Reimagining the University of Pretoria: Engaging in the realisation of the circular economy as a transformative approach to a sustainable global future

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Introduction

Universities are under pressure from multiple sources to change. There are demands that higher education institutions should be more inclusive (Trisos, Auerbach & Katti 2021), that curricula be decolonised (Ndlovu-Gatsheni 2015), transformed, and integrated, that students be better prepared for the future world of work (Kupe 2021a), that Sustainable Development Goals (SDGs) be starting points for all teaching and research (Kestin, Van den Belt, Denby, Ross, Thwaites & Hawkes 2017), that learning be blended, and that universities play a more active role in rebuilding the economy (Kupe 2021b; Petersen 2020).

The University of Pretoria is already responding to a lot of these pressures. It has initiated processes for cultural transformation, curricula transformation, and blended learning. It is building a Centre for the Study of the Future of Work. It is actively pursuing transdisciplinary research as a new approach to solving complex social problems. It is building new networks with African universities through the African Research Universities Alliance (Kupe 2021a).

Such responses are important. However, universities should not just be responsive; they also need to encourage the practice of experimentation, to try new ideas in the hope of building better futures. Universities not only mirror society, they are also instrumental in building the types of societies in which we hope to live. It is with this perspective on the role of a university that I present this input to the broader discussion on 'reimagining the University of Pretoria'.

Directionality and the second deep transition

Environmental collapse and social inequality are the two most important challenges for the modern world. Barely a day passes without a news item on the consequences of global warming such as devastating fires, floods, cyclones,

or droughts. In its pre-release of the Sixth Assessment Report, the International Panel on Climate Change (IPCC) concludes that unless there are immediate and sustained reductions in the emissions of greenhouse gases, global warming will cross the 1.5 °C threshold within 20 years and no region will escape one of its several consequences, including heatwaves, loss of habitats, and flooding (IPCC 2021).

Similarly, the Covid-19 pandemic has pushed millions of people below the poverty line and deepened inequality (Buheji, da Costa Cunha, Beka, Mavric, De Souza, da Costa Silva, Hanafi & Yein 2020; World Bank 2020). The events of the last two years have reinforced the importance of addressing economic inequality and climate change, whilst making it more difficult to do so. The SDGs adopted by the United Nations as a blueprint for a future without poverty and environmental degradation (UN General Assembly 2015) seem more remote and unattainable than in the five years from 2015 to 2019, when global economic growth reached 3%.

One possible solution is to reconfigure the meta-rules and underlying values of global socio-technical systems, as suggested by the principles of the Second Deep Transition (Kanger & Schot 2019). The revision of society's meta-rules, in accordance with the SDGs, will introduce a new 'directionality of development', steering it towards circular, low carbon, and resource efficient practices, reflected across a broad range of socio-technical systems (Schot & Kanger 2018). In this context, socio-technical system refers to a 'configuration of actors, technologies, and institutions' fulfilling a specific societal function such as mobility, energy, and food production (Kanger & Schot 2019: 3). The adoption of alternative meta-rules will expedite the emergence of new and more sustainable systems, disrupting the historical patterns of consumption and exploitation.

Within a university context, such a reconfiguration will induce a redirection of the teaching and research activities towards the circular economy (CE). In the next section, the concept of CE is explained.

Overview of the circular economy

The exact origins of the concept of CE are somewhat unclear, as is its precise meaning (Kirchherr, Reike & Hekkert 2017). The idea appears to have emerged from the theoretical contributions from several disciplines, including industrial ecology and environmental economics (Ghisellini, Cialani & Ulgiati 2016). It was

first reported in the academic literature in the late 1990s (Zhu 1998), and became formally accepted as a new development model for China in 2002 (Dajian 2008; Yuan, Bi & Moriguichi 2006).

In this article, CE is used to refer to a systemic shift in patterns of production and consumption from 'take, make, and dispose' to 'recover, repair, refurbish, and recycle', the latter known as the 4Rs of CE (Stahel 2019). Such an approach to the use of natural resources is illustrated in Figure 4.

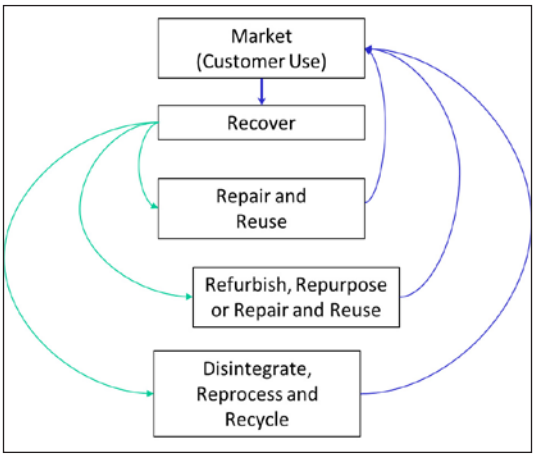

Figure 4. The 4Rs of the circular economy

The potential impact of CE is significant and appealing, given its close link to the priorities of environmental sustainability and social justice. It can address many of the SDGs, especially SDG 7 (access to affordable, reliable, sustainable, and modern energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), and SDG 12 (responsible consumption and production).

However, most of the technologies which will be required to give materiality to CE have yet to be developed. Industrial processes for the production of green hydrogen or the refining of metal ores without the use of coal, or the manufacture of bioplastics have only been validated at small scale, and are presently costly relative to the fossil fuel-based routes. Moreover, in sectors such as electricity generation, although the renewable technologies are competitive, there are many technological problems still to be resolved before global energy systems

can become totally reliant on energy sources such as wind, solar, geothermal, and hydro.

Universities and other public research organisations will need to play a major role in the development of technologies to support the emergence of CE. In the next section, further proposals as to how the University of Pretoria could become a leading organisation in such programmes are outlined. The proposals are divided into areas relating to research (Section 4) and teaching (Section 5).

Priorities for new knowledge generation (research)

Implementation of CE within socio-technical systems will require extensive new knowledge, generated in transdisciplinary spaces at public research organisations such as the University of Pretoria. Already, research on CE has attracted widespread attention and interest is growing exponentially, as shown in Figure 5.

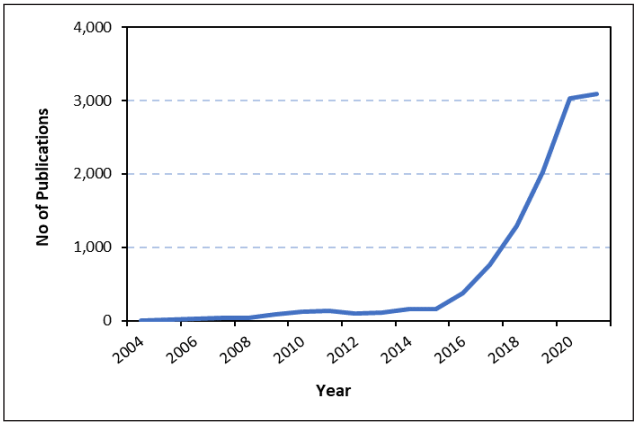

Figure 5. Scientific publications on the circular economy (2001 to 2020)

Several areas of opportunity for the university are now presented; the ideas are drawn from a number of sources and personal insights of the manufacturing sector (Iacovidou, Geyer, Kalow, Palardy, Dunn, Hoellein, Xiong & Chen 2021; Dewick, Bengtsson, Cohen, Sarkis & Schröder 2020; EU Circular Cooperation Hub 2020; Mendoza, Gallego-Schmid & Azapagic 2019).

All of the areas share three underlying values or principles: first, the importance of transdisciplinary research; second, the conduct of research as

'an agent of change', and third, the framework of *Ukama*, which considers that human existence has meaning only in relationship to the well-being of other forms of existence and the physical world (Swilling 2019). Together, the three principles endorse a post-modernist perspective that knowledge is contextual and situated. In their methodological decisions, researchers therefore have an obligation to ensure not only that their research questions are aligned with broader imperatives for change, but also link directly to processes that can facilitate this change.

Area 1: Design for circularity

Design is a cross-cutting activity which includes aspects of architecture, industrial engineering, business science, accounting, creative arts, and materials science. Design for circularity is a holistic approach which focuses on how a product can be more easily recovered, separated into components, and then either repaired, refurbished, or recycled, depending on the extent of its malfunction or redundancy (Medkova & Fifield 2016).

Examples of this approach to design include eco-design and the six strategies of circular product design, namely product attachment and trust; product durability; standardisation and compatibility; ease of maintenance and repair; upgradability and adaptability; dis- and re-assembly (Medkova & Fifield 2016).

Area 2: Transition studies and research activism

The adoption of CE will require fundamental changes to individual behaviour, and the engagement of citizens in the transition process will be critical. Based on the theoretical framework of the social construction of technology, cultural practices and norms are inseparable from the technologies, the producers, and the users. Furthermore, prior studies have shown that household consumption is responsible for 72% of global greenhouse gas emissions (Dubois, Sovacool, Aall, Nilsson, Barbier, Herrmann, Bruyère, Andersson, Skold & Nadaud 2019). It is apparent that changing patterns of consumption at household level will be fundamental to an overall reduction in carbon emissions. Disappointingly, changes through voluntary means will result in an estimated 50% reduction relative to the required levels (Dubois et al. 2019). Forced changes seem inevitable.

Using the methodology of action research, social scientists can support the development of new cultural practices relating to many parts of CE, including waste management, recycling, second-hand markets, upcycling, and resource utilisation. The objective of this research area would be to understand processes of transition, and also to train new generations of research activists, who will facilitate the development of new cultural practices to support the goals of CE.

Area 3: Circular materials and decarbonisation

In most cases, the manufacturing and construction sectors rely on raw materials obtained through energy and carbon intensive processing. In some cases, these materials are being rapidly depleted. The refining of metals, the production of cement, and the manufacture of plastics all require the use of coal or oil, and emit large volumes of carbon dioxide. The decarbonisation of these processing routes and their conversion to CE is an important research topic, the pursuit of which could place the University of Pretoria as a leading CE research organisation.

Examples of high priority areas including the commercialisation of bioplastics, and the decarbonisation of steel production, cement manufacture, pulp and paper production, and chemicals manufacture (Nurdiawati & Urban 2021). Addressing these challenges could be achieved in a transdisciplinary initiative across the university, with the involvement of several faculties.

Area 4: Recovery technologies and waste management

Many manufactured items, such as motor vehicles and electronic equipment, use a complex mixture of primary materials including metals, plastics, glass, and chemicals. At the end of life, these individual components need to be separated and recovered. There are two main approaches to this challenge, a priori design for recovery and then the use of sophisticated sorting equipment. In terms of the latter, there are existing technologies based on physical, electromagnetic, and other properties of the materials, including X-ray diffraction and moisture content (EU Circular Cooperation Hub 2020).

However, these technologies are only an initial step towards CE. Another potential area is the use of blockchain technology to trace and recover precious metals, to monitor household level consumption, and to find opportunities for

enhanced recycling technologies (Upadhyay, Mukhuty, Kumar & Kazancoglu 2021; Kouhizadeh, Zhu & Sarkis 2020).

Priorities for education

In terms of tertiary education, CE will require the development of new modules, new educational materials, and new degree programmes. Most significantly, it will be an opportunity for the university to experiment with novel transdisciplinary programmes that allow students to combine courses from different disciplines in order to prepare themselves for a new economy, based on the principles of CE.

For example, an undergraduate programme resulting in a bachelor's degree in CE design could include courses from industrial engineering, fine art, business science, and materials science. Similarly, programmes in CE transition studies could draw on modules from sociology, political science, engineering, and the built environment.

Public education organisations need to educate students not only to prepare them for employment, but also to enable them to take decisions based on evidence and the principles embodied by the SDGs, including the need to address issues of environmental and social justice. In addition to domain-specific skills, educational programmes also need to include the development of core skills in hermeneutics (analysis, interpretation, understanding, and communication); the issues of *Ukama* and social justice; the concept of the public good (contributing to the development of capabilities in areas that will lead to necessary changes); development of self-confidence and capability (making sense of their lives and realising their goals); and creativity (finding novel solutions).

Ultimately, one of the most important benefits of a university education for a student is the development of capability to function, or the enhancement of agency through the development of individual capabilities, resulting in the realisation of functionings (Walwyn & Combrinck 2021). The model derives from the work of Amartya Sen, who considered that development was primarily an issue of education (Sen 1999), as illustrated in Figure 6.

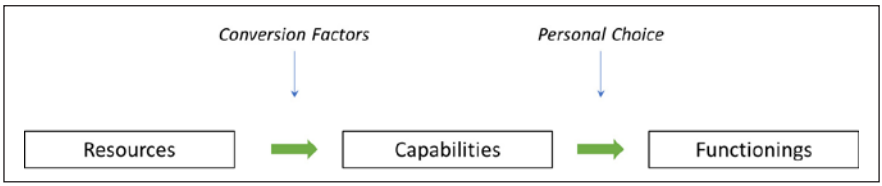

Figure 6. Conversion factors, capabilities, and functionings

Conclusion

The transition to a circular economy will require fundamental changes to the way that natural resources are accessed, manufactured into technological products, recirculated, and replenished. The University of Pretoria can support this transition through its research, teaching, and outreach activities.

It can establish new research themes in important areas such as circular design, transition studies, circular materials, and waste management. It can introduce new transdisciplinary qualifications, especially in post-graduate degree programmes, that combine modules from different disciplines so as to provide students with marketable skills in CE.

It will not be able to achieve these outcomes on its own. It needs to build university industry clusters at local and continental level, support social innovations like living labs, the training of entrepreneurs, and engage in partnerships with other universities. The university must also be part of the change process. In this way, it will not only provide the knowledge and skills for CE, it will also be a model for the type of society within which we want to live.

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