Victoria University of Technology

1997 Beanland lecture

What kind of university?
Research and teaching in the 21st century

Michael Gibbons

Summary

Universities have only recently taken up the mantel of research and organized themselves to produce new knowledge as well as preserving and transmitting it. Research in universities has become a core value. In making this adjustment universities have taken on a function which is bound to change them because the knowledge available to be transmitted is changing all the time. The production of knowledge is guided by a set of research practices which determine, among other things, what shall count as new knowledge. It has a disciplinary structure and this governs the organization and management of universities today.

The disciplinary structure not only provides the channels along which research outputs flow but it also provides the framework for the curriculum whether in science, social science or the humanities. The disciplinary structure is the vital institution which makes it possible to argue that in universities teaching and research must be connected. Through research, the stock of specialist knowledge grows and transforms the content of disciplines and, in time, this changes the curriculum, alters what is regarded as essential to be taught. Research also contributes to the differentiation of the disciplinary structure, introducing more and more specialisms.

But, new research practices are being introduced, the mode of knowledge production is changing in significant ways. We can now distinguish two modes of knowledge production: mode 1 and mode 2; each associated with a distinctive set of research practices. In many areas of scientific advance, knowledge production is cutting loose from the disciplinary structure generating knowledge which so far is not being institutionalised in the conventional way. The numbers of research centers, institutes and think tanks are multiplying while faculties and departments remain the preferred form for carrying out teaching. Universities are confronted with the challenge of how to accommodate these new research practices. At the very least they will have to become more open, porous institutions *vis-à-vis* the wider community, with 'fewer gates and more revolving doors'.

This development within the research enterprise also presents a challenge to the teaching side of university life. There are now at least two different modes of knowledge production and each can provide a basis for curricular development. What balance should be adopted? In the more open flexible structures that are carrying research, how will the knowledge produced be absorbed into the curriculum? If it is codified differently, or perhaps not at all, how will it be transmitted? What will a transdisciplinary 'curricula' look like? What rules will govern their construction and development? What are core skills that need to be acquired to function in this mode? These are crucial questions for universities and they have less to do with whether a university is to be a research or a teaching institutions than deciding on what modes of knowledge production to invest resources.

What kind of university?
Research and teaching in the 21st century?

Michael Gibbons

It is hardly controversial to assert that it is only recently that universities have organized themselves to carry out research. Although individual research activities can be found in universities going back to the 19th century and even earlier, it is really only since the end of World War II that research – particularly basic research – has been institutionalized in the universities and become one of their core values. Throughout the 20th century, universities have added the function of generating new knowledge to their previous ones of preserving knowledge and transmitting it.

Disciplinary structures

The research enterprise that has gradually been put in place in universities is guided by a set of research practices, a system of behavioural and institutional norms, which ensures that results are sound. These research practices set the terms of what shall count as a contribution to knowledge, who shall be allowed to participate in its production and how accreditation shall be organized. These practices have generated what we know as the disciplinary structure of science and this structure, in turn, has come to govern the management and organization of universities today. In particular, it should be noted that the disciplinary structure is specialist. Whether in sciences, the social sciences, or the humanities specialism has been seen as a secure way to advance knowledge.

The disciplinary structure also organizes teaching in universities by providing a framework for the undergraduate curriculum. The disciplinary structure is the essential link which connects teaching and research and which underpins the argument that in universities they properly belong together. Of course, research not only adds to the stock of specialist knowledge but transforms it as well. The research enterprise is dynamic. Its research practices articulate the disciplinary structure and, overtime, modify what are regarded as the essential ideas, techniques and methods that have to be learned.

Changing research practices: mode I and mode 2

As I have indicated, most universities use a model of knowledge production that has a disciplinary basis. This structure provides the guidelines about what the important problems are, how they should be tackled, who should tackle them, and what should be regarded as a contribution to the field. In brief, the disciplinary structure defines what shall count as ‘good science’. Because the disciplinary structure has been institutionalized in universities, naturally they have become the primary legitimators of this form of excellence. For the purposes of this lecture let us label this mode of knowledge production as mode 1.

But there is empirical evidence to indicate that a new mode of knowledge production may be emerging. The new mode is appearing across the board in the sciences, the social sciences and the humanities. Let us label it as mode 2. It is the burden of my argument to try to persuade you that the characteristics of mode 2 are essential ingredients to understanding what universities are going to be like in the future.

First, let me identify the principal differences between mode 1 and mode 2. The term mode 1 refers to a form of knowledge production – a complex of ideas, methods, values, norms – that has grown up to control the diffusion of the Newtonian model to more and more fields of inquiry and ensure its compliance with what is considered sound scientific practice. Mode 1 is meant to summarise in a single phrase the cognitive and social norms which must be followed in the production, legitimation and diffusion of knowledge of this kind. For many, the rules that govern mode 1 are identical with what is meant by good scientific practice. Researchers who adhere to these rules are by definition 'scientific' while those who violate them are not. It is partly for these reasons that whereas in mode 1 it is conventional to speak of science and scientists it has been necessary to use the more general terms knowledge and practitioners (or researchers) when describing mode 2. This is intended merely to highlight differences not to suggest that practitioners are of mode 2 are not; behaving according to the norms of scientific method.

It is my contention that there is sufficient empirical evidence to indicate that a distinct set of cognitive and social practices is beginning to emerge and they are different to those that govern mode 1. The only question may be whether they are sufficiently different to require a new label or whether they can be regarded simply as developments that can be accommodated within existing practices. The final answer to this question depends, partly, on acquiring more data and, partly, on how mode I adapts to changing conditions in the economic and political environment.

Changes in practice may provide an empirical starting point. These changes appear in the natural and social sciences but also in the humanities. They can be described in terms of a number of attributes which when taken together have sufficient coherence to suggest the emergence of a new mode of knowledge production. Analytically, the set of attributes are used to allow the differences between mode 1 and mode 2 to be specified. To summarise using terms which will be explored more fully below; in mode 1 problems are set and solved in a context governed by the, largely academic, interests of a specific community. By contrast, mode 2 knowledge is worked out in a context of application. mode 1 is disciplinary while mode 2 is interdisciplinary. mode 1 is characterised by homogeneity, mode 2 by heterogeneity of skills. Organisationally, mode 1 is hierarchical and tends to preserve its form, while mode 2 is more heterarchical and transient. Each employs a different type of quality control. In comparison with mode 1, mode 2 is more socially accountable and reflexive. It includes a wider, more temporary and heterogeneous set of practitioners, collaborating on a problem defined in a specific and localised context. As such it involves a much expanded system of quality control.

Some attributes of knowledge production in mode 2

Let us now look at some aspects of this new mode. In brief, it is characterized by –

1. knowledge produced in the context of application

2. transdisciplinarity

3. heterogeneity and organisational diversity

4. enhanced social accountability

5. more broadly based system of quality control.

Knowledge produced in the context of application

The relevant contrast here is between problem solving which is carried out following the codes of practice relevant to a particular discipline and problem solving which is organized around a particular application. In the former, the context is defined in relation to the cognitive and social norms that govern basic research or academic science. Latterly, this has tended to imply knowledge production carried out in the absence of some practical goal. In mode 2, by contrast, knowledge results from a broader range of considerations. Such knowledge is intended to be useful to someone whether in industry or government, or society more generally and this imperative is present from the beginning.

Knowledge thus produced is always produced under an aspect of continuous negotiation, i.e. it will not be produced unless and until the interest of the various actors are included. Such is the context of application. Application, in this sense is not product development carried out for industry, and the processes or markets that operate to determine what knowledge is produced are much broader than is normally implied when one speaks about taking ideas to the market place. Nonetheless, knowledge production in mode 2 is the outcome of a process in which supply and demand factors can be said to operate, but the sources of supply are increasingly diverse, as are the demands for differentiated forms of specialist knowledge. Such processes or markets specify what we mean by the context of application. Because they include much more than commercial considerations, it might be said that in mode 2 science is both in the market but also gone beyond it! In the process, knowledge production becomes diffused throughout society. That is why we also speak of socially distributed knowledge.

Research carried out in the context of application might be said to characterise a number of disciplines in the applied sciences and engineering - e.g. chemical engineering, aeronautical engineering or, more recently, computer science. Historically these sciences became established in universities but, strictly speaking, they cannot be called applied sciences, because it was precisely the lack of the relevant science that called them into being. They were genuinely new forms of knowledge though not necessarily of knowledge production because, they, too, soon became the sites of disciplinary-based knowledge production in the style of mode 1. These applied disciplines share with mode 2 some aspects of the attribute of knowledge produced in the context of application. But, in mode 2 the context is more complex. It is shaped by a more diverse set of intellectual and social demands than was the case in many applied sciences while it may give rise to genuine basic research.

Transdisciplinarity

mode 2 does more than assemble a diverse range of specialists to work in teams on problems in a complex applications oriented environment. To qualify as a specific form of knowledge production it is essential that inquiry be guided by specifiable consensus as to appropriate cognitive and social practice. In mode 2, the consensus is conditioned by the context of application and evolves with it. The determinants of a potential solution involve the integration of different skills in a framework of action but the consensus may be only temporary depending on how well it conforms to the requirements set by the specific context of application. In mode 2 the shape of the final solution will normally be beyond that of any single contributing discipline. It will be transdisciplinary.

Transdisciplinarity has four distinct features. Firstly, it develops a distinct but evolving framework to guide problem solving efforts. This is generated and sustained in the context

of application and not developed first and then applied to that context later by a different group of practitioners. The solution does not arise solely, or even mainly, from the application of knowledge that already exists. Although elements of existing knowledge must have entered into it, genuine creativity is involved and the theoretical consensus, once attained cannot easily be reduced to disciplinary parts.

Second, because the solution comprises both empirical and theoretical components it is undeniably a contribution to knowledge, though not necessarily disciplinary knowledge. Though it has emerged from a particular context of application, transdisciplinary knowledge develops its own distinct theoretical structures, research methods, and modes of practice, though they may not be located on the prevalent disciplinary map. The effort is cumulative, though the direction of accumulation may travel in a number of different directions after a major problem has been solved.

Third, unlike mode 1 where results are communicated through institutional channels, the results are communicated to those who have participated as they participate and so, in a sense, the diffusion of the results is initially accomplished in the process of their production. Subsequent diffusion occurs primarily as the original practitioners move to new problem contexts rather than through reporting results in professional journals or at conferences. Communication links are maintained partly through formal and partly through informal channels.

Fourth, transdisciplinarity is dynamic. It is problem solving capability on the move. A particular solution can become the cognitive site from which further advances can be made, but where this knowledge will be used next and how it will develop are as difficult to predict as are the possible applications that might arise from discipline based research. mode 2 is marked especially but not exclusively by the ever closer interaction of knowledge production with a succession of problem contexts. Even though problem contexts are transient, and problem solvers highly mobile, communication networks tend to persist and the knowledge contained in them is available to enter into further configurations.

Heterogeneity and organisational diversity

mode 2 knowledge production is heterogeneous in terms of the skills and experience people bring to it. The composition of a problem solving team changes over time as requirements evolve. This is not planned or co-ordinated by any central body. As with mode 1, challenging problems emerge, if not randomly, then in a way which makes their anticipation very difficult. Accordingly, it is marked by –

(a) an increase in the number of potential sites where knowledge can be created; no longer only universities and colleges, but non-university institutes, research centers, government agencies, industrial laboratories, think tanks, consultancies, in their interaction.

(b) the linking of sites in a variety of ways – electronically, organisationally, socially, informally – through functioning networks of communication.

(c) the simultaneous differentiation, at these sites, of fields and areas of study into finer and finer specialties. The recombination and reconfiguration of these sub-fields form the bases for new forms of useful knowledge. Over time, knowledge production moves increasingly away from traditional disciplinary activity into new societal contexts.

In mode 2, flexibility and response time are the crucial factors and because of this the types of organization used to tackle these problems may vary greatly. New forms of organization have emerged to accommodate the changing and transitory nature of the problems mode 2 addresses. Characteristically, in mode 2 research groups are 1ess firmly institutionalized; people come together in temporary work teams and networks which dissolve when a problem is solved or redefined. Members may then reassemble in different groups involving different people, often in different loci, around different problems. The experience gathered in this process creates a competence which becomes highly valued and which is transferred to new contexts. Though problems may be transient and groups short-lived, the organization and communication pattern persists as a matrix from which further groups and networks, dedicated to different problems, will be formed. mode 2 knowledge is thus created in a great variety of organisations and institutions, including multi-national firms, network firms, small hi-tech firms based on a particular technology, government institutions, research universities, laboratories and institutes as well as national and international research programs. In such environments the patterns of funding exhibit a similar diversity, being assembled from a variety of organisations with a diverse range of requirements and expectations which, in turn, enter into the context of application.

Social accountability and reflexivity

In recent years, growing public concern about issues to do with the environment, health, communications, privacy and procreation, and so forth, have had the effect of stimulating the growth of knowledge production in mode 2. Growing awareness about the variety of ways in which advances in science and technology can affect the public interest has increased the numbers of groups who wish to influence the outcome of the research process. This is reflected in the varied composition of the research teams. Social scientists work alongside natural scientists, engineers, 1awyers and business managers because the nature of the problems requires it. Social accountability permeates the whole knowledge production process. It is reflected not only in interpretation, and diffusion of results but in the definition of the problem and the setting of research priorities, as well. An expanding number of interest, and so-called concerned groups are demanding representation in the setting of the policy agenda as well as in the subsequent decision making process. In mode 2 sensitivity to the impact of the research is built in from the start. It forms part of the context of application.

Contrary to what one might expect, working in the context of application increases the sensitivity of scientists and technologists to the broader implications of what they are doing. Operating in mode 2 makes all participants more reflexive. This is because the issues which forward the development of mode 2 research cannot be specified in scientific and technical terms alone. The research towards the resolution of these types of problems has to incorporate options for the implementation of the solutions and these are bound to touch the values and preferences of different individuals and groups which have been seen as traditionally outside of the scientific and technological system. They can now become active agents in the definition and solution of problems as well as in the evaluation of performance. This is expressed partly in terms of the need for greater social accountability, but it also means that the individuals themselves cannot function effectively without reflecting – trying to operate from the standpoint of – all the actors involved. The deepening of understanding that this brings, in turn, has an effect on what is considered worthwhile doing and hence on the structure of the research itself. Reflection of the values implied in human aspirations and projects has been a traditional concern of the humanities. As reflexivity within the research process spreads, the humanities too are experiencing an increase in demand for the sorts of knowledge they have to offer. (Cambrosio, et al).

Quality control

Criteria to assess the quality of the work and the teams which carry out research in mode 2 differ from those of more traditional, disciplinary science. Quality in mode 1 is determined essentially through the peer review judgements about the contributions made by individuals. Control is maintained by careful selection of those judged competent to act as peers which is in part determined by their previous contributions to their discipline. So, the peer review process is one in which quality and control mutually re-enforce one another. It has both cognitive and social dimensions in that there is professional control over what problems and techniques are deemed important to work on as well as who is qualified to pursue in their solution. In disciplinary science, peer review operates to channel individuals to work on problems judged to be central to the advance of the discipline. These problems are defined largely in terms of criteria which reflect the intellectual interests and preoccupations of the discipline and its gatekeepers.

In mode 2 additional criteria are added through the context of application which now incorporates a diverse range of intellectual interests as well as other social, economic or political ones. To the criterion of intellectual interests and its interaction, further questions are posed, ‘ Will the solution, if found, be competitive in the market? Will it be cost effective? Will it be socially acceptable?’ Quality is determined by a wider set of criteria that reflects the broadening social composition of the review system. This implies that ‘good science’ is more difficult to determine. Since it is no longer limited strictly to the judgements of disciplinary peers, the fear is that control will be weaker and result in lower quality work. Although the quality control process in mode 2 is more broadly based, it does not follow that because a wider range of expertise is brought to bear on a problem that it will necessarily be of lower quality. It is of a more composite, multidimensional kind.

Commentary

The thrust of the new mode of knowledge production is that research in many important area is cutting loose from the disciplinary structure and generating knowledge which so far at least does not seem to be drawn to institutionalise itself in university departments and faculties in the conventional way. At times, it often seem that research centers, institutes and ‘think tanks’ are multiplying an the periphery of universities, while faculties and departments are becoming the internal locus of teaching provision.

Leading-edge research

Universities are now confronted with the challenge of how to accommodate these new research practices. Important intellectual problems are emerging in a ‘context of application’. The establishment of the research agenda and its funding are increasingly the outcome of a dialogue between researchers and users, regulators, interest groups, etc. and unless that dialogue produces a consensus no research will be done. Leading edge research has become a more participative exercise involving many actors and experts who move less according to the dynamics of their original disciplines and more according to problem interest. Pursuing problem interest means that academics will be required to work in teams, with experts from a wide range of intellectual backgrounds, in a variety of organisational settings. They will contribute problems solutions that cannot be easily reduced to a recognisable 'disciplinary contribution’. Those individuals who would contribute to research in this mode must adopt a different set of research practices. But, if

they do, they will be out of 'synch' with the existing reward structure of universities. The rubric of survival in academic research is changing from 'publish or perish' to 'partnerships or perish' (Gourley, private communication). How can existing university structures be modified to account of this fact?

Technology transfer

All universities have become interested of late in technology transfer and in commercialising the results of their research. Many have invested significant sums in setting up science parks, technology transfer centers and venture capital funds to assist academics in commercialising their work. But, I would suggest the model is not so much wrong as out of tune with the research practices of mode 2. The model of technology transfer which is operative at the moment is based on the image of the innovative process as a 'relay race'. In this view, some of the discoveries made by scientists within university departments are deemed to be capable of commercialisation but that there is a gap between the university and the marketplace. In other words, the ideas are there but for some reason the baton is not being successfully passed between universities and industry in the race to commercialisation. The solution to this dilemma has been to create a range of technology transfer organisations to bridge this gap; to reduce the probability that the baton will be dropped and the race lost.

These organisations are meant to mediate between the world of academe and the world of business. But, in mode 2, research is carried out in the context of application in which there is a continuing dialogue between interested parties – including producers and users of knowledge – from the beginning. In mode 2, universities that want play a role in the commercialisation of research need to he involved in the discussion from the beginning. It is certainly not a game that can be played by limiting one's role to the discovery end of the process. The relay race model reflects a mode 1 view of the knowledge production process with discovery up front and in the hands of universities. Rather than a relay race the appropriate model for mode 2 would be a soccer or a basketball game. In these games the ball (the baton) involves continually between the players. Nobody can afford to neglect either its own game plan or that of its competitors. In particular, no one leaves the field until the game is over. In this model, universities which are interested in generating an income stream from their research need to put technology transfer amongst their core values. They need to form appropriate partnerships with business and government and, in all probability, invest their own resources in the process. In brief, they need to become actively involved in a process.

Cores and peripheries

Perhaps the most significant change that mode 2 imposes on universities concerns its intellectual capital. Heretofore universities have been factories for the employment of intellectual capital. Faculty have been specialist, working according to the research practices which we have identified with mode 1. The unit of organization has been the department. Following the dictates of mode 1, universities have elaborated the department structure and have recruited the best staff they could afford. Universities have often seen themselves as 'owning' this intellectual resource and have used it to establish their reputations vis a vis one another. The inexorable advance of specialism and, in particular, the costs associated with it have meant that front line research is, if not already, it will soon be the preserve only of the well endowed universities.

In mode 2, as we have seen, different rules operate. In the context of application the research agenda is formed and funds attracted in a different way. Researchers work in

teams on problems that are set in a very complex social process and are relatively transient. And they move about according to the dictates of problem interest. Participation in these problem contexts is necessary to keep up with what is going on. As a consequence, some of the best academics have tunnelled out of their institutions and have joined problem configurations of various kinds. To some this is seen as a weakening of loyalty both to their institution and to their discipline. To operate at the leading edge of research, universities need to change their view of intellectual capital. They need to ensure that they are able to participate in the appropriate problem solving contexts. But so diverse and volatile are these that no university can afford to keep 'in-house' all the human resources they would need to guarantee a presence everywhere.

The models of the future would seem to demand a relatively small core of permanent full time faculty together with a much larger periphery of other experts that are associated with the university in various ways. Universities will need to experiment with a much wider range of employment contracts; and accept the fact that they do not own outright the human resources that they need. Vice-Chancellors of the future will be distinguished by their ability to manage intellectual capital in a way that maxmises their institutions' goals but does not presume that every member of staff is a full time employee. How will these 'others' fare in the university setting? How will their contribution be recognised? Will they be promoted? According to what criteria? How much will they cost? How will they relate to graduate students? Will they have to do any teaching? These are some of the questions that need to be asked but it seems clear to me that they cannot be answered without changing the nature of universities substantially.

Research and teaching

Universities that wish to be research active in mode 2 will, at the very least, have to become more open, porous institutions vis-a-vis the wider community, with 'fewer gates and more revolving doors'. They will have to become much more entrepreneurial in the ways that they use their 'intellectual' capital, and this may mean experimenting with a much broader range of contractual employment arrangements. But, to the extent that universities go down this road, they will be helping to establish two parallel structures within universities; one which will carry teaching (mode 1) and another for research (mode 2). How will these structures be related to one another? lf they are to be related, what would the organization of such universities look like? If research grows and develops in the ways I have suggested, outside disciplinary structures, more in the context of application, how will the results of research be absorbed by the wider academic community and, through them, make their way into the development of new curricula?

In the new, open, more flexible structures that are carrying research, knowledge is codified and transmitted in a different way. Information about the state of the art on a particular question resides less in conventional paper publications – whether in paper or electronic form – than in the collective memory of the problem solving teams. But as we have seen these teams are transient groupings. These teams form and dissolve according to the imperative of problem solving interest and the memory of what has been accomplished moves with the relevant experts. It is doubtful if traditional modes of publication will be sufficient to grasp the knowledge and information that is produced in this way. Will it be codified? If not, how can uncodified knowledge be translated in a curriculum? If it is not codified in books and/or papers, how will it be transmitted?

What, for example, would a transdisciplinary 'curriculum' look like? How would it be taught and by whom? How can the knowledge produced in the context of application be accessed by those who have not been part of that context, if it resides primarily in the collective memory of the problem solving teams? Will participation come to replace

books? What are the skills required to participate in this mode of knowledge production? How are they to be acquired?

I have been trying to persuade you that there are now two co-existing modes of knowledge production – mode 1 and mode 2. Each can provide a basis for research and curriculum development. What balance should be adopted? The key questions have less to do with deciding whether a university is to be a research or a teaching institution than deciding between which modes of research – and teaching – to invest scarce resources; if, that is, it is still thought desirable to keep a link between teaching and research. These are major questions for any university and their resolution implies even more diversity of institutions than is currently available.

mode 1: investigator-initiated, discipline-based
mode 2: problem-focussed, interdisciplinary

We now speak of “context-driven” research, meaning “research carried out in a context of application, arising from the very work of problem solving and not governed by the paradigms of traditional disciplines of knowledge.”[22] It involves multidisciplinary teams brought together for short periods of time, often connected only by means of telecommunications.

22. Camille Limoges, «L’université à la croisée des chemins : une mission à affirmer, une gestion à réformer,” Actes du colloque ACFAS.CSE.CST (Québec, 1996), p. 14-15.

Gouvernement du Québec
Ministère de l'Éducation, 1998
UNIVERSITIES AND THE FUTURE
Government Policy Options Regarding Québec Universities
Consultation Paper
http://www.meq.gouv.qc.ca/REFORME/universi/cons-univ-a.pdf

mode 1 and mode 2

Aide memoire

Characteristic	**mode 1**	**mode 2**
	academic	context
Knowledge production	discipline-based	transdisciplinary
Location	academy	application
Practitioners	specialists	wider group
Skills	homogeneous	heterogeneous
Groups	continuous	transient
Organisation	hierarchical	heterarchical
Structure	uni-form	diverse
Feedback	stakeholders	reflexive
Accountability	government	social
Quality control	peer	broad-based