UNIVERSITY OF LEEDS

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Constructing careers, creating communities: findings of the UK KNOWING research on knowledge, institutions and gender.

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Executive Summary

This report presents the main findings of research exploring academic careers and communities in the UK, conducted between 2006 and 2008 as part of the EC Sixth Framework Programme project KNOWING: Knowledge, Institutions and Gender - An East West Comparative Study. This multi-methods study explored knowledge production contexts and practices in the biosciences and social sciences. It draws on data generated by the multiple methods used in the study: life-course questionnaires, participant observation studies, in-depth individual interviews and focus groups. It is also informed by an extensive review of the 'state of the art' literatures and statistics on the research landscape and national science policies in the UK, and by detailed discourse and narrative analysis undertaken on women and science national policy documents. The study was based in two departments at a medium sized, research-intensive university. Two laboratory groups in biology and members of staff in a social science department and two of its affiliated applied research units participated. Two contrasting labs were chosen – one larger biology group headed by a female professor, and one long-standing but smaller group of researchers. In the social science department we negotiated participation with individual staff. These were primarily lecturing staff and fixed-term contract researchers and mainly women.

We focus on two main areas that we found presented particularly complex and important challenges for the analysis of knowledge, institutions and gender: *the academic research career* and *ways of working together and alone* in both disciplines. In section two we examine the construction of the research career in dominant policies and discourses and show how this shapes different experiences of and opportunities for career progression across the two disciplines. We pay particular attention to the emergence of a 'two tier' contractual system within universities which shapes different conditions of work and research activity for core funded, permanent teaching staff contrasted with research-only staff on fixed-term contracts. We then trace some of the gendered implications of these changing conditions for the construction, meaning and experience of research careers. In section three we turn to look in detail at how researchers work together and apart in the two different disciplines, focusing on how research groups are structured materially, organisationally, epistemically and discursively, and on how collective and individual research practices are understood and negotiated by researchers. We pay particular attention to the differential experiences of men and women in the context of their disciplinary communities, and to the gendered divisions of epistemic and organisational labour therein, analysed against the backdrop of norms for assessing individual research excellence. We note that the kinds of knowledge production and career activities and achievements that can be 'seen' and rewarded within an academic research culture – primarily concrete, identifiable outputs - means that some people and particular types of work that are fundamental to research can become invisible. This is a particular problem for women but as the model of the male breadwinner breaks down it is also having consequences for some men. In our concluding discussion we consider the policy implications of our findings in three key areas: women in science, career and the natural/social sciences.

Our findings (section four) paint a complex picture of knowledge, institutions and gender from which it is difficult to extract a simple list of policy recommendations. However, we point to a number of key areas that demand further attention from government, funding councils and Universities.

In relation to women in science we recognise the positive attention to the issue in national policy and the steps taken by institutions to change research cultures. However, we are concerned that they tend to be 'added on' to underlying norms of the linear research career. We suggest that there is a need for a broader range of career paths, and a wider recognition of the invisible interconnecting roles that women in particular tend to play in science and social science. We argue that the focus upon maximising work-life balance is an inadequate way of dealing with the demands of academic work because this is not just a matter of time management but it is bound up with people's very identities as knowledge producers. We therefore suggest that policy attention ought to shift away from women and work-life balance to a broader analysis of the demands of academic work and identity and how best to manage them in ways that combine the recognition of 'invisible' academic work and discretion for individual researchers.

In relation to research careers, we recognise positive changes put in place following the universities' Concordat on the management of fixed term staff (1996) and the Roberts report (2002) on research careers. While we agree that opportunities for researchers to join the standard career track need to be opened as widely as possible, we also suggest that there needs to be greater recognition of a range of different research career tracks and the valuable role they play in the academy in terms of knowledge generation and dissemination. It is important to recognise that research careers that stop and start, move across and between disciplines, and involve periods of teaching and knowledge transfer work as well as traditional research outputs are as valuable as the linear career towards individual excellence. Research councils should support these *moving careers* and more diverse options for *late career researchers* by the provision of a range of funding opportunities beyond fellowships based upon narrow criteria of individual excellence. There also needs to be greater recognition of the vital role that long term research-only staff can play in supporting complex 'research ecologies'. However, the onus to change is not just upon Universities. Funding councils also need to recognise the importance of researchers and provide sufficient funds to support these roles.

In relation to science and the knowledge economy, we argue that social science has a role to play in informing science policy debates which tend to be rooted in the STEM subjects, as well as having something to learn from knowledge production cultures in the biosciences. Looking at and adapting models from the natural sciences might open up ways of taking career development more seriously in the social sciences. There is also scope for social science departments to learn from the integrated small-team model predominant in biology, and consider ways of involving PhD researchers and early career researchers more systematically in stable teams and departmental structures. On the other hand, the different models of research in the social sciences might shed new light on taken for granted

practices of research in the natural sciences. The reflexive and feminist currents in the social sciences also challenge assumptions about what women in research need, as well as taking a critical perspective on the dominant narrative of the linear career and attempting to make more visible the masculine norms attached to successful research identities. In the longer term, policies need to address these issues, as well as those related to the dynamic reproduction of the gendered academy raised in this report, in order to make long-standing and solid changes in the name of gender mainstreaming.

1 Introduction: the UK KNOWING research

This report presents the main findings of research exploring academic knowledge production contexts and practices in biology and the social sciences in the UK. The research was conducted between 2006 and 2008 as part of the EC Sixth Framework Programme project KNOWING: Knowledge, Institutions and Gender - An East-West Comparative Study. This report draws on findings from the multiple methods used in the study, working across data generated from life-course questionnaires, participant observation studies, in-depth individual interviews and focus groups. It is also informed by an extensive review of the 'state of the art' literatures and statistics on the research landscape and national science policies in the UK, and by detailed discourse and narrative analysis undertaken on women and science national policy documents. Although our findings raised a range of issues and demand fine analysis using different approaches, we focus on two main areas that we found presented particularly complex and important challenges for the analysis of knowledge, institutions and gender: *the academic research career* and *ways of working together and alone in both disciplines*.

We begin in section two by examining the construction of the research career in dominant policies and discourses and show how this shapes different experiences of and opportunities for career progression across the two disciplines. We pay particular attention to the emergence of a 'two tier' contractual system within universities which shapes different conditions of work and research activity for core funded, permanent teaching staff contrasted with research-only staff on fixed-term contracts. We then trace some of the gendered implications of these changing conditions for the construction, meaning and experience of research careers. In section three we turn to look in detail at how researchers work together and apart in the two different disciplines, focusing on how research groups are structured materially, organisationally, epistemically and discursively, and on how collective and individual research practices are understood and negotiated by researchers. We pay particular attention to the differential experiences of men and women in the context of their disciplinary communities, and to the gendered divisions of epistemic and organisational labour therein, analysed against the backdrop of norms for assessing individual research excellence. We note that the kinds of knowledge production and career activities and achievements that can be 'seen' and rewarded within an academic contract research culture – primarily concrete, identifiable outputs - means that some people and particular types of work that are fundamental to research become invisible. This is a particular problem for women but as the model of the male breadwinner breaks down it is also having consequences for some men. In our concluding discussion we consider the policy implications of our findings in three key areas: women in science, career and the natural/social sciences.

1.1 The research sites

The UK KNOWING research was based in two departments at a research-intensive university. Members of two laboratory groups in biology and members of staff in a social science department and its affiliated applied research units completed questionnaires and

participated in one-to-one interviews and focus groups. We also conducted participant observation in the labs and with members of the department. Two contrasting labs were chosen – one larger group headed by a female professor, and one long-standing but smaller lab. Both groups included a professor/lab leader, post-doctoral researchers, post-graduate students, and technicians. The smaller lab was mainly staffed by women, although it was headed by a male professor. The larger lab group consisted of roughly equal numbers of men and women. In both groups lab members changed during the course of the research, with new members arriving and others leaving. We had good support from the head of department in biology for the research in all its phases. In the social sciences it proved difficult to gain access to the department and its affiliated applied research units as a whole and instead we negotiated participation with individual staff. These were primarily lecturing staff and fixed-term contract researchers and mainly women; post-graduate students were not included in the social science part of the study.

1.2 Methodologies

At the heart of the KNOWING data generation were the participant observation studies undertaken in the two laboratories and with individual staff members in the sciences. We visited the university on a weekly basis between June 2006 and April 2007, with more intensive and extended periods of observation taking place for the six months from September 2006 to February 2007. We focused on finding out about the activities of the lab groups and social science researchers, their research fields, the spatial and institutional contexts in which their work took place, and the ways in which knowledge is produced and communicated within intimate knowledge networks (lab groups, research colleagues) and beyond. As the main empirical researcher on the project, Lisa conducted the participant observation research across the three sites. Detailed daily field notes were written up shortly after observation periods. The fieldnotes were coded and managed using NVivo 7 software.

Prior to the participant observation we had collected responses to closed-answer type life-course questionnaires (LCQ). The LCQ was designed to give a broad overview of individual biographical details, research career paths, epistemic networks, and participants' evaluations of the structure and culture of the university as a research centre. It was sent to a targeted sample of relevant researcher groupings in the departments where the observation study and interviews were conducted. Fifty-two questionnaires were sent to research staff, students and technicians in biology and twenty-three were returned, a response rate of 44.2%. Eighty-five questionnaires were sent to social science researchers, including PhD students, with a response rate of 16.5%.

One-to-one interviews were also conducted with nine biologists (one female professor, one male professor, four post-doctoral researchers, three female and one male, two post-graduate students, one female and one male, and one female technician) and five social science researchers (one female professor, two female lecturers, and two research fellows, one female and one male). The interviews were used to explore participants' biographies in relation to their research careers, their sense of themselves as epistemic subjects, and their

understanding of the knowledge production contexts within which they worked. The topic guide created for the interviews by the KNOWING consortium was used selectively to shape semi-structured discussions. Interviews were recorded, fully transcribed, and coded using NVivo software. We draw on these interviews extensively in this report.

In October 2007 we conducted three small focus groups with researchers in biology and social science. We approached the focus groups as rich sources of information about epistemic cultures and identities and the institutional and social organisation of knowledge production. The focus groups were structured according to discipline and position. In the social sciences we conducted separate sessions with permanent teaching-and-research staff in the core department (three female lecturers) and with research fellows based in two applied research units (three female and one male researcher). In biology we conducted a focus group with staff members (two female lecturers and two male professors), but were unable to recruit participants for a post-doctoral researcher focus group. Drawing on reviews of the relevant secondary literatures, emergent findings from participant observation studies with researchers in biology and the social sciences, and analysis of key institutional/national policy and strategy discourses surrounding women, research and career, we identified three key strands that could be productively explored using the focus group method: academic disciplines and disciplinary identities; science in public and in private; and gender, research practices and institutions. Interviews were recorded, fully transcribed, and coded using NVivo. Detailed extracts from the focus group sessions are analysed in this report.

Note on anonymisation of data

In order to preserve the anonymity of participants we have not named the university in this report. We have avoided referring to individuals by name. We have not provided details about the research work of the two lab groups and individual researchers in the social sciences in order to avoid revealing the identities of participants and their institutions by inference.

2 Making it: constructing the academic research career

2.1 Contextualising careers

In this chapter we focus on the academic research career in the UK, approaching career from three main angles: the structural and material conditions that currently shape career paths and possibilities for researchers in the social and biological sciences; the institutional and other policies and discourses that are now emerging to formalise and standardise research careers; and the experiences and meanings of career for individual researchers and collective actors in concrete organisational contexts. The research career is negotiated by individuals in specific HE institutions, but it is shaped by larger structural changes, particularly changes in research funding which have seen the growth of project-based research and the massification of higher education. Project and programme funding is time limited and awarded via processes of competitive application, and now accounts for 68% of the total research grant and contracts income of UK Higher Education Institutions (HEIs), (Universities UK 2005: 2). The expansion or 'massification' of higher education has also greatly increased the numbers of academic staff. It is estimated that there was an overall growth rate of academic staff in the UK HE sector of 20% between 1995/1996 and 2005/2006 (Universities UK 2007). Both these developments have taken place within a national policy context that emphasises the importance of research and development to the growth of a competitive 'knowledge' economy; and since the mid-1990s there has been increasing public investment in research and education. At the same time, universities, like the rest of the public sector, have been restructured according to the demands of the 'new public management' which emphasises accountability, efficiency, and the introduction of quasi-market mechanisms. A key outcome of all these changes has been the enormous growth of both the number and proportion of researchers who now work in British universities on fixed-term contracts funded by external agencies. In the academic year 2005-06 just under of 41% of the UK's 164,875 academic staff were on a fixed-term contract (HESA 2007). Most of them are research-only staff (AUT 2004; see also AUT 2002), and the largest number of research-only staff in UK HEIs are in the biological sciences (HESA 2005/06, as reported in UCU 2007: 10). The shift towards contract research posts contrasts with the tradition of job security and permanency in British universities in the 20th century (Court 1998), creating a growing body of researchers with little job security and whose institutional status and value can be unclear. Efforts are underway to improve this situation, and more researchers are now being placed on permanent contracts with better training and support from their institutions.

As a result of these changes there has been a formalisation and standardisation of career paths, especially in the natural sciences. Issues relating to the recruitment and retention of contract research staff have been on the national science policy agenda for some time, and the government commissioned 'Roberts Report' on science careers was crucial in framing these issues (Roberts 2002). However, there is still a lack of research on the qualitative experiences of post-doctoral and other fixed term and contract research staff, and on the changing nature of academic research careers more widely (Hockey 2002; Allen Collinson

2003). Our fieldwork generated rich data on the experiences and meanings of contract research across two different disciplinary contexts, enabling us to begin to address these absences. The issue of the science career path in general and contract research culture in particular are also important in understanding questions of gender and knowledge production. As we discuss below, policy formulations of the 'women and science' issue have largely been focused on addressing issues of recruitment, retention and career development within research institutions. The linear, normative career structure appears in some respects to be a particular problem for women, although as we will argue below when examined carefully it reflects more broadly gendered discourses and cultures of career and gendered organisational practices.

Drawing in detail on empirical data from participant observation, individual interviews and focus groups, we look below at the complexities of 'making it' in academic research. We explore what it means to establish and pursue a successful research career – both in terms of structures of opportunity and constraint, and from the point of view of individuals negotiating them – as well as taking a more critical look at the ideal/normative research career as a discursive and institutional construct.

2.2 De/constructing the normative research career

A singular, standardised career route is becoming embedded in the biological sciences, reflecting national and institutional policy discourses focused on the early stages of the career. We found this normative career path reiterated, internalised and sometimes resisted across a range of contexts – at departmental meetings, in training sessions and in documents provided by one of the field's key public funding bodies, in conversation with post-doctoral researchers and in focus group discussions with biology academic staff. The early academic biology research career was constructed in terms of discrete, progressive stages leading to a permanent lectureship or independent fellowship position. In the following extract from a focus group with permanent teaching-and-research academics in the biology department, a younger female lecturer described her "typical" career:

> I did a degree. I did a PhD immediately afterwards. One short post-doc and then one longer one. Maybe that's not typical. I got in a nice comfortable well funded position. And then I got a lectureship position and I didn't drop off the bandwagon.

From responses to the KNOWING life-course questionnaire this career path appears to have been in place for some years, although older staff recalled a time in their own early careers when "they were still appointing, actually, people without PhDs to lectureships" (male professor, biology staff focus group). However, we found that more recently it has shifted from being typical to normative. The dominant construction in the biological sciences is of a research career that is relentlessly linear, continuous, and with a single upward trajectory. Biology staff talked about it in terms of the need for constant movement through distinct phases, making career breaks or sideways moves very difficult. It was also taken for granted, with some exceptions, that 'good' researchers would be institutionally and geographically mobile, particularly during the early post-doctoral career phases. It tended to be assumed that the career began with the commencement of an undergraduate degree at eighteen years and that there would be no breaks in progression thereafter:

> …we have some new appointments in the department and they're, what, 31, 32. So if you leave school at 18 I reckon it will take you ten, twelve, thirteen years before you're in a position to I guess write a grant to fund yourself. The apprenticeship is quite long and pretty intense. And if you drop out it's so difficult to get back in again [male professor, biology staff focus group].

Biology staff framed the forward-moving dynamics of the academic research as an outcome of the pace of the discipline itself. Career was characterised in terms of getting on and staying on an upwardly moving trajectory within a highly competitive and constantly progressing field. The alternative was to leave academic research after a limited number of years or fixed-term research contracts. We found the option for post-doctoral researchers to move into industry, the public sector and other careers, for example in the media or science outreach work, was strongly emphasised and supported within the biology department.

In contrast, in social science we found no consensus on what constituted a typical career path, and no strong policy agenda constructing the normative career, although one social science professor contrasted the 'old days' with the current situation in terms that imply the emergence of new career structures, about which she was guardedly positive:

> I think there wasn't much notion of career progression or career management. It was very much that people were or weren't self-directed. I mean there was no kind of idea of talking about how you might enhance your performance or develop a career structure or anything like that. So I'm not sure that they were the good old days to that extent. I mean I think it was quite sloppy. I'm not completely in favour of some of the structures and mechanisms that have come in [female professor, social science, interview].

The route from PhD to fixed periods of post-doctoral research to lectureship was recognised by social science staff as one important academic trajectory. However, it was often questioned and juxtaposed against multiple others. We also found that in social sciences the age/stage relationship common in biology broke down. It was much more usual to find people with

non-linear and discontinuous career paths, including lecturers who had begun in academia as mature students, sometimes as a second career or moving into research and lecturing from professional practice backgrounds, people who had taken career breaks to care for their families, and people working as researchers either without a PhD or whilst studying for one.There was also much more disciplinary and sub-disciplinary movement - we found researchers with disciplinary backgrounds in psychology, history, social work and statistics all working in the social science department and applied research units, contrasting with the more coherent disciplinary trajectories of biologists In the social sciences, then, notions of career path were more plural and less explicit, although in some ways they were more insular and insistently academic; there was little discussion of the possibilities of moving out of academia beyond the post-graduate level. In contrast to academic staff members in biology, who felt that they were working hard to stay on a predetermined career track, some staff in social science felt that they were grappling with problems of progression in a culture of ambivalence and silence, as in this excerpt from an interview with a female lecturer:

> So there's somehow in my head, nobody has ever told me this but somehow in my head there exists some sense in which at this stage in your career you should have this number of publications or your profile should look like something. But no one is actually telling me what that is. In America it was you would have ten publications […] you know, these were the minimum requirements. It would be much more transparent. Not that I'm necessarily in agreement with that but there was a sense in which everybody knew what you were expected to achieve in a certain amount of time. And here it's all by osmosis.

In the biological sciences, researchers seemed to have more readily accepted the norms of a linear, standardised career path, especially people who were ambitious and successful relative to their career stage (they had gained independent research fellowships or PhD funding from prestigious funding bodies, for example). They gave straightforward accounts of their research careers in terms of continuities and a smooth relationship between past experiences and future expectations, emphasising career plans from an early stage as in the following typical example from an interview with a young male PhD student:

> Oh, yeah. I think I am very ambitious. I've always had a very clear idea. I want to get this lectureship thing in the next however long it will take and I want to be very good at what I do […] I think there's a set path. I mean people who've had [prestigious research scholarships] in the past have done very well. They get their PhD and then they have a good post-doc and then they get a Royal Society fellowship and then they get their own lab.

We found that the organisation of research in the biological sciences – in particular the laboratory structure and the prevalence of undergraduate projects undertaken within active research labs – made it much more likely that researchers would be involved from an early stage in real world projects and work closely with more experienced researchers, particularly those at the next career stage. Researchers who construed their career in terms of a linear

plan were more likely to have had early experience in research labs, contacts with senior researchers, and awareness of the institutional and funding context of academic research. In the social sciences, where PhD students are more likely to work closely with one or two academic supervisors and are often organisationally and spatially located separately from funded research projects, researchers' accounts stressed a lack of information about and knowledge of research as a career, as in this example from our focus group with social science research fellows:

> I think when I was doing my degree the people who knew that they wanted to do research, we were just all told that was a case of graduate, Masters, PhD. We all had a lot of experience doing the practical bits of research… But obviously I didn't have a clue about doing a PhD until I started work here and when you actually get into these real world issues […] it was all very much focused on the research. I was a research assistant and I didn't have any involvement with applying for funding and what have you.

Other participants in the social sciences explicitly distanced themselves from the idea of career plans, or actively resisted the notion of having a career strategy. While researchers in the biosciences were much more likely to endorse or adopt a strategic approach to career, they also stressed enjoyment, love of the work or a "vocation" for science. Indeed it was notable that a passionate commitment to research was in many cases framed as the primary prerequisite of successful career building. In the social sciences, this vocational sense of identification with career was rarely mentioned.

In both biology and the social sciences we found many career accounts that we might call 'fragmented.' Here, themes of accidents, luck and even "mistakes" were emphasised. Participants in biology who had not moved forward according to the expected steps or did not conform to the normative age/stage – particularly people who had entered undergraduate or postgraduate science as mature students – seemed to find it particularly difficult to narrate their future career aspirations or plans in linear terms. Officially 'career' is framed as a one-way trajectory but we found that individuals' narratives were often recursive and backward-looking, especially for those who had not or could not adopt the standard career path. One post-doctoral researcher with a young family in biology commented during the participant observation phase that she couldn't be ambitious at this stage in her career, because in order to do so she would need to have been ambitious before. This captures the slippery and ambiguous nature of the lived career well.

In sum, the linear career path is a double-edged sword. In the biological sciences, information about career routes and support for making conscious career decisions and plans appeared to enable some researchers to construct a meaningful and positive future path. This appeared to be a positive development for some career 'high fliers'. Our data also suggested that it worked particularly well for researchers at the end of their PhD who were looking for jobs in science outreach or considering roles in industry, enabling them to make a positive choice to leave academia. However, when the career narrative was experienced as

highly formalised and standardised it also cut off future options for researchers, and tended to reinforce the marginal positions of those who had not followed the normative route from the outset. In the social science department, the absence of a structured career path and explicit information about how to build a successful career based on research was a source of anxiety and strain for some. At the same time, individuals were more free to construct accounts of 'making it' on their own terms, producing different identities and identifications related to success which in some cases involved resisting career plans and strategies. We discuss in more detail the gendered aspects of the linear career path in the final section of this chapter.

2.3 Post doc is (not) a career?

Within the normative career path mapped by institutions in the biological sciences, post-doctoral contract research is represented as a "crucial" (Roberts 2002: 45) but transitional phase for researchers moving from education to a permanent academic research post. Five years after the Roberts Report, we found that the message that 'post-doc is not a career' was firmly embedded in funding and research institutions in the biological sciences. We encountered it at training and career development discussions within the university and the biology department as well as from one of the field's main public funding councils, and reproduced by post-doctoral researchers. Senior staff in the biology focus group commented that "[a]s a department we've been hammering it home," and in interview a professor confirmed the common stance that "there is no such thing as a long term post-doc in the biosciences. It's a huge policy issue at the moment. And I feel quite strongly that there shouldn't be any". The department spread this message by the provision of advice and support for researchers, most notably in the appointment of a post-doctoral career advisor. In biology, then, post-doctoral contract research was seen as a transient career stage for early career researchers in order to progress to a lab leadership/lectureship position. It is certainly the case that the majority of post-doctoral roles in the natural sciences have never been permanent positions. However, post-doctoral researchers no longer occupy the structural position in academia that they once did - that of "a small elite group" whose routes into academic careers were all but assured (Roberts 2002: 146). There are now large numbers of post-graduate and post-doctoral scientists moving through the system. In 2002 Roberts estimated that only around 20% of them would find permanent teaching-and-research posts in HEIs (Roberts 2002, 12). The route to a permanent lectureship or fellowship is highly competitive and, as we explore below, more risky for some individuals. And unsurprisingly, we found that the post-doctoral period functioned as an increasingly managed exit point for large numbers of researchers.

Senior staff recognised the need to advise and support researchers in relation to career progression, framing it as a collective organisational obligation and for some laboratory leaders as a personal moral duty. However, ultimately it was seen as the responsibility of the individual to make choices about the most appropriate career path, as the extract from an interview with a biology professor below illustrates:

> And it's actually about empowerment as well I think [...] you know, one of the reasons I object to the, 'this is what you have to do career path'. That's not the point. The point is you're an individual; you need to decide what you want to do. And we're prepared to help you in the following ways achieve it once you've decided.

This rhetoric of choice and empowerment has opened up new and non-academic career routes for researchers and encouraged them to consider options in a reflexive and informed context. In the light of the structural changes to funding arrangements, there is a clear emphasis in biology on encouraging researchers to take their science skills, experience and knowledge into other career arenas. For some researchers some way into their career, encountering the message that post-doc is not a career had been distressing initially but ultimately productive. Others were still struggling to come to terms with it. However, from an organisational point of view it was also important for senior staff to address the structural constraints within which such choices operate. As a senior professor put it in an interview, they had a role in "managing expectations" in relation to the mass of post-doctoral researchers moving through the 'pyramidal' career structure. At the laboratory and department level, this was framed in terms of the 'turnover' of researchers and the "constant supply of those people" rather than in relation to individual career prospects (biology staff focus group).

In the context of the linear biology career, the post-doctoral career phase was often framed as training to be independent. However, this notion of post-doctoral research as 'training' was linked to some complex and contradictory meanings of independence, autonomy, and intellectual value circulating in the biology department. In terms of research cultures and life in the lab, autonomy was an important value and aspect of epistemic identity from a very early stage. Independence in research was strongly associated with traditional academic values of intellectual autonomy. The two laboratories, in different ways, operated on principles which gave individual researchers considerable freedom to pursue their own research. We found that from the post-graduate stage researchers made powerful claims to ownership of their own projects, albeit within the context of hierarchically structured teams, and that senior staff acknowledged that the PhD is about "training… to be an autonomous scientist". However, in career contexts 'independence' meant something rather different – the capacity to attract research funding and the possibility of leading research projects and lab teams,either as a core-funded permanent member of university staff, or by winning what the Roberts report calls a "prestigious" personal fellowship. This was recognised in the biology staff focus group:

> I mean there is this other level of being a post-doc, which is to be an independent research fellow. So you bring in your own funding and you're not dependent on an academic member of staff […] that's fairly long term, but again it's not indefinite… those people we call research fellows and other people get called post-docs or research associates.

The multifaceted meaning of research independence had consequences for individuals

and raised issues at the organisational level. Here we focus on the roles played by post-docs in the research ecology of biology laboratories and the department, looking in particular at the relationship between post-doctoral researcher and technician roles in terms of their different demands and statuses. We also consider the implications of positioning post-doctoral research as 'training' in relation to the career trajectories and identity investments of researchers.

The idea of post-doctoral research as a transient 'training' phase is complicated by evidence of some rather different practices on the ground. We found some researchers had worked continuously on short-term grant funding for long periods. This is not unusual in the natural sciences. In relation to the recent employment tribunal ruling on fixed-term contracts in the case of a researcher at the University of Aberdeen (see footnote 3), it emerged that 70 post-docs in its School of Biological Sciences had been continuously employed for six or more years on fixed-term contracts (Newman 2008). In our study, researchers who had not moved up or moved out of academic research after one or two post-doctoral posts found themselves in an anomalous position given an organisational culture in which what one participant in the biology staff focus group called "perennial post-docs" are not officially supposed to exist. Some expressed frustration at what might be perceived as the downgrading of professional research work to 'training'. These experienced post-doctoral researchers were involved in running the experimental side of projects, supporting post-graduates at the bench, in communicating their research and contributing to writing research grants - as well as attempting to build an academic name as a legitimate knowledge producer in their own right by publishing research articles. We identified tensions between their role in supporting the lab as a collective entity, and their future careers in a highly individualised system of reward and recognition. Long-term post-docs risked becoming invisible to the institution and their opportunities for career progression were very limited. In national policy and within the biology department we found some recognition of the need for skilled post-doctoral researchers who might stay in lab groups with specific roles in lab management and supporting continuities in skills and analysis at the bench. However, these 'super post-doc' roles were scarce and particularly difficult to maintain in the current short-term, project-based funding context. We also noted that being able find such a position seemed to depend upon personal and professional relationships between lab leader and post-doc which were built over a longer period in one lab than was endorsed by the current career narrative. The issue of the specific role of post-doctoral research was also connected to a further tension we identified related to career progression in the natural sciences: the prospect of eventually leaving the bench and moving into a more managerial and supervisory role. For some highly skilled and experienced researchers, the desire to remain experimentally active in the lab had caused them to detach their ambitions from a lab leadership role; we discuss this issue further in relation to gender, below.

It might be argued that the 'invisible' roles of supporting research activity and conducting high level bench research are ones already played by technicians and senior technicians within biology laboratories. Indeed, one of the professors in our study makes this argument and commented that the consistent undervaluing and perceived low status of technicians

is a significant problem, not least in terms of exploring possible parallel and alternative careers for experienced post-doctoral researchers whose career trajectory does not lead to a permanent lectureship or fellowship post. Such roles are on the whole more likely to be organisationally supported, with transparent structures for progression, and may be less precarious than post-doctoral work - although we found that more than one technician in our study had worked for long periods on fixed-term contracts or permanent contracts dependent on external grant funding. This professor argued that the aspiration and ambition to be independent in both senses that we explore above – intellectually autonomous, with one's own research group and projects, underpinned by a permanent post or independent funding – were the hallmark of the qualities of an excellent academic scientist and which should be developed and nurtured during the post-doctoral phase. Those who were primarily interested in or best at research support and high level bench work should be encouraged and helped to pursue senior technician roles or think about opportunities outside academia:

> …technicians are people who are technically very good. They're not stupid. And their main interest is in doing the experiments. Yes, they've got the intellectual input into them, but they don't have the big picture and they're not… it's a different thing. In my mind if you want to be a post-doc till you're sixty-four you should be a technician…I can't see you wanting to work in somebody else's group at that level. It doesn't make sense. Because if you've got the kind of intellectual input that a post-doc ought to have then you're not going to be satisfied doing somebody else's projects forever. That's the way I see it [female biology professor, interview].

However, the longer term post-docs we came across were not only working on someone else's project; and they did have a 'big picture' view which was distinct from that of the lab leader. Their interests also spanned experimental and analytical, theorising work that would not be expected of technicians. Moreover, a key difference between technicians, however senior, and post-doctoral researchers at present is also that post-docs have been 'in training' for a considerable period of time – a four year PhD plus one or two post-doctoral contracts, for example, may add up to some seven to ten years conducting research in an academic setting and, currently at least, orienting towards a permanent academic career. The "long, intensive apprenticeship" referred to above demands considerable investments of time and commitment. It also involves a prolonged period of enculturation into the world of academic research. Most researchers past the PhD level in our study had formed strong academic identifications. This was reinforced by the strong culture of vocationalism that continues to circulate in academic research organisations.[1] Science was not something researchers *did*; researchers *were* scientists. These vocational discourses strongly linking epistemic work and selves meant that moving out of academic research involved not only taking one's (transferable) skills and knowledges elsewhere, but also a good deal of identity work related to either the anticipation or retrospective explication of a significant discontinuity in one's professional *and* personal biography. Indeed, the importance of vocation and self-identity

1 This issue is explored in depth in the KNOWING project final comparative report, forthcoming 2009.

in science work was also marked in our study by some expressions of resistance to the discourse of 'transferable skills' from junior researchers. It may be six years after the PhD before any individual post-doc makes the difficult decision that they are not going to be one of the 20% who will make it as career academic scientists. Moving on to an alternative career at that point is not simply a matter of organisational support and information about career options; it is matter of re-evaluating the commitments and identity investments of one's adult life.

The situation was very different in the social sciences, where we found a culture of contract research. Post-doctoral research in the social sciences did not appear to be the object of normative or policy discourses to the same degree as the biosciences. The language of 'post-doc' research and researchers (with the connotation of fixed, pre-determined career stage) was not used in the social sciences, as our social science research fellow focus group noted. Most research-only staff working on short-term project research have the official title of 'Research Fellow' and informally the concept of contract researchers is more widely used than in biology.[2] In the social sciences, the notion of a contract research career – albeit a tentative and problematic one – was in circulation, at least among contract researchers (see also Hockey 2002; Allen Collinson 2003). We found a number of research fellows and senior research fellows who had been working continually on short-term research projects, often several simultaneously, for more than ten years. Contract researchers in the social sciences were largely (though not exclusively) concentrated in applied social science research units affiliated to the core research-and-teaching department. Much of their funding came from government departments and charities for projects that could run for as little as three months. Some researchers were on fixed-term contracts and others on what were described as 'open' contracts – formally permanent, but nonetheless dependent on external funding sources. Longer term contract researchers tended to be concentrated into research units which were somewhat detached from core departmental structure, compared to the multi-level team structure in biology. In this context, one social science lecturer who had previously worked in an applied research unit talked of there being "a much clearer identity around policy-funded research… some individuals have made their careers around being the person that the department tells to do research on a particular area". In the research fellow focus group, researchers discussed the recent emergence of the idea that "you can have a career as a contract researcher" and often explicitly framed their role as one that is valuable in its own right and which they would like to pursue as a career, as in this extract from an interview with a social science research fellow:

> Interviewer: But you're comfortable with being a researcher?
> Participant: Yeah, absolutely.
> I: In terms as research as a long-term career looking forward […] I'm inferring from what you've said that the idea that contract research leads to an academic

2 In the social science department in our study, contract researchers without PhD qualifications were usually called 'Research Assistants', but elsewhere in biology and the social sciences this term is also used for post-doctoral researchers. This variety of names for contract and post-doc research positions is a marker of the ambiguities and pluralities of the role in HEIs, a fact of which many researchers are acutely aware (see Council for Science and Technology 2007; Bothwell 2007).

post, a lecturing post, is not something that you're particularly interested in?
P: No, it's not. I would see me as a researcher having a role and a job as a researcher and that can be informing academic debates. It can be informing policy debates. First and foremost I would see it as informing policy debates.

As this quote suggests, the identity and career of research-only staff are closely tied to the applied nature of the work and its relevance in the policy process. In our focus groups, researcher fellows in the applied social science research unit spoke about valuing the social usefulness of their research to policy-makers and even more importantly to welfare service users and marginalized groups. However, they also found that there were problems in translating the kinds of capital that contract researchers and applied research units can build up – a steady stream of commissioned research, the production of research reports and briefing papers – into the kinds of legitimate academic capital that count for building a career within higher education research, especially academic publications. Contract researchers saw their research as cohering around particular topics or social problems to which they applied a range of theoretical, methodological and analytical approaches, rather than being situated clearly within a disciplinary paradigm. As such, their accounts of their research identities expressed some ambivalence towards disciplinarity. Disciplinary knowledge tended to be seen as rather abstract, detached from the 'real world' issues their research focused on, although it was also valued as a stock of (largely theoretical) knowledge that could be drawn upon to enrich their work. However, the evaluation of university research outputs is undertaken through disciplinary mechanisms, which put particular emphasis on original, theoretically informed basic research and which tend to devalue policy reports.

Career issues for contract researchers were also organisational. Even for researchers located within a relatively well-established contract research culture there were deeply felt concerns around career and status. In part these were to do with the funding insecurity of contract research. The 2002 Fixed Term Employees Regulations reshaped universities' legal obligations as employers, emphasising their responsibility to avoid treating fixed-term staff less favourably than permanent workers, and placing limits on the successive use of fixed-term contracts over long periods of time. As a result, some research-only staff in universities have been placed on permanent contracts (this is reflected in HESA statistics which show a drop in the proportion of research-only staff on fixed-term contracts from 89% in 2004/05 to 84.7% in 2005/06; see UCU 2007). Most of these posts, however, are not 'core' or HEFCE funded and continuing employment depends on attracting external ` grant funding.[3] Researchers in the social science research fellow focus group did not talk about having experienced periods without research work, but of a stressful environment in which enormous energies constantly had to be devoted to securing the next income stream and managing the resulting feelings of anxiety, as the following exchange suggests:

3 Despite the 2002 Regulations, in many cases permanent contractual status has not been given to researchers on the grounds that funding for research posts is short term and that this constitutes an 'objective reason' not to make a contract permanent. This has recently been challenged by the ruling of an employment tribunal in the case of a fixed-term researcher in Zoology at the University of Aberdeen (see Newman 2008).

> A: I would say to someone this is a great job if you can afford to treat it like a hobby. If you aren't relying on it for your financial security. Because it is so precarious. And things usually do turn up in my experience. There usually is work at the end of the day but not knowing exactly what's going to happen in the next year or two is very stressful for people.
> B: Yeah, definitely. And, say, in a situation where there is all of a sudden discussion of redundancy because it's so insecure. Everybody is like a rabbit in the headlights. Because so often things do turn up so you can kind of keep it going. You know, I've been going in the department for 13 years now but when all of sudden there was discussion of, well, actually we might let one of you go. You know, my God, it's a completely different ball game then.

Research-only staff also expressed frustration at the organisational blindspots of universities and their marginal position within them. Universities on the one hand relied on contract research income and the research outputs this could help to generate in a context of output audit and performativity, but at the same time appeared unable to acknowledge the emergent culture of contract research and its distinctive working practices. In particular, researchers in the social science research fellow focus group suggested that the team-based nature of contract research were at odds with universities' highly individuated mechanisms for supporting career progression:

> One thing I find frustrating is that, because perhaps it is a new area that within academia, teamwork isn't valued. The way that performance indicators are used it's all about individualised performance and working as a team is not rewarded or respected particularly. So although there's one named person there's a whole team behind that person that's allowed the project to proceed. That team doesn't really get acknowledged. And that can cause problems further down the line in terms of your own performance reviews.

There were also issues of organisational status, including accounts of encountering "stark hierarchies" within academia, particularly for contract researchers within teaching-and-research departments working alongside permanent core-funded colleagues who treated them as marginal and peripheral. During the participant observation phase of the research other contract researchers (in biology as well as social science) commented on their official designation as 'academic-related' rather than 'academic' staff within higher education organisations as undermining their research identities and status. As we have noted above, there seemed to be institutional and departmental tendencies to segregate contract research staff (who were often located in separate office spaces from the core department) from colleagues in the academic department, at the risk of making them further invisible to the institutional centre. As a result of these complex pressures, researchers expressed pessimism about the possibility of higher education institutions recognising alternative career paths, as in this example from the social science research fellow focus group:

> I suppose one thing I've learnt from working in a couple of different institutions is actually in trying to engage with the university […] Trying to engage with developing a career for contract researchers in a university setting actually I've leant just to shut up. Just from trying to engage with more senior members of universities in terms of as contract researchers there may be a different career path […] Perhaps things have changed. I mean I'm talking about a few years ago. Maybe it's different now but I just don't think it is. That in trying to engage with a dialogue about different career trajectories, I've given up.

However, the issues around research independence/autonomy and the ambiguous line between research training and research practice we identified in biology did not appear to be experienced in the same way in the social sciences. Individuals' sense of their own identities as independent researchers seemed to be taken for granted, whether contract researchers or permanent academic staff; at the same time the concept of 'the independent researcher' appeared irrelevant. While there was no question here of post-doctoral contract research being redefined as training, researchers and academics did sometimes problematise their own status as knowing subjects. In the focus group, contract researchers expressed as a concern over the "deskilling" tendencies of the fragmented nature of the work:

> With each new project you take on you're going into a new area. So by the time I'd finished my PhD I'd been working on that for years and years and obviously I had some expertise in that area [...] But then you move on to a new project which uses the research skills that you've had before and some elements of knowledge but mostly it's a whole new area. And then you're deskilled again […]

Previous research on the contract research career (see Allen Collinson 2003) makes a similar point with regard to 'technical' deskilling; but at the same time argues that social science contract researchers build up extensive informal 'craft' skills in keeping this marginal and difficult career going against considerable odds, which may contribute to the sense of research independence that social science research fellows appear to have developed. During the participant observation a permanent lecturer in the social science department also gave accounts of her career in which she explored feeling permanently like an "inexperienced academic" despite having spent five years in the role; both research and teaching were framed here in terms of constantly presenting new challenges and the constant acquisition of new skills and knowledges.

We found, then, that post-doctoral research was not simply managed and experienced differently in the two different disciplines, but in fact to some extent was a different object. In biology 'post-doc' was a transient career stage that must be passed through in order to achieve research independence and secure a permanent academic post. For the most part researchers were acutely conscious of what post-doc meant in relation to the research career, and academic institutions were actively managing post-doctoral career issues. However, issues of insecurity and the ambivalent status of contract researchers seemed to have become normalised and researchers who did not fit the career pattern tended

to become invisible at the organisational level – although certainly not in the labs and to colleagues. In the social sciences, the funding landscape and organisational responses to it had created the possibility of pursuing a (tenuous) 'contract research' career. The emergence of the contract research culture in the social sciences appears to have grown up alongside the embedding of the normative research career, benefiting from the ambiguous role of the social sciences and humanities in national science policy discourses,[4] and on the margins of the core spheres of higher education organisations. However, little attention seemed to have been paid to career progression and researchers as individuals or in specialist units were left to negotiate the system and find a way to support their research or locate opportunities for permanent, secure posts. The dominant policy discourses around contract research staff are modelled on the career path in the natural sciences. Structurally, however, the social sciences have different funding patterns (particularly in applied areas), and we found a key difference in the organisational location of contract researchers in units that were somewhat detached from the core teaching and research department, as well as a more widely shared set of assumptions about the meaning and identity of social science researchers as independent. In this context, attempts to fully redefine post-doctoral / contract research as a transient career phase for all researchers would be problematic.

2.4 Gender and career

Given the complex structural, cultural and discursive construction of research careers and the wide variation across disciplines and between staff groups in how they are negotiated by individual researchers, what can be said about gender and the research career? Is making it for women different than for men? We suggest that careers in knowledge production are subtly gendered, but that this is not a simple matter of men benefiting from traditional structures while women remain junior and marginalized. In both biology labs and in the social sciences we encountered ambitious, successful and senior women - as leaders of large and prestigious labs, research team heads, and powerful professors. Looking at the bigger picture, however, women are statistically still less likely to advance to the most senior positions in academia. Moreover, women are over-represented in contract research roles. This raises the structural question of whether as women have entered academic research in greater numbers, the areas in which they are most likely to work have become feminised – devalued, marginalized and insecure. This is a particularly pertinent question in the biosciences and social sciences, which have rather high proportions of women researchers.

In biology, we found some very visible initiatives underway to put and keep gender on the institutional agenda. We were invited to women and science career support sessions set up by the department's post-doctoral careers advisor. During the participant observation the department was in the process of applying for a SWAN charter award for gender-equal

4 Whereby all academic disciplines are formally nominated 'sciences' for the purposes of national policy documents and funding allocations, but wherein STEM (science, technology, engineering and maths) are the primary focus of most policy initiatives. Support for post-doctoral research/ers post Roberts has had an uneven effect in the social sciences; for example, prestigious 'Roberts' independent research fellowships have been awarded bringing post-doctoral fellows into new prominence within core teaching-and-research departments, but with relatively little effect on applied research units.

employment policies and staff in the biology focus group stressed efforts to

> put in place initiatives that are going to help people, females. But we consider that's important for both genders here. To facilitate. It can be like changing from full time to part time if they need to look after somebody. More flexibility in work. Trying to break this thing of rigidity that you need to work 80 hours a week and you have to suffer, which I think is a big thing to break down. [biology staff focus group].

These initiatives are related to national policies on women in/and science dating back some ten years or more, which focus on supporting women's career progression and embedding positive policies on work-life. We have looked at these policies in detail elsewhere (Garforth and Kerr forthcoming) and found that they display a surprisingly narrow authoritative discourse of women in science. Two issues are particularly relevant here. Firstly, the women and science discourse takes the linear, unbroken research career for granted. The emphasis is upon helping women onto this career path rather than changing the shape and pace of the career path itself, an emphasis that we also found in interviews with staff in biology. Secondly, policy attention to the women and science problem has meant that female difference has become hyper-visible. Women's dual roles in parenting and work are continually reiterated. Women scientists are presented with role models who have successfully combined science and motherhood. These activities tend to be undertaken in the name of promoting a healthy work-life balance for all knowledge workers, although it is women in particular who are thought to benefit most from these changes. Highlighting women and women's differences in this way means that men's non-work selves remain largely hidden, and the divide between work-life as neutral and objective and home-life as embodied and emotional is perpetuated. As Hearn and others have pointed out, in the more entrepreneurial culture of higher education after the new public management, it is the 'ambitious young men' that some of our participants mentioned who are more likely to become the invisible model around which academic success is drawn (Hearn 2001, 2004; Whitehead 2001).

In relation to the linear career, our empirical data suggested that gender equality measures within the organisation to support women in science careers tend to remain add-ons to underlying assumptions about research excellence and career success, rather than promising fundamental changes. When we asked the biology staff focus group explicit questions about gender and the research career they mentioned the initiatives quoted above. However the same group also reproduced the narrative of an unbroken linear career path as an unquestioned norm, and saw keeping up with a fast-moving research field as a basic prerequisite of the research career. We also found a tendency amongst senior staff in particular to look elsewhere for reasons for women falling off or behind the career ladder – away from structures and organization within their purview to external societal factors including conservatism around male and female roles in the family or masculine and feminine work identities, which one professor suggested made it easier for women to drop out of academic research and made it difficult for men to leave. In relation to female

visibility, we found considerable ambivalence around the visible linking of women, science and career in our study. Female biologists seemed more comfortable presenting themselves as gender-neutral researchers rather than drawing further attention to themselves as women. Many scientists, from senior professors to post-graduate students, men and women, were insistent that the best way of making science accessible to everyone was to "humanise" scientists – that is, to present themselves in gender neutral terms as 'ordinary people' rather than distant figures in white coats.

In the social science department there seemed to be far less attention to gender and research careers at the organisational level. However, gendered aspects of the research career were more widely discussed by our research participants; this was partly related to a shared disciplinary reflexivity (including our own), including feminism, in the social sciences. What seemed to emerge from these discussions was that in the absence of a well-defined career path issues around gender and academia were more likely to be constructed in relation to how the identity of the successful researcher was performed, and the ways in which that identity was more easily appropriated by and acknowledge/valued in men. Two of the female social science lecturers raised the issue of organisationally mobile "ambitious young men" still appearing to constitute the ideal image of fast-track career progression in their department. Women in the social science department also talked about difficulties in pursuing other traditional means of career progression, such as University committee work and networking, because of the demands of parenthood. It was suggested that while these were demands on time that might be resisted in the name of work-life balance, they also made practical and emotional demands on women that could be difficult to come to terms with. Finally, with one or two notable exceptions, we found that it was women who were more likely to give the 'fragmented' accounts of career described above, and also to emphasise chance and external factors shaping their career trajectories (including family life). These accounts suggest two issues: firstly, that the predominant institutional framing of work-life balance as a matter of day-by-day, week-by-week time management is too narrow to encompass the broader entanglement of work and life over the course of a career. Secondly, it suggests that rhetorics of individual choice and empowerment in relation to making career choices need to be complemented by a greater focus on the structural and contextual conditions in which such choices are made.

There were also suggestions from female researchers in both disciplines that masculine models of career success depended on a kind of "tunnel vision" – an intense and instrumental focus on career building activities, especially publications, to the exclusion of becoming involved in less output-driven roles of collegial and group support. For core academic staff in the social science department this could be seen as a kind of male withdrawal from teaching and supporting students, or of taking for granted that other staff would cover their research leave. For one of the biology researchers, a narrow focus on one's own experiments and was contrasted with the qualities of "peripheral vision" that enabled women to attend to the material and practical context of knowledge production in the lab. Another older female post-doc also suggested that perhaps "women, including me, are too fulfilled by the bench work stuff". The image here is of women being more engaged with what is going on around

them in the present moment rather than looking forward to the next step demanded by the strict linear career.

Our findings in relation to gender and career, then, suggest two main points. Firstly, there is the danger that initiatives to promote women in science - in terms of career support, career breaks and policies for work-life balance for example – tend to be added on to existing institutional structures and cultures of career rather than involving a critical analysis of more fundamental norms and expectations of career progression and success. Secondly, we found that career-building was understood by participants, primarily in the social sciences, as an issue not just of support, training and outputs but also as an issue of identity, and that dominant images of career success were primarily masculine. Current policies on women and science suggest the need for more female role models and mentors to redress this imbalance; as we will go on to discuss, however, as we have seen attention also needs to be paid to the 'invisible' masculinity of career norms, identities, and research cultures.

3 Working together apart

3.1 Epistemic communities and cultures

A key part of the KNOWING research was the time we spent undertaking participant observation research in two biology laboratories and with researchers in the social sciences. This situated, ethnographically oriented approach enabled us to look closely at the everyday working practices and relationships that constitute significant aspects of face-to-face epistemic communities. Our grounded observational research was followed up with detailed interviews and small focus groups with participants. Here we explored with researchers their experiences and understandings of working alone and working in groups. This study has been influenced by science and technology studies, where there has been a long-standing critique of assumptions that scientific knowledge producers are individualised actors (Pickering 1992; Knorr Cetina 1999). Ethnographic studies of laboratory life form a strong tradition focused on the embedded and embodied skills involved in making natural knowledge. Much attention is also paid to the ways in which knowledge communities are constituted 'at a distance', and the roles played by nonhuman actants (including discourses and inscription devices, materials and machines) in epistemic production. These kinds of studies, however, emphasise the epistemic dimension, paying relatively little attention to what knowledge work, undertaken alone and with others, means for the individuals involved in terms of identities, job satisfaction and career progression. They also rarely look at knowledge production communities outwith the natural sciences. Within the still somewhat separate tradition of educational and organisational studies of British universities issues of individual contentment and organisational cultures are more prominent. However, there has been a long-standing focus on commonalities in the experiences of academic staff without attending to disciplinary differences, and a reliance on interview methodologies which rarely place researchers' experiences in the context of their practice.

Here we begin to look across epistemic practices, disciplinary cultures, individual experiences and organisational structures to explore how academics work together and separately to produce and communicate new knowledge and ideas. We found many differences between the natural and social scientists who participated in the study, and initially at least we examine the two areas separately in this chapter. However, our findings also challenge taken for granted assumptions about the nature of research in biology and the social sciences, in particular the idea that the former is based on a relatively unproblematic team structure, and the latter is done by lone 'craft' researchers. Rather, we found that elements of alone-ness and togetherness characterised both research fields. Thus we adopt the more complex concept of 'working together apart,' developed by our Finnish colleagues (Ahlbeck-Rehn 2007) as a way of capturing the nuanced and ambiguous dynamics of alone-ness and togetherness which constitute the relational contexts in which knowledge is produced.

3.2 Stable structures? The biology laboratories

We focus here on the contrasting ways of achieving productive models of working together that we found in the two labs. The first laboratory we visited had a strong sense of togetherness as a 'team'. We found this in their narratives about working in the lab, especially in the accounts of the longest serving members, and observed it at close hand, in the informal culture of support and banter on a day-to-day basis. This historical narrative also had a distinctive 'family' feel, as accounts of people who had worked there and gone on to form their own teams themselves were prominent, especially in the lab leader's discourses. This sense of continuity and closeness in the lab was compounded by the fact that two members of the group who had completed their PhD research there had returned after working elsewhere for a time, either in post-doctoral roles or as casual members taking time to write up research papers. The feeling in the lab was relaxed but with a strong focus on research activities, and it was clear that members of the group had space and support to pursue their academic interests. This group also had a long-standing and much valued technician who played a crucial role in the lab's collective activities. This was a small team – when the observational research began there were two full time post-doctoral researchers, a more senior researcher, three post-graduate students, and two technicians as well as the professor. The lab also had a strong sense of being networked with a range of policy and professional actors in the field, as well as on-the-ground practitioners; their research is strongly linked with clinical practice.

This contrasted with our impression of a more asocial arrangement in the other lab, where people worked as individuals alongside each other but appeared to have few horizontal connections. As one of the researchers commented in interview: "I think we have a group of individualists and I think that's how [the lab leader] built it… And also I think the work with her is very one-to-one. I wouldn't call that really team work." There was a sense of researchers moving through the lab rather than staying for long periods as members came and went on to more senior roles once they had completed their post-doctoral research. This was particularly marked at the beginning of the observational research phase – in our first meeting with the team a senior post-doc had just left, and the laboratory leader and other researchers wondered how we would cope with the constant fluctuation of the group - and towards the end, where the last laboratory meeting we attended was marked by announcements of a number of new researchers due to arrive over the next few months. Although the lab leader was also well networked with funding councils and associated bodies, our main sense of the lab as being part of wider networks was via their outreach work with various publics, including local events with schoolchildren.

The contrast was also found in the spatial organisation of the labs. The first lab had a small shared writing space and lots of 'through traffic' in a corridor that ran through its middle. The group routinely gathered together for tea breaks here, and it also provided a space for both work discussions and social conversation. The lab leader's office had an outer room often used by other group members. The write-up area of the second lab was larger and more modern, where individual working spaces were sectioned off into semi-private spaces with screens. It was also a much larger group, with between fourteen and seventeen researchers, postgraduate students, technicians and an administrator present at different times of the observation phase. The working laboratory spaces too offered a contrast. In the second lab, each researcher worked primarily at their own designated bench space in a spacious and airy room, each with drawers and shelves crammed with the equipment and materials currently in use by individual researchers, who moved around to other areas and small side-rooms to use specific equipment. In the first lab there were no designated bench spaces and researchers tended to gather together in the small culture lab and outer 'dirty' prep space to work on experimental material together. In part these spatial arrangements were a consequence of the particular physical lab spaces that the two groups had been allocated within the department. However, the ways in which they were inhabited by the two groups was also very different.

These initial impressions seemed to suggest contrasting versions of epistemic and social togetherness; the first lab an integrated team, and the second lab working apart but alongside one another. However under closer scrutiny in observation, interviews and focus groups with lab members, other stories, experiences and relationships emerged. The first lab's narrative of togetherness was not shared by all of its members, and it was also being articulated against a backdrop of tension about securing future funding. We found that one or two of the group gave accounts of life in the lab that suggested a degree of marginalisation and exclusion. This had an emotional dimension that was difficult to suppress, particularly for those who were facing an uncertain future as their contracts came to an end. Even for those who were most connected to the life of the group, there was a sense that their future was also becoming precarious. The norms of this lab were designed to smooth social engagement and support professional practice. This group, for example, stuck to a core working day structured around office hours, although researchers often stayed or came into the lab for extended time periods, including evenings and weekends, and it was felt that the lab leader kept a benign eye on the presences and absences of the group. In contrast, the second lab seemed to be more stable and perhaps secure for its members, even although they did not necessarily stay long. There was a consistent level of close, 'low key' support from the lab leader for lab members that bound them together as a group. During the observation we found that the lab leader was involved in managing researchers on a one-to-one basis, attending not just to their work projects and career progression, but also taking into account peoples' personalities, ambitions and qualities. In interviews lab group members talked of the "relaxed but hard-working" atmosphere in the lab, an ambience they all attributed to the character and management style of the (female) lab leader. This included a strong sense that the lab leader wasn't interested in monitoring the time schedules of researchers in the group:

> Participant: …she doesn't care. First of all she doesn't see us. If she's going to see us she goes through the corridor. She's not going to see the difference between us not being in or just not being at the desk.
> Interviewer: So there's no sense that she's keeping an eye?
> P: No. I think she's interested in the science in general and in people being happy and successful. She already told me. I asked her for vacations and how many days you can take and she told me do what you want. If you don't work you get nothing and it's your career. And if you do work you'll get stuff. It's your balance. [female biology post-doc, interview].

This atmosphere of trust, autonomy and cooperation was particularly important to two post-doctoral researchers who had previously worked in lab groups they described as aggressively competitive. They discussed the emotional consequences of these environments in interviews, giving accounts that stressed feelings of disempowerment, unhappiness, insecurity and doubt about their abilities. They strongly valued the cooperative, supportive atmosphere in this lab group, particularly in terms of feeling content and supported in their everyday work. Nonetheless, it was in the smaller lab where we as researchers felt the most welcome and observed on a day-to-day basis the friendly, cooperative working relationships between members of the group.

We also found many similarities as well as differences that underpinned togetherness in the labs, particularly their dependencies on shared materials, and on shared machines and practices for nurturing and sustaining experimental materials and making experiments work. Materials and machines were key to sharing and passing on skills, techniques and ideas and in this sense at the heart of the ways in which face to face epistemic communities are part of wider epistemic cultures (Knorr Cetina 1999) – but can also be read as microcultures in themselves. The two labs achieved epistemic togetherness in very different ways. In the larger lab each researcher tended to have their own separate lines of materials which to a large extent could be maintained and generated by individuals and shared among the lab group as a whole. However, the acquisition, sharing, storing and archiving of different types of material within the lab was a key practical focus of the group's weekly lab meetings during our period of observational research, where experimental techniques and also emergent findings were also discussed by the group as a whole. The smaller lab largely worked on tissues which arrived via external sources according to regular routines. Because this material needed to be prepared and handled in a short time frame, on many occasions several members of the group would collect in the prep and culture labs to work together. Here, then, was a focal point for discussion of work and the sharing and learning of delicate techniques distinctive to the research field. In both cases, the lab groups worked broadly within an overall intellectual and analytical framework or vision set out by the laboratory leader. In the larger lab this was partly driven by new developments within the wider field of biology (including especially the emergence of systems biology); in the smaller lab, there was more of a sense of the accretion and inheritance of successful experimental practices building into a coherent methodological approach. However, in both cases the shared analytical vision was realised in experimental practice through complex interactions and exchanges between

researchers at the bench. Although the ultimate prize of *new knowledge or innovation* clearly bound these labs together, the *preservation of skills and incremental innovation* was also fundamental to their existence (Amin and Roberts, 2008). This depended upon several key individuals in both labs, particularly researchers and technicians who took on a mentoring and organizational role complementing that of the lab leader. Much of this more invisible work was fundamental to the running of the lab, especially the management of resources and relationships, although it was not routinely acknowledged as such by all of its members, including some of them who apparently took on these roles unwittingly. We comment more on this in the section below on gender.

Two features of the more external institutional and ethical/policy environments also seemed to play an important role in constituting the togetherness of these labs. The first was their position in the federal structure of the department of biology, and the ways in which they were separate from the routines and structures of the teaching programme in a broad sense, although almost all post-doctoral members engaged with some form of teaching or mentoring, including working closely with undergraduates undertaking projects in their specialist field, and in outreach work. The second was the ethical/political context of the science in which they engaged. The first lab worked in a more ethically contentious subject area where there is considerable public debate, so talked as a group about their views on these matters, and sought to feed this into policy discussions in which the lab leader was actively engaged. This sense of ethics was often commented on by members of this lab, particularly longer serving staff in routine situations while undertaking experimental work. The second lab also worked in an area of science with contentious aspects, and were also outward looking in their approach to these matters, particularly in outreach activities with school children. We should also note here that these labs, whilst together in themselves, did not always interact much with other labs in the department. The most mobile and institutionally connected members seemed to be those at either end of the hierarchy – the professor and the technician. There were many opportunities for lab members to attend department and research stream seminars, and several researchers described their experiences working individually with researchers in other labs and with technicians, but there seemed to be few formal opportunities to share knowledge, skills and innovation between labs. We also found some instances of unsuccessful efforts to build connections, such as the post doc in the first lab's proposal to 'share' lab meetings with another group that was resisted by others on the grounds that they just wanted to get on with their work and stay focused on their own specialist field.

The policy literatures on knowledge communities acknowledge organisational factors but tend to privilege the epistemic (Knorr Cetina, 1999) above these contextual and cultural connections that cut across knowledge making. Amin and Roberts (2008) propose a heuristic typology of knowledge in action based upon specific modes of knowledge work – task/craft-based, professional, epistemic/creative and virtual. Our study found elements of all four of these categories in both labs. Knowledge workers are not primarily bound by organisation either, as individual personalities, biographies and 'styles' also matter to how relationality plays out in practice. It is emotional, embodied individuals who constitute

knowledge communities, and their sense of belonging/and or isolation has an affective dimension that interacts with organisation and knowledge.

There is clearly no one ideal model for sustainable or successful groups of knowledge producers. These two labs appeared to offer different types of security and togetherness to their members. In the smaller lab, this was based, despite some dissenting stories, on strong horizontal relationships between group members and good social relationships, underpinned by the lab leader's emphasis on continuities and maintaining connections in the research field. Over its longer history this lab had produced a large number of PhD students, of whom more than the average proportion had stayed in science and even in the same field. This had enabled a high output of research articles underpinned by strong collaborative relationships. In the larger and newer lab, this support and togetherness was underpinned by the exceptional success and reputation of its professor, drawing in ambitious and high-flying researchers and in gaining funding enabling the expansion of the lab. The importance of sharing, dialogue and support as opposed to competition amongst group members came through strongly in both contexts. However, it was striking how those performing supportive roles were often in especially precarious institutional positions or at difficult points in the career track (see the discussion of post-doctoral research in the previous section; this group also included experienced lab technicians), and that elements of their work were *invisible*, even sometimes to others in the lab, not least because aspects of their work are repetitive or cyclical, or its 'outcomes' disappear into the embodied skills or enhanced confidence of others. This contrasts with the model of *visibly* individual excellence at the heart of most promotions and funding schemes in the STEM subjects and the emphasis upon mobility in post-doctoral careers. It could be argued that individually excellent research performance, evaluated primarily in terms of objective outputs, depends on sustained and low key support from workers who are not always themselves recognised or supported by institutions. Funding arrangements tend to perpetuate a contract culture that makes it difficult for lab leaders to find money to underpin and recognise research support and management roles; and as increasing numbers of post-docs come through laboratories, as we saw above, new and promising researchers demand more attention than experienced long-term staff. As we shall go on to argue, this has a gender dimension that is worth unpacking further. The lack of dialogue and support between lab groups was another striking feature of our results. There is potential for more to be done to make connections between groups, to foster innovation and job security for researchers and technicians who are not able or willing to be geographically mobile and who have a skills, experience and ideas that it would make sense for the organization to preserve rather than lose.

3.3 Organised aloneness? Public performances and inaccessible offices in the social sciences

Our 'unit of analysis' in the social sciences was much less clear than that of the archetypal 'lab' in biology. This was due, in part, to the diverse organisation of the social sciences - both in terms of which disciplines can be found in any one university department, and in the range of relationships of research groups to teaching within the department. It was also

due to the lukewarm reception to our study within the department that we looked at, by the head of department and the applied social science research groups. We therefore found a more limited set of entry points that were more transient than in the biology departments, so our analysis is more uneven. However, our experiences as social scientists gaining and not gaining access to study other social scientists gave us additional insights into the forms of togetherness and 'aloneness' at play in this department and the social sciences more broadly.

The most public expressions of togetherness that we found took place in the departmental research seminars. These were key occasions at which external speakers were invited to share findings and current research with a small audience that changed from week to week. We found that that as well as being times for the communication of new knowledge, these sessions also involved a series of underlying and complex narratives about disciplinary belonging and epistemic community. They were sites of the ongoing production and reproduction of public epistemic identities which were related to shifting sets of communities, constituted variously as social scientists, 'critical' social scientists, social policy researchers, sociologists, and/or academics more generally. However, the collective 'we' in these seminar sessions was a particularly ambiguous and shifting one. Sometimes in the space of one question and answer exchange it could shift from referring to a small collaborative team of researchers to calling into being a much larger community of social science knowers. It was notable that in these contexts shared epistemic terrains and disciplinary collectivities were often mapped with reference to key theorists and shared concepts. However, these were not taken-for-granted; speakers often used rhetorical constructions such as 'do we all know Beck's work?' or 'I don't know if people are familiar with the idea of the risk society' to draw attention to the ways in which social science knowledge locks together not around a central linear narrative of disciplinary progression with multiple satellite and somewhat separate sub-fields, but as a patchwork of dynamic and overlapping epistemic domains. This sense was reinforced when we spoke to individual researchers in the social science department and applied research units, who often described their research area or disciplinary training and background in terms of 'not fitting in' to the extent that at times it seemed that the discipline was precisely constituted by an absent centre. Constructions of community looked outwards as well as inwards in order to solidify a collective disciplinary identity. We found fluid points of tension and coherence around the usefulness of applied social science research in these sessions, tensions that were often marked by a range of claims about academic work 'making a difference,' either directly or ideally. In these settings, researchers often positioned themselves in relation to but detached from policy-makers and administrators and the service user groups they had researched. These narratives were not deployed without irony - indeed a sense of irony was often crucial to their successful reception in the seminar - marked by shared smiles and subdued laughter. This points to the ways that social science epistemic communities seemed to be performed in specific and occasioned ways, rather than in biology, where the notion of collective research was embedded in day-to-day practices and organisationally enduring contexts.

These public displays of disciplinary knowing brought often quite disparate actors, concepts and texts together to produce a version of epistemic community that was largely discursive and often ephemeral and fleeting. When we visited the social science department we found a contrast with its more enduring spatial and organisational arrangements. These appeared to point to profoundly individual, even lonely, patterns of working that contrasted with the bustle of the lab, even in the larger and quieter of the two labs. In the core teaching-and-research department, academics worked in single offices and we often found empty corridors with closed doors. With some notable exceptions, the metaphor of 'working together apart' appears much more apposite for the social, as opposed to the natural sciences. We spent a day observing with a research fellow in the department and saw only one other person during that time. When we talked to some members of the department who had agreed to participate in the study – all women, no professors - we found that a sense of isolation cut across their different experiences. One lecturer talked in an interview of the department in terms of "fragmentation", saying it was "very isolated" and "there's not much collegiality here". In an interview, another reflected on a failed attempt to establish research groupings in the department in terms of feelings of isolation and insecurity. She went on to discuss the difficulties this aloneness generated for conducting research projects:

> Participant: So you're very alone and you're very individualistic…
> Interviewer: You would see yourself as being a lone researcher?
> P: I do and that's very inhibiting.
> I: So what is it about it that's the core of that kind of sense?
> P: First of all I would have to generate the ideas myself and respond to research paper calls or research bids. If I want to do the research myself, the field work, the analysis, the writing up, then that's fine but therefore it has to be small scale. Otherwise I have to turn into an employer and put someone else on the contract and look after that person and create space for that person in the department. Employ, advertise. Huge. So a huge job.

However, some staff members also commented on the good personal support they had had from particular senior colleagues in the department, particularly with former PhD supervisors. This was especially prominent in the accounts of lecturers who had remained in the department since their undergraduate or postgraduate degree:

> The department I work in has been hugely supportive and I think that's partly

> because I was home grown. And it is very supportive of home-grown talent [female social science lecturer, interview].

They spoke of being "at home" and "comfortable" in the department, and of good networks and "trustful relationships" (interview, social science lecturer) built up over the long term – in this case over some eight years. The role of these experiences and narratives of continuity and permanence contrasted strongly with the emphasis on career mobility, especially at the post-doctoral stage, in biology. However, these support networks seemed to be rather variable and personal, rather than being embedded in the culture of the department, and one lecturer also noted that they came at the cost of experiencing some difficulties of presenting herself as a professional rather than continuing to be seen as a student or junior academic.

Isolation seemed to be exacerbated by the teaching-research divide in the social science department. The applied social science research units affiliated with the department are set up with a group of research-only staff who must fund their own salaries, whereas so-called core staff on teaching *and* research contracts do not have the same pressures to generate income. Research-only staff often framed their experience in terms of feeling culturally and practically separate from the core department, despite the strong organisational/institutional links between the two. Core staff were more likely to feel a sense of connection with the department as an organisational and cultural entity. This was often inflected through teaching and administrative roles, and was particularly marked by permanent lecturing staff using the language of 'collegiality' to describe their relationships. However, these collegial connections could prove problematic; some of our participants commented on how they needed to physically leave the department and its administrative and student demands in order to find time and space to engage with analysis and writing, perhaps further enhancing a sense of epistemic and organisational isolation that is particularly related to research tasks. Moreover, in terms of research, as we saw above, for core staff connections are likely to be seen as fragile and fragmented. It seemed particularly hard for core lecturing staff to make lasting connections with researchers in the applied research unit, who are constantly chasing the next round of funding. Only the most senior professors who had long-standing and complex connections with research groups within the research units had the flexibility and the resources to make the most out of working with a research team. This meant that some lecturers felt part of a culture of intense competition, exemplified in the following quote:

> To all intents and purposes there is no hierarchy within academia. I could have an office next to a professor who can't tell me what to do […] there is an undercurrent of equality. But that's absolute nonsense. The reality is it's dog eat dog and the person who sits in the office next to you [...] If you had to stab them in the back to get the next research contract I think most people would […] In the private sector the lines of demarcation and responsibility are much clearer [female social science lecturer, interview].

This contrasted with the narrative of the team that the contract researchers stressed in

the focus group, particularly the importance of 'team skills' and 'getting the work done'. In the applied research units, teams were not long-lived, even by the standards of a lab group; researchers talked about being involved in "constantly making and breaking teams". However, always being in *a* team formed a core part of their epistemic identities; they gave accounts of themselves as "strong team players" and "feeling part of a team". This seemed to correlate with a sense of well-being and competence in their research that perhaps offset some of the feelings of insecurity and marginalisation associated with the contract research career. We also observed isolated instances of a 'team-based' approach amongst core members of the department, for example in a day-visit to present results to civil servants, where we found a strong sense of solidarity amongst the team, in the face of some uneasy relations with their sponsor (although there were some tensions within the team about time commitments and division of labour).

These observations point to different permutations of togetherness from those we identified in biology. We found less evidence of the importance of preserving shared skills and practices in the social sciences, and more emphasis on learning to narrate belonging/lack of belonging across contingent and plural situations and sometimes with skilful irony. Competition, even with colleagues, was more openly acknowledged by the people we spoke to, although it was seen as detrimental rather than facilitative. The flatness of the hierarchy and culture of (problematic) collegiality in the core teaching and research department seemed to leave little space for management in the sense of co-ordination and formal arrangements for support. In the research units there seemed to be much clearer coordination of and support among small teams, but individuals within these groups experienced the problems with staying and building a career measured on individual as opposed to team contributions to knowledge. There was no equivalent of the strategic, invisible and long-standing facilitative work of technicians and key researchers within the labs in the social sciences, perhaps because of the apparent lack of dependency on materials or practical skills in nurturing and supporting the growth of those materials. We could point to informants and interview-skills or contacts in the policy world as shared resources/practices in the social sciences but we did not observe these at close hand, in part because people we approached declined to participate because of concerns about confidentiality for their informants. However, we did find very little traffic between research groups or research groups and the 'core' departmental staff.

Although social scientists often position themselves as 'knowing' more about organisational cultures than their colleagues in the natural sciences, it seems that in this instance we may have something to learn. A more collegiate, shared and even managed set of relationships within the social sciences in the manner of biology labs may bring benefits to social scientists whose sense of isolation, precariousness and ambivalence about 'making a difference' risks undercutting their contribution to knowledge. This is not to say that a federal structure of labs and the core department is necessarily optimal, as it sets up its own divisions and 'skills silos'. As we learnt from our research participants, laboratories with uncongenial, competitive and divisive atmospheres – or labs whose futures were uncertain – could tend to set up difficulties for individual researchers. However, a more strategic set of connections between groups, and a more diverse set of opportunities for career development and job security for

research and teaching staff could offset some of these problems in both disciplines.

3.4 Engendering research communities

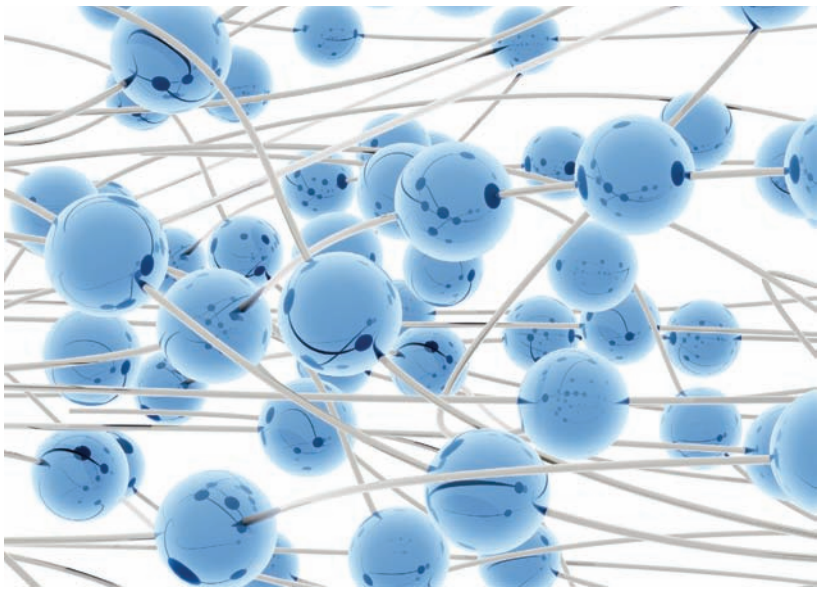
In this final section on togetherness we turn to the issue of gender. We were not surprised to find that some of the key discourses of feeling isolated and undervalued came from women in our study, in both disciplines. It was also women who tend to have the 'housekeeping' roles and unconventional, often unrewarded working histories in our study (see also Etzkowitz et al 2000). Women did not tend to perform their sense of belonging or not belonging in such explicit ways as men - in the dialogue of the seminars in the social sciences, for example, it tended to be men who dominated debate. These are all findings that we would expect from our reading of organisation studies and feminist science studies (Acker 1990; Harding 1991; Meyerson and Kolb 2001; Smith 2001; Strathern 2001). This is not to adopt an essentialist view of gender differences, but to acknowledge the different life experiences and commitments that women and men bring to their knowledge-work, and the different support systems and conventions that they gravitate towards because of these experiences. We discuss below some of the ways in which working together and working alone are profoundly gendered in academic organisations. The implications of these gendered patterns of knowledge work for the organisation of reward and recognition, staff well-being and the facilitation of innovative knowledge-making in Universities today are a pressing concern. Our research shows that organisational and policy arrangements that are historically deeply rooted in masculine models of working life and career are now having difficult impacts not just on women but on younger men. The complexities of this situation are particularly visible in relation to time and work-life balance in research.

Work-life balance is traditionally cast as a problem for women because of the long-hours culture of academia. We found that the flexibility of academic work gave women and men opportunities to reach a balance between work and home which suited them, particularly in couples where both partners were academics. Although in some contexts organised togetherness is crucial, working alone on analysis, thinking, and reading is also a core condition of research life. The overall emphasis on research outputs rather than observable research processes also means that the times of togetherness and aloneness are much less structured than they might be in other professions. In biology, experimental material and procedures have their own rhythms and temporal demands on individual researchers, often involving late nights or weekend work, that were treated simply as a fact of bench life by almost all the researchers we talked to. Contract researchers in the applied social science research units appeared to be much less comfortable with the external time demands placed upon them by project funders. However, we found that individual autonomy around time was highly valued by both male and female researchers - it had enabled one social science contract researcher, for example, to work four days a week to accommodate a role in caring for his young family, and on returning from maternity leave a senior female post-doctoral researcher found that she could still accommodate the long and often anti-social hours demanded by her particular experiments provided she could plan her own time in the lab, for example around picking her children up from nursery.

This temporal flexibility nevertheless came along with symmetrical inflexibilities in the way that academic work is evaluated and assessed. Women in the social science staff focus group commented for example on the fact that despite formal recognition given to part-time hours and career breaks in recent iterations of the Research Assessment Exercise, informally they felt that normative expectations of productivity and output linked to the masculine norm of the full-time unbroken career of remained unchanged. There was a strong sense in both departments that academic success (or even competence) depended on cultivating and simultaneously disciplining a productive epistemic self. This integrated, vocational aspect of researchers' identities meant that work-life balance issues could not easily be reduced to issues of time flexibility in the workplace, and that often researchers struggled alone and as individuals with negotiating the particular demands of their workloads in relation to current priorities (both work and beyond) and in relation to future career aspirations. In some respects these issues were clearly gendered – one social science lecturer discussed being able to work for a week until 9pm each evening on a tight report deadline only because her children were grown up; another used the language of working nine to five to delineate her strategies for switching off from work to not just manage but enjoy her home and family time. We found both men and women grappling with internalised epistemic demands and identifications which were often characterized (both positively and negatively) in terms that stressed their unbounded nature, compared with what one post-doctoral researcher referred to as a (mythical or real) 'proper' job with a clear delimitation on working hours and commitments. It is clear that rhetorics of work-life balance are inadequate to deal with these issues, which are as much to do with identity as with time management, and in which the tensions of work and life played out across the epistemic self may be felt equally by men and women.

However women, especially in the social sciences, were particularly reflexive about the gendered trade-offs around work and life that academic roles involved. They were much more likely to be critical of the long hours culture and vocational demands of academic life, and also gave accounts that foregrounded how this had shaped their work and career choices at different stages of their lives and careers. Discussions of the issues facing academic women were part of a wider dialogue of critique of the asocial nature of the social sciences that constituted loose networks of social science researchers and lecturers that were largely though not exclusively female. We point to these network as members as well as observers, and note that they profoundly shaped our access to and findings within the social science department in this study. Women and likeminded men are networking in a way that offsets some of the isolation and sense of alienation that they can feel from the 'discipline' or 'department' and these networks can span the research and research-teaching divide. As some women progress up the career ladder their involvement in these networks may wane, but they may also be used strategically to develop other women's careers or support particular organisational changes that could benefit people-like-them. We do not point this out here to establish parity with traditional 'old-boys' networks, as there are many differences, not least the partial dismantling of old systems of privilege in favour of a more diffuse and embedded culture of privilege. Instead, we highlight these networks of critique and marginalisation as an important and possibly valuable counterpoint to women and other marginalised actors

seeking support and guidance, whilst warning against romanticising women's networking, given its potential for institutional capture and unfairness.



The complexity of the working times of knowledge production and networks in knowledge communities caution against easy solutions to 'the problem of women in science' (and social science) such as flexible working, work-life balance, mentoring or training. Instead, we need to think beyond gender to the interlinked role of organisation, episteme, culture and individual biography and the best permutations for job satisfaction and innovative knowledge for the widest range of people involved in research, both as individuals and as members of inherently collective and relational bodies of knowledge production. At present, efforts to manage staff involved in academic research tend to be focused on individual excellence. Becoming visible as a high achiever means performing according to expectations that are not straightforwardly male, but are rooted in masculine epistemic models and organisational cultures which privilege autonomous, independent individuals. The importance of fostering and supporting 'connecting roles' within and between research groups is a key finding of this report. Their gender dimensions should not be overlooked - nor should they be assumed.

4 Conclusion: policies for engendering knowledge production

These findings paint a complex picture of knowledge, institutions and gender from which it is difficult to extract a simple list of policy recommendations. However, we can point to a number of key areas that demand further attention from government, funding councils and Universities themselves. The first concerns women in science policies and initiatives. The second concerns policies on contract research, specifically the current emphasis on 'post doc is not a career'. The third concerns the social sciences and their relationship to the natural sciences and the broader issue of the knowledge economy.

4.1 Women and science

Statistically, women remain under-represented in science disciplines and acutely under-represented at the most senior academic and management levels in universities (Research Directorate-General EC 2001). Generational and demographic factors cannot explain the whole of the gender deficit in career progression. Although the metaphor of the 'leaky pipeline' is problematic, it does draw attention to the ways in which women are not simply coming through the science system slowly, but rather are dropping out at each level of the career in greater numbers than men (Research Directorate-General EC 2001: 12, 15). Multiple studies (see *inter alia* Morley 2002, 1999; Etzkowitz et al 1999; Bagilhole 2000; Halvorsen 2002; Bebbington 2002; Glover 2002) have also shown that women in science often experience feelings of marginalisation and difficulties in achieving career success. Feminist critiques of scientific epistemology have also revealed the distinctly masculine rationalities that are part of epistemological processes themselves (see *inter alia* Rose 1994, Fox Keller 1985, Harding 1991, Haraway 1989, 1988).

However, in our study gender inequalities often seemed invisible in the labs and departments, and in interviews and focus groups discussions. Participants, especially in the biology department, rarely reflected on gendered identities, relationships or problems in the workplace. There were no obvious issues of gender discrimination or divided cultures to be seen in labs or departments. The more obvious issues of inequalities, insecurities and marginalisation in academic knowledge production settings appeared to be related to the contract research culture rather than to any straightforward gender divide. We encountered powerful senior female professors in biology at the same time as we struggled to understand the dilemmas of an experienced male post-doc trying to put the next foot on the academic career ladder. We found many women (and men) apparently unperturbed by the long and erratic working hours often demanded by academia, particularly experimental routines.

We recognise that these findings reflect, in part, positive changes in academic organisations as outcomes of successive rounds of policy initiatives. At the same time, we should not take the linear unbroken research carer for granted nor view work-life balance as a panacea for gender equality. Our findings suggest that we need to move beyond the linear career path to consider changes to the shape and pace of the academic career itself. We also need to find ways of recognising the invisible interconnecting roles that women in particular tend to

play in research in the sciences and social sciences. We have argued in this report that the focus upon maximising work-life balance is an inadequate way of dealing with the demands of academic work because this is not just a matter of time management but it is bound up with people's very identities as knowledge producers. Therefore we suggest that policy attention ought to shift away from women and work-life balance to a broader analysis of the demands of academic work and identity and how best to manage them. We note here that time autonomy, flexibility and discretion were key to participants' sense of being contented and productive at work. This needs to be preserved because it supports women in research careers and opens up potential for new gender relations around caring responsibilities. However, this sits in tension with our other argument below, about the need to value invisible work in academia. This could render more of what constitutes work transparent and therefore put discretion about working patterns at risk (see Star and Strauss 1999 for a fuller discussion of this tension between visibility and discretion). These tensions around in/visible aspects of work need to be carefully considered in policy-making in this area.

4.2 Contracts, research, careers

The UK universities' 'Concordat' on the management of fixed term research staff (1996) and the Roberts Report (2002) put the issue of contract research firmly on the UK policy agenda over ten years ago, and initiated important changes in relation to career progression, including more competitive salaries for post-doctoral researchers, better training and support in institutions, and the provision of new career-track independent fellowships across the STEM subjects and beyond. The 2002 Fixed Term Employees Regulations reshaped the legal context in which universities operate as employers with a responsibility to avoid treating fixed term staff less favourably than permanent workers. Whilst these changes represent positive steps, fixed-term contract research remains a particularly stubborn structural issue in the organisation of research as indicated by the recent Council for Science and Technology Report (CST 2007). This report points to natural science researchers remaining trapped in cycles of short-term contracts and an ongoing lack of professional recognition for post-doctoral researchers (CST 2007; Hall 2007; Bothwell 2007). It recommends a change of culture in HEIs in the context of developing a national framework for research careers, and more formal recognition of the wide range of responsibilities of research staff, along with a further increase in independent research fellowships for early career researchers. It also considers novel options for valuing and supporting researchers, including institutional funding for a core body of research staff as a resource for lab groups and departments, strengthening the ties between HEIs and contract researchers (CST 2007: 15). Our results echo these findings but also go beyond them, in two areas.

Firstly, while we agree that opportunities for researchers to join the standard academic career track should be opened as widely as possible (for example through the increased provision of independent fellowships in relation to project and grant funding), we also suggest that there needs to be greater recognition of a wide array of different research career tracks and the valuable role they play in the academy in terms of knowledge generation and dissemination. It is important to recognise research careers that stop and start, move across

and between disciplines, and involve periods of teaching and knowledge transfer work as well as traditional research outputs are as valuable as the linear career towards individual excellence. Research councils could support these *moving careers* by the provision of a wider range of funding opportunities beyond fellowships based upon narrow criteria of individual excellence. The emphasis upon expanding opportunities for *early* career researchers in current policy takes little account of the need for long term and stable funding and the importance of *late* career researchers with non-standard career histories to the academy. Universities need to provide core-funding for research posts, and to stop treating contract researchers as merely academic-*related* staff.

Secondly, there needs to be a greater recognition of the vital roles that long term research staff play in securing research funding and supporting the collectives in which they work. These roles in maintaining and expanding complex 'research ecologies' within the university – 'lab' or 'research' managers, or 'super post-docs' in biology, and applied research units in the social sciences - are often unrecognised in the current system of rewards and career progression. The Council for Science and Technology report (2007) emphasises the need to support *independence* in the early career; our findings suggest the need to recognise and value *interdependence* and relationality in research work. Attending to the overlaps - and differences - between the roles, skills and career trajectories of post-doctoral researchers on one hand and senior technicians on the other might open up possibilities for recognising and creating novel positions and roles for a range of epistemic actors. The funding structure of research remains focused on the short-term and upon cost-reductions at the cost of making expensive longer-term commitments to senior researchers. However, the onus to change is not just upon Universities. Funding councils also need to recognise the importance of long-term researchers and provide sufficient funds to support these roles. Research careers need to have prospects and security in their own right, not just as a precursor to a permanent lectureship. There also needs to be support and acknowledgement for the researchers who stay in the institution and the vital connecting roles they play, as well as the skills they accumulate. These versions of a research career must be embedded in the institution rather than dependent upon on old or new networks of patronage.

4.3 Science and the knowledge economy

National and institutional research policies on career progression and support are almost exclusively modelled on the natural sciences. This is rooted in ambiguities in the British research system. In terms of policy-making and the research funding system, 'science' formally refers to all areas of academic knowledge production, but the more narrow meaning of 'science' often functions to make the social science and humanities disciplines less visible. Most policy initiatives – including those around women and research – are addressed to the STEM (science, technology, engineering and maths) subjects where statistical gendered inequalities and recruitment issues are most marked. Looking for areas in which structures and cultures in the social sciences might inform those of the natural sciences, and vice versa, might open up some interesting directions for policy-makers. As we have shown, the social sciences tend to be more reflexive about their own conditions of knowledge production, display more variation in terms of the age and career backgrounds of researchers, and seem to involve an openness to a wider range of possible career paths. Applied social science research is further distinctive in its access to varied sources of funding and types of research projects that differ from the standard one to three year funding council model. However, there is also markedly less formal disciplinary and institutional support for contract researchers and some uncertainty over career progression for core teaching-and-research staff.

In this context, we do not believe that the introduction of highly standardised career paths, especially the redefinition of post-doctoral research as extended training for an independent permanent academic role, is appropriate in the social sciences. However, there is a strong case to be made for considerably more attention to be paid to support for early career researchers in the social sciences. The reflexive nature of social science cultures and the strong socialisation into independent, autonomous research identities from an early stage suggests where and why there may have traditionally been resistances to the need for formalise such career support. However, there are good reasons to believe that making career progression more transparent in the social sciences will have positive effects for women especially but for all early career academics. Looking at and adapting models from the natural sciences might open up ways of taking career development seriously. There is also scope for social science departments to learn from the integrated small-team model predominant in biology, and consider ways of involving PhD researchers and early career-contract researchers more systematically in stable teams and departmental structures. Given the specific funding conditions of policy-related research in the social sciences, there is also scope for more institutional recognition of the possibilities of contract research as a career and for integrating applied research units more firmly into their related departments and the university more widely.

On the other hand, the different models of research in the social sciences might shed new light on taken for granted practices of research in the natural sciences. One example of this is the new types of team working and team identities articulated by social science contract researchers, which offer an alternative to the problems of dependence/independence we

found in biology. The reflexive and feminist currents in the social sciences also question taken-for-granted assumptions about what women in research need, as well as taking a critical perspective on the dominant narrative of the linear career and attempting to make more visible the masculine norms attached to successful research identities. In the longer term, policies need to address these issues, as well as those related to the dynamic reproduction of the gendered academy raised in this report, in order to make long-standing and solid changes in the name of gender mainstreaming.

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