Donut Plugin: A Circular Design Tool to Implement Circular Economy

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ABSTRACT

The paper aims to integrate the circular economy and design process to develop sustainable artificial intelligence (AI). Designers are known for comprehending people, imparting values, attitudes, and perceived user demands and want. We laid down a basis for theory-building regarding the role of designers within the circular economy (CE). We contribute to the process of implementing CE principles in order to reduce the harm caused by the production and consumption of technology. Using CE principles, the paper develops in the direction of making technological developments that are ecologically beneficial, leading to the design of better AI. This work suggests a circular design plugin that may be used with design prototyping software to build AI.

CCS CONCEPTS

• **Human-centered computing** → **User centered design**; • **Computing methodologies** → *Cognitive science.*

KEYWORDS

Circular economy, Circular design, Design tool, Sustainability, Artificial Intelligence

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1 INTRODUCTION

The circular economy is a perspective about how the world's economy may develop in a manner that is regenerative and restorative by purpose and design [26]. It is a compilation of various concepts collected to reframe the argument around resource usage and waste [7]. It is based on a *systems thinking* approach and aims to eliminate wastage and other negative externalities, conserve and enrich natural capital and circulate goods, components, and materials at their optimum level of utility and value [31].

When designers and developers are articulating a user-centred design (USD) framework for supporting the design of systems that meet user requirements [1], there is also a need to build a system that is sustainable leading to achieving circularity. In USD, the design strategy prioritises users' demands and follows an iterative design process that keeps the user's needs in mind at all times. In the USD framework, they focus on usability goals, user characteristics, tasks and workflow of a product, service, or process at each stage of the design process [30]. Designers must take into account user interactions and communities of users' experiences with the product and its milieu. Currently, numerous assumptions are made about how people engage with the product after purchasing it [24]. USD allows developing empathy for the individual for whom the design is for. In the circular economy, designs are created not just for a consumer or user, but also for a variety of people who may be involved in the extended value chain. It will assist in gaining a better insight into what is essential to people at each stage of the product or service development process [36].

USD is silent on the sustainability dimension, concentrating on empathy, defining, ideating, prototyping, and testing to benefit users. Sustainability as defined by the United Nations (1987) means the capacity to meet the requirements of the present generation without compromising the capability to meet the needs of the future generations [29]. It is unclear how the concept of circular economy (CE) will lead to sustainable USD in terms of conceptualizing the designer's opportunity with the CE with the synthesis of information from the social sciences by understanding the consumption pattern, consumer behaviour, and cultural development. The existing approach dismisses design as a 'radical humanist' orientation, which has ramifications on how individuals are viewed (from 'users-as-subjects' to 'people-as-participants') creating ethical concerns regarding design application under diverse circular economy framings. The study serves as a foundation for future study and theory development to provide a more complete understanding of the designer's role in the circular economy [24].

Technological advancements are revolutionising our way of life while also propelling us farther into the abyss of disaster, as seen by climate change and resource shortages. The industrial revolution ushered forth a slew of innovative technologies with enormous potential but leading to negative externalities also by causing air and water pollution and depletion of natural resources. Though the technologies are referred to as machines and devices developed for applications to put scientific knowledge for practical purposes, they end up causing harm to this planet. So, their development should

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be done in an environmentally friendly manner to prevent the planet's health. For example, in the transportation sector, vehicles contribute to air pollution by nitrogen dioxide and sulfur dioxide emissions, known or suspected to cause cancer or other severe health and environmental effects. To reduce these emissions, the transport industry must switch towards renewable energy sources to run vehicles to prevent these.

Similarly, electronic garbage, often known as e-waste, refers to gadgets that have been dumped electrically or electronically. E-waste includes used electronics meant to be destroyed but non-biodegradable. They turn into waste. So, instead of ending the product's life following the linear principles, companies should transit towards circularity by reusing, recycling or regenerating the used gadgets to minimise wastage. Further, data centres are mandated to facilitate the flow of data uninterruptedly. Being in the era of digital economy, AI's energy usage is considerable, and data centres are necessary for storing the massive volumes of data required for AI systems, but they use much energy and emit greenhouse gases, and this needs to take care of by the operators of the data centres.

This paper seeks to contribute to the process in which the adaptation of CE principles can facilitate minimising the harm caused by the production and consumption of technology. The research advances to make advancements in the technology as environmentally friendly by using CE principles. This work proposes a circular design plugin compatible with design prototype tools.

2 RELATED WORK

It is usual in the history of human civilization for societies to experience a lack of information on how to improve their sufferings while a substantial insightful notion for the solution of the suffering stays unexploited by its contemporaries and forefathers for decades. A notable illustration of this is the origin of the wheel, which was created and utilised in Mesopotamia about 3500 BC [40]. The wheel did not become a necessary component of technology until the Industrial Revolution. Substantial progress in technological innovation has been accomplished in altering several manual chores and activities which had been in existence for many years where people had exceeded the thresholds of physical capability. Artificial Intelligence (AI) offers the same transformational potential for the augmentation and possible replacement of human functions and activities in a broad range of industrial, cognitive, and social contexts. The rapid change in this new AI technological age is astounding, with fresh discoveries in computational machine learning and autonomous decision-making establishing new possibilities for future innovation [16]. The effect of AI might be enormous, with industries such as banking, healthcare, manufacturing, retail, supply chain, logistics. Artificial intelligence (AI) advancement and possibilities have been debated by both technology enthusiasts (those who believe technology offers opportunity and reduces disparities) and technophobes (those who are disproportionately fearful of technology) [27]. AI has been a contentious topic since its start in the 1950s by John McCarthy [37]. However, Turing noticed and addressed the prospects of "machine intelligence" or "artificial intelligence" as early as the mid-1940s [14]. AI can be defined as a set of technologies [39] and frameworks, notably statistical and symbolic [18], aimed at emulating human cognitive functions [21] or displaying aspects of human intelligence by undertaking different tasks, with analytical intelligence coming first followed by intuitive intelligence and empathetic intelligence [19]. AI has been a persistent theme in computing science, with numerous scholars, including Turing, conducting study on the subject.

Human experiences are at the heart of design practise [15], and this is recognised as a key initial point for innovative solutions [42]. Designers are acknowledged for their abilities to comprehend people, impact values, attitudes, and perceived user demands and desires [43]. Designers are ideally positioned to build culturally dominant value systems through the development of symbolic meaning [44]. Addressing a consumption culture [20], in which things are prematurely aged [12] and discarded, necessitates changes in both consumer behaviour and culture [11], implying that there is significance in drawing on design abilities for the creation of circular economy solutions. However, design has previously been discussed in the context of the circular economy purely as a technique of engineering product life-extension (through durable design, modular upgrades, repair and design for maintenance). So, it is essential to bring CE as an initial thought in designing and developing AI.

The global economy continues to be driven by narratives of growth-driven capitalism, whose exploitative and profit-driven character is related to climate change and high rates of environmental degradation, exceeding the Earth's capacity to replenish its limited resources [34]. The circular economy is one of the revolutionary concepts that is challenging the present model of mainstream economic development. Although the definition of the CE is still evolving, based on various disciplines and ideologies [25], it refers to the practices which are regenerative based on the principles of reuse, repair, refurbish, remanufacture and recycle. It mitigates the leakage of resources, wastes, emissions and energy by obstructing, closing and limiting the energy and material loops using long-lasting design and maintenance. Kirchherr et al. analyses 114 definitions of CE and then proposes a definition by referring to circular economy as an economic system which is based on business models that substitute the notion of *end-of-life* with the constructs of reuse, recycle and recover materials to alter the patterns of consumption and production/distribution at the micro, meso and macro levels with the target of attaining sustainability in growth and development [23].

3 PROVOCATION

There have been thousands of ecolabels that have been made to indicate on environmental, social, and governance metrics of a product or service [38]. These labels help to give a sense of the environmental impact to the humans that use the products, but is this enough? Despite bringing different measures, the technologies built are not being circular. This is due to a shortage of systemic thinking processes. Designers are looking at little pieces of the system and optimising them but forget to look at the bigger scale. To apply system thinking, designers should think of efficiency rather than effectiveness. For example, instead of optimising the cars to reduce pollution such as making electric vehicles will not solve the problem of pollution and traffic, rather the problem might be somewhere else. Second, designers tend to work on the immediate

symptoms rather than fixing fundamental problems when developing technology. This is known as burden-shifting, where the focus is on attacking symptoms, leading to further dependence on symptomatic solutions [22]. Furthermore, designers should be aware of the rebound effects that says technological progress that increases the efficiency with which a resource is used tends to increase (rather than decrease) the rate of consumption of that resource [4].

When thinking from the systems perspective, designers should think of the root causes of the problems from where they occur. Find leverage points that are points of power, where there would be more impact while building the solutions [2]. Systemic thinking from the economic domain could be used in the design world while making design decisions. The focus of the provocation is to nudge the designers to think critically about the design decisions that they make while making a software [3]. Currently, software development is viewed as an iterative process. Requirements talks, requirements definition, software architecting, implementation, and testing are all common aspects in this process [41]. Making a software architecture is a decision-making process. It entails making the appropriate decisions at the appropriate moment. These design decisions are usually not clearly stated in the artefacts that describe the design and are not thought from a sustainability perspective. They exist only in the creators' thoughts and are thus system thinking process is not involved. In the early design phase, much work is put into making the proper design decisions. However, because the focus is solely on the outcomes of the decisions and the single product, the design's systemic thinking is rarely thought about. As a result, the designers' analysed options, trade-offs, and reasons for the decision stay from the product perspective only and not from the environment perspective. This tacit knowledge of systems is not cared about. To care for the tacit knowledge, we propose integrating the nudging technique at the early stage of the design process that helps designers remember why decisions were made. These decisions should involve thinking from a circular economy context-based perspective following the principles mentioned in Figure 1.

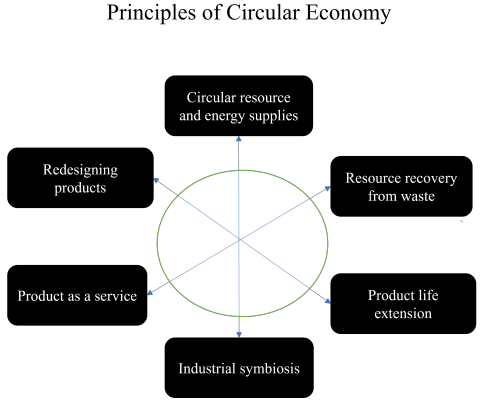

Figure 1: Principles of Circular Economy

There has been couple of examples where circular economy principles have been used in making digital technology sustainable. Such as *Apple Trade-In* allows customers to trade in their old Apple gadgets for an Apple Store Gift Card or a refund. This creates a win-win situation where the customer may buy a new product and the brand can recycle previously sold items to make new ones [10]. *Project Ara* is a modular smartphone that can be upgraded easily by swapping out individual components or modules. The phone is made up of 12 to 22 interconnected modules that may be assembled without the need of screws, glue, or other tools. At the heart of this design is the single module's aesthetic (colours, materials, and finishes) and functional (data storage, functions, and demands) upgradability [17]. *Repairability Index* spans from 0 to 10, is stated on a ten-point scale. The product is more likely to be repairable and hence long-lasting if the score is close to 10. In order to be noticed, the evaluation will be put next to the price in-store or online. A colour code will emphasise this rating from red (the lowest rating, implying that the product is good to throw away if it breaks down) to green (the highest rating for devices that are easy and economical to repair) via orange (intermediate note for a possible but expensive repair). This score is decided by three factors: the clarity of the user's handbook on device operation; the degree of difficulty of disassembly and reassembly in the case of a device; and the degree of difficulty of disassembly and reassembly in the case of a repair; and, lastly, the availability and cost of replacement parts [33].

These above mentioned interventions are the good stepping stones to achieve circular economy but would not be sufficient. Hence designers need to consider circular economy principles while making design decisions. These design decisions should be part of the design thinking process. Design thinking is a non-linear, iterative approach that allows teams to better understand their customers, challenge assumptions, re-frame challenges, and develop and test novel solutions. Both USD and design thinking find solutions to people's problems and focus on being empathetic, collaborative, and iterative nature. We choose 5 stage design thinking process for the provocation as it consider technological feasibility and business goals into consideration [13, 35]. They are given as follow:

- **Empathize:** Understanding the human needs involved
- **Define:** Re-framing and defining the problem in human-centric ways
- **Ideate:** Creating many ideas in ideation sessions
- **Prototype:** Adopting a hands-on approach in prototyping
- **Test:** Developing a testable prototype/solution to the problem

3.1 Integrating CE into Design Process

We propose that designers start thinking about sustainability using circular economy principles during the ideation and prototype stages. The design decisions made during this time have longer impacts on both the users and the environment. Designers must consider contextual interactions and communities of users' experiences concerning the product and its setting. There are numerous assumptions about how people engage with products once they have been purchased at the moment. In practice, designers must consider the individuals who will be utilising the service at several points: at the point of sale, throughout use, and during any further contact with a provider.

A great focus is placed on product and design in order to engineer design techniques in the circular economy literature [5, 8]. Design techniques that consider the symbolic significance of 'person-product' interactions (e.g., through memory attachment and personalisation) have been created in the design literature as a strategy to bridge the knowledge-behavior gap discovered among pro-environmental customers. [28]. Reported user aspects consider 'emotional / visual' (e.g. surface damage, wear and tear) reasons for product replacement [9] and technical obsolescence [11]. Similarly, Baxter and Childs argue that understanding people's connections with their belongings and object attachment is essential [6]. In this approach, design may be used in a much broader sense, beyond design engineering methods, to build on these social insights. Thus figure 2 represents the combination of circular economy principles with five stages in design thinking process.

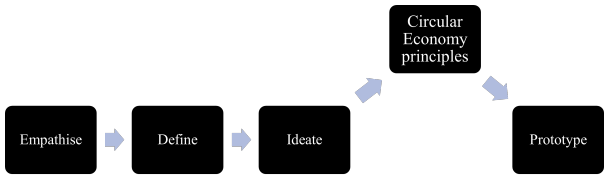

Figure 2: Combining Circular Economy principles with 5 Stages in the Design Thinking Process

3.2 Circular Economy Plugin

Donut plugin, based on circular economy principles, indicates that designers must incorporate sustainability while designing digital technology. The donut represents the constraints of living on a planet together. Donut plugin reframes the design theories to enable a human centred and sustainable futures as showcased in figure 3. This plugin is helpful when talking about design as well as sustainability. Design is often talked about in terms of constraints but less in terms of sustainable or communal values. This plugin is created to remind the designers to design within the ecological constraints of natural resources and ecosystems. So, the donut plugin seeks to reshape the mind of designers, reform the vision of the users and drive systematic change in how we treat the planet.

The Donut Plugin is inspired by Doughnut Economics diagram explained by Kate Raworth as: the Doughnut model itself is simple enough. Two concentric rings each represent either a social or ecological boundary. The area between those two rings defines the "ecologically safe and socially just space" in which we should strive to live. Anything that crosses these boundaries represents social or ecological deprivation [32].

Thus, this plugin aims to bring circular economy as an initial thought in developing a digital product or service. It nudges designers to highlight the product's life cycle to minimise the harmful environmental impacts during its usage.

Next we showcase the features that donut plugin will consists of in figure 4. These features proposed a donut plugin that employs

Figure 3: Donut plugin: Based on circular economy principles (designed in figma software)

CE principles to encourage designers to think in terms of systems rather than single users and products.

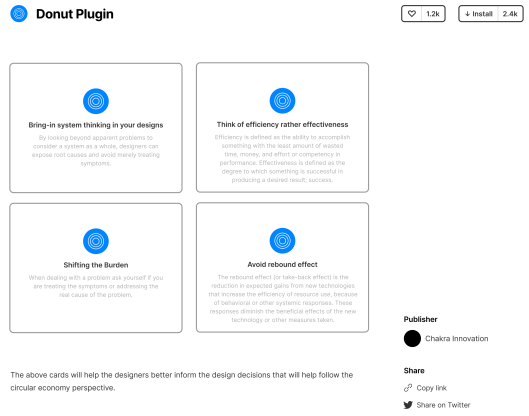

Figure 4: Features of donut plugin

- **Bring-in system thinking in your designs:** By looking beyond apparent problems to consider a system as a whole, designers can expose root causes and avoid merely treating symptoms.
- **Think of efficiency rather effectiveness:** Efficiency is defined as the ability to accomplish something with the least amount of wasted time, money, and effort or competency in performance. Effectiveness is defined as the degree to which something is successful in producing a desired result; success.

- **Shifting the Burden:** When dealing with a problem ask yourself if you are treating the symptoms or addressing the real cause of the problem.
- **Avoid rebound effect:** The rebound effect (or take-back effect) is the reduction in expected gains from new technologies that increase the efficiency of resource use, because of behavioral or other systemic responses. These responses diminish the beneficial effects of the new technology or other measures taken.

As InContext: Futuring User-Experience Design Tools workshop focuses on having digital tools that enable designers to create appropriate, enjoyable, and functional experiences, we propose a donut plugin. This plugin emphasizes designers' focus on systemic thinking that acts as a novel approach to advancing toward a sustainable world.

4 FUTURE WORK AND CONCLUSION

This early-stage paper aims to integrate the circular economy principles into designing technology by emphasizing a designer's role. We proposed a donut plugin that uses CE principles to nudge designers to think from systems rather than focusing on a single user and a product. The proposed plugin tool needs to be tested with the designers and developers to test the hypothesis and understand it. Currently, it is a theoretical model and needs to be validated.

We have identified a range of aspects for additional research through this paper to commence a more in-depth conversation on the designer's opportunities within circular economy research. Design research in the circular economy must generate information on developing products and services while considering norms, behaviours, attitudes, and the circumstances of people's social life. While much work remains to be done, there is a clear need to better build on existing knowledge developed both within and outside the discipline of sustainable design, participatory design and value-sensitive design.

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