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Living labs and co-production: university campuses as platforms for sustainability science

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Living labs and co-production are increasingly popular strategies for universities to address sustainability challenges and yet the links between them remain largely implicit. This paper discusses the potential of living labs to provide a holistic and iterative framework for the co-production of knowledge. The University Living Lab initiative was launched in 2012 to transform the University of Manchester campus into a site for applied teaching and research around sustainability. Its goal was to provide a framework for students and academics to engage with the opportunities to work with Estates staff and their environmental consultants on applied sustainability challenges. This paper discusses the generation of living lab projects, the design of the campus as a living lab, and institutional visibility, identifying the key strengths of the living lab approach and the challenges of applying it more broadly.

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Introduction

Universities concentrate huge amounts of untapped human resources. Some quick calculations produce rather startling figures. Our institution, the University of Manchester, has 40 000 students, a quarter of whom study subjects related directly to sustainability. These 10 000 students spend an average of 1500 hours per year studying, of which perhaps half could be directed towards applied research on real world problems with non-academic stakeholders. This would yield 7.5 million hours of research time for applied sustainability issues. Nationally, a similar calculation produces a total of 0.5 million students studying on sustainability related courses in the UK [1], who could offer 375 m hours or 42 808 years of research time per year. Globally there will be 262 m students in higher education by 2025 [2], and applying the same multipliers results in an annual global research resource for sustainability of 49 billion hours, or 5.6 m years.

Even granting considerable margins of error, these figures suggest that the task of engaging university students in real world sustainability challenges is worthwhile. This paper presents our experiences doing this at the University of Manchester by transforming the campus into a living lab for applied teaching and research. Living labs constitute a form of experimental governance, whereby stakeholders develop and test new technologies and ways of living to address the challenges of climate change and urban sustainability. They involve staging intentional experiments in real world settings which are then monitored and learnt from in a rigorous way [3]. The living lab approach is increasingly popular with universities, who recognise that their campuses offer amenable real world locations in which to conduct applied research. Because the living lab approach emphasises monitoring and learning it offers a framework to connect students to applied research. Living labs promise to bring researchers, students, external stakeholders such as NGOs, SMEs, and environmental consultants, and university estates and facilities staff together to co-produce knowledge about new sustainability technologies and services in real world settings. This paper identifies some of the physical, institutional and virtual challenges to making this happen, drawing on our experiences establishing and embedding a living lab model to support applied teaching and learning. The paper evaluates the potential of living labs to support the co-production of knowledge and enhance the ability of universities to contribute to sustainability challenges.

Living labs

The contemporary focus on co-producing knowledge recognises that the immense urban and societal challenges we are facing demand concerted collaborative efforts across sectors as well as between disciplines [4,5]. Co-production involves stakeholders understanding each others' contexts, in order to work together to frame research that delivers more effective solutions. While the range of initiatives that call themselves living labs is diverse, three core characteristics distinguish them from

other approaches such as internships or practicums [6]: they comprise a geographically or institutionally bounded space, they conduct intentional experiments that make social and/or material alterations, and they incorporate an explicit element of iterative learning. JPI Urban Europe [7] defines living labs as 'a forum for innovating... [and] the development of new products, systems, services, and processes, employing working methods to integrate people into the entire development process as users and co-creators, to explore, examine, experiment, test and evaluate new ideas, scenarios, processes, systems, concepts and creative solutions in complex and real contexts'. In the field of sustainability living labs address applied problems surrounding built design, green infrastructure and low carbon technologies through collaborative experiments that integrate users and stakeholders as co-producers of knowledge. The living lab model resonates with the concerns of this special issue, offering a real place in which to frame problems with non-academic stakeholders and support management and decision-making.

Living labs have the potential to strategically frame co-production processes in two ways. First, consulting users and stakeholders allows complementary sets of projects to be strategically planned that offer holistic solutions to sustainability challenges. Second, by emphasising the iterative process of experimenting and learning from year to year they provide a more coherent basis for action over time. Both of these elements are valuable in a university setting, joining up the institutional response to sustainability challenges and engaging students in focused and applied projects that clearly contribute to a longer term, bigger picture of sustainability.

Specific bodies of work have emerged addressing the role universities are playing in establishing living labs for sustainability [8,9•,10•]. Living labs enable applied research and provide real world experience that will prepare students for a competitive job market. As König and Evans [8] state (p. 4), 'living laboratory type initiatives that use the university and city or parts of them as places to experiment with sustainable forms, technologies and lifestyles have become hugely popular around the world precisely because they have the power to harness the academic capacity of universities to address the challenges of sustainable development'. This work has highlighted the importance of problem framing, institutional setting, social interaction and learning to university living lab initiatives. As infrastructure experiments become increasingly central to urban innovation [11] it is critical to understand the role universities can play in hosting and studying them. This relates to a broader set of questions concerning the ability of living labs to enhance the broader sustainability of cities [5,12]. This paper brings these debates together by considering how living labs can catalyse new styles of teaching and learning that contribute to the sustainability of both universities and cities. The next section briefly considers how sustainability is currently framed within the University of Manchester.

Sustainability on campus

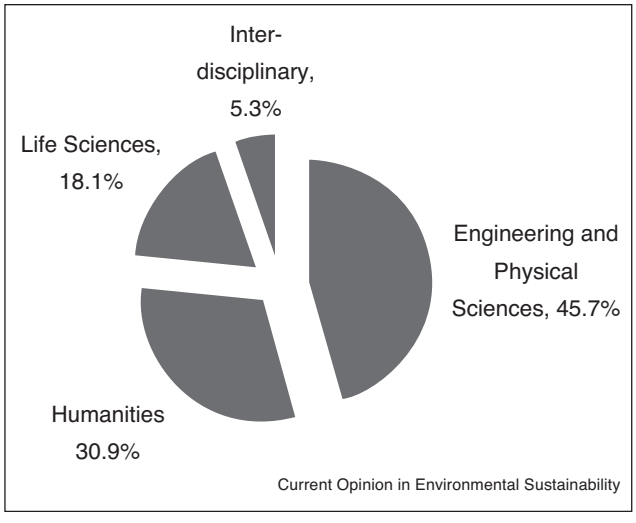
Universities have struggled to integrate sustainability into their organizational structures and business models [13]. The University of Manchester frames sustainability as part of its broader social responsibility agenda, which has been institutionalised as a top-level goal on a par with research and teaching [14]. The University has a legacy of applied teaching and learning branded as 'the Manchester Method', which involves working with non-academic stakeholders to develop real-world skills [15]. This tradition is maintained most strongly by the business school and draws on the wider reputation of Manchester as the original industrial or modern city. Numerous courses make use of applied teaching and learning across the University in some way, but the explicit focus is more on community and industry engagement than sustainability. The Manchester Leadership Programme, a flagship interdisciplinary module, gives students the chance to tackle complex, multi-faceted problems, including the issue of sustainability, in which leaders from business, academia, government and the third sector present and discuss their ideas with students. An interdisciplinary Industry Projects module requires students to write a professional sustainability report for an industry or sector with a presence in Manchester.

While social responsibility has been hardwired into University governance through the creation of positions throughout the academic and administrative hierarchy, environmental sustainability has been framed as an 'enabling strategy' that underpins the institutions ability to deliver its research, teaching and social responsibility goals. It sits firmly within the remit of the Estates Division and associated support functions and is largely concerned with performance metrics around energy and campus design [16]. There is no over-arching structure or organization of teaching and learning relating to sustainability either at University level or within any of the main faculties. Although the University has recently established a college of interdisciplinary courses that are intended to address grand challenges that will appeal to students across campus, which includes 'Innovation for a Sustainable Society' and 'Ethical and Sustainable Business Enterprise', sustainability is not systematically embedded across the University curriculum [17]. There are a number of smaller initiatives, including a community of practice focusing on Embedding Sustainable Development, but this group lacks executive powers or strategic remit. Specific challenges involve bridging the divide between the social sciences and physical sciences, which are situated in different faculties that bear the legacy of having been in different universities before the merger

that created the current institution in 2004, and between the academic and estates functions.

Despite a lack of coherence, our work reveals that the University hosts a huge amount of sustainability teaching. In 2012–13 there were 112 courses with approximately 7000 students distributed across eleven schools. Figure 1 shows that almost half of these students were in the Engineering and Physical Sciences and almost a third in the Humanities. Increasingly the University is seeking to integrate students' exposure to ideas around sustainable development in a non-prescriptive manner. Net Positive is a tool designed for University of Manchester students to explore their environmental impacts, providing them with an action plan to become 'net positive' overall. By filling in an online questionnaire about their interaction with the institution and the city, students receive constructive advice on how they can reduce their carbon footprint. Through the Ethical Grand Challenge initiative, students from across the four faculties are confronted with ethical dilemmas and 'wicked problems'. Piloted in September 2014 with over 200 students from across the four faculties a different Ethical Grand Challenge is offered to students each year, with Sustainability being the focus in Year 1 (Social Justice in Year 2, and Workplace Ethics in Year 3). The sustainability exercise placed students in the role of a planning team for a university campus expansion, and challenged them to select from a range of facilities, with a fixed budget, taking into account economic, social and environmental considerations. The pedagogic rationale behind this exercise is that by allowing students to approach and consider sustainability issues within an open-ended team-based exercise, debates will come to the fore and a greater number of students will engage on a substantive level with ideas (and dilemmas) around sustainability.

Figure 1



Distribution across faculties of students on sustainability related courses at University of Manchester in 2012–13.

The University itself is an ideal place in which to study sustainability challenges. The campus is essentially a small town, comprising 347 buildings of various ages and types spread over 290 hectares, including 850,000 m^2 of academic and support space and 9000 student residences. A £1 billion programme of building and refurbishments is currently underway, including the relocation of the engineering campus to the main Oxford Road campus. At the same time, the university is located in and integrated into the infrastructure of a major city — Manchester — and offers a starting point from which to engage with places beyond the University itself. In response to these opportunities the University Living Lab initiative was launched in 2012 to transform the University of Manchester campus into a site for applied teaching and research around sustainability. Its goal was to provide a systematic framework for students and academics to engage with the opportunities to work with the Estates staff and their environmental consultants on applied sustainability challenges that are in the real world and on their doorstep. The team comprises lead academics from the two main faculties and a research assistant, plus a lead manager and two support people in the Estates Sustainability Team. The emphasis of the living lab approach on a cycle of experimentation and learning resonates with arguments that urban sustainability graduates should be able to develop, test, implement, and evaluate strategies for sustainable development [16]. The next section reports our key experiences and reflects upon the ability of the living lab framework to transform University approaches to sustainability.

The University Living Lab

This section discusses the physical, institutional and virtual design attributes that enable a living lab style learning environment through three key elements of our work: generating a pipeline of living lab projects on campus, the construction of the new engineering campus as a living lab, and the development of institutional visibility.

Where applicable, living lab style projects have been incorporated into the performance metrics and goals against which consultants are now assessed through the University Sustainable Buildings Tracker. The University's existing environmental consultants represent a major non-academic partner in the living lab and have engaged enthusiastically with this process, identifying projects that span engineering, design, governance and behavior change. Their motivations include genuine excitement about being asked to work more innovatively, an appetite for more robust knowledge concerning their operations, services and products, and the potential to use the living lab projects as graduate recruitment

pipelines. A major challenge involves parcelling these opportunities into manageable projects that can be executed in the short term using resources available within the university community while feeding into tight schedules for design and construction.

The Living Lab team communicates with course leaders to understand the subject focus, research requirements and deadlines of specific programmes; and it liases with different University departments such as Estates and Procurement, and their external consultants, to identify current and mutually beneficial research opportunities. Many of the questions posed by staff in Estates and their consultants are big and complex, or concern components that are situated within larger systems. Taking a systems approach enables complex research questions to be broken down into suites of complementary projects. This has resulted in a list of over 40 projects focused on ongoing refurbishment projects, new campus developments and procurement and supply chain innovation. These are published on the Living Lab website as well as advertised directly to students through social media. The interest has been significant, with enquiries from students in Planning, Geography, Innovation Management, Biology and Renewable Energy Programmes. This academic year sees the first active collaborations across the faculties of humanities and engineering and physical science. One dissertation for the Innovation Management Masters programme at the Manchester Business School looks at the decision-making processes around sustainability features in heritage building refurbishment. In another project, a group of second year undergraduates are investigating the implementation of sustainability standards in a green refurbishment project for their Sustainable Business module. A group of Masters students from the Renewable Energy and Clean Technology Masters degree in the School of Electrical and Electronic Engineering are about to start projects investigating the barriers to renewable energy inclusion in heritage buildings.

Although it is too early to comment on the successes of individual projects, some observations have emerged that have a bearing on the integration of Living Lab projects into the University curriculum. First, Living Lab research projects require particular motivation from the students, as the research will feed directly into ongoing work on campus and involves a wider set of non-academic stakeholders. However, students see this as a positive challenge and recognise the value of this experience for their future careers. Students are vetted based on the quality of their proposals and the supervision burden upon academics tends to be no greater although there is a time requirement of between two and eight hours from the non-academic partner. Second, projects require a commitment from academics to work in ways that are often outside of their administrative or disciplinary channels. There is a wider role for the University to facilitate this cross-disciplinary working from an administrative perspective. Finally, the permanent inclusion of Living Lab student projects into the curriculum should not be seen as a disjointed sustainability initiative but is part of a wider drive towards applied learning and employability skills. The role of the University Living Lab is to generate and strategically coordinate a pipeline of applied projects that feed into a range of courses.

A second element involves facilitating the design of the new engineering campus as a living lab for applied teaching and research in the future. The new engineering campus is the largest element of a one billion pound capital build programme currently underway, and offers a major opportunity to design living lab enabling features into the buildings. Consulting with academic staff revealed a range of possible features, from simply increasing the spacing between wires on building fuse boxes from a few centimetres to 10–15 cm so as to enable students to attach clips to them to monitor energy flow, to distributing sensors in the concrete that is used in construction to provide a research platform for assisted navigation. Specific design requirements vary in terms of cost and complexity, and a major part of the University Living Lab work involves liasing with the design team to produce costings and work schemes to enable the proposals to be evaluated and if approved effectively worked into the build schedule. This involves facilitating more sustained engagement between academics and designers to develop cases for the proposed interventions that are robust enough to convince finance managers and the scientists who will work on the new campus. Our work facilitating the design of the engineering campus as a living lab (and the living lab projects with consultants outlined above) has been funded by an Engineering and Physical Sciences Council knowledge transfer grant. This process of identifying and proposing changes to physical landscapes and infrastructure applies to design features that would support a living lab approach across campus more broadly. Physical signposts and eco-revelatory design that can be used to highlight functions and open them up to study and potential re-design require considerable consultation and resource in order to be approved within the tight financial and legal frameworks of campus development.

A final challenge involves awareness raising and visibility within the institution. Funded by a central University grant the University Living Lab has developed a network of people and projects, which has been turned into a searchable website to help academics, students and Professional Support Staff to find each other [17]. The site also provides information about how to collaborate with estates to develop applied teaching and hosts case studies of successful projects related to both research and teaching. These include the Manchester Cycling Lab; 'i-trees', an experiment demonstrating the role of trees and other

vegetation in mitigating climate change effects; 'Campus Calculator', a learning tool that allows students to easily simulate, analyse and critique different energy use scenarios for each of the university's buildings, and the student-run Sackville Street Living Lab for experimentation with electrics, lighting, ventilation and ambient temperature. The living lab framework is also connecting students to large applied research projects on campus that have non-academic stakeholders. For example, the living lab framework has framed four masters project around a recently funded Smart Cities and Communities project called Triangulum, working with local SMEs and the City Council.

The website and associated social media advertise opportunities to work with staff in Estates and consultancies they have contracted. Virtual support is critical to host a single point of information for staff, students and stakeholders interested in taking part. It is also necessary for disseminating results and impacts, ensuring continuity from year to year to enable formal learning to take place as a basis for changing future practice. Figure 2 shows the University Living Lab logo that was designed with the help of Sustainability Communications consultants, and which is used to create an identity for the range of projects and opportunities that exist.

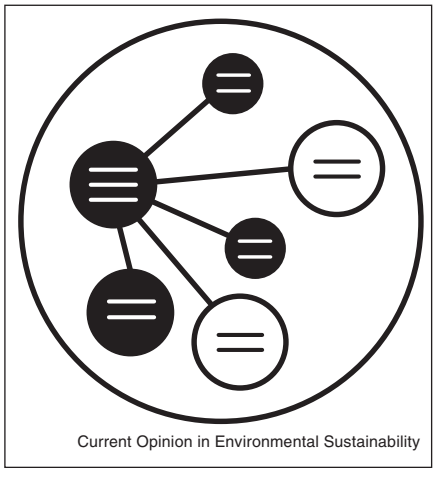
Conclusions: transforming universities to support sustainability

This paper has presented our experiences establishing a living lab framework at the University of Manchester to re-tool the campus from a passive to an active environment for teaching and learning. The key strengths of the living lab approach are that it provides a systematic approach to facilitate student (and academic) engagement with applied sustainability issues. Questions are co-produced through consultation between non-academic and academic stakeholders within a clearly bound institutional and geographical context. Projects can be coordinated horizontally with one another and vertically from year to year. Working in this way maximises the benefit of knowledge produced to non-academic stakeholders. In terms of the individual projects that have been completed the living lab model has delivered on its promised strengths; the challenge involves scaling the model up. The living lab approach has been incorporated into the University Sustainability policy and is producing a pipeline of applied projects on campus, but the majority of proposed living lab projects have yet to be adopted by students, due primarily to the competing time demands upon gatekeeper academics. The pragmatic reality of co-production is that it requires considerable time and effort towards the start of a process that can be off-putting in terms of both its resource demand and unfamiliarity. A key challenge for co-production involves facilitating and streamlining the identification of applied projects and partnering of students with non-academic stakeholders.

Our current strategy uses the web more extensively to advertise living lab project opportunities and the results of previous projects directly to students. In its first nine months, the website generated nineteen thousand unique page views, revealing a considerable appetite for innovative approaches to sustainability learning and doing. While involving higher upfront costs, hosting video interviews with non-academic stakeholders to explain specific challenges, and providing easy access to existing data, for example around building energy use would significantly reduce the facilitation burden and enable more direct engagement between clients and students. Our experiences suggest that focusing on specific problems or infrastructures is effective as it allows the creation of a community of interest, while working with non-academic stakeholders shows clear pathways to real-world impact. The iterative and stakeholder-led approach of living labs enhances the community of interest by showing how specific student projects build on each other from year to year and complement each other to generate more holistic solutions.

A final consideration involves the ability of the living lab framework to facilitate engagement with non-academic stakeholders beyond campus, either working in the wider city or enabling third parties to work on campus. While not the main focus of this paper, these kinds of partnership are critically important to bring the full resource of universities to bear upon sustainability challenges. In the UK and European contexts infrastructure development and testing through living lab frameworks are becoming a political priority, and the potential for universities to host this kind of work provides a major potential avenue through which they might support broader sustainability. A number of non-academic stakeholders are now engaging through the living lab including Siemens, Manchester

Figure 2



The University Living Lab logo.

City Council and Transport for Greater Manchester. In order for universities to realise their potential to address sustainability challenges they need new frameworks that synthesise their core business or research, teaching and social responsibility. Living labs provide new ways of working that can systematically frame co-production opportunities to achieve just that.

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