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**Disciplining the Sustainable City:
Moving Beyond Science, Technology or Society?**

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Abstract

Is interdisciplinary research possible? Over the past decade three UK research councils, the Engineering and Physical Sciences Research Council (EPSRC), the Natural Environment Research Council (NERC) and the Economic and Social Research Council (ESRC), have collectively put over £30 million into a key interdisciplinary research site – the ‘sustainable city’. This paper examines how the Research Councils framed the problem of the sustainable city and, in so doing, put interdisciplinarity into practice. In each case, the Councils recognised that the problems of the sustainable city transcended conventional disciplinary boundaries but the collective outcome of their research has remained resolutely disciplinary in focus, something that has been particularly frustrating for policy-makers and other potential users.

The tension between recognising the complexity of the research problem and formulating realistic research questions is most apparent in the research programmes through which Research Council mapped the original interdisciplinary problem on to the more narrow set of disciplinary paradigms they represent. Thus EPSRC sees the ‘sustainable city’ mainly in terms of technological systems and fixes; NERC sees it in terms of the flows and stocks of natural resources; ESRC sees it a distinctive form of social organisation. Unfortunately, in setting the problem up in this way, what was originally a complex combination of science AND technology AND society has been reduced to science OR technology OR society. In other words, to the extent that interdisciplinary research occurred, then it was within research councils not between research councils.

The critical question is whether this outcome could or should have been avoided. As Science and Technology Studies (STS) shows, moving between scientific disciplines, particularly non-cognate ones, raises problems of incommensurability in both language and purpose. Yet interdisciplinarity requires this and more. The perspectives are supposed to add up the single, integrated view that policy-makers and other users can use to inform decisions and take action. Given what we now know about the risk and uncertainty within even the narrow boundaries of disciplinary science, this paper argues that seeking certainty in interdisciplinarity is to search for the Holy Grail. Policy-makers and others will need to find other ways to act.

1. Introduction

Ever since it emerged as a research and policy priority in the late 1980s and early 1990s, urban sustainability has been constructed as presenting a new and distinctive type of research problematic.² One of the most important aspects of this uniqueness is the interdisciplinarity of the research required. Moving from unsustainable to more sustainable forms of urbanism appears to demand research that is not solely ecological or environmental, that is relevant for and even led by users, and which is funded in a way that reflects these needs. Although the UK's Research Councils have collectively put over £30 million into meeting this challenge, the results have been mixed as the practical problems of interdisciplinary research proved more intractable than had been thought. Collaboration between scientists seemed to offer the hope of a more complete or more robust solution, but the outcome, especially when viewed from the perspective of the users, fell some way short of this.

The reasons for these difficulties are to be found in the way 'doing' interdisciplinary perturbed the relationships between researchers, their users and their funders. For the researchers, undertaking interdisciplinary research meant challenging the conventional disciplinary boundaries of the urban research agenda and dealing with the recognition that the research problematic was neither a solely scientific, technical nor social issue. New disciplinary collaborations needed to be developed, with social scientists engaging in research on technological and/or ecological issues and science and engineering disciplines re-focusing their agenda on social and political aspects of urban issues. The research thus required collaborations that cut across conventional disciplinary approaches. The trouble was that combining technological knowledge and expertise from natural and social sciences turned out to be a significant challenge as the common ground between the different disciplines was far smaller and more antagonistic than was initially assumed.

Secondly, users, and especially policy-makers, became more important. The research problematic was about the reconfiguration of real cities around more sustainable social practices and technologies. This meant that the researchers needed to enrol users in the definition of the research problem, the conduct of research process and the dissemination of the research to practitioners and professionals. As a result, the research communities had to develop new ways of engaging an enlarged set of users - private sector, government

departments, environmental regulators, etc. - into the urban research process. Once more this proved to be a significant challenge.

Finally, the social organisation of urban research programmes had to be re-thought. For example, if the research was supposed to cut across disciplinary boundaries, then research funders would have to work together and take on complex strategic questions about the relevance and porosity of the disciplinary boundaries that they themselves represented. In practical terms, the funding councils would need to sustain conventional disciplines whilst also facilitating research that cut across those same boundaries and engaging non-academic users in the specification and dissemination of that research. This, too, turned out to be difficult.

In sum, doing sustainable cities research meant that the research funders, research users and the research community all had to act differently. A policy challenge that could not be contained within one disciplinary frame required a process that looked across these boundaries, generated new knowledge and expertise and made 'interdisciplinarity' real by problematising the strength of the boundaries between science, technology and society. This paper thus examines what interdisciplinarity means in practice by exploring what happened when the research funders, the research community and users in the United Kingdom responded to the challenge posed by the (un)sustainable city. Our central argument is that interdisciplinarity in the context of the UK urban sustainability research is an aspiration that was made real in different ways in different locations. We show how the initially noble ambitions of the UK research councils to promote interdisciplinary research gradually gave way to more conventional disciplinary based frameworks, leaving users with the responsibility to create interdisciplinary policy solutions out of the disparate matrix of natural, engineering and social sciences.

The rest of this paper is divided into six sections. The first section provides a very brief overview of the research programmes that form the basis of our analysis and reviews the methods sources that we use. Sections, three, four and five then set out the three the different modes of interdisciplinarity that we identify and show how the research programmes that were developed understood the 'sustainable city' in very different ways. These sections thus chart the movement from a radical interdisciplinarity that cut across research council boundaries to more limited forms of collaboration between cognate

disciplines and finally the development of a strategy in which the work of interdisciplinarity was ‘outsourced’ to the research users. In documenting these transitions we make use of a series of diagrammatic representations that summarise how each research council approached the city and highlight the different ways in which the linkages between science, technology and society were understood. Section 6 then looks across the three research councils, and the different ways interdisciplinarity was put into practice over time, to critically evaluate the idea of interdisciplinarity itself. The focus here is on the contributions disciplines made to scientific practice and the tensions that attempting to transcend them appears to create. Finally the conclusions return to the need for interdisciplinary work despite the problems identified in the earlier parts of the paper. The idea of problematising the boundaries between science, technology and society remains important, even necessary, so we finish by setting out some of the consequences of ‘doing interdisciplinarity’ for the social organisation of research funding, the research process and the role of users.

2. Interdisciplinarity and the Sustainable City: Case Studies and Methods

The paper analyses the development of sustainable city research funding initiatives and programmes in the UK. The paper is based on the set of research programmes that three UK research councils funded between roughly 1990 to 2000 and which are summarised in Figure 1. The key initiatives are the Civilised City scoping study; the collaboration between ESRC and SERC that led to the publication of Cities and Sustainability; the development of 3 distinct city-based research programmes by SERC, ESRC and NERC; and the formation of the Local Authority Research Council Initiative

As set out in the introduction, the overall narrative is one of boundaries being challenged and then re-instated as a radical form of interdisciplinarity becomes reduced to a more cognate mode of interdisciplinarity and finally an attempt to ‘outsource’ the interdisciplinarity to the users communities. In effect what happens is that the duty to ‘triangulate’ or combine disciplines and methods shifts from the research communities and on to the user communities. Our concern is not so much to examine whether this process was either fair or effective but to understand how, despite the recognised need for interdisciplinary research, the primary location for interdisciplinarity comes to be found not in the research community but in the user community.

Figure 1: Research Programmes Addressing Cities and Sustainability, 1990-1999

	EPSRC	ESRC	NERC
1999			Phase 3 URGENT
1998	Final Phase Sustainable Cities		Phase 2 URGENT
1997	Local Authority Research Council Initiative Launched		
	Phase 3 Sustainable Cities	Cities and Competitiveness Launched	Phase 1 URGENT
1996	Phase 2 Sustainable Cities	Scoping Cities Programme	Scoping URGENT Programme
1995	Sustainable Cities Network Launched		
	Phase 1 Towards the Sustainable City		
1994	Cities and Sustainability		
1993	Clean Technology	Phase 3 GEC	
	Red Bus Report		
1992			
1991	Towards the Civilised City		
1990			

In setting out our account, we have drawn upon three key data sources. First, the authors were involved professionally in all the three key research council programmes reviewed in the paper. This involved participation in research council led workshops that consulted with the research community and disseminated research to users communities; responding to calls for proposals; working on three projects funded by two different research councils; reviewing research proposals and assessing completed research projects funded by two research councils; and finally working with a third research council on the dissemination of their urban research programme. In writing the paper, we have sought to critically reflect on our own experience and participation in interdisciplinary research and the challenges of working across research council boundaries. Second, because of our participation in these research programmes, we have been able to draw upon a range of sources including access to grey materials, interactions with programme officers, users and researchers from a wide range of disciplines. Using these sources we have been able to construct an historical narrative of the main features of the research programmes, their stages and their consequences for research process and users. Finally, we have made extensive use of diagrams as illustrations of how the research councils see cities. Most of the diagrams were produced by the research councils to illustrate how the city was conceptualised in a research programme. Because they were designed with this purpose in mind they provide a very powerful representation of how each research council constructs the research problematic of the sustainable city. Each illustration is a representation of how one set of disciplines view the research problem. As such they represent a disciplined city - a city seen through the lenses of a particular disciplinary frame³. We are particular interested in how the figures represent the technical, science and social and illustrate the relationships between them.

3. Stage 1: Radical Interdisciplinarity and the ‘Red Bus Report’

The first attempt to create an interdisciplinary approach to researching the city began in the early 1990s with two parallel but distinct research initiatives whose subsequent blending created the ‘sustainable city’ as a site for interdisciplinary research. The first of these two initiatives was ‘The Civilised City’ scoping study, commissioned by what was then called the Science and Engineering Research Council (SERC, now the Engineering and Physical Sciences Research Council or EPSRC) and the Agriculture and Food Research Council (AFRC, now the Biotechnology and Biological Sciences Research

Council or BBSRC).⁴ The other was the ‘Global Environmental Change Programme, run by the Economic and Social Research Council (ESRC).

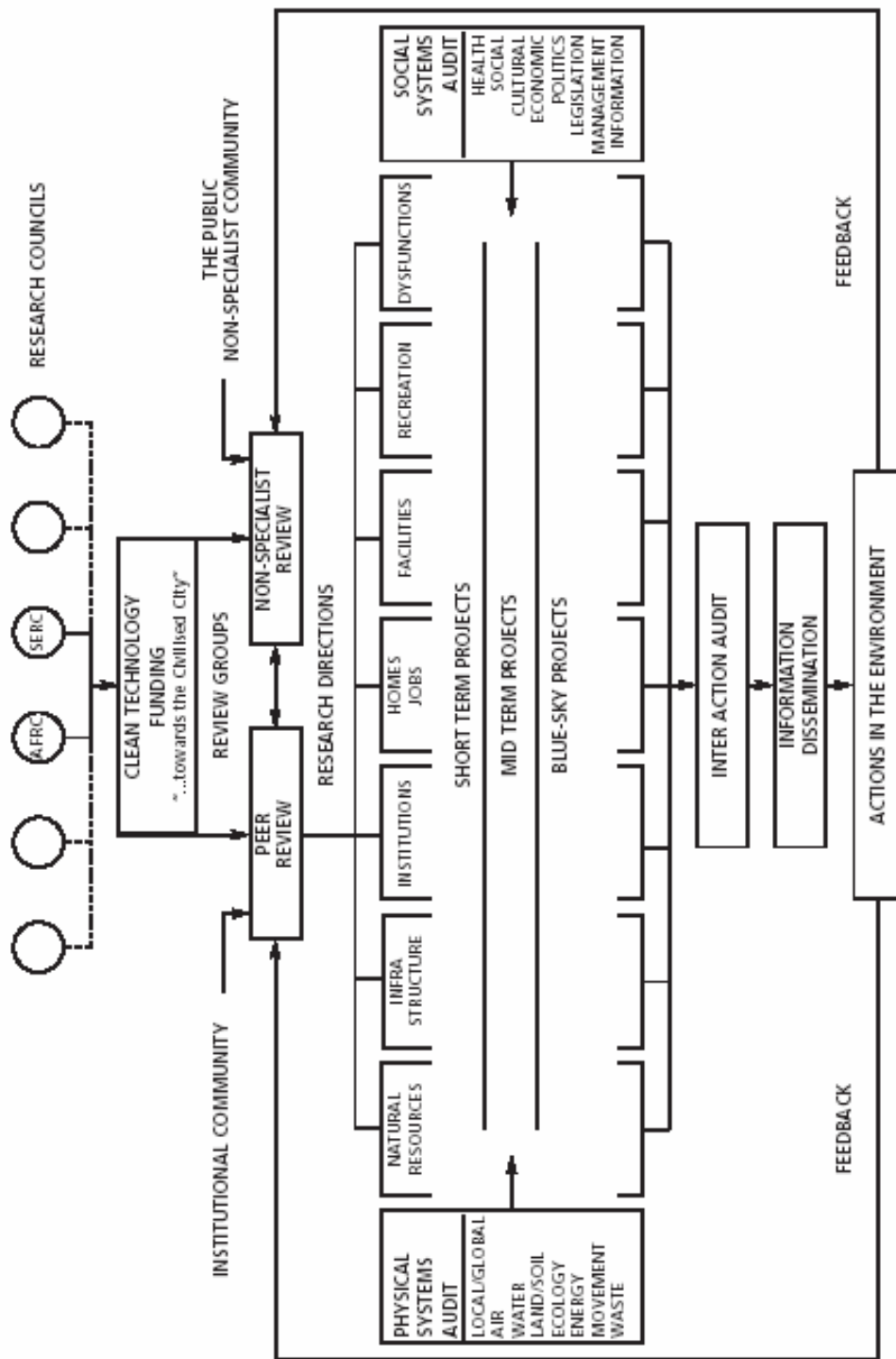
The Civilised City scoping study was funded by the Clean Technology Initiative, itself a joint venture of the SERC and the AFRC, and its aim was to respond to the way in which urban research inevitably involved dealing with several overlapping areas. For example, travelling to and from work requires transport (and transport infrastructure), which in turn uses energy and creates pollution, which in turn has implications quality of life, health and the environment. The problem that motivated the ‘civilised city’ programme was that much of the research being done at that time tended to stay within its own area. The result was that:

In trying to deal with the problem of ‘commuter traffic’ and its consequent adverse effects, many lines of action have been proposed to reduce those effects such as working from home, road pricing or promoting better public transport. Research into these ‘solutions’ has a tendency to become narrowly focussed, both in terms of the impact of the proposal on the physical and social systems but also in terms of the opportunities the project might bring for those same systems and the requirements to bring the project about and be effectively implemented.⁵

The solution to this problem is summarised in Figure 2, which is the organisational chart produced by one of the contributions to the scoping study. Although complex in some ways, its key ideas are relatively simple. The first is that the Clean Technology Initiative provides the funding. The Civilised City programme is thus envisaged as embodying co-operation between research councils and as making an explicit effort to break down the disciplinary ‘silos’ that characterise UK academic work.⁶ In principle the diagram allows for the inclusion of other research councils too, although it is just SERC and AFRC that provide funding at this early stage. Nevertheless, even this limited collaboration is important as it shows that the research councils and the research community more widely are taking responsibility for ensuring that their work adds up to a coherent whole.

The next tier of the diagram shows how the funds created through the Clean Technology Initiative would be distributed to research projects. This appears to replicate what is now

Figure 2: Organisational Diagram of the 'Civilised City' Programme



the common practice of combining peer review with reviews by non-specialists, including representatives of the public and other 'end-users'. As might be expected (and is probably

right and proper) it is the peer reviewers that provide the input in to the next tier, which is the decisions about which research directions shall be pursued.

It is at this stage that the second innovation proposed by the Civilised City Initiative is introduced. Rather than the projects being implemented in the traditional but ‘narrow’ discipline or research council fashion, the authors of the scoping study recommend that:

A simple but novel environmental and social auditing procedure ... is to be used as a check to identify potential interactions, consequences and opportunities that can or should be considered within the research ... Thus a potential proposal under the infrastructure heading concerned with transport, energy and pollution would automatically cover three of the physical environment categories in the audit. The other categories may or may not be relevant to the proposal. Rather than limiting attention to just the three categories in the proposal, however, our approach encourages the research groups to consider the implications of the proposal in terms of the other categories.⁷

The result of implementing this would be a clear requirement on the researchers to look beyond their own disciplinary horizons and consider both the wider physical and social context in which their own research might be used and developed. How far the researchers should go in this direction is not clear. Certainly there were other scoping studies commissioned for the same programme took a more traditional tack, setting out what might be thought of the standard ‘engineering view’ in which the role of the scientist is to act as a neutral adviser, setting out alternatives and their consequences, but leaving the political process to choose between them. Thus, C.J. Baker wrote:

In this report the approach that will be adopted is to suggest that the major thrust of work in this area should be towards the development of a model for the physical and biological interactions within a city, that can be used in the planning and development process as a tool to enable planners and politicians to determine what effects their initiatives might have. In other words the research programme that will be proposed later in this report should be seen as helping in the development of the quantitative physical and biological component of a perhaps rather wider, more qualitative and subjective model of urban interactions that may

be developed in the future. Such work falls partly outside the scope of SERC and AFRC and might be better funded in association with ESRC.⁸

Significantly, at about the same time as these discussions within the SERC/AFRC, their erstwhile collaborator, the ESRC, was also turning its attention to the problems of environmental change, although here the focus was on the global rather than urban environment. The ESRC's Global Environmental Change Programme, which went on to become at that point 'the largest ever social science research initiative in the UK on any issue',⁹ was launched in 1991 in order to provide a social science input to the burgeoning natural science activities that were already driving research and policy:

GEC [Global Environmental Change] has been viewed as a sequential process; changes in the atmosphere are expected to affect biological systems and, ultimately, to carry implications for human populations. The Inter-Governmental Panel on Climate Change (IPCC) reflected this linear perception by setting up three working groups on: the scientific evidence; the impacts, and the responses. However, this traditional approach does not recognise the role of human economies and societies at **each stage** in GEC as, indeed, was recognised in some of the research evidence taken by IPCC. From a social science perspective, GEC is a complex process in which the human-actor must be centre stage.¹⁰

Although the initial focus of the programme was on global environmental issues like climate change, the focus did gradually shift over time towards a greater concern with sustainable development and the local, regional and national issues that influence it. An early indicator of these later developments can be seen in the joint SERC-ESRC seminar on 'The Sustainable City' held in July 1992. Organised by the Clean Technology Unit, the seminar brought together a wide range of scientists and policy makers in an effort to build on the GEC and Civilised City programmes. The outcome of this workshop was a determined attempt to promote the combination of natural and social science disciplines that were needed to understand and tackle the problems of urban sustainability. Published as Cities and Sustainability, but quickly re-named the 'Red Bus Report', this document was the first joint statement of radical interdisciplinary produced by the research councils and it began by stating that:

The research councils are working together to stimulate research on how cities could be made more sustainable. We [i.e. the research councils] particularly want to encourage ideas that consider the city as a whole, crossing the traditional boundaries between (for example) engineers, social scientists and architects.¹¹

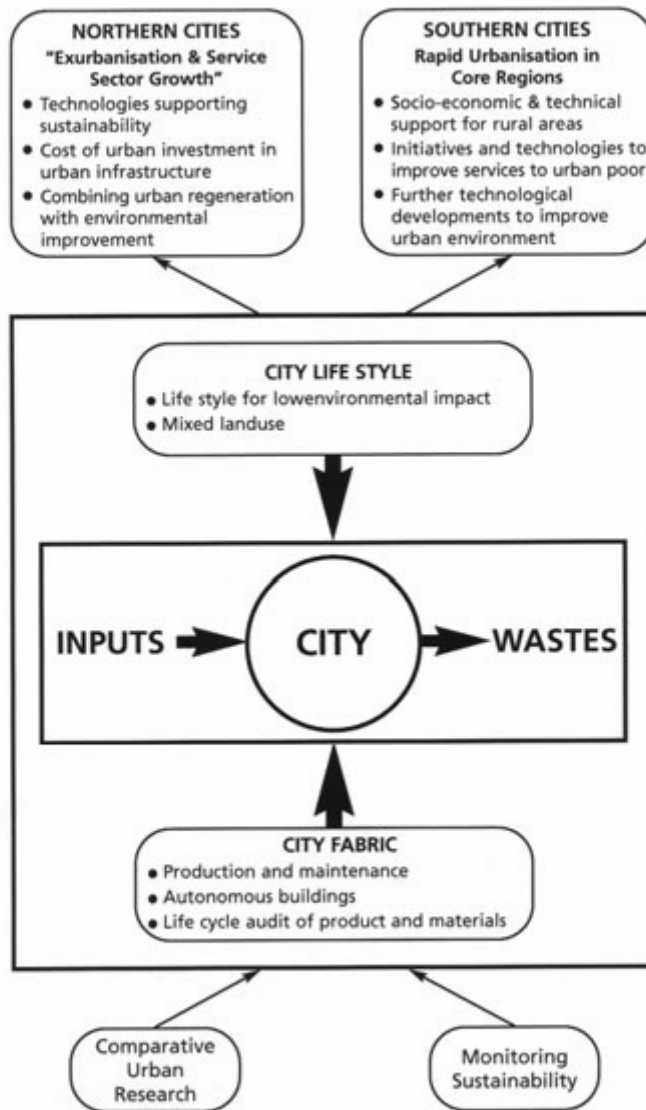
The rationale for this joint research programme was that:

Science and technology have always played an important part in the development of cities, influencing both why and how cities are built, how people live in and move around them and how they communicate internally and externally ... At the same time, city life is profoundly dependent on the culture in which it is embedded, on a city's history, political status and organisation, along with a host of other socio-economic factors. These determine how a city will react to technological innovations and whether it will benefit from or be damaged by the changes they bring. Hence, if formulating policies to address ecological problems, it is necessary to understand not only the environmental impact of a proposed technology but also the socio-economic circumstances in which it is to be applied. Because understanding of both is critical to success, both need to be investigated, preferably in an integrated manner.¹²

The Cities and Sustainability report thus put forward a very distinctive view of the city and of the research programme that was needed to address the problems of its increasing unsustainability. The research was to combine the insights of different academic disciplines and, significantly, the aim was to integrate these accounts. This ambition reflected the understanding of the city upon which it was based, which is summarised in Figure 3.¹³

The core of the Cities and Sustainability report is an input-output model of the city, in which the energy and other resources needed to make city life possible go in and the wastes and other pollution these lifestyles create comes out. The unsustainability of the city arises for reasons that draw on cultural, natural and technological factors. On the one hand, the inputs required to maintain city life are simply too great for the city's hinterland, which in the Red Bus Report is defined so as to include 'the whole earth and biosphere'.¹⁴ As a result, the irreversible depletion of resources becomes a real danger.

Figure 3: City Diagram for the 'Red Bus Report'



On the other hand, the wastes produced by the city further damage this hinterland. The combination of these factors has the potential to undermine city life either by posing unacceptable environmental problems or by rendering the city unviable economically or even aesthetically.

In response, the input-output model suggests that more sustainable cities will be created by changing lifestyles (e.g. so they become less resource intensive) or by changing technologies (e.g. so that they operate more efficiently) or by some combination of the two. In other words, the problem is not one of science or society but of the interaction between the two. The other advantage of the input-output model is that, by recognising the complexity of cities and their uses, the Red Bus Report was able to differentiate different types of cities. For example, the Report distinguished between ‘overheating’ Southern cities, where populations are increasing, and ‘de-industrialising’ Northern cities, in which the decline of traditional manufacturing industries was creating different problems.

Of course, this move, which was largely led at this stage by SERC, requires some explanation. In particular, why did they want to break with the established disciplinary structures and introduce this radical interdisciplinarity? Perhaps unsurprisingly, the explanation is to be found in the prevailing social context. The early 1990s were the time at which governments in the UK and elsewhere had discovered the environment and research councils were under pressure to provide relevant research. In the case of the natural sciences, the IPCC programme provided an obvious focus, whilst the social sciences had, through the ESRC, just launched its GEC programme. This left the engineers in need of a policy relevant programme they could call their own. In this context, the Red Bus Report thus represents an attempt by engineers to re-orientate their existing city-based research and give it a more environmental and urban policy perspective through collaboration with social scientists, planners and other disciplines.¹⁵

4. Stage 2: Cognate Interdisciplinarity creates 3 Urban Research Programmes

The publication of the Red Bus Report marked the high point in the collaboration and co-operation between the research councils. Its publication signalled a determined effort to break down the boundaries between research communities and allow researchers to develop a genuinely interdisciplinary agenda. Perhaps the most enduring outcome of this attempt to create a new dialogue across disciplines was the creation of the Sustainable Cities Network, which provided a jointly funded forum for researchers from across the research councils.¹⁶ Unfortunately, the story of the Sustainable Cities Network is emblematic of the fate that befell the wider ambitions of the Red Bus Report.

Although the early meetings of the Network did try to push the interdisciplinary agenda forward, the reality was that, after these initial meetings, the agendas of the different disciplinary groups tended to drift apart. Cynics would no doubt argue that this was inevitable given that the Red Bus Report itself acknowledged that no single ‘pot’ of money would be available to fund the research agenda it was announcing and that, instead, funds would be distributed by the research councils acting separately. As a result, and despite the efforts of many of the participants, the boundaries that had (almost) opened up started to close again. Where there was supposed to be a single research programme, jointly promoted by two research councils, there developed a series of parallel research programmes each associated with a specific research council. Although each programme cross-referred to each other, so that the appearance of an integrated approach was maintained, something important had changed. The research councils were no longer actively promoting the integration across disciplinary traditions. Radical interdisciplinarity had thus failed to develop and, instead, a more conservative, cognate style of interdisciplinarity, in which collaborations within councils were encouraged, began to emerge instead.

This new approach saw three programmes emerge as the now separate SERC and ESRC programmes were joined by a new programme launched by the Natural Environment Research Council (NERC), which had decided that, like SERC, it too needed major policy-relevant research programme. Each of these programmes is described in more detail below, but it is worth briefly highlighting some of the factors that led to the re-assertion of traditional disciplinary frames. The main reasons were the difficulty of maintaining dialogues across disciplines when key assumptions, practices and priorities were not shared; the tension created within research councils through the perception on the part of some scientists that ‘their’ research money was being diverted to other disciplines; and the problems of publication and research outputs that would be recognised within an essentially discipline-based Research Assessment Exercise¹⁷. Taken together this combination of alternative demands and pressures worked against the ambitions of the Red Bus Report and, although there was some attempt to put the more radical mode of interdisciplinarity into practice (e.g. the EPSRC sustainable cities programme did fund projects that combined social science and engineering perspectives) the predominant trend was to fracture to proposed unity by commissioning three separate strands of research.

This change to a new mode of interdisciplinarity is important. Not only does it begin to reassert the traditional relationship between academic disciplines and, to a lesser extent, between academic disciplines and their users, it also introduces not one but three new ways of understanding the sustainable city. As such, the move back to multiple understandings raised, once more, the original questions about the promise of, and need for, interdisciplinary research. In particular, do the disciplines complement each other, overlap with each other or provide partial but incomplete and (worst of all) incompatible perspectives?

EPSRC: Towards the Sustainable City Programme

Given that the Red Bus Report grows out of an initiative launched by the Clean Technology Unit, itself part of the SERC and then EPSRC, it is hardly surprising that the most serious attempt to implement its radical agenda was pushed by the EPSRC. The EPSRC 'Towards the Sustainable City' programme was launched in 1993 to: "stimulate interdisciplinary, collaborative, user-orientated research intended to deliver practical tools for making cities more sustainable".¹⁸

By 1997 the 'Sustainable City' programme had awarded over £6 million to 56 research projects, although 35 of these grants accounted for over £5 million of this funding. Within this group latter group, which was characterised by being the most relevant for central government policy, there were also clear indications of the programmes interdisciplinary intent. The 35 grants were awarded to 26 different academics and involved participation:

from 29 different disciplines (or specialisms) working with 75 third party collaborators from 22 different types of background ... The range covered by the 29 disciplines involved is very wide, running across architecture, engineering, computing and physics to climatology, and from economics, planning and psychology to medicine ... These policy-relevant projects show clear inter-Research Council collaboration in terms of the disciplines involved. Projects judged to be less policy-relevant by the DETR [Department of Environment, Transport and the Regions] typically involved only intra-EPSRC collaboration, i.e. between separate disciplines traditionally funded by EPSRC.¹⁹

From this, it would appear that the programme was a success, and in many ways clearly was. For example, it certainly prompted a significant amount of collaboration that presumably would not have happened otherwise. The problem, however, was how to make it a sustainable success. As noted above there was some tension within the research council about the way in which funds were going to other disciplines and not to core EPSRC work. This sense of ‘not looking after our own’ was not helped by the findings of the EPSRC’s own audit of the programme, which showed that:

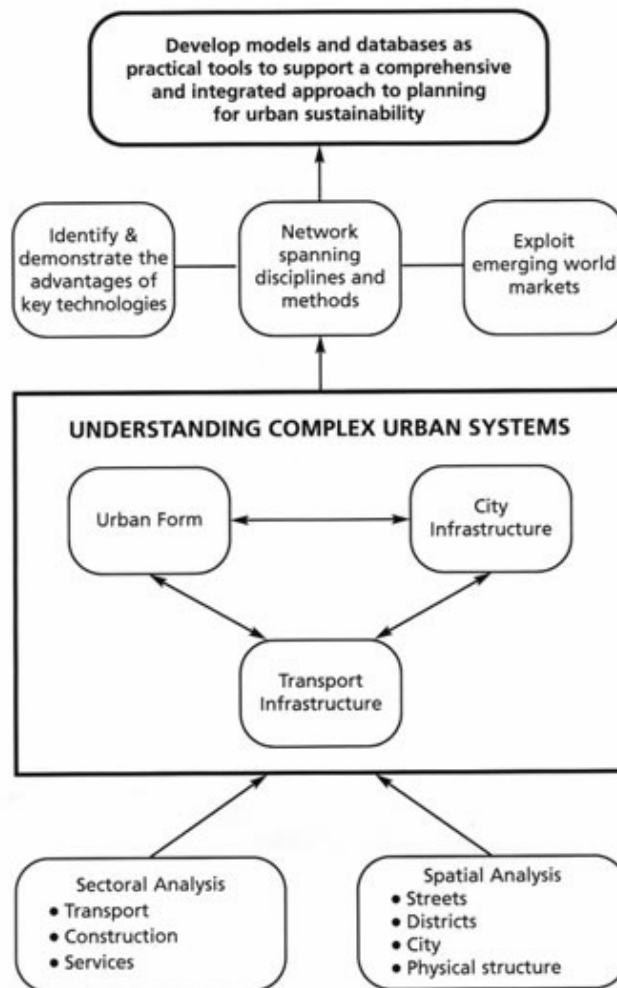
despite the emphasis on applied research in calls for proposals, only one of the 35 projects surveyed [in the management audit] reported a major application of findings by the time of the review.²⁰

Most significantly of all, however, the review identified enhanced modelling capacity as the ‘major practical benefit delivered by the programme’ but noted that future developments were ‘threatened unless further work is undertaken to tackle problems of missing data, to validate models and to make them more operationally robust and user friendly.’²¹ The consequence of this was that the EPSRC re-directed the Sustainable Cities Programme back towards its ‘core’ business of developing environmental monitoring and modelling techniques. As the work became increasingly focussed on these issues, so the possibilities for collaboration across disciplines reduced and, in the final call for projects, social science inputs were effectively ruled out completely.

But why did this happen? One important part of the explanation that reinforces the institutional trends identified earlier is the view of the city, illustrated in figure 4, that is embedded in the engineering approach to the problem of the sustainable city. The essence of the engineering approach is to see the city as a technology. The challenge of sustainable development is thus to break the city down into its component parts and find more efficient ways of performing the various functions. Models are important in this because they perform two key functions. Firstly they identify the key parts of the city that the engineering perspective is concerned with (e.g. in the case of transport models, this may be roads, junctions, traffic flows and public transport but not pedestrians or cyclists) and attribute characteristics to them. For example, road users are sensitive to prices and journey times so will be discouraged by increasing journey costs and delays. But models do more than simply provide ontology of the city, they also make it malleable. Within the

model, engineers can vary the different parameters and watch the effects of these changes on the environmental characteristics of the city.

Figure 4: City Diagram for the EPSRC ‘Towards the Sustainable City’ Programme



In other words, the engineering perspective takes a systems approach and applies it to the city, which is conceptualised as being made up of different sub-systems, such as the transport infrastructure, the energy and water networks and the building stock. By dividing these up into spatial units and mapping the flows of energy and waste between them, the

engineering assume a more or less static social structure that is managed and contained by a more dynamic urban infrastructure that can, with appropriate technologies, adapt to the demands made upon it. These changes might be one-off changes, such as the introduction of new bus lanes or a more dynamic process in which the city continually adjusts to changes in the demands through technological innovations such as flexible prices for road-use or domestic energy.²²

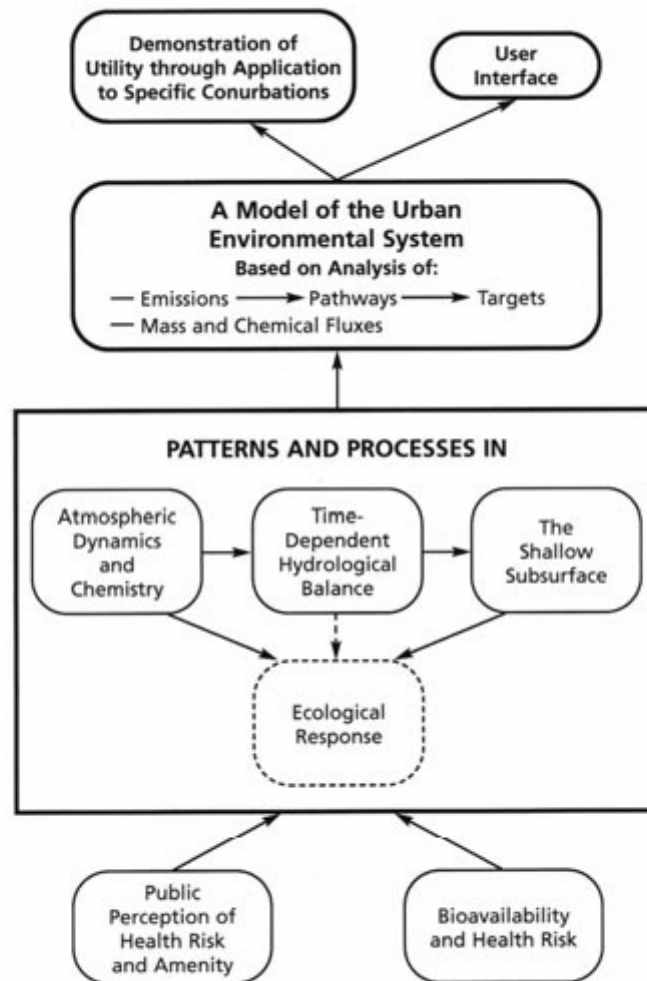
It is important to note what is not in this perspective, however, and that is a conception of the city or society as something that can be changed. Thus, for example, demand for travel is taken for granted in many traffic models, which instead simulate the different ways in which a given number of trips can be accommodated on various different configurations of the transport infrastructure. Questions about the need for travel itself can only be considered outside the model. Thus, society in the broader, cultural sense only appears, if it appears at all, as a backdrop to the research problem, not as part of its solution. This is, of course, a long way from the integrated, interdisciplinary vision of the Red Bus Report.

NERC: Urban Regeneration and the Environment Programme.

The NERC URGENT programme was the vehicle through which the natural sciences made their contribution to the debate about the sustainable city. In this respect, the urban environment was an ideal site for NERC as it provided a single location where many of its disciplinary concerns came together and could be applied. For example, urban sustainability addresses traditional NERC topics of water quality, air pollution and resource use that have ramifications that can be seen on the global scale. The NERC programme is thus an attempt by the environmental sciences to develop their application in the modern context by including the 'grey' of the urban environment with its more usual 'green' and 'blue' connotations.

In some ways, the NERC approach, which is summarised in Figure 5, is similar to the EPSRC one. It sees the city as a kind of system in which the urban area is conceptualised as an object that can be researched using scientific methods derived from the existing expertise in areas like atmospheric science, hydrology and ecology. As Figure 5, which was used by NERC in their first call for research proposals, NERC's sustainable city is a place where the flows of wind, water, energy or pollutants through and between them.

Figure 5: City Diagram for the NERC Urban Regeneration and the Environment Programme



Within the NERC programme, the problem of sustainability is thus understood in terms of the underlying constraints of nature. There are natural processes and events – flows, capacities, reactions and so on – that provide a pre-existing framework of constraints and possibilities. Overlaid on this are the human activities that, for example, increase the flows of water or produce excess emissions of carbon dioxide. NERC’s research then traces the consequences of these actions through the environmental systems. The role of the natural

science research projects, which had largely ignored the city prior to this point, is thus to understand and quantify the extent to which human activities are degrading the environment. The outcome is thus a model of the urban environmental system in which targets for emissions and other activities are specified and the sustainable city is thus understood as one that does not exceed the natural capacity of the local and global ecosystem.

Within this equilibrium model, a couple of other points are worth noting. Firstly, the idea of a system is clearly similar to the EPSRC model and has similar consequences for the role of society within the sustainable city. Although NERC sees human activities as central to the processes through which the capacities and flows of the natural environment will be challenged and perhaps even damaged, society itself does not really feature in the model. It appears (perhaps) as an input at the bottom, though only here in terms of public perceptions of risk and amenity, but nowhere is it constitutive of the environmental problem. In this way, the NERC model ignores social agency in much the same way as the EPSRC one. There is, however, one way in which the NERC system differs from the EPSRC's view of the city. In the NERC model there is much less malleability. For example, the dynamics of the atmosphere do not change, all that can change is the extent to which the city makes demands on the atmosphere and the capacity of so-called 'carbon sinks' to re-absorb the carbon dioxide created by urban transport and other utilities.

In summary, then, the NERC approach sees the city as a site where a series of overlapping ecological processes come together. By understanding how atmospheric flows, hydrological balances and chemicals and other pollutants interact, the programme reveals the science that constrains urban environmental problems. Policy makers are left with little choice but to attempt to meet the targets below which urban systems stop damaging these eco-systems but how they do this remains unclear. In this way, society is understood in very similar terms to the EPSRC programme.

ESRC: Cities and Competitiveness Programme.²³

The ESRC's role in this process of re-disciplining sustainable cities research is harder to document as Cities and Sustainability were relevant to several of its research programmes. For example, although the Global Environmental Change programme was not specifically about urban issues it did address sustainability. Similarly, the 1992-1996 Transport and Environment programme had funded several transport modelling and other projects

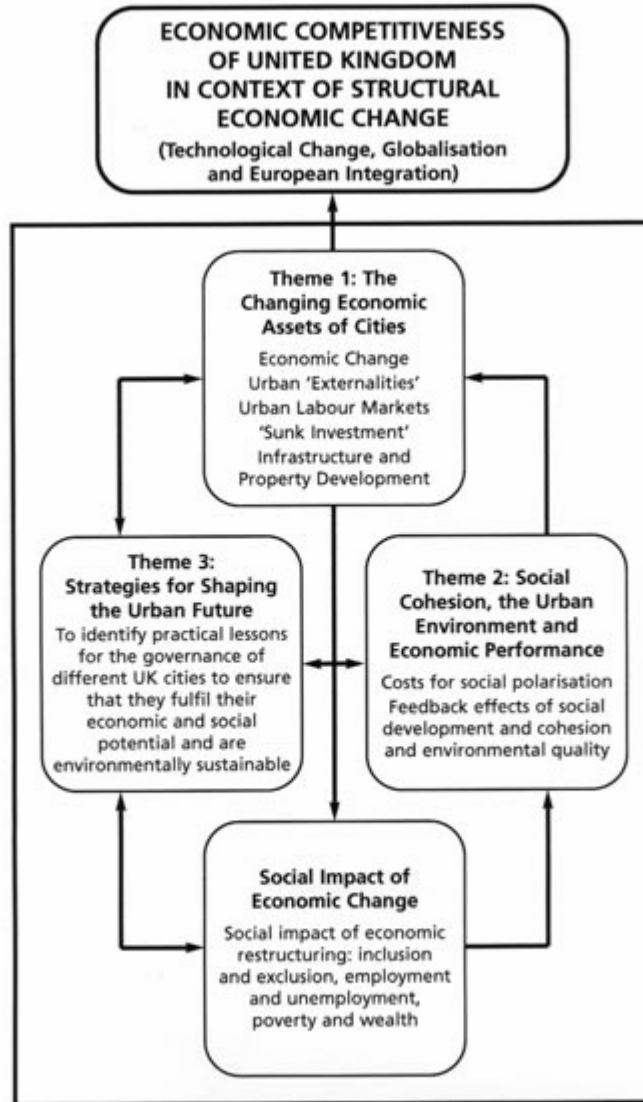
linked to environmental issues at regional, national or even European levels but without necessarily having a particularly urban focus. Conversely, the specifically urban programme, the Cities and Competitiveness Programme, that the ESRC did launch at this time gave sustainability and the environment as a relatively small part in its urban research agenda.

These different priorities no doubt reflect many concerns. As noted above, the environment had already received considerable attention in other ESRC programmes and was also the focus of major programmes in the other research councils. Ironically, therefore, the existence of the EPSRC and NERC programmes that effectively ignored the social dimensions of sustainability became part of the reason for not having a further ESRC programme that did address these dimensions! In addition, the external political climate meant that appearing to focus too heavily on social welfare or similar problems was not a viable option and so the programme focussed instead on the opportunities that cities could create for economic wealth and the creation of new jobs. In other words, far from being an environmental problem in the making, the ESRC programme presented cities as a national asset that needed to be nurtured, developed and even encouraged.

The 'city diagram' for this ESRC programme is shown in Figure 6. As can be seen, the view of the city that it embodies differs from both the EPSRC and NERC diagrams in several important respects. The most obvious difference between the ESRC diagram and the others is that cities are not a place in which the natural sciences, technology or the environment play an important part. Thus, within the ESRC framework, it is the different concentrations and types of interactions that cities make possible that matter and which shape difference for social, economic, technological and environmental processes. In other words, there is definitely a 'city effect', and the programme clearly indicates that it matters, but just how powerful it is, and how it is to be understood, is not clear.

In relation to sustainable development and interdisciplinarity, the diagram reveals that environmental sustainability forms only a small part of the ESRC's conception of cities as centres of economic activity and innovation. This view thus retains the idea of urban sustainability as a technical rather than social issue, an effect that is reinforced over time as

Figure 6: City Diagram for ESRC Cities and Competitiveness Programme



sustainability drops down, and ultimately off, the research agenda of the Cities programme. Instead, the city is seen as the place where the social impacts of economic activities are felt. Whilst these may have some consequences for the environment and sustainability (perhaps understood through regeneration, re-development and so on) the Cities programme itself ultimately pays little attention to these issues.

From Radical to Cognate Interdisciplinarity

The three programmes outlined above represent a major attempt to understand the city and its role in economic, ecological and environmental questions. What is interesting, however, is the ways in which they all move away from the radical interdisciplinarity of the Red Bus Report and return to more research council based framework. For NERC the city becomes a place where its core skills can be used to map environmental pathways and capacities. There is co-operation between disciplines within the NERC remit but not between NERC and those outside its portfolio. The same is true for the ESRC. In their view, the city is primarily a place of economic activity, with all the social and political tensions that may bring, but curiously none of the environmental consequences. Social scientists from different disciplines may debate with each other the most appropriate way of understanding the ‘city effect’ on social, cultural and economic life but they do not consider their effects on the environment nor, conversely, the effects of environmental degradation on social, cultural and economic life. Only in the EPSRC Sustainable Cities programme can we see anything like an attempt to match the radical interdisciplinarity of the environmental question with an equally radical interdisciplinary research agenda. In practice, however, this effort was not successful and the radical approach of the programme eventually collapsed back into the same kind of research council centred approach as the others.

This transition marks a shift from a radical mode of interdisciplinarity to a cognate one, in which collaboration occurs between disciplines within the same research council portfolio rather than between the research councils themselves. No doubt some would see this retrenchment back into disciplinary perspectives as a failure of nerve. After all, the ambition of the Red Bus Report, was for a radical interdisciplinary approach to environmental sustainability in which social, engineering and natural sciences all contributed their relevant expertise. Such an approach also chimes well with other writing about the problems of sustainable development in which the inherently interdisciplinary nature of the problems are highlighted. Examples of these approaches might include Hajer’s Ecological Modernisation, Beck and Giddens’ different takes on the ‘Risk Society’, Functowicz and Ravetz’s idea of ‘post-normal science’, Rip et al’s elaboration of Constructive Technology Assessment, Nowotny et al’s idea of ‘articulation’, and Bijker’s experiments with citizen participation in the Netherlands.²⁴ Indeed, many of these approaches would go even further and advocate the inclusion not just of the full range of

scientific expertise but also the inclusion activist groups that may have specific, local expertise or even lay citizens. Thus, for example, as Brian Wynne has recently stated:

To the extent that public meanings and the imposition of problematic versions of these by powerful scientific bodies is the issue, then the proper participants are in principle every democratic citizen and not specific sub-populations qualified by dint of specialist experience-based knowledge.²⁵

The implication of these perspectives might seem to be that what is needed is a community of all the experts, where 'expert' is defined increasingly broadly and in which the different experiences, knowledges and politics are all included in an integrated, holistic approach to a complex problem or set of problems. It is even possible to see how such an approach might make sense within the context of the increasing public scepticism about science and its now questioned claims to universal knowledge. For example, if (as many in the social studies of science would argue) it is the case that scientific knowledge (i.e. the sort produced by the disciplinary approaches privileged by the research councils) is more accurately understood as the cultural knowledge of a particular social group (i.e. scientists within a disciplinary tradition) and not as an epistemologically superior understanding of the world, then the reasons for excluding other groups diminish. Indeed, once the claim to include other knowledges is recognised, the drawing the boundaries may become increasingly difficult to do.²⁶ Within this viewpoint more disciplines lead to more complete knowledge as the gaps and lacunae of one group are filled and complemented by the skills and knowledge of the others.

There is, however, a real problem here. The notion of radical interdisciplinarity relies on the implicit notion of triangulation between theories and methods. The assumption is that there is just one problem and that, by approaching it from many different sides, we can build up a complete picture that will enable an accurate and effective policy response to be developed. At this point, those who are sympathetic to the cause of feminism, post-colonialism and other moves towards standpoint epistemologies will feel the deadly chill of the grand narrative. This then is the paradox of sustainable development research. The nature of the problem suggests an interdisciplinary approach, but the understanding of scientific knowledge that follows from Kuhn and Wittgenstein suggests that there is no reason to suppose paradigms are either cumulative or complementary.

When these insights are added to the social and political pressures of resource allocation it is perhaps no surprise that the challenges of radical inter-disciplinarily proved too much and that the more congenial camaraderie of the cognate disciplines seemed more productive. Nevertheless, this approach is not without problems either. The original vision of the Red Bus Report was that, despite the differences, the responsibility for resolving the disciplinary tensions and differences lay with the research community. It was their responsibility to strive towards the more integrated approach in which the contributions of different approaches were brought together. Even though achieving the unified meta-narrative might always have been an impossible dream, producing an integrated research programme that at least identified where disciplinary perspectives might complement or contradict each other should have been possible. To the extent that this did not happen then the user community – the local authorities and government actors who needed scientific research to inform their policy choices – were left with a series of different and often contradictory accounts and not the single ‘one-stop shop’ they felt they needed.

5. Stage 3: Out-sourcing Interdisciplinarity: LARCI

The most important consequence of the research council based approach that developed in the UK is not that it makes it difficult to fund truly interdisciplinary research, but that it makes it very difficult to ask interdisciplinary questions in the first place.²⁷ This is particularly clear in the case of the sustainable city where, not only did the programmes fall back within the disciplinary boundaries of the research councils, the evaluation of those programmes were also conducted within the same disciplinary frameworks. Thus, even though the three research council programmes all conceptualised the city in very different ways, as was shown in the previous section, there was no evaluation that looked across the programmes as a whole to see how the complemented or contradicted each other.

Given the failure of the research councils and communities to provide an integrated research programme, the local authority users were left with little choice but to try and make the connections themselves. The focus for these efforts was the Local Authority Research Council Initiative (LARCI), which was created in 1997 in order to address the problems created for Local Authorities by the increasingly fractured nature of the sustainable city research.²⁸ When it was established, the aims of LARCI were:

- to promote research council funded research that is relevant to local authorities;
- to obtain the views of local authorities on priority areas and new opportunities for research;
- to explore opportunities to take forward new areas of research by joint research council action;
- to establish lines of communication that will enable regular dialogue between the research councils and local authorities;
- to encourage local authorities to contribute to research council peer review and evaluation techniques.²⁹

The LARCI initiative is particularly relevant to the sustainable city research programmes because:

The unifying focus for the [LARCI] initiative is sustainable development that brings together issues relating to the environment, economics and social equity. Whilst some successful working relationships already exist LARCI is seen as a vehicle for achieving collaboration at a more strategic level.³⁰

The role of LARCI was thus to fill the ‘gap’ created by the different cultures of the academic and local authority communities. The problem was that, although research councils had an obligation to take the needs of users into account, and despite the statutory obligations that made local authorities key users of sustainable city research, there was a sense of disconnection between the two groups. Local authorities felt that their needs were not being addressed by academic community, whilst the academic community was unsure what Local Authorities actually did or wanted:

It was also acknowledged [in 1997, when LARCI was set up] that there was a gap between the cultures of local authorities and academics that impeded joint working and it seemed appropriate to explore opportunities to improve this. In a similar way there were perceived gaps in understanding between research councils and local authorities, with neither fully understanding precisely what the other did and how they might benefit from working together in the future. Furthermore the

research councils recognised that the gaps between academia and local authorities were greater than that between academia and industry.³¹

Closing this gap was an ambitious target, but it was one that became increasingly important, as the research councils own attempts to promote interdisciplinary research began to falter. In effect, what happened as research was increasingly orchestrated around a cognate interdisciplinarity was that the work of making the connections between the different research council frameworks was out-sourced to LARCI. Rather than interdisciplinary research, it was now interdisciplinary users that were being promoted.

The success of the LARCI initiative thus depended on the extent to which it was able to bring together the variety of frameworks and programmes conducted within the research councils and their associated disciplines. The 2002 review identifies that this process was a difficult one, particularly due to the resource constraints that local authorities were working under and, of course, the technical knowledge needed to understand and interpret scientific research. This should be predictable to anyone familiar with the science studies literature. If science is a skilful practice developed over time, it is no surprise to find that the limited amount of time available to local authority officers made it difficult for them to assimilate and appreciate research from across a range of disciplines. Thus:

The review also suggested that local authorities might only be interested if the results have practical applications that are directly relevant to what the local authority does. The majority of those interviewed reported that they didn't have time to search through lengthy reports hoping to find something of interest.³²

The outcome of these tensions was that LARCI became configured as a kind of clearing house for research council dissemination, providing the 'bite-sized summaries' of key projects that local authority officers could then investigate in more detail.³³ Whilst this idea was intuitively appealing it suffered from two related problems.

The first is the same one the researchers encountered when they tried to put the interdisciplinary ambitions of the research councils into practice: interdisciplinary users are as difficult to develop as interdisciplinary researchers and for much the same reasons.³⁴ Working across disciplines is hard. Of course, this is not to say that it is impossible, but it

does take time and training to understand the different perspectives involved and to see how they relate to each other. In the absence of this, however, then it is not clear that providing local authorities with brief summaries of a research projects is going to be that useful. This was certainly the experience of many, who found that the diversity of projects, and brevity of the descriptions, made it difficult to see how they would be used.³⁵ Whether local authority officers can reasonably be expected to develop sufficient expertise to interpret and integrate outputs from across the full range of research council programmes seems doubtful.³⁶

The second problem relates to differences in time horizons. Even if local authorities did manage to fully appreciate the complexities of research council work, it is not clear how they would use it. This is because:

Most research council funded research, but not all, is medium to long term. There are some shorter-term programmes within each council's portfolio of research, but the dominant message from a local authority is one of seeking solutions for today's problems, through looking ahead and tackling fundamental, hard-to-solve challenges. By contrast much local authority work is short term; an issue brought into sharper focus by the transient nature of local politics.³⁷

The result was, therefore, that the gaps between academic and local authority cultures tended to remain and, as they tried to engage with the research councils, local authority officers quickly discovered that the results did not 'add up' in any simple way. Instead, the three research programmes had abstracted and idealised certain aspects of the city, effectively creating three different cities that co-existed in the same physical space, but without addressing the problem of how to put them back together in a representation that matched the complexity of the city as it was encountered by the local authorities. Given this, it is perhaps not surprising that the conclusion of the LARCI review is that:

there is a lot of support for LARCI and its aims, although it hasn't yet developed sufficiently to demonstrate its full value.³⁸

6. Looking Across the 3 Cities Research Programmes

The paper has described how ‘doing’ interdisciplinarity changed during the course of a research endeavour that consumed over £30m and lasted over a decade. Although it would be easy to tell this as a story of failure and of disciplinary loyalties preventing important research from reaching its full potential that is not the story we want to tell. There are many reasons for this, but perhaps the most important is that such a story presumes the availability of some kind of grand narrative or integrated account that incorporates all the diversity and produces a single solution. We are sceptical of this view and thus see the failure of sustainable cities research to attain it as almost inevitable. Nevertheless, we do want to say that the historical narrative sketched above does not represent the best that could be have been achieved and nor should it set limits on the ambitions for future research.

Instead, we would argue that it emphasises the importance of incorporating the sociology of knowledge into thinking about research programmes and funding. In particular, it is important that those seeking to promote collaboration between different scientific and policy communities take seriously the social and cultural dimensions of knowledge. The existence of different cultures is acknowledged in the LARCI report, but their significance does not appear to be fully appreciated. In this respect, however, the report merely follows a much more general trend in which science and technology are regarded as ‘hard’ and the social as ‘soft’. In fact, the opposite is true. As new genetic technologies continually show, what we think of as the pre-given and stable nature is actually surprisingly malleable and mobile, whilst in the social world, culturally based forms of prejudice, discrimination and simply ways of thinking remain incredibly difficult to change.³⁹

When the story of sustainable city research is told from this perspective, some of the problems that were encountered become much more understandable, even if they remain no less intractable. Scientists within disciplines are operating within shared paradigms or frameworks.⁴⁰ Within research councils the various disciplinary paradigms that co-exist together appear as variations around a set of core ideas or principles and it is these shared elements that give the research councils their distinctive identities and shape the research programmes outlined above. For scientists, these collective commitments provide the intellectual and social scaffolding they need in order to be recognised as experts within a specific area and also the peer review and debate needed to maintain and develop that

expertise. The important point to note, however, is that their expertise is relative, and relevant, to the social group – i.e. their scientific community – that values these ideas, practices and techniques in a similar way.

The difficulty of sustainable research is that it appears to require co-operation not just within these frameworks or paradigms but also across or between them (and perhaps also the ‘paradigm’ that characterises the local authority view of the city). The crucial question is thus are the different research council paradigms or frameworks incommensurable?⁴¹ The implicit presumption of sustainable cities research, at least as set out in the Red Bus Report, is that they are not, and that some kind of shared understanding is possible. However, it is unclear whether or not the difficulties involved in rendering different paradigms commensurable were fully appreciated. For example, is the task ‘simply’ one of translating between different paradigms, of adding new elements to existing ones or is it the much more ambitious one of achieving a single new paradigm that includes all the others?⁴²

It was certainly the case the research councils appeared ill-suited to the task of breaking down the distinctions that gave their own identity meaning. Their reward structures and research funding processes all tended to work against the radical interdisciplinarity suggested by the Red Bus Report. This occurred not just because of the politics of the ‘pork barrel’ but also because paradigms and frameworks do serve a useful and productive function. Within a paradigm, there is a clear idea of what constitutes ‘normal science’ and thus of the problems that scientific research should be addressing. In this context, research efforts progress reasonably smoothly, with regular findings, refinements and outputs.

Interdisciplinary research, on the other hand, is like a revolution but without the excitement. It unsettles many of the assumptions and categories of the taken-for-granted paradigm and introduces a long period of quasi-revolutionary scientific work in which all partners must (or at least should) try to understand the perspective of the other and then work out how to translate between them. The problem is, of course, that the opportunity cost of this work – which produces little in the way of recognisable research findings or outputs – can be seen as unreasonably high if the quality of the scientific work continues to be measured against the standards of ‘normal’ science. Indeed, if this does happen, then

there may be little incentive to put in the work required to achieve the understanding needed.

The introduction of local authorities as users only serves to further complicate this process. Whatever their differences, research councils are nonetheless committed to promoting and maintaining the standards of academic research and this gives them a distinctive set of priorities and interests. As the local authority officers were only too aware, these priorities were very different to the ones that they were being asked to work with. In effect, local authorities have their own paradigm (not in the true scientific sense, but in the broader sense of beliefs, experiences, and ideas) for understanding the city and it differs from the scientific ones in many ways. This further complicates the problem of sustainable development research, and again may account for the splintering of the original collaboration into its constituent parts. Certainly the evidence from LARCI is that the local authorities knew that they were different from the scientists, but they also felt that the scientific communities were not doing enough to break down these barriers and present their users with something usable.

The end point of our historical narrative can thus be summed up as follows. The city is disciplined by the different research frameworks, which construct it in different ways. This may seem obvious with hindsight but it is important not to take it for granted. This, in part, explains the problems faced by policy-makers – they keep getting told different things by different academics using different languages and they find it very difficult to reconcile the inconsistencies in order to produce coherent policies. In effect, the users wanted the research councils to find some way of translating between the different programmes and to explain to them, in a language that they could understand, how the different types of research, which appeared to produce quite different types of knowledge, should be used.

This then suggests a new research agenda for the academic community too. The academic community needs to think how it can deal with the boundaries that exist between different research frameworks or paradigms. We cannot simply dismiss them – the notion of paradigms shows that they are fundamental to much scientific work – but in the case of the sustainable city they also seem to be part of the problem. There is thus an important need for the research community to critically examine its own practices and think about how these boundaries can be challenged and a joint understanding of the city – one that

reflects the knowledge of existing disciplines and the policy community – produced. Somehow the complex social, technical and natural aspects of the environmental problem need to be at least debated in the same language.

7. Conclusion - Sustainable Cities: Knowledge and Interdisciplinarity

The challenge of creating a shared understanding from which to address the environmental problems associated with modern cities is not to be taken lightly. In this final section we conclude by addressing some of the steps that might be taken to promote rather than hinder the interdisciplinary work that is needed. The first, and perhaps most important aspect, is to recognise what is involved in the concept of interdisciplinary research. Naïve ideas of triangulation and complementarity between research disciplines and frameworks need to be rejected at the outset, as they do not correspond to the reality of scientific life and work. Instead, the intrinsically social nature of knowledge, including scientific knowledge, needs to be recognised. Once knowledge is seen as a cultural phenomenon, and not a set of abstract propositions, several important lessons follow:

Firstly, the epistemic superiority typically granted to the scientific framing of problems is questioned. This is not to say that science is never the answer to questions of sustainable development, but it does mean that it becomes possible to ask whether the scientific framing is the right one and whether the scientific framing exhausts the possible questions. Where scientific research is appropriate it should, of course, be encouraged.

Secondly, the participants in expert debate, even that which involves scientific questions, need not be restricted to scientists alone. Scientists represent a particular source of expertise but their expertise does not necessarily exhaust all relevant knowledge. Local citizens, social movement organisations, planners and many others may have experience that is legitimately classed as expertise, even if it is not formally recognised as such by certificates and publications.

Thirdly, widening participation in this way only serves to increase the problems of translating between perspectives, frameworks or paradigms.⁴³ Some moral responsibility is thus needed to correctly identify who is responsible for ensuring that different views are included, even if they start from very different assumptions. In the first instance it would seem reasonable that the research councils – the organisations devoted to the development of new knowledges – should promote this activity.

Fourthly, if research councils are to recognise that developing expertise in new subject areas, including that of 'local government', is legitimate research work then funding structures and assessment mechanisms will need to reflect this. For example, research projects may have to include a specific 'learning' phase in which the participants are expected to do nothing but talk to each other and learn to translate between their different perspectives.⁴⁴

Fifthly, there may emerge a new class of experts or intermediaries (knowledge brokers) whose expertise consists of translating between different frameworks and paradigms.

Finally, an alternative vision of what the outcome of such a process should be is also needed. If feminist and other 'standpoint' critiques are correct, then including new voices in this way will increase the range of views articulated but may not produce agreement.⁴⁵ As a result it is important to recognise that although knowledge and expertise play an important role in these debates, they may also involve more than this. In particular, it may be necessary to explicitly recognise both the contingency and uncertainty of scientific knowledge and thus introduce a more explicitly political or democratically accountable process for choosing between the competing claims and voices.

In conclusion, the paper has shown how a determined attempt to create an interdisciplinary approach to an avowedly interdisciplinary problem faltered. Our argument, however, is not that this represents a simple failure of will on the part of the research communities involved. Rather, our claim is that it reveals the importance of research frameworks in shaping approaches to sustainable city research. Breaking down these barriers is a difficult and unpredictable task and, crucially, in the current climate it is an un-rewarded one. Despite this, however, the problem of the sustainable city remains – indeed it is arguably more urgent than ever – so some new approach is needed. Our aim in this paper has been to provide a diagnosis of the current problems and to develop our own framework through which they can be addressed. Although we can offer no guarantees of success it is certain that, unless the hidden work of interdisciplinarity is made visible, the problems of the past will be repeated.

Notes

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² Houghton, Graham and Hunter, Colin, (1994) Sustainable Cities: London Regional Studies Association

³ In section 4 these diagrams are particularly important for our argument. The NERC diagram is simply reproduced from the original. The order of the boxes in the ESRC diagram has been reversed to match the logic of the NERC diagram. There was no EPSRC diagram - here we provided the research manager and consultant with examples of the NERC model and asked them to draw a similar representation of how the EPSRC model would have been drawn.

⁴ These changes are part of a wider scale reorganisation of research councils that took announced in 1994 and implemented on 1 April that year. The reorganisation created EPSRC, BBSRC and PPARC. Details of parliamentary debate are at:

<http://www.parliament.the-stationery-office.co.uk/pa/cm199394/cmhansrd/1994-02-02/Debate-2.html>

see esp. columns 902 and 905 [accessed 5 August 2003]

⁵ Berrett, B. and Hopkinson, P.G. (1991) ... towards the Civilised City: Scoping Study, Leeds: University of Leeds Environmental Research Centre. Quote at p. 3, emphasis in original.

⁶ UK universities may be different to others in the tenacity with which they have hung on not just to CP Snow's two cultures, but also to the distinctions within the sciences and arts.

⁷ Berrett, B. and Hopkinson, P.G. (1991) ... towards the Civilised City: Scoping Study, Leeds: University of Leeds Environmental Research Centre. Quote at p. 3.

⁸ Baker, C.J. (1991) The Civilised City: A Project Definition Study, Nottingham: Nottingham University Dept. of Civil Engineering. Quote at p. 2.

⁹ source: <http://www.gecko.ac.uk/> [accessed 7 August 2003]

¹⁰ ESRC Global Environmental Change Programme Specification. Paragraph 3.2.

¹¹ Cities and Sustainability (Red Bus Report), Clean Technology Unit, p. 1.

¹² Cities and Sustainability (Red Bus Report), Clean Technology Unit, p. 4.

¹³ This diagram does not actually appear in the Red Bus Report, but was produced by one the report's authors and Simon Marvin.

¹⁴ Cities and Sustainability (Red Bus Report), Clean Technology Unit, p. 2.

¹⁵ Of course, this still begs the question why they tried to enrol the other disciplines. Why not a policy relevant programme for engineers alone? One answer is that the research councils, and particularly the SERC, were following the emerging industry trend of multi-disciplinary research and thus developing something like the 'Mode 2' knowledge production identified by Gibbons et al.¹⁵ Whilst there may be some merit in this, it also raises some important questions, which will re-appear later. In particular, Mode 2 work is characterised by an emphasis on specific tasks, the language of integrated research suggests something closer to the more traditional scientific goal of a complete theory.

¹⁶ The Sustainable Cities Network web site is at:

<http://www.hull.ac.uk/geog/research/html/suscity.html> [Accessed 19 May 2004]

¹⁷ Source: Interviews and personal communications

¹⁸ Cooper, Ian (1997) Management Audit of the Sustainable Cities Research Programme. p. 1.

¹⁹ All data from Cooper, Ian (1997) Management Audit of the Sustainable Cities Research Programme. see pp. 3-4.

²⁰ Cooper, Ian (1997) Management Audit of the Sustainable Cities Research Programme. p. 1.

²¹ Cooper, Ian (1997) Management Audit of the Sustainable Cities Research Programme. p. 1.

²² See for example, the Clean Zone initiative and Leeds Instrumented City project(s)

²³ The programme specification is on web at:

<http://www.lse.ac.uk/Depts/london/econcomp/cities.htm> [accessed 11 August 2003]

Programme website (which does not contain this info, but does list projects and publications etc) is now at:

<http://cwis.livjm.ac.uk/cities/> [accessed 11 August 2003]

²⁴ References: Hajer, Maarten (1995). The Politics of Environmental Discourse: Ecological Modernisation and the Policy Process, Oxford: Clarendon Press; Beck, Ulrich (1992). Risk Society: Towards a New Modernity, London, Sage; Giddens, Anthony (1990). The Consequences of Modernity. Cambridge: Polity Press; Functowicz S.O. & Ravetz J. R. (1993) Science for the post-normal age, Futures, 25, pp.739-755; Rip, Arie, Misa, Thomas J. and Schot, John (Eds) (1995) Managing Technology in Society: The Approach of Constructive Technology Assessment, London ; New York: Pinter Publishers; Nowotny, Helga, Scott, Peter and Gibbons, Michael (2001) Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty. Cambridge: Polity; Bijker, Wiebe (forthcoming) Sustainable Policy?: A Public Debate about Nature Development in the Netherlands, Social Studies of Science?

²⁵ Wynne, B. (2003) "Seasick on the Third Wave? Subverting the Hegemony of Propositionalism: Response to Collins & Evans (2002)." Social Studies of Science 33/3 (June): 401-417. Quote at p. 411

²⁶ For an attempt to do just this see: Collins, H.M. and Evans, R.J. (2002) 'The Third Wave of Science Studies: Studies of Expertise and Experience', Social Studies of Sciences, Vol. 32, No. 2, (April), pp. 235-296.

²⁷ There are, of course, other models of funding in other countries – notably in Norway and Canada – where different approaches have been, and are, used.

²⁸ The importance of this for research councils was stressed in third report of the House of Lords Science and Technology Committee. See: House of Lords (2000) Science and Society: Science and Technology Select Committee, Third Report, London: HMSO. Also available on WWW at: <http://www.parliament.the-stationery-office.co.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm> [Accessed 23 January 2002].

²⁹ Source: LARCI (2002) A Review of Progress: A New Way Forward, Research Briefing 12, Jan 2002. Quote at p. 4, emphasis in original.

³⁰ Source: LARCI (2002) A Review of Progress: A New Way Forward, Research Briefing 12, Jan 2002. Quote at p. 5.

³¹ Source: LARCI (2002) A Review of Progress: A New Way Forward, Research Briefing 12, Jan 2002. Quote at p. 6.

³² Source: LARCI (2002) A Review of Progress: A New Way Forward, Research Briefing 12, Jan 2002. Quote at p. 16; see also p. 27 where it is reported that:

There were some concerns among local authorities that LARCI is organised around a world that the research councils understand and this in effect serves to exclude them. It has become clear during this review that there is a gap in understanding on the part of the local authorities as to what the research councils do. Primarily local authorities perceive the research councils as being preoccupied with maintaining levels of academic achievement and driving forward 'pure science'.

The do not believe the research councils have any interest in applied research. Comments included a perceived lack of consistency between the research councils with each of them having different agendas.

From a local authority perspective, the research councils give the impression that they have a 'hands off' approach towards the programmes they fund once the elements of that programme have been decided. Even where the research is relevant to local authorities there does not appear to be any obvious attempt by the research councils to ensure their involvement. The way the councils are funded from central government was perceived to further restrict their ability to engage local authority interest.

³³ A typical example of this sort of activity is the summary of research projects presented at the LARCI conference "Communities 2000: the Local Government Research Agenda" The report provided a brief overview of over twelve research projects together with contact information for obtaining further details. See: LARCI (2000) Report of a Conference on Communities 2000: the Local Government Research Agenda.

³⁴ The authors can both testify to this from personal experience!

³⁵ In this sense, best practice guidelines might seem more useful, but even here similar problems arise. In effect, as Harriet Bulkeley has argued best practice guidelines are like algorithms and suffer from the same problems as scientific papers – informal networks of trust, experience and reputation are important factors in deciding what ideas within the best practice database will work and in what context. Source: Harriet Bulkeley (2004) 'The environmentally sustainable city: learning from best practice?'; paper presented at the Resurgent City Symposium, LSE, 20 April 2004.

³⁶ Indeed, there is a kind of moral dimension here too. Should the local authorities have to become capable of discussing all science, or should scientists take responsibility for understanding local authorities in much the same way as they seek to understand the entrepreneurial needs of the private sector? Collins and Evans (2002) suggests that the responsibility for making things understood should rest with the scientists not the local authorities.

³⁷ Source: LARCI (2002) A Review of Progress: A New Way Forward, Research Briefing 12, Jan 2002. Quote at p. 23.

³⁸ Source: LARCI (2002) A Review of Progress: A New Way Forward, Research Briefing 12, Jan 2002. Quote at p. 4 and 29.

³⁹ This argument is made with respect to organ donation and xenotransplantation in Welsh and Evans (1999).

⁴⁰ Kuhn's term of paradigm is probably the most well known but the least clearly defined. We are using it in what I think is the sense that he later termed 'disciplinary matrix', which is the more inclusive sense that includes concepts, techniques and exemplary experiments.

⁴¹ Like all Kuhn's key terms, incommensurable is also open to multiple interpretations. The key differences are between those who think it is impossible to communicate between paradigms and those who think it is impossible to believe both at once. We adopt the second approach, as the first is self-evidently refuted by the existence of the sociology of science amongst other things.

⁴² It has been pointed out by Harriet Bulkeley that this last option would seem to be the way that the integrated assessment approach to climate change has been developed – the emergence of a new 'transdisciplinary discipline' with its own journals, conferences and so on.

⁴³ Some way of limiting participation is also needed. See Collins and Evans (2002) for a theory of expertise that provides a framework for discussing these issues. See also Vol. 33, No. 3 (June 2003) of the same journal for critiques of that theory and a reply.

⁴⁴ The research councils will also have to accept that this might be the end of the project as no shared frame emerges.

⁴⁵ Of course it is also possible that the new forums will be seen by some as co-opted by the establishment. As a result, some may not participate. See e.g. Rip, Arie (1986) 'Controversies as Informal Technology Assessment', Knowledge: Creation, Diffusion, Utilization, Vol. 8, No. 2 (December), pp. 349-71.