The Black Holes of Space Economics

A discussion of space utilisation and space charging in higher education

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INTRODUCTION

The Pearce report recommends that higher education institutions consider the introduction of space charging schemes, suggesting that charging can encourage those using space to do so more efficiently. "Space charging", the report claims, "is gaining increasingly wide currency as a means achieving improved accounting for and management and utilisation of space". (Paragraph 73).

The experience of estate managers and accommodation planners from seven universities suggests that space charging systems will have some impact on the institutions in which they are introduced but that they have no necessary consequences for space utilisation. Three of those interviewed operate some method of charging, four did not. Their beliefs and practices and the solutions to the immediate pressures of space management illustrate a range of possible responses, discussion of which helps to illuminate the relationship between space charging and space utilisation.

Two Cultures

The interview material suggests that systems of charging for space are unlikely to make much difference to the ways in which higher education buildings are actually occupied and used. This is, in part, because the people who influence space utilisation, who are concerned with timetables and with allocating and booking rooms, are not generally involved with maintaining and managing property. More than that, there seems to be a real culture divide between those providing estate services and these occupying space.

Managing Property

The very idea of charging for space comes from the world of estate and property management and brings with it a specific understanding of the value of space. From an estate management perspective, organisations have paid due attention to people and to money but have tended to overlook their third key asset, property. Traditionally viewed as "a free good", as something which was simply there, space has been an invisible resource cared for by correspondingly invisible works staff. In the National Health Service, the report (1983) drew attention to the cost of underused and surplus, property and to opportunities for making better use of existing stock rather than building new. Such recognition of the significance of space helped to transform the role of works staff, justifying their inclusion on top management teams as estate managers. The Pearce report parallels the Davies report, applying similar ideas to higher education some nine years later. Both reports share a view of property as capital asset and both define good space utilisation as effective use of that asset. This is an approach which locates the value of space in terms of the market value of property. The view is that money is the only common language in which resources can be assessed and manipulated and space must be understood in these terms if it is to take its proper place in the institution's decision-making. The focus is therefore on the building, on its cost, its estimated value, its condition and its maintenance requirements, rather than on what goes on inside.

Using space

Functional suitability and fitness for purpose are important elements in the property equation, as are norms and standard yardsticks relating areas and activities. However, analysis of use rarely goes much further. Architects, planners and surveyors are not at all familiar with the clashing and meshing of users' interests and they have no means of grappling with the layering of use, or with the temporal organisation of space and the integration of activity. If we define good space utilisation in terms of the efficient organisation of activity and accommodation over time (rather than in terms of the efficient use of a capital asset) we require a detailed understanding of the everyday realities of using space and of the inextricable links between spaces, activities, and patterns of social interaction. This falls way outside the property manager's remit though it is of central importance to those involved in academic planning and programming.

The logic of charging for space

Charging for space, an idea which belongs firmly within the tradition of *property management*, is expected to change the way in which people *occupy* buildings. The presumed link between charging and use depends on the assumption that budget holders are able to control the use of space and that these key individuals will use space more responsibly when there is a cost attached. Space charging underlines the fact that space is not a free good and provides a basis for rational, well informed decisions about the use of property at every level within the institution. The theory is that occupants will adopt patterns of space utilisation which make sense in terms of property management once they recognise the real value of space.

In the higher education sector, space charges tend to be based on the cost of maintaining the estate, divided and apportioned to budget centres responsible for well defined pockets of territory. This strategy mixes money from one cultural context (that of estate and property management) into an environment in which decisions are shaped by radically different priorities (i.e. those associated with teaching, time tabling and organising and co-ordinating activity). The result is inherently unpredictable for higher education spaces are used by all sorts of different people and choices about when and how buildings are occupied reflect many different preferences and priorities. Factors influencing the use of space certainly can be manipulated and intricate networks of activity re-organised in ways which allow the institution to use property more efficiently. However, those whose primary concern is to modify the fit between people, time and space adopt quite different strategies compared with those whose purpose is to translate space into money. Such translation may, in the long run, influence the distribution and organisation of students and staff but much else intervenes and there is no simple connection between using and valuing property.

What constitutes good space utilisation in terms of property management may be quite unlike that which constitutes good space utilisation defined in terms of the effective integration of activity, accommodation and time. Space charging may be an effective device for reminding institutional managers of the value of property but it is of no necessary relevance for those elsewhere in the organisation responsible for juggling people, space and time. Indeed it may be positively dangerous to stir real resources into decision making processes which are already pulled this way and that by so many competing interests.

In addition space charging does not in itself help an institution determine whether or not it is "full" nor does it show how close the organisation is to that limit. This really is a pressing issue for at least some universities and the danger here is that space charging systems divert attention from such questions and disguise the first signs of cracking in infrastructures which are about to crumble.

Those adopting space charging on the grounds that it is "a good thing" should therefore take care as should those harbouring the vague hope that the attribution of a cost to a budget centre will change the inter-locking actions of staff and students. There are, of course, other reasons for adopting space charging and there may be value in introducing such a system for the sake of appearances. Some institutions have, for instance, developed charging systems in anticipation of the funding council's presumed preferences, adopting charging as much for external as for internal purposes.

Whatever the intention, charging systems do not ensure the efficient use of space and the management of people, accommodation and time is as important in institutions which charge for space as in those which do not.

The following sections expand on these ideas, filling out the argument and summarising the experiences of those who have and who have not adopted space charging systems.

CHARGING FOR SPACE

Three of the seven respondents adopted some method of charging for space. Reasons for doing so varied. In one case, charging for space was part and parcel of a major programme of financial devolution. Departments were given responsibility for many previously central budgets and there was no compelling reason to exclude space from this process. Others described a mixture of motives. The idea that charging would necessarily result in more efficient use of space was influential as was the belief that such a system would force managers and heads of school/faculty/department to re-evaluate the financial significance space and with it the role of the Estates department. Getting ahead of the game was also important for those who suspected that the funding council would look favourably upon institutions operating some form of space charging. The relative significance of these different motives varied from case to case with immediate practical consequences for the resolution of certain crucial decisions. It is useful to review alternative responses to some of these key issues.

The question of realism

The degree to which space charging is viewed as a "real" or a notional enterprise has far reaching implications for the detailed operation of the charging system. Systems designed to modify patterns of space utilisation need not relate space costs to any real figure nor do they necessarily involve the manipulation of cash. By comparison, those inspired by a general trend toward devolution aim for a higher degree of realism. In these contexts the charging system must involve transferable money if it is to be compatible with other elements of the institution's financial structure and the cost of space must have some real foundation.

Interestingly, even the most committed "realists" stopped short of incorporating estimated property values into their charging equations. Notional rents and capital charges make good sense in terms of the ethos of estate and property managers, but rather than employing surveyors to value individual buildings and define appropriate rents to be paid by the occupying departments, higher education institutions have tended to opt for the easier route of relating space charges to known running costs. In other words they have chosen to levy a service charge rather than a notional rent. As a result, those occupying desperately sub-standard spaces pay as much, per square metre, as those in the most luxurious accommodation. This is unfair and, in market terms, unrealistic, but the arrangement has its advantages.

Universities already have a stock of buildings and an identity which is attached to a specific location. Advocates of realistic charging have no intention of encouraging academic departments to become property speculators within (or even outside} the institution's grounds and administrators are reluctant to edge towards a charging structure which even hints at that possibility. Institutional efforts to rationalise space would collapse if departments were free to move around between more and less "expensive" quarters depending on the financial priorities of individual heads of department. In these contexts, charging is introduced in the full knowledge that the university is not a conventional landlord and that there is no real market for space.

Less than "realistic" approaches have other advantages. The property market is not especially stable and in some parts of the country "realistic" rents for large awkward buildings would be "unrealistically" low, including, perhaps, introductory rent-tree periods, free maintenance and other enticing offers.

For these and other reasons, estimated property value is generally left out of the equation and debate therefore centres upon more and less realistic methods of calculating running costs. It is easy to mistake detail for realism and spreadsheets have a seductive appeal, allowing the development of apparently precise estimations of running costs broken down building by building and even room by room. The relevance of such tiny grains of information depends upon the purpose of the charging system. Institutions aiming for a detailed understanding of actual figures really do need to compare the cost of re-painting a room with the cost of re-planting the flowerbed outside it. By comparison, those concerned to establish a convincing charge-out rate for research space can and do work with larger units of data which demand less complex analysis. Meanwhile, institutions simply searching for an easy method can divide the present maintenance bill by the total area and thus arrive at an average service charge per m^2. There are any number of options along the way and in the cases studied some bills were averaged across the whole institution while other expenses, for example, energy bills, were monitored, metered and met by individual departments.

Methods of allocating spatial resources

Having decided how to establish a charging rate, institutions must also decide how to provide departments and schools with the means to pay for the space they use. Strategies vary depending on the organisation's overall approach to financial management and again on the purpose of charging. Those choosing to impose a service charge based on current running costs tend to inject the once central maintenance budget into the departmental budgeting system. For this strategy to work, every square metre of property must be allocated to one budget centre or another. Establishing and measuring departmental territory can be an arduous process fraught with potential dispute about the rightful ownership of millimetres of space and thus about the size of the service charge.

It takes time to establish agreed boundaries and the publication of Estates data usually marks the start of much detailed negotiation. One head of department, for example, found himself to be the proud possessor of a ladies toilet but not of the gents next door. Some institutions enter into debate about "fit" and "suitability", adjusting *real* areas so as to take account of, say, the 10% or so of floor area which, is deemed to be unusable and thus excluded from the *chargeable* area. Others stick with measured area and argue instead about the thickness of the walls and conventions of measurement. Whatever the strategy, defining and policing spatial responsibility is a never ending business for there are constant territorial re-arrangements as activities expand and contract. Careful control over who should be paying for what is, however, crucial for budget centres must "pay back" all the space-related resources which they have been allocated if the maintenance department is to "receive" the funds required to *run* the estate.

Such a system puts a price on space but does so in a way which implicitly assumes that the institution's spatial requirements are perfectly matched to its spatial resources. If one department contracts another must expand; either that or the charging rate must be increased to cover the costs of maintaining unwanted or temporarily relinquished space. While this type of charging methodology can be tweaked to encourage departments to use space differently (the money allowed for buying space can, for example, be related to the area which a department should have rather than to that which it currently occupies), the basic mechanism of charging does not in itself relate to the efficiency with which Space is used.

Decisions about the scope and scale of charging

Space charging generally applies to "departmental space" or to "budget centre space" only. Different methods of costing are employed with respect to lecture theatres and other centrally bookable teaching rooms. These spaces are usually "hired" by the hour using money allocated to budget centres on the basis of FTEs and other weighting factors. Hiring rates are not tied to running costs and can therefore be adjusted arbitrarily to take account of time as well as area. In theory, this two tier economy of space can be manipulated to encourage different patterns of use. In practice, budget centres have not (perhaps because they cannot) responded to price differentials between "owned" space and that which is centrally bookable. As one respondent explained, the number of lectures did not increase in his institution despite the fact that lecture theatres could be booked for "free" while all other spaces attracted a charge.

There is other evidence that the introduction of this form of space charging has little bearing on the organisation of activity or on the efficiency with which space and time are managed. Consider, for instance, the case of a large department with an established research income. Such a department can afford to occupy space inefficiently and, caught by its own space charging system, the wider institution can do little to alter that situation. In this context, space charges are of comparatively little financial significance within the total departmental budget and space is treated accordingly. The same institution may also contain poorer, smaller, departments whose budgets are dominated by the space charge. Even if charging were to inspire rational action in terms of space utilisation (which is itself doubtful) those actions are likely to vary systematically within the institution.

Some charging systems involve the exchange of real money, others rely on "funny money" and on notional accounting. Leaks between notional and actual financial systems often occur along the margins of space charging with departments paying a notional space charge internally and, at the same time, passing real space charges on to external organisations commissioning research. The practical significance of such interchange between real and funny currencies depends on the overall financial structure and on the way in which it is operated. What is important, in terms of space utilisation, is that charging systems are imposed and responded to in the context of complicated financial environments. In such situations, quite bizarre uses of space can make perfect financial sense.

Questions of status and responsibility

At least some institutions hope that the introduction of space charging will enhance the perceived significance of space and with it the standing of the Estates department. In reality, the introduction of space charging tends to confuse the Estate function. Space charging inevitably emphasises the maintenance aspect of the Estates role for budget centres are asked to pay what they see as a service charge to what they see as a service department. At the same time, the process of allocating space to responsible departments undermines the perception of Estates as the institutional centre of space management. This leaves accommodation planners and Estate staff with a range of sometimes incompatible functions. On the one hand they act as landlord or as landlord's agent, setting charges, collecting money and putting pressure on "tenant" departments. On the other, they are the providers of a service for which those same "tenants" pay. More radically, estates staff can see themselves as space consultants, advising individual budget centres on their mini-accommodation plans while at the same time trying to steer those plans in ways which benefit other users and the institution as a whole. Who now is the client? Exactly what is the service which the Estate department provides? When prompted by the introduction of space charging, these questions may fragment rather than consolidate the Estates operation.

Despite these warning observations I do not want to give the impression that no good can come of space charging. If introduced in isolation it certainly does draw attention to the institutional significance of property and maintenance though, as I have suggested, this can have negative as well as positive consequences. When introduced as part of a total package of financial devolution space charging has no special significance though the process of attaching money to space can again modify the perception of accommodation in unpredictable ways. The important point is that the effects of charging are unpredictable and organisations which charge for space also employ a whole variety of non-financial strategies to encourage more efficient patterns of space utilisation. The next section considers methods of improving space utilisation adopted by chargers and non-chargers alike.

ACCOMMODATING ACTIVITIES

Institutions primarily concerned to make good use of their accommodation tend to concentrate on the organisation of time and activity rather than on the measurement and allocation of space and there is a sense in which use-based approaches and space charging systems depend upon fundamentally different understandings of the nature of building use and of space and time. Consider, for instance, the theories of building occupancy which inform the two perspectives.

Building use

Charging systems presume that individual budget holders can directly affect the use of space and that there is an optimum pattern of space utilisation. Thus a head of department can choose to be efficient just as he or she can choose to use space wastefully. In contrast, alternative approaches to space management acknowledge the interdependent, sometimes conflicting, interests of students, lecturers, timetablers, heads of department, budget holders and administrators. From this perspective, each has their own interest in space utilisation and each their own definition of effective space management. So, for example, it really is in the timetabler's interest to deliberately over-book space. Similarly, wasteful "hanging about" for staff and students is a precondition of "efficiency" for administrators eager to stretch the teaching day and (in their terms) make better use of space. To complicate matters further, activities interlock and timetables must allow staff and students to meet. In this context individual budget holders cannot single-handedly change the way properties are occupied for attempts to tinker with the delicate balance of space and time have knock-on implications right across the system. Use-based analyses of space therefore concentrate on inter-departmental co-ordination rather than on the preferences and actions of individual budget holders.

Space and Capacity

Space charging systems require detailed information about area but when the focus is on use, capacity is the critical factor. There is little point in measuring the size of a room when all you really need to know, is how many people it can contain. Similarly, it is the distribution of rooms of different capacity, not the total area of the building stock, which influences the number of students taught and the way in which that process is organised. Descriptions of space appropriate for an analysis of building use are thus much less detailed than those required by space charging systems.

Space and Time

The third characteristic of use-based approaches to space management is their emphasis on time. If a department is charged for space then it "owns" that space twenty-four hours a day, three hundred and sixty five days. a year, and the institution has no influence over, and no knowledge of, the frequency with which rooms are used or the times at which they are occupied. Information about timetabled and actual use and about the gap between the two is, by contrast the very stuff of space utilisation. Those interested in building use therefore set out to acquire a detailed understanding of the dynamic patterns of occupation, day by day, term by term, and year by year.

There is a pattern here. Space charging systems concentrate on area, not capacity, they presume autonomous budget holders rather than interdependent users and they revolve around static rather than dynamic analyses of occupancy. The other critical difference is that, once introduced, space charging systems are inescapable. Everyone is involved and for this reason alone charging systems are inescapable. By comparison, methods of improving the actual use of buildings generally focus on discrete problems, different strategies being devised to tackle, for example, the problem of over-booking of centrally managed space, the problem of departmental hoarding of allegedly specialist space, and so on. Techniques such as those reviewed below are therefore invented, applied, and discarded as required.

Defensive booking

As noted above, it makes sense for timetables to reserve more space than they actually need for this makes the inherent unpredictability of the timetabling process easier to handle. From an institutional paint of view, such defensive booking is unfair and frequently wasteful efforts are therefore made to limit the practice and/or minimise the pressures which encourage dummy booking. In institution, departments are fined if they are caught not using rooms which they have backed. In another, departments are allowed a space/time quota and are obliged to provide special justification for booking additional rooms. In each instance, information is collected and evaluated at a grain and a level appropriate to the task in hand. Spot checks relating actual use to that described in the published timetable enable the operation of the first system. The second requires prior estimation of group sizes and teaching hours (based on information about student numbers and teaching methods) and a thorough knowledge of actual room availability.

Space hoarders

Departments are understandably keen to maintain total control over as much space as possible. "Specialist" teaching space is not usually included in the central timetable and rooms are routinely appropriated on the grounds (or on the pretext) that they fall into this category. Institutional devices for recovering inappropriately designated "specialist" space generally involve pressure and persuasion combined with the careful publication of information describing the total number of room-hours actually "consumed" by a department and the number theoretically required. In this context, information is frequently gathered and analysed with reference to space norms not because it is really thought to capture what is actually going on, but because it can be used to put pressure on those believed to have more room than they deserve.

Squatting and swapping

Although institutions do take published timetables as indicators of space utilisation, there is always a gap between what should be happening and what actually takes place. Surveys of actual use provide vital information about the inaccuracy of data on which space related decisions are routinely based and "black and white" timetables have been found to be between 10% and 50% adrift. Such surveys also identify failings in formal space management systems. Detailed inspection of inconsistencies and discrepancies can, for example, reveal systematic squatting (in which staff and students are found in "empty" rooms) and widespread swapping (in which classes take place in the "wrong" rooms at the "wrong" times). Privately negotiated adjustments may, of course, improve space utilisation producing a better result for all concerned. From an administrative point of view the problem is that such "efficiency" is unmeasurable and, if encouraged, private arrangements might ultimately undermine the formal system. While not necessarily a problem, efforts to measure and control squatting and swapping raise issues about the proper location of responsibility for the management of space and time.

Responsibility for space and time

The practical operation of space-time management is often marked by established divisions between property management (the province of the Estates department) and space utilisation (the province of academic and administrative staff). Estates staff working within an environment of space charging like those subscribing to a more traditional "Works" position tend to see themselves as the providers of a service properly defined by others. Timetablers and room bookers operate within an equally well defined role, aiming to fit people into predetermined spaces. Such institutional division between space and time can create problems and in two of the cases studied accommodation planners had the task of managing both sides of the equation. These people could, for example, see the advantages of temporarily swapping office for teaching space, they could argue for an evaluation of space and time to be included In the process of validating new courses, and their position in the organisation was such that they had a joint appreciation of both space and time.

To summarise, institutions have developed a variety of non-financial strategies for dealing with different dimensions of space utilisation. If there is a problem of over-booking then it makes sense to do something about it and about the conditions which sustain it. Similarly, epidemics of swapping and squatting have their own causes and thus their own appropriate responses. Such measures address specific problems, one by one. Institutional efforts to overcome the organisational divide between space and time, between Estates staff and timetablers, have much greater potential to change the way in which space is conceptualised and managed. Those who operated an accommodation planning service were, for instance, able to recognise and exploit trade-offs and arrive at solutions which would not be identified within a more traditional organisational structure and which would be even more difficult to recognise within an environment of space charging.

REACHING THE LIMIT

More efficient use of the existing stock delays the day when more space is required. Although the interviews concentrated on methods of space management and on ideas about space charging it was impossible to ignore a recurrent anxiety about absolute capacity. How close was this real physical limit and just how many more students could be taken on without upsetting some critical balance?

There is no easy answer for there are many possible indicators of "fullness" and, in any case, the critical moment can be delayed by adjusting any number of different variables (space, time, teaching method, the meaning of education, the nature of quality etc.). Increasing student numbers can perhaps be handled by making better use of teaching time though short-term efficiency may herald other longer term problems. Corridors, for instance, wear out faster when more people walk along them and the infrastructure may not be able to sustain an extremely efficient use of space. Expansion has other knock-on effects. It may, for instance, be possible to teach more students in the same space by changing teaching methods and by extending the teaching day. However, each student brings with him or her a standard pack of administrative labour and it is usually more difficult to ease the strain on office space. While some aspects of spatial pressure increase in proportion to the number of people accommodated, others do not. There are, for example, recognisable thresholds of capacity and much depends on the proximity of these break points. Lecturers' offices designed to accommodate genteel seminar groups of eight can, at a squeeze, be used for groups of ten. If numbers rise to twelve such arrangements are simply not practical.

When this point is reached, office space is technically under-utilised (it is not used for teaching at all) and there is an unforeseen demand for larger seminar rooms. To complicate matters, congestion in some areas has greater impact on everyday life than in others. The public effect of turning students away from overcrowded lecture theatres is, for example, greater than that of providing cramped accommodation for office staff. Crises in one type of space management frequently spill over into other areas and although some difficulties can be predicted and perhaps avoided, present methods of organising and analysing space make it difficult to appreciate the spatial and temporal implications of increasing student numbers for the institution as a whole.

Estates staff and administrators are variously responsible for repairing over-worn corridors and for pacifying over-crowded employees but nobody really knows just how far the physical resources are stretched. Again the conventional separation of responsibility for space and time disguises points where the ice is thin. What is missing, then, is a method for evaluating and understanding the distribution and character of spatial pressure. Space charging systems are designed to tackle necessarily unspecified "problems" (to reduce "waste", to change attitudes etc.) and although other methods of space management have a definite purpose these are essentially responsive measures introduced to contain existing difficulties. None of this is of much use to those haunted by the looming spectre of an ultimate limit and anxious about the stresses and strains on the institution's social and physical fabric. If this is the driving concern then institutions need to look again at the organisation of space, time and activity across the whole estate. They need to determine appropriately simple indicators of pressure, concentrating on capacity (not area), and on actual (rattler than timetabled or theoretical) patterns of use. In this context, norms and agreed standards, maintenance costs and charging systems are all irrelevant for the first task is to understand what actually goes on within the existing stock.

THE BLACK HOLES OF SPACE ECONOMICS

I have suggested that there are three different approaches to space utilisation. The first is inspired by a view of space as property and an understanding of the financial significance of estate resources. The second focuses on the everyday details of occupancy and on the organisation of activity. The third is concerned with the limits of space utilisation and the identification of critical areas of spatial pressure.

Described strategies of space management reflect these differences of approach. The relevance of formal timetables, the significance of surveys of space usage, the role and value of space norms, the nature of information collected and the level of analysis applied varies depending upon the institution's informing motives.

The chart below summarises the practical implications of each approach, highlighting differences between methods of space utilisation rooted within a tradition of property management and those which have developed in response to the pragmatic problems of accommodating activity.

Motives and methods of space management

Informing Motives	Units of Measurement	Information about Space usage	Relevance of Space norms	Relevance of Space charging
Managing Property	Area in M2	Formal timetable	Can be used to set space allowances, otherwise not relevant	Makes sense as part of overall devolution, for appearances, or to enhance Estate's role
Using Space	Capacity - student places and teaching room sizes	Focus on the gap between formal timetable and actual utilisation	Not usually relevant	Not relevant
Limits to expansion	Capacity - of all sorts of space	Surveys of actual space utilisation	Not relevant	Not relevant

What the chart does not show is the degree to which strategies inspired by property management inhibit the practical implementation of measures designed to make better use of space. Collecting and analysing information about space in meters squared diverts attention from the evaluation of capacity. Furthermore, space charging reinforces the organisational divide between these managing space and time. Responsibilities are thus handed to budget holders who are organisationally unable to influence patterns of activity and who have no option but to simply pay the going rate for whatever space they have to use. At best, charging systems have no necessary implications for the use of space and, at worst, they generate a type of information and a set of organisational arrangements which limit the effective co-ordination of accommodation and activity. Charging systems may also obscure really important areas of spatial pressure, blinding institutional managers to impending disasters end creating an entirely false sense of security. They need not have this effect though they certainly do change the units in which space requirements are assessed and evaluated. Finally, space charging may have any number of financially sensible but spatially ridiculous consequences as departments exploit wrinkles and loop holes in the artificial market. It may be that financially sensible options also make sense in spatial terms but there is no guarantee that this will be the case. Translating space into money and then pouring the maintenance budget into the fray of departmental finance is a risky enterprise and nobody knows quite what will emerge from the black hole of space economics.

In conclusion, if the focus is on the organisation of space and activity there is much more to be gained by re-organising the management of estates and timetabling functions than there is from the introduction of space charging. Similarly, if institutions are really concerned about the limits to expansion they should develop methods for identifying and anticipating thresholds and pressure points. Again, space charging will not help.