will, sooner rather than later, bring candidates to a less specialised level of knowledge than now. This being the case, there will have to be some "designing down" of courses. Rather than do this reactively on being faced with students having serious difficulties with their studies, how much better to do it proactively and think through course design in anticipation of the new skills of the students - in a sense more restricted skills, but in another sense wider skills. And, while doing it, why not proactively design the courses for an AS-level intake in the sequential subject(s) rather than a full A-level? Even if AS-levels turn out to be unsuccessful, very little will have been lost. What will have been gained is that the courses will be more accessible to other students with non-conventional qualifications - such as candidates from Scotland and candidates with the various kinds of baccalaureates - and to mature students perhaps with no formal qualifications at all. And if the A-level candidates have an easier transition into university from their pre-university studies, that would be no bad thing. And if there is even yet any "spare time" in the first year, it can be used either for further sequential development of material or for broadening - or both.

It may be objected that this is fine if all universities do it, but if only some do it there will be some graduates in a given discipline who have proceeded distinctly further in the subject than others. The objection would be that this would be confusing to employers and that some of the graduates would be regarded as having only "second class degrees".

This last point is the worst kind of academic snobbery, and the author is absolutely certain that it would exist - but only initially. As far as the vast majority of employers are concerned, all the evidence is that they couldn't care less, and indeed may actually prefer to have graduates who have gone less far if this is accompanied by some broadening. The academic snobbery argument can be refuted on two counts. First, there is ample room in the British university system for more diversity of courses. Universities can, if they wish, differentiate themselves here, some providing courses of a much more traditional nature than others, but with everyone understanding that "lower and broader" does **NOT** mean "less academically respectable". The second point is that academic snobbery will in any case disappear in a few years because, as

discussed in chapter 5, old attitudes to entrance qualifications just will not stand up in the face of the changes in the school system. All universities will have eventually to take a more eclectic attitude; if they do not, they will have great difficulty maintaining adequate recruitment.

Far better to be in the vanguard of making the changes. Re-design courses fundamentally, welcoming a less-specialised entry, and designing in more breadth and flexibility to suit individual requirements. None of which, in any sense, requires any compromise of academic respectability.

6.5 THE MATHEMATICS "PRODOCT"

The special difficulties of mathematics, all stemming from the highly sequential nature of the subject, have frequently surfaced in this paper. In such a sequential subject, it is even more important to ensure that the first year at university meshes properly with pre-university education. So the fundamental re-appraisal of courses argued for in the previous section has to be even more thoroughly undertaken in mathematics-based subjects.

The distinction brought out in sections 3.2 and 3.3, between "mathematics-for-its-own-sake" and mathematics as a service subject, is important here. In the former case, the management responsibility lies clearly and unequivocally with the mathematicians. It is their duty to themselves, to their universities, to the public, and to their subject, to thoroughly review and re-design their courses in the manner of the previous section. Their task will be harder than that of colleagues in non-sequential subjects. But their opportunities are greater, to remove the aura of unnecessary difficulty that so often accompanies perceptions of mathematics, and to open the subject to new categories of students who might not have previously thought of themselves as potential mathematicians.

The author would beg to present Brunel University in a favourable light here as an example. True, Brunel still insists on a full A-level mathematics subject as a normal entrance requirement, and usually at a quite high grade. But Brunel will accept candidates with only one A-level mathematics subject, and takes the view that whatever supporting subjects are offered they are welcome, provided that a reasonably good level of performance is achieved. Thus the student body in Brunel's mathematics department includes those whose three A-levels are mathematics, English literature and religious studies or mathematics, French and German as well as the more traditional scientists with mathematics, physics and chemistry and those with various combinations such as mathematics, economics and geography. And it is abundantly true that the candidates from varied backgrounds on the whole do just as well as those from a wholly scientific background, and certainly they do not have the slightest difficulty in obtaining excellent employment immediately on graduating.

This position at Brunel is in marked contrast to that at some other universities, where there is insistence on two full mathematics subjects or, at the very least, a wholly scientific background. Indeed, Brunel goes even further, in accepting A-levels in pure-

mathematics-with-statistics as a full A-level mathematics subject, whereas quite a number of universities fail to recognise this subject in this way. The author has no hesitation in attributing the academic snobbery epithet to such institutions.

And even at Brunel, there is difficulty. Arguments do rage. Some colleagues clearly have grave hesitations about recognising "pure-with-stats" as being a "proper" A-level in mathematics. And some would clearly prefer a much deeper mathematics background in general, rather than mathematics combined with wholly disparate subjects. Fortunately, broadness has its energetic defenders at Brunel - and none more energetic than the broadly-based students themselves, who contribute enormously to the general culture of the student body, and some of whom, year after year, carry off excellent First Class degrees. But it is clear even from Brunel that there is a long, long way to go to break down entrenched old-fashioned academic attitudes.

Turning to mathematics as a service subject, the situation is bedevilled by the serious political problems outlined in section 3.3. These problems must not be allowed to stand in the way of the fundamental process of course review. It is obvious that this review must be undertaken by the subject specialists of the main discipline. Among many other tasks, they will have to consider what level of mathematical knowledge is to be required in their students and, from this, how much mathematics needs to be taught within the courses themselves. Naturally the mathematicians should be consulted for advice. But, ultimately, the mathematicians will have to live with, and provide for, the requirements of the main discipline (indeed, the mathematicians will, in the most fundamental sense, have to market mathematics in this context - find out what the "customers", i.e. the other departments, want, and provide it). But at the same time the subject specialists in the main discipline must live with a requirement for mathematics. If they are unwilling or unable to continue to insist on a fairly high level of mathematical ability on entry to their courses, they must make realistic allowances for mathematics to be taught within the courses.

As has already been pointed out, the political problems here are very great. Probably the best start the mathematicians can make is to do a good job, and be seen to do a good job, in reviewing their own courses.

6.6 MATURE STUDENTS

Everyone in principle welcomes mature students. They bring a breadth of experience and usually a highly committed attitude to their studies. The annual statistical returns of the Universities Central Council on Admissions show that their numbers are increasing, though of course from a very low level; they remain a very small proportion of the total student population at undergraduate level.

Their admission is usually based on absolutely no formal entrance qualifications, though in general some attempt will have been made to see that there is something in their educational background to suggest that they will be able to cope with the course. In non-sequential subjects, this is relatively easy. But the old

trouble of sequential development surfaces yet again in mathematics. Indeed, not only is it likely to be extremely difficult for a mature student without a "normal" mathematics background to cope with the material, but also a lengthy gap in mathematical study will create difficulties even for a student who does have a reasonable mathematics background. Mature students in mathematics-based subjects are therefore few and far between, and probably the more old-fashioned mathematics academics welcome them in practice rather less than they do in principle.

(This has certainly been the author's experience at Brunel. The author, when an Admissions Tutor, admitted a mature student with no A-level mathematics background to one of the mathematics-based courses. The author is wholly and completely unrepentant about having done so. But there has been much criticism from some quarters about the presence of such a student in the department. Certainly the student has had much difficulty with the more heavily mathematical courses, and was within an ace of being failed altogether at the end of the first year. But overall the student has done well. The author fervently believes that it is right that such students should have the opportunity to take mathematics-based courses; to object to their presence is another old-fashioned academic attitude that just must change in modern times - and the sooner the better.)

The re-design of mathematics courses, to make them more accessible to students with a lower level of previous knowledge, should surely benefit mature students. Hopefully, more mature students might come forward for mathematics-based courses if they know that such re-designed courses have been wholeheartedly adopted. Universities would thus be enabled both to benefit themselves, by having a greater number of mature students on the enrolment, and to benefit the public, by making university-level mathematical education more accessible to adults.

There may even be a very much bigger prize within reach. Britain does not currently enjoy any significant "continuing education" culture. To be sure, Master's Degree courses are often well-subscribed by mature adults seeking new qualifications and/or new opportunities; and a wide variety of institutions are very successful in running all sorts of post-experience courses. But the total number of participants in such ventures is small. Just think what would happen to student numbers if the availability of broadly-based and accessible (and skilfully marketed) undergraduate-level courses brought about a sea-change in Britain to an ethos of continuous training and re-training, and if this was mainly done through universities rather than through other institutions or through companies' in-house activities.

6.7 IMPLEMENTATION

Implementation of the material in section 6.3, fitting the market to the product, does not really need to be discussed. The basic ideas are access courses and preliminary years. Access courses have already been implemented; many are already "up and running". Preliminary years are not really within universities' collective gift to implement; only government can beget them, by providing the

funding. Obviously, universities could put pressure on government in this direction, and hope for the best. But, as explained above, the author sees virtually no prospect of success. So this section will be concerned with the implementation of section 6.4, fitting the product to the market. (If, out of the blue, funding for an extra year did then materialise, there might be a case for arguing for an (optional) extra year at the end of the course, perhaps for a Master's Degree, rather than at the beginning. One or two cases do exist, particularly in engineering, where something of the kind is available.)

Implementation of major innovation is required.

Much attention is devoted in the management literature to the management of innovation. The classic study is probably that of Burns and Stalker (1961, reprinted many times since); see also, for instance, Drucker (1985) more particularly on the management of the search for innovations. Texts on general business strategy also contain, or ought to contain, sections on innovative activity; see, for instance. Porter (1980) or, for a rather different approach, Quinn (1978). These writers identify and discuss major problems, not so much of failure to generate innovations within organisations, but of the widespread prevalence of organisational structures that are not receptive to innovation and where the very real organisational conflicts that accompany innovative activity have not properly been thought through. The situation is beautifully summed up by a delightful verse quoted by Child (1984) as having been written about the management structure of one of Britain's largest enterprises:-

> "Along this tree from foot to crown,
> Ideas flow up and vetoes down."

It really is not possible to summarise these general management issues in a few sentences for this paper; the author's full dissertation contains an extended treatment. It must suffice to say that the conditions symbolised by the above rhyme are widespread but must be avoided. This can best be done by management creating a climate (or "culture") in which innovative activity is encouraged and rewarded, but largely refraining from direct involvement so that enthusiastic local initiators can get on with the job without unnecessary constraints.

For it is the local people who know the local situation. They will (or they should! - and if they don't, no-one else will) know about the backgrounds of potential students in their own disciplines; and they will know the sort of subject matter that it is proper to incorporate in university courses in those disciplines. So leave them to get on with it. Recognise that they are highly skilled professionals who will do a good professional job. They have no need of any strong central control. Worse, central control will get in the way. Central control will tend to impose structures and procedures that may look absolutely rational and reasonable but that will, in all sorts of insidious ways, hamper the actions of the local initiators. What is needed is a flexible, adaptive and proactive response to local circumstances, within a broadly laid down overall strategy that there shall be newly-designed, broader and more accessible courses. In the context of commerce, it would be regarded as local entrepreneurship. In academic circles it may need to be

called something else to avoid raising too many blood pressures, but the basic idea is still the same. It is essentially a matter of enthusiastic local flexibility.

As has been mentioned, this largely requires the absence of executive involvement by top management. The key duty, responsibility and fundamental necessity of top management is to establish a culture in which individual departments are encouraged to look for changes, developments and innovations in their own subject areas, and in which the departments likewise encourage individual members of staff to do all the same things. For the real local innovators are usually individual members of staff, not departments somehow acting corporately. Positive management is indeed required, but at local - very local - levels of initiative. And it is vital that this should take place. For if a university does not engage in real innovation in its undergraduate courses, many of the courses are likely to atrophise for want of students.

CHAPTER 7

CONCLUSION

7.1 WIDER ISSUES

This paper has focussed on major changes that are taking place in the universities' marketplace of prospective undergraduate students. Massive though these changes are, they are only a subset of the totality of major changes currently facing universities.

These changes include the replacement of the University Grants Committee by a new intermediary body. There seems to be an expectation that government policy will be implemented through the new body in a rather different way, perhaps with the universities being required to enter into arrangements that approximate more to contractual agreements than the previous system. It is very unclear whether this will make any overall difference to the situation regarding undergraduate teaching; but certainly there will be no diminution of individual universities' responsibilites to make proper arrangements for undergraduate teaching in the light of all the new circumstances discussed in this paper. Indeed, if the new body has an increased representation of industry, business and commerce, as opposed to being almost entirely dominated by academics, it is possible that it will itself give a little more attention to matters

Partly related is a distinct possibility of a move away from the system of "dual support" of research by both the UGC (and its successor) and the Research Councils. Any such change would be of great importance to universities. And while it can in a sense be argued that it does not really affect the teaching issues discussed here, it can also be argued that it becomes even more important for a university to get its teaching right so that management attention can be given to important research matters.

Two developments that will undoubtedly be of absolutely crucial importance to universities' undergraduate teaching are changes in fees structure and in student support arrangements that the government seems inexorably determined to make. Concerning the fees structure, the fee paid nominally by each student (in practice by his or her Local Education Authority as part of the grant arrangements) is to be substantially increased, with universities apparently to be encouraged to increase their income by increasing their student intake. And in the case of student support arrangements, it seems likely that a move towards loans rather than grants will start in 1990. Some commentators even advocate the introduction of vouchers for university education, exchangeable at the institution of the candidate's choice. Perhaps the system will not move this far, but the introduction of loans looks certain. All sorts of political statements have been made, to the effect that it will be either a huge success or an unmitigated disaster, depending on one's political point of view. No doubt the only safe statement that can be made is that no-one has the slightest idea what difference (if any?) it will make!

What is for certain, though, is that universities will need to be

even more on their mettle in ensuring that their courses are up-to-date, relevant, attractive and accessible. If there is to be a major change to the market as a whole, it is all the more important for any player in that market to have a good competitive position.

Another possible imponderable comes with the removal of intra-EEC barriers in 1992. There is some serious talk of establishing a "common currency" in end-of-school qualifications. Any such move must make a major difference to universities' entrance requirements, and could bring about yet further broadening of school education in England and Wales towards what commonly obtains in the rest of Europe- The question might also be raised as to whether there might appear also a "common currency" in degree qualifications; but to a large extent there already is, with so many employers of graduates both operating and recruiting internationally - which, in passing, further highlights the fact that the highly specialised education in English and Welsh universities is not necessarily in itself of overwhelming importance to employers.

7.2 CLOSING REMARKS

Change, change, change. The French, of course, have a saying for it, suggesting that despite more and more change things stay much the same. But complacency here will not do. The changes are fundamental, structural and inexorable. The whims and fancies of politicians will not alter demography; they are unlikely to be allowed to reverse the moves towards an enhanced learning experience at schools, of which more breadth but less depth is an inevitable consequence; and they will not want to renege on moves towards wider access to university education. The market of prospective students, and the market of employers of graduates, has already become more important as a determinant of provision at universities, and will without doubt become much more so.

Change begets opportunity. Opportunity for universities to help the public and the nation, and at the same time help themselves. Innovation is called for, and is fundamentally necessary. It requires university managements to attach far more importance to the management of teaching, but in a "hands-off" style. Encourage local innovators to get on with it. Allow local innovators to get on with it. Leave local innovators to get on with it.

For if the innovations are not made, a university's teaching may go into terminal decline.

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