8   What might a sustainable University look like? Challenges and opportunities in the development of the University of Luxembourg and its new campus

Ariane König, University of Luxembourg

With their combined mission of research, education and civic engagement, universities have a central place in processes fostering social and technological transformation for sustainability, at the local, regional and global scale. From this perspective one key role of the University is to understand factors that affect local and regional quality of life, whilst also producing new knowledge to enhance the adaptation capacity and resilience to local and global change. As argued throughout this book, Universities are particularly well-placed to stage living laboratories as platforms for the participatory development of new technologies and best behavioural practices, helping cities and regions to cope with new demands on societies and infrastructures, whilst attending to needs of future generations.

However, recognition of the need to better address socially salient, complex problems, also invite a re-conception of how knowledge is produced in more applied and local contexts, and what role science and research universities can play within such processes (Gibbons, 1994; Nowotny, 2001; Jasanoff, 2005; Robinson, 2008). This re-conception of knowledge production presents two main challenges in the university setting: First, there is a need to build capacity to better understand uncertainty, areas of ignorance and blind spots of knowledge between scientific disciplines. In consequence, interdisciplinary research and education can only answer to these requisites if conducted from a reflexive stance, which critically considering merits and limitations of self-referential sets of disciplinary theories, methods, models and underlying assumptions, and processes for validation. This may not come easily for some of the more disciplined academics (Boix Mansilla, 2010). Second, the production of locally applicable knowledge is a different goal from the production of disciplinary science, as Mertonian norms

including reproducibility and claims of universal validity are often the basis for systems of legitimation of new disciplinary knowledge. These systems for legitimation of new knowledge are often tied to performance assessment and reward systems in academia (Martello and Jasanoff, 2004; Krohn 2010). Thus, the relation between generalising science, and situated knowledge for local change needs to be better understood, and taken account of in the organisation of the social institution of scientific research and education.

This chapter considers the case of the development of the University of Luxembourg (UL) to explore, whether these tensions have surfaced and been managed in practice. The case of the UL is particularly salient, as it was only recently established based on a legal decree from 2003 that mandates interdisciplinarity as a fundamental organizing principle. This University was also the site for the parallel development of the Charter of the International Sustainable Campus Network and a local strategic action plan for sustainable development. Moreover, the University that is striving for recognition in terms of excellence in research will be moving to a newly developed campus built on industrial wasteland that was embedded in a region suffering from industrial decline and depression with expectations that it should contribute to regional development. In consequence of this large campus construction project it was easier to direct attention within the organization to questions of sustainable development.

In order to provide a theoretical grounding, Section 1 outlines recent changes in the conception of scientific research and knowledge production as we come to face challenges of sustainable development. The focus is on challenges of interdisciplinarity and connection to practice of research and education in a university setting. The subsequent sections will consider the case of the UL. Section 2 describes how sustainable development was rooted as a stated remit in the organization. Section 3 discusses the new campus in Belval and challenges and opportunities this presents for the university. The case may not offer path-breaking achievements on these fronts, but it serves well to discuss challenges to organizational change, and strategies to overcome these in an unusually young and dynamic institutional setting with a favourable legal remit.

The concluding Section 4 offers concrete propositions for more far reaching measures that might be considered. By re-considering the role of Universities in the face of sustainability

challenges, we will argue that possible tensions between more the traditionally conceived functions of universities and the goals of interdisciplinarity and connection to practice, can to some extent be reconciled by approaches to integrating research, curricula, pedagogical method and community engagement, such as those practiced in a living laboratory for sustainable campus development. In doing so we develop the concept of a 'Sustainable University' and point out the inherent contradictions such a university will have to wrestle with to enhance its transformative capacity in a rapidly changing world.

1. **On the reconception of knowledge production for better taking account of complexity**

The interplay of social structures and systems with the reshaping of the material world including technologies, and our cognition of, or example in urban settings (such as in the design and use of building and transport systems), present complex phenomena. They can be perceived and represented only by simultaneously using several complementary and possibly contradictory narratives, which look at different scales of analysis each with its own fineness of perception (Giampietro et al., 2012). It is common practice today in our system of knowledge production that the social-science perspectives on factors affecting individual and institutional behaviour are always neatly separated from the understanding and design of the material make-up of the world we live in, which is the domain of the natural and engineering sciences. Moreover, our systems of knowledge production, including the scientific disciplines, which aim at a certain consistency and reproducibility, each focuses on its own particular scale, rate of change and fineness of perception (Allen et al., 2001; Giampietro, 2006), and is thus committed implicitly or explicitly to reducing or denying complexity. The disciplinary fields of knowledge we have constructed over the last centuries usually direct attention at a specific system (such as the economy, a geographic region, or an ecosystem) at a specific scale (the planet, a country, organizations, a field, an organism, cell, DNA). Moreover, affiliation with an epistemic community sharing an approach of knowledge production often involves adopting shared

knowledge filters not only of shared concepts, methods and theories, but also of common problem framings and objectives, institutional practices, world views and values (Knorr-Certina, 1995; Latour, 1999). Quality criteria of newly produced knowledge usually are embedded in research procedures and approaches to describing and representing these procedures of specific disciplines. Often tacit knowledge among disciplinary epistemic communities that cannot easily be expressed and made explicit, but is shared through joint routines and rituals, is just as important as explicit knowledge in giving clues to the credibility and quality of research. The concept of complexity thus has a critical epistemological dimension, as it analyses 'how we know' about something, which is dependent on our particular dominant designed systems for producing knowledge.

Accordingly, in the face of complex societal challenges, the need to remake our conceptions of how knowledge is created in research and innovation processes in our society is being emphasised in an increasing number of academic camps from diverse fields of knowledge, including the sociology of science, history and philosophy of science, and Science and Technology Studies (STS). This section will consider challenges for the legitimation of science in academic settings from the viewpoints of interdisciplinarity and of a closer connection to practice.

1.1. Interdisciplinarity

A rudimentary definition for interdisciplinary in research and education can be ' the integration of concepts, methods, and theory from two or more disciplinary fields in order to advance fundamental understanding or address complex issues that are too broad for drawing on a disciplinary field' (NAS, 2004; Klein, 2010). What 'integration' can and may mean will vary across cases. Integration of new insights from diverse disciplines, each of which has disparate underlying assumptions, theory and models, which are operable at different scales and with diverse mechanisms for legitimation of resulting knowledge, is not easy. In fact, reaching such a deep understanding of 'integration' is often not necessary: Multi-disciplinary research, in which diverse disciplines are deployed along-side each other and insights are combined at the end is

often (but not always) successful in addressing a problem society faces (Krohn, 2010). Industrial research often is organized in this way. This form of successful purpose-driven multi-disciplinarity has also been called instrumental interdisciplinarity (Klein, 2010).

In 'interdisciplinary research', problem framing and the conduct of research relies on the interaction of disciplines. In such cases dialogue across disciplines is required to reveal the limitations of specific disciplinary, generalized models and assumptions in describing realities. This poses a fundamental challenge to traditional ways of assessing the quality of and legitimating knowledge in the disciplines. Interdisciplinarity thus challenges our current understandings of 'the scientific method for legitimate knowledge production'. Therefore, capacity building for interdisciplinary scholarship and analysis, framing, conduct and assessment of research thus needs to rely on discipline-independent sets of tools to evaluate the quality of knowledge claims (see e.g. Oeberg, 2009).[i]

Accordingly, integrative processes benefit from reflexivity at how knowledge is produced and legitimised for interdisciplinary learning and knowledge production through research (Boix Mansilla, 2010). Experts from fields like STS gain increasing recognition and traction in interdisciplinary projects (Jasanoff, 2010). STS is an interdisciplinary field of research united by the quest of better understanding how knowledge is produced, legitimised, stabilised or dismissed both within science and outside. It draws on very diverse disciplinary methods, concepts and theories to better understand how we construct our realities, highlighting the co-production of orders affecting where we direct attention and resources in terms of science, technology and social norms, and social systems and structures, including our technologies of representation. Complex, practical, and locally situated cases are usually the starting point to generate such insights. Some would argue such a perspective belongs to all research projects and courses that lay claim to deeper interdisciplinarity.

In sum, quality control and the assessment of the validity of knowledge from interdisciplinary processes presents challenges for validation of knowledge in diverse disciplines, and has thus significant repercussion also on requisites at Universities to organize for interdisciplinarity. Requisites include spaces for interaction and funding opportunities,

support for processes for evaluation of such research projects, and reviewing career incentives, especially where established measures of excellence within a discipline may fail for individuals with a greater focus on drawing together insights from across disciplines.

1.2. Challenges to notions of excellence in science from connection to practice

As stated above, critical interdisciplinary research relies on joint problem framing and the constant critical cross-questioning interaction of disciplines. Limitations of individual disciplines in representing layers of realities then have to be overcome by their juxtaposition to arrive at sufficiently close descriptions of complex and contingent realities to find tenable and lasting solutions (Krohn, 2010). Interdisciplinary knowledge production has been distinguished from disciplines on the basis that learning of the specificities and constitution of a problem or a case is as important as the scientific search for common features and generalizations based on decontextualized knowledge of a given domain. Case-based research allows drawing on diverse disciplines to characterize in detail complex circumstances in research projects closely connected to practice, such as building design, urban planning, restoration ecology, technology assessment, or the mobilisation of a community to adopt a best practice or new technology (all these examples are relevant to sustainable campus development).

This presents another challenge to the predominant discourse on what makes for scientific excellence: case-based research changes the usual relationship between the specificities of an individual case and the general knowledge base established in disciplinary fields. This not only questions processes of validation in the disciplines discussed above, but also invites a fundamental re-conception of how we think about scientific law and exemplary application, or in other words, the relation between 'ideographic' generalized abstract knowledge with claims to universal applicability and 'nomothetic' detailed locally-situated and case specific knowledge of issues and their local causes (Krohn , 2010). This links to the concept of the experimental society emerging (Gross and Krohn, 2005), and to the role living laboratories can play in generating locally contingent knowledge to help transition in a way that is sensitive to the epistemological and ontological issues of operating across disciplinary and organizational boundaries (König & Evans, Chapter 1). This in turn raises the question of which

of this knowledge is just applicable to this case, and thus local – and which of this knowledge can be generalized, and why can it legitimately travel across the globe and have claims to universality.

Similary, Martello and Jasanoff posit 'situated knowledge' as a supplement to globally circulating science, and as a necessary requisite for change and effective development and implementation of environmental politics (Martello and Jasanoff, 2004). The generation of knowledge in connection with practice, across disciplinary and organizational boundaries is therefore generally accepted in the community researching on socio-technical transformation for sustainable development as a necessary and complementary process to generation of scientific knowledge by the disciplines, in particular in order to serve as an acceptable basis for concerted action by diverse groups of stakeholders in social learning processes for local change. In applied contexts, quality is often also judged according to social, political and economic and functional criteria (Funtowicz and Ravetz 1993; Gibbons et al., 1994; Gieryn, 2006). However, extrapolation of a subset of new local insights to more general applicability is required for fostering the regime change capacity of niches of innovation (see also König & Evans, Chapter 1).

The situatedness of knowledge in terms of mental, institutional, virtual and physical spaces has also gained attention in the management sciences. Starting from the premise that information needs to be contextualized for meaning making and knowledge creation, Nonaka describes knowledge as a living process, situated and embedded in work practices (Nonaka, 2008). Accordingly we need to create such spaces that are complementary and conducive to allow groups get the right inspiration to jointly produce knowledge that is not yet embodied that will help sustainable futures to emerge (Nonaka, 2001).

To summarize, calls for the investigation of complex challenges of sustainable development in research and education and closer connection to practice present fundamental challenges to how the scientific method and the legitimation of new knowledge have traditionally been conceived of and organised for in academia .

1.3 Requisites for education and research for sustainable development

A sustainable education seeks to foster individual construction of meaning and the awareness of how we know, why we accept, and what personal responsibilities we have (Wiek et al., 2011; Riekmann, 2012). Learning is considered an iterative participative process over a whole life that provides practice in conceptualizing problems in complex terms (Sterling, 2001). Learning in this case requires a safe and person-centred environment to develop the emotional certainty to feel comfortable in the face of complexity, uncertainty and systemic ignorance. Sustainable learning also requires the appreciation of value conflicts between personal beliefs and ethical considerations within oneself, between others, and across generations.

An international, multi-lingual and -cultural environment is key for coming to appreciate plural perspectives in this manner. Similarly, whilst training in specific disciplines is a necessary basis for structured thought and systematic analysis, awareness of limitations of disciplinary models and perspectives needs to be fostered. This requires complementing training in the disciplines with courses aiming for example at solving problems on campus or in the neighbourhood (Brundiers et al., 2010). Embedding sustainable development in the curriculum thus benefits of linking education with research and opportunities to change social practice, the built environment, and operational systems, as a "living laboratory" for sustainability.

Ideally, academics of diverse disciplines and professionals combine forces to develop active and creative learning experiences. Much of the work in problem-solving centred courses is done in small peer-groups. This focus on contextualized learning, learning communities and real world problem solving not only aids in developing citizens of the future but borrows from best practices about how optimal learning takes place and how expertise is formed stemming from the growing body of literature on human learning from the developmental and learning sciences. Whilst personal attention to students is a strong point of the sustainable university, this will be complementary to an open-source approach to curriculum development and dissemination, for example by web-casting, as information technology will contribute to democratizing education along with other areas of society.

Summing up this first more theoretical section that provides the grounds for selection and composition of the case narrative: The strategic goal of fostering interdisciplinarity in education can thus be re-formulated as aiming to stage education and research in such a manner that it does not lose sight of the limits of diverse disciplinary models and of our cognition, or of the complex intertwining of the material and social world. This requires formal and informal spaces for diverse disciplinary communities, including from the natural and social sciences to closely engage with each other and with practitioners on specific projects to develop mutual understanding, a common language and common conceptions. Given the extended time-frame required for interdisciplinary teams to develop common language and rituals, it is as good as impossible to dissociate interdisciplinary education, research and practice. New connections of knowledge and practice should also be reflected in the curriculum.

2. The University of Luxembourg: challenges and opportunities of developing a sustainable university

The UL is the first and only university of the Grand Duchy of Luxembourg. One provision in the 2003 law on the establishment of the UL, which makes for particularly fertile grounds to promote sustainable development, is the promotion of interdisciplinarity as key organizing principle. Building on this, Article 16 foresees the creation of three interdisciplinary research centres. The profile emphasizes its multilingual, international and research-oriented character that is proud of a personal atmosphere. An early mission statement from 2005 refers to organisational values including respect, equity and sustainable development. The working languages of research, teaching, and the administration are French, German, and English. During the winter semester 2011/2012 over 5600 students were enrolled at the UL, from 100 nationalities. There are three faculties comprising the Faculty of Science, Technology and Communication, the Faculty of Law, Economics and Finance, and the Faculty of Language and Literature, Humanities, Arts and Education; and two interdisciplinary centres, the

Interdisciplinary Centre for Security, Reliability and Trust and the Luxembourg Centre for Systems Biomedicine.

The Board of Governors upon briefing by the University President decides on general policies and strategies. Three Vice Presidents, one for each research, academic affairs, organization and international affairs, and the Director of Administration report directly to the President, as does the Head of Sustainable Development. The Vice President for Academic affairs and the Head of Sustainable development are co-responsible for fostering interdisciplinarity in education. A large share of the university's budget is provided for by the Luxembourg government.

The organization of research subjects and degree programmes at the UL is influenced by political, social, and practical considerations of its specific particular organizational context, as well as by requisites of professions. Accordingly, the university's strategy is to develop a particular profile centred on a strategic selection of priority subjects that explicitly respond to the particular political, social and practical requisites of Luxembourg and the path-dependent development of the University. These priorities play a role in resource allocation in the faculties and give direction to research and optional specialisations in degree programmes at Bachelor and Masters level. These priorities include research on securing the role of Luxembourg as a financial centre in Europe; European and commercial law, in connection to the European Court of Justice in Luxembourg; education and learning in multi-lingual and multi-cultural contexts, which are also of strategic importance to Luxembourg society. Further priorities are also embodied in the two Interdisciplinary Centres, one on Security, Reliability and Trust (SnT) and the Luxembourg Centre for Systems Biomedicine (LCSB), which are most closely associated with the Faculty of Science, Technology and Communication.

These priorities are reflected in the first and second Four Year Plan presented to the Luxembourg government. The current four year plan 2010-2013 defines implementation actions for interdisciplinarity for both teaching and research. A first outline of the third four year plan (2014-2017) that is currently in development suggests sustainable development as a key cross-cutting area for further guiding the development of a profile and the reorganization of the University.

2.1. Instituting sustainability at the University of Luxembourg:

    connecting the global and the local

In the beginnings in 2006, a group of staff formed an informal Working Group on Sustainable Development. Since 2008, this group under a new chair who reports directly into the President (the author of this chapter), expanded from eight to over fifty members and coordinated the development of the UL Strategic Action Plan on Sustainable Development (2010-2013) in a participatory process. As stated in the UL`s Strategic Action Plan on Sustainable Development,

> "The main goal for the UL relating to sustainable development is to define and convey to students, staff and interested civil society basic knowledge on principles and practices of sustainable development, and the capacity to create solutions to reduce environmental impacts and improve social cohesion by drawing on different disciplines. The associated learning processes are conceived as being situated in a community."

Furthermore three interlinked strategic goals are to foster applicability to practice of research and teaching that centres on environmental and social issues; connections between disciplines to explore the multi-causality of societal challenges; and greater integration of research, teaching, campus operation, design, management and planning. The three activity areas of the action plan are (i) campus operations, management and planning; (ii) research and education; and (iii) social cohesion and civic engagement (see Figure 8.1.).

[INSERT FIGURE HERE]

Figure 8.1. Three interconnected activity areas in the UL Strategic Action Plan on Sustainable Development (2010-2013)

Based on the presentation of this action plan to the rectorate, in March 2009, the university created a Cell for Sustainable Development with a head, an administrative assistant, and the possibility to engage students contractually. The Cell is attached and reports directly into the President of the University. The Cell's role is to see to the implementation of the action plan, involving students and staff. The Working Group on Sustainable Development that now includes members from all faculties, the administration, students, and other public research centres in Luxembourg, advises on, and contributes to, the activities of the cell. The Cell continues to actively contribute to work of key international networks like the International Sustainable Campus Network (ISCN) and its collaboration with the Global University Leadership Forum (GULF) that is active under the auspices of the World Economic Forum in Davos.

The single most influential factor that contributed to giving plans on sustainable development traction at the UL was the effective connection of local action and international networking. At the same time as assuming chairmanship of the UL Working Group in spring 2008, the author was also voted co-chair of the Working Group of the ISCN in charge of drafting a Charter for this network with many prestigious universities. At the ISCN symposium in Zürich in 2008 this ISCN Working Group had confirmed that a novel sort of Charter was required that invited Universities to assume public accountability for progress on transformation for sustainability. Therefore the plan was to include a reporting commitment and request signature at the level of the university president. The Charter and the associated reporting process would present a unique tool to foster exchange of best practice and tools between leading universities at the international level and thus speed up developments on this front. However, some ISCN members thought chances were very low that any University president would ever sign such a document emerging from such a young network, and hence the drafting was not a popular job. The author assumed this responsibility thinking that any feedback would be very useful for the Luxembourg strategic action plan which was just in the making, if for nothing else…

The first Charter text was largely based on discussions in the ISCN's Working Group on the Charter, and literature research. The drafting was a rewarding process as the international team made many substantive and detailed suggestions.[ii] The parallel drafting of the UL's local

first Action Plan on Sustainable Development for 2010-2013 benefitted enormously from
insights of Universities already ten years ahead on campus development. Likewise, the ISCN
Charter benefitted from insights gained from local stakeholders in the participatory process
staged on the Luxembourg action plan, highlighting merits and limitations of proposed wordings
of general principles from multiple local perspectives.

The issue of finding signatories amongst the presidents of leading universities got solved
through a fortuitous Swiss connection: the ISCN representatives of EPFL (École Polytechnique
Fédérale du Lausanne) arranged for my presentation of the Charter content to members of the
GULF, an organization at the level of University presidents who meet annually at Davos during
the World Economic Forum. The Charter text was revised with them, and the vast majority of
GULF members adopted the Charter as ISCN-GULF Charter in their meeting at Davos in
January 2010, and committed their schools to its provisions (see Annex A of this book with the
officially adopted ISCN Charter Text). Now the Universities of Oxford, Harvard, Tokyo, Tongji,
INSEAD and seventeen others had become signatories and committed to adopting three
Charter principles as goals for their organization, setting locally adapted targets, monitoring and
reporting on them.

Subsequently, the proposal of Charter signature was actively supported by the UL's
Working Group on Sustainable Development, the Conseil Universitaire, and the rectorate, each
time enjoying unanimous support. The final signature by President Rolf Tarrach benefitted from
much positive feedback from across all levels of the organization, and press coverage in
Luxembourg. President Tarrach attended the ISCN Symposium 2010 organized in the
Luxembourg Pavillion at the Shanghai Expo to proclaim the news and engage more deeply with
sustainable development. Since then, and since the dissemination of the University's first ISCN
Charter Sustainability Report for the period 2009/2010 the membership of the UL Working
Group and interest in the Cell's work has grown substantially.

The signature of the ISCN Charter in June 2010 represents a further commitment to
interdisciplinarity that is also reiterated in the Action Plan on Sustainable Development (2010-
2013). Another key factor for sustainable development at the University of Luxembourg in this

new plan is the fact that a new campus is being built in Esch-Belval that will house two out of

three faculties. The remainder of this section will consider current and planned activities under

the three activity areas of the UL Strategic Action Plan for Sustainable Development. The

subsequent Section 3 assesses implications and opportunities for the progressive moving of the

University to the Belval campus over the coming years.

2.2. Campus operations, management and planning

The overarching goals for this activity area include management, construction and

refurbishment of buildings in a resource-efficient manner, and a campus that teaches about best

practices for improved use of natural resources and reduced waste. This requires an improved

linkage between organizational strategies and the campus community. This in turn can be

achieved by combining environmental considerations in infrastructure development and

management with clear communication and campaigns that foster adoption of best practices at

the individual and institutional level.

The University's 'Service Infrastructure et Logistique' is working incessantly on reducing

environmental impacts and saving costs by improving energy efficiency to ensuring

procurement of the right cleaning products and working with the caterers to ensure precedence

is given to regional, seasonal food and fair trade products. The Cell works closely with this

service and develops regular sustainability reports. Current focal activities of the cell include the

participatory development of a sustainable transport strategy, also based on regular transport

surveys of staff and students. Measures that are being prepared for implementation based on

survey results include a parking management scheme, promotion and subsidies for public

transport, and campaigns and lobby to influence demand for public and low impacts modes with

staff and offers from the municipalities, and measures to promote possibilities of avoidance of

commuting to work at peak times of road congestion.

However, in the long run the relocation to Belval is a great chance to change old

patterns of transport related behaviour of students and staff, and overcome current routines of

car overuse. The pilot survey showed that about 45% of the staff used his/her car for commuting. The rectorate just committed to subsidize up to 30% the cost of individual subscriptions to unlimited use of public transport in Luxembourg by staff. A second example is our Green Student residence Award Scheme that invites students in university housing to assume new responsibilities for reducing environmental impacts and fostering social cohesion in their housing community.[iii]

2.3. Research, education and learning

The main goal in this activity area is to build capacity within and beyond the campus community to propose solutions for complex and interlinked environmental and social issues and to assume to individual and collective responsibilities to address these. This requires problem-centred research and teaching, which transcends disciplines, connects with practical know-how, and relies on new participatory methods to find local solutions reconciling trade-offs and conflicts of interest.

Considering research, as detailed above in the introduction of Section 2, similar as in education, all priority subjects draw on several disciplines, and are closely connected to industrial sectors or practical needs prevailing in Luxembourg. Accordingly, the University demonstrates already a strong bias of being organized around research and concomitantly teaching subjects that draw on several disciplines, rather than only on one, and a strong connection to practice. In fact, the strong connection to practice also stems from the recent establishment and political struggles associated with this, which were resolved in the promise of creating a University that conducts research and offers teaching directly addresses the needs of the country. Thus, most interdisciplinary projects are strongly driven by technological, scientific and economic problems and also experience significant political pressure to directly account for large sums of research money spent by the state. These external pressures for organizing for interdisciplinarity however also means that instrumental interdisciplinary as defined above in Section 1 prevails.

One exception may be that all research units in the faculty that houses social sciences, educational sciences and the humanities are organized in an interdisciplinary manner focusing on subjects that draw on diverse disciplines, such as education in multi-lingual contexts, social inclusion, or learning, evaluation and cognitive science. This abundance of research subjects bridging disciplinary fields is also reflected in the organisation of the degree programmes of that faculty. Research in the cognitive sciences drawing on neuroscience and psychology and now recently engaging a philosopher is located in this faculty, as is a research project on local identities and regional development in the Greater Region of Luxembourg, and adjacent regions in France, Belgium and Germany. In general in the field of natural science and technology and engineering, the increased collaboration between life sciences and medicine, as well as in material science and engineering present two key fields of continuously emerging interdisciplinary projects. The engineering research unit at the UL has one focus on energy and the built environment, and has recently supervised an environmental psychologist doctoral candidate together with the department of psychology.

Considering education for sustainable development first, given that interdisciplinarity is posited as a fundamental organizing principle in the University's founding law, the starting point of making curricula more interdisciplinary can perhaps already be considered as quite advanced compared to some more traditional main stream Universities in Europe. Most if not all degrees offer some courses that are not of the central discipline of the degree, but which still are field or subject specific connections. However, for practical reasons, degree programmes are largely organized at the heart of one research unit, this often results in one prevailing framing of questions and issues society faces.

To expand the offer of learning opportunities across diverse disciplines, the Head of Sustainable Development together with the Vice President for Academic affairs developed the 'Open Course' programme. The 'Open Course' programme instituted for the first time in the winter semester 2010/2011, and progressively expanding, ensures a wider offer than just what is considered of primary relevance for careers relating to a particular discipline aiming at opportunities for exchange between disciplines in more heterogeneous learning communities.

'Open Courses' of general interest to students from all faculties can be elected as options, and which count towards a degree. In a few degree programmes no replaceable options exist as yet, and there Open Courses can be taken in addition to courses of the degree programme. The implementation of the Open Course programme is also being subject to measurement as an indicator for interdisciplinarity in the performance report of the UL to the government. We distinguish between indicators assessing *multidisciplinary* and *interdisciplinary* learning opportunities. Indicators for multi-disciplinarity include the number of courses that students can take that are not formally associated with their degree programme but that count towards their degree input. An output measure would be the number of graduands with at least 10% of their credits from courses that are not an integral part of their degree programme. For more level implementation of the 'Open Course programme' at the University the UL should set the target that all BA programmes dedicate a minimum of 10% of the Total ECTS points of a degree to optional courses that can be selected from the Open Course Catalogue. There are however relatively few opportunities for those who seek 'interdisciplinarity' in education, where students are assessed on the development of the capacity to actively draw on insights from several disciplines to develop more effective problem-solving skills within a course, or within a degree programme. An example of a well-established exception is a course within the 'Formation Continue de l'aménagement du territoire' that problematizes integration of insights across disciplines and practice for spatial planning purposes. Such attempts are however disparate and remain the exception rather than the rule.

Compared to requisites to 'sustainable education' described in Section 1.3. above, courses that sofar had emerged from research units at a faculty do not go far enough in organizing for 'transformative' learning experiences that equip participants to act as effective change agents. As one starting point in view of the desire for deeper curriculum change, the Cell for Sustainable Development advanced a degree programme leading to a Certificate on 'Sustainable Development and Social Innovation', which was approved by the UL board of governors in the autumn of 2012.

This new degree programme is unique, as it is offered to both students at all degree levels and professionals with the goal of serving as platform for social and experiential learning across disciplinary and organizational boundaries in a diverse community. All courses are explicitly interdisciplinary and connected to practice with a focus on issues salient to Luxembourg. The core course 'Science and Citizens meet Challenges of Sustainable Development' considers challenges of resource management and pollution we face combining perspectives from the natural and social sciences and from practice. The course equips participants to design and implement experimentation for social and technological change, focussing on how they can better take account of the co-production of science, knowledge and social norms; the plurality of interest, stakes and truths; and complexity and tensions arising from local and global interconnectedness. Peer group projects with practical implications are an important aspect of the course. A second course on Social Enterprise and innovation was launched in October 2012, which focuses more on social and technological change in terms of reorganisation of economic activities (for example distributed generation and ownership of energy-systems or cooperative housing schemes) through social enterprise. Case studies and peer group projects serve to explicitly integrate theory on legal, financial, sociological and management aspects of social enterprise to cases and test their applicability in complex real cases.

To sum this section up, in terms of organizing for interdisciplinarity, the University of Luxembourg presents a success story with room for improvement. The University lacks research projects that leverage natural and social science to frame and cross-question each other's assumptions to better understand complex challenges society faces.

The second, and more systemic critique voiced here, is that at present no University policy on interdisciplinarity has been adopted that attempts to create a basis for developing more of a mutual understanding of what 'interdisciplinarity might actually mean in the institutional context of the UL, that sets targets on the implementation of organizational measures to support interdisciplinary research, education and career paths, and that amongst other things posits the need for closer collaboration of natural and social scientists already as

research problems are framed. Such a policy is recommended as a first step to more a

systematic approach to support interdisciplinarity at the University, and provides a basis and an

implementation plan for other organizational measures to create spaces for supporting the

development of interdisciplinary education, research and recognized career paths (see section

1.2. above). This policy could also develop a strategy on funding and recommendations to the

national research funding authority. The Certificate on 'Sustainable Development and Social

Innovation' presents a first step towards more systemic efforts planned to foster curriculum

change.

2.4. Spaces for social cohesion and civic engagement

The current spread of the University across three campuses without a central place for all is

not helping social cohesion, apart from the odd bench here and there or the cafeteria there is no

space foreseen for work in peer groups or informal get-togethers of smaller groups. Also given

the significant proportion of public funds that finances the University, many, if not most research

units are running projects of research for social or environmental improvement in Luxembourg,

in close coordination with the respective Ministries in charge, but little of this is of the

collaborative nature implying also framing of such projects together with natural and social

scientists that we have described above.

3.   A new campus in Belval? Implications for the university's identity and mission

Since the turn of the 20th century, the development of the country's economy has depended

to a large extent on the development of the local steel industry (Primm, 2009). Belval was

Luxembourg's largest brownfield site on an area of about 200 ha. Belval was owned by Arbed,

the Luxembourg steel group founded in 1911. Today, the site of Belval presents Luxembourg's

most ambitious large urban planning project for regional development of the South. The

Luxembourg government dedicated the future use of 120 hectare area of this site to the construction of a Science Park (the 'Cité des Sciences'). The 'Cité des Sciences' shall accommodate the main campus of the UL, and other public research organizations, student life, start-up activities, secondary education, public services and administrations, culture, sports and leisure. Belval is located in the south of Luxembourg, close to the French border, on the territory of the municipalities of Esch-sur-Alzette and Sanem. ArcelorMittal continues its operations on the adjacent terrain in Belval, one factory for electrical steel production and recycling remains operational on the site. The state together with ArcelorMittal created the public-private society AGORA for the development and sale of the area, and has defined the site as a national development pole. Today there is already first circumstantial evidence supporting this view from the rising demand of office space and habitation in the area. The site is being developed to house 5000 inhabitants and 20 000 daily users who come to work on site.

The total public investment dedicated to the project is € 1,000,000,000 for all public buildings and the associated infrastructure. Planned over a period of 15 to 20 years, the Cité des Sciences will consist of about 25 public buildings on a total surface area of 27 hectares. The Cité will house over 7,000 students as well as 3,000 teachers and researchers. The Cité de Sciences will provide room for a large part of the University of Luxembourg , three Public Research Centres, and a range of other public services such as national archives, music hall and national center for industrial culture. In charge of the project is the Fonds Belval, a public institution created in 2002 in order to oversee the construction. The principal tasks of the Fonds Belval include drawing up construction programmes, organizing architectural competitions, oversight of all associated studies and of the implementation of the building projects, as well as financial management and accounting. The first building on the new campus in the Cité des Sciences in Belval, the Luxembourg Centre for Systems Biomedicine, started to operate in September 2011. The relocation of further research units is planned to start in 2014. The Faculty of Law, Economics and Management will largely remain in Luxembourg city.

3.1. Planning Esch-Belval

The UL strategic action plan and the ISCN Charter both include goals on buildings and campus planning, that are most relevant to the construction of our new campus in Esch-Belval, in particular as there were decisions to make few if any investments in the current campuses before the move. This subsection illustrates challenges of staging participatory processes if they are not stipulated for in contracts or bylaws, and if one or two organisations, who will not be key users of the site, have responsibilities over the entire budget and outcomes.

The development of the Master Plan for the site of Belval by the urban planning office 'Joe Coenen' from Maastricht takes account of main criteria for sustainable urban planning were respected, including to minimize consumption of space and natural resources; rationalize and manage efficiently urban flows; protect the health of the urban population; maintain cultural and social diversity, whilst avoiding poor coherence; ensuring equal access to resources and services. The development of the Master Plan for the site of Belval by the urban planning office 'Joe Coenen' from Maastricht takes account of three key criteria for sustainable urban development: it foresees mixed-use urban quarters, ensuring easy access to all commerce to meet basic needs by walking and cycling, an excellent public transport network connecting Belval with rest of region, and 30% of the area is dedicated to green space that also ensures high quality environmental amenities for leisure (in the Park Belval). Furthermore, the development company AGORA promotes sustainable construction in terms of building design and materials used. Planning took care to optimise connections to Esch as the country's second largest city with 27 000 inhabitants and the adjacent commune of Sanem. Luxembourg city, at twenty kilometers distance North, and Thionville, a major population dense area 20 km across the French border are well connected with public transport, a new train station has been built for this purpose (Belval Université), and improved bus services are planned. For more details please see Chapter 13 by Becker and Hesse elaborating considerations of sustainable site development and its improved embedding in the region and its economic activities.

Agora, developer of the Esch-Belval project, has recently participated in a pre-certification phase of new urban development projects organised by the German organization

for sustainable construction DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen). Agora received the GOLD pre-certificate, the highest distinction in the category "urban area of mixed use" among 13 international projects which have been evaluated.[iv] This international label is gaining rapidly acceptance across several countries and major new development projects are rated according to 45 evaluation criteria which are divided into five subject areas: ecological quality assessing environmental assets and infrastructures; economic quality; socio-cultural and functional quality; technical quality; and the quality of the planning, settlement and usage process. It represents a true invitation for interdisciplinary deliberation in participatory processes.

Looking at the sustainability of buildings, some of the new buildings in Esch-Belval have benefitted from successful integrated environmental design, such as the Maison du Savoir. The Fonds Belval, the public agency in charge of construction of all public buildings and infrastructure in the Cité des Sciences, places emphasis on integrating energy management in design: building form, quality of technology, use and comfort, proportion of renewable in overall energy used, passive solar gains and building orientation, costs of technical installations compared to total building cost, % of translucent surfaces of the facades (optimum at ~30%) are all criteria that are assessed in the pre-evaluation phase. A second key principle of the Fonds Belval is that building-users should bear a maximum of autonomy and responsibility for energy-management, and hence a building's technical services should be minimized.

The university will be the single largest user of the site, but it has no formal legally binding role in the planning process, and so far there has not been an important budget for infrastructures in Esch-Belval attributed to the University. The Fonds Belval consults the UL on its needs where it deems necessary. It is as yet unclear whether the university will own the buildings, or whether the state will maintain ownership and make them available to the university. The university developed together with the Public Research Centre Henri Tudor and the Fonds Belval a set of target values and recommendations relating to measures for efficient energy and water use that were included in competitions and distributed to all planning and construction teams.[v] Other elements of the ISCN Charter principle on campus planning, such as participatory planning (integrating end-users such as faculty, staff, and students) and life-cycle

costing (taking into account future cost-savings from sustainable construction) are more difficult to achieve in view of the current organization of the campus planning and construction process; the University has no own budget for campus construction and it is as yet uncertain of whether it will attain ownership of the buildings after moving to Esch-Belval. The recommendations apply for all stages of planning, construction and operation, and also have led to notch up the involvement of the University's engineers in the planning process a little bit.

Upon the university's request to consider DGNB certification of buildings, the Fonds Belval organised a process with local and external experts to develop locally adapted sustainability criteria and assess the site, which was led by the Swiss consulting firm Baseler and Partner, who had also been the lead consultant on energy considerations in building and site development. The main opportunity for regional development was seen in the clustering and development of a regionally well connected site for new knowledge production and innovation. Along with challenges, the study identified five interdependent core topics that will have to become central action fields in the near future to ensure the sustainable development of the site: an increased share of built surface area for housing; sustainable mobility including provisions for commuting across the border; an enhanced quality of habitation; an appropriate approach to use of energy and natural resources; and ensuring the quality of the planning and development process. These are requisites for a Cité des Sciences with a lively attractive mixed-use of the terrace of the blast-furnaces with a high and sustainable environmental quality assuring a high quality of life. Chapter 13 offers more detailed insights on the significance of these points and approaches to address them.

3.2. Integrating operations, research, education and civic engagement: challenges and opportunities in Esch-Belval

With several faculties being connected on one main campus, and with a central building designed as a turn-style for the University community, the centralised arrangement of teaching space not only makes sense for social cohesion for students and staff across departments, but

also environmentally and economically in terms of effective use of teaching space at full capacity through an efficient electronic scheduling system. Projects shaping the identity of the site could include development of buildings and public spaces and structures that teach within the university's space. The best building technology fails without user awareness (see also Meehan, Chapter 6). Eye-catching demonstration projects of environmental technologies such as solar panels, and publicly-displayed attractive visualised monitoring of energy and water consumption can be combined with other awareness raising design measures to foster behavioural change at the individual and institutional level. Development of such projects can help to integrate sustainability as a core value for improving operations and academic programmes. Beyond technology, art work connecting on-lookers with the natural elements, such as rain-, wind-, or sun-driven mobiles, have been realised in other world areas.

It will be easier to institute curriculum changes and interdisciplinary courses on such a single site. The region's particular challenges are amenable to be addressed in participatory research projects that can be closely connected to teaching and educational projects conducted as part of degree programmes such as on social housing. At least infrastructure, if not other organizational barriers can be designed to foster the coming together of diverse disciplinary cultures in courses and research projects.

In terms of opportunities for research, with the UL's new campus and three other public research centres being situated in Esch-Belval, this site holds particular promise for establishing living laboratories. Living laboratories could here well constitute a specific type of niche for innovative experiments in sustainable development. Living laboratories provide a space for diverse learning communities of multiple stakeholders to address local challenges, by jointly framing issues and defining needs and producing new knowledge that is deemed by all an adequate basis for concerted action. The purpose of living laboratories is not only to allow new things to be tried that would not be possible in conventional urban settings, but also to carefully monitor their social and physical impacts in order to provide a basis for shared learning and concerted action. Living laboratories thus serve to produce situated knowledge to better address specific local challenges, such as improving energy-efficiency of building operations or

promoting less polluting transport choices. Bounded spaces, in terms of buildings or specific quarters of the site could be chosen for new forms of public-private partnerships that emphasise joint knowledge production processes that given direction by jointly developed visions for local sustainable development scenaria.

The design of new indicators and monitoring technologies to set and track sustainability related goals in processes that engage research, stakeholders and inhabitants alike can potentially be tackled in Esch-Belval in a particularly effective manner. There is compelling evidence on the effectiveness of achieving at least short term behavioural change and reduced energy-use based on monitoring and feedback technologies targeting building inhabitants. But longitudinal data on the formation of new habits and understanding of the value of energy and its uses in individuals and organisations is lacking.   Moreover, the ethics of the use of such monitoring and surveillance tools in particular at the workplace is an under-researched field. Esch-Belval with its cluster of new buildings, public research organisations and private firms who will just have moved there, will offer unique opportunities to stage research partnerships to address these and other questions relating to the co-production of new technologies and social norms for improved quality of life with reduced environmental impacts. See also Chapter 13.

To ensure appropriate priorities for regional transformation for sustainable development and social salience of research plans and outcomes, a reframing of role of Vice Rectorate for Research could be considered from 'connecting a stakeholder, often in the private sector, with a research project he deems instrumental for his strategy' to 'staging participatory processes for priority setting and project definition', thus offering a platform for co-creation of a research strategy and projects. Such processes would provide a much needed platform for envisioning of alternative futures with respect to specific social and technological innovations of local and global significance, with participation from local and regional government, private interests, organized civil society and interested citizens.

Infrastructure requisites for the UL's new Esch-Belval campus view of connecting the University with the city and the region it is embedded in requires permeable campus boundaries, in the form of pro-actively connected infrastructure and social networks. A prerequisite for exchange in practice are boundary design processes which engage

representatives of the University and city communities, as well as planners and engineers (see also Chapter 13 by Becker and Hesse). Connective spaces between Esch town and campus should foster low impact modes as walking and well-distributed short term hire bicycles. Given the relatively short distance between Esch and Belval, a visible and attractive walking way (e.g. with bridges over larger roads) could be developed that provides a convenient and safe connection as well as directing attention to the presence of University in town and pointing to the flagship site Belval.

The main challenge for true regional integration and more ambitiously, transformation of the university and the development of research and education projects that are closely connected to local needs and local society, is the cultural gulf between academic values and a local blue collar community afflicted by regional industrial decline, with manifestations in the country's highest unemployment levels and highest proportion of school drop-outs. A new focus on improving regional quality of life with research and teaching will require reframing governance processes for developing research priorities and projects. Several universities in Japan are accumulating experiences on projects and policies developed jointly between university, city and regional councils and companies for environmental conservation, renovation, social integration, spatial planning and economic revitalization. Such endeavours have been found to work well if they rely on contractually formalised Town-Gown Partnerships that require annual reporting duties (see Chapter 12 by Kurata, Ozasa, Ueno and Hisashi). Successful examples in Japan include projects promoting low carbon mobility, gardening in the city, and the establishment of green businesses helping social inclusion of socially disadvantaged.

4. Challenges and opportunities for a forward looking University

The new campus offers a unique opportunity to improve on integrating operations, research, the education curriculum and civic engagement for transformation for greater sustainability of the university itself and concomitantly by contribute to regional transformation. This idea is

ambitious, a long-term plan, and difficult to measure in terms of cause –effect relationship once the university has moved.

Some critics claim that the striving of research and education for interdisciplinarity and for closer ties to practice creates tensions and trade-offs with more classical remits of Universities to train disciplined, rigorous critical and autonomous thinkers in a more liberal tradition. And how can we avoid that Universities are captive of too close a connection to private sector entities driven by economic short term purposes? The recognition of such tensions in the remit of Universities is however not new: there are similar tensions in the five main functions that have often ascribed to Universities in policies and academic literature over the last century: discovery; vocational training; socialisation and skills for engaged and effective citizenship; skills of critical and autonomous analysis; and transformation to effect rapid change of practices in society. If made explicit, these tensions can become fruitful grounds for improved strategies for forward looking Universities in view of society's grand challenges as we meet the biophysical limits of the carrying capacity of the planet and need to plan for according curricular change and research approaches.

The preceding case demonstrates how the building of a new campus and effective connection of insights from a global network with local considerations have helped to embed sustainable development within the remit of the UL. The new campus in Esch-Belval offers a unique opportunity for the development of a flagship site and central turn-style for the UL community, ensuring an image of high visibility and a clear identity and positioning for the UL in the South of Luxembourg. Central shared spaces for formal and informal interaction around key activities such as teaching, conferences, public events, and student-led activities is considered a prerequisite for a growing together and coordinated growth across departments, and improved mutual understanding across disciplines.

The campus planning and construction process however also illustrates the gulf between theory, on the one hand, so easily making idealistic recommendations of participatory governance processes for engaged communities jointly planning and living in sustainable environments, and on the other hand the difficult practice of diverse organizations with disparate identities and values and each received a different set of power and budget cards determining

influence in the process. Thus, how exactly the move to Esch-Belval will affect the evolving identity of our young University remains to be seen.

Considering the development of the university to-date, evolving strategies for research and education have been given strong direction by the founding law and by the broader legal, social, political, and economic environment the University is embedded in. Whilst interdisciplinarity is an explicit goal of many lead-projects, instrumental interdisciplinarity prevails. The challenge is to connect the natural and social sciences for reflexivity to better understand and question our blind spots and values underlying the generation of new knowledge. Furthermore, the relation between generalizing science within disciplines that is associated with the career reward structures and system of legitimation in universities and generation of situated knowledge for transformation and change needs to be better understood.

Summing up the more theoretical part with insights from this case, this chapter concludes with a vision for a 'Sustainable University' that seems attainable for the UL on one main new campus in Belval, considering the environment it is embedded in. A 'Sustainable University' thus ideally presents a platform for social and technological transformation for improving present and future quality of life by addressing equity issues and reducing adverse impacts and inefficient use of natural resources. A prerequisite to fulfilling this remit is that universities develop concrete projects on complex issues such as energy-efficiency in buildings or social housing, or sustainable transport in cooperation with policy-makers and citizens which help the local shared meaning of sustainability to emerge, and identify suitable pathways towards attaining these. Strategies and actions to reframe our conceptions of economic activity and progress in terms of the underlying values, also in view of low-carbon value generation towards attaining a 2000 Watt society, will play a central role in fulfilling this remit.

Research and education at a 'Sustainable University' is reflexive about how we know and why we accept, fruitfully draws on diverse perspectives revealing different truths, and takes account of tensions arising from the global interconnectedness of local circumstances. The goal is to stage research and education in such a manner that it does not lose sight of the complex intertwining of the material and social world, or the limits of diverse disciplinary models and of our cognition. The university community shall foster development of responsible citizens and

reflexive practitioners who have learnt to assume their own personal and professional stance on how to face challenges of sustainability.

Meanwhile, a reflexive organization also pays attention to staging co-creation processes for developing strategies and action plans, involving companies, and the city and regional councils even at the cost of time and money, as in the longer term this may lead to more socially salient and beneficial outcomes in view of the ned for transformation to attain greater sustainability. Such participatory processes and embedding sustainable development systematically in and integrating the curriculum, research, campus development and operations, requires dedicated central resources.

The current profile characteristics of the UL of 'a close connection to practice', 'interdisciplinarity', 'internationalization', 'an educational approach concerned with personal development', and 'attention to a firm anchorage in society' present a compelling starting point to develop a 'Sustainable University'. The resulting profile might be summarized in the following mission statement: 'to strive for scientific excellence and *social and technological transformation* for sustainability in a *caring environment* that *values diversity'*. This mission statement invites to focus knowledge creation on the interfaces between the economy, society and the environment in an interdisciplinary manner. Success in interdisciplinary endeavours requires diverse disciplinary communities to closely engage with each other and with practitioners to develop mutual understanding, a common language and common conceptions. A tall order, some would say it only achieved through regular close contact and shared routines and rituals over long time periods. The future campus of Belval that will house most if not all of the university presents one key step forward into that direction.

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Endnotes

[i] Oeberg suggests to create common ground across disciplinary research communities by discussing criteria of academic quality jointly exploring how to answer five questions: 'Is the study sufficiently demarcated?; Is the study sufficiently anchored in the relevant literature in terms of the framing, methodology and analysis?; Has the information been collected in a reliable manner and is it of sufficient quality?; is the information analysed with an informed, reflective approach?'; Are the form and structure consistent with agreed norms and does the text consistently follow the chosen form and structure?' Notions of sufficiency and coherence promise a lively, but hopefully productive debate between communities with different norms and values.

[ii] The Charter is based on discussions in the ISCN's Working Group II and dialogues between ISCN and GULF members on how the charter can best serve as a commitment to sustainability by leading organizations of research and higher education. The majority of the text was drafted by Ariane König (University of Luxembourg and co-chair of the ISCN WG II), in collaboration with the group's other co-chair at the time Joseph Mullinix (National Univ. Singapore), as well as Bernd Kasemir and Matthew Gardner (Sustainserv), Julie Newman (Yale Univ.), and Roland Stulz (Novatlantis). Strategic inputs by the participants of the "leadership track" at the ISCN/GULF conference in Lausanne, as summarized by Hans-Björn Püttgen and Kristin Becker van Slooten (EPFL) were key for preparing the current version. Inputs by T.

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[iii] More comprehensive information on the UL Strategic Action Plan and individual implementation measures can be found on www.uni.lu/sustainability .

[iv] Founded in summer 2007 as a registered non-profit association with the main objective of promoting sustainable construction methods, which contain a high level of economic efficiency and are environment-friendly, the DGNB (German Sustainable Building Council) has developed a comprehensive overall system for the sustainable evaluation and certification of buildings and urban areas, which in a holistic manner accompanies the complete development cycle of the project. http://www.belvalgold.lu/en/belval-gold-district/ DGNB website , http://www.dgnb.de/_de/).

[v] http://wwwfr.uni.lu/content/download/34543/418263/file/Charter%20Report%20on%20Sustainable%20Development%202009-2010.pdf