Interdisciplinarity and the Transformation of the University

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Cover and logo design by Byron Henderson
Editing, interior layout, and design by Nora Russell

CANADIAN CATALOGUING IN PUBLICATION DATA

Fairbairn, Brett, 1959–

Interdisciplinarity and the transformation of the university
ISBN 0–88880–408–3

1. Interdisciplinary approach to knowledge. 2. Universities and colleges. 3. Education, Higher--Philosophy.
I. Fulton, Murray E. II. University of Saskatchewan. Centre for the Study of Co-operatives. III. Title.

HD255.F34 2000 001.2 C00–920124–6

Printed in Canada
04 03 02 01 00 / 5 4 3 2 1

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Contents

Special thanks to our colleagues who commented on earlier drafts
We look forward to future collaborations

Introduction

There is a good deal of talk these days in universities and granting agencies about interdisciplinarity, although in many cases the practical implications of the term remain vague. Of course, many people are actively engaged in interdisciplinary work, have thought deeply about it, and are clear on what it means for them. Such scholars have little need for our contribution to the subject, though we would welcome their comments, criticisms, and discussion. We are writing this essay because we have an unusual and, we think, informative relationship to interdisciplinary research, teaching, and extension. The authors—a historian and an agricultural economist respectively—have worked side-by-side for almost fifteen years in an interdisciplinary centre. This centre has involved, besides our own two specialties, about half a dozen additional disciplines. In this essay, we aim to analyse our own experience and generalize as best we can about the nature of interdisciplinary scholarship and its importance for contemporary universities. Our thoughts here, while directed for the consideration of our university colleagues, likely also have applicability in other institutions.

Misconceptions

There are, in our opinion, numerous misconceptions about interdisciplinary work. We think these arise from three main sources. First, academics have been entrenched in disciplinary ways of thinking that are exactly that: not just tools or methods, but ways of thinking about the world, about colleagues, and about careers. This makes it difficult to conceptualize interdisciplinarity. Second, universities are organized around disciplinary perspectives in ways that reinforce discipline-based attitudes, values,

and patterns of social interaction. In effect, while interdisciplinary work may not be inherently difficult or counterproductive (we will argue it is the opposite of these things), pursuing it in the given institutional setting might appear so. Finally, within the complex of attitudes and structures that makes up a modern university, there may easily be an impression that interdisciplinarity is being imposed "from above"—because university leaders talk about it—or "from outside"—because social and economic organizations, including businesses, may articulate the need for it. This can all too easily produce a defensive reaction among faculty, who leap to defend traditional disciplinary scholarship even when it is not seriously threatened.

Our perspective (to give away an important point in advance) is that interdisciplinary work does not conflict conceptually with disciplinary work. The two are not substitutes, but rather complements, to one another. Interdisciplinary research and teaching are desirable, perhaps indeed are required, in order to revitalize and strengthen disciplines. And strong, vibrant disciplines are required for solid interdisciplinary work. We believe that the results of an interdisciplinary emphasis at a university like ours will include more and better publications, seminars, and courses within various disciplines, as well as, to be sure, other publications and education outside the traditional disciplinary modes.

With this point of view, we are reacting against comments such as the following, which we believe are misconceptions:

- interdisciplinary research or teaching means lowering standards or losing focus
- interdisciplinarity means creating new departments
- interdisciplinarity is a disadvantage for faculty members, because their work will be judged negatively by their peers and colleagues
- interdisciplinarity means each faculty member involved has to become competent in more than one discipline

Contrary to these views, we think interdisciplinary research, teaching, and extension represent a particular kind of team approach to academic work, a team approach in which individual contributions are enhanced and complemented by being part of a larger effort.

Putting Matters in Context

But before addressing some of the practical ways in which we see interdisciplinary work occurring, it is necessary to put matters in context. It is premature to debate *how* to conduct interdisciplinary work without establishing what it is and, above all, why it is important. In many ways the questions of how to organize, conduct, and evaluate interdisciplinary work are derivative questions that sort themselves out once interdisciplinarity is seen in a certain context.

We would like to contribute to establishing such a context in the following sections by outlining, first, our own perspective and experience; second, what we see as the crisis of the current model of university organization; and third, the broad patterns of a new form of organization. This will bring us back to where we have begun, namely the question of how interdisciplinarity should work "on the ground" for faculty members engaged in their core activities of research, teaching, and extension.

Interdisciplinarity in Action: A Problem-Based Approach to Economic and Social Development

Interdisciplinarity represents a change from the methodological approach that has characterized university education and research up to the present time, to a more problem-based analysis. Structural changes are going on in our economy, society, and culture. Some sense of these changes is captured by the buzzwords "the knowledge economy." That notion is useful, but it represents only part of a larger trend; one could refer to many other slogans that characterize an ongoing transformation. Major changes are occurring that are giving rise to a demand, in fact a need, for interdisciplinary work in universities just as for interdepartmental work in government or work-team approaches and new alliances in industry. It is important to understand why this demand is

occurring, and the role that an interdisciplinary approach can play in economic, social, and cultural development.

The two authors came to work in an interdisciplinary fashion because we joined a research centre that focusses on a social-economic "problem." This experience has conditioned our conception of interdisciplinarity and raises, we think, important points about interdisciplinary work in general. Our hypothesis is that interdisciplinarity can be defined as a problem-based approach—or what we might also call an object-based approach—in which knowledge and methods are brought to bear as needed to solve a complex problem or to address an object of study. The problem or the object is defined externally to the disciplines involved; it is not a simple intellectual construct or abstraction. Such an approach is distinct from disciplinary research, in which problems are conceived within the knowledge and methods of the discipline.

The Centre for the Study of Co-operatives

To understand the nature of interdisciplinarity and how it differs from other approaches, it may be helpful to discuss our specific example. The Centre for the Study of Co-operatives, at the University of Saskatchewan in Saskatoon, was established in 1984 to undertake teaching and research on co-operatives of all types. The genesis of the idea emerged in the late 1970s with the recognition that, despite their importance to both the economy and society of the province, very little research was being done on co-operatives. The university, some of the province's co-operatives, and the provincial government came together to sponsor the creation of a centre. These interests have been represented since the inception on a management advisory board. To carry out its work, the Centre has had a changing mix of academic and nonacademic staff.

The results of the Centre's work are visible. In 1985, there was only one class on co-operatives being taught at the university, in the economics department. It was a struggle to find enough material to put together a half-semester course. That's no longer true. Due to the work of the Centre, its partners and affiliated faculty members, and others, there is now a large

body of theoretical and empirical literature. The University of Saskatchewan is now recognized as a leader in this field, not only nationally but internationally. There are numerous courses, and we are now investigating the possibility of a theme or concentration in co-operatives that could be taken in conjunction with various degrees. Finally, the university has been brought closer to an important set of audiences through the extension, public education, and community involvement carried out by members of the Centre.

It is interesting that the establishment of the Centre corresponds to the general pattern of how co-operatives themselves are developed: a response to a felt need that a vital area is not being addressed. There was no abstract design, *a priori* logic, or master plan that dictated that the university should have a co-operative studies centre; rather, the chain of events started with the identification of a gap related to the university's mission and its surrounding community. This kind of process is a common theme among other co-op research centres in other provinces and countries; and perhaps not only in the field of co-operative research.

The make-up of the faculty at the Centre has changed over time. It began with four academics from the disciplines of law, agricultural economics, commerce, and history. Currently the Centre has representatives from agricultural economics, history, and sociology (with one temporary vacancy). Depending on the nature of the topic that is being undertaken, the Centre's research is either multidisciplinary or interdisciplinary. By multidisciplinary we mean parallel studies from the perspective of different disciplines, with a low degree of integration: an example would be an anthology around a broad theme. In an interdisciplinary approach, concepts are borrowed from the assembled disciplines to tackle a particular research topic in integrated rather than parallel fashion.

What holds together a centre like our own is its common focus on something that is "real" (that is, not just an abstract concept, a theme, or a method, but something with a social and physical presence) and that is "out there" (in other words, is a concern of people external to the university, and has an identifiable constituency in the community). The problem we are constituted to deal with is something like: how can we understand what co-operatives are, how they work, and what role they can or should

play within the wider system of changing economic and social institutions? The need to answer this question forces each of us beyond the boundaries of a single discipline's answers, and requires us to lean on and learn from our colleagues. Instead of focussing on a variety of problems from the point of view of (for example) economics, we need to examine an object, such as (in our case) co-operatives, or an issue such as economic and social development, or a problem such as sustainability, with all the available means at our disposal. We know that history can help explain origins and ideas and organizations, and that economics can explain market imbalances and transactions costs, and that in addition to these we need sociology, management, law, political studies, adult education, and other disciplines. The problem or object of study structures our scholarship and defines the interdisciplinary team.

The interest and attention of external, nonacademic stakeholders also continually remind us of our focus, and inspire new research topics that bear no necessary relationship to any of our individual disciplines. Communities—social and physical objects of study—raise questions that disciplinary academics might not think of or focus upon. This is especially true when the community in question has a voice and the academics are prepared to listen. In this respect, the social sciences and humanities are well-suited to interdisciplinary work: they deal with human beings and social phenomena, which are as complex as anything in the natural world; and in addition they offer the possibility to involve external audiences and communities in the university's research and scholarship. We think this should be borne in mind in relation to claims that the demand for interdisciplinarity is being driven by the needs of the "hard" sciences. In comparison to, say, a geological research team, we in the social sciences and humanities have an advantage; it is as if we not only come together to study rocks, but also have a management board of rocks to whom we can report and from whom we can get insights that spur new research. Interdisciplinarity is certainly suited to complex scientific objects of study; it is also certainly suited to anything that has to do with people and society.

Crossing Boundaries

Framing an interdisciplinary subject is about crossing boundaries. For example, very often economic development and social development have been considered in isolation from each other. In fact they are not separable. One common bond is social capital, which is comprised of trust, modes of interaction, and access to networks. A community has more social capital if individuals in that community have greater access to outside sources of information. A community has greater social capital if it has greater acceptance of diversity both within and from without. And this notion of social capital is being increasingly seen as a key component of economic development. The essential connection between social and economic development is this: without social capital, economic development will be severely constrained, limited, even distorted.

This specific union of the social and economic aspects is evidenced in the Centre's research and extension concerning what are known as New Generation Co-operatives (NGCs). Due to networks that we had developed with colleagues in the northern United States, Centre researchers noticed the phenomenon of NGCs and began to talk about it in 1995. NGCs are initiatives such as processing facilities, pasta plants, bison processing plants, corn sweetener facilities, and specialty dairy operations that are owned by farmers in a co-operative fashion. NGCs involve farmers putting up substantial amounts of equity capital and signing delivery contracts requiring them to deliver certain amounts of product to their co-op. Many have been formed, particularly in North Dakota and Minnesota. The Centre has been working quite actively to transplant some of these promising ideas to Saskatchewan. It is surprising that the absorption of this idea in Saskatchewan has not been instantaneous, and this has led us to additional research and thinking about the processes of co-operative development.

Saskatchewan, we know, is a province in which co-operatives have played a major role. Why hasn't Saskatchewan embraced this other form of co-operative activity? In order to understand this problem, researchers have to examine development work and understand the legal régime and the taxation policy. A master's thesis by a researcher/developer associated with our centre looked at the role of adult educators in the development of

NGCs: extension and adult education are important to understanding why co-ops are being developed. Researchers also have to consider the cultural and social factors, particularly farmers' attitudes: Saskatchewan farmers are reluctant to sign production or delivery contracts. History comes into it, and particularly farmers', governments', and co-operatives' misunderstanding of how successful development has occurred in the past. The myth that co-ops arise spontaneously when there is a need for them (while it is perhaps at least half-true) justifies inaction. And then there are the basic economics: what are the commodities in which the economics of NGCs are most promising? These are not necessarily the same areas as in the U.S., but in general, specialty crops and specialty livestock are the areas in which NGCs are going to work. Future work needs to link the development of producer organizations with university research and development, and the R&D has to proceed concurrently in studying organizational structures, agronomic characteristics of specialty crops, food uses, and market potential. A combination of different disciplines, and different modes of inquiry, are required in order to tackle this particular issue.

Our centre may or may not end up having contributed in a specific way to specific community-based ventures. If the area takes off, future research will go far beyond our centre; indeed, we can expect to have less and less to do with it as time goes on. Probably, we will move on to other questions and problems. The central matter from our point of view is that we have been compelled to articulate and integrate theory and ideas in ways that advance the understanding of co-operatives and of processes of social and economic development. The research involved may promote NGCs, but is of far wider relevance, and we are already incorporating the ideas involved into our own disciplinary research as well as other interdisciplinary projects.

The model we have described is one that hinges not simply on applying theory, popularizing innovations, or launching ventures, but is based on formulating, questioning, reformulating, and debating disciplinary and interdisciplinary interpretation and theory. Our belief is that this kind of activity can best occur in a university, and that it is good for a university that it occur there. It has certainly been our experience that this kind of work has been a spur to thinking and teaching as well as to our profes-

sional development within our disciplines. This has been reflected, for example, in a paper presented within a disciplinary economics forum concerning the mathematical modeling of how ideology and values affect economic behaviour of people; and in work published in a mainstream history journal on how systems theories can be applied to the development of social movements. We suspect our disciplinary colleagues found our papers interesting precisely because of the nondisciplinary ideas from which they proceeded.

Keys to Success

There are several characteristics of our centre that have been extremely important to the success of its interdisciplinary initiatives. One is that the Centre has been housed separately from any of the disciplines of which it is a part. This has enabled a sense of coherence and a critical mass —a physical space where colleagues can interact and have those kinds of hallway conversations that spark ideas. Another significant factor is that the academic faculty are each hired into their own respective departments; all tenure and promotion decisions are made in the home departments, so, for example, the historian had to go through all the hoops that a historian goes through as well as doing research, teaching, and extension related to the Centre's mandate. As we will describe, there are important aspects of the disciplinary approach that should not be lost. What benefits from being organized in an interdisciplinary way is the core work that academics do—research, teaching, and service.

Nonacademic staff are also central parts of our group. While support staff are essential to every unit on campus, they are not always recognized as such and are rarely integrated into the intellectual work and decision making of units. In our case, we have found that interdisciplinary work opens up new possibilities and new needs. Because of the Centre for the Study of Co-operatives's need to publish and communicate its research to meet the demand of its outside constituency, we maintain a full-time writer and editor on staff. This facilitates publications in nondisciplinary channels, to be sure; but it is also surprising how much our individual re-

search reaches our disciplinary colleagues elsewhere initially through more popular or mass-market forms. There is also a librarian and web designer because, again, of the need to get material out in different fashions. We have a specialist in community-based technology initiatives. And of course, there are researchers of different terms, ranks, and types working on a changing array of short- and medium-term projects. The constellation of nonacademic staff changes according to the linkages we can make among people who are available, graduate students looking for work in research or extension, and jobs that need doing.

We have tried to outline some aspects of our own experience. In order to explain why we think these aspects are significant, we need to deal with some much larger issues, and then come back at the end to questions of structure and technique for pursuing interdisciplinarity. Our main point is that our centre's structure and success does not arise from a master design or plan, but rather from following the internal logic that flows from a problem-based approach. Why is this so significant? We believe it is because of larger economic and cultural factors. In order to understand the importance of the foregoing characteristics of interdisciplinary work as we have experienced it, it is necessary to examine the changes going on in the economy and general society. Since the authors are writing from Saskatchewan and have a shared interest in rural areas, we begin with the agricultural sector of the economy—though in fact our point is that parallel changes are occurring in each sphere of society.

The Old and the New Economy in Agriculture

The public is widely aware—at least in Saskatchewan!—that the agriculture industry and rural society are going through profound and painful transformations. What is perhaps less widely appreciated is that these transformations are closely connected to wider patterns. Of the major changes that have occurred in agriculture in the past fifteen to twenty years, the most significant are outlined on the facing page:

The Transformation of Agriculture

- More and more controllable production
- Focus on differentiated products, not basic commodities (adding value)
- Decline in the importance of primary agriculture
- Increased reliance on genetics and biotechnology to differentiate products
- Higher levels of specialization
- Increasing interdependence of each segment of the marketing chain
- Changing role of government—less ability to exert control through bureaucratic institutions or uniform programs

There are many more changes than these. However, the essential result is that we are seeing much higher levels of specialization in agricultural production. The hog industry, for example, which less than ten years ago was focussed on farrow-to-finish operations in one building, is now using three geographically distinct sites—which may be owned by different people—to carry out the same operations. In virtually every aspect of agriculture, tasks are subdividing into more and more specialized segments. Even crop production bears witness to this, with the rise of custom operators who are doing custom spraying, custom harvesting, and so on. Paradoxically, at the same time that this specialization is occurring, each segment of the whole agricultural chain is becoming more and more interdependent. There is a fragmentation, but at the same time each of the fragments is more interconnected with the other segments.

An example of this interdependence—extending all the way from grain production to the retail level—is a bakery in the United Kingdom called Warburton's, which markets a premium loaf of bread at a 50 percent mark-up over standard bread. Warburton's discovered a number of years ago that their ability to consistently deliver that quality of bread to their defined market hinged on the quality of wheat they were getting from

Canada. Their research revealed that three varieties of Canadian hard red spring wheat—Teal, Pasqua, and Columbus—were providing the characteristics that enabled them to produce high-quality bread. As a result, they set up an identity-preserved system to chart those particular genetic varieties through the whole grain production and handling system in order to ensure bread of the desired value. This is but one instance of enhanced interdependence in the agri-food sector. Increasingly, genetic qualities highly affect end-use value of particular commodities. There is a greater focus on differentiated products rather than commodities, and of course, the increased reliance on genetics and biotechnology to differentiate those products. All of this represents a decline in the role of primary agriculture.

As this trend continues, value is created either in genetics or processing, or in some combination thereof. Farmers, who learned in the last generation or two to view themselves as single-commodity-production specialists, now find themselves specialized in the production of commodities that are not much valued by the market. The sectors where value is created are often controlled by large concentrations of corporate power. The result is not only an income crisis, but also stress and uncertainty for farmers who may feel torn by impossible demands: to grow wheat (or whatever the commodity might be) and also to understand and participate in its processing and marketing, to think clear through to the consumer level; to run an independent farm while negotiating with corporate interests; to apply new technology and to conceptualize one's own job in entirely new ways.

Changes in agriculture also revolve around a crisis in identity for farmers. Accustomed to thinking of themselves as "producers," and more recently as specialized producers, they now find that those categories don't apply—or at least are not sufficient to define an occupation that can sustain most of those who aspire to it. What is a farmer, if not someone who cultivates, full time, large acreages of wheat or herds of livestock? At the present juncture of events, such a question is confusing and difficult to answer: our recent concept of farming no longer fits well with reality. And so we see the emergence of concepts of on-farm diversification, off-farm income, "hobby farming," and all manner of catch phrases whose collective effect is to obscure the central question: who are farmers? What do they do? What is their relationship to the rest of society?

Interestingly, some farmers from earlier eras of history would have had less conceptual difficulty adjusting to recent changes. Five hundred years ago, many prosperous agriculturally based communities were diversified into all manner of processing and production. They probably did not think of themselves as producers of raw commodities; they produced finished consumer goods, for themselves but also sometimes to sell. It was the market, science, and the state that taught farmers in places like Saskatchewan to become specialized producers of raw commodities. This meant huge increases in productivity, along with improvements in management and technology and many other aspects that farmers probably do not want to lose. But it is this *recent* mindset of commodity-specialization that is now a hindrance to success and indeed to survival.

Such processes are the result of a long line of development. The current industrial model of agriculture is an advanced articulation of changes that began decades or centuries ago. The tensions created by specialization and interdependence are contradictions inherent in the model, and their intensity reflects a kind of systemic maturity, or systemic crisis. It is precisely the pressures associated with specialization and interdependence that compel people to look for new forms of re-integration. Ultimately we believe this is what interdisciplinarity is about: to go beyond specialization, to collaborate on common goals, to embrace interdependence, to deal with key problems that fragmented occupations and perspectives cannot grasp.

The problems faced by external social and economic actors, and their solutions, are mirrored in the university's problems and solutions for the organization of work: all of these are parts of a single social system. We believe that the farmer and the university professor are not in qualitatively different positions in this set of transformations. If it has not done so already, the current model of organizing university work will also lead faculty members to feel torn apart by impossible demands. Professors trying to maintain their self-definition as specialized researchers, while also confronting systemic pressures for integration and the realities of interdependence, will find themselves confronting basic questions of identity.

The Industrial Model of Organization

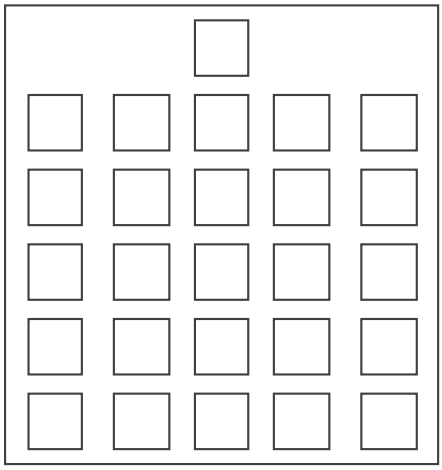
The phenomenon of specialization with simultaneously greater interconnectivity is occurring throughout the entire economy and society in general. To highlight the changes, it is helpful to reduce the existing model of organization to its essentials, and contrast these with the emerging model.

The recent model of thought and action in our society can be characterized by what we call the industrial model. In adopting this term, we are seeking to relate the organizational-conceptual model to a time period, namely the industrial era of the nineteenth and twentieth centuries. This was a period of economic change through capital accumulation and investment, through refinement of technologies and occasional breakthroughs, and through characteristic forms of organization of work, notably through systems of division of labour. Central to the industrial system were corporate power, market rationality, professionalization, and detailed exercise of control through knowledge and process design. These features were bound up with differentiation of labour by class, gender, race, and region. While not all countries underwent industrialization and not all aspects of society were "industrialized," all were strongly affected by ideas, markets, corporations, technologies, and government structures rooted in the industrial model. The features of this model that we would like to highlight are three—hierarchy, order, and compartmentalization—all clearly evident in the illustration on the facing page.

This picture is an abstraction of the way that people have, often unreflectively, conceptualized social and economic systems. What does it represent? It could be an organization chart. Some would say it is a lecture theatre. For our purposes, we will use this diagram to illustrate the overall pattern according to which our general social and economic systems have

been structured. Where this conceptualization closely matches the underlying features of a system, it is powerful; there are many historical instances of its effectiveness. But it has also been applied where it does not match, and in other cases has persisted even after the underlying structures have changed.

The Industrial Model



The Structure

Considering economics, it was roughly over one hundred years ago that the idea of a marketing system emerged; industries started to structure themselves as vertical systems. They set themselves up to look like the picture above by formalizing the sequence of stages that products would go through. This is a picture of the way we've organized the production system within our economy. The column on the right might be agriculture, with the separate boxes representing the input supply sector, primary agriculture, transportation, processing, and so forth. The next column might be the automobile industry, or the petroleum industry. The essential idea is that each of these industries is fairly separate from the other, forming a kind of free-standing pillar. Each segment within each chain is also discrete and is more or less independent of the next above it or below

it. For example, in the traditional agricultural system, the quality of the product coming off the farm really didn't determine the quality of the product coming off the processing end. Any deficiency or defect at one level could be "fixed" at another before the final product was delivered. Such a structure is linear and revolves around a concept of vertical market chains.

Interestingly, once developed, this model of the larger economy was replicated within other more specific areas such as organizations, the school system, or roads; the diagram above could represent the way townships were surveyed in this part of the world to prepare for European settlement. This structure was used over and over and over again. Why? In part because it coincides nicely with people's assumptions about the mechanical processes at the heart of the industrial world. Such processes were standardized and orderly—it was their orderliness that permitted them to be relatively easily managed and controlled by emerging institutions such as modern corporations and governments. It was, naturally, the elites in these institutions who found it convenient—indeed, automatic and unquestionable—to replicate the thought systems upon which their own power and success were based. To simplify and compartmentalize, identify and classify, was the first step towards "rational" exploitation of resources and people. Such systems were never universal or uncontested. Often a key step in dissent was for people to dispute the definition of the categories in which others held them. From workers redefining the meaning and dignity of work, to women asserting the rights that went with being women, to minorities and regions breaking out of dependent roles, a long series of social movements was concerned with challenging the definition and valuation of the "boxes" out of which industrial society was made. Despite such successes, the basic model was a dominant institutional and conceptual pattern imposed by institutions on vastly different spheres of society.

Specialization

Parts or components in industrial systems were specialized, but they were comparable to one another in how they fit into the larger scheme; and the products they produced were standardized. Account-

ing departments in firms produced financial control and analysis; history departments in universities produced history; and if you took one of these units out of one firm or university (or took out one accountant or one historian) and plugged it into another such firm or university, it could with minor modifications play the same role as before. But neither one could play a *different* role: they are interchangeable only with others just like themselves.

Specialization, in the industrial system, also means a specific kind of standardization or interchangeability of components, which permits managers to reassemble the pieces into more efficient configurations based on rational design. The particular kind of rationality embodied in the industrial model does not account effectively for unique qualities and relationships among units. The model captures only those features of units that can be reduced to their place in a linear control or production chain. Such mechanical systems came out of the Industrial Revolution and were the foundation of the technology as well as the organizational structures with which industries were built.

A Reductionist Viewpoint

All of this in turn mirrors the reductionist viewpoint of the time. In a reductionist philosophy, the whole equals the sum of the parts—an engine can be taken apart and reassembled, revealing all that is necessary to understand how it works. Though powerful, this pattern of thinking does have its limitations and its blind spots. Reductionism is helpful at finding discrete solutions to discrete problems: discovering that sulphur needs to be added to sulphur-deficient soil, or that excessive tilling will contribute to soil erosion. Where the problem is not discrete, where the systems involved are too "complex"—have too many interconnected parts—such methods are less helpful. Take, for example, the social, ethical, environmental, and consumer issues surrounding biotechnology. The reductionist study of the individual gene or even the individual organism is unable to address concerns about what the introduction of such a gene or organism will ultimately lead to in a specific social or environmental context.

Today, organizations and processes constructed according to the classic model are suffering criticisms or setbacks in numerous spheres of society. This includes all manner of institutions, whether public, private, or co-operative. Wherever they exist, these structures are under some common kinds of stress. They are criticized as inflexible, as rigid, as bureaucratic. They answer the wrong questions or solve the wrong problems. Industrial-type organizations may have too many layers, and we try to tinker with them by removing layers; or industrial-type processes may have too much rigidity and standardization, and we struggle to cover more and more niches with special programs, products, or marketing. But the basic flaw lies in the idea of compartmentalized boxes itself, in drawing boundaries around units or processes and trying to protect the rational geometric arrays of their organization.

Unpredictability

One of the chief characteristics of new economies, new technologies, and new ideas is that they create unpredictability. Established organizations experience this as turbulence, and industrial-model organizations cope poorly with turbulence. Since the 1970s—we can date the change according to the first oil shock and the deregulation of currency exchanges—there has been a prolonged period of increased economic turbulence, together with changing cultural values and ideas. While the industrial era was characterized by theories of long-term, linear, structural change or progress—theories such as Marxism or capitalism—it is no accident that the last generation has seen the rise of chaos theories. In scientific-conceptual terms, the twentieth century began with relativity, progressed through uncertainty, and ended with chaos. We will come back to chaos below, but first we want to make clear that the travails of the industrial model are highly relevant to universities.

The Industrial Model and the University

Universities pride themselves on being centres for independent criticism and creative thinking about what is going on in the rest of society—and rightly so. Universities are arguably the only institutions in society where large numbers of people are paid to *think*. Other knowledge workers are paid for thinking that is involved in design groups, process management, and R&D labs, among other sites; they think as part of what they are paid for. The distinction of university faculty is that their knowledge is not explicitly tied to any other product. This gives them invaluable importance in social, political, and economic respects. But while stressing this, it is also true that independent, critical, creative, and thoughtful people in universities are sometimes somewhat blind to the ways in which they are themselves part of the systems they are studying. The industrial model of organization sketched above is a case in point. There are university faculty members who see the influence of economic models as something being imposed on the university from outside, for example through government and corporate influence. These are concerns; yet from our perspective, the dominant organizational model of society has already been imposed on the university, decades ago, from within—substantially through the assumptions and behaviours of faculty members themselves.

The modern university bears little resemblance to the medieval European community of scholars it sometimes invokes for legitimacy; and, indeed, the image of the community of scholars is a heavily idealized model. Medieval universities were, more or less, clerical institutions, training functionaries for service as priests, clerks, lawyers, and physicians; and doing so through systems that resembled apprenticeship. They were closely bound

up with the political and religious structures of their day, and heavily influenced by church dogma and by powerful bequests from wealthy and influential individuals. These medieval universities evolved through cycles of decay and renewal—corrupt in ages of decadence and stagnation, progressive in times of reform and idealism. It was only in the nineteenth century that the basic outlines of the modern university became apparent. Not coincidentally, the nineteenth century was the era of western European and North American industrialization, of the advance of science and a rising belief in progress, of the widening supremacy of markets and industrial corporations, and of bureaucratic government.

Universities embody key ideas of knowledge, specialization, status, and individualism that resemble the dominant values of nineteenth- and twentieth-century Euro–North American civilization. Processes of professionalization, bureaucratization, and technocracy that were moving forward in corporations and government were replicated in universities. Hierarchy in itself was not new; what was perhaps new was hierarchy based on a certain definition of merit, based on the authority of specialized knowledge and the apparent excellence of individual performance. To sum up the translation of these values into organizational practice: individual faculty members, acting alone in their separate fields, add up to a department. The excellence of the individuals makes the excellence of the department. Excellent departments, added up, make colleges or faculties, and eventually a university. Or to rephrase this into the actual, rather conservative fashion in which things work: a university is a more or less arbitrary collection of individual faculty members working autonomously of each other. They are occasionally reviewed by their colleagues, and do have meetings or seminars in common; but when each faculty member teaches or does research or extension—their defining activities, the core work of the university—this is generally regarded as a private matter in which colleagues are rarely asked to involve themselves. Such a system of privatized scholarship requires a certain minimal degree of co-ordination; departments are the primary regulators of the mechanical processes of scheduling and approvals. Interestingly, departments rarely discuss matters of content or substance. The university is a clockwork mechanism of formal pieces. Its actual work happens in the minds of individuals who are isolated from each other by the structures within which they work.

A Bastion of the Compartmentalized Model

The university is one of the bastions where the compartmentalized model remains entrenched and indeed perhaps under siege. The university has become structured around methods of inquiry—plant science, agricultural economics, history, English—where each discipline is separate from the next. Individuals can and do cross these boundaries, and certainly learn from colleagues elsewhere; but such activity is not the norm and is rarely recognized. The disciplines are windows onto reality; they frame overlapping subjects, and are differentiated not so much by what they study as by how they do it. Canola may be a subject of research by crop scientists or by economists or by others (biotechnologists, perhaps; nutritionists; engineers interested in lubricants; ethicists; sociologists interested in relations between farmers and corporations). The press in twentieth-century Canada might be studied by historians or by specialists in English, communications, or linguistics; its management and ownership might be studied by industrial-organization experts. When we say a historian and an agricultural economist study different "subjects," this is a misnomer. We may very well study the same subjects, but (traditionally) we use different methods. These methods are the basis of how we know, how we formulate and test hypotheses, what evidence we use, where we submit it for criticism by peers, how we teach students, what standards we must meet for tenure and promotion.

There is a saying, indeed a cliché, that if the only tool you have is a hammer, you will see every problem as a nail. To paraphrase: if the only tool you have is history, you will see every problem as a question of finding documents in archives. If your tool is economics, you will represent reality as the outcome of maximizing agents whose behaviour can be captured in equations containing Greek letters. The disciplinary organization of the university amounts to having teams of people who all wield hammers, others with saws, still others with sandpaper—each group trying to finish each job unaided by the others, and with no general contractor. In reality, the situation in an actual university is a good deal worse than the above analogy suggests. The department of carpenters, for example, likely consists of people highly specialized in entirely different styles and branches

of carpentry—so much so that no two of them can work together on a common project.

To change metaphors, a colleague once compared a university department to a zoo: it has one of each kind of animal—one specialist in every area of the discipline—each in its own cage bearing a prominent label. While there are reasons for this, notably the desire to "cover" wide fields of knowledge, we should acknowledge the consequences. Unless we deliberately hire faculty members in integrated clusters, they can hardly work together, *especially* within their own departments. Their closest peers and collaborators are indeed likely to be faculty members in the same subspecialization at other universities. Within the same university, it may indeed be likely they will find appropriate partners for research, teaching, and extension only within other departments or colleges.

Departments or colleges are therefore curious entities, because they consist of people who are all the same (in general methods) yet so different (in the subjects they work on) that they usually cannot actually collaborate in the university's real work of teaching, research, and service. A department is almost programmed, in terms of these fundamental functions, to be a fragmented collection of individuals. But in regulatory matters—in co-ordinating and supervising budgets, personnel, and the formal mechanisms of academic programs—it is an effective and autonomous administrative unit. The autonomy of faculty members and the autonomy of the department are indeed closely connected. Departmental autonomy serves to prevent outside interference and shield individuals from senior administrators. Some see the current system as an effective safeguard of academic freedom. It has been said that the purpose of the department is to be a shield for the individual faculty member against the college; the purpose of the college, to be a shield against the university administration; the purpose of the university, to be a shield against the state and everything else outside. Actually, the current structure makes a great deal of sense if viewed in this way: it is intended to be immovable, inflexible, and without any active collective purpose. With an allowable degree of oversimplification, one can characterize a university as an elaborate apparatus that is designed to be ineffective and so to protect the autonomy of individual faculty members—certainly, an end goal that is not devoid of merit.

Isolation and "siloing" are inherent in the industrial model, but for purposes of protection, the modern university has taken them to an especially dysfunctional extreme.

Is the Whole the Sum of Its Parts?

But consider the idea that the whole is the sum of its parts, as applied to a university. On the one hand, this idea has the potential to foster change and adaptation, for when parts change, the organization changes. Such a model could in this sense be decentralized, bottom-up, adaptive. But if the parts are excessively autonomous, such a structure is not adaptive at all. Instead, each unit fiercely defends its own interests, with no attachment to the whole and no basis for identifying common projects of greater importance than local interests. Anything that deviates from formal, standardized equality of units causes conflict. Now suppose that the organization is under stress, that—like other large, conventional institutions—it is criticized for inflexibility and lack of responsiveness. Support is waning; resources are curtailed; demands are growing. What will the constituent entities do, in the absence of a shared vision of something greater than the parts, except defend their autonomy by defending the meaningless structure that embodies it? In this way, decentralized compartmentalization becomes a frozen impasse; the apparently orderly institution loses its coherence; units and people end up mutually blocking one another and devoting their energies to the defence of structures and practices they don't truly value or believe in. This is a crisis of a model of organization, and there is no direct way out of it.

Of course, universities don't entirely lack larger visions. Units buy into some collective outlooks and values, which do provide some grounds for making decisions and changing course. Individual faculty members can and do rise above the barriers among themselves and their departments. But the overall pattern looks uncomfortably like the reductionist-mechanical or industrial model. The legacy of the received organizational model is dysfunctional entities that are largely incapable of genuine strategic planning or of effective management or of common action at the supradepartmental or intercollege level. It is only with great effort that the tendency

towards disintegration into an agglomeration of mutually suspicious departments can be arrested. The result is wasted energy and a shortage of elegant innovations. The mood of many units, in such a situation, could be characterized as one of reactionary defensiveness and wounded pride.

We suspect that such circumstances do prevail, and not only at the university we know best, but also in other universities and in other kinds of institutions. Such problems do not reflect any particular choices or policies of any administrators; nor do they primarily reflect underfunding or excessive demands, though those are always bound up in any systemic institutional crisis. (If there were ample funding and small demands, institutional deficiencies would hardly be apparent. It's when the pressure mounts that the cracks widen.) There are important opportunities in seeing such difficulties not as the fault of specific individuals or policies, but as aspects of a pervasive culture or system that all of us could do something to change. It is true that, *in theory,* most things that need doing could be done within the existing structure and institutions—if only we had the right head/dean/senior administrator; if only we changed this policy or that; if only this or that! Such wishes are unrealistic. Good organizations are those in which the stars don't have to be perfectly aligned before something can happen. In practice, systemic problems of collective action create pervasive hindrances to change. What is needed are more flexible forms of organization, structured so as to reduce the costs (time, energy) and increase the likelihood of innovation.

The Necessity for Shared Missions

The missions of teaching and research and extension are shared missions in which many people and departments and units must play complementary and mutually supporting roles. Effective teaching and research, in our view, require openness beyond the boundaries of disciplines; they require engagement with external "problems" and communities. There are existing models for doing this, including the centre where we work. The question that must be asked is whether these existing examples of interdisciplinarity were achieved because of or in spite of the current set-up of the university and its colleges. We suspect it is very much the latter, and that

the current organization of the university should not be given credit for what interdisciplinarity has evolved. Power and resources flow solidly within disciplinary-departmental channels; interdisciplinary activities are marginal and dependent on inclinations of individuals. Our own centre was created due significantly to outside support and initiative. We were almost forced on the university by a compelling outside problem, by interested outside sponsors, and by a determined president. Over the years we believe our performance has convinced many skeptics; but would our centre have even had a chance to demonstrate its utility if the university had had to create it using its own resources? How many other interdisciplinary centres should exist, but do not because the university takes no initiative?

As society at large moves into a more knowledge-based economy, a university should be a key player. Connected to a wider field of knowledge workers and organizations, it should be a home for engaged, critical inquiry into matters of relevance to the human condition. But this role is frustrated by fragmentation and atomization. The university needs to loosen up. Disciplinary and methodological and inter-unit boundaries have to be relaxed, and this has to touch on basic questions such as work assignments, hiring practices, administrative structures, teaching responsibilities, research offices, physical locations of faculty members, and many other matters. In all of these areas and others, the key issue is to nurture the willingness of people to engage in work across boundaries, directed towards common goals. At root, what is needed is for more faculty members to work as *teams* to solve *problems*. Such an idea is quite different from the departmental organization of the university. It is not necessarily incompatible with the existence of conventional departments and programs; but what it means is that such departments and programs can't be rigid channels—or ruts—within which the work of the university is compelled to flow.

Complexity and Mutualism

Some of our colleagues might agree with our analysis of the pitfalls of autonomous, specialized individualism in universities, yet still hold that this system is better than what they see as the alterna-

tive—which might involve someone else telling them what to do. We think this is the real root of the fear and tension around interdisciplinarity (and other changes or reforms for that matter): the fear that the freedom and self-direction of faculty members, protected in their disciplines and programs, will be violated by orders or pressures from elsewhere. Since the present structure is founded on individualism, any change would seem to threaten faculty autonomy. This is an example of how the mechanistic culture is unable to formulate a strategy in the face of change. It is also a problem based on perceptions and, indeed, misperceptions. The critical independence of professors is indeed valuable; and gaining co-ordination by subjecting the university to more centralized control from above would hamper the performance of its most fundamental functions. But is it true that the only choices are fragmented individualism or centralized collectivism? What if we can take matters in an entirely different direction, and supplement our individualism without negating it?

Individualism and collectivism are not exclusive alternatives. There is also mutualism.

Interdisciplinary structures should not be imposed by any authority, nor should they be codified, standardized, entrenched, or otherwise bureaucratized. This would miss the point entirely. Interdisciplinary arrangements—not necessarily structures in the sense that departments or degree programs are structures of the university—should evolve on a voluntary basis among faculty members within and between departments and colleges. There must be a culture and institutional arrangements to support such voluntary coming together around problems, to be sure; but the administrative arrangements are not the central point. Interdisciplinary concentrations or ventures should be flexible and adaptive, not designed to be permanent to the degree that colleges and departments and their programs are largely permanent. Systematization and compartmentalization are what is to be avoided—these are attributes of the model that has now reached its limits, and which does not deal with unpredictability or turbulence.

In systems theory in the last twenty years or so, there has been growing discussion of what has been termed “complexity.” Complexity, in this technical usage, does not mean the same as complicatedness, but, indeed, rather the opposite. Complexity is the evolution of pattern from the inter-

action of parts; it is the "self-organization" of a certain kind of dynamic system. Pattern and interdependence can evolve out of an initially rather chaotic system. Components of a system (an ecology, a community) change, interact with each other and with the surrounding environment, find their niches—or fail, or find new niches—and through these processes build up coherence among themselves. These self-evolved patterns and feedback relationships can maintain relative stability at the same time that there is constant adaptation by both the whole and the parts; there is an equilibrium that is dynamic rather than static. New properties become apparent on larger scales of organization—emergent properties—that could not be predicted from reductionist analysis of the parts. Nature is full of complex patterns of organization; in fact, it seems to be a characteristic of life—including human life—to develop such spontaneous, complex patterns.

A complicated organization is probably a bad thing—overdesigned, maladaptive, poorly integrated. But a complex organization is one that evolves continuously while maintaining a balance between self-integration and adaptability. It does this through the way in which its components form connections with one another and with the outside.

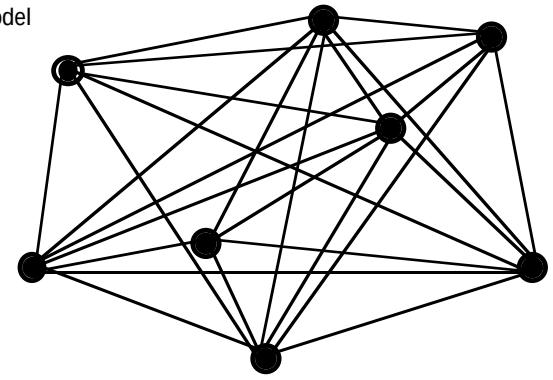
Universities need to be more complex and less mechanical; more like a dynamic system and less like a mechanism. This requires more emphasis on process, relationships, and interconnections; less emphasis on design, authority, turf, or standardization. It requires greater internal flexibility; stronger contacts between units and with the outside world; an environment of grassroots creativity and risk-taking as well as rewards for success. Interdisciplinarity is almost certainly a key element of the complex university, perhaps the main means in which new connections, new mutualisms, and innovations will be made. More generally, interdisciplinarity is an example of the network mode of organization that will characterize the processes of a complex university.

Network Models

Patterns of organization tend to repeat themselves at many levels throughout a complex system such as human society. Much of the turbulence of the last quarter century has been related to the emergence of new, postindustrial patterns of thought and organization. These patterns have not simply swept away older ones, but they are steadily remaking important relationships in society. Along with changes like globalization and new technology, observers have pointed to other important changes such as the rising importance of services, the prominence of nonmaterial values in marketing and consumer choices, the increased importance of human resources in economic organizations, and so on. Such changes are basic challenges to the older, industrial model.

The industrial model, we have argued, with its neat, discrete boxes, no longer represents the world that is emerging. The network model, with its many nodes and interconnected pathways, offers a more accurate image for the future, complex organization.

The Network Model



Today's world is about networking rather than reduction; interconnection rather than isolation. A straight linear process is now very rare; separate segments do continue to exist in systems or organizations, but they are increasingly interconnected. There may be increasing specialization, but at the same time there is increasing interdependence. This network model is the basis for value creation in the knowledge economy of the information age; it is also the basis of new social movements and new social values. Why? Because new ideas, new ways of thinking or of doing things, are usually formed by combining old ideas in new ways. This is facilitated by a network system, where elements can be substituted and clustered in changing ways. Even true breakthroughs or paradigm shifts—which are much more rare—are often inspired by lateral thinking, which is probably fostered by borrowing or sharing between specializations.

Synergies and Complementarities

The rigid, industrial mechanical structure doesn't encourage synergies and complementarities—the sort of mutual or interdependent relationships out of which complexity develops. A reductionist framework does not lend itself to seeing complementarities in the first place, since it views the whole as only the sum of the parts. Synergies and complementarities, in contrast, allow for a whole that is greater than the sum of the parts. This complex web of interactions allows for both specialization and interdependence. And it reflects (as did the industrial model) the technological and cultural foundations of its time—in today's case, postindustrialism, postmodernism, the knowledge age. The network model and the assumptions that go with it are finding their way into many different areas. In the biotechnology field, for example, genes are recombined in new ways to create something completely different, and the result is not always clear because the interactions are effectively infinite.

An excellent example of this new system is computing. The computer language Fortran typifies the old industrial model. It was linear and rigid in structure; programs were written around complicated and minutely defined sequences of precise instructions. One person wrote the code and

only that person could likely understand it. It was exceedingly difficult to take a portion of a program written for one purpose and adapt it to another. Interaction by multiple users was difficult, and only with difficulty could programs of this type create an appearance for the user of a fluid and flexible environment. Some kinds of interrelationships might even be impossible to program. In contrast, the current set of programming languages are based on object-oriented programming. The "objects" are modular structures, discrete chunks of code or information with defined properties. Such objects can more easily be rearranged, and they interact with each other—"talk" to each other—in multiple ways. Diverse users can link them in various arrangements, using similar modules for different purposes. Objects can be added, removed, and substituted easily. New programs can be created much more quickly. With a common set of rules that govern how these objects interact with each other, no one individual is responsible for understanding or designing the whole.

One reason we like this analogy is that object-oriented programming does not entirely replace linear or sequential processes—rather, it combines linear and nonlinear features. Procedural sequences and hierarchies may be present in the primitives used to write the code that builds the objects. But they are not present in the overall design, team working arrangements, object combinations, reuses, modifications, or methods of production of the software. You can, at least in theory, do most things by either method; but—once people have made the necessary transitions in their thinking—one of them lends itself more easily to innovation and elegant thinking. This makes it both more satisfying and more productive.

On the cultural-intellectual side, the shifting web with its interconnected nodes, multiple authors, and shifting boundaries between creator and user may also serve as an illustration of postmodernism. Instead of a neat hierarchy of ideas, previously authoritative interpretations are decentred. New voices and perspectives are brought in; people and groups formerly depicted as subordinate are now constructed as agents and subjects —though not autonomous ones, for they function within fields of power and inequality, and are connected to each other through mutual perceptions. People define themselves by reference to others; the powerless

or the powerful cannot be studied without reference to the system of power within which they participate. Even the observer is drawn into the web of analysis.

One of the striking things about the network image is that it dissolves boundaries. The neat compartments of the industrial model become fluid and overlapping. Even the nodes of the network may not be discrete units; they may be networks themselves, whose components are interlinked with those of other node-networks.

A Network Model of a University

While the network model is influencing many spheres of activity today, the university, we have argued, remains comparatively a bastion of compartmentalization, despite the efforts of individuals to the contrary. Budgets, resources, power, and most importantly, attitudes, remain centred on departments, which are united only by their methods of inquiry.

A Problem-Based Approach

But interdisciplinarity is on the rise. In this new world, there is a need to re-focus the university around problems, topics, issues—*objects* of inquiry rather than *methods* of inquiry. We need to have a purpose to our inquiries rather than simply a means.

What we need, in more cases, is teams of people with *different* and complementary skills, methods, and disciplines. Such teams can come together around common problems and questions. There will, of course, still be groups of people who use the same methods, who work in the same discipline; and they should probably still come together in a discipline-based department for purposes of academic administration, program matters, tenure and promotion, and so on. We should not relax, and possibly

don't even need much to change, appointments, standards, reviews, programs, and so on. What we do need to change, for more faculty members, is how the *actual work* of the university—research, teaching, and extension—is organized.

This change in focus has a number of implications, as we have indicated in the preceding pages. Once a certain kind of topic of inquiry has been identified, it becomes clear that other disciplines need to be involved; the enterprise forms the team. Focussing on a problem allows new ideas from different disciplines to be recombined to form something new. It allows for synergies and complementarities in a way that doesn't exist within a single method of inquiry. Equally importantly, a problem-based interdisciplinary approach provokes new questions, generates new insights, causes researchers to revisit and elaborate theory, and makes for better-quality and more innovative research, teaching, and extension. Such an approach requires not only faculty who differ in approach, but also nonacademic staff. An interdisciplinary centre ought to bring together a different mix of people than is often seen in traditional academic departments. This group is more diverse, and the nonacademic members of it are more equal and more fully integrated into a team outlook.

An extremely important outcome of this approach is that it facilitates the development of linkages with community groups. If it is somehow difficult to talk to farmers about university research, part of the reason may be that farmers really don't care about the methodology of agricultural economics *per se*. They don't really care about the methodology of history, either. Those are the things that preoccupy academics, not what interests farmers. However, farmers do care a great deal about co-operatives; they do care a great deal about economic and social development; and about many other relevant subjects. Focussing our research on problems is a way of making it comprehensible and more connected to various publics.

We have stressed that in determining objects of inquiry it is important to be careful about the boundaries drawn around those objects. We should draw boundaries in order to include things that were not usually included together before. In our case, our centre received an important impetus from deliberately bridging an intellectual divide between economic and social development. We were not the first or the only ones to straddle this

boundary, but our point is that doing so was central to what we were able to accomplish. The importance of defining a group or project around an object of inquiry, as opposed to a method of inquiry, lies in recognizing the fallibility of the reductionist view. What is needed is an integrative framework that allows for the examination of objects in interaction and combination.

A Supportive Culture

Interdisciplinarity also has to be founded in a supportive culture and in the values held by the university community. Interdisciplinarity requires that we value people's contributions somewhat differently, with somewhat more weighting on integration and somewhat less on separation and reduction. Ideas from different places and people must be valued and taken seriously—certainly including ideas from those who are marginalized or in different disciplines, from members of the university community who are not faculty members (staff, graduate students, undergraduates, sessional instructors), and from communities outside the university. Cutting loose from established assumptions of hierarchy and purity does require something of a leap of faith. It requires faith in oneself and in an approach based on intellectual engagement with the surrounding world, rather than on intellectual isolation from it. High standards are then something we maintain by how we handle ourselves in a complex and permeable environment, not something to be maintained by rigid and arbitrary rituals of exclusion. Many of the necessary values are already present in the campus community, but they could stand to be affirmed and to be operationalized with greater determination.

We believe many of the characteristics we have observed are generalizable, are indeed necessary aspects of interdisciplinary work. Work needs to happen more often in teams. Teams need to be built around problems or objects, which normally will cross disciplinary and conceptual boundaries. Members of teams will be diverse: not just members from different disciplines, but members of different rank and skills and orientations.

Faculty Concerns

What does this mean for faculty members? We referred at the outset to concerns that faculty members engaged in interdisciplinary work may not be valued or rewarded by their colleagues, that they may suffer from a double workload, that they may have to master many disciplines or else, failing this, end up as jacks of all trades and masters of none. By now, it may already be clear that we don't see these concerns as fundamental. Our own experience is that interdisciplinarity enriches and transforms disciplinarity. Coming together with academics from other disciplines, and with nonacademics and representatives of relevant communities, around a concrete object of study, has forced us to employ our disciplinary knowledge in new ways. We have not only learned about each other's disciplines. We have learned to be more innovative and perhaps more elegant in the employment of our own.

The observation made by some colleagues that interdisciplinarity is better suited to established academics able to take risks, than to academics trying to establish themselves, in our opinion misses the main point of the concept. It is true that well-established academics have a good foundation from which to join interdisciplinary projects, that they bring distinctive strengths, and that they should be encouraged. However, because interdisciplinarity is a way of working and thinking, it might be something that less-established scholars might learn more quickly in some cases. It seems foolish to argue that the newest scholars, trained in the newest methods of their disciplines, looking for focusses for their research, teaching, and extension, somehow have less to offer or less to gain than their senior colleagues—foolish, and condescending. It may be that less-established scholars will find it especially important to make sure they publish in disciplinary channels as well as nontraditional ones, but we have already argued that this is not incompatible with interdisciplinarity.

The issue is not one of treating disciplinary and interdisciplinary research differently. The standard is simply whether research is of high quality and of interest to others. To judge this, university tenure, promotion, and review committees might have to look more at quality of work and less at quantity—but then, they should do that anyway. They might have to

allow that more time is needed to do high-quality work—but they should do that anyway. Perhaps it is too soon to consider tenure after three years, not just for faculty members who do interdisciplinary work, but for all of them. Perhaps some recognition needs to be given to nontraditional publications, but there is, at the same time, no need to relax the minimum expectations, for example, about publication in peer-reviewed disciplinary journals. Learning as part of an interdisciplinary team should give new or old scholars a creative edge and help them make their mark within their disciplines.

Becoming Interdisciplinary

Academics don't necessarily need to agonize about how to make themselves interdisciplinary. It is really a question of finding a problem and a team. Interdisciplinarity is natural and logical, once a research object is chosen, and flows from the group environment. The real responsibility is not on the individual participant to learn the disciplines of the others, but rather to *interpret one's own discipline to the others* so that they can learn what they need for the common project. In many ways, interdisciplinarity is about representing and applying one's familiar discipline in an unfamiliar setting; the learning about other disciplines comes from others doing the same thing. It is true that individuals may become more interdisciplinary through their involvement in such ventures; however, we believe that at root, interdisciplinarity is a property of the team more than of the individuals within it. If the interdisciplinary group is conceptualized as itself constituting a complex system, then interdisciplinarity is an emergent property of this complex system. If we permit complexity to evolve within a dynamic network, interdisciplinarity will emerge.

For this reason, we believe discussion of interdisciplinary departments, interdisciplinary degrees, interdisciplinary journals, and so on, misses the bull's-eye. Such structural and institutional innovations may be required in particular cases, but they are not the sole point of the exercise. If *work* occurs in an interdisciplinary fashion, participants will ensure it finds its appropriate outlets and expressions. If this requires the founding of a new

journal or program, well and good—this is then an appropriate response to an identified need. But we should not assume that interdisciplinary thought may not find its chief expression through the existing programs, journals, career designations, and c.v. categories. Interdisciplinarity emerges when work is organized in a certain way. It does not need to be mandated, measured, systematized, regulated, boxed, confined, scrutinized under a microscope, or relegated to a pedestal—which are the ways in which an industrial-model university normally deflects problems. It needs to be incorporated into a culture.

Some believe that interdisciplinarity is fostered by large, monolithic academic-administrative units that formally encompass many disciplines. This opinion appears to be based on a misunderstanding, or rather an exceedingly minimalist definition, of what constitutes interdisciplinarity. It is true that large colleges, large programs, can offer students a wide smorgasbord of offerings. This is, at best, multidisciplinary; and it is multidisciplinary in teaching only—not necessarily in research or in public service. Interdisciplinarity arises from small groups that work (do research and teach) together, not from large groups that administer together. Sizes and configurations of academic units have little to do with interdisciplinarity and should be based on whatever considerations are relevant for effective administration. Interdisciplinarity is quite different. It happens across and between the line units of the university, and is developed through the encouragement of networks and problem-based centres or institutes parallel to the more permanent academic-administrative structures.

It would be in the university's interests to loosen the connections between the concepts of *programs* (degrees) and *academic units* (colleges and their departments); and to distinguish both of these from *interdisciplinary centres* (or institutes, research units, and the like). We should have some programs that correspond to single academic units, as is now normally the case; other programs that are shared among several academic units; and some that are run by "virtual colleges." (This is, incidentally, an outlook we missed in the recent debate about the possible division of the College of Arts and Science. The college could in fact be divided into separate units for administrative purposes, while still offering a shared set of B.A. and B.Sc. degrees under joint administration.) Interdisciplinary groups

work within and between and among programs and units, and constitute an entirely different concept of organization. The university should be clear, however, that interdisciplinary groups are important and should not be overlooked—indeed, should be encouraged—because they are not neatly contained within the programs and academic units of the university. Interdisciplinary groups should not be forced to turn themselves into programs, departments, and colleges in order to be taken seriously and receive resources. In most cases, they will do more good if they do not follow such a route.

There are, of course, places where the university's structures, policies, and procedures may need changing in order to encourage interdisciplinarity. It is not a case of replacing the existing structures, but rather of loosening them up and supplementing them with a growing number of interdisciplinary entities of various kinds. We do not, however, wish to minimize the challenges that may be involved. Greater discussion and greater flexibility are called for. Some of the innovations that arise may be genuine administrative headaches.

Challenges

As well as opportunities, there are some real challenges facing interdisciplinary centres within universities. The funding of academic positions within these centres has to be independent enough of outside influence and short-term changes so that faculty members can be linked on a long-term basis with disciplinary departments. This is extremely important. Disciplinary departments are sources of the information, methods, and ideas that interdisciplinary departments can reconfigure. New ideas in agricultural economics can be discussed with historians and incorporated into their work and vice versa. A linkage to the disciplinary departments is essential in order to have access to these ideas. However, there must similarly be some independence from the discipline. Otherwise, demands put on individuals by the home department can be so great as to preclude their interdisciplinary work. This is why independent funding has, so far, financed thinking that is outside the box. It is a significant challenge for the

university to conceptualize how this can occur more often, and particularly how it can provide independent funding to interdisciplinary ventures from within its own budget rather than innovating only when others are willing to pay the bill.

Accountability structures are another piece of the picture. There is a need for processes that enable interdisciplinary groups to be accountable in various senses to a wider audience and to broader interests than is traditionally seen in a disciplinary structure. Budgetary accountability and personnel review are important, though they can perhaps be handled through modifications to existing departmental, college, and university committees and administrative procedures. In an intellectual sense, other kinds of accountability are likely even more important. To explain research and teaching to an advisory committee that includes nonuniversity representatives is a salutary exercise and one we recommend to our colleagues wherever there is a living, breathing constituency for what universities do.

There also need to be mechanisms that allow for the fluidity that networks require: it must be easy for interdisciplinary groups to form, to rearrange the nodes of the network into subgroups with much greater ease than is currently possible. A university needs to be able to reconfigure these networks as the problems change, because the one thing known with certainty is that problems will continue to shift, and the structures that are set up in response will not then be equipped to solve the next problems that emerge. A university needs to be more flexible and responsive. The university itself needs to develop social capital. Since what we are calling for is a relaxing of departmental boundaries and an increased engagement in a wider and more flexible academic community, it is clear that no standardized model is the answer. The future system of colleges and departments should not be a single, comprehensive, uniform system, but rather an evolving, complex web of multiple and overlapping real and virtual units. These should be interlinked, interdependent, with plenty of communication and shared focal points—rather than being merely a complicated assortment of separate pieces.

Another challenge relates to our observation that—in our case—being physically located in a single space was important to our integration as a group. It facilitated the focus on a common problem, and was critical for

learning from each other. A lot can be done in periodic seminars and discussion groups; but more happens when offices are side-by-side, when people talk in the hall, when visitors come by to see a cluster of researchers. What would it mean if this experience were to be replicated more widely? Clearly the university would have to find space for more centres, and the space needs of departments would change. People would need to be clustered. Architectural design in new and renovated buildings might be different. And consider the implications for the University of Saskatchewan's strategy of "virtual colleges." These are intended to be programs composed of researchers and teachers located in different colleges and departments; such virtual colleges have no physical centre or structure. They exist in the abstract, as a form for recombining existing resources in new ways. This may be desirable in specific cases, but as a general model our experience implies that the virtual-college concept may be backwards. Instead of virtual interdisciplinary units with real programs (degrees), what we may more urgently need is real interdisciplinary units (people physically located together) with virtual programs (that is, programs that exist only through and in connection with existing departments and degrees).

Our Vision

Based on our own experience, we are interested in developing a cluster of graduate students from different disciplines—and some of them may be interdisciplinary where this is appropriate for their interests—connected with our centre through common research on co-operatives and through integrative projects, seminars, and events. Some of our graduate students share offices at our centre. Similarly, in undergraduate education, we propose to develop a "theme" in co-operative studies that could be undertaken in conjunction with various undergraduate degrees. We actually have little interest in creating "our own" graduate program or our own undergraduate degree program. In terms of the official, academic structure of the university, our centre and its educational role will, if our ideas work, remain quite invisible; and yet, our role and contribution will be real. This way of thinking parallels our concept that we can pursue interdisciplinary

research, while publishing it as well in disciplinary channels. Whether in graduate or undergraduate education, in extension, or in research, the common theme is that the administrative-structural changes that are necessary to promote interdisciplinarity may be less than one would at first assume. The real issue is where and how work is done. The real difficulties lie not so much in university rules, but in culture and attitudes, which are only partly embodied in rules and procedures. This has a positive side. Every member of the university—faculty, administrators, staff, and students—if they wish to be involved in interdisciplinary work, can begin to create the necessary culture by striving to embody it in their own thoughts and actions.

Perhaps the most fundamental point is that interdisciplinarity means opening oneself up in a personal sense. The ego of academics can sometimes be at odds with recognizing that important intellectual work is greater than one's own contribution. Working in an interdisciplinary, networked fashion requires tolerance and a willingness to share power. Seeing oneself as part of a network implies attaching respect to relationships, connections, and community. It also implies valuing people and ideas precisely for their differences, since it is the differences that add to the capabilities of a team. Interdisciplinary group endeavour will almost invariably touch at some point on barriers between faculty and nonfaculty, between one specialization and another, between the university and other communities. Participants face the choice at every such encounter to build the barriers higher by slighting the contributions of others, or to overcome barriers by appreciating those contributions. Successful networks arise from the mutual trust created through myriads of such decisions. Once such connections are nurtured, there is no telling where they might lead.

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