RES-000-22-0571 – Scientists' Transitions from Public to Private Sector Research Environment

There is a drive to attract more private funding into scientific research. Less public money is available to universities; more research is being done in the private sector, and governments increasingly expect universities to commercialise their research through spin-out companies. There is a debate about the merits and disadvantages of different methods of producing knowledge - for example, does commercial pressure remove the possibility of pursuit of pure knowledge for its own sake, and is this trend detrimental to the wider interests of society. This study sought to investigate the impact of these developments on the career paths and attitudes of individual scientists. It has also developed a 'model of career transition,' showing the factors that influence scientists' career choices. These factors were principally; available public sector funding for their area of interest; an identifiable career path; and whether or not they had personal contacts among commercial scientists specializing in their particular field

Key Findings

Perceived benefits of conducting science in the private sector

Scientists in private industry believed that people and society will derive a greater benefit more quickly from their research because of the imperative to commercialise new findings. Such individuals believed they were more constrained by bureaucratic regulations, but freed from the demands of university authorities, research councils, academic colleagues and students

Disadvantages of the private sector

Scientists in university settings suggested that there would be difficult ethical issues to deal with in the private sector. Scientists working in private industry did not find this problematic, but they did say there was less collaboration and a greater expectation that findings would be kept secret for commercial reasons. For scientists making the transition between university and commercial life, this posed difficulties because of the need to publish university research in order to attract more funding.

Influences which lead individuals to make the transition

The issue of lack of career development and opportunity was a frequently repeated theme in discussions about why people had moved away from traditional university roles. There is better research equipment and often a better career path in the private sector. This is particularly true for women, who reported they found it easier to advance in new scientific disciplines, and also newer specialist fields such as technology transfer, which is intended to facilitate the commercialisation of scientific discovery.

Implications for future research

The findings will be used to develop an interactive website for schools, to help sixth formers identify different opportunities for careers in science, and also to get data from people using the site about what sort of career choices they are making.

About the Study

The research was conducted by the University of Birmingham Business School and Loughbourough University Business School and involved interviews with 62 scientists. The interviewees were in three categories: academic researchers taking part in a government-funded programme to help them commercialise; scientists already working in small entrepreneurial private sector companies, and scientists with fully-fledged careers in large pharmaceutical or other private sector industries.

Key Words

Scientist, commercialisation, ethics, funding

Scientists' Transitions from Public to Private Sector Research Environments
End of Award Report

Background

In recent times there has been a recognition that universities as the dominant organizational form for production of science have come under increasing challenge. Various forces have been argued to be at play. According to a group of European researchers (European Group on Organization Studies 2003), globalization and the competitive pressures that it has engendered have stimulated greater industry interest and involvement. Government involvement and science policies have also begun to change in a range of countries, encouraging and promoting new approaches, funding arrangements, and forms of organizing. Thus it has been argued there is a move towards more participative and collaborative structures for the production of publicly available knowledge coupled with a counter move towards its privatization.

In our previous research into natural sciences research in publicly funded institutes (Cohen et al 1999a 1999b) and university departments (Duberley et al 2002; Cohen et al 2002), issues concerning the relationship between the private and public sectors, and in particular perceptions of opportunities for scientific and career development within each context emerged as central to scientists' accounts. Following on from this work, this study investigated the ways in which biomedical scientists who had made or were embarking upon a transition from the public sector to a variety of different private sector contexts experienced and accounted for these changes.

Aims and Objectives

This study focused on research scientists who had moved between public and private sector contexts. In particular we examined university scientists who were engaged in setting up spin out companies; scientists who had moved from the public sector to young, entrepreneurial companies and those who had moved to large established companies. The objectives of the project were:

- To contribute to the debate on changing modes of knowledge production by examining scientists' accounts of doing research in public and private sector contexts.

- To develop a model for understanding how scientists experience and manage the interplay between the scientific, commercial and ethical imperatives that they face. This will include consideration of the role of external stakeholders such as customers, other research establishments, regulatory and legislative bodies and the general public.

- To construct a theoretical framework for understanding scientists' career transitions between the public and private sectors.

- To contribute to the training and career development of scientists through an exploration of the constraints and challenges of moving across sectors.

These objectives stayed the same throughout the project and were all achieved, as will be discussed in the results section.

Research Methods: approach to data collection and analysis

This research was concerned with individuals' understanding of the nature of their own reality: their perceptions of the purpose and practice of scientific research, of their roles as scientists and business people, and of the extent to which their expectations and aspirations could be realised in their current working contexts. In order to access individual scientists' accounts, sixty-two semi structured interviews were undertaken between September 2004 and February 2006. Separate interview schedules were developed for each group in the sample (please see appendix 1 for the semi- structured interview schedules). The interview schedules provide headings of subject areas we wished to cover and initial questions to start the process but it was intended that they should not overly constrain the conversation that develops.

The research sample was made up of three groups: the first group consisted of individuals who were taking part in a government funded initiative to help them set up spinout companies (the Galileo programme). The majority of these respondents were in the early stages of setting up a company. The second group involved people who had already set up a company and were now operating as scientists in small entrepreneurial private sector companies. The third group included scientists who had left public sector science to work in a large company. Twenty interviews were planned with each group. We actually undertook 23 interviews with group one, 19 with group two and 20 with group three. One unexpected finding from this project relates to the diversity and complexity of scientific careers and the difficulty that exists trying to neatly categorise them. Whilst we talked to scientists as part of three distinct groups, it soon became dear that there existed a good deal of blurring at the boundaries of each group and that although people may at this moment in their lives fit within one category, they had at various times fitted in other categories and would possibly move again in the future. Thus, for example, we saw scientists who had left universities to work in the private sector, who later returned and then set up a spin out company. There was also a sizeable group of scientists who had set up spin out companies but who had chosen not to make a full transition into the private sector, preferring instead to remain with one foot in academia and one foot in the private sector. Thus an important task for us was to map the career transitions of each individual in the sample. As we will discuss in the results section, this clearly had implications for relationships with various stakeholders. Access to interviewees on the Galileo programme was facilitated by the manager of the programme. Other interviewees were approached individually and a snowball approach was used towards sampling.

Interviews were fully transcribed and were analysed initially using Nvivo software. Although Nvivo proved very useful, we found that it was rather reductionist and we have therefore utilised more traditional approaches to thematic analysis of data alongside this (King 1998). Data analysis is not yet exhausted and will be on-going as we continue to write up the research from this project. The results of our study were presented back to all respondents in the form of a written report (please see appendix 2) and respondents were asked to comment with regard to accuracy of the findings and the extent to which they felt the model we developed was useful for understanding their career transitions. To date, we have received sixteen replies. All agreed the interpretations presented and were very positive about the model.

Results
The results are discussed under each objective, although there are dear areas of overlap which we will highlight.

To contribute to the debate on changing modes of knowledge production by examining scientists' accounts of doing research in public and private sector contexts.
As discussed earlier, there is agreement from a number of commentators that the ways in which science is organised and performed is changing dramatically (see for example Ziman, 1994; Jordan, 1999; Buhrer, 1999; Whitley, 2000). For university scientists, such change has been described as a move from discipline based, curiosity-driven research to an emphasis on application, transdisciplinarity, networking and collaboration, and social accountability (Nowotny, Scott and Gibbons, 2002). We were interested to understand how scientists who move into the private sector understand these changes in the nature of knowledge production.

There were some key similarities across all three of our groups and a few issues specific to each. The entire sample commented that the nature of their science was applied. They saw little conflict between knowledge development and knowledge application, arguing that biotechnology is an applied subject area and that science in this field is geared towards application. Thus they saw the opportunity to work in the private sector as a way of seeing their science through to its ultimate destination - to see the science actually having an impact on people. In that sense these scientists presented themselves as being concerned to do good in the world. There was a feeling, though, that colleagues from academia perceived things differently and saw them as having moved 'to the dark side' and that their work was now tainted by commercialism.

One aspect of commercialism that scientists across the three groups mentioned was the need to modify their activities to keep in mind the needs of the customer, an issue we will return to in more depth in the following section. This meant for some there was occasional frustration that they could not take the science as far as they might like to. For those in the larger companies, it was felt that the situation had become tougher in recent years and that there was now less room to go off at a tangent than previously. Thus they were aware that the extent to which their science was funded depended upon the extent to which it supported current company strategy. There was some discussion of the disappointment and frustration that occurred when projects were dropped. However, these scientists argued that the faddish nature of science in industry mirrored the faddish nature of science in academia, where funding for research projects depended upon what was seen as 'flavour of the month' by the various funding bodies. Indeed some scientists commented how the skills learned trying to sell research proposals to funding bodies were very similar to those required to sell proposals within their companies.

The whole sample was also very aware of issues relating to patenting and intellectual property (IP) and its impact on how science was presented. The majority of interviewees commented that these were things that they had paid little attention to in academia in the past. Scientists discussed how the need to ensure they retained IP impacted upon the process of science by making them less willing to collaborate across different organisations than they were previously and that knowledge sharing or presenting their

research did not take place until they could be sure that they had dealt with IP regulations. It might have been expected that publishing would not be such an issue for those working in the private sector, but in certain large pharmaceutical companies scientists are encouraged to publish, as a way of gaining independent verification of the quality of their science and also to enable networking with others in the field. For those who were developing spinout companies but also currently employed by a university this issue was most problematic. This is because these individuals are judged within the university in terms of RAE submittable research publications, yet for the business they need to ensure that they have ownership over the science they wish to utilise. The challenges faced by academic entrepreneurs setting up spinouts are explored in more depth in our nominated outputs: 'Accounting for the careers of scientific entrepreneurs: towards a model of career transition' submitted to the *Journal of Vocational Behavior* (Duberley et al 2006).

Most of the scientists recognised the importance of universities as producers of knowledge, although they commented that procedures in university laboratories were sometimes poorly applied and that academics often relied on inadequate equipment and resources. In particular, scientists saw universities playing a vital role training new scientists although there was some debate about whether universities should collaborate more with industry to develop the scientists required by industrial organisations or whether they should maintain an independent role, free from concerns about the short term needs of industry, in order to produce the scientists of the future. Scientists working in small companies (group 2) and established companies (group 3) discussed the compromise they had made personally in the sense that whilst they now had better resources and for some a more dynamic working environment, they had lost the freedom to let their scientific interests dictate the work they did. Interestingly, those Galileo scientists setting up spinouts (group 1) felt that they were doing just that — taking their science through to its natural end point.

The findings on the changing nature of knowledge have been disseminated with the findings from the next objective concerning the impact of commercial and ethical imperatives and are outlined at the end of the next section.

To develop a model for understanding how scientists experience and manage the interplay between the scientific, commercial and ethical imperatives that they face.

In our previous research university-based respondents were emphatic that the most ethical science was conducted in universities. As they saw it, knowledge produced within these settings was somehow 'purer' than that generated in other contexts. At its best, it was curiosity inspired, theory led, independent, and without a profit motive. The notable exception to such a perspective came from scientists who had prior industrial experience (Cohen et al, 1999b). The literature also points to ethical dilemmas arising from conflicts between fundamental and commercially driven science (Etzkowitz, 2003). We had concerns about these polarized views, and so through this research sought to examine the perceptions of scientists who had moved between sectors.

Galileo scientists and those involved in spinouts and other entrepreneurial ventures (groups 1 and 2) had substantially different things to say from those in large, established organizations (group 3) in response to questions about the ethical dilemmas they faced, and specifically about the conflict between fundamental and commercially driven science.

These scientists voiced none of the ethical conflicts between academic science and commercial application noted above. Rather for the majority of respondents, commercialisation (either by spinout or license) was seen as a means of ensuring that people and society actually benefited from their inventions. In this sense, commercialisation was seen as entirely compatible with respondents' scientific and social interests. Indeed, it was through the creation of scientific products (instead of focusing exclusively on scientific theory) that the social value of their discoveries could be fully realised. Notably, respondents insisted that this commercial imperative was nothing new, that they'd always had a desire to see their work being used in the public domain. The difference was that formerly it would have been 'taken to market' by someone else, probably a large company, in which case the individual scientist would invariably have lost control over the process. By taking charge of the commercialisation, the individual scientist could maintain this control, and guarantee that the process was conducted in an ethical way. That said, twelve respondents discussed the potential conflict of interests between the business and the university, not because of the nature of the activities themselves, but rather resulting from ambiguity around financial arrangements, relationships and accountability. In particular, ethical difficulties arose over issues concerning who was to benefit financially from the business, and roles and relationships between business partners, and between academics and their customers.

Regarding group 3 respondents, those in large companies, in every case interviews were conducted after they had made the transition and were well established in their private sector organizations (some for many years). Thus it appeared that any ethical dilemmas they faced at the time of the transition had long been reconciled. It was respondents from this group in particular who explained how private sector experience early in their careers (often as part of a placement programme or in the course of their doctoral work) had dispelled previously held stereotypes. And all spoke emphatically of the ethical stance taken by their organizations (sometimes in contrast to some of their competitors!), which was cited as one reason why they initially sought to work for those companies. Of course we are not in a position to make judgements about these organizations' ethical practices. However, what resounded in the data was, first, that respondents were very conscious that as biomedics and biotechnologists, they were working in ethically challenging, often highly controversial fields in terms of public opinion. Second, there was a strong sense of public accountability in these data, and an awareness that as scientists working in this space they had to put a lot of effort into combating negative publicity and presenting themselves and their organizations as having the highest possible ethical standards, and working above all for the public good.

Permeating respondents' discussions of what they saw as the ethical challenges they faced were issues about their duties and responsibilities to stakeholders. We have already noted scientists' stated commitment to society, and the expressed desire to use their science to improve people's lives. In our dataset, this emerged as an overriding concern. In addition, each of the contexts we examined brought with it particular stakeholders whose needs had to be taken into account. In our previous research we identified the range of sometimes conflicting stakeholders to whom public sector scientists saw themselves as accountable (Cohen et al, 1999b; Cohen et al, 2001; Cohen et al, 2004), including university research leaders and senior managers; research councils and commissioning organizations, academic peers and students. These stakeholders were again discussed by respondents in group 1, as well as those in group 2 who had maintained links with their universities. Galileo fellows

were likewise answerable to the programme leaders, who imposed certain requirements and assessed performance on the basis of criteria largely relating to the acquisition of business skills and acumen. We have described elsewhere how the need to satisfy the demands of these sometimes conflicting imperatives can be a source of considerable anxiety for scientists. In this study, this finding was reiterated, particularly be respondents in group 1 and who maintained, as one respondent put it, ‘a foot in each camp’. These findings are reported in Duberley et al (2006).

On one hand, then, were those stakeholders associated with the university context. On the other was a whole diversity of stakeholders who were seen as integral to the corporate scientific environment. This included, in different combinations: staff, shareholders, parent companies, customers and various levels of regulatory authority (for example, in one organization respondents spoke of their accountability both the US Food and Drug Administration, and to its European counterpart). In addition, there were regulatory bodies to oversee the actual work being done (in the case of one organization the Human Fertility and Embryology Authority) and the wider context in which the organization operated (in this case the UK Healthcare Commission). Of course these regulatory bodies would have also been involved in university science, but were often dealt with by central university departments, and thus scientists were to an extent shielded from some of their demands. However, in the private sector, particularly for the most senior staff (directors, owner/managers, senior managers etc,) satisfying the requirements of such bodies was of paramount concern. Indeed, it was only in doing so that their businesses could continue to operate.

While those regulations which oversaw the actual operational work were seen by respondents as onerous but vital to the maintenance of high standards, public safety etc., those bodies which regulated the context in a less direct way were described as hugely bureaucratic, time-consuming and often irrelevant. Because the organizations we researched were sometimes the first of their kind, and always operating at the cutting edge, these regulatory bodies had no established blueprints for dealing with them. Thus, respondents in these organizations found themselves slotted into frameworks that were designed for others, and which really did not make sense in their particular situation. Adhering to these inappropriate demands was described as a significant source of stress and frustration for scientists, particularly those in group 2. For example, directors of an assisted reproduction facility described how they had to comply with child protection regulation — they saw this as highly ironic, as their clients were childless adults.

Finally, the idea of staff as stakeholder is worth a brief mention, as it is not something that arose in earlier research. This point was identified by some scientists throughout the sample but mainly those in group 3 who worked in large organizations. The issue they raised was that although the decision to fund one project or another is essentially strategic, and that staff are well aware that business needs mean that projects can be cut at any point, there is enormous emotional fallout from such decisions. In previous work we heard a lot about the positive emotions associated with science: passion, love, fun, excitement. In addition to those, in this research we also heard about the sadness that people experience when a project is stopped midstream, sometimes after years of work, and of the feelings of failure and loss when expected results don’t materialise. What was vivid in these data was the extent to which scientists invest themselves in their work.

Indeed, scientists in all three groups talked about being accountable to their science: this involved seeing the science through from its conception to its development as a commercial product, ultimately to be used in therapeutic applications. As one scientist explained, this could also be seen as accountability to self. This idea of science and the scientific career as projects of the self emerged as a permeating theme in earlier research, and was again articulated by respondents in this study.

Findings on the interplay between the scientific, commercial and ethical imperatives that scientists face will be disseminated in three ways. First, they appear as central themes in our paper: 'Entrepreneurial academics: developing science and scientific careers in changing university settings' (based on group 1 respondents), submitted to *HgherEducation9uzv1er/y*. Second, in 'Accounting for the careers of scientific entrepreneurs: towards a model of career transition' (based on group 2 respondents), submitted to the *Journal of Vocational Behavior* we develop a model for understanding scientists' career transition. Here the network of stakeholders operating in the scientific environment is theorised as central to the context in which scientists develop their careers. Finally, in the next three months we will be further developing these findings in a paper, 'Accounting for Science: ethics, stakeholders and scientific enterprise' which we will be submitting to *Social Studies of Science.* This paper will draw on the entire dataset.

To construct a theoretical framework for understanding scientists' career transitions between the public and private sectors.

There is a huge amount of literature in the careers field which examines transitions. A great deal of previous research exploring career transition has its origins in developmental psychology and career counselling. Here the emphasis lies with the individual and analyses deriving from these traditions have focused on how personality characteristics or other individual attributes influence the career course (Nicholson and West, 1988) and early career choice processes. Although there have been calls for a theory of job transition that takes into account both structural and individual causation for decades (eg Coates and Pellegrin, 1956, DiPrete and Nonnemaker, 1997; Vardi, 1980), this has rarely been attempted. This research focused on a transition from universities to the private sector. Although we focus at the level of the individual to try to understand how scientists account for this transition, we aim to keep in mind the recursive relationship that has been identified between institutional context, career scripts and individual action (Duberley et al 2006a, 2006b, Mayrhofer et al 2004, Arthur et al 1999, Barley and Tolbert 1991). We believe that models such as those described above provide a vital insight into the relationships between individuals and their context and that any study of career transition should take account of the context within which people work as well as their individual aspirations and experiences.

A model of career transition was developed inductively from the scientists accounts. Examining these scientists' accounts in detail highlighted the many ways in which scientists gave examples of the intersection of structure and agency in the transition process. For example the impact of institutions and institutional change such as changes in government funding clearly played a large role. In contrast, at the level of the individual, there was discussion of scientists' skills and networks as important career

capital facilitating the transition process. Given the intertwining of structure and agency in accounts of transition we decided to further develop the Barley (1989) model of careers which we had utilised in our earlier work. The initial starting point here was to view career scripts as mediating between structure or institutions on the one hand and individual on the other. Thus institutions legitimate new career scripts for individuals. However individuals do not just pick these up blindly, they respond in diverse ways to a changing context which will also influence the development of career scripts and may also impact back upon institutions. The model we have developed is a significant advance on the previous Barley work for a number of reasons. Firstly, it provides a more detailed analysis of institutions that impact upon scientific careers. Secondly, the concept of career script has been criticised and did not reflect the ways in which scientists in this sample discussed their careers. Therefore we have broken this down into career guiding principles and career pathways. Finally at an individual level we have drawn from the work of Bourdieu (1991) and Mayrhofer et al (2004) the concept of career capital into the model, in addition to considering individual's mode of engagement.

This work has been disseminated in two ways so far. Firstly we presented the model to the careers stream at the *European Group on Organization Studies* in 2006. We then wrote this up as 'Accounting for the careers of scientific entrepreneurs: towards a model of career transition' which has been submitted to the *Journal of Vocational Behavior* which is one of our nominated outputs. Please see this paper for more in- depth discussion of the model and diagrammatic representation. We also plan to present the model at the careers stream of the *American Academy of Management* 2007.

One unexpected finding from our research relates to the careers of women scientists. Although there was a good deal of diversity of experience of our female interviewees, a significant number commented on the fact that they were making the transition away from traditional scientific careers as a result of a perceived lack of opportunities for women. Women, instead, saw themselves focussing in areas where there was a less established structure such as newer scientific disciplines and newer occupational professions such as technology transfer. These scientists also commented a great deal about the intertwining of their domestic and professional lives. This is the subject of a paper comparing the experiences of female scientists today with those in the nineteenth and twentieth centuries which we are currently completing entitled 'Uneasy careers and intimate lives revisited: New perspectives on women in science'. We will submit this to the journal *Gender Work and Organization.*

To contribute to the training and career development of scientists through an exploration of the constraints and challenges of moving across sectors.

Scientists talked at length about the challenges faced moving across sectors, most of which have been covered in previous sections. The major issue that bothered many of our interviewees was the lack of careers advice they were given about where scientific careers could take place. Thus there was a feeling for many interviewees that they fell into their current career and did not have information to make informed choices throughout their education, particularly at the point of choosing their degree studies. As a result of this finding, we developed a workshop for sixth form students which aims to give them an insight into the various opportunities which exist for a career in science.

The workshop is based on this research and one aspect of it involves telling students the career stories of a sample of our interviewees before engaging them in a variety of activities. We have undertaken four pilots of the workshop and received positive feedback (see attached letter). We are now in discussion with Mr Gary Grubb at ESRC to develop this workshop into a web based tool in order to provide far wider access to the material.

We have also fed back our results to Catherine Alexander, director of the Galileo programme who also gave very positive feedback and plans to use our findings to develop the Galileo programme further (please see letter in appendix 3).

Activities

- We have presented a written report to all interviewees.
- We have conducted a feedback seminar to the management team of the Galileo programme.
- We contributed to the ESRC seminar series on scientific careers which was part of the 'Critical Perspectives on Career and Family Friendly Policies' series.
- We presented at the Leeds University Social Science Institute seminar on scientific careers.
- Papers were presented at EGOS 2005 and EGOS 2006. Additionally we are planning to present papers at Critical Management Studies conference 2007 and Gender Work and Organisation Conference 2007.
- A prototype career workshop has been developed and four workshops have been held with sixth form students (please see letter in appendix 3)

Outputs

Duberley, J. Cohen, L. and Mallon, M (2006) Constructing Scientific Careers: change, continuity and context. *Organization Studies*, 27(8) 1131-1152. This paper presents many of the conceptual ideas from this project but utilises other data so has not been included as a nominated output.

Cohen, L., Duberley, J and Leeson, M (2005) Entrepreneurial academics: developing science and scientific careers in changing university settings. Presented to *EGOS conference 2005* and submitted to *Higher Education Quarterly*

Duberley, J., Cohen, L and Leeson, E (2006) Accounting for the careers of scientific entrepreneurs: towards a model of career transition. Presented to *EGOS 2006* and submitted to *Journal of Vocational Behavior.*

Duberley, J. (2005) Scientists careers — transitions from public to private sectors presentation to ESRC seminar series *Critical Perspectives on Career and Family Friendly Policies,* Lisbon

Cohen,L., Duberley, J and Leeson, E (2006) Scientific Careers in Transition. Presented at *Leeds University Social Sciences Institute seminar series*

Duberley, J (2004) review *of Academic Entrepreneurship* by Scott Shane, *Prometheus*, 22, 4, 471-474

We have also edited a special edition *of* International Studies in Management and Organisation focussing on international comparisons in the organisation and management of science. This will be published early in 2007. Duberley, J. and Cohen, L. (2007) Introduction to Special Issue on Organizing Science. *International Studies of Management and Organization* (forthcoming)

We have developed a project website (www.scientistscareertransitions.org.uk) which gives details of the project and our outputs.

Forthcoming Outputs

We have negotiated a book contract with Ashridge to publish a collection *of* our papers on the management of UK science and scientific careers in the UK The business of Science and Scientists' careers: managerialism, consumerism and the scientific labour process'

Cohen, L. and Duberley, J (2007) Uneasy careers and intimate lives revisited: new persectives on women in science. Paper to be submitted to *Gender Work and Otganiation Conference,* then revised and submitted to *Gender Work and Organisation* journal.

Duberley, J., Cohen, L., and Leeson, E (2007) 'Accounting for Science: ethics, stakeholders and scientific enterprise' will be submitted to *Social Studies of Science.*

Impacts

Academic

We have contributed to two key debates:

1. Debates concerning the nature of knowledge production and development.

2. Debates around the theorisation of career transition and the social embeddedness of career action.

Practitioner

1. Our findings have impacted on the development of the Galileo programme (see attached letter).

2. The research has informed career choices of A level students who have participated in workshops through illustrating the wide variety of scientific careers that are possible. We now plan to extend this impact through developing these into a web based resource.

Future research priorities

We have been involved in the development and submission of a proposal to the British Council to examine the Indian National System of Innovation and scientific labour mobility in India. We are also currently working with a colleague Dr M.N Ravishankar to collect data from Indian scientists about their careers to provide a comparison with this UK study. We are also currently investigating opportunities to develop a comparative aspect to this research with Professor Louise Ackers who heads the centre for the Study of Law and Policy in Europe at Leeds University and has conducted extensive studies

into the globalisation of scientific careers. Finally we plan to develop the web based resource for schools in such a way that *it* can be a tool for students to help them identify possible scientific careers and also that we can gather data from those using the site to explore the career options that young scientists feel are available to them.

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ACTIVITIES AND ACHIEVEMENTS QUESTIONNAIRE

1. Non-Technical Summary

A 1000 word (maximum) summary of the main research results, in non-technical language, should be provided below. The summary might be used by ESRC to publicise the research. It should cover the aims and objectives of the project, main research results and significant academic achievements, dissemination activities and potential or actual impacts on policy and practice.

Objectives

This study focused on research scientists who had moved between public and private sector contexts. In particular we examined university scientists who were engaged in setting up spin out companies; scientists who had moved from the public sector to young, entrepreneurial companies and those who had moved to large established companies. The objectives of the project were:

- To contribute to the debate on changing modes of knowledge production by examining scientists' accounts of doing research in public and private sector contexts.
- To develop a model for understanding how scientists experience and manage the interplay between the scientific, commercial and ethical imperatives that they face. This will include consideration of the role of external stakeholders such as customers, other research establishments, regulatory and legislative bodies and the general public.
- To construct a theoretical framework for understanding scientists' career transitions between the public and private sectors
- To contribute to the training and career development of scientists through an exploration of the constraints and challenges of moving across sectors.

Main research results

- Á Scientists did not necessarily view commercialisation as competing against the development of science. The majority of interviewees who had either set up a spin out or moved into a small dynamic company saw the application of their science as the ultimate goal of their research and felt that they were able to do so in their current setting. Those who worked in large organisations were more aware of the fact that their science would only be funded if it fitted with corporate objectives and the majority of interviewees in this group had tales of funding being halted.
- Á Scientists were acutely aware of the power that stakeholders held over the purpose, process and output of their science. In moving to the private sector scientists did not report feeling more constrained by stakeholders. Many saw similarities between the selling of ideas to gain funding for research in universities and the private sector.
- Á There was a huge amount of diversity in effectiveness of university policies with regard to supporting spinout companies and equity holdings in spinout firms.

This had a big impact on the ways in which scientists commercialised their research. University development offices were often seen as lacking sufficient experience and knowledge.

- On the basis of our results a model of career transition has been developed. This model takes account of the impact of the influence that factors in scientists social context have upon their careers as well as factors related to the individuals concerned

Significant academic achievements

- Refinement of conceptual model for understanding career enactment *(Organization Studies* paper). Structuration theory has been seen as very difficult to operationalise and hence is rarely used in empirical settings. In this paper we refined Stephen Barley's model so as to enable such application. In his review, Nic Beech, the Deputy Editor commented that 'Your work develops an insightful understanding of the complexity of this form of discursively constructed structuration of people and their careers. In so doing, it makes a very useful contribution to the literature... it is an achievement which will be acknowledged by those within the research community. Well done for producing a high quality paper which takes this important area forward'.
- Through this research the model was further developed to accommodate career transition (paper submitted to *Journal of Vocational Behavior).* Existing frameworks for understanding transition tend towards reductionism. Our challenge here was to capture the complexity of our data in a model that could be applied to empirical settings.
- We are currently working on a paper on gender and scientific careers, where we will be further developing the concept of career capital — a concept that has thus far only received limited attention in the extant literature. We shall be using historical analyses (Abir-am and Outram (Eds.) *Uneasy Careers and Intimate Lives. Women in Science, 1789-1979)* together with the data generated in this study to develop these ideas. The paper will be submitted to *Gender, Work and Organization.*

Dissemination activities

- We have presented a written report to all interviewees.
- We have conducted a feedback seminar to the management team of the Galileo programme.
- We contributed to the ESRC seminar series on scientific careers which was part of the 'Critical perspectives on Career and Family Friendly Policies' series.
- We presented at the Leeds University Social Science Institute seminar on scientific careers.

  Papers were presented at EGOS 2005 and EGOS 2006. Additionally we are planning to present papers at Critical Management Studies conference 2007 and Gender Work and Organization Conference 2007.
- A prototype career workshop has been developed and four workshops have been held with sixth form students.
- We have developed a project website which gives an overview of the project and details of publications.
- We have edited a special edition of International Studies in Management and Organisation focussing on international comparisons in the organisation and management of science. This will be published early in 2007.
- We have secured a book contract with Ashridge to publish a collection of our papers on the management of UK science and scientific careers in the UK called

'The business of Science and Scientists' careers: managerialism, consumerism and the scientific labour process'.

Impacts on policy/practice

Our research has identified a number of important issues in scientific careers that could impact on policy. Firstly it appears that there is a perceived lack of information about potential scientific careers for people choosing degree programmes. We are presenting these findings to careers officers and hoping to develop an interactive website based on our workshop to help tackle this. Scientists in our sample who had been involved in spinout programmes all complained about the way that universities dealt with them and the lack of procedures with regard to equity holding and support of spinout activity. We have fed this back to the Galileo programme directors and plan to examine this issue in more depth in the future.

Careers in Science: moving from public to private sector contexts.

Summary research findings - Report to interviewees

Dr Joanne Duberley, Dr Laurie Cohen and Dr Elspeth Leeson

1. Introduction[1]

1.1 The aim of the study was to gain insights into how scientists make sense of their transition between public and private sector contexts in order to: a) contribute to current social scientific debates on changing modes of knowledge production; b) to contribute to the career training and development of scientists through an exploration of the constraints and challenges of moving across sectors. To this end, in depth interviews covered a diversity of topics including respondents' career chronologies, factors (ranging from government policy to organizational practice) which they saw as constraining and enabling their career progress; managing relationships with stakeholders; and notions of career success and failure. Interviews lasted between one and one-and-a-half hours, and were fully transcribed. Coding of interview data was undertaken using NVivo software.

1.2 Between September 2004 and April 2006 we conducted 60 confidential interviews with scientists working in biotechnology and related areas who had moved between public and private sector contexts. Our respondents were evenly divided into three groups. In the first were university-based researchers who had been seconded to a government-supported initiative aimed at encouraging entrepreneurship in research science. The second group consisted of scientists and medics who had left university contexts to set up spinouts or take a leading role in other entrepreneurial ventures. Finally, the scientists in the third group had moved from university departments to R&D departments in established organizations.

1.3 So far we have disseminated our findings to practitioner and academic audiences. Regarding the former, we have presented the research to the director of the entrepreneurship programme noted above, and are planning other such sessions in the coming months. We have also embarked on a series of workshops with A-level science students in which we discuss some of the alternative scientific career paths that we saw in our data. We are currently seeking funding to develop this into a web-based resource available to science students more widely.

On the academic side, we have presented papers at three conferences, and are currently developing these for submission to relevant business and management journals. We are developing a model of career transition model, based on our findings, which is appended to this report. We would welcome any comments/observations on the model (and indeed on any aspects of the report), and would of course be happy to send out copies of the papers if requested.

1.4 In what follows the key findings arising from the data are outlined. Section 2 highlights issues which permeated the dataset, while section 3 focuses on each of the three groups noted above. In the final section we identify summarizing points for reflection. It is important to note that in every case respondents were

[1] The authors would like to acknowledge the support of ESRC grant reference RES-000-22-0571 for this research.

assured of the confidentiality of the interviews. In what follows, then, all quotations are unattributed and untraceable to individuals.

2. Permeating Issues

2.1 *Lack of awareness of career options and role of serendipity in career building*. Very few respondents in our sample had at any point in their careers been given formal careers advice, and at the outset most felt that they had very little understanding of the options beyond the university or NHS sectors. Instead, permeating our data was a sense that individuals' careers had been in some ways 'accidental'. Rather than setting out with a career plan or a final destination in mind, most felt that their careers had unfolded in often unanticipated directions as they seized and exploited opportunities that came their way.

2.2 *Damaging university politics*. All of the respondents in our sample had had some experience of university science, if only as a PhD student or post-doctoral researcher. There was a consensus in our data that the university scientific context was highly competitive, deeply political and often very opaque in terms of the distribution of roles and responsibilities, resources and career opportunities. For many, these features made the university an extremely negative working environment context – for both individuals and for the conduct of their science.

2.3 *Limitations of university career structure*. Although many respondents explained that at the start of their careers they had seen a university professorship as the main marker of success, the possibilities of achieving this were very limited. Many respondents commented on the difficulties of post-doctoral short term research contracts. In general, career opportunity – in terms of stability, remuneration, continued hierarchical progress etc. was seen as severely restricted within the academic context. Nearly all of our respondents saw this as a very real (and ultimately untenable) constraint to both the pursuit of scientific excellence and continued career development.

2.4 *Benefits of working in a research culture*. The importance of working in an environment in which a wide range of research interests could flourish was seen as a tremendous advantage to all of the scientists in our sample. Not only were such communities viewed as hugely important scientifically, but also for career progress where they were seen to provide access to influential academic networks, often extending beyond the boundaries of the university or employing organization.

2.5 *Blurred boundaries between basic and applied research*. For many scientists in our sample there was no clear cut conceptual divide between 'blue skies' and applied science, and no concomitant difference in status between the two approaches. Rather, science was described in stages which led ultimately to the clinic or the field. What appeared to hold these stages together, emerging as a kind of overarching idea in people's accounts, was a desire to use science for the public good, to enhance people's lives. This idea of science as value-driven was a striking aspect of our data.

3. **Findings from the three groups**

This section identifies distinguishing features from the three groups. It is not intended to reiterate the points made above, but highlights key differences which emerged in the transcripts with the aim of providing more contextually specific insights. In this sense it is designed to compliment (not replace) the issues already discussed.

3.1 Sponsored entrepreneurship programme secondees

3.11 *Competing priorities*. Respondents in this group explained that universities' increased emphasis on commercialisation does not mean that scientists are now under less pressure to publish in academic journals or teach. Rather, entrepreneurial activities have been added to their existing workloads such that many felt that there was simply not enough time for everything that needed to be done. In the eyes of respondents this is resulting in people working excessive numbers of hours, or becoming anxious because they are unable to fulfil what they see as increasing and often incompatible demands.

3.1.2 *Money*. Changing funding arrangements, constantly shifting priorities (at the level of science policy) and increasing short-termism were central to the accounts of scientists in this group. It was explained that such vagaries in research funding together with a certain 'faddishness' (whereby, in the words of one respondent, areas of scientific interest 'go in and out of fashion') make it very difficult to make plans and to think strategically about research, as well as constraining scientists from engaging in curiosity-driven, and more opportunistic endeavours.

3.1.3 *Business skills and contacts*. Respondents saw the acquisition of business skills (including activities relating to intellectual property, like writing patent and license applications as well as accounting etc.), making contacts and developing relevant networks, as central in this putative commercial environment. Respondents were very positive about the programme which they were involved in and many saw it as an important way of gaining business skills which could open alternative career pathways up to them

3.1.4 *Technology transfer – a new career pathway*. Several respondents in this group saw a new career path available to them in technology transfer. We have already mentioned (section 2.1) how up to this point most respondents had received very little formal careers guidance, and felt that they had a narrow view of the options. Involvement in the programme made respondents aware of a greater diversity of available career paths. It is worth noting that the move into technology transfer appeared to be an especially attractive option to many of the women in our sample. This issue, and the more general idea of scientific careers as gendered, is something that we would like to investigate further.

3.2 ***Spinouts and other entrepreneurial ventures***

3.2.1 *Problematic relations with universities*. The development of spinout companies and other entrepreneurial ventures often meant working with universities in new ways, with regard to contractual arrangements and responsibilities, remuneration, time and intellectual property. Many respondents in this group found such negotiations difficult, stressful and often unsatisfactory. In addition,

scientists from some institutions saw technology transfer officers as constraining rather their enabling their commercial pursuits. Many respondents felt that university business development staff did not have the required levels of skill and knowledge to help the effectively.

3.2.2 *Acquisition of new skills*. For most in this group, the need to develop business skills proved problematic at the outset of their ventures. Many explained that they had decided to spinout because of the value of their science, yet what they found themselves doing was business. Here, access to the networks mentioned in sections 2.4 and 3.3.1 were very valuable. We noted that those who appeared happiest with this aspect of their business were those who had bought in the required expertise, rather than attempting to learn it themselves. Respondents frequently talked about the benefits of having a mentor or advisor with business experience. However, some felt that this was not possible until the business reached a certain size, the transition period during which individuals were having to do things they felt they had little aptitude for, was seen as a significant challenge.

3.2.3 *New regulatory environment*. For some the shift from university-based science to business ownership/management meant a change in their regulatory environment, and accountability to a new set of stakeholders. Working to new sets of requirements (which did not always seem relevant) and satisfying the needs of these diverse stakeholders was a source of frustration to many respondents in this group.

3.2.4 *Control and autonomy*. These issues permeated the data from this group. Although aware of the limitations of their new environments, they saw the establishment of a spinout or other sort of entrepreneurial venture as a way of taking control, not only of their science, but also of their career. They also felt that as business owners/managers, they were able to work far more autonomously, on an everyday, operational level as well as in terms of strategic decision making.

3.2.5 *Seeing the science through*. One thing we had not anticipated was the extent to which scientists saw setting up a spinout as a way of taking their science through to its ultimate destination. As mentioned in section 2.5, in this sense, application was understood as the endpoint of a process, rather than an activity totally distinct from discovery stages. Some explained that whereas previously they would have taken the science only so far, and then handed it over to someone else to commercialise, they now took great pleasure in taking on this part of the process. Commercialisation thus provided an opportunity to fully realise the science.

3.2.6 *Occupational identity*. Something that interested us in the data from this group was the extent to which the spinout experience had led to a shift in respondents' sense of occupational identity. Some in this group certainly felt that they had changed in this regard. Whereas previously they had been scientists, orienting to academic communities, they were now business owners/managers, identifying with other business people as their closest peers. Others, though, saw the move

as a way of reinforcing their identities as scientists, identities which they felt were not always fully realised within the more constraining university setting, particularly in cases where individuals had large teaching and administrative workloads.

3.3 R&D in established organizations

3.3.1 *Freedom and constraint*. Generally speaking, the respondents in this group had moved furthest away from universities. What for us was most noteworthy in these data was that there was far less discussion of constraint and limitation, particularly in terms of individual career progress. Indeed, there was a strong sense that the kind of pettiness they associated with academic career building was simply not a feature in larger, industrial sectors. Likewise, while respondents recognised that they had less autonomy in terms of what they studied, they explained that they had a great deal in term of how they went about it. In addition, they appreciated the high level of resourcing, better remuneration and greater recognition than they had experienced in academic settings.

3.3.2 *Opportunity to stay at the bench.* Although the majority of the scientists in our sample had chosen to move away from the lab bench, some had no such aspirations. While doing science on a long term basis was not seen as available within the university sector (given the insecure nature of research posts) and not relevant in the case of the spinouts, it did appear to be a viable alternative in the established R&D organizations. The scientists we spoke to who had chosen this route recognized the financial limitations of such a decision, but felt that this was compensated by high levels of recognition and extremely rewarding work.

3.3.3 *Science for the good of society*. As noted in 2.5, a recurrent theme in our data, and particularly notable in the accounts of scientists in the pharmaceutical industry, was the idea of doing science to improve people's lives. This appeared to be one of the incentives behind scientists' desire to work towards application. What made the pharmaceutical data especially interesting in this regard is that this sentiment was coupled by an awareness of the ethical challenges posed by the sector, and the often negative public opinion about the way in which the sector conducts itself.

3.3.4 *The emotional nature of science*. During the time we have been doing research about the organization and conduct of research science we have frequently heard scientists using words like 'fun', 'curiousity', even 'passion' and 'love' to describe their work. However, in these data we also heard about the sadness people feel when a project fails, or when the organization decides to stop a particular programme of work. This was described as a particular feature of the biotechnology and pharmaceutical industries as so few projects are ultimately put to clinical use. Although this talk of 'emotional fallout' was only a very minor theme in our data, we felt it was worth mentioning as for us it highlights the extent to which scientists identify with their science, and they way in which their own feelings of self-esteem and value seem, at some level, to be tied up with the success of their science.

4.0 Concluding themes for reflection

In the concluding section we identify some key themes emerging from the data. These highlight some important challenges in the development of scientific careers.

4.1 *Science as bridging public and private sector contexts*. Emerging in our data is a recognition that excellent science can happen in a range of sectoral and organizational contexts, and often in inter-sectoral partnerships. The scientists in our sample are continuing to look for the best ways to manage such relationships, including through 'Case' PhD studentships, industrial placements (for Masters level students), through industrial sponsorship of Masters degree programmes, cooperation in research contracts, and private sector outsourcing of particular processes to university experts. However, there is likewise an appreciation that that diverse scientific organization and sectors often have quite different perspectives and priorities, such that interaction is not always easy. Private sector scientists often commented that although they might have liked to operate in a university context, it would be impossible to move back into universities as salaries were uncompetitive.

4.2 *Individuals' strategic positioning*. Although there was considerable talk of luck, serendipity and 'accidental' careers, there was nevertheless a strong sense of active career management on the part of the scientists in the sample. Whilst this never involved formal career guidance, it did involve making contacts, participating in relevant – and well-reputed- academic communities, taking up posts with the most influential people and developing informal mentoring and sponsorship arrangements to facilitate career movement and progress. To progress in any arena it appears that scientists need to build up career capital. Implicit in the data was the sense that career development could not be left up to the university or even the private sector organization. Rather, it was the scientist who had to go out and build their career. Whilst this appeared to be most strongly felt by those university-based scientists working most closely to universities, it was nevertheless a recurrent feature across the dataset. The major difference, though, were the specific communities that scientists were participating in – ranging from international, academic communities, to more diverse (and more local) business networks, and to government, policy-level groups.

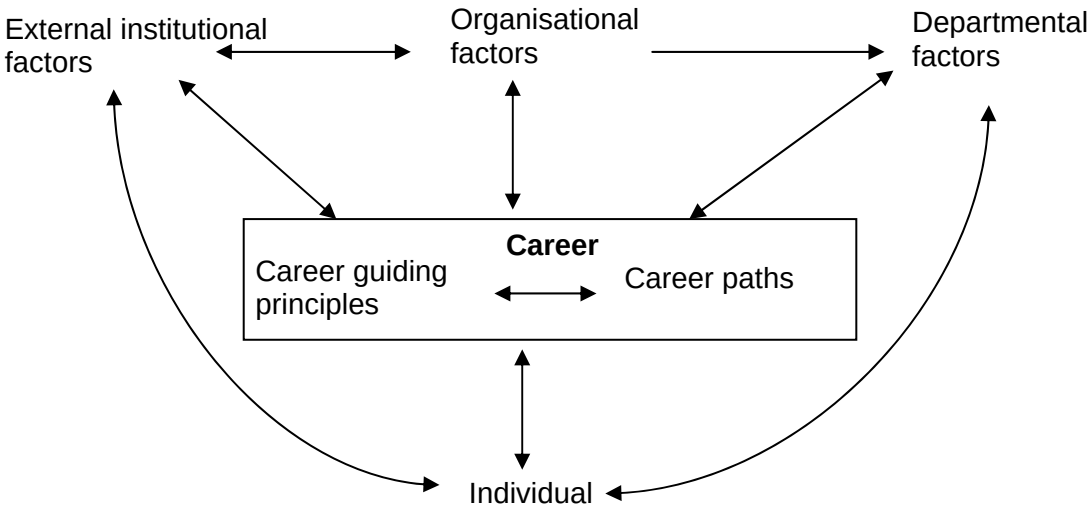
4.3 *Changing skill sets*. The need for scientists in both public and private sectors to develop commercial and entrepreneurial skills was apparent throughout the data. Central here was learning about the processes of commercialisation (how to apply to patents and licenses etc.), fundraising etc., as well as post start-up business management and development. Of utmost importance, once again, was access to and participation in relevant social networks and business/scientific communities. For some scientists in the sample the development of these sets of skills/contacts meant refining and honing activities they were already doing, while for others it involved re-framing their science in a very new way.

4.4 *Fads and fashions in science*. Notwithstanding commonsense ideas about science being dispassionate and neutral, what resounded very strongly in the data was a sense of science as politically motivated, circumscribed by a whole

4.5 *Scientists' relationships with employing organizations*. What we found striking in this data is that the scientists in the three groups described their relationships with their organizations in very different ways, with significant consequences for human resource management and career development prospects. Many of the university-based scientists in the first group expressed a complex mixture of loyalty and commitment to their groups or departments, but a great deal of cynicism and frustration with regard to their universities more generally. Careers, for scientists in group one, belonged to individuals, constrained or enabled by their university contexts. In contrast, for those in the second group, there was a strong feeling of identification between themselves and their businesses. In this sense, business success and career success were inextricably linked. While there was no such identification between the organization and the individual for those in group three, these scientists did describe a much closer relationship with the organisation's strategic goals than those based in the university. These industrial scientists described their commitment to their organizations. In exchange, they expected good career opportunities, in terms of remuneration, promotion prospects, quality of work, physical resources, and recognition.

Appendix One

A model of career transition



This model has been developed from our interview data. Briefly, career is placed at the centre of the model as a link between the individual and their context. We argue that individual action with regard to career transition is influenced by the career paths that are seen to be available and the career guiding principles that are seen as legitimate to particular groups of people. These paths and principles will be influenced by external institutional factors such as national culture and government policy; organisational factors such as organisational policies, systems and processes and departmental factors such as the culture and leadership of particular departments and labs. The model is recursive though in that it is recognised that in the long term individuals have the chance to influence their context and so they may play a role in changing the career paths that others see as available and also effecting organisational and institutional change.

If you would like greater explanation of this model please contact us and we can send a copy of our latest paper which goes into the model in more depth, with examples.

Entrepreneurial academics: developing science and scientific careers in changing university settings

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Entrepreneurial academics: developing science and scientific careers in changing university settings

Abstract

There is an emerging consensus that the contexts and conduct of science are changing, encapsulated in concepts of “academic entrepreneurialism” and the “entrepreneurial university”. The extant literature has taken a strategic view, with limited consideration of implications for individuals’ careers. This paper opens up debate into this area. Based on the findings of a study into scientists’ transitions from public to private sector contexts, it explores the career accounts of university based bio-scientists involved in a government-sponsored entrepreneurship training initiative. The paper makes three related contributions to existing understandings of the entrepreneurial university and its implications for scientific careers.

Entrepreneurialism, university scientists, careers, knowledge production

We must not forget that when radium was discovered no one knew that it would prove useful in hospitals. The work was one of pure science. And this is a proof that scientific work must not be considered from the point of view of the direct usefulness of it. It must be done for itself, for the beauty of science, and then there is always the chance that a scientific discovery may become like the radium a benefit for humanity (Marie Curie, Lecture at Vassar College, Poughkeepsie, New York)

There are no such things as applied sciences, only applications of science (Louis Pasteur)

Introduction

This paper reports on findings from a study into research scientists' move from public to private work settings[1] . There is an emerging consensus that we are experiencing a "radical, irreversible, worldwide transformation in the way that science is organised and performed" (Ziman, 1994: 7; Jordan, 1999; Buhrer, 1999; Alonso et al, 1999). For university scientists, such change has been described as a move from discipline based, curiosity-driven research to an emphasis on application, transdisciplinarity, networking and collaboration, and social accountability (Nowotny, Scott and Gibbons, 2001). However, while considerable research attention has focused on this changing context and its implications for universities generally (Fuller, 1999; Calas and Smircich, 2001; Steier, 2003) to date very little is known about its implications for individuals' careers. Our aim here is to open up debate into this under-researched area.

The paper is based on a study of scientists based in the United Kingdom whose careers, spanning the university and private sectors, could be seen to encapsulate

[1] We would like to acknowledge the support of ESRC, grant reference: RES-000-22-0571

the current context. The full study investigates the experiences of university scientists who have made three different types of career transition: to government sponsored entrepreneurship programmes; young, entrepreneurial companies; and toR&D departments in established organizations. In this paper we report on the first of these groups, university-based bio-science researchers who were awarded fellowships to participate in Galileo, a government-sponsored entrepreneurship training initiative. Based on the data presented, we make three related contributions to existing understandings of the entrepreneurial university and its implications for scientific careers.

Entrepreneurial science: principles and processes

In the United Kingdom as in other Western countries, the role played by the university in the production of knowledge has come under increasing scrutiny. As Calas and Smircich argue:

> Knowledge production in universities has become a widely contested affair. The moment 'knowledge' was positioned as a commodity in the wider context of capitalist modes of production and ('free') market forces, universities were to receive declining support for continuing as sanctioned sites for the production of innovation… and still less support for continuing as places for 'distinterested knowledge' in the quest for a better society (2001: 148).

Underpinning this rather bleak statement are tensions between knowledge for the sake of knowledge on one hand, and market-oriented knowledge on the other, and between the public and the private sectors as sites for knowledge production (House, 2001). These tensions are likewise central to Delanty's overview of "the university today". Delanty identifies four key approaches to the issue of the role and purpose of the university in the age of postmodernity and globalisation (2001: 149-150). First,

what he describes as the *entrenched liberal thesis,* is based on the view of the university as a vehicle for the reproduction of culture. This view celebrates the notion of the "canon", and its expression through traditional curricula. It bemoans current challenges attempts to undermine these curricula "in the same of diversity". Second, the *postmodern thesis* represents just such a challenge, taking issue with the traditional, liberal view of knowledge as emancipatory, and highlighting the impossibility of knowledge as codified through set programmes, texts or syllabuses. In this view, the concept of the university itself is an impossibility. Delanty refers to the third perspective as the *reflexivity thesis*, based on the emerging reflexive relationship between producers and users of knowledge. This view takes issue with earlier notions of the academic as expert, focusing instead of knowledge production as a local phenomenon. Within this perspective the university is certainly losing its pre-eminence, and could potentially fade into obsolescence. Finally, within the *globalization thesis* the university is depicted as eschewing academic freedom in favour of market values, and so playing a central role in the development and dissemination of global capitalism (Slaughter and Leslie, 1997; 2001).

Delanty's position, as ours, is that together these perspectives can help us to understand the often conflicting dynamics currently at play within universities. The tensions implicit in these contradictory imperatives, between basic and applied knowledge, and between the public and private sectors have for several years been at the heart of debates on the organization and performance of science and education (Ziman, 1994; Gibbons et al, 1994; Tight 2006; Steier 2003). In their examination of the current context, Nowotny, Scott and Gibbons discuss what they see as an uneasy convergence of university, government and private sector scientific research establishments. In their view, universities play a somewhat ambiguous role.

In the United Kingdom as elsewhere, this “triple helix” of university-industry-government (Nowotny et al, 2001: 107) has been associated with two parallel trends in the contexts in which university scientists work. First, as a result of significant reductions in government funding, over the past 25 years UK universities have been under pressure to adopt a more “entrepreneurial” approach. Typically this involves the generation of research income, greater collaboration with industry and a strong focus on the outputs (often short-term) of scientific endeavour. Whereas in the past university science departments were able to rely heavily on non-output specific funding, financial support (where available) is now more focused and output driven, strictly geared to meeting national priorities and more closely monitored (Cohen et al, 1999).

Second, these changes in orientation have been linked with the growth of the knowledge society and the significant role played by science within this society (described as the “scientisation” of society (Fuller, 1999). In particular, a number of writers have argued that the need for wealth creating industries, such as computing, information technology and biotechnology, to have a strong and dynamic scientific base, has led to closer involvement of university science in industry, resulting in much more reciprocity and interconnectivity between universities and society than existed previously (Delanty, 2001). As Etzkowitz suggests, “Science has emerged as an alternative engine of economic growth to the classic triumvirate of land, labor and capital, the traditional sources of wealth” (2003: 109).

Both of these trends can be seen as embodying aspects of Delanty’s *reflexivity* and *globalisation* theses, synthesising knowledge production and knowledge use through contexts of application (and thereby blurring boundaries between private and public sectors) and working in the interests of wealth creation. Etzkowitz (2003) reflects on this emerging phenomenon. In contrast to critics who see the entrepreneurial

university as a rupture with the past, he argues that the attempt to articulate academic goals, and to translate these into “economic and social utility” (2003: 114) is entirely consistent with the university’s original purpose and early development. As regards characteristics, these include what Etzkowitz terms “interface capabilities”, including liaison and technology transfer offices (Stevens and Bagby, 2001) and facilities, ranging from intellectual property to technology, to manage and market the knowledge produced at the university. In her study of biotechnologists, Oliver (2004) extends this analysis through her identification of three types of entrepreneurial scientist: those who manage research teams in conducting large scale commissioned projects; academic scientists who use their knowledge to set up or collaborate with commercial enterprises, resulting in joint academic publications and contributing to firm success; and finally those scientists who realise the commercial value of their work through patents and licenses. Likewise Kloften and Jones-Evans (2000) in their comparison of academic entrepreneurship in Sweden and Ireland derive a similar typology of activities. They describe consultancy and contract work as “soft” and spin-outs, licensing and patents as “hard” activities. Interestingly, they argue that while the soft activities are much more popular amongst scientists and seem to be more consistent with their academic orientation, they are frequently neglected by entrepreneurship support initiatives which tend to focus their energy on the higher profile hard ones.

Evaluating the implications of the entrepreneurial university, ethical as well as conceptual, Etzkowitz raises a number of concerns. From an ethical perspective are questions about the role of the university in economic development, and about whose interests scientific research should be aiming to serve and promote. We would argue that a consideration of how individual scientists resolve these questions in relation to the development of their own research (including decisions about

commercialisation and about establishing links with private industry) will provide useful insights into these thorny but very pertinent issues.

On a more conceptual level are questions about whether commercial and academic perspectives represent oppositional (and conflicting) cultural orientations, or whether they could be complimentary and compatible. The former position is in some ways reminiscent of Delanty's concept of the entrenched liberal critique, noted above (and reflected in Marie Curie's word cited at the outset), and its implicit assumption that there is an inevitable barrier between these orientations, that "the breaching of a barrier, whether natural or moral, will lead to catastrophic results" (Etzkowitz, 2003: 9 of 17). An alternative approach is for universities to acknowledge the difference between business and academic activities, but to integrate them under a broader university mission (this could be seen as akin to Delanty's reflexive thesis). However, of course it may not be the case that business and academic do constitute two separate and incompatible spheres of understanding and activity. Indeed, our own research has revealed that some scientists experience these as mutually enriching (Cohen et al, 1999; Cohen et al, 2001). Here Etzkowitz (2003) makes the interesting observation that many of the values of entrepreneurial science are probably already embedded in the practices and processes of university science departments. Thus the problem is not the imposition of a new set of values from outside, but rather that universities themselves embrace meaning systems which are sometimes contradictory, and whose co-existence can be difficult to navigate. This idea of the university as an arena in which different, and sometimes oppositional sets of norms and values are contested and negotiated, echoes Delanty's view, noted above, of the university as polyphonic and "reflexively connected with society" (2001: 152).

By and large, the extant literature has considered the concept of the entrepreneurial university from a strategic level (Slaughter and Leslie, 1997; 2001; Ibarra-Colado,

2001; Muller and Subotzky, 2001), depicting numerous examples of infrastructural reform and innovation and debating their implications. It is a fragmented, highly charged and rapidly changing picture, with implications for the constitution and enactment of scientific careers. However, to date there has been very little consideration of this career dimension in discussions of the entrepreneurial university. Given the capacity of the career concept to illuminate the relationship between individuals and their social worlds (Duberley et al, 2006), we argue that a consideration of how scientists who have been charged with promoting entrepreneurial values and behaviours, make sense of this in the context of their unfolding careers, will make a valuable contribution to our existing understandings. Thus the research reported here aims to shed light on two key research questions:

1) What are the implications of academic entrepreneurship for individual scientists' conceptions of their careers?
2) What does entrepreneurialism mean to the scientists in this study? To what extent is it reconcilable with their scientific aspirationsl?

Background to study

Part of a larger ESRC-funded study, as noted earlier, this paper is based on qualitative interviews with 23 fellows on the first two phases of the Galileo programme, working across five UK universities. The participants all worked in the field of biotechnology, and ranged from doctoral student to professor. An interpretative and qualitative stance was taken. Interviews were in-depth and open-ended (Kvale 1996). Respondents were invited to reflect back on their careers, highlighting reasons for embarking on the programme, expectations and experiences of the programme, and career expectations as their fellowships came to an end. Through our questioning we encouraged participants to reflect on the diverse contexts in which worked, what they saw as the available routes and opportunities for progress and growth, and the choices and decisions they made in enacting and

developing their scientific careers. All interviews were taped and transcribed verbatim to address issues of credibility and confirmability. Data analysis was on-going throughout the project. This iterative process led to the emergence of a coding template for analysis of the data into inductively generated categories (King 1994).

At this stage it would be useful to give a brief description of the Galileo programme, and of UK academic scientists' careers more generally. Funded by the Higher Education Funding Council for England (HEFCE) this initiative, conducted in the initial stages at five English universities, seeks to foster a spirit of entrepreneurship in biotechnology. Two-year fellowships were awarded to researchers and academics through a competitive selection process. Fellows were given entrepreneurial and business training, equipping them in the process of exploiting research, science and technology in a commercial context. The aim was for fellows to have the skills and knowledge needed to embed a culture change within their departments and organizations by championing enterprise and entrepreneurship, in both research and teaching activities. Some fellows embarked on the programme with established ideas that they seek to develop commercially, others did not, but were interested in learning more about business and commercialisation. Our interviews took place towards the end of the first group's final year, when many of them were preparing to move on to other things or thinking about what type of career they might want to follow. We recognise that as our respondents were engaged in an entrepreneurship programme, they are likely to be positively disposed towards it. Therefore we do not aim to provide an assessment the views of all academics towards such activity in universities. Our focus is upon those who are adopting entrepreneurial practices and trying to devise new careers within this context.

The table below outlines the sample of interviewees. The fellows are split into two groups. One group works on the Galileo project full time, which means that they take

on a consultancy type role in their departments, conducting technology audits and helping others to spin out projects. These are often people who have either just finished their doctorates or have done one or two postdoctoral research projects. The part-time fellows tend to be established academics and here the emphasis is more on giving them time to spin out their own companies. There is a mix of male and female fellows and the majority of fellows have previous experience of industry. Either being employed in the private sector, having had a placement of collaborating with private sector companies in research projects.

Insert Table 1 about here

Turning to UK university scientists' careers more generally, our data indicates a path which is seen by individuals as typical and which, from the outset, the majority of academic scientists expect to follow. The initial stage is the completion of a first degree in a scientific discipline, usually including an element of project work (this generally happens when people are in their early 20's). Some scientists then enrol on doctoral programmes in the same department or university in order to further develop this work. Others, however, embark on doctorates in different universities, a change triggered by research interests, a desire to work with specific teams or individuals, funding opportunities or personal/lifestyle reasons. In addition, some graduate scientists seek industrial experience before starting their doctoral work, but in our research this has always been a minority route. In the UK, funding for doctoral studies can come from a range of sources, including self-funding, university grants, government research council bursaries and industrial support. Upon completion of their PhD (usually in their late 20's), most scientists seek positions as post-doctoral researchers, both in the UK and overseas, as a stepping stone to a university-based career. These are typically fixed-term contracts, often funded by research grants and commissions. Although all the post-doctoral researchers we've spoken to had initially

hoped to achieve permanent lecturing posts (ultimately culminating in professorships), for a large number this was seen as increasingly unlikely. Instead, these scientists saw their post-doctoral years as characterised by high mobility, financial insecurity and uncertainty about the future. For the junior scientists, Galileo represents to progress their careers in unanticipated directions.

As we are seeking to develop insights into scientists' career development within an increasingly entrepreneurial context, it makes sense to start our data analysis with a consideration of Galileo fellows' career aspirations. We developed three core categories to reflect these, as highlighted in the table below. Entrepreneurialism was seen by all three to be making a significant impact on university science and the ways in which scientists built their careers. Group one, the largest, was mainly made up of established academics who talked about a desire to stay in the university but with more spinout activity. Group two comprised those who saw themselves as technology transfer professionals, assisting others in commercial endeavours. The majority of these thought they would stay in the university, however two preferred a move to the private sector. Finally, the scientists in group three were using Galileo to build the career capital necessary to take advantage of diverse opportunities in both sectors. That said, at the time of interview, most anticipated a move to the private sector where they saw more attractive career prospects.

Insert Table 2 about here

Group one: entrepreneurial academics

Most of these individuals tended to see themselves as dedicated scientists who belong in academia doing science. However, in contrast to Marie Curie's rigid delineation of 'pure' and 'useful' science (and her dismissal of the latter), the

respondents in this group felt that excellent science could be done in a commercially sensitive way, and sought to pursue work that was at once ground breaking and marketable. We will return to this issue below. Regarding their career progression, the respondents in this group had followed what is seen as the traditional academic career path. In most cases, they had built their reputations on their fundamental scientific work, and had only latterly begun to develop their commercial activities. For example HG commented:

> *I will always be an academic. If I have, and I do have a business idea, the idea will be that I will still stay in academia, but the business will be going on, kind of thing, in parallel'*

Similarly, PF explained:

> *The most I would do is take a sabbatical to help the commercial concern, but at the end of the day I'd come back to being what I am, which is a university scientist. Yes, more than anything else, but at the same time I want this commercial concern to succeed and if it was majorly successful, again I still would not give up being an academic… that's what I'm best at doing.*

Although they had largely reconciled the tension described by Marie Curie, respondents in this group identified other, operational rather than philosophical, challenges which they felt often constrained them from fulfilling the potential of their scientific work. We will return to this point below.

Group two: technology transfer professionals

Group 2 includes those individuals who see careers as technology transfer professionals. Notably they were younger than those in the first group, and more junior within their departments. The majority wish to stay working in a university context but don't see themselves staying at the lab bench. Having experienced Galileo they see their futures instead as enabling active scientists to commercialise their products. Here it is worth mentioning that neither this group nor the previous one talked much about what Kloften and Jones-Evans (2000) described as "soft" activities, such as consultancy and contract research. Rather, these appeared to be taken for granted as part and parcel of the academic world, rather than a consequence of the current emphasis on commercialisation and entrepreneurial activity.

Two driving forces appear to motivate the individuals in this group. First is a strong desire to get out of the laboratory. Having spent years, as doctoral students and post-doctoral researchers, on what they described as routine and often extremely tedious experimental work, they sought opportunities for greater variety. As AL explains:

> *I don't want to be doing lots of lab work so it was that that made me think, 'Oh, there's no way I want a career where you're repeating things again and again day in and day out'.*

Secondly, whereas the respondents in group one saw themselves as scientists and oriented to traditional academic career structures and opportunities, those in group 2 described themselves as both scientists and business people, and saw these roles as entirely compatible, and mutually enriching. That said, the majority nevertheless anticipated that their careers would unfold within university settings. In the main this was due to the lifestyle, most especially the freedom and flexibility, characteristic of

this context. Furthermore, although they were keen to get away from the bench, these respondents had no wish to leave science behind. They expected that pursuing technology transfer on a university campus would enable them to stay close to science, as DM pointed out:

> *Realistically it's the only way to keep that abreast of different technologies to stay within an academic environment and I do like the fact that I get to be in contact with the academics. It's not fully commercially driven. It is still driven by the wonderful research that they just do because they feel like it or it's exciting for them.*

Interestingly, this respondent notes a difference between academic and commercial orientations, in particular the potential for discovery-based research within the university (in her view unavailable in a more commercial setting). However, this is cast not as an ethical difference (as identified by Etzkowitz, 2003), but rather in terms of personal satisfaction. This issue of what scientists' work really means to them and what they want out of their work and careers is important, but is frequently overlooked in the literature which tends to take a more strategic, macro orientation.

On this personal level, for the post-doctoral researchers in our sample, building a career had thus far had involved a series of temporary positions and on-going grant applications. The young scientists in group 2 recognized that government policy and university funding means that a position in the emerging field of technology transfer is likely to be a better (more secure) career option for them than continual short term post-doctoral contracts. As AW highlights:

> *The great thing about Galileo is it's come along just at the right time because there aren't many people who are trained to do this type of work*

to do technology transfer work and the funding councils and HEFCE have put a much bigger emphasis now on doing technology transfer. I think this June there's certainly money coming so there's probably going to be whole host of jobs available for technology transfer work and there are not going to be enough people to full the vacancies…So for me it's great because it means that by the end of this summer there should be a whole range of jobs that I can apply to.

Two people within the group, however, see technology transfer in the private sector as the route for them. Both of these individuals had worked in the private sector previously and it seems that this made them aware of the possibilities available. This is an interesting finding and relates to our previous research (Cohen et al 2001) which showed that those who had prior experience of the private sector had much more positive perceptions of the opportunities it presented than those who had never left the university setting.

Group three: Career capital builders

Finally, Group 3 is made up of younger people who have either recently completed, or are about to complete their PhD. Most seem unsure where their future direction lies and are using the Galileo programme to develop the knowledge, skills and resources which they see as vital to the development of a successful career. Drawing on Bourdieu (1991), career theorists Iellatchitch, Mayrhofer and Meyer (2003) use the term career capital to describe the personal and social resources which individuals deploy to negotiate and navigate between diverse career contexts (eg. disciplines, organizations, sectors). They identify four forms of career capital: economic, social, cultural and symbolic, and argue that every individual has a unique

portfolio of these which enables them to operate with varying degrees of success within particular career field.

The scientists in our third group were well aware of the traditional scientific career path and its status, but saw it as largely unavailable – a relic of the past that was now only offered to the lucky few. With seemingly little interest in or knowledge of the ethical and strategic concerns highlighted in the literature, their aim was to find – or develop - a career path which would allow them to use their science, provide opportunities for growth, and offer a degree of security unavailable to the large numbers of post-doctoral scientists who find themselves in a seemingly endless spiral of short term contracts. For example, MT comments:

> *Well, I think there are more and more doors open out there now. I don't know what exactly I'll do, but as I've said, I think the skills that I've gained from here I'm hoping that they'll be of use to a number of professions… where I can use my science basis, but sort of work more at the business side of things*.

The majority of these respondents see their options as open and quite diverse. They may stay in the university or go into the private sector, and through Galileo are developing the career capital which is perceived as valuable and legitimate in both. Notably, they constructed a clear distinction between university and industry and offered fairly stereotypical views of the advantages and disadvantages associated with each. In particular, respondents in this group spent a great deal of time talking about the problems of life as a university scientist, with little security and meagre financial rewards, and the relative advantages of industrial science. Significantly, whereas the individuals in the other two groups were excited by career options which integrate science and entrepreneurialism (either by staying in academia but

operating in a more commercially sensitive way or by moving into technology transfer), these individuals still seemed to see science and business activity as distinct and typically see their futures as doing either one or the other. For example KB comments:

> *I would like to have some experience of private industry before possibly long term moving back, but I think that particularly for the next few years I want to get out and experience sort of research in an industrial context, which hopefully will either give me some ideas and make me want to come back and be an academic, or I can just wave it goodbye for good.*

What is interesting here is that while these respondents reported that the Galileo programme had widened their career opportunities by giving them other transferable skills, they adhered to highly polarized ideas about what constitutes a legitimate scientific career, in contrast to scientists in the other two groups. One reason for this rigidity could be what we discerned as a notable lack of individual autonomy in the accounts of these young scientists. Although they described their proactivity with respect to the building of career capital and identified diverse routes along which this capital could be deployed, they articulated little confidence in deviating from these paths, or creating alternatives.

Doing entrepreneurial science: ethical and operational challenges

As Galileo fellows, the scientists in our sample were very interested in the practical application of their research. Like Pasteur in the introductory quote, they did not point to a fundamental distinction between applied and basic science, but rather felt that most science could ultimately be put to practical use, and were motivated by this prospect. In our discussion of academic entrepreneurship we noted Etzkowitz' (2003) concerns about the potential for ethical conflict as academic science and commercial

application become ever closer. Amongst our respondents few concerns were expressed about possible ethical tensions between academic research and spinout activity. Rather, for many of the scientists in our sample, spinning out was a means of ensuring that people and society actually benefited from their inventions, as this comment by HG suggests:

> *I enjoy blue sky research, but I like to see that there is some use for it at the end of it rather than … it's hard to say rather than just knowledge for knowledge's sake because some of the most important discoveries I think come out of blue sky research. You can't see the application when you start, but that doesn't mean you shouldn't be looking for it as you go along. I think what we're doing at the moment we hadn't planned necessarily to start off with to spin out. It was something that came up probably in the first couple of years of the project. We saw it was one of the ways of taking it forward.*

Another scientist, IF, illustrated this point, highlighting the potential value of his blood testing product:

> *I'm motivated by the fact that certainly it'll save the NHS about 80% of its budget for haematological testing for, you know, leukaemia, which would be quite nice. It could be used in the developing world, which I think it'd be quite nice as well because there's a lot of sort of generic anti-cancer drugs being made in India and China, but then, of course, they haven't got the means to test the population to use the drugs. So I can see how it could be used there, which I suppose is fairly altruistic.*

This quote is representative of our sample in that the majority of respondents could see real advantages to the public of spinning out their products. This is what they said motivated them, rather than the prospect of financial returns. Commercialisation was thus entirely compatible with respondents' scientific and social interests. Indeed, it was through commercialisation that the social value of their discoveries could be fully realised. Notably, respondents made the point that this commercial imperative was nothing new, that they'd always had a desire to see their work in the public domain, but formerly it would have been "*taken to market*" by someone else, probably a large company, in which case the individual scientist would invariably lose all control over the process.

That said, twelve respondents discussed the potential conflict of interests between the business and the university, not because of the nature of the activities themselves, but rather resulting from financial arrangements. In particular, ethical difficulties arose over issues concerning who was to benefit financially from the business), and roles and relationships between business partners, and between academics and their customers. JH sees the role issue as a major problem:

> *There's a big tension between the company and the university staff, a big tension because I'm so far in breach of contract. Professor [X] who is the Chairman of the Board for the company, is also the Director of the School, so when it comes to pulling strings, he's got a handle on some fairly large ones and can smooth the way. You know, as far as he's concerned it benefits him and the university to have me doing more time on the company versus the university so that's a very big tension because I disagree with him on all counts, but what do I do… I think he's got a huge conflict of interests that he has not declared to the Board of the*

company, nor has he declared it to the university, so I think he's in an exceedingly bad position.

We must stress that the corruption described here was not typical in the accounts we heard. However, the potential for a conflict of interests between the university and the fledgling businesses they were trying to support was certainly seen by those involved in spinouts as a sensitive problem with no obvious solution.

Operationally, the process of spinning out was seen as difficult and complex. Amongst the fellows we interviewed there was a huge amount of criticism regarding the level of support offered by the universities and departments. They spoke about the tension they experienced in trying to maintain a world class scientific base and conduct commercial activities as well as undertake departmental administration and teach. As JH explained:

It would mean giving up the research completely because I just don't seem to have any time unless I'm prepared to, I mean as it is I come in at half seven in the morning and I don't leave until about six most days, and then I get home and I'm starting again at about half seven and working through til 11. So there's really not much time left in the day and majority of that is company stuff. Admittedly last night I was marking essays, which are something like two months overdue… if I did go for the corporate thing, it would be because I wanted to go wholesale with the corporate thing and make a real strong fist of it, not necessarily to augment an academic career.

This was echoed by five of the other scientific entrepreneurs. PF describes her experience of this conflict:

Obviously my main raison d'etre as far as the university is concerned, I should point out that it should have been research, but teaching is also a major element of it now, but at the same time it's commercialisation, and one thing that I'm not at all concerned about saying with utter frankness, if you like, the conflicting messages we get from our administration in respect of what is the most important aspect of our role as lecturers, as university employees because it seems to vary from, I don't know, week to week or whatever. So we have conflicting requests for excellence in research and that basically is the criterion by which we appoint… But at the same time we have a strong commitment to providing the best quality teaching that we can, and since, you know, the responsibilities that we have in respect of students are so great, that that has to take a major, major priority. But of course progress within the system is actually on the basis of research output and not our teaching, and of course commercialisation is a very, very poor third to all of that.

Returning to Delanty's (2001) conceptual framework, what seems to be happening here is not a shift from one approach to another, but an uneasy synthesis between a traditional, liberal model which expects academics to take on teaching, administrative and research responsibilities, a more reflexive model in which academics are charged with developing different sorts of relationships with the users of their products, be they pedagogic or scientific and a more global, market oriented model in which wealth creation through the commercialisation of science is seen as the priority. The conflict, for some of the scientists at least, is not the result of some ontological difference between commercial and academic science, but rather operational, about not having the resources to do all these things. Here the respondents in group two are significant in that by aspiring to be technology transfer

professionals, they are opting out of the academic career structure, the RAE imperative and the conflicting pressures implicit in this context. These fellows saw real benefits to be gained from linking academic and commercial science, and envisaged their careers as straddling the two.

In addition to this issue of trying to accommodate the conflicting demands of teaching, research, administration and commercialisation, eight respondents explained that whereas the distinction between discovery and applied science was not itself problematic, the dissemination of findings generated through commercial research sometimes poses difficulties when it came to producing academic publications. HG discussed this in relation to her reporting of findings from clinical drug trials:

> *A lot of publications now, when you actually submit your article, they'll ask you whether you have any conflicting interests and they'll ask you to declare who your funding sources are and so that enables the reader to say, 'Ah, this is saying the drug is fantastic, but look who sponsors them!'. And so people can then start to draw their own conclusions.*

However, it is interesting that this seemed to be a difficulty that people had heard about (and was highlighted in the UK press) rather than something that many had experienced themselves. Indeed, several scientists explained how they were able negotiate a path through these restrictions. Here AH discusses this point:

> *We've got a patent that's with the patent boys at the moment and a publication is just finished and we're going to send it off next week and they're going to have to do it. It's as simple as that you know. We told them two or three weeks ago that we'd be ready to publish by the end of next*

week coming up and they said, 'Yes, I can work with that'. So it shouldn't be a problem as long as you're accustomed to give the patent people, the IP [intellectual property] people, sufficient warning to give them a chance to do their jobs and don't pin them down at the last minute… But there is a lot of mis-information out there about IP protection and publication, and it's simply not true.

Indeed, one of the roles of the Galileo fellows was to facilitate other colleagues in their commercial activities, which included guiding them through this process.

In our review of the literature we discussed Kloften and Jones-Evans' (2000) concern about attention being given to "hard" activities like spinouts, patents and licensing, at the expense of the "softer" more conventional contract research and consultancy. Galileo certainly emphasised the former, and in our data there was very little discussion of those softer activities – rather a sense that they were taken for granted in this context. However, JH did take issue with the current focus on spinouts, and its potential implications for university science:

Well, who's most likely to spin out? It's going to be your top academics who've got the good ideas, who've got the drive and the enthusiasm to make it work. If it starts to work and money starts coming in and they realise, 'Well, hang on, this was my idea. I'm doing what I love and I'm getting paid for it, what incentive to stop in academia is there?' I see none. So I think the emphasis on spinout is lunacy to be honest, and the only way, if universities want to retain academics as they say they do, is to go down the patent/license route.

Although this concern was put forward by a number of respondents, none of the senior academics in our sample expressed a desire to leave the university setting. That said, permeating our dataset was a strong sense that universities were imposing too many conflicting demands on people, were not attending to crucial career issues (like long term contracts and pay) and that, as spinout came to be viewed as a more legitimate scientific activity, universities could struggle to keep their top scientists.

Discussion

As Nowotny and her colleagues (2003) and other critics have argued, the nature of scientific research and the process of knowledge production are being transformed, with an emphasis on: "(a) the 'steering' of research priorities, (b) the commercialisation of research, and (c) the accountability of science… As a result of these and other trends, the research that is variously described as 'pure', 'blue skies', fundamental or disinterested, is now a minority preoccupation, even in universities" (2003: 179, 184). This paper has investigated the implications of such transformation for careers in research science. Focusing on the accounts of fellows on the Galileo entrepreneurship programme, it has examined scientists' career aspirations in light of Galileo, and critically explored their perceptions of the relationship between academic and commercial science – a relationship which as Nowotny et al and others (eg Calas and Smircich, 2003), have indicated (is up for grabs.

Based on the data reported above, our study makes three related contributions to understandings of scientific careers in the current UK climate. First, while there is significant variation in how scholars understand this changing context (Calas and Smircich, 2001; Nowotny, Scott and Gibbons, 2001; Delanty, 2001), the studies upon which these analyses are based generally take a macro perspective with scanty

attention to individual levels of understanding or enactment. Seeking to shed light on this under-researched dimension, our data illustrate that the entrepreneurial imperative in the university science setting does not impact on individuals (even the entrepreneurially-oriented Galileo fellows) uniformly. Rather, the ways in which the scientists in our sample interacted with and responded to such imperatives depends on their particular interests and values, together with the constraints and opportunities of their current work contexts. This is partly related to an individual's level of seniority and significantly, their perceptions of autonomy - not only in terms of their day-to-day activities, but also the extent which they feel in control of their career development.

Some respondents (notably the entrepreneurial academics and the technology transfer professionals), seem to experience greater levels of control over their situations and choices than the more junior career capital builders. Through their accounts interviewees spoke of how they found ways of overcoming constraints and using opportunities to achieve their aspirations. While the scientists in the first group appeared to negotiate with existing structures so as to develop their science as they saw fit, those who aspired to careers in technology transfer, described their participation in activities which would ultimately transform existing structures - a new career path in a new occupation. Those in group three, however, didn't seem to have clear aspirations, and perhaps as a result their response to the entrepreneurial imperative is less easily discerned. Unlike those in groups one and two, they did not appear to have the conceptual career scaffolding on which to hang the Galileo experience. Thus they presented themselves as attempting to acquire the career capital needed to move between university and industry, but somewhat paradoxically, with little sense of control over the outcome. The aspiration, then, was "a career" and this career could take a variety of (established and codified) forms, in a range of public or private sector organizations.

Second, our findings provide new insights into the enactment of entrepreneurial science. Consistent with the arguments put forward by Oliver (2004), and Kloften and Jones-Evans (2000), our data show that within the Galileo programme there was an emphasis on what have been described as “hard” activities, such as patenting, licensing and spin-outs. In this context, traditional “soft” activities including contract research and consultancy did not appear to be part of this entrepreneurial shift, However, unlike the studies noted above, our findings revealed that these hard activities themselves were further differentiated in the eyes of our respondents, with each posing their own dilemmas, challenges and spaces for negotiation (eg. publishing, in the case of patents). Amongst our respondents, particularly several of the more senior academics, there was a view that spinouts in particular raise very distinct challenges for the individuals involved and, in the long term, for universities, including potential conflict of interests in terms of power, contractual obligations and financial matters. In addition, respondents expressed their concern that this current emphasis on spinning out could potentially result in a brain drain from university departments as the best academics sought to develop their research interests and reap greater financial rewards working for themselves.

The third contribution of this study relates to conflicts, noted by Etzkowitz, (2003) and Delanty (2001), in the overlap between academic and commercial activities, and the broader question of whose interests are ultimately served. The respondents in this study, like the American scientists in Cassier and Gaudilliere’s study (2000), viewed commercialisation as a possible way of realising the potential of their particular science. Science and commerce were viewed as neither incompatible, nor complimentary. Rather, the important issue was how they were managed, with what resources, and to what aims. What the respondents in our study really struggled with (and this was particularly those in group one with senior, academic jobs, who

had achieved career success in the traditional model) was that they were simply working to too many different imperatives and that they had insufficient resources to meet the various demands imposed by each.

According to the data generated in this study, universities could be seen as having aims and conducting their affairs in line with at least three out of four of Delanty's critiques (there was not much evidence of his postmodern perspective). What became apparent through our analysis was that often these converge in individuals' work settings, such that scientists are trying (and are expected) to perform in accordance with each of these regimes at the same time. Of course as Galileo fellows, the full-timers, at least, were released from the majority of their academic duties (or in other words, the demands of Delanty's "entrenched liberal" model). However, they were well aware of the conflict looming once the programme came to an end. Indeed, given their increased involvement in commercialisation, they feared that the pressure could be even greater than before. Linked to the point made earlier concerning successful scientists leaving universities in order to spinout their companies, this raises significant issues for the future of universities. Our research indicates that new young researchers are looking beyond the life as serial post-doc researchers, and those more experienced academics may find the pressures to be researcher, lecturer, administrator and business person too demanding. This seems to suggest new and different careers for many people who would once have been university academics. As individuals forge new career paths, their actions will impact back upon existing social settings, suggesting further dynamism in the conduct of science and the development of scientific careers.

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Table 1 The Sample

Gallileo Fellow	***Age Group***	***Gender***	***Full/ Part time***	***university***	***Experience of private sector***
Ms AH	20-30	F	Full-time	A	None
Dr AW	30-40	M	Full-time	B	UG placement Research project collaboration
Dr AB	20-30	M	Full-time	B	None
Dr DM	30-40	M	Full-time	C	UG placement
Dr EC	30-40	F	Full-time	D	None
Dr EP	30-40	M	Full-time	C	None
Dr JD	20-30	F	Full-time	C	None
Dr KB	20-30	F	Full-time	A	None
Dr MT	20-30	F	Full-time	B	Research project collaboration
Dr SH	40-50	F	Full-time	C	None
Dr LM	30-40	M	Full-time	A	UG placement
Dr NP	20-30	M	Full-time	A	None
Dr AL	30-40	M	Part-time	E	Employment
Dr AH	20-30	F	Part-time	D	Research project collaboration
Dr CB	20-30	M	Part-time	C	Employment
Dr HG	30-40	F	Part-time	D	UG placement
Dr IF	20-30	M	Part-time	B	Spinout
Dr JH	30-40	M	Part-time	A	Spinout
Dr PF	40-50	F	Part-time	E	Spinout
Dr VB			Part-time	A	Research project

	20-30	F			collaboration
Dr WY	20-30	M	Part-time	D	Consultancy Research project collaboration
PROF CD	40-50	M	Part-time	C	UG placement Consultancy
PROF PG	40-50	M	Part-time	B	Research project collaboration

Table 2 The categories

Fellow	***career stage***	***career aspiration***
Group 1: Entrepreneurial academics		
Dr AH	academic	stay in university as academic
Dr HG	senior academic	stay in university as academic
Dr IF	academic	stay in university as academic
Dr JH	longterm postdoc	stay in university as academic
Dr PF	academic	stay in university as academic
Dr WY	academic	stay in university as academic
PROF CD	senior academic	stay in university as academic
PROF PG	senior academic	stay in university as academic
Group 2: Technology transfer professionals		
Dr AW	longterm postdoc	tech transfer in university
Dr VB	longterm postdoc	tech transfer in university
Ms EC	Writing up	tech transfer in university

	PhD	
Dr AL	Returned from industry	tech transfer in university
Dr SH	Recently completed PhD	tech transfer in university
Dr DM	Recently completed PhD	tech transfer in private sector
Dr CB	Returned from industry	tech transfer in private sector
Group 3: Career Capital Builders		
Ms AH	Writing up PhD	Not sure but probably in private sector
Dr EP	Post doctoral researcher	Not sure but probably in private sector
Dr JD	Recently completed PhD	Not sure but probably in private sector
Dr KB	Recently completed PhD	not sure
Dr MT	Postdoc	not sure
Dr AB	Recently	not sure

	completed PhD	
Dr NP	Recently completed PhD	not sure
Dr LM	Recently completed PhD	not sure

QUESTIONS R&D GROUP

Beginnings
What is your career history to date? On completion of your PhD, did you always plan to go into the private sector? How did you expect your career to develop (after PhD)? What made you decide to move to the private sector? Why to that particular company? Before opting for the private sector, did you ever consider staying in the public sector?
The science in their current context
Are there any differences in carrying out scientific work in the public and private sector? Is there anything you miss from the public sector? Do you have any feelings of constraint in the work? Who decides what you do? Are you always happy to go along? Have there ever been any examples when you haven't been? Who decides how you do it? *(probe strategic autonomy –long term)* *(probe short term freedom of work)* Are you using all your scientific skills and knowledge?

What do people generally ‘moan’ about here?

Outputs

What are the outputs of your work? Are they publications? If not what are they?

What is the policy of the company with regards to publishing- are they interested?

Is there a policy or emphasis to produce academic publications? If so –who decides what is published?

Is that about status within the scientific field?

Do you participate in international meetings and give presentations? How important is that?

If so, why do you do it?

Is that the same in other companies?

What is the intention from an industry perspective?

Do you collaborate with the public sector?

If so, with whom and why?

Is it for a particular purpose?

Who instigates/controls these collaborations?

Career pathways

What aspects of your work are most valued by the organisation, your skills as a manager or as a scientist?

What is the career pathway in the organisation?

Is there a point at which you become a manager rather than a scientist?

Is there a scientific pathway not into management?

Who manages your career?

Who do you feel accountable to inside or outside the company?

Would you ever go back to the public sector?

Would you like to if the salaries were better?

Is there anything that would make it attractive?

What advice would you give someone embarking on a scientific career?

What would your ideal scientific career be?

Would you like more opportunities to cross the public private sectors?

Do you think in the future there would be more opportunities to cross the sectors?