EXPLORING THE POLITICAL DYNAMICS OF KNOWLEDGE INTEGRATION

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Introduction

Scientific breakthroughs, the most publicized in recent years being the sequencing of the human genome, have spawned the development of numerous 'new' developing fields of science within the broad domain of genetics in areas such as bioinformatics, genomics, pharmacogenetics etc. In order for the results of the genome project to be translated into biomedical innovation however, demands a high degree of interactivity among the various institutional actors involved (e.g. academics, clinicians, policy makers, industrialists). In practice, this high level of interactivity is typically not occurring and the development of biomedical innovations is being hindered[1.] This is evidenced in the pharmaceutical industry by the fact that, after five successive years of decline, 2003 saw just 26 New Molecular Entities (NMEs) launched on the world market. This is fewer than any time in the last 20 years. NMEs are novel, often radical medicines not previously available for therapeutic use (e.g. cancer vaccines) and as such, the number of NMEs brought to market is a key indicator of pharmaceutical industry innovation. In addition, drug development time has also increased to an all time high of 12 years and costs increased to $50.3 billion in 2003 representing a 5.3% increase over the last 5 years[2.]

It has already been recognized that failures to develop biomedical innovation often occur because breakthroughs are potentially 'competency destroying'[3] and therefore highly disruptive[4]. New developments made possible by breakthroughs in science do not tend to align well, with existing powerful professional communities[4 5]. It is, therefore, not simply the scientific breakthrough – the creation of new knowledge - that generate biomedical innovation but, rather, the ability to successfully *integrate* knowledge arising from new fields of science associated with that breakthrough - with existing knowledge across a network of powerful professional communities and organizations[6]. In this paper, a UK policy initiative explicitly designed and implemented in order to facilitate the translation of scientific breakthroughs in genetics into new medical treatments is examined in order to analyze the degree of interactivity and political dynamics occurring across the various institutions and actors involved.

In the next section the dynamics of knowledge integration and the nature of scientific collaboration are considered. An overview of some of the literature, on power and politics that is used to frame the analysis follows, drawing primarily on the

work of Hickson et al[7] and Hardy[8]. The initiative is then presented chronologically in two parts. First, the background and rationale for the UK government's launch of the Genetics Knowledge Park (GKP) initiative is considered between the period 1996 to 2001. This is followed by consideration of the bidding and funding process along with the operation of the GKPs between 2002 and 2005. The paper concludes by reflecting upon the implications for the development of biomedical innovations in the genetics field following this explicit attempt to create bridging mechanisms to foster the development of scientific research and innovation in the genetics field.

Knowledge integration and the nature of scientific collaboration

There are differing views in the literature regarding the ways in which knowledge integration occurs depending on the definitions of knowledge employed[9]. Writers adopting a 'content' or 'object' view of knowledge tend to define integration as simply the 'combination' of different bodies of explicit knowledge[10]. Others, however, with a 'relational' or social constructivist view[11], place greater emphasis on the development of shared understandings and perspectives across multiple stakeholder groups and the need to engage in boundary spanning activities as a pre-requisite of integration[12 13].This latter perspective, which is adopted in this paper, highlights the way in which knowledge has both explicit and tacit dimensions such that the integration of knowledge has an important social component.

In the not too distant past scientists could to some extent work relatively autonomously within their own distinct fields. However, today scientific collaboration is the norm as a consequence of an augmented division of labour among scientists and the development of an ever-increasing number of fields and sub-fields of science[14 15]. This collaboration is characterised by a need to integrate knowledge across an increasingly disparate set of scientific groups (academia and research institutes), industry and government that are often geographically dispersed. Scientific research and collaboration has thus becoming increasingly internationalized[16 17]. Co-authorship of papers is considered to be a useful proxy for the measurement of scientific collaboration[18 19 14]. For example, The number of internationally co-authored papers written in collaboration with UK scientists rose by 14% to almost 55% in the 12 year period to 1997[18] indicative of this internationalization process and the degree of collaboration that needs to occur within this field. Collaboration is particularly prevalent in the biomedical field, compared to more mature scientific fields such as

chemistry and physics, as the core science – biotechnology – is considered to be "a developing science, in which the R&D process is based on tacit knowledge, with little a priori understanding, and the process is exploratory and based on learning by doing"[20] (:584). It has therefore been characterized as a tightly coupled, reciprocal research process heavily based on integrated teams of interdisciplinary experts[21 22]. Whilst some writers contend that knowledge integration in these collaborative arrangements is a relatively straightforward process because of the natural sciences analytical, rational base[23] others note that "Natural sciences have a subjective element to them that's not purely objective, and the personalities involved……the way work gets done, there's definitely a human side"[24] (:952). This suggests that the relational view of knowledge and knowledge integration is perhaps more appropriate in these settings. Bozeman & Corley suggest that the acquisition and deployment of scientific and technical (S&T) human capital is the vehicle through which scientific knowledge is created, highlighting that S&T human capital is "the sum of researchers' professional network ties and their technical skills and resources" (:59). It follows therefore that research collaboration is the major vehicle through which S&T human capital develops[19]. Moreover, Bozeman & Corley maintain that whilst external institutions may influence the nature of these collaborations, "many of the factors governing individual scientists' collaboration choices remain very much within the control of the individual, especially when the researcher works in an academic institution" (:600). This concept usefully illustrates the way in which the social, relational aspects of scientific collaboration which are typically informal are an important factor that cannot be overlooked in the creation and integration of scientific knowledge within the biomedical field.

It is in this way that communities and networks of practice emerge[25] in a largely unplanned manner with radical innovation often occurring "at the interstices between, firms, universities, research laboratories"[6] (:121). The idea that innovation occurs at the interstices of communities and networks of practice highlights that what is required, particularly in the emerging biomedical sphere is the effective *integration* of new knowledge with existing scientific and practice-based business and clinical knowledge rather than simply the transfer of this knowledge across community and network boundaries. The informality and complexity of these arrangements – particularly in new scientific fields of enquiry such as genetics, genomics etc. cannot

be under-estimated[26] , challenging the more formalized view of the way in which biomedical innovation occurs[6].

Perspectives on power and politics

Hardy[8] and Swan & Scarbrough[27] note that political analyses of innovation processes have focused upon "the more overt forms of political influence, ……The emphasis has been on the ability to develop power *over* other groups, through the mobilization of resources (for example, financial resources, information, and staff). However, the negative connotations of a focus on coercive power have tended to steer research on innovation away from a deeper analysis of the dynamics of power"[27] (:920).

Swan & Scarbrough highlight that a focus purely on the exercise of coercive power is very limited in the context of networks of relationships. Scientific collaboration for innovation is inherently networked and in the case of the introduction of GKPs the networks are extended to include an array of actors across multiple organizations (e.g. government, universities, hospitals, firms). It is necessary therefore to widen the scope of political analysis in order to acknowledge power as a *productive* force that affects outcomes [8]. This draws attention to factors beyond the immediate confines of particular innovation processes – specifically, to the wider institutional context within which such processes unfold [6]. In the case of the introduction of GKPs, for example, the actions and activities of government regulatory bodies may play a significant role in generating power shifts across the genetics community and between the government and the community.

It is important to recognize the different forms and sources of power which may be exercised in the context of innovation processes. These have been usefully categorized as power based on resources, processes and meaning, respectively [8]. Resource power suggests that those parties who have control of particular resources are in a power position to create dependency relationships with other parties who need such resources. The formation of social networks, through, for example, the funding of new initiatives like GKPs that are aimed at facilitating collaborative work, may shape the distribution of resource power by creating new patterns of interdependencies between groups[7.] Hickson et al's work conceptualizes resource

power as embedded in networks of intra-organizational relationships. It focuses on the power dynamics that exist across sub-units within an organization in terms of their ability to control resources framed as strategic contingencies. Control of any or all three contingencies - coping with uncertainty, substitutability and centrality – confers power on a particular sub-unit in relation to the dependent sub-unit(s). In the analysis that follows this resource dependency perspective is useful and with respect to the control of strategic contingencies is broadened to consider the role of specific actors and forces at the institutional level in shaping power/dependency relations at both the organizational and inter-organizational level (cf. Elg & Johannsson[28]). This allows for an exploration of the inter-organizational relationships that exist between government, regulatory bodies and the genetics community / knowledge domain.

The second, process dimension highlights the political importance of knowledge being embedded in decision-making routines, and its implications for the inclusion or exclusion of particular groups. Process power may be seen, then, as a product of an actor's particular position in the network of interaction and their ability to act as 'obligatory passage points' in the decision process[29]. The third dimension meaning power[30] operates through the semantic aspects of organizational life, involving the legitimating or de-legitimating of particular activities. The power of meaning thus refers to societal mechanisms which perpetuate the status quo and political quiescence[30]. In the analysis that follows the power of meaning is particularly pertinent. For example, societal 'norms' exist regarding the nature of the relationship between the scientific community, perceived as an expert body, and government[31]. Despite scientific communities being reliant to a significant extent on government funding, traditionally it has been accepted by society that they be left to self- regulate and organize.

Whilst government funding is necessary in order to promote scientific innovation the resource allocation process typically relies upon members of the scientific community themselves, with scientific advisory systems to government typically enjoying uncontested authority, based on claims of scientific objectivity and value-neutrality, which allows them to grant legitimacy to the process[32]. Thus, which fields of enquiry to pursue and new knowledge created in scientific fields is legitimated by the experts in that field and traditionally government does not directly intervene unless it is felt to be in the public interest to do so. Thus control or

governance of the knowledge domain resides with the professional, scientific communities themselves, rather than government. This mode of governance is referred to as the expert-elite model of governance[31] and is embedded in the formal and informal collaborative relationships occurring within that domain.

Methodology

This case presented here is one of 11 longitudinal cases currently being conducted as part of a large UK/US comparative study of biomedical innovation[1]. The project started in 2003 and will end in 2006. The first phase of the research was a large interview based survey (N@100) of key stakeholders in the UK and US biomedical field including scientists, clinicians, policy makers, industrialists, venture capitalists etc. Longitudinal case studies commenced in the summer of 2004 as part of the second phase of the research. In this phase access was negotiated to all of the scientists, clinicians, ethicists, managers etc. working within one of the GKPs. The author is also working collaboratively (sharing data) with another researcher who has access to another GKP and also the national committee (the Advisory Group on Genetics Research - the AGGR) that is reviewing the progress of the GKPs over their funding period. 17 interviews have been conducted at the focal GKP and approximately 30 interviews have also been conducted by the collaborator[2]. A number of secondary sources of data – primarily government publications, white papers etc - were also analyzed in order to develop an understanding of the rationale for the GKP initiative. This allowed for triangulation[33] across different data sources. In the next section the case is presented in two parts. The period 1996 – 2001 describes the background to the introduction of this initiative. The period 2002 –2005 describes the operation of the GKPs from inception.

Background to the launch of the GKP initiative 1996- 2001

Since the early eighties a host of temporary committees and permanent advisory boards have been set up to deal with and advise government on many of the issues directly related to the field of genetics. Prior to 1999 there were no less than 11

[1] This research is jointly funded by the ESRC and EPSRC as part of the ESRC Evolution of Business Knowledge Programme.
[2] Whilst the author would like to express gratitude for the data shared and acknowledge the contributions of this collaborator, in the interests of GKP anonymity it is not possible to identify this individual.

regulatory and technical bodies that had been set up by the UK government to advise on issues such as experimenting with human embryos, gene therapy, issues relating to the transplant of animal organs into humans etc[34]. The main body dealing specifically with broad issues arising from developments in human genetics. -The Human Genetics Advisory Commission (HGAC) - was set up in 1996. Between 1996 and 1999 two major political crises occurred in the UK which severely eroded public confidence in the Government's ability to control and regulate biotechnology innovations arising from genetics.

The first was the BSE (mad cow) crisis which led to the culling of approximately 4.6 million cattle in the UK and to date[3] 151 deaths. The government, on the recommendation of experts in the field, had set up the spongiform encephalopathy advisory committee (SEAC) back in 1990 when the disease in animals was first identified. However in the face of the crisis this committee was urgently reviewed and reorganized to include a number of experts in the field of genetics, neuropathology etc. The committee has been dealing with the problem ever since, largely outside of the public gaze, relying on this extended network of scientific experts [35]. Whilst the BSE crisis was not specifically a genetics issue, it did highlight to the government that there was a lack of public trust in the institutions of governance for biotechnology[34] [32].

The second major political issue which led to diminished trust in the government's ability to regulate the biotechnology industry was what was considered to be the unregulated introduction of genetically modified (GM) foods to the UK from the US. GM tomatoes, as puree, first appeared on British supermarket shelves in 1996. Consumer furore surrounding GM technology did not erupt until February 1999. This occurred because a controversial study suggested that a few strains of GM potatoes might be toxic to laboratory rats. These experiments, subsequently criticised by other experts, were carried out in Scotland. What followed was a European anti GM food campaign which was led by UK environmental groups. It culminated in an unofficial morotorium in the UK and across the rest of Europe on the growth and import of GM crops leading to a trade dispute with the US which is still not fully resolved today.

[3] Estimated definite and probable deaths referred to the CJD surveillance unit in Edinburgh @ 4th October 2005

In May 1999, in the wake of these events, the government urgently conducted a review of the advisory and regulatory framework for biotechnology recognizing *"the government's overriding priorities in biotechnology and genetic modification are to protect the health of the public*"[34](:i). The review emphasized that all advances in the fields of biotechnology and genetic modification "must be properly monitored and controlled" (:i). The outcome of the review was a disbandment of the existing, complex regulatory framework and the setting up of two strategic advisory bodies, the Human Genetics Commission (HGC) and the Agricultural and Environment Biotechnology Commission. These bodies were to conduct strategic analyses of biotechnology developments, address all ethical considerations and identify gaps in the regulatory framework.

Whilst recognizing that "*the Government's first concern in regulating biotechnology is to ensure the protection of human health*"[34] (:2), the review went on to highlight that "*recognizing the economic potential of the sector, in which the UK is a world leader, it is important that the regulatory system should not place unnecessary burdens on the industry or barriers to its development"*[34] (:2). Hence, the government was trying to achieve a delicate regulatory balance between political and economic imperatives[32] acknowledging that too much regulation could stifle research, business initiative and investment in a potentially profitable field, but at the same time recognizing that too little (or inappropriate) regulation could further undermine public confidence in the government's ability to control innovation occurring within genetics.

In July 2000 the NHS Reform Plan was published and it was in this document that the idea of setting up GKPs was first mooted. The plan stated "*Working with the private sector and other partners we will commission NHS research and development in new centres of excellence. These medical knowledge parks will evaluate all aspects of the emerging developments in genetics, from the laboratory testing to the requirement for counseling patients. They will bring together NHS research, the private and charitable sectors alongside front-line NHS staff and patients*"[36] (:99). Aside from scientific endeavor, a major tenet underlying the introduction of the GKPs was to provide an institutionalised forum that would encourage dialogue regarding the social, ethical and practical issues that arise as a result of developments in human genetics and stimulate debate and discussion across a wide spectrum of stakeholders,

notably the public. One of the members of the AGGR, the body monitoring the performance of the GKPs commented:

"It appeared very late in the drafting of the NHS plan, virtually just a sentence, just a throw away sentence that took everyone by surprise and when Alan Millburn was questioned what was it (?)- he said- ' You tell me'. We then began to develop some themes. We felt GKPs were about focusing on an aspect of genetics knowledge and really becoming a centre of excellence, a world leader".

In April 2001 in response to the reform plan the government announced the creation of a £10 million Genetics Challenge Fund to establish four GKPs. The call for tenders went out in August 2001 and bids had to be submitted by October 20th. Several AGGR members commented that the speed of the commissioning process could be traced back to political pressures at the time *"to do something in genetics"*.

During the review process, conducted by the AGGR in December 2001, six bids stood out. Fortunately the DTI was reported to be 'under-spent on budgets' enabling additional funding to be found through its Harnessing Genomics Programme in order to fund all six. An emphasis on the development and perpetuation of regional parks - in keeping with general DTI regional policy – was apparent in the tender specification document where it was highlighted "*access to the funds will necessitate demonstrating the vision and capacity to develop further the concept of genetic knowledge parks, possibly through the strengthening of a bioscience cluster. It is likely that successful contractors for this work will need to look to a variety of other funding streams, for example the Regional Development Agencies or local authorities …. to enable the vision to be realized*"[37] (Appendix A:2).

The Genetics Knowledge Parks 2002-2005

The six Genetics Knowledge Parks that were funded were located in Cambridge, Oxford, London, North West, Newcastle and Wales. The commissioning process was very competitive. Significantly, the bidding process fuelled competition between specialists across regions that previously had not existed. Prior to this '*a harmonious genetics community in the UK'* (GKP member) had existed. However, it appears that the genetics community has been severely disrupted with the implementation of this initiative.

"We've had very good relations and we haven't been subject probably to the same kind of constraints that most services have. We've been born out of research projects, research departments and there's still a bit of us, you know, 20 years on, that have that kind of philosophy behind us. The Department of Health is naturally enough trying to move us into, you know, their view of the way things should be and of course that involves changes, which people find uncomfortable and so it's been difficult. It's a difficult time for genetic services. …I mean we've had a lot of freedom in the past. I think it's fair to say that both clinically and with regard to the services that have been developed in laboratories, there has been a great deal of freedom". (GKP member)

Another member of one of the GKPs commented on the impact that the bidding process had on the community; *"The Knowledge Parks (apart from Wales) are centred in regional genetic centres, which, consist of, clinicians and scientists out of small communities. So we all know each other and I previously knew all the people working in the different Knowledge Parks. So in a way we have had to try to re-establish relationships that had been severely bruised by the competitive procedure."*

When asked in 2005 about collaboration across the GKP network there was little evidence of knowledge sharing, and knowledge integration occurring across them. Whilst two of the parks have work packages with the same research focus there is only limited collaboration occurring and that only began quite recently. To date the only genuine collaboration that has occurred across the parks is joint public engagement and education events in line with the emphasis placed on these activities in the original tender document. The need for the GKPs to foster and facilitate public engagement with the field of genetics was emphasised as a crucial activity in the tendering document which is in accordance with the proposed shift towards a more democratic model of governance that the government are keen to promote at this time [35]. Whilst these activities are important to raise public awareness of genetics, these activities do little to promote the development of innovations in the field. In addition, collaboration between those working in the GKPs and those geneticists working outside of these forums is now extremely problematic. A GKP member commented three years into the initiative:

"We are trying to make those links but one of the problems initially was that the GKPs got a lot of funding and there are a lot of genetics departments operating

on a shoestring and we have felt that resentment. At the start I went to University X but they are supposed to be in the GKP anyway (!), then I went to University Y where there was a lot of anger even though we were trying to extend the hand of friendship and collaboration. I was going to go to university Z but after the University Y experience I thought why bother".

In 2005 a new head of the DoH R&D directorate was appointed and she has held a number of meetings with representatives of the GKPs aiming to establish what commonality exists across the GKPs and whether the model should continue to be funded. One of the representatives who attended a meeting with her commented:

"It was clear that they needed to see a united front from the GKPs and it was up to us to persuade the other GKPs to produce a set of objectives and outputs under 4 common headings. This has been broadly adopted although GKP (anon) sat outside".

Whilst now most of the GKPs are using common reporting standards in order to demonstrate a 'united front' there is in fact little commonality across the parks. The vision of the 'GKP' in the original tender had enough interpretive flexibility[38] to stimulate interests across a wide range of groups in the genetics domain. For example, the research plans of the London and Oxford Parks focus on identifying genes involved in the development of coronary heart disease and developing associated diagnostic tests. The Northern GKP focuses on genome instability as it relates to ageing, cancer and early human development. The Cambridge Park focuses on ethics, the law and social science, building on its strength in public and health genetics. The Northwest Park focuses on pharmacogenetics and the provision of genetics services. The flexibility of the vision of the 'GKP', rather ambiguously defined in the tender document, has therefore had paradoxical effects in relation to knowledge integration. On the one hand, it has facilitated collaboration across specialist groups and some (largely private) organizations within regions. Thus, within regions, specialists in different disciplines are, to some extent, attempting to change their practices (for example, in hospitals) and to work more closely together in order to produce genetics applications. At the same time, across regions, each multidisciplinary group has approached the task of being a 'GKP' in a very different way. The regional aspect of the initiative has also meant that each GKP has developed its own regional

infrastructure, organization and management processes, and importantly specific sets of networks.

Since the outset significant effort has also had to be put into reporting 'results' to the AGGR and the DoH. The GKPs report quarterly on their progress-to-date. In addition, annual reports are expected and a mid term review was conducted by the AGGR in 2004. End-of-term reports are due in March 2006 – only 45 months into the five year period. The rationale given for this (premature) reporting is that it is expected to take 9 months to conduct the review and so was required to start well-ahead of the end-point. This level of reporting is a cause for concern to the GKPs. It is very difficult for example, to be able to comment on significant achievements scientifically (or otherwise) every three months as the timescale is far too short. When the GKPs were initially set up the work plans that they developed covered the entire five year period and now they are expected to report back against objectives 15 months before the end of the period. The audience for this reporting activity is also a cause for concern. As a member of a GKP commented: *"We have to report to a wide spectrum of people but not really a spectrum of people we would deliberately have chosen. It is not like the peer review system. Whilst there are good people on the AGGR, our work is being judged by people who are not necessarily experts in the field"*.

It is evident therefore that by implementing this initiative interactions and collaboration appear to have declined across the genetics community, between those involved in the different GKPs subsequent to their establishment and also between the GKPs and the rest of the genetics community. This does not bode well for the development of innovations in this field which was the specific remit of the GKPs from the outset. The power dynamics and reconfigurations of power between government, other institutions and the genetics community that may have unintentionally led to this situation are the focus of the following discussion.

Discussion

It is clear that prior to 1996 trust in scientific self regulation pre-dominated in the field of genetics and biotechnology more generally. This was a societal norm and an example of meaning power[8]. As Jones & Salter[35] emphasise "Scientific authority

was pre-eminent, public trust could be assured through the use of science as an integral part of the regulatory system itself"(:22). Up until this point Government had largely *reacted* to developments in the genetics field and the rather unwieldy regulatory framework that existed at the time was illustrative of this. Governance of genetics knowledge was based on an elite-expert model[31] and other institutional bodies were minor players. Even though the community relied to some extent on government funding, it was the community itself that effectively decided upon the allocation of that funding. Adopting a strategic contingencies perspective[7], the genetics community had significant resource power at this time. It controlled a key strategic resource – knowledge about developments in the field of genetics and was de facto better placed than any other institution with regard to coping with uncertainty around the science. The community (as a whole) also had centrality with respect to decision making regarding biomedical developments in this field and was therefore non–substitutable. The Government was thus dependent on this scientific community at this time. In terms of process power the traditional elite expert model as the authoritative basis for the legitimacy of governance decision making predominated [31] and other bodies and the public were largely excluded.

Had it not been for the BSE crisis and the GM food debacle the genetics community may have remained in this position. However these two major incidents caused the government to rethink the authoritative basis for decision making, looking to expand the actors involved in decision making forums in order to move towards a more open, democratic model, specifically to restore public confidence in the biotechnology sector[35]. Firstly the government reviewed and simplified the regulatory framework in an attempt to provide greater transparency and accountability of the sector. The two new strategic bodies set up to advise government were characterised by clarity of role and importantly, a far broader membership to include many new stakeholders and expert disciplines. Specifically the review highlighted that "*The new strategic commissions will need to include a wide range of interests: lay members, ethicists, consumers and those with knowledge of the industry. The HGC will need to include medical practitioners and patient representatives…..Where the best scientific experts have links to industry, they should not be excluded provided that the rules on conflict of interest are carefully applied and maintained*"[34] (:21). By changing the composition and content of the regulatory framework in this way, the power of the

genetics discipline to self-regulate -at least in principal - was significantly diminished a classic example of creating and mobilising institutional bias. The community now had to answer to regulatory bodies with a more diverse representation than simply other scientists. The Government were attempting to signal to the public here that the accepted status quo that had existed in society - regarding the legitimacy of science to control science, had subtly shifted in favour of a more open, democratic model. These actions, in themselves, did not however substantively impact the genetics community in terms of the way in which scientists, clinicians etc. collaborated to integrate knowledge in the field. Subsequent events, specifically the introduction of the GKP initiative had far more impact.

In 2000 Sir John Pattison (who co-incidentally had chaired the commission overseeing the BSE crisis) took up a new post as Director of R&D for the NHS. He was in a powerful position to shape NHS policy reform that was underway at that time and it was in this context that the idea of GKPs first emerged. More specifically in the R&D section of the NHS reform document, the idea of knowledge parks are first mentioned and it is assumed here that the idea was proposed or at least strongly endorsed by Sir John Pattison in his role at that time. Simultaneously the government was keen to stimulate UK economic growth through innovation in the biotechnology sector[39] and allocated significant financial resources to the sector – specifically genomics - seeing this as an important sector for economic growth. Hence, coinciding with NHS Reform, the government had also provisioned for the injection of significant financial resources into the genetics field. The bids were clearly strong and the government were keen to fund more than the original four proposed. The DTI were keen to become involved as this initiative supported DTI policy of promoting the development of regional clusters and an emphasis on the translation of science into practice with potential economic benefit.

This policy decision had unintended power effects. By organising the genetics community on a regional basis and allocating resources across 6 regional centres has meant that scientific collaborations, many of which were typically informal, often opaque and existing across the whole community, have been artificially reshaped or synthesised within particular regions. Divisions have also emerged between those conducting research in GKPs and those working outside of the GKP network. Moreover, the initiative has done little to foster collaboration across the GKP

network. As Bozeman & Corley[19] highlight, collaboration is typically a case of personal choice which cannot be institutionally determined. Another competitive bidding round is considered likely in 2006 which militates against the development of further genuine collaboration. Knowledge integration appears then to have been hindered rather than facilitated with the introduction of this initiative. This is likely to be damaging with respect to the development of biomedical innovations arising from breakthroughs in genetics as knowledge integration is crucial.

Notably from a political perspective, these synthetic collaborations within GKPs are now transparent, work packages are well defined and the government is (at least from the public's perspective) in a position to manage them far more closely through the accountability of GKPs to the AGGR which reports back to the HGC and the DoH. The level of reporting that is required highlights the level of accountability scientists working in the GKPs are subject to. In this case, while this increase in control was intentional there are unintended consequences that negatively impact innovation at least in so far as they potentially divert attention from the research process (which in this field is very much long-term focused) to the need to demonstrate short-term achievements (which are very unlikely).

To conclude this analysis it is useful to consider the introduction of the GKP initiative in relation to a recent argument proposed by Jones & Salter[35] and subsequently reinforced by Salter as written evidence to the Select Committee on Science and Technology[40]. Jones & Salter suggest that the elite expert model of governance is still alive and well in the field of genetics, operating in parallel with the introduction of a more open democratic model which they argue is built largely on rhetoric, aimed solely at rebuilding pubic confidence in government's ability to control the field of genetics. They support this argument by highlighting that whilst there is a genuine commitment on the part of the recently formed HGC to demonstrate transparency, inclusion and participation, when key decisions need to be taken (e.g. to allow new forms of stem cell research to be conducted on human embryos), ad-hoc expert groups have been mobilised to take these decisions with no engagement with the public or the necessary regulatory bodies couched with authority to make such decisions. Salter[39] argues that bodies such as the HGC only exist at the periphery of the policy community somewhat remote from an inner core which remains closed and expert-base. Adopting this argument, the GKP initiative could also be viewed as

constituting part of the policy periphery – acting primarily as a signifier on the part of Government shaping meaning power[8] – perceptually at least, demonstrating the government's power to reorganise a scientific community, in a way that is easier to monitor and control. The emphasis that has been placed throughout on the GKPs need to demonstrate engagement with the public tends to support this view. Finally, this analysis has also demonstrated the role of key individuals, and other bodies in shaping political outcomes that serve to redefine the power of meaning, highlighting the way in which power is embedded in networks of interaction across government departments, organizations and more informal grouping such as professional and scientific communities[29].

Conclusion

It is widely acknowledged that there are many structural and biological impediments to the development of biomedical innovations. More fundamentally however, it is a contention here that it is the integration of knowledge across the biomedical domain (involving, clinicians, ethicists, business managers as well as scientists), which is crucial if any progress and improvements in innovation development time and costs are to be made. Whilst in principle the UK government could be perceived as encouraging the integration of knowledge across the genetics knowledge domain, with the creation of the GKPs, a political analysis of the impact of their introduction offers another reading of the situation.

The analysis has highlighted how the regionalization policy and the need for the Government to be perceived as having some control over the knowledge domain has actually led to fragmentation of the community. Whilst the GKPs may well be operating effectively and integrating knowledge within their regions, this is unlikely to lead to radical innovation and major breakthroughs more generally because of the localized nature of the work. The GKPs are encouraged to forge links across multiple stakeholder groups within their regions which appears to stimulate a form of institutionally sanctioned (and controlled) knowledge integration but the scope of such networking is limited as demonstrated by the lack of involvement of some university based geneticists with GKPs that exist in their own region. The signals that were sent out to the genetics community as a whole when the outcome of the bidding process was announced suggested that certain groups (and particular aspects of genetics research) were considered better than others. The analysis suggests that

many of the previous informal, collaborations that had existed across the community were fractured with the introduction of this initiative as only the institutionally sanctioned 'preferred' areas of genetics research were funded and the rest of the community has subsequently had to continue to operate with limited funding and look for other sources of funding. The data demonstrates therefore that the distance between those geneticists working in universities and those working in the knowledge parks has increased. Whilst it may well be important (and in the public interest) for government to maintain a degree of control over radical new scientific domains such as genetics, it is important to recognize that by synthesizing new collaborations in a way that the Government perceive provides more control of the field may actually be damaging for the development of biomedical innovation.

It is also perhaps important to note that this initiative is only just entering its fourth year and the potential for a re-forging of earlier collaborations may yet occur. In addition, the GKPs are now earnestly attempting to present a united front, largely to encourage the DoH to provide further funding, exemplified in the way in which they are trying to standardize on objectives and outputs. The GKPs would obviously welcome further funding, however it should be recognized by policy makers that another competitive bidding process on a national scale could well further fragment the community, particularly if the DoH decided to disband the GKPs or to fund only a select few.

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