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Engagement with the Community: the emergence of a new social contract between society and science

By

Michael Gibbons

Abstract

A new social contract between society and the university is moving the idea of engagement from its traditional association with outreach into the very conduct of its research and teaching. This paper focuses on the changing nature of research practices and argues that the challenge for universities is to become sites for the production of socially robust knowledge. Paradoxically, it is on this development that the future of university autonomy depends. The new contract autonomy can be sustained only to the extent that universities become engaged in the joint production of knowledge with their communities.

Engagement with the Community: the emergence of a new social contract between society and science

Michael Gibbons

Prologue: the prevailing social contract with universities

The University, along with other institutions of industrial society, has the particular shape it has and is able to function as it does because of an underlying agreement between its practitioners and the rest of society. There are many different social contracts in any particular society. For example, there are social contracts between society and government, between society and industry, as well as between society and science. The contract also sets up relations of trust that the agreement will be adhered to on both sides. More specifically, the social contract between society and science, particularly university science, has been structured primarily in terms of a certain form of knowledge production (basic science), education and training. Thus, in return for public funding, the science of the universities would provide new knowledge; that is, provide a flow of discoveries, techniques, and methods for society generally. In addition, they would train succeeding generations of scientists, most of whom would go out into the world of work, mainly in industry. By contrast, industrial R&D was to provide for the "appliance of science" and carry the knowledge of basic discoveries into product and process innovations on which economic growth was perceived to depend. Government science was meant to fill the gap between the public good of the university science and the private good of industry; that is, to carry out research in relation to principal functions of government, defence, public sector utilities, public health, safety standards, etc.. Thus, the specific social contract between society and science was supported by three major social institutions - government research establishments, industrial laboratories - and the universities between which there were relations of complementarity. In some countries, science was further supported by a research council system was intended to supply the financial resources to universities for specific scientific projects. These institutions had distinct functions and were, to an extent separate, each possessing its own resource bases its own set of research practices and characteristic modes of behaviour.

It is this system of relatively separate institutions each associated with a specific type of knowledge production process that underpins much current thinking about the university's engagement with society. Under the terms of this contract, universities are expected to engage with society through its principal institutions, but rather at arm's length. In research, for example, the current contract which enshrines an element of institutional autonomy for universities implies that research agendas will be set by university scientists even though the expectation is that the outputs of research need to be communicated to the wider society, whether industry, the health sector or the social services. Under this social contract, engagement with society is primarily about communicating the *results* of research to organisations *beyond* the university, though precisely how this is to happen was, until recently, left unspecified.

In this mode of engagement, the information to be tendered travels primarily in one direction, from university science to society. In this, science has been spectacularly successful and few are in doubt that the outputs of scientific discoveries from universities have contributed greatly to the maintenance of international competitiveness and the enhancement of the quality of life. But, because the social institutions which carry out research have tended to be relatively impermeable, engagement has been seen, and to a degree fostered, primarily in terms of linkages.

Strengthening engagement has, therefore, been a matter of the increasing the numbers of particular linkages; with industry, for example, through establishing technology transfer centres to bridge universities and industry. In these cases, the belief is, rightly, that science has much to communicate to industry but, the creation of technology transfer centres acknowledges that the exchange is far from automatic and that, from the point of view of a potential user, knowledge being communicated might need not a little "development" before it can be used effectively in the context of industry.

From this viewpoint, the extent of engagement could be measured in terms of the numbers of linkages that a university had with research programmes supported by government, or with industry. For any particular university, these may be extensive, but if engagement is to be a core value more is required. At the very least, one would expect research linkages to have altered somewhat institutional practices, not least in terms of the topics that are investigated. To the extent, however, that communication has been primarily one way – from universities to society – there was little reverse impact on universities, their organisation or ethos. Rather, universities have struggled to preserve what they perceive as their autonomy in research matters against the transgressivity of other groups and interests, where autonomy means the absolute right to be able to pursue unfettered scientific inquiry. Alas, it is precisely this transgressivity – the trespassing of one set of institutions on the ground of another - that characterises so many of the social changes taking place in our society and that is altering the fundamental terms of the prevailing social contract and with it the terms of engagement between universities and society.

The beginnings of the dissolution of the prevailing contract

During the twilight of the Cold War, if not before, the relative institutional separation between societies' major institutions had begun to breakdown, not least in the domain of research. First, in government research with the privatisation of the system of government research establishments. Second, as governments gradually moved their priorities to the maintenance of international competitiveness, many long-established industries were de-nationalised and, in many countries, firms which had been dependent upon government for R&D support were forced to find these resources internally. Third, in universities, too, the massification of higher education moved universities into a market place for students but this was accompanied by the introduction of a culture of accountability and a mounting social demand for "value for money" which soon reached into the heart of the research process. And finally, the research councils, themselves, created initially to support basic research in the universities were transformed into instruments for attaining economic and social priorities through an increase in programme and project funding. These trends are observable in virtually every country in the world, though the timing and rates of change have varied with historical circumstances.

The upshot of this decades long series of changes is by now evident. The once clear lines of demarcation between government, industry and the universities, between science of the universities and the technology of industry, between basic research, applied research and product development, between careers in academe and those in industry seem no longer to apply. Instead, there is movement across established categories, greater permeability of institutional boundaries, greater blurring of professional identities, greater diversity of career patterns. In sum, the major institutions of society have been transgressed as each has crossed into one another's terrain. In this, science has been both invading (the outcome of one way

communication with society, described above), but also invaded by countless demands from the side of society. These changes were not primarily the result of the policies of impecunious governments, of greedy industrialist trying to take over the universities, or of a disgruntled citizenry disappointed by the performance of science, though some elements of each can be discerned in their histories. Quite the contrary, it is because institutional leaders, industrial managers, and people generally understand very well the importance of science that they have responded to the growing complexity of the contemporary world by wanting to draw the research capabilities of universities into their interests and concerns. Given these pressures, it is hardly surprising that some scientists now participate in more open and complex systems of knowledge production.

The phenomena which we have described in the case of research reflect, and are reflected in, society more generally. Contemporary society, too, is characterised by a pervasive uncertainty, generated by the same processes of transgression that science is experiencing. Here, too, the formerly clear boundaries between the State, the Market and Culture have become more permeable. Here, too, uncertainty, in its turn, is generating greater willingness to explore alternatives, whether in organisational forms, or inter-institutional co-operation, which in turn affects the jobs people do and those with whom they are prepared to work. The upshot is that societies now comprise more open, exploratory systems. In society and science, this openness and exploratory orientation is both a cause of, and a response to, growing complexity and uncertainty of the problems and issues that need to be addressed and it is spurring on the emergence of new kinds of exploratory systems many of which take the form of networks. We will address the question of what goes in inside some of these networks in a later section.

Society speaks back: the contextualisation of research

As we have seen, the prevailing contract between science and society is premised on a degree of separation between them. By and large, science was understood to be the fountainhead of new knowledge and was always prepared to communicate its discoveries to society. Society, for its part, did what it could to absorb these messages and laboured to transform the results of science into new streams of products, processes, and defence applications. In this, science has been eminently successful and, for as long as science could deliver the goods, the existing social contract could be maintained. Yet, this very success has had the effect of changing the relationship between society and science. Principally, it has had the effect of drawing science into a larger and larger number of problem areas, many lying out with traditional disciplinary structures that govern research in universities. To put the matter somewhat differently, whereas under the prevailing social contract science was expected to speak to society, now, in the regime of increasingly permeable institutions, society can, and does, "speak back" to science. In this paper, the reverse process though which society speaks back is denoted by the term, contextualisation.

It is widely understood that when science speaks to society, society is likely to be changed. But, what is less often appreciated is that society, when it “speaks back”, transforms science. Thus, contextualisation as a process, may be expected to affect scientific activities in many different ways. For example, over the past twenty years the strategic policies of both industry, government and the research councils, have been increasingly driven by a variety of socio-economic demands, involve a more diverse range of research competences, and exhibit many more cross-institutional

links. In so doing, not only has the balance of research funding coming to universities shifted away from its dependence on government sources but so too have their forms of organisation, division of labour and day-to-day practices. Witness the plight of the growing numbers of staff that work on short-term research contracts in universities these days, or the growth in the numbers of peri-university research institutes, or the explosion of university-industry partnerships. As a consequence, university research is a more complex affair. It now tackles more interdisciplinary problems, is funded from a variety of sources, and exhibits more cross-instititutional links. In a word, the university community is broadening the base of the kinds of problems that it considers worthwhile working on and over time this is bound to change its research practices and methodologies, its modes of organisation, and its reward structures. Thus, society speaks back not deferentially but by demanding innovation in a variety of ways - whether through the medium of government-formulated national objectives or the emergence of new regulatory regimes that insist on the involvement of users in the research process.

Socially robust knowledge

Contextualisation is affecting science even deep down in its epistemological core. Scientific authority is now based less on the results achieved (these are recognised to be provisional) than on the methods that have been used to obtain them. This much, at least, is uncontested by most scientists. But if methods determine "what works", "what works" has itself moved on and has now acquired a further dimension that includes knowledge that seeks to be effective in a range of contexts and therefore could, in a sense, be described as knowledge that is valid 'outside the laboratory'. Through contextualisation, then, social demand enters the research process, influencing its problem formulation, implementation and evaluation phases. To capture this shift, it may be useful, if a little provocative, to describe contextualisation as a process that shifts research from the production of merely reliable knowledge (knowledge valid within certain carefully controlled laboratory conditions) to the production of socially robust knowledge (knowledge valid beyond the laboratory, because tested in a range of other contexts).

Similar methods and techniques might be utilised but the sources of information and the contexts in which they are applied differ. Consider, for example, the case of Deep Vein Thrombosis (DVT), a condition that has been linked to the cramped conditions that passengers have to endure when they take long flights. DVT is a well known medical condition. Many of its characteristics, for example, its relation to genetic make-up of individuals, have been investigated in laboratory-based research. Still, the link between the onset of DVT and changes in the nature of aircraft travel apparently went undetected. In the early years of air travel, the question of whether air travel might induce DVT, or indeed other medical reactions, was investigated. But links with the onset of DVT were set aside because on the basis of the tests then carried out – that is, relatively short flights in airplanes travelling at 6000 feet using mainly military personnel - no correlations emerged. Alas, passengers now fly at 35,000 feet for ten to fifteen hours at a time and as a population exhibit a greater variety of medical histories. When tested in these circumstances, it now seems that human physiology can be adversely affected by flights under these conditions. One could say that the initial research produced reliable knowledge; reliable in the context in which the tests were carried out; there are no symptoms of DVT at low altitudes and on short flights, involving healthy young people. But to be socially robust, tests need to be replicated not only on a range of different flight environments, but also taking into account the fact that many more people now fly and, therefore, each flight

is now more likely to contain a medically much more diverse population. Both these conditions need to be met.

To put the matter simply, in this case each new context involves at least three elements; the flight environment, the length of the flight and the medical histories of the passengers. The extent to which it is accepted that the design of research protocols depends critically on knowledge "possessed" by passengers – that is, their medical histories - the closer one will move toward socially robust knowledge. But the knowledge that passengers have can only be effectively accessed and assessed by involving them at the formative stages of the research design. Further, the greater the extent to which society is aware that the relevant individuals have contributed to the design of the testing procedures, the more acceptable will be the results when they finally emerge and, therefore, the more socially robust will be the knowledge produced. In the production of socially robust knowledge, then, epistemology – the research design and the methodologies used and the range of data that has been used are closely linked.

To the wag who once asked, somewhat rhetorically, whether it would be preferable to travel in an aeroplane designed on the basis of reliable knowledge or one designed on the basis of socially robust knowledge, the answer is obvious. The socially robust aeroplane will always be, by far, the safer vehicle!

It must be becoming evident that the reverse communication between society and science and the imperative to develop socially robust knowledge requires that a different perspective engagement.

Networks: informal and formal

It remains that something be said of the nature of sites within which socially robust knowledge is conducted. Clearly, socially robust knowledge will be produced in a variety of settings but in general these exhibit network forms of organisation. The process works something like this: at any given time, on any particular issue there are a large number of individuals, groups and organisations that have an interest in, and knowledge about it. Increasingly, these various actors are linked electronically but only informally; they are largely spontaneous and no one is in charge. From time to time, these informal relations become formal; a focus of interest appears, a prototype organisation emerges and someone takes charge. More often than not, the catalyst is "something" that works to draw, from the wider informal network, an initial configuration experts and individuals who are attracted to work more together in a more systematic way. Of course, membership in any configuration remains open, flexible, and will change over time as the problem develops; but in the beginning the "something" acts as a magnet to hold the participants together. As we will see later, the somethings vary but whatever form they take they function as catalysts of collaboration.

To summarise:-

The prevailing contract between society and the universities has rested upon the presence of relatively impermeable institutional structures. The new contract is being built in the context of more open institutional structures, where science and society interact more strongly.

The prevailing contract built around large categories, with “society” linked to "people" through the “institutions” of representative government and the rules of bureaucratic accountability. The new contract will allow more diversity, be self-organising, and generate its own audit systems. Decision making, therefore, will be both more disaggregated and more participative.

In the prevailing contract, science made discoveries and offered them to society. The new contract will be based upon the joint production of knowledge by society and science.

The prevailing contract produces knowledge, reliable in the restricted context of specific laboratory conditions. The new contract must produce socially robust knowledge; knowledge demonstrably reliable in a broader a range of contexts. Such knowledge is the product of many different actors working in network forms of organisation and so in this context we speak of the joint production of knowledge.

In the older context, universities could consider engagement with its communities in terms of outreach; in the new context, because society now speaks back, the nature of outreach has been modified to include the intensity of “in-reach”.

Transaction spaces: the “how” of it all

The interaction of contextualisation, and the production of socially robust knowledge in network forms of organisation are the outcome of broad changes in society as well as in the production of knowledge. But it is contextualisation that provides the most direct route to discovering the implications of these broad changes for engagement between society and universities.

Accordingly, we turn to examine the “how” of contextualisation and to work out the practical impact of the intensification of reverse communications between society and the universities. There are three elements that need to be considered: the degree of contextualisation, boundary objects and transaction spaces, and trading zones.

Degrees of contextualisation

Three different degrees of contextualisation can be distinguished: weak, middle range and strong contextualisation, depending upon the strength of the reverse communication. In weak contextualisation, society speaks back largely through the voices of its institutions that, with the advice of experts, interpret social concerns of the wider society in research terms. Paradoxically, most government-funded programmes are of this type. Programme funding typically sets research in the context of some social or economic objective. Yet, the process of contextualisation is weak because social demand – say for more research into road safety - is still communicated through the filters of bureaucracy to which, in due course the scientific community is expected the “respond”. The programmes originate at one remove, so to speak from the concerns of either people or scientists. In strong contextualisation, the reverse communication involves direct participation of civil society and even of individuals from the beginning in the identification and formulation of problems and issues. Medium strength contexualisation lies somewhere between these two extremes. In sum, each level of contextualisation - from weak to strong - describes a mode of knowledge production in which problem formulation and implementation is more closely engaged with society.

A thought-provoking example of strong contextualisation has been described by Latour in his analysis of the development of research into muscular dystrophy in France. (Latour, 1996) Here, a group of individuals – scientists, administrators and most importantly *patients*- initiated the discussion. One underlying assumption was that muscular dystrophy could be advanced if more of the knowledge that patients had about their condition was taken into account in formulating research questions.

Indeed, this idea was taken forward and can be seen, perhaps most dramatically, in the design of the administration building where there is a definite "space" for patients and where their inputs could be constantly fed into the research process. Policy did not drive this initiative, nor was government funding sought. Rather, muscular dystrophy was, initially at least, funded directly from the public through a sequence of telethons. Patients, it seems, were unwilling to wait until muscular dystrophy came to the top of somebody else's research agenda. They acted independently and, it must be said, with great effect. Strong contextualisation is evident here in the close interactions between people (patients), scientists, and administrators/fund raisers. Interestingly, attempts to cure muscular dystrophy in France now includes a research programme in medical genetics. But the research being undertaken has been contextualised, in part, by knowledge about the disease that has been drawn systematically from the experience of large numbers of patients. It would be interesting to investigate whether research pursued in this way opened up avenues of exploration or made different discoveries different from those that emerged through the conventional operation of France's national research system.

Boundary objects

In the process of contextualisation a way must be found to encourage experts and others, who may be connected informally but nonetheless inhabit different social worlds, to interact effectively in transforming an issue or problem into a set of research activities; that is, one needs a way to transform an informal network into a formal one. In this, two things - boundary objects and transaction spaces - are essential entities if cooperation is to be promoted and consensus generated.

The notion of a boundary object is simple enough and can be elucidated using a very mundane example. Consider a man and a woman walking in Hyde Park, in London. Socially, it is still very awkward for the man to approach the woman, or vice-versa, with the aim of striking up a conversation. It is not impossible, but it is awkward and, because the intent of the "first move" is ambiguous, and defensive mechanisms can be expected to be brought into play. However, if both parties happen to be walking their dogs, then, of course, a conversation might originate, around the "dogs", while other issues remain in the background, for the time being. In this example, the dogs constitute a boundary object. Neutral entities around which information can be exchanged and this helps to create the conditions of the possibility of a dialogue on other, more serious matters, in due course. Boundary objects help in the constitution of "spaces" where discussion and debate can begin and relevant information exchanged.

In research, typically, boundary object is not a dog but an concept or idea which refers to a scientific object or objects which both inhabit several intersecting social worlds and satisfy the informational requirements of each of them; for example the generation of a new research facility in some aspect of bio -science, or the construction of a large longitudinal database in social science or a complex tunnel project as was the case in Boston recently. "Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties

employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognisable, a means of translation." (Star, S.L., *et al.* (1989), p. 393)

Transaction spaces and trading zones

Not every boundary object will generate an effective transaction space. In the early stages, these "spaces" provide an important framework in which still tentative, and as yet inadequately institutionalised, interactions can take place. However, these interactions are more than random encounters. To the extent that they do develop into genuine transaction spaces they have some of the essential features that Peter Galison has described for the 'trading zones' he came across when analysing the history of nuclear physics in the twentieth century (Galison, 1997). In this work, we are made to encounter *within the disciplinary structure* of one sub-field the fascinating exchanges and intense collaborations between three sub-cultures of the nuclear physics community – theoreticians, experimentalists and engineers (who build the machines used in nuclear physics). These traditions remained intact, preserved inside the collaboration, while the co-ordination of exchange took place around the production of the two competing instrument cultures of 'image' and 'logic', which ultimately joined. In this case, the choice of the technology to be used in detecting the fundamental particles functioned as boundary objects.

Taking his lead from anthropological theories, Galison observes how the often ….exchanges between the various sub-cultures of physics can be compared to the incomplete and partial relations which are established when different tribes come together for trading purposes. Nothing in the notion of trade presupposes some universal notion of a neutral currency. Quite the opposite: much of the interest in the category of trade is that things can be co-ordinated (what goes with what, for what purposes) without reference to some external gauge. Each tribe may bring to this interaction and take away from it completely different objects as well as the meanings attached to them. An object which may have a highly symbolic or even sacred value for one tribe may represent an entirely banal or utilitarian object for another. Nevertheless, interaction and trade is possible and actually takes place to the obvious benefit of all because, if this were not so, dialogue would have ceased.

Trading may also give rise to the emergence of contact languages, like 'pidgin', as a means of communication which is inevitably incomplete and truncated. Galison's insight was that physicists and engineers were not engaging in translating knowledge from one sub-culture to another as they pieced together their microwave circuits, nor were they producing "neutral" observation sentences, as the philosophers would wish them to do. *They were working out a powerful, locally understood language to co-ordinate their actions.* Despite obvious limitations, some kind of understanding and exchange does occur in such situations.

For Galison, then, the crucial question was not "how different scientific communities pass like ships in the night" communicate with one another. It was rather "how, given the extraordinary diversity of participants in physics – cryogenic engineers, radio chemists, algebraic topologists, prototype tinkerers, computer wizards, quantum field theorists - they speak to one another at all. And the picture . . . is one of different areas changing over time with complex border zones that sometimes vanish, coalesce, and even burgeon into quasi-autonomous regions in their own right." (Galison, *op. cit.* p. 63).

The idea of transaction spaces, as developed in this paper, is an extension and generalisation of the concept of a trading zone beyond interaction amongst scientific sub-cultures to wider exchanges that take place across both disciplinary and institutional boundaries. The idea of 'transaction' implies, first, that all partners bring something that can be exchanged or negotiated and, second, that they also have the resources (scientific as well as material) to be able to take something from other participants. Of course, the meanings attributed to exchanged objects may differ greatly for different participants. But the success of these exchanges depends upon each participant bringing something that is considered valuable by someone else – whatever that value might be. Participants usually will return to their 'home base' with their gains, thereby re-enforcing the links and exchanges that have already occurred by sharing with others.

As may already be becoming evident, the three aspects of contextualisation - society speaking back to science, boundary objects and transaction spaces can be used to underpin a new language of engagement. This can be illustrated by returning for a moment to the work of Peter Galison. Galison notes that a "trading zone is an intermediate domain in which procedures could be coordinated locally even where broader meanings clashed . . . The work that goes into creating, contesting, and sustaining local coordination is at the core of how local knowledge becomes widely accepted." In other words, rather than depicting the movement across boundaries as one of translation (from theory to experiment, or from military to civilian science, or from one theory to another)" it may be more useful to think in terms of work at boundaries, "where local languages grow, and sometimes die in the interstices between sub-cultures". As has already been indicated, under the prevailing social contract the language of engagement is largely about moving knowledge across boundaries, in particular from universities to society.

This point can be illustrated by reflecting on the mechanisms which are currently in place to render more efficient the translation of scientific discoveries from universities to industry. Working, silo-like, with the discipline-based structures of science and scholarship, it is often presumed that the knowledge produced by universities is in some way primary. For example, scientific discoveries are commonly regarded as essential ingredients for successful technological innovation and not infrequently universities have assumed that they are the prime source of many of these ideas. Accordingly, we tend to think it important to move this knowledge *across* boundaries. This language is perpetuated at several levels: with regard to cognitive boundaries in the translation from pure to applied science, to institutional boundaries in the translation from universities to industry, and so forth. Given the prevalence of the idea of translating knowledge across boundaries, it is perhaps not surprising to find many universities and government agencies have put in place administrative structures – research managers, technology transfer offices, innovation incubators, science parks, etc. - to help with the translation of knowledge across boundaries.

The notion of a transaction space shifts the metaphor from translation across boundaries to dialogue **at** boundaries. This shift underscores precisely that it is dialogue at the boundary that makes it possible to access knowledge held by others and appropriate it by promoting the search for a common language within which to treat a problem or issue. As Galison has argued, common languages, when and if they occur, provide the "evidence" that some sort of common understanding has been achieved. By contrast, simply moving information "packages" across boundaries leaves much unsaid and, not surprisingly, it is often the case that such translations are not successful.

Concluding remarks

Though you may not have thought about it in this way, there is some evidence that all scientific work is heterogeneous and progress always requires consensus and cooperation across different social worlds. As the example of nuclear science indicates, this may be the case even in discipline-based science.

Of course, the problem of establishing co-operation and eliciting consensus is rendered all the more difficult because, when society speaks back, the problems that need to be addressed turn out to be more complex, demand multidisciplinary approaches, and require more actors and consensus building across a broader range of social worlds. While in these cases a more diverse range of social worlds needs to be accommodated, delivering consensus becomes even more complicated when the range of viewpoints (social worlds) to be accommodated extends beyond the realm of "experts" into the wider society where it might be said that some of the actors have knowledge about specific problems if not expertise about them. This extension of the research process to involve people in boundary work who are non-experts is closely associated with the shift, described above, from the production of reliable knowledge to socially robust knowledge. Further, the production of socially robust knowledge cannot be left to simple-minded aggregation of viewpoints (pluralism) or to laissez faire (the naïve hope of automatic progress).

Boundary work needs to be facilitated and managed, and to do this specific knowledge and skills are required. It is but a small step to grasp that the effectiveness of their engagement strategies will be determined to the extent that universities embrace reverse communication. Further, engagement as a core value will be evidenced by the extent to which universities invest resources in the facilitation and management of transaction spaces and support the appropriate boundary work that is necessary to generate the cooperation that is required to formulate and pursue complex problems through research. In other words, engagement as a core value will be evident in the extent to which universities do actually develop the skills, create the organisational forms and manage the tensions that will inevitably arise when different social worlds interact. It is by commitment to resolving these tensions – by shifting from the production of merely reliable knowledge to socially robust knowledge - that universities will be able to demonstrate that they have embraced engagement as a core value.

This could be expressed otherwise by saying that in the 21st century universities will need to learn to build on their strengths in disciplinary research and manage the tensions between the production of reliable knowledge and the production of socially robust knowledge. To embrace this form of engagement entails that universities themselves be prepared to participate in those potential transaction spaces in which complex problems and issues will be initially and tentatively broached. To do this, they will also need to broaden their skills base and to revise their reward structures.

A concluding scientific paradox

Finally, universities are the homes of discipline-based research and the front line in the institutional defense of university autonomy. Universities, as institutions, have seen it as their function to protect research from the intrusion of non-scientific determinants that might limit or alter in some way the unfettered pursuit of scientific inquiry. Of course, the knowledge produced within universities circulates freely amongst specialists and, indeed, is, in principle, available to anyone who wants to acquire the training necessary to understand what has been produced. In science

this knowledge is offered free –as a gift – both to other scientists and to society as a whole. Some scientists still resist bitterly any attempt to privatise this knowledge because it breaks the social contract with society in which publicly funded research constitutes a public good and is expected to circulate freely. As institutions, universities often seek to exclude from the research process outsiders; those that have not been through the appropriate, largely discipline-based, legitimation processes, preferring to leave it to others to interpret their findings or applying them to other contexts. Here autonomy is exclusionary and defined in terms of freedom from illegitimate outside interference. Freedom from external encumbrances defines autonomy.

If the university department is the organisational form which carries discipline-based research, the form necessary to support the production of socially robust knowledge is the network. Networks emerge in situations where knowledge inputs are multi-faceted and continuous feedback essential. But, in joining in this type activity, one must give up some autonomy in return for reduced vulnerability that sharing brings.

Let me explain. Networks are a way of pooling risks of various kinds: the risk of environmental disaster, the risk of a competitive threat, the risk that one might miss out on a major intellectual advance that might touch or transform one's field. But, producing knowledge jointly in this way is a direct challenge to current scientific orthodoxy because networks can generate new knowledge that lies out with the norms of disciplinary science, weaken disciplinary loyalties, reduce somewhat the status and role of individual creativity and require nonconventional forms of quality control procedures. Because the sciences (and, indeed, large sections of industry and government) remain for the most part institutionalised in bureaucracies, it is very difficult for us to grasp how embeddedness in social relationships that extend beyond the disciplinary boundaries and indeed beyond the university might underpin and preserve autonomy rather than undermine it. But, in a network society where the rates of knowledge production, interactivity and uncertainty are all growing, the greatest need for individuals as well as institutions is access, the greatest danger isolation. The burgeoning of network forms of organisation is no accident. They are a response to the vulnerability of isolation not only for academics engaged scientific research, but for industry and government, as well. Joining a network, then, is an individual, organisational and institutional coping strategy and, if we are to believe what economists, political scientists, sociologists and business managers are saying and beginning to document, then we can expect network formation to increase.

However it is essential to recognise that in the emerging network culture, autonomy means not freedom from interference but embeddedness in continuously shifting sets of social relations of the sort that we have already explored in transaction spaces and trading zones. Paradoxically, in a network environment, we are more free – free from constraints that uncertainty puts on our intellectual development, our careers, our futures - when we share what we know with others. Conversely, when we strive to maintain boundaries and pursue individual and institutional autonomy, we expose ourselves to social isolation. It follows, then, that fuller participation with our communities is crucial for universities if they truly wish to maintain their autonomy.

Embeddedness in shifting sets of social networks through participation in network organisations of various kinds is now essential to demonstrate to society that universities intend to serve the public good. That universities should serve the public good has been at the core of the social contract with society and the universities since their inception, though it has been reformulated many times to reflect changing

social circumstances. In our day, the terms of engagement are being reformulated once again, this time to meet the exigencies of our day.

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