Sustainable universities: fostering learning beyond environmental management systems

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Abstract: This paper builds on previous research on the contemporary role of the university, which was based on the conceptual approach that the accumulation of knowledge is the fundamental driving force behind economic growth. We argue that the university must respond to changes in the world that challenge its well-established pedagogical and epistemological traditions or face loss of institutional respect. Concerns over the rapid pace of exogenous socioeconomic change and the increasingly unsustainable state of the world, raise questions about the efficacy of the positivist, discipline-based model for learning, research, and teaching, and charge universities with the important task of diffusing the concept of sustainability. An alternate model of reflexive learning in practice (living) is introduced as a potential model for the building of the ‘sustainable’ university. The analysis shows that interdisciplinary research and curricula are critical, and integrative concepts, such as industrial ecology, can guide the design of new institutional structures.
Keywords: sustainability; university; industrial ecology; pedagogy; interdisciplinary; reflexive learning; curricula.


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1 Introduction

Much has been written about the existing trend in developed economies towards an increasing investment in advanced technology, research and development, education, and culture. Concepts such as learning ability, creativity and sustained flexibility were shown to have greater importance as guiding principles for the conduct of individuals, institutions, nations and regions (e.g., OECD, 1996; Lundvall and Borras, 1997). In this context, the functions that society commonly attributes to the university are beginning to be shared between a wide range of institutions in the context of the knowledge-based economies, so that the university is faced with demands that require a strengthening of its ability to create and disseminate knowledge (Conceição and Heitor, 1999). At the same time, there is a growing tendency to classify companies as ‘learning organisations’. Terms such as ‘learning management’ are used more and more, with Nonaka and Takeuchi (1995) being perhaps the classic example of this trend.

To a certain extent, the analysis suggests a trend towards a breakdown of the institutional boundaries between companies and universities: although this convergence is, to a certain extent, to be welcomed, it can also be dangerous. Rosenberg and Nelson (1996), Dasgupta and David (1994), Pavitt (1987) and, more recently, Conceição and Heitor (2000a–b) argue that the institutional integrity of the university should be preserved, and an important point in terms of public policy is that state funding of universities should not be reduced. However, this measure by itself is not enough. From a more pragmatic viewpoint, the university should plan its strategic positioning facing the needs of society, which include rapid and unforeseeable changes in the structure of the employment market, and the need to furnish its graduates with new skills beyond purely technical ones, in particular the learning ability towards a sustainable societal development. This paper deals with ways of responding to this last issue, with the ultimate goal of building a conceptual background for sustainable higher education policies.

In this context, the basic question to be addressed is how far universities are currently effective in supporting the greater goals of society? This is perhaps the most important of all the questions, as should the answer be ‘no’, then universities are very likely to fade away or change dramatically as an important societal institution. But like so many ‘big’ questions today, the answer seems to be both ‘yes’ and ‘no’. If one looks at links between universities and economic development, then there is considerable support for the positive and critical role that universities play in maintaining growth (Conceição and Heitor, 1999; Conceição et al., 1998b). Serious questions related to this link to societal progress take this tie for granted and tend to focus more on the best policy to maximise the impact of university research budgets and on mechanisms to cope with the changing relationships between universities and industry (Caraça et al., 1998).

If one begins, however, to examine what many critics term the unintended consequences of modern progress – environmental and social stresses that now manifest themselves globally – then the answer is not so positive. In a related sense, if one adds to this question others related to the full achievement of the intended results from large technologies and complex organisational infrastructures, then again the answer is ‘no’ or a very highly qualified ‘yes’. The university is certainly not the cause of these problems in a positive sense, but it must be doing something that is not working fully. We can look to two of its more tangible products, the knowledge it produces and the students
it educates as being closer to the cause of the problems. Further we can look at the process by which both the research that creates the knowledge and the education of students proceed.

However, it should be noted that whatever aspect is considered, analysis has shown that the fundamental ability of human beings lying at the heart of economic prosperity is learning, which is a very important distinction related to the university. The classic notions of education (from the Latin word meaning ‘leading to’) were grounded in some sense of competence building or learning. The classic form of liberal education was (and still is) thought to be the ground for broad skills needed to face life in general – that is to be able to make one’s way in a world of both myriad choices and pitfalls. When the world was arguably simpler and knowledge was not so subdivided as it is today, education beyond the tradesman’s level was approached through such a wide-angle lens. Coping skills were not so important in a world where “the life of man [was] solitary, poor, nasty, brutish, and short” (Hobbes, 1651). Just to survive for a few decades was thought to be a victory.

Traditionally students come to school to learn whatever flowed out of the pedagogical process in which the two sides of teaching and learning connect in a linear fashion. Teachers throw knowledge at the students or lead them to the source of knowledge as in books, and the students catch or acquire the knowledge as a set of representations in their minds. The extent of their learning is testable through various forms of inquiry, such as exams or writing exercises through which the teacher can make an assessment of the knowledge that has been imparted. Action is produced after the completion of the educational period by processing the acquired knowledge according to a rational, positive calculus that resides in the mind of the actor. In general, more knowledge should lead to more competence in acting. To distinguish this notion of learning from a second which will be introduced just below, we will call this form of acquiring knowledge, learning-what. Conceição and Heitor (1999) refer to this process as learning-by-learning.

Since what matters in productive activities is practical at the roots, we will consider learning as related to the development of competence in the production of some intentional end state. We define learning-to as an observable improvement in the competence of an actor or set of actors or, stated otherwise, an increase in their ability to produce an intended output routinely. Learning-to must be assessed in the context of both the satisfaction of the intended output and also measures of unintended consequences. Note that there is no explicit mention of knowledge in this definition as there is in the first. Learning-to is not an abstract measure of the ‘knowledge’ content possessed by an individual. These two notions may become intermingled in special circumstances such as taking an examination or other forms of assessing one’s knowledge. What is being measured here is the competence to perform on the test or exam. Although the common beliefs of pedagogy today equate this form of competence with competence in practice, it is a mistaken notion. The two are associated, to be sure, but not in a deterministic fashion.

We will also develop and apply a model of human action, departing from the traditional positive, Cartesian model of human action. The model we use is traceable to Heidegger (1962) and other scholars (Schön, 1983; Giddens, 1984), who predicate that competent human action rests on embodied structures that have been acquired through experience. Note the inclusion of competent or effective in the previous sentence. This model of action is focused on the everyday activities of individual or collective sets of actors and on the routines that they perform. Conceição and Heitor (1999) refer to this
form of learning as *learning-by-living*. But it is exactly such routine actions, reproduced over time and space that define a cultural boundary, such as a society, company, or family. And that is exactly the domain corresponding to the question we asked earlier. *Do universities produce effective actors in a cultural sense?*

The remaining of the paper includes four sections. In Section 2, we discuss the concept of ‘sustainability’ as a critical goal for societal development, and present sample evidence of current university practices oriented by missions which consider environmental and social aspects, besides the more traditional university functions. The analysis clearly brings some evidence of the need to clarify the role of the university, but also shows the important requirement of defining the fundamental principles that should rule practices leading to ‘sustainable universities’. In Section 3, we describe *learning* as the *model of human action* that should allow to determine and understand the role of the university, as well as to design higher education policies. Section 4 presents related implications for the university, building on a new pedagogy based on the concepts of *interdisciplinary* and *learning-by-living*. Then, the university functions of teaching and research are briefly described. Finally, we conclude in Section 5 arguing about the need to promote living environments that facilitate the ability to learn by experiencing sustainable societal conditions.

# 2 Sustainable societal development: from concepts to practices

## 2.1 Building a conceptual framework: sustainability

### 2.1.1 Societal threats

Every critic of society has his or her favourite *bête noire*, but we will point to several that have taken up attention at high levels of social and political conversation. One is related to the dynamics of economic development and, in particular, to the rapid rate of change of the knowledge base, of technology that springs from that base, and of forms of industrial and other institutional structures. The second is the subject of sustainability, which arises from questions of the ability of the natural and social systems to support human development far into the future.

The first simply accepts rapid change as an exogenous fact and asks whether or not current methods of education can produce competence that lasts over an individual’s economic life and, collectively, can continue to support economic development. The second is less neutral in that it assumes that something is wrong with both the knowledge structures and the way they are being applied. The knowledge about the world that we have created is vast, but somehow its application has led to consequences that may be threatening that very world. Threats to sustainability are endogenous within the economic system and its ties to the roles of the university.

Sustainability has drawn the attention of many critics who claim the present threatened state of the globe is due to modernism, capitalism, industrialism, or some other *ism*. That is not our argument. We will argue rather that the problems we face are, to a large part, created by the insufficiency of knowledge as it is constituted in a positivist, disciplinary academic world, and by a mistaken view of human action, learning, and education. The cutting up of knowledge into a myriad of disciplines and sub-disciplines has led to an explosion of details about smaller and smaller parts of the world but at the same time to a serious diminishing of the ability to understand the whole.
2.1.2 Rapid change

The world today is changing very rapidly such that the knowledge acquired during the formal period of education becomes obsolete and the competence of the older actors in society fades in comparison to the more recently and ‘better’ trained producers. New tools and institutional arrangement replace those that had been the context at the time the university learning took place. Such failures are very important in an economic system where competence, quantified as productivity, is the key to progress.

Traditional education is generally based on the positive, reductionist form of knowledge. Students choose a specialty or discipline to pursue at some point in their educational trajectory. The choice occurs quite early in some European systems – even in high school in Finland, for example. In the USA, students typically choose a ‘major’ after one or even two years at the university. At that point their education becomes primarily focused on subjects that provide content and methodologies pertinent to the specialty. The students’ worlds become increasingly limited to the knowledge base within the specialty. Upon leaving the university, the students enter some form of employment that is designed to produce something of value demanded in the society. They virtually always require some sort of on-the-job training to gain the practical competence required by their peers, their clients (or customers), and by societal normative standards such as professional standards or licenses granted by the government. Over a period of time, they progress through a sequence of learning-to stages from beginner to effective practitioner to master, perhaps.

But this normal characterisation of competence is always made in the context of the job or some other economic measure of productivity. Given the broad social problems induced by the rapidity of change and the large unintended consequences that show up even in the face of mastery, one must ask whether this traditional system of education and learning is working effectively. Workers (and their employers) find that it is increasingly difficult to maintain competence in the face of both technological and institutional change. The tools that have become familiar become obsolete very quickly with the result that the worker’s value in the market, always based to a large degree on competence (productivity or the ability to produce satisfaction), falls over time.1

Workers are increasingly likely to find someone else, perhaps younger or from another country, taking over their job. Structural change within the private sector is accelerating as companies are aggressively eating others up in the quest to become more competitive in a global marketplace, or are tightening up employment in one or another of the latest rationalising strategies promoted by management consultants. Even if workers manage to continue doing what they were ‘trained’ to do, they are becoming less and less happy or satisfied according to polls taken in the USA and elsewhere. Stated otherwise, educated people in developed, industrial societies are not able to continue to learn-to effectively within the context of their own economic spheres.

One possibility behind this situation is that the educational process produces too little learning-to competence at the expense of learning-what. These two approaches to the production of human competence are fundamentally different. Section 3 of this paper will develop the notion of learning-to further. But at this point we will say only that one problem in the university is the fundamental belief in the learning-what mode of human action and in the way knowledge is created and acquired.
2.1.3 Unintended consequences

A further shortcoming of the traditional educational process is that it has not produced the kind of world that conforms to the broader societal norms that shape the university in the first place and relate it as an institution to the society as a whole. Service to society has always been an additional norm for universities besides that of knowledge creation and education. For some two or three centuries, western societies have been predicated on the belief that knowledge is emancipatory in essence, freeing humankind from the rigors of both the natural world and the domination of other human beings. In today’s highly technological world within the dominant forms of Western political economy, there are many signs that this fundamental social paradigm may be breaking down. Concerns over the health of the natural system, now under great stress from human economic activities, coupled with calls for more equitable sharing of this natural patrimony and man-made resources have led to calls to address the new issue of sustainability, for example at the Rio (1992) and Johannesburg (2002) summit.

These observations focus on unintended consequences of purposeful actions that arise even in the face of great competence. Here, the problems arise from two sources. One is grounded in the limitations of the positivist categorisation of knowledge. Positive knowledge is always some reduction of the observed world to a set of linguistic symbols. Knowledge can take the form of a mathematical or linguistic formula or a story. Learning—what is the acquisition of such knowledge and is always limited by the bounds and unexamined assumptions of the disciplinary categories into which the knowledge being acquired has been placed. For example, a medical doctor, however capable, cannot design a ship nor fix its engine. Further, with increasing use of technological tools, doctors focus more and more on some isolated part of the human body, viewed as a machine, and lose sight of the whole person being treated.

This kind of problem is common to all practitioners today. Both the form of education and the increasing use of specialised, powerful technologies tend to blind practitioners from the impacts of their action on domains of the world other than those within the narrow confines of their specialties. On a larger scale, the collective total of human (economic or productive) activities blinds institutions to the collective unintended consequences of normal practices. And on the largest scale, the sum total of societal actions has lead to the present apparently unsustainable human political economy. Clearly, reductionism is part of the roots of this situation.

But there is another important ground that arises from the blindness to the unintended consequences. One of the mantras of the TQM movement is, ‘What gets measured gets managed’. Another, but different, way of saying the same thing is that humans come to know only what they are concerned about (Habermas, 1971). Or even that we act only to take care of the problems or opportunities that show up in our own idiosyncratic world and that such worlds are shaped entirely by what we have come to know through experience. Reliance on reductionist forms of knowledge and on technological means to produce action have lessened our ability to recognise problems that lie outside our immediate, increasingly narcissistic, ego-delimited spheres of activities. Taking care of the world becomes someone else’s problem to solve because they, not I, have the requisite knowledge to deal with the problems. We are increasingly acting as one-dimensional human beings with all the pathological consequences that Marcuse
(1964) wrote about in the turbulent 1960s. We are neither equipped with the competence to observe the world beyond our own areas of concern, nor to adjust our modes of acting to reflect the appearance of negative consequences.

We argue that this latter failing arises in part due to the reliance on a pedagogy that stresses learning-what at the expense of learning-to. Learning-to, as we will develop further below, comes only with the ability to observe and reflect on the state of the world brought forth by action. The world we are able to see (and only then potentially act to effect) is shaped by the concerns (norms) we have developed over our lifetime. For many, the experience of university life is a major source of such norms or interests. Without asking at this point where the legitimate source of norms should be, we will examine what a university can do to instil concerns about broad societal concerns over sustainability as a metaphor for problems arising both in the natural and in the social world.

2.1.4 Sustainability

The now familiar UNCED (Brundtland, 1987) definition of sustainable development (Sustainable development is a form of development or progress that ‘meets the needs of the present without compromising the ability of future generations to meet their own needs’) was a major step in two ways. One was the acceptance that the preservation of the essential life-supporting qualities of the environment did not have to come at the expense of economic well being. The second was that our natural patrimony is limited and must be shared equitably by all who live today and who will be born in the future.

Given the dominating role of technology in modern, industrial societies, it is not surprising that ‘technological fixes’ have been the primary response of business and most governments worldwide. Sustainable production efforts far outweigh sustainable consumption programmes. The business community has created the notion of ‘eco-efficiency’, basically promising more service or function while using less materials and energy. This idea parallels the call for new technologies that are 4 to 20 times more energy and material efficient than those that they replace. While such improvements are necessary for the creation of sustainability, they are insufficient. Their failings spring from several sources. One is simply the insufficiency of efficiency improvements to counter the absolute impacts due to more rapid growth than that of the improvements. Such growth is expected and projected by virtually all models of near-term global development.

A second shortcoming is that this definition and associated criteria fail to capture the inherent radicality of sustainability. Many scholars and critics coming from very diverse points of view and disciplinary bases have foreseen that more than technological improvements are needed. For example, Ophuls (1996) writes:

“...The human race has reached a critical point in its social evolution when it has no choice but to make peace with its biological origins and to learn how to live again as a member and partner of the natural community rather its dominator and destroyer. In other words, we must rediscover how to live as our savage ancestors once lived – in nature, rather than apart from it, much less above it … how such a profound transformation of civilisation … can be achieved is obviously an immensely difficult problem, for it will clearly entail quite radical changes in the way we think and act.”
Another feature that makes the Brundtland concept of sustainability development problematic is that there is no way to ascertain whether or not the momentary state of the world is sustainable – that is – whether the desired conditions will be present in the future. Sustainability is essentially not assessable other than to observe that the present world is, indeed, flourishing or not. Unsustainability, on the other hand, can be observed in the present and is a characteristic of our modern mode of living. Our knowledge of the rules that govern the transformation of the present to the future is doomed to be insufficient to allow us to determine whether the present conditions can or will persist into the future. Thus sustainability cannot be reduced to some deterministic set of characteristics and rules. Even in a positivist epistemology, sustainability is fundamentally problematic. The next section suggests that the challenge sustainability poses to human societies and to the educational process is closely tied to a meaning of sustainability that departs radically from the Brundtland form above.

2.1.5 A new definition of sustainability

In seeking an alternative way to think about sustainability, one of the authors (Ehrenfeld, 1998b) has argued that sustainability is (ontologically) a possibility that human and other life will flourish on the Earth forever. Flourishing means not only survival, but also the realisation of whatever qualities humans declare that make life meaningful – justice, freedom, and dignity. As a possibility, sustainability is a guide to actions that will or can achieve its central vision of flourishing day after day. Possibilities are empty, created by the declarative power of human language and are unconstrained by the limits to action created by following deterministic rules that are always the product of past experience and limit action to incremental, but not necessarily insignificant, change. Sustainability as possibility is, thus, a profoundly and radically different notion of world than those ideas that dominate our current way of thinking.

This sense, however, is insufficient as a guide to action, although it can be a very powerful way of thinking and acting about sustainability. Ehrenfeld (1998b) suggests the following working definition:

“Sustainability is a possible way of living or being in which individuals, firms, governments, and other institutions act responsibly in taking care of the future as if it belonged to them today, in equitably sharing the ecological resources on which the survival of human and other species depends, and in assuring that all who live today and in the future will be able to satisfy their needs and human aspirations.”

Again compared to the sustainable development construct, this way of talking about sustainability is a radical conversation. It is directed at moral actors, not just utility maximisers, and not at some shapeless development process as is the Brundtland form. One keyword in the above definition is responsibility. Responsibility is important as it returns a moral or normative dimension to economics and deepens the role of the actor (agent) as much more than a utilitarian maximiser. We will return to this normative aspect of sustainability when we examine the potential roles for the university in this domain.
2.2 Sample evidence: practical implementations at universities

Moving from the 1980s to the 1990s, almost 20 years after the generalised awakening to the emergence of important global environmental problems, awareness started to grow on the important role higher education institutions could play in this scenario of growing apprehension to environmental threats. The perception that these institutions should be given not only partial responsibility in the resolution of these problems but also in their creation, either actively (by using unsustainable campus management practices) or passively (allowing students to graduate without ever being teach any concept of sustainability), led about 30 university leaders to sign in October 1990 the Talloires Declaration. Signed in Talloires, France, this was the first world-scale document recognising the major role universities should be charged to play in the future, concerning the implementation and diffusion of sustainability (ULSF, 1999).

Since the signing of this declaration, which was done mainly by higher education institutions ‘top-managers’ (the main ‘flaw’ cause of this document according to most stakeholders), many other documents including this same kind of perception were written and signed, among which the Halifax Declaration, the Kyoto Declaration and the Copernicus Declaration standout. Some important mention should also be done to the Agreements drawn in the Earth Summit, and the Student Declaration for Sustainable Future that despite having different origins have the same objective than the previous declarations (IISD, 1999).

With differing number and type of signers, all these declarations assume for the university the responsibility of spreading in several ways and in several scales, environmental consciousness, examples of which are the use of environmentally-sound practices in campus management or, in a more deep intervention, embed environmental themes in student’s education, namely through green curricula.

If at the present, almost ten years since the signature of the Talloires Declaration, most of the basic principles since then stated, seem to remain unapplied, some important actions have nevertheless emerged. Actually, since the beginning of the 1990s many schools have started waking up to the issue of environmentally-sound practices in campus management and, on a much smaller scale, have taken deepest interventions creating and/or shaping student’s environmental consciousness through green curricula.

In a brief overview of ongoing activities, it is possible to realise that a growing number of universities have implemented, or are preparing to implement, ‘foot printing’ studies of their campus, and in a smaller but growing scale, EMAS or ISO standards compliance. Others have implemented recycling programmes, energy management systems, green building policies and many other types of initiatives aimed to reduce universities’ campus impact on the environment. NAU Recycles (NAUR) which is a recycling programme from Northern Arizona University, Brown is Green (BIG) initiative concerning the greening of Brown University’s operations and the Oberlin College’s Adam Joseph Lewis Center for Environmental Studies green building are fulfilled examples of this.

NAUR aims to integrate environmental awareness and responsibility into the daily life of the campus community (faculty, staff, and students) through recycling and other waste management actions. Different kinds of containers are installed around the campus and campus stakeholders are taught to separate waste, providing the necessary basis for clean recycling. This initiative includes a pickup service supported by the university’s own vehicles and recovery facilities.
The BIG initiative led to the implementation of programmes aimed at resource conservation and reduction of the environmental risk of campus operations. Expanding this ‘green commitment’ to all campus’ stakeholders, Brown University with the BIG initiative aims to provide a model for active learning, namely through the use of effective energy and water management systems, a recycling programme and green building and transportation policies. Results are being published so that stakeholders understand the potential and the need for such approaches. Particularly through the use of energy management systems Brown University upgraded lights to higher efficiency lamps producing a reduction of 30% in annual electrical consumption with a payback on the net project cost in three years. Through the upgrade of old motors by high-efficiency motors, Brown University also reduced the environmental burden of campus operations with a payback on net project cost in approximately 1.3 years. Through the upgrade of showerheads in all dormitories Brown University estimates savings greater than 5.6 million gallons per year. Estimates also indicate, that by continuing the types of conservation measures Brown has been implementing, a 34% reduction is possible in water consumption equivalent to approximately $300,000 annual savings.

Different in scope but similar in the overall objectives to the previous examples is the Oberlin College’s Adam Joseph Lewis Center for Environmental Studies green building. With this initiative Oberlin College aimed to build “a model for sustainable design in the areas of energy, water, waste, materials, landscape and aesthetics”. Oberlin College’s goal was that this building could become ‘a living laboratory for students and the community’ and ‘a model for sustainable architecture’. To achieve such goals the centre was built to be a self producer of energy and able to reuse its wastewater, it uses only materials known to be non-carcinogenic, non-mutagenic, or non-endocrine disrupters and that were grown or manufactured sustainably. This is now implemented and serves as an example of strategies that aim to increase people’s awareness about environmental problems and teach them to live sustainably through the creation of a sustainable environment where people learn on a day-to-day basis simply by living on it.

A much different example of what is being done at the university level is the Environment Across the Curriculum programme from Carnegie Mellon University. This programme is based on the belief that all students, whether pursuing an environmental career or not, must learn about environmental issues as part of their regular coursework. With this initiative all students, independently of the programme in which they are enrolled, are offered a basic introduction to environmental issues. In particular, students are offered elective courses that provide a deeper understanding of scientific, engineering, economic, social, and policy issues relating to the environment. Practical implementation includes guest lectures, laboratory experiments, group projects, field trips, and other class activities that blend naturally with materials in existing core courses. Simultaneously, grants from several industries ensure that students are exposed to real-world environmental problems.

These are descriptions of only a few examples in implementation at the university level. Table 1 presents a more detailed list of some other sample examples.
<table>
<thead>
<tr>
<th>Institution</th>
<th>Country</th>
<th>Characteristics</th>
<th>Policies for sustainability</th>
<th>Implementation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie Mellon University</td>
<td>USA</td>
<td>1 campus; 7 colleges and schools; 7500 students; 530 regular faculty; 2500 staff including researchers</td>
<td>Env. research agenda; green curricula cooperative programmes</td>
<td>Chemical waste reduction; recycling energy; some general environmental courses</td>
<td><a href="http://www.cmu.edu">http://www.cmu.edu</a></td>
</tr>
<tr>
<td>Northern Arizona University</td>
<td>USA</td>
<td>1 campus (+1 small secondary campus); 12 801 undergraduate students + 5791 graduate students; 650 faculty (FTE)</td>
<td>Curricular; recycling</td>
<td>Course of reading and writing to all first-year students; recycling centre</td>
<td><a href="http://www.nau.edu">http://www.nau.edu</a></td>
</tr>
<tr>
<td>Brown University</td>
<td>USA</td>
<td>1 campus; 5750 undergraduate + 860 graduate FTE students; 7535 total students; 540 teachers; 2400 staff</td>
<td>Resource conservation; green building; green purchasing; green decision-making energy management</td>
<td>Energy management system; recycling programmes; water conservation guidelines; optional environmental introductory courses</td>
<td><a href="http://www.brown.edu">http://www.brown.edu</a></td>
</tr>
<tr>
<td>Tufts University</td>
<td>USA</td>
<td>3 campus; 11 schools; 8800 students; 2492 staff; 1034 teachers (40 campus in Toulouse-France)</td>
<td>Sustainable use of natural resources; recycling; revitalisation; materials sustainable management; green curricula; environmental research agenda; societal form of discussion</td>
<td>Environmental auditing studies; recycling activities; dining strategic plan</td>
<td><a href="http://www.tufts.edu">http://www.tufts.edu</a></td>
</tr>
<tr>
<td>Northland College</td>
<td>USA</td>
<td>800 students; 50 faculty</td>
<td>Energy efficiency; green building green self; 3 R's policies; green campus; green accounting; env. audits</td>
<td>Environmental living and learning centre</td>
<td><a href="http://www.northland.edu">http://www.northland.edu</a></td>
</tr>
<tr>
<td>Maldenium University</td>
<td>USA</td>
<td>2 campus; 10 depart.; 11 000 students (1/2 in Eng); 400 teachers</td>
<td>Green curricula</td>
<td>Green curricula</td>
<td><a href="http://www.maldeniumsw.org">http://www.maldeniumsw.org</a></td>
</tr>
<tr>
<td>Assiniboine Community College</td>
<td>CA</td>
<td>1500 students; 75 teachers; 75 administrative</td>
<td>Environmental plans and procedures; Paper reduction; energy management</td>
<td>Ongoing implementation of SD principals in curricula; market driven green training programmes</td>
<td><a href="http://www.acrc.mb.ca">http://www.acrc.mb.ca</a></td>
</tr>
<tr>
<td>University of British Columbia</td>
<td>CA</td>
<td>1 campus; full-time faculty = 804; full-time salaried staff = 3700; undergraduate students = 28205; graduate students = 6228</td>
<td>Recycling</td>
<td>Recycling activities (small scale &lt;15% of students)</td>
<td><a href="http://www.yale.ca">http://www.yale.ca</a></td>
</tr>
<tr>
<td>Yale University</td>
<td>USA</td>
<td>1 campus; 1 college + 1 graduate school + 10 professional schools; 10 990 students; 3106 faculty; 7123 FTE staff</td>
<td>Environmental courses; interdisciplinary research</td>
<td>Environmental courses; interdisciplinary research</td>
<td><a href="http://www.yale.de">http://www.yale.de</a></td>
</tr>
<tr>
<td>University of Oregon</td>
<td>USA</td>
<td>1 campus; 2 colleges + 1 graduate school + 6 professional schools; 16 780 students; 1200 faculty</td>
<td>Environmental courses; interdisciplinary research</td>
<td>Environmental courses; interdisciplinary research</td>
<td><a href="http://www.oregon.edu">http://www.oregon.edu</a></td>
</tr>
<tr>
<td>Boston University</td>
<td>USA</td>
<td>1 campus; 9 schools and 6 colleges; 15 434 undergraduate + 10 80; 34 440 non-degree students; 7 1900 facility</td>
<td>Environmental courses; interdisciplinary research</td>
<td>Environmental courses; interdisciplinary research</td>
<td><a href="http://www.bu.edu">http://www.bu.edu</a></td>
</tr>
<tr>
<td>University of York</td>
<td>UK</td>
<td>1 campus (+1 secondary small campus); 6511 undergraduate + 1813 graduate students; 9733 undergraduate + 1 552 Christmas students; 400 academic staff (430 FTE) + 25 staff</td>
<td>Environmental courses; interdisciplinary research</td>
<td>Environmental courses; interdisciplinary research</td>
<td><a href="http://www.york.ac.uk">http://www.york.ac.uk</a></td>
</tr>
<tr>
<td>University of Manchester</td>
<td>UK</td>
<td>1 campus; 8 faculties; 3 graduate schools; 70 departments; 18 000 students; 2000 academic staff</td>
<td>Education; students’ and staff’s; waste and recycling purchasing; transport; building energy and water information</td>
<td>n.a.</td>
<td><a href="http://www.man.ac.uk">http://www.man.ac.uk</a></td>
</tr>
<tr>
<td>University of Northumbria</td>
<td>UK</td>
<td>4 campus; 5 faculties; 23 000 students; 792 FTE academic staff; 11 500 FTE supporting staff</td>
<td>Energy; transport; recycling; waste; emissions; green purchasing</td>
<td>n.a.</td>
<td><a href="http://www.nu.ac.uk">http://www.nu.ac.uk</a></td>
</tr>
<tr>
<td>Open Polytechnic of New Zealand</td>
<td>NZ</td>
<td>1 campus; 1 campus (virtual university); 300 staff on campus; 1 300 FTE teachers; 2 100 students (556 FTE)</td>
<td>Energy; transport; waste management; recycling; green purchasing; green networks; green training programmes; green auditing; implementation of env. responsibility in mission statement</td>
<td>Green curricula</td>
<td><a href="http://www.opnz.ac.nz">http://www.opnz.ac.nz</a></td>
</tr>
<tr>
<td>Southern Alberta Institute of Technology</td>
<td>CA</td>
<td>1 campus; 700 students</td>
<td>Green curricula; green operations</td>
<td>n.a.</td>
<td><a href="http://www.sait.ab.ca">http://www.sait.ab.ca</a></td>
</tr>
<tr>
<td>Red River Community College</td>
<td>CA</td>
<td>2 campus + several regional centres; 6000 full-time students; 730 staff</td>
<td>Sustainable management of energy sources; transport; green building coordination; recycling; waste management; green purchasing maintenance and enhancement of local biodiversity; monitor the university’s environmental performance; green curricula</td>
<td>Sustainable management of energy sources; transport; green building coordination; recycling; waste management; green purchasing maintenance and enhancement of local biodiversity; monitor the university’s environmental performance; green curricula</td>
<td><a href="http://www.rrc.mb.ca">http://www.rrc.mb.ca</a></td>
</tr>
<tr>
<td>Flinders University</td>
<td>AU</td>
<td>5 campus; 4 faculties; 69% full time + 40% part time; 451 external undergraduate; 134 full time + 682 part time + 225 external undergraduate; 700 academic staff; 858 non-academic staff</td>
<td>Sustainable management of energy sources; transport; green building coordination; recycling; waste management; green purchasing maintenance and enhancement of local biodiversity; monitor the university’s environmental performance; green curricula</td>
<td>Sustainable management of energy sources; transport; green building coordination; recycling; waste management; green purchasing maintenance and enhancement of local biodiversity; monitor the university’s environmental performance; green curricula</td>
<td><a href="http://www.flinders.edu.au">http://www.flinders.edu.au</a></td>
</tr>
</tbody>
</table>

Table 1: Sample examples of ‘green’ initiatives for the university
With this brief synopsis on the recent past and present of ongoing activities concerning the contribution of universities to the spreading of the concept of sustainability, we classified these programmes according to two major vectors of action, one concerning greening of operations and other concerning implementation of green curricula. If we try to characterise some of the previously described examples in the space of action formed by these two vectors we obtain what is shown in Figure 1.

Figure 1  Characterisation of sample initiatives according with two main vectors of action

![Diagram showing the characterisation of sample initiatives according to two main vectors of action.]

What this figure shows is that if we have a vector of action relating greening of operations, which ranges from a type of operations management constrained by the traditional way of thinking and acting to a type of operations management much more keen on having all operations as environmentally sound as possible, it is possible to characterise both NAUR and BIG initiatives on the upper quadrants of Figure’s 1 space of action. Moreover, if we have another vector of action relating implementation of green curricula, which ranges from a discipline oriented type of teaching that channels to specific scientific areas to a multidisciplinary type of teaching where linking between scientific areas and the environmental themes is promoted and disciplines are organised on a horizontal basis, it is possible to characterise Carnegie Mellon’s initiative Environment Across the Curriculum on the right quadrants of Figure’s 1 space of action.

Although these are the two main vectors of action, still the teaching component is much less considered in the projects than the management-based line of action. Most of the actions relate to essentially physical operations and there is still a tremendous lack of intervention at the educational level so that the concepts can be implemented in a less superficial way.

2.3 The research question

Clearly universities have started to accept their role in helping society attaining a sustainable development, as shown by the several examples presented in Section 2.2. However, most of the activities listed in Table 1 lack broader and more integrative interventions. The question is how should universities contribute for a societal sustainable
development, namely in terms of the approaches to allow the context (Schön, 1983; Holland et al., 1989), learning (Conceição and Heitor, 1999) and use of the concept of sustainability (Ehrenfeld, 1997; 1998a) in a way that reflects in both students’ future thinking and acting. And, what are the levels at which changes must occur, so that universities manage to fulfil this objective.

3 Learning-in-action: a model for the university

The traditional model of a university is a place where students come with a ‘tabula rasa’ and leave with a mind filled with the knowledge that will be the base of their competence in the career that they choose to follow. The process of filling the slate has become equivalent to the process of learning. One acquires knowledge of the world and how it works and takes that knowledge back out into the world and applies it to produce successful outcomes in a chosen domain of production. This simple model of learning is not sufficient on several grounds. One is the recognition in virtually every field of endeavour that knowledge in this sense is not sufficient alone to produce competent actors. Professionals such as doctors need to embed themselves in practice before they are able to perform competently. Or stated otherwise, the generalised forms of knowledge acquired in the traditional learning process lack context that can be obtained only by some form of learning on the job. Further, master performers cannot explain how they can do what they do. Even ordinary actors cannot explain how they do what they do. All humans (with very few exceptions) are competent speakers but none of us possesses ‘knowledge’ of how we speak.

3.1 Reflexive practice

Given the practical sense of learning we have adopted, it is essential to begin with some model for human action. In place of the Cartesian, rational actor, utilitarian model, we have adapted several forms of reflexive practice models combining ideas found in Heidegger et al. (1962). In this model, human beings are always involved in some form of intentional behaviour or action. This means they are acting to satisfy some specific aim or objective. Another way of saying this is that they are acting to bring forth a world (that is, the experience of the immediate present) that was not present at the instance they began to act. Life is spent moving from one act to another, always creating the future out of the present. The present is sensed reflexively by the actor. At any moment, the actor is aware of whether the intention has been satisfied. Action proceeds transparently during this process. The actor uses embodied structures and familiar available (ready-to-hand) resources (Heidegger, 1962) to achieve the intentional end. These resources are embodied as structures in the practical consciousness of the actor (Giddens, 1984). Without specifying the internal processes, Schön (1983) argues that mastery comes through a process of reflection in which the actor becomes masterful by embodying ‘knowledge’ of successes and failures. All argue against competence as being merely the output of ‘technical rationality’ as Schön deems the conventional mode of acting.

The models of human action we draw on, although distinct, have common features. Action is an observable (productive) activity that human agents engage in to produce an intentional (desired) state of the world. All the models imply some sort of reflexivity, that is the monitoring of the world by the agent and ability to make assessments about
Sustainable universities: fostering learning beyond EMS

that world. Giddens (1984) posits a set of structures and a process (structuration) by which these structures produce competent action and are in turn constituted through the action and concomitant reflexive monitoring. Actors create a sense of the world through the interpretation of incoming phenomena via a set of cognitively bound codes of signification. These codes enable the actor to make sense of the present moment. If asked, the actor will respond discursively with a story (explanation) of what is going on.

Such an assessment of the world alone does not produce action. A second category of structure, normative rules, call out what is to be done under this particular set of circumstances. They produce an intention by the actor to do something. Again, the actor if queried, would say what he or she intends, or since questions usually follow action, intended to do. If the actor makes a commitment to produce the intended action, he or she will call upon a set of worldly resources that Giddens divides into two kinds: authoritative resources and allocative resources. They refer, respectively, to the ability of the agent to call upon other people and make use of technological devices to bring about (empower) the change in the world needed to complete of the action and bring forth the future state previously contemplated (presencing). Heidegger refers to these resources as being ready-to-hand, that is, familiar and available to the actor. They have no meaning except as contextually related to their role in bringing about the desired world. Conceição et al. (1998a) use the term wetware, which corresponds closely to these embodied resource structures.

Giddens (also Schön) adds the feature that actors monitor the progress of the action reflexively, that is, make assessments as they go. Such assessments occur in breakdowns or interruptions in the flow of action. Breakdowns are essential in the process of learning-to and will be discussed further below. If the outcome is satisfactory and the desired new present world does indeed show up, the structure that had been somehow accessed becomes reinforced. This duality of structure as both constituting action and being constituted in the process of reflexively monitoring the outcome is deemed structuration by Giddens.

So far, we have spoken of an isolated actor operating out of structure created only in the context of the actor’s historical narrative. But social actors always act in a collective setting and create their personal structures within a broad cultural context. Giddens claims that all members that constitute a particular society or institutionally distinct organisation share the codes of signification and normative rules that produce meaningful action in a societal or cultural sense. The members share a common worldview in general (codes of signification), norms, and make use of more or less the same sets of resources.

3.2 Learning-in-action

Competence in this scheme can be defined as the routine, successful completion of some intentional action that is responsive to the norms of the individual and, with respect to unintended consequences, the norms of those upon whom these unintended effects are visited. Learning-to is the process by which an actor gains such competence. Following structuration theory as the model for routine action, we can point to three processes that relate to learning-to:
the process by which an individual embodies a set of structures that permit him or her to interpret the world

a similar process in which norms appropriate to the institution in which the action is proceeding (family, work, society, etc.) are embodied

the way in which ready-at-hand strategies are produced. The structures become more deeply embedded and become more robust as an individual becomes more competent (learns). Robust here means that the toolbox of ready-at-hand strategies grows such that the action may be successfully completed even if some of the resources fail to produce the expected results.

3.2.1 Unproblematic success

Reflection is the obverse of transparency. In the routine act, the world has receded from the view of the actor. But if the action is interrupted, the world returns to the actor’s consciousness. In cases where the action has been completed to the satisfaction of the actor, the intended world is assessed to have become present and the normal strategy that had just been used by the actor is reinforced in the actor’s structures. We might say, in this case, that practice makes perfect. This form of learning is so familiar to us that we tend to overlook it entirely. It is the way we learned to speak, write, walk, drive, and perform all of the everyday routines that most people execute competently, even masterfully.

The more interesting case, in terms of potential ties to the university, is that of incomplete satisfaction, caused by an interruption occurring in the midst of performance. Any such interruption (breakdown) forces the actor to reflect, that is, assess the present state of the world. When action loses transparency, the world shows up in the actor’s consciousness. The actor can continue to cope or may abandon the present action and turn to something else.

3.2.2 Successful coping

We will examine two such circumstances. The first is created when the normal resources being applied fail to produce the intended results. Maybe the actor is ill or otherwise incapacitated. Maybe the resources (tools or other people) are not working as usual. The actor can, if available, fall back on alternative (ready-to-hand) strategies that have become embodied and quickly restore the action. If such alternatives are not available, the actor must construct a new strategy (that is, select new resources) that restores transparency or must abandon the effort.

But from where can such resources be drawn? All that exists in this moment of breakdown is the world constituted by the sum total of the meaningful knowledge that appears to or can be discovered by the actor. This world, the present in everyday jargon, includes everything in the actor’s consciousness at that moment – all the rules that the actor has learned in the conventional sense and linguistic representations of those that have been embodied in practice. Such knowledge has been previously embodied through codes of signification that have been acquired in formal education or in auto-didactic endeavours, which we will now define as the process by which general ‘rules’ or ‘stories’ about the world are embedded in the memory (discursive consciousness) of an actor. This form of ‘knowledge’ is often referred to as ‘software’ (see, for example, Conceição et al., 1998b). We referred to it earlier as output of learning-what.
These rules (Giddens’ codes of signification) or stories are context-free in the positivist sense. They have no practical utility in this form. The actor must be able to make some sort of transformation to convert this present-at-handedness (using Heidegger’s terms) to the ready-at-handedness of resources. In a sense, the actor holds a conversation with himself or herself in which all the possible means are surfaced and some choice made among them. In Giddens’ terms, the knowledge must move from the level of discursive consciousness (the domain we draw on when we explain what we know or do) to practical consciousness (the domain we draw on when we act).

In addition to the software or general forms of knowledge, humans and artefacts also become present. If the actor can interpret their meaningless phenomenological presence in a way that suggests they have potential as a ready-at-hand resource, they also can be picked up and used. Thus, a carpenter whose hammer has broken may observe and use some nearby object that an observer would call a rock but which appears as a ‘hammer’ to the actor. The actor must have possessed some metaphorical hammering structure in his or her codes of signification that give presence and meaning to the objects in the world that became present in the breakdown. Such tangible objects, both human and not, are usually referred to as ‘hardware’ to distinguish them from the above-mentioned abstract forms of knowledge. In practice however, they are not distinct; software is no different from hardware. Both are merely worldly phenomena until the actor gives them some purposeful or utilitarian meaning. They are simply meaningful constituents of the world-at-hand that offer the actor potential resources to apply to the stalled action. If used, both disappear into a normal strategy for getting a particular job done; both become wetware in normal, routine practice. It is important to keep in mind that what appear as objects or specific forms to an observer \(^1\) are nothing but meaningless phenomena to an actor until they are interpreted in a reflexive moment of breakdown.

To the extent that the actor is successful in making the transformation and finds a new resource to apply to the intended task, an observer would say the actor has learned to do whatever it was in a richer, more robust sense. In the actor’s moment of reflection at the completion of the task, he or she would add a new resource to the practical consciousness available to be called on in the future. To the extent that this new strategy becomes used more effectively, it will, perhaps, supplant the older routine and an observer would say that the actor has learned.

### 3.2.3 Coaching

A second form of breakdown occurs when an observer of the action or someone outside the immediate context of the action intervenes. Here a breakdown is created by an intrusion that stops the transparent flow of action. One common form of intentionally induced breakdowns is the result of coaching. Coaches are observers of action whose function is to intervene deliberately when they believe that there is an opportunity for a reflective breakdown in which the actor can embody something from the present-at-hand world that will improve effectiveness. As observers, coaches can assess the effectiveness of the manner by which resources are being used by the actor even when the actor is blinded by the transparency of the moment. By intervening and pointing to other forms of knowledge or other tools, coaches add to the self-generated world of the actor. Learning-to, in theory, can occur in isolation, but is always problematic in this case.
because only the actor’s past world tends to show up at moments of breakdown. This aspect of structuration explains why it is very hard to break old habits by oneself. Intervention by others can expand the world that appears.

Coaches are particularly powerful agents to enhance the learning-to process because, in many cases, they occupy this role simply because they have had past successes in the practice. But one must be careful to distinguish coaches from traditional teachers. The ‘knowledge’ (learning-to) that coaches provide is always contextual and relates to some action; the ‘knowledge’ (learning-what) that teachers provide is acontextual and away from the action.

3.2.4 Permanent changes in the world

Another form of external intervention in a routine setting is some permanent change in the actor’s world created by others. It might be a new set of rules, new organisational hierarchy, or some new technology that is to be used. The first time an actor encounters this new world, it is very likely that the breakdown, which will inevitably be created by unfamiliarity, produces a loss of effectiveness because the actor’s normal strategies will not work. The actor will have to learn-to again but in the face of a world that may seem strange and meaningless. Such is exactly the problem created by rapid exogenous change.

A breakdown is a sign that the existent set of rules, the structure, lacks a strategy for coping with the present situation. In order for the actor to get back to work, he or she must interpret the newly available world in some way that makes it appear useful within the context of the only strategies they have, that is the old ones. The potential resources can become strategic only after the actor makes some sort of metaphorical transformation such that they appear familiar (ready-at-hand). This distinction is important. The conventional notion is that the actor has a set of general knowledge that he or she can always use to make sense of a new situation. It is the appearance of familiarity that is critical. Even this does not mean that the new coping strategy will work. Indeed, it often fails or produces less than the intended results.

Without going into a lengthy discussion, it should be apparent that actors need competence in two domains to cope successfully with rapid change. They need 1) a rich source of possibilities in the general knowledge they possess about the world, and 2) practice in reflection, itself, as this is the mode of consciousness in which such possibilities are discovered. Many have observed that people react very differently to situations where the world has suddenly appeared strange or where their bags of tricks have lost their magic. Some plunge ahead trying many new strategies. Others become fearful and retreat. Such differences in response are often placed in the categories of emotions and personality but even these are learned actions and could be directed towards more effective responses to permanent change and temporary loss of capability. For example, fear can be treated through psychotherapy, which could be considered a form of coaching in this model of learning and change.

Universities have traditionally approached the challenge of change in the world by broadening the amount of general knowledge the students take away. Economic realities place a limit on the quantity of knowledge that is consistent with the standard learning period in a university programme. Increasingly, one finds offerings for people on the job
but these are usually limited to adding knowledge closely aligned with their present line of work. Little or no attention is paid to the process of learning-to itself, leaving the actors with the same limited ability to reflect, create possibilities, and cope with change.

3.2.5 Critical thinking and unintended consequences

Before moving to discuss how the university can enhance the effectiveness of individual actors and that of the societal collective, it is important to comment on the notion of unintended consequences. Unintended consequences are any results of intentional action that were not intended by the actor. The actor may observe such outcomes in the breakdowns that signal unproblematic success or successful coping. To the extent that such appearances are deemed normatively unimportant, the actor will tend to ignore them and move along. The model of action developed above is contained within the actor’s immediate world. Intentions form and are satisfied (or not) within the actor’s world. Teachers provide the software to enlarge the present-at-hand world of the actor. Coaches intervene to enrich the reflective structuration process. Those with a stake in the actor’s results provide the hardware.

The actor, however much these others have a broad world-view, can make assessments only of that which appears meaningful to him or her in the course of action. The world that appears in the moments of breakdown is immediate to the actor’s context in time and space. Only those parts of the ‘real’ world for which codes of signification are already present can appear. Parts of the world seen by other observers will not be present, and the actor cannot determine whether or not anything has changed in the observer’s worlds as a consequence of the actor’s actions. Even if the actor does sense some untoward change, he or she may not consider it important enough to act accordingly. In this case, the normative rules that have been previously embodied could be said to accord low priority to taking care of this unexpected ‘problem’. The result of this normal shortening of the horizon of action to the actor’s immediate world is that any consequences of the actor’s efforts that occur out of sight or later after the actor has moved on to another world are not observed. They are, obviously, unavailable to contribute to the reflexive learning-to process.

In a world where technology has lengthened the time-space characteristics of society and, according to Giddens (1990), has become one modernity’s principle sociological features, the consequences of action, both intended and unintended, are increasingly unavailable to the actor during reflexive breakdowns. Further, as noted earlier, the reductionist form of knowledge creation and transmission promotes the likelihood of unintended consequences. We noted earlier that concerns over sustainability reflect the extent that unintended consequences of social action are coming to equal or surpass those that were intended in the first place.

In thinking about the role of the university in serving society, it is important to extend the notion of unintended consequences to the undesirable outcomes of action that are observed by others. Such observers’ worlds are not constituted by the same structures as the actors. They can ‘see’ changes that run counter to societal norms or to collective social visions. If such observers are powerful in society, they can turn social attention towards the appearance of these unintended consequences and towards the creation of a new structure that avoids them. Giddens and others (see, for example, Beck et al., 1994) argue that the structuration now occurring in modern, industrial societies is beginning to reflect the growing problems of ecological stress. The sociological term for the process is
ecological modernisation (Hajer, 1995). The first sign is that the collective social consciousness is becoming aware of the problems. The Rio 1992 Summit and other actions in the public sphere attest to this. This group of sociologists also argue that the actions that subsequently flow from the larger, more powerful institutions (government, politics, private business) of society have begun to cope more effectively with these stresses. Such coping requires that, at the societal or even global level, individual actors must become aware of the conditions of the world beyond their immediate everyday concerns and act accordingly. New norms which elevate priorities to take care of the world in general must replace those that focus on closer-at-hand domains of concern, such as job, personal security, ego-satisfaction, and so on. Sustainable forms of resources (authority and tools) must supplant those that have become familiar.

The tendency of modern technology to extend the time-space dimension has lessened the ability of actors to act responsibly in the very fundamental ethical sense of not doing harm knowingly (Jonas, 1973). Given the ethical sense of sustainability as developed earlier in this paper, this general characteristic of modernity is of particular relevance to technical education and especially to technical universities. The positive form and compartmentalisation of knowledge produces a certainty of outcome that is unjustified with respect to the actual results. With few exceptions such as in the case of accidents within complex technological systems (Perrow, 1984), research on and the teaching of risk focuses on the likelihood of some desired, expected event. Few courses discuss even the possibility of undesired side effects occurring. This practice rests on the strong positivist normative structure in modern industrial societies. The dominance of positive thinking has become deeply embedded over the past 200–300 years of the Enlightenment. Alternate norms, such as the precautionary principle, are only slowly beginning to find a place in societal norms. The former epistemological norm tends to ignore unintended consequences; the latter takes their possibility for granted and argues for a heightened consciousness during breakdowns when new strategies are selected, individually or socially.

Whether or not ecological modernisation, including the emergence of new consciousness, norms, and practices, is taking place at all or is occurring at a rapid enough rate to counterbalance the threats to sustainability is arguable. Virtually all natural and social systems are more stressed today than they were in 1992 at the time of the Rio summit. Given the focus of this paper, one may ask how universities could reduce the impact of these inevitable unintended consequences by changing the learning process. It is not the intent of the authors to discuss any particular technological or institutional fixes.

4 Towards a new university pedagogy for sustainability

The arguments made so far suggest that the unsustainability of historic practice can be attributed, among other factors, to:

- the reductionist mode of knowledge production and pedagogy
- the absence of ‘sustainability’ norms
- incompetence in reflexive learning practices.
The university, alone, cannot radically change any of these deeply historic cultural structures, but can begin to introduce new structures in both the research and the teaching being provided.

4.1 The basic questions
4.1.1 Interdisciplinarity

The first problem, disciplinary limitations, has been long recognised as a problem in traditional technical education. MIT, generally recognised as a world leader in the development of technical pedagogy, has recently formed an interdisciplinary unit, the Engineering Systems Division, to circumvent many of the problems arising from the typical disciplinary department structure of universities. More specifically regarding sustainability, it is critical that universities provide a curriculum and research programme unconstrained by disciplines. Both are needed as curriculum development and knowledge production through research are linked. As noted in Section 2.2, in the past several years, research programmes examining various aspects of sustainable development have sprung up, but most have a fundamentally technocratic core looking at vastly improved economic policy instruments or new technologies as the springboard to the future. Drawing from the diverse participants in the Greening of Industry Network, Schot et al. (1997) present a broad research agenda which, although focusing on the roles of business in a sustainable world, argues for interdisciplinarity. New holistic concepts for designing technological artefacts and institutions, such as industrial ecology (Ehrenfeld, 1997) or Natural Capitalism (Hawken et al., 1999), are slowly emerging. Exposure to subjects presenting a more robust model of how both the natural and the social worlds work adds to the software students carry away with them from the university.

Support for broad sustainability research agendas has been problematic in the past. The predominant share of funds from government and industry have been directed to technological solutions. But the situation is changing. Increasing public concerns and related political pressures on governments to address sustainability is starting to be reflected in educational and R&D policy. Recent policy developments in Europe recognise that sustainable development cannot grow without changes in the educational system. Tilbury (1999) notes that changes in the curriculum will, however, lag changes in the research portfolios of universities.

The above and other more traditional systems-oriented subjects, such as ecology, find their way into core academic programmes only with difficulty. There is no easy solution to bringing interdisciplinarity to the campus. It takes the same kind of critical break that is so hard to bring to life in general. Ehrenfeld (1998b) reports the findings of a student’s recently finished Masters research project and thesis examining integration in the university (Martinez, 1998). Integration was his term for the process of achieving interdisciplinarity. If the university is to move towards becoming a more effective player in society’s attempts to achieve sustainability, his research argues that it is essential to:

- Improve the channels of communication among faculty, between faculty and administration, and critically between the entire university community and society. The linguistic bounds that separate the disciplines and the separate institutions (faculty, staff, students) within the university must be softened.
Stand up and be counted. Leadership is essential. Leadership in such a radical situation is threatening, faculty and university leaders must do more than put their minds on the line. Changing paradigms means putting one’s body on the line alongside of the brain.

Put up the resources. Adequate resources need to be dedicated to the task. Change within the university of the magnitude implied here will require substantial funds, institutional priorities, and a very long time. All are precious resources, but much more needs to be directed to this challenge.

Universities are picking up this challenge. As noted above, a few years ago, a handful of university presidents met in Talloires, France and declared their commitment to provide the leadership and resources to respond to the then emerging challenge of sustainability. The list of some 20 charter signatories has grown in a decade to more than 250 institutions of higher education around the globe. The Talloires Declaration is the guiding document for the Association of University Leaders for a Sustainable Future (ULSF) and serves as a framework of action outlining the role and responsibilities of universities in supporting environmentally sustainable development and advancing global environmental literacy.

4.1.2 Learning-by living

As noted above, providing more robust software enhances the capability of practitioners who have become aware of situations that require new ways of thinking and acting. The richer the software resources are, the more possibilities for design can be discovered. But software is only a necessary condition for designing sustainable practices. The actor must be able to recognise the breakdowns created or about to be created and must care enough to do something about them. Both attributes can be learned in a university setting, but only through the living experience. Unlike software, reflexive competence and ethical norms can be embodied only through experience.

Universities can create a living context for the entire university community by introducing sustainability into the research agenda, the curriculum, the operational management, and the social/community that constitutes the stakeholders. Commitments to sustainability are an essential beginning as noted in the examples shown in Section 2.2.

Key to the creation of critical thinking and the development of sustainability norms is the experience of living (and learning). Opportunities for learning simply by being in the university setting have been largely overlooked in traditional pedagogical models. The wholeness of the student’s social life and the learning experience are generally divided into two separate domains. By merging the two, in the context of sustainability, the university can provide a place where students can learn simply by being there. But such learning needs coaching in reflective practice and the creation of breakdowns in which the students embody the normative structures of sustainability along with the formal software offered. Industrial ecology offers a possibility for the design of the living experience. This concept, closely tied to sustainability, stresses the importance of material loop closing and networks in general but also points to the importance of community, cooperation and connectedness in building sustainable systems (Ehrenfeld, 1997). These last three notions are potentially powerful metaphors to guide the design of
a sustainable university. The idea of networks is not just limited to sustainability. Kelly (1998) has provocatively proposed that understanding of networks and their economic significance is critical to strategic success in the coming decades.

Another potential tool for creating the sustainable living/learning community is the introduction of an Environmental Management System (EMS) into the overall university governance structures. Mora and Martin (1998) discuss the benefits of installing the EC Environmental Management and Auditing System (EMAS) in universities rather than in more common industrial settings. The process of selecting and implementing such a system creates a rare opportunity to bring faculty, administration, students, and surrounding community together.

Sustainability is about community and interconnectedness at the core. If the students and the knowledge that universities produce are to be a primary force towards sustainability, as the authors believe is critical, then the university must itself be a microcosm of sustainable thinking, norms, and practices that are taken away by the students as they leave for their life-long pursuits. The situation today is far from this state, but this paper points to many encouraging signs of change. As is so often the case, the possibilities are emerging from the murk of the past, all it takes is commitment, leadership, and persistence to convert them to reality.

4.2 The impact on the university functions

We turn now to the specific analysis of university functions and begin by analysing the university function of teaching, which contributes to the accumulation of knowledge, specifically of skills, through the formal process of learning through education, or ‘learning-by-learning’ following the analysis of Conceição and Heitor (1999). This process is divergent: a university education combines the transmission of codified knowledge by the teachers with the individual characteristics of the students, in a process in which the interpretation of ideas leads to the accumulation of unique skills. Given this situation, each student can profit from these skills in the future.

Besides the well-known externalities associated with university education, which justify state support for education in virtually every country in the world with the possible exception of Japan (Eicher and Chevalier, 1993), analysis of the need to provide the skills necessary for promoting sustainability, strengthens the arguments in favour of state support for university education. The question which does arise is how this education can be effectively oriented, transmitted and assimilated to allow societies to move towards a sustainable world. Ehrenfeld (1998b) calls for a broad and deep design exercise, which goes far beyond the positivist, disciplinary framework in which human beings created, categorise, access and apply knowledge today. Since the university is perhaps the major player in maintaining the current disciplinary structure, thinking and acting differently will indeed be the challenge to face.

The increasing awareness and public pressure on national and international governments to address environmental and social concerns is resulting in a growing recognition of the vital role that education needs to play in attaining sustainable development. However, the critical issue is that, as explicitly recognised in European environmental policy, sustainable development cannot occur without education for change. As noted before, Tilbury (1999) has implicitly identified how research can play an important role in addressing this paradox. She suggests that education for
sustainability will continue to feature more strongly in environmental policy than in curriculum practice, until educational research concerns itself not just with studying the curriculum problems, but also enabling curriculum developments to occur through the research process itself.

According to Conceição and Heitor (1999), this process should be analysed considering its various sub-functions, namely, Research and Development (R&D), Research and Teaching (R&T) and Research and Learning (R&L). Moreover, R&D and R&T are convergent learning processes, the purpose of which is the creation of ideas. In this context, selectivity is required in the choice of individuals with suitable skills for these types of activity. In turn, R&L is associated with a divergent learning process, which seeks to develop learning skills through the experience of doing research. It is important to disseminate these opportunities, presenting research as a cultural factor. In these circumstances, a diversified system could respond effectively to the different demands made of it in the emerging economy, by being selective in R&D and R&T, and comprehensive in R&L.

Considering the issue of building a research agenda, the question addressed in this paper is that of the contribution of research to the process of building a sustainable future. The agenda of Schot et al. (1997) expands the disciplinary bounds of the original Gladwin (1993) paper, but still focuses on the social sciences, making an important distinction between two potential pathways towards sustainability: eco-efficiency and system change. The former is a search for rational strategies to produce, in the worlds of global business, 'more with less'. Following Ehrenfeld (1998a), key themes include internationalisation of externalities, resource productivity, loop-closing and regulatory reform, which underlie many research priorities, except those tied with consumption. The latter theme, systems change, arises from concerns that any strategy based on efficiency alone will not address the critical sustainability dimension of equity nor will it reveal the deep-seated structures on which modern industrial societies rest. Einstein's often quoted comment is most relevant here: "The world we created today as a result of our thinking thus far has problems which cannot be solved by thinking the way we thought when we created them".

The practical implication of this comment in the current socio-economic context emphasises the challenges universities are facing: new roles for governments, businesses and higher education, and how university research can contribute to a sustainable world. This will involve identifying paths for systematic change, which may be launched based on the causes for changes in the structures of modernity (Giddens, 1990; Beck et al., 1994; Mol, 1995). The imperative of becoming sustainable must also be addressed in terms of the operation of social institutions and social values in a sustainable society. A complementary, but key issue discussed by Yearly (1998) is that sustainable societies are not necessarily dependent on technological breakthroughs, but they will make unprecedented calls on expertise. At the same time, the very issues over what expertise will need to be most authoritatively exercised are the most open to question. Although most visions for a sustainable society place heavy reliance on innovation (for new energy sources, for greater efficiency in resource use, for close-looping strategies, among others), the question of how to run a sustainable science and technology policy remains largely unknown.

To address this type of questions, Andersen (1998) considers an evolutionary economic perspective to look at the innovative potential of the market. This is because research on sustainability has focused on the possibility of restraining market forces
through legislation, and an alternative approach is to analyse how far the market forces may go ‘green’. This should consider the learning mechanisms of the market – how do institutions accumulate ‘green’ competence and legitimacy issues? Following Andersen’s argument, if we take the path-dependent and cumulative nature of learning processes seriously, one has to recognise that we are dealing with transformations, rather than creations. This has clear implications to university-based research towards sustainability, and requires the analysis of the systematic nature of major technological change processes and ways of inducing such change by government and public policies.

Two further implications for research policy can be drawn from the discussion above. First, research policies must not frame the issue of knowledge transfer only in terms of dissemination and outreach (Schot et al., 1997; Welford, 1998). Instead research policies must aim at stimulating and underpinning communications processes within networks between users and producers of knowledge. Second, such policies must focus at new ways of creating accumulation and accountability within systems of knowledge production, which include economic institutions beyond the universities.

5 Conclusions: towards sustainable universities

This paper argues that the expected contribution of universities to economic development has gone much beyond the ‘standard model’, and has even surpassed what the more common ways of learning (i.e., by-learning, by-research, and by-doing, following Conceição and Heitor, 1999) would lead us to expect. The concept of reflexive learning in practice is introduced as a potential model for building the ‘sustainable’ university – a new form of this old institution designed to meet the needs of sustainable societal development. The model of ‘learning-in-action’ explicitly addresses the development of norms as part of the learning process and ties this to a concept of sustainability in which responsibility is central.

Starting from the basic concept of preserving the institutional integrity of the university, and in a situation in which education should promote learning skills, the paper points to the need to promote interdisciplinary within a context of increased awareness of the requirements towards sustainability. Awareness should be provided not only through the traditional university functions of teaching and research, but also from the creation of living environments that facilitate the ability to learn by experiencing sustainable societal conditions. The practical implication is that, besides the implementation of adequate teaching and research programmes, the university should provide to students and teachers the experience of a sustainable ecosystem. Important principles to stress in the intellectual framework are such ecological concepts as tightly closed material loops and thermodynamically efficient energy flows, which offer important themes for technological and institutional design. Other important framing ideas are three other collective features of stable ecosystems: connectedness, community, and cooperation (Ehrenfeld, 1998b). The ecological system metaphor fits well into other models for the shape of the future economic system. In the ‘new’ economic order, success will flow primarily from understanding networks, as provocatively proposed by Kelly (1998).

Sustainability is about community and interconnectedness at the core. If the students and the knowledge that universities produce are to be a primary force towards sustainability, as the authors believe is critical, then the university must itself be a
microcosm of sustainable thinking, norms, and practices that are taken away by the students as they leave for their life-long pursuits. The situation today is far from this state, but this paper points to many encouraging signs of change. As is so often the case, the possibilities are emerging from the murk of the past – all it takes is commitment, leadership, and persistence to convert them to reality.

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References


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Notes
1 By worker we refer to all who produce some intentional output, such as traditional wage earners, professionals such as doctors and lawyers, and even those who labour in the home.
2 Sustainability or its converse, the threatened state of the natural world, can be thought about as a general metaphor for the seriousness of unintended consequences that have emerged alongside the progress attributed to modernity (Giddens, 1990).
3 Such limitations apply both to professionals and to traditionally less sophisticated forms of work. Manufacturing jobs, for example, require higher levels of education today as technologies have become more and more advanced.
4 President Nancy S. Dye of the Oberlin College
5 It is not quite correct to use the metaphor of a clean slate as access to the knowledge at the university requires prior preparation in primary and secondary schools.
6 The present is an interpretation the actor makes of the phenomenological world he or she is immersed within. Again another way of saying this is that humans are aware of the world outside only by means of sensory inputs that are merely signals they become aware of. Unlike the Cartesian model of reality where these signals are deemed to encode the reality in a timeless, context-free set of symbols and signs, the phenomenological model attributes the world to an interpretation of these signals based on the specific historical experience of the actor.
7 Transparency means that the physical dimension of the resources and the world fade from the view of the actor during the course of routine actions. Referring to a famous passage from Heidegger, an actor is merely hammering; no hammer is present. Only an observer would ‘see’ a hammer.
8 In this model of behaviour, there is no internal computer that has a fundamental set of logical operators built in. All that exists is a set of experientially based rules.
9 The fact they will always offer an explanation if pushed does not mean that the explanation is correct. Many argue that the connection between the ‘real’ reason for acting and the discursive reply is tenuous at best and that the real reasons are buried deep in the unconsciousness.
10 The conventional notion of technology is that of a tool with some given function. Its transformative power is embedded in the artefact. In this model of action, the artefact is merely a phenomenal object without meaning until the actor ascribes a purposeful use to it.
11 An observer, outside the action, is able to describe or explain what the object is, but such explanation rests on the observer’s world, not the actor’s.
12 Possibilities are strategies for action that are unencumbered by the actor’s past experience in the circumstances at hand.
13 Classic texts in this field cover subjects such as decision-making under uncertainty but, with few exceptions, look only at end-states within the intentions of the actor.
14 To read the text of the Declaration, see http://www.ulsf.org/index.html.