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UK Higher Education Space Management Project

Impact on space of future changes in higher education

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Foreword

One of the largest challenges facing each higher education institution is that of working out how much space it will need in the future. Estates infrastructure decisions are far-reaching, both as to their costs and the long-lasting nature of their outcomes. This report, produced by Professor Ronald Barnett and Dr Paul Temple of the Institute of Education, is the result of a survey of changes in institutions' current space usage and their likely future space needs. It was commissioned by the Space Management Group as a contribution to research in this area. Our hope is that it will act as a stimulus to further debate across the sector.

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Executive summary

This report to the UK-wide Space Management Group, by the Institute of Education, is intended to stimulate debate about the use of space in higher education institutions (HEIs). It approaches space use from the perspective of how academic activity might change in the medium term. The report will be of interest to academics and managers who are seeking a fit between their changing operations and the physical infrastructure.

Our main findings, as set out below, are based on a research methodology focused on interviews with academics and managers in a cross-section of English HEIs.

HEIs are complex organisations, performing a variety of tasks for a range of stakeholders, both of which change over time. Space is an important input into the institution's production process: but institutional managements have to consider it as one of a number of inputs to be blended to optimise the desired mix of outputs. Maximising space usage, as an end in itself, is not a rational objective for an HEI: space needs to be considered as part of its overall resource planning process.

The UK higher education system is becoming increasingly diverse: it is almost impossible to claim that any set of policy prescriptions (whether about academic priorities, students and staff, or resource acquisition and use) can apply across the sector. This increasing diversity is already leading to diverging approaches to the use of space, particularly between teaching-led and research-led universities. This divergence is likely to increase.

However, for differing reasons, no institution is likely to experience a significant reduction in overall space needs in the foreseeable future. Reductions in one area will be offset by new demands elsewhere. Across the sector as a whole, we predict that a modest increase in space use will be observed over the coming decade.

Space will be subject increasingly to remodelling for new needs or to meet new standards. With imaginative design, space can be deployed flexibly to meet multiple uses. Even so, constraints on capital budgets will probably limit the benefits to be obtained from this process.

We believe that 'learning space' will be seen as one of these new needs, with more provision being made for student-led and 'blended' learning (a mixture of face-to-face plus IT-mediated learning). This will demand more relatively small and adaptable spaces. IT developments are enabling more intensive use of space for teaching and learning, but will not permit significant reductions in overall space use.

Research activities will require a small net increase in space, concentrated in a small number of institutions.

The quality of an institution's physical facilities will increasingly be seen as an important marketing asset and will accordingly attract more resources and management attention.

The Space Management Group recommends that this report be circulated widely in HEIs and that the issues raised should be considered by academics, managers and governors as they plan the continuing development of their institutions.

1   Terms of reference and introduction

1.1   Our terms of reference for this study were:

To assess the impact of future changes in higher education on space requirements. This should include known trends in demand for courses, methods of teaching and learning, the impact of widening participation, and possible changes in research activity. The project should also look at the impact of distance learning, e-learning and self-directed learning.

1.2   We interpreted these terms of reference as asking us to look forward across something like a ten-year timeframe: shorter than this, and the context is largely already set; much beyond this, and the unknowables can begin to outweigh intelligent guesswork.

1.3   The study addresses non-residential space needs in accordance with the remit of the UK Higher Education Space Management Project. We agreed that our study should omit consideration of space needs for medical education, as this is generally bound up with hospital space.

2   Methodology

2.1   Our approach has been to undertake a series of semi-structured interviews with academic and administrative staff, and to see various types of space use, in a broadly representative group of higher education institutions (HEIs). These institutions were:

- University College London: a long-established, research-intensive institution, with a wide mix of building types in central London

- University of Leicester: a civic university in a provincial city/suburban setting

- University of Sussex: a 1960s campus university on a greenfield site

- University of Hertfordshire: a teaching-oriented post-1992 university in a suburban setting

- University of the Arts London: a specialist art and design-related institution, dispersed on a number of sites in central and inner London

- Cass Business School, City University: a business school in new purpose-designed premises in the City of London

- School of Pharmacy, University of London: a science-based professional college in central London.

2.2   We consider that our discussions with staff in this group of institutions provided us with views which reflect both the educational variation, in most key dimensions, found in UK higher education today, and the physical settings in which this education takes place. But our purpose, of course, was to look forward, not simply to report on current patterns of use.

2.3   We are most grateful to colleagues in the institutions mentioned who generously gave up their time to talk to us.

2.4   We were assisted in our field studies by John Farrant of Universitas Higher Education Management Consultants.

2.5   Our approach was to enquire about space use by reference to categories of potential change (decrease, change within the current envelope, and increase) and the factors which might be affecting these changes. Our initial ideas on what might be driving these changes are summarised in Figure 1.

2.6   In addition, we undertook a literature review, in which we were assisted by our colleague Dr Kaori Okumoto, and considered the implications of the other studies conducted and reports produced as part of the Space Management Project.

2.7   There is little work of any great weight, analytical or descriptive, in the literature which directly relates to our research question. We hope that this report might go some way to filling this apparent gap in understanding.

Figure 1: Potential drivers for change in space usage

Reduced space use	Changed use within envelope	Increased space use
Increased efficiency in space use	Increased student and staff numbers	
Increased use of distance learning/IT	New teaching methods (including IT use)	Research needs
'Portfolio' staff, not working in institution	Lifelong learning, causing new space mix	Enhanced community use of facilities
Increased student-staff ratios leading to unit space savings	Move to higher-value activities	New health and safety or access demands
Workplace-based learning	Changed approaches to library use	Better student facilities (for international students)
Space redesign/restructuring of functions		New central infrastructure demands (marketing, quality)
Changed subject requirements		

2.8   We have not attempted to predict the future size of the higher education system or its estate, in terms of either student numbers or research output, or their space demands. Rather, we have tried to identify how the drivers of space demands for any given number of students and quantity of research work are changing, and might change further. Nevertheless, the major changes which have affected the higher education system over the last decade or so must colour any views of the future – notably the end of the division between universities and polytechnics, the rapid growth in student numbers towards a 50% participation rate, a reduced unit of resource for teaching, efficiency gains, and greater research selectivity. We have tried not simply to reflect views expressed about the current situation (though naturally this was what tended to preoccupy many of our respondents), but to look to the future.

3   Space and the HEI's role

3.1   Over the next decade, higher education will come to occupy an even more prominent place in the national life of this country, and of other advanced countries, than it does now. Developments in 'the knowledge society' will make higher education's role in the production, understanding, application and transmission of knowledge of all kinds fundamental to most elements of social and economic activity. Some commentators have suggested that higher education will become one of the largest global industries in the early decades of the 21st century (Duderstadt, 1999).

3.2   Might this enhanced role for the HEI mean, though, that physically it becomes more dispersed and varied, its location less relevant? Or at least, that the traditional campus becomes a minor part of its total 'virtual estate'? Might the HEI become embedded in a range of other public and private institutions – workplaces, shopping centres, cultural venues – taking advantage of far more flexible and powerful IT devices: a face-to-face but virtual university, in fact? (Agre, 2002). This is what one study seems to have in mind when it predicts that 'increasingly organisations [such as universities] will move outside of the physical container of their own buildings' (Harrison and Dugdale, 2004).

3.3   We expect that this will happen to a certain extent; but one of the university's most

remarkable features is its durability as a coherent organisational and physical form. Clark Kerr, formerly President of the University of California, has claimed that, of the 75 or so institutions in the Western world established before 1520 and still existing today in a recognisably similar form, 60 are universities in the traditional sense of the term. The design and use of an HEI's physical spaces may, in turn, indicate much about the enduring culture of the university. This organisational and even cultural stability reflects paradoxically, we suggest, HEIs' evolved skill at handling change: an apparently unchanging exterior masks constant interior turmoil.

3.4   Without pursuing this theoretical consideration, our empirical work has emphasised the integrated nature of most of the institutions we have observed. Their strengths derive from internal trans-disciplinary contacts, from the connection of teaching with research, from the connection of the academic with the social, from the relatively non-hierarchical connection of senior academic staff with junior colleagues, and so on. (It is the preservation and development of this integrated form which provides many of the management challenges in higher education.) As well as enhanced effectiveness in terms of learning and research outputs, these integrations produce economies of scale and reduced transaction costs. For HEIs, the whole is greater than the sum of the parts.

3.5   We suggest that HEIs' more or less coherent and continuing physical presence is, to an important extent, what allows these integrated features to operate, and so to make them dynamic and resilient organisations. (This need for physical coherence may also help to explain why the 'branch campus' approach – on the face of it a sensible way to spread the benefits of academic excellence more widely – is usually problematic in practice: there are no important global universities.) The importance of a continuing physical presence partly explains why, as Kerr observes, so many of the pre-1520 universities are on their original sites, some still using their original buildings. It is why effective institutions will not move towards giving up

large parts of their core space and instead purchasing 'space…on demand, on an hourly, daily, or monthly basis' (Harrison and Dugdale, 2004). A further practical reason is that relatively little commercially-available space is immediately suitable or available for teaching use. Nor have we seen any signs of the prediction by these writers that HEIs will be concerned about how to manage their 'long-term space surpluses'. Instead, institutions generally appear to be attempting to balance the immediate demands of working with space that is at least partly out-dated, and planning for longer-term restructuring.

3.6   The physical form of the HEI, then, is related to its academic effectiveness, though in ways which are not fully understood, and which are often overlooked when making planning decisions. One recent study of the design of HEIs made this point neatly by quoting Winston Churchill to the effect that 'we shape our buildings and afterwards our buildings shape us' (Jamieson et al, 2000). By contrast, Harrison and Dugdale's (2004) assertion that what is needed is 'a fundamental re-evaluation of the way that academic institutions function' because changes in space use are 'challenging traditional academic practice' seems to put things back-to-front, by implying that space issues should provide the basis on which educational objectives are determined.

3.7   Rather than HEIs becoming physically dispersed, we suggest it is more likely that other organisations of all types will wish to cluster round them, both physically and conceptually. The growth in UK university science parks, and what has been called 'the Cambridge phenomenon' (SQW, 2000), where firms spun-off from the HEI remain in its locality and through network effects attract others (something which the Government's new 'science cities' initiative hopes to repeat), are local examples of a global trend. Demand and planning constraints will mean that the value of space within, and close to, significant research institutions will tend to increase in the long run. This will apply not only in science and technology (as with most current science parks),

but increasingly in the social sciences and in subjects allied to the creative industries.

3.8   Interconnections with an HEI's regional business community are being promoted by a wide range of agencies. In addition to HEFCE's Higher Education Innovation Fund (HEIF), Regional Development Agencies, the NHS and numerous other agencies have injected significant capital into HEIs. These new relationships between institutions and their wider communities are associated with new forms of knowledge production and new conceptions of knowledge itself, as it takes on more of a problem-solving character (Gibbons et al, 2004). In turn, there are not just novel uses of space on campus but often a blurring of the ways in which an HEI's physical facilities are used, across teaching, research and 'third-stream' activities with business and the community.

3.9   There is undoubtedly an element here of 'branding' – other organisations wishing to associate themselves with an HEI's good reputation – on which the Harrison and Dugdale study sets such store. But the more powerful driver of links and clustering is likely to be the network effect, which has been studied empirically in various settings and industries but is especially important for knowledge-based firms (Maskell, 2000). These firms contribute to, and draw from, a shared pool of knowledge, which usually has quite limited physical parameters: California's Silicon Valley is perhaps the most-studied example of this phenomenon (Cohen and Fields, 2000). 'Location, location, location' is the mantra for the knowledge industry as much as for the property industry.

3.10   It has been argued until quite recently that e-learning at a distance will become so pervasive as to halt, or at least to slow, the physical development of campuses. 'New educational systems will be created by technology-based teaching. They will eliminate geographical and jurisdictional boundaries…[it will be] a world in which traditional [methods of] higher education will no longer work' (Daniel, 1998). A similar view is that 'the impact of information technology…[is] challenging the historic models

of what a university is' (Harrison and Dugdale, 2004). We could cite much else in the same vein, mostly written at the height of the dot.com boom. We discuss e-learning issues affecting space later. We shall suggest that claims of the kind made here are generally unfounded, and that new technologies for teaching and learning will have only a limited impact on institutions' space needs (although they may, ultimately, have significant pedagogic impacts).

4   Factors affecting space demand

4.1   Space requirements in higher education are determined by exogenous factors (those originating beyond the HEI), covering relations with the wider society, student demand, government policies, and so on; and endogenous factors (those emerging from within academia, broadly defined), covering changes within academic disciplines, new pedagogic methods, organisational changes, and other internal issues. The two sets of factors may interact: changes in government policies, for example, may affect organisational structures.

4.2   Exogenous factors are extremely hard to predict beyond the short term of a year or two. Current government policies for increasing and widening participation in higher education, for example, have had major impacts on space planning, as exemplified by the new building seen at many institutions, new and old. Political change could halt or even reverse these policies, though various social forces make the latter highly unlikely (Wolf, 2002). The impact that such changes would have on actual space use would in turn depend on a range of unpredictable variables, such as the financial situations of the institutions concerned, and conditions elsewhere in the world higher education market.

4.3   Space demands are of course affected by the institution's mix of on-campus students (full-time as compared to part-time, and the disciplinary mix); and the extent to which it uses distance learning of various kinds. It is estimated that demand for **undergraduate places** in the UK

(total headcount, ie, not simply new entrants) to 2010-11 will increase by between 160,000 and 240,000, driven by a mixture of demographic growth and improved A-level results (Aston, 2004). The increase in the 18-20 year-old cohort levels off after 2008-09. While this projected growth in demand is significant, it has to be set against a current comparable student number total of some 1.7 million undergraduates, out of a total UK higher education student population of 2.3 million. The projected increase is therefore in the range of 6-10% of the total. (The Secretary of State's December 2004 grant letter to HEFCE plans for an increase in total student numbers of 5.6% by 2007-08, which is consistent with these estimates.) Part of the growth in undergraduate student numbers will take place outside HEIs, mainly in further education colleges, and some will be for two-year programmes, with a correspondingly reduced demand for space. Most of the rest of the increase will probably take place in teaching-led HEIs, where it will have a slight impact on space demands. (Admittedly, conjectures about future demand for student places have to be treated cautiously until the effect can be seen of the introduction of variable fees in 2006.)

4.4   Growth in home/EU and overseas **postgraduate student** numbers, mainly on taught masters programmes, has been rapid in recent years, driven particularly by growth in overseas numbers. There has been a slight fall in numbers on doctoral programmes, and a larger fall in demand for diploma and certificate courses, other than the postgraduate certificate in education. A recent estimate (Sastry, 2004) suggests that a further 10% growth in postgraduate numbers – about 50,000 students – might take place during the current decade. A further increase in postgraduate numbers may have an impact on the configuration of space use within HEIs, as we discuss below, and will probably lead to demands for marginal increases in space overall, driven by the needs of the humanities and social sciences. But, in institutional terms, postgraduate numbers are relatively concentrated, particularly for research degrees: half of all institutions have virtually no research postgraduates.

4.5   In 2002-03 **overseas students** comprised about 8% of all students, split roughly equally between undergraduates and postgraduates. Overseas numbers are subject to considerable fluctuations for economic and political reasons: compared with five years previously (1997-98) numbers fell slightly both in absolute and percentage terms, with decreases in undergraduate numbers being offset to some extent by an increase in postgraduates. We do not anticipate overseas student numbers as such to have a significant impact on future space demands, although this market is likely to continue to be volatile.

4.6   A further exogenous consideration is that of changing student preferences, exemplified by the current swing in demand away from science and technology and foreign languages. We consider this point later. We note, however, that the Government is now expressing concern that falling demand may have damaging long-term national consequences for provision of these subjects. We therefore expect that space for currently undersubscribed subjects will continue to be provided, although possibly in slightly reduced quantities, as it is has long been for 'minority' subjects, mostly languages, that are considered to be nationally important.

4.7   The Open University has some 160,000 mainly part-time students undertaking distance learning. There are no data available on distance learning activities of other HEIs, but we believe them to be small in terms of overall student numbers. We know of no evidence, as distinct from assertions, that this activity is likely to grow significantly in the foreseeable future (Slater, 2005). Indeed, so far as UK students are concerned, national policy appears to be to make new or improved physical provision (such as the UHI Millennium Institute in Scotland, and developments in Cumbria and Cornwall), using distance learning in support – 'blended learning' – rather than to rely on distance learning delivered in these regions by existing HEIs, as would have been entirely possible. Given this approach, it seems unlikely that institutions will in future be providing a significantly higher proportion of their UK-based teaching output by

distance techniques than they do now. Growth in distance learning for overseas students will no doubt continue, but will have minimal impact on space demands. We consider these student number-related issues further below.

4.8 So far as endogenous factors are concerned, three broad sets of factors will affect higher education's demand for space during the next decade or so. One will be changes in the nature of **academic disciplines**, causing them to need either more or less space to undertake the same quantity of teaching and research as now. Another will be changed **pedagogic approaches**, affecting the size of student groups, the frequency with which they meet, and the type of space they need. The third set of factors is **managerial**, covering issues of institutional organisation, structure and methods. Here we include changes to the length of the teaching day or year, space allocation methods, and technological changes (in IT, particularly). The impact of these factors on space use will come about through organisational changes of various kinds.

4.9 Of these endogenous factors, we consider that the managerial ones will have the greatest effect. We discuss the factors in more detail in the next section.

5 Trends in space management

5.1 The relationship between an institution's teaching and research goals and its use of space is a complex one. HE managers will have a view of existing and likely future space availability when making strategic choices, and there is inevitably an interaction between academic, financial, space and other considerations in the decision process. HEIs arrange the production of teaching and learning, and research, in different ways: existing space will be one factor affecting the choice, or a decision to undertake certain teaching or research may lead to the provision of new space. 'Inefficient' use of space in a narrow sense may lead to larger efficiencies in the institution's total outputs. From a strategic management perspective, it makes little sense to

consider space use in isolation from other institutional goals.

5.2 HEIs have, however, become more efficient in their use of space, teaching much larger numbers of students since the late 1980s without a proportionate increase in accommodation. This has reduced average gross non-residential space per full-time equivalent student in the period from 1992 to 2001 by 42%, from 14.7 m^2 to 8.5 m^2 (AUDE, 2003). Since 2000, the area of teaching space has remained fairly constant, despite a further increase in taught full-time equivalent students of 8.2% over this period (HEFCE, 2004). Space for research has increased by some 9% since 2000, driven by increased funding through research grants and contracts rather than by student numbers. This is not to say, however, that individual spaces are necessarily used more intensively (though we think that most are): other ways of managing student learning have been devised.

5.3 To cope with these changes, all the HEIs we studied now operate centralised timetabling and room-booking services for all except small rooms and specialised teaching spaces, although in large institutions these functions may, for practical reasons, be centralised at campus or faculty rather than HEI level. These developments have allowed institutions to operate more complex modular degree structures and to make space available for new academic functions.

5.4 Individual departments or units have mostly lost control of 'their' space, except when it is highly specialised. While this has improved the utilisation of space overall, some academic staff point to a loss in the quality of the student experience. This may arise from reduced teaching time, as students spend more time moving from one teaching session to another across the campus, rather than staying within the department; a reduced ability to conduct informal teaching, for example, providing further explanation of difficult points immediately after a lecture or seminar; and reduced staff/student social contacts. In other words, efficiency gains measured in the amount of space per student

have been bought, it seems to many, at the price of some diminution in learning and of the student experience more broadly. Good practice in space management may be able to offset these difficulties, for example by zoning to co-locate activities and thereby reduce student movement, but there will necessarily be a balance to be struck between these two pressures.

5.5   Most HEIs have also aimed to improve space use by extending the teaching day, and/or week, and/or year. We found, for example, that where the teaching day had traditionally been from 0930 to 1730 hrs, it now ran from 0830 to 1830 hrs. These two extra hours a day – the equivalent of nearly one and a half extra days per week – should have had a major impact on space utilisation. But reluctance by staff and, in particular, full-time students to attend early and late sessions, for a variety of reasons (including child care and travel issues), usually limits the space savings which should otherwise occur. Even so, one institution we visited now had 15% of its teaching undertaken after 1700 hrs, using space which would otherwise be largely unused. We expect that, over time, the extended teaching day will become more acceptable, allowing these gains to be extended. But insofar as students come to see themselves more as paying customers, as they may increasingly do with the new fee arrangements from 2006, they may expect classes to be provided at times convenient to them, rather than at times which allow institutions to maximise space usage.

5.6   Similarly, attempts to extend the teaching week or year have created tensions with academic staff under pressure from different managerial imperatives, for example to undertake research or third stream activities. In one case, space efficiency has been deliberately sacrificed by concentrating teaching into the first two terms (though with only partial success), to make more time for research between April and September.

5.7   This highlights the point that, in managing an HEI, space is only one of several production factors which need to be managed in order to maximise a defined set of outputs. The HEFCE

Good Management Practice study of space management concluded that institutions would adopt differing approaches to space use according to their differing missions: 'effectiveness must be considered alongside efficiency' (University of Newcastle upon Tyne, 2002). It may be perfectly rational to plan for a superficially inefficient use of space (for example, leaving teaching space unused for long periods) if other high-value outcomes are thereby achieved, such as a high RAE score or a high-quality learning experience. This finding shows that the future demand for space needs will not depend on relatively simple drivers such as student or staff numbers, but on a set of complex factors related to institutional missions and aspirations.

6   Teaching space and learning space

6.1   Most studies of teaching and learning in higher education (such as Light and Cox, 2001) focus on the cognitive and sociological aspects of the process, rather taking for granted the physical environment in which these processes take place. A recent paper draws attention to the similar lack of consideration of the connections between the physical environment and learning in schools (McGregor, 2004). The challenges of managing an enlarged higher education system should mean that, in future, space issues form a more central component of such studies, and of management concerns related to teaching and learning.

6.2   A notable recent trend has been a recognition of the need to provide **learning space**, as distinct from teaching space. We can categorise the use of such space for student-led learning in terms of formal (timetabled) or informal use, and individual or group use. This trend is particularly observable in library or learning centre planning, where space is increasingly being provided for students to work by themselves, either in groups or individually. We were struck by the tendency in libraries/learning centres to relax prohibitions on noise to allow for group project work. This is apparent in research-intensive institutions as well as in teaching-led ones, though the trend is more

marked in the latter. In these environments, noise management becomes an increasingly important issue.

6.3   The design of **generic teaching space** in new buildings is also taking account of the need for more flexible provision, to allow for different-sized groups working in different ways, perhaps outside already extended working hours. This may have access and even catering implications (Jamieson et al, 2000). Such a learner-centred design philosophy points to greater adaptability in the design of space of all kinds, which will have more digital facilities built-in: 'spatial, human and digital connections must be optimised within the building', as one group of university designers puts it (Kopp et al, 2004). The most modern higher education buildings now provide much more of their space in units which can be reconfigured, and in small rooms designed for group learning. We anticipate that these developments will continue, with institutions providing more space for unstructured/ad hoc self-directed learning and peer-teaching among students.

6.4   Little consideration, however, seems to be given to whether such provision will occupy more, or less, or the same space as traditional facilities. We may hypothesise that greater flexibility and adaptability should reduce present distinctions between space types, and so allow more intensive use. This greater intensity of use might lead to a reduced overall demand for space. Any such reduction is likely to be small, however.

6.5   More intensive use is being seen in longer library opening hours: 24 hour opening during the working week is becoming more common, especially where many students are part-time, possibly working shifts. Self-service book issue machines have facilitated this trend. This is another way of maximising space use, though at the cost of increased spending on staff, technology and facilities management.

6.6   Learning space is also sometimes provided in the form of rooms with banks of PCs, printers and so on, available for general student use, or sometimes for informal teaching. Connections to the HEI's network in student residences, and the introduction of wireless systems throughout the campus, allied with virtual learning environment (VLE) systems, are leading to the situation where almost any space can be used by someone with a suitably configured laptop – for writing, studying lecture materials, or communications. There was no suggestion, however, that VLEs would of themselves lead to space savings as distinct from efficiency gains for staff and students; rather, the implication is for increased flexibility in space design. Nor does it seem likely within the immediate future that the demand for fixed PCs, and their peripherals, will diminish noticeably; there is likely to be a convenience factor associated with them for some time to come.

6.7   Learning space merges with aspects of more general amenity space, including common room areas and cafeterias. Student demand for facilities of these kinds with standards comparable to good commercial provision has led to constant upgrading across the sector. More on-campus provision is also being made for shops, banks and other facilities. Taken together, these facilities may be seen as part of making the institution into a more balanced community. This implies an enlarged estate, though one with a compensating income stream from users.

6.8   The demise of the formal lecture has long been predicted, based on empirical findings as to its general ineffectiveness as a means of learning. Nothing that we have heard or seen, however, suggests that this will happen in the foreseeable future. The lecture is still seen, particularly in the first year or so of the undergraduate course, as a means of inducting students into the discipline. Students themselves are said to have objected to planned reductions in the number of formal lectures. In fact some HEIs are now building new lecture theatres, as increased student numbers mean that existing lecture theatres are too small.

6.9   More creative design of lecture theatres (with horseshoe-shaped layouts and better eye contact, for example), and easier-to-use technology, means that lecturers are able to present material in a variety of formats, and to demonstrate processes, in ways that once would

have been impractical. These improvements may partly account for the lecture's continued popularity.

6.10   At postgraduate level in the humanities and social sciences, there is a move towards providing the equivalent to a laboratory environment. This would be an area where students could work both privately and on joint tasks, with access to advanced computing and facilities such as virtual reality environments. It is likely that such facilities will attract research partners from outside the HEI to work on joint projects. There will thus be an increased load to be managed.

6.11   These changes are leading to demands for more flexible and highly-serviced spaces, and the blurring of the boundary between academic and social areas, but seem unlikely to diminish the overall net demand for space. Increased student load is likely to require more small-group work, and therefore more small rooms, for groups of 10-25 people.

7   Academic offices

7.1   The provision of academic office accommodation is a sensitive topic probably in every HEI. As AUDE has observed (2003), individual academic offices in most pre-1992 universities were provided on the assumption that they would be used for tutorial teaching of perhaps two to four students at a time. The academic office was therefore a complex work environment: a private study space, a semi-public teaching space, a room for small staff meetings, and a space for the reception of professional visitors.

7.2   However, tutorial groups are now often what would once have been considered seminar-sized – say eight to ten students – and academic offices are too small for teaching them. Many HEIs are accordingly seeing a demand for more small and medium-sized seminar rooms. It is often then considered by managements that offices are too large for one member of staff; but rigidities in building layouts often prevent remodelling (other than at excessive cost in

relation to benefits) to extract the space savings that might otherwise be possible.

7.3   In many institutions, the need for all academic staff to have their own office, with space for their own books, is seen as an important aspect of academic life. In such institutions, growth in the size of teaching groups will therefore normally lead to an increase in the number of teaching rooms, in excess of that strictly called for by student numbers, as new seminar rooms are provided in place of office space. This may not necessarily mean an increase in overall floorspace, as new teaching space may be obtained by taking space from non-teaching functions, or by reconfiguring laboratories or workshops to provide more general teaching space. However, the likelihood is that there will be some net expansion.

7.4   Where new building or major remodelling takes place, the individual academic office may be replaced with a shared office for perhaps three to six staff. There then needs to be a set of conveniently-located small and medium-sized rooms, which can be used for meetings and small-group teaching. This arrangement may be particularly appropriate when academic staff are out of their offices a great deal, for example because of high class-contact hours, visits to students on work placements, professional practice of various kinds, or specialist facility-based research work. The acceptance of shared offices may be further enhanced if good common-room facilities are provided as part of the restructuring. A reception area with secretarial staff and other facilities may also be part of this redesign. One would expect this arrangement to produce some net space savings, although if adequate teaching, meeting and support service space is also provided, the savings will normally be modest.

8   Administrative space

8.1   Demands for administrative space in higher education have grown. Examination of statistics from the Universities Statistical Record and the Higher Education Statistics Agency suggests that expenditure on administration and central

services has grown from about 6% of total higher education spending in the early 1980s to about 13% today. This reflects the creation of essentially new functions such as quality assurance, marketing and external fundraising, and widening participation work; and the provision of more extensive and sophisticated services in established areas such as finance, research administration, and student support of various kinds.

8.2   It is likely that there will be further growth in demand for administrative space. Students are becoming more demanding users of administrative services, a trend that, as we have observed, may become more noticeable when variable tuition fees are introduced from 2006. Other administrative services related to more market-oriented higher education organisations will also demand more space.

8.3   New buildings offer an opportunity to co-locate administrative functions in ways that improve efficiency, offer an enhanced service to academic staff and students, and save space. In one case, a space reduction of about one-third was reported when a range of administrative functions were relocated from dispersed small offices to a single, large, open-plan office with an adjoining 'one-stop shop' for students.

8.4   The HEFCE Good Management Practice report on space management (University of Newcastle upon Tyne, 2002) noted that, in contrast typically to academic space management, administrative space was not subject to detailed review in order to create efficiency gains. There are, therefore, some efficiencies to be obtained from better use of administrative space, but these savings are likely to be offset by new administrative functions. The overall picture is likely to be one of slow expansion of administrative space.

9   Research and disciplinary change

9.1   The conclusion that we draw from our discussions with academic researchers from a wide range of disciplines is that major changes in recent decades in the intellectual content of disciplines, and associated technological change, have led to little net change in space requirements per unit of activity, once general teaching space (related to increased student numbers) is removed from the equation. Most researchers, on the basis of past experience, took the view that changes in disciplinary knowledge were unlikely to lead to major changes in net floorspace, plus or minus, in the foreseeable future. That the volume of space for research has recently grown, and will continue to grow, is more a function of the growth of research per se, and is linked with changes in the relationship between HEIs and the emerging knowledge economy, as we discuss in paragraph 3.8.

9.2   In science and engineering research and advanced teaching, the general picture over recent decades has been one of equipment using existing technologies shrinking in size, having a wider range of applications, and becoming more easily portable; while equipment using new technologies tends to be, at first, much larger and immobile. This means that net unit space demands tend to stay roughly constant, though often with efficiency gains as more staff and students become able to use the smaller pieces of equipment. This may happen when scientific advance means that previously highly-specialised equipment becomes of use to researchers working on a wider range of problems, and better equipment enables faster results to be obtained: the application of crystallography was one example given of this process. (In some cases, though, the equipment becomes so cheap that more units of it are acquired.) In one case, as a result of changes in equipment design and technology, and new space configuration, we were told that 135 academic staff are now working in an area used in the 1970s by 46 staff, in the same physical science research field. New laboratory design is also able to provide space efficiencies, partly by providing shared writing-up space. The erosion of the distinction between teaching and research spaces has also allowed better space use.

9.3   Some comparable developments may be seen in art and design, where remodelling of space has led to more intensive use. Computers

have to a large extent replaced printing machines, for example, although craft skills are still taught and valued; while more flexible room layouts, modelled on professional workplaces, have allowed more students to use the same area.

9.4   The replacement of laboratory, workshop or studio-based experimental or design work by computer modelling throughout science, design and technology has also led to space savings, although some laboratory space is still required, and space is obviously needed for the computer work. At the same time, computerised instrumentation of equipment that may itself be quite small has increased space demands.

9.5   In the humanities and social sciences, however, there are signs of a trend in the opposite direction, with moves to a clearer differentiation of teaching and research space. Two London institutions, for example, have recently established a joint 'knowledge lab' in a separate building to respond to challenges in understanding the changing relationships between learning, knowledge, media and technology. Its research is both social and technical in nature, drawing on a multi-disciplinary team from the two parent institutions. We may expect to see more large-scale research initiatives of this type, with more temporary research staff, and calls for more highly-serviced space than was usual in the past for non-science work. These developments will probably result in a small net increase in space demands.

9.6   An exception to the general picture of space saving in the natural sciences through technological progress is where radically new science and technology is concerned. A historical example would have been when nuclear science and engineering began in HEIs, and nuclear reactors and other highly-specialised and expensive facilities had to be provided. The current example often mentioned is nanotechnology, which demands buildings or parts of them to be separate, and purpose-designed to prevent external vibration, as well as highly-specialised equipment. Although this field

is attracting large amounts of research funding, the costs of the work are so high that it is likely to lead to only small net space demands across the sector. On this model, it is perhaps likely that future radical scientific and technological developments will be so expensive that they will need to be concentrated at a small number of national or international centres, to which researchers will travel, with a small impact on space across the sector. (The current international collaboration on fusion research, where the costs are too great even for EU-level funding to be feasible, is perhaps an extreme case in point.)

10   Changing patterns of student demand

10.1   Changes in the pattern of student demand for higher education courses will have an impact on space needs, although in overall net terms this is likely to be small, and will probably be masked by other changes. The current swing away from science, mathematics, engineering and modern languages is likely to have only a small impact on overall space demands. (The introduction of variable fees in 2006 may have some effect but that is difficult to estimate now: for example, there may be scope for HEIs to support under-recruiting subjects through scholarships.) Where student numbers decline but a department continues its work, it may simply use its space less efficiently, or lose some to other uses, or both. Where a department closes completely, its space then becomes available for other uses and is likely to be reallocated to growing (or at least, overcrowded) areas of provision within the institution. Depending on the subject, this may or may not lead to economies in the use of space per FTE student. In one case we examined, a contracting chemistry department surrendered one of its two laboratory buildings to the archaeology department, which had increasing student numbers who needed laboratory space to allow more science-based work. But the net impact on space use across the institution was minimal.

10.2   Changing patterns of demand, in teaching and research, are significant risk factors for

HEIs. The ability of institutional managements to reallocate space is an important means of managing such risks. This may imply accepting a sub-optimal use of space as a means of dealing with future changes in demand.

11   e-Learning

11.1   We have indicated that, across the sector generally, we do not expect e-learning at a distance to supplant face-to-face teaching in a significant way. The costs of introducing e-learning in higher education were initially underestimated, and its attractiveness in the student market overestimated (Rich, 2001). Moreover, where there are significant e-learning activities, space is still needed for both academic and administrative staff. We have noted that the trend within the UK is to extend face-to-face teaching to areas not well served by existing institutions, rather than to develop e-learning programmes to meet the needs of these areas. Internationally, developments in e-learning will continue: although we note that in East Asia, for example, Western HEIs appear to see the future in terms of new physical campuses, rather than the virtual ones that writers such as Daniel (1998) predicted.

11.2   Campus-based e-learning (VLEs) will continue to develop, and should improve the efficiency of space use, by allowing students to work more flexibly, on and off the campus. We saw one example where studio space, although on the face of it inadequate for the student numbers involved, worked well because at any one time many students were working elsewhere on their projects, using their laptops linked to the campus wireless network. This flexibility is likely to increase, leading to better use of (and so reduced provision of) specialised space – though total space demand will probably be largely unaffected.

12   Other novel modes of delivery

12.1   Workplace-based learning is already a significant activity in further education, and may be expected to increase. It offers educational advantages in terms of creating 'communities of practice' and recognising the importance of tacit knowledge, for example (Evans, 2001); as well as more efficiency in terms of time and travel costs for students. Some HEIs are likely to become more involved in this work, particularly at foundation degree level, allowing them to increase their student load with minimal increase in space demand. There are also examples of masters courses being tailor-made for particular organisations, and delivered on their premises.

12.2   Activities of this type still of course require the HEI to provide space for academic and administrative staff, together with library, IT and other support services. The saving is on classroom or similar space. We found no evidence to suggest that off-campus delivery would remain anything other than a minor aspect of higher education activity.

12.3   We have noted the suggestions that the HEI will somehow merge into its surrounding physical, economic and cultural environment. We believe that this view misunderstands how institutions work, and is unlikely to occur to a significant extent. But in some fields, notably art and design, staff and students are said to be becoming more itinerant, making more use of cities' cultural infrastructures, practitioner workplaces, and so on. This may allow the same space in the institution to serve slightly more students, but, because of the contingent nature of the activity, will not allow any reductions in core space. Moreover, as partnership arrangements are often involved, the institution may have to be prepared, at some point, to import as well as to export people. It is hard to imagine developments of this kind leading to net reductions in space demand.

13   Modelling changing space demands

13.1   Future space demands in higher education will be affected by a range of space drivers, related to the institution's mission, as shown in Figure 2. The space drivers will affect demands for different kinds of space in the institution: as the driver changes in scope or intensity, so it will impact upon different types of space use.

Figure 2: Summary of space drivers

Possible space drivers:	Effect on space for work involving:				
	Teaching	Research	Third stream	Admin	Social
Subject mix	✓	✓			
Institutional mission	✓	✓	✓	✓	✓
Student numbers	✓			✓	✓
Students by mode	✓				✓
Staff numbers		✓	✓	✓	
Non-funding council income			✓	✓	
Community activities				✓	✓

14 Space and the HEI in 2015

14.1 We speculate here on the shape of the HEI of 2015 in terms of its space needs.

14.2 The separation of HEIs into two categories, research-intensive and teaching-led, already apparent in 2005, has become more complex, following some further expansion in student numbers (including more EU students opting for an English-language based education), continued pressure for widening access, and the increased costs of advanced research in the natural sciences and (increasingly) the social sciences.

14.3 At the risk of doing an injustice to an increasingly diverse sector, with institutions having a complex portfolio of elements in their 'missions', we suggest that three models of space utilisation can be observed: research-led, teaching-led and 'middle of the road' institutions. In 2015 the members of this last group have found themselves unable to compete in a EU-wide market for research, and have either turned to the mass student market (where they have a marketing advantage in many EU states), or have followed the US model and have become liberal arts-type colleges, offering a high-quality student experience, with good staff-student ratios and attractive campus facilities, with correspondingly high tuition fees. Tuition

fees now cover about half the cost of the median first degree.

14.4 These three different types of institution exhibit different patterns of space use, though on some points similar approaches will be taken.

14.5 The teaching-led institution needs both large lecture theatres and large seminar-style rooms (for 30-40 people). These latter spaces are increasingly multi-functional, with a range of digital technologies allowing teachers and learners to produce and manipulate images and data of all kinds. Laboratory and workshop space have reduced substantially in area, with greater reliance on computer modelling and digital representation, and the same space increasingly serves the needs of different disciplines. Most learning materials are available digitally, and the library has few traditional books or journals. Social spaces have tended to merge with informal working areas and the learning centre, as students carry with them most of the learning materials they need in light, easy-to-read digital form. They access additional material from the HEI's own VLE and from the web wherever they are.

14.6 The liberal arts institution shows a use of space familiar from the 1960s, with a limited number of modest-sized lecture theatres and more room for small-group teaching. Academic

offices have regained their original purpose and are used for tutorial teaching. There is a relatively traditional library. Only basic laboratory space remains, as most science teaching can use digital methods.

14.7   The research-led institution shows some similarities with the teaching-led HEI, with more multi-use spaces and small rooms for student group work. Despite a far greater proportion of research resources being available digitally, the research team working together physically remains the dominant way of doing research. Laboratories tend to be more specialised, though they have adjacent work areas with specialised computing facilities. These institutions have as many postgraduates as undergraduates, sometimes more, and need to provide separate, higher-quality space for their needs. These spaces may partly take the form of humanities and social science 'labs', with both private workspaces and computing and digital equipment. The library remains at the heart of the institution, with a large stock of traditional books, and with specialist collections which play a part in institutional branding. But it is also the place from where the digital learning environment is managed. The higher fees charged by these institutions will be reflected in better standards of furnishings and equipment.

15   Conclusions

15.1   Returning to Figure 1 in section 2, which set our approach to the study, we draw the following conclusions as summarised in Figure 3.

15.2   We think that the future of HEIs over the coming decade is one of continuity and change. Continuity, in that the HEI (more or less in its current physical and organisational form) will continue to be the dominant producer and transmitter of advanced knowledge. And change, in that the higher education system will have to cope with an increased range of social, economic and disciplinary pressures, leading to increased institutional diversity.

15.3   We have identified pressures pointing towards higher education making increased space demands, and others pointing in the

opposite direction. The last decade has seen greatly improved efficiency in the use of space across the sector in terms of the amount of space per student FTE, but these gains are at (or close to) an end: further 'efficiency gains' are, in our view, likely to seriously compromise learning and research effectiveness. We therefore expect the items listed under 'reduced space use' in Figure 3 to have only limited effects.

15.4   On the other hand, we do not expect that the 'increased space use' items will have a major impact either, other than if large increases in student numbers occur (which seems improbable). Across the sector, we think it likely that increased demand in one institution will be offset, at least to some extent, by reductions in another. But the net effect is likely to be a small expansion.

15.5   What we expect to happen is that HEIs of all sorts will need to remodel their existing space, or to redevelop parts of their estates completely, to provide for new teaching and learning methods, new research approaches, new technologies, and new social expectations. The extent to which they can do this will obviously be constrained by the capital funds available to them and institutional choices of various kinds. It is by these routes that we expect to see higher education making most of its adjustments to changed demands on it, rather than by major increases or decreases in the size of its estate.

15.6   We conclude with these key observations:

- the UK higher education system is becoming increasingly diverse – it is almost impossible to claim that a set of policy prescriptions can apply across the sector

- for differing reasons, no institution is likely to experience a significant reduction in overall space needs in the foreseeable future

- space will, however, be subject increasingly to remodelling for new needs or to meet new standards

- 'learning space' will be seen as one of these needs, with more provision being made for student-led and 'blended' learning (face-to-face plus IT-mediated)

- a relatively small increase in research-specific space (for research funded by the Research Councils) will require a small net increase in space, concentrated in a small number of institutions. However, many if not most institutions will want to expand their physical space to accommodate new modes of knowledge production funded by a range of agencies, in which the boundary between research and third stream activities will be blurred; and they will need capital to achieve this change in the configuration of their estates

- the quality of the institution's physical facilities will increasingly be seen as a marketing asset and will attract more resources and more management attention.

Figure 3: Summary of conclusions

Driver	*Reduced* space use	*Changed* use within envelope	*Increased* space use
Institutional planning & management		Changed teaching/research mix	
	Extended teaching day/week/year	More space for taught postgraduate and research students	
	Staff working away from institution	Increased community use of facilities	New central infrastructure functions
	Better space management techniques		Higher standard/more extensive student facilities
	Increased student-staff ratios, leading to unit space savings		
	Remodelling and better design of new space		
Changes to teaching and learning	Workplace-based and itinerant learning	Changed approaches to library use	Partnerships with other institutions
		New mix of teaching space sizes	
		IT use leading to more flexible space use	
		Increased social/group work space for student-led learning	
Disciplinary changes	Size reductions and improvements to equipment	Changed equipment needs	New research fields requiring specialist facilities
		Specialist space for social science and humanities work	

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