ENABLING DESIGN FOR ENVIRONMENTAL GOOD

SUB REPORT

ECO-DESIGN PRINCIPLES

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EXECUTIVE SUMMARY

'Enabling Design for Environmental Good' is a project that deploys insights and approaches from design, innovation, and sustainability to propose a suite of actions to improve the design and specification of products, materials, and processes in the Australian context.

The Department of Climate Change, Energy, the Environment and Water (previously The Department of Agriculture, Water, and the Environment) commissioned an RMIT-led consortium, with Arcadis and One Planet Consulting, to run the 'Enabling Design for Environmental Good' Project (the Project).

This report is an extract from the original, focusing specifically on Eco-Design which is the underlying concept of the approach to design and associated interventions in this report.

Enabling Design

Design is the focus of the Project, as it has been touted as locking in up to 70% of the environmental impacts of a product (Lewis et al. 2001) with up to 85% of the financial costs across product life cycles. Environmental impacts such as climate change, toxicity, and pollution have a direct link to human health. Thus, design has a crucial role to play in ensuring products and materials are environmentally and economically sustainable, and better for humankind and their habitats.

This Project found that there are many contributory factors to good or bad designed products and materials; it is not solely the responsibility of designers. The design and lifespan of products and materials are determined by regulatory, policy, financial, and educational levers formed and managed by governments, industries, businesses, associations, institutions, and communities. Changes to the environmental impact of products and materials can be enabled by design but require the above parties to change their approaches that prefigure outcomes and externalities. It became clear in the research that Australia has many voluntary measures but has not taken the next steps to embed and mainstream these measures via procurement, labelling requirements, and financial and regulatory mandatory mechanisms, among other actions.

Thus, the central intent of the Project was to recommend actions for a range of stakeholders regarding the design of products, to lower product-based environmental impact or improve environmental performance. These actions can also assist policy and program formation, both industry and government based, so that design can better contribute to nationally agreed targets for resource recovery, reuse, and per capita waste reduction. In short, to extend product life and ensure they are durable, reusable, repairable, and recyclable (more circular). It is envisaged that measures recommended by the Project will help reinvigorate key manufacturing sectors, modernise the recycling sector, increase resource security and productivity, and strengthen Australia's competitive position in the circular economy (CE).

The Project

The Project presents ten (10) overarching cross-cutting levers for products that span the Australian economy and details four (4) priority sectors/product categories. This approach ensured key sectors ripe for change are supported and engaged, and that the overarching principles and actions apply to, and benefit other sectors across Australia's economy. The industry-specific dimensions of the Project are covered in other reports produced by the Project.

While products and materials have a range of potential environmental impacts, the Project's key focus is on the primary impacts and opportunities afforded by the materials specifically, with energy, water, and other environmental aspects secondary considerations. Thus, the Project particularly relates to United Nations (UN) Sustainable Development Goal (SDG) 12, which is to ensure sustainable consumption and production patterns. This aligns with a global movement underway to improve products and materials, shifting away from recent trends that enable high consumption and waste disposal of single-use, short-life, unrepairable and unrecyclable products.

A literature review was undertaken in this context and structured to provide a comprehensive knowledge base for the Project. Following the literature review, a detailed consultation period commenced. The Project team conducted this phase as an iterative approach involving key stakeholders, consisting of interviews and workshops, to collate their views about adoption options for initiatives that could enable Eco-Design in various contexts.

Eco-Design

'Eco-Design' is a term used as a catch-all concept of enabling design for environmental good in the Project, for "any form of design that minimises environmentally destructive impacts by integrating itself with living processes" (see Van der Ryn & Cowan 2013). Going further than the traditional notion of 1990s-based Eco-Design, the Project definition is far more inclusive of the concepts of; regenerative design - transitioning from designing 'like' to 'with' nature'; designing in systems and for life cycles; designing for zero waste - moving from a take-make-waste model to circular economies; and making better design choices, or ethical design for collective wellbeing which includes links to Indigenous knowledge and expertise. In this respect, the definition is aligned with the re-energised Eco-Design approach of the European Commission (as part of the related Circular Economy Action Plan).

What follows is an overview of the four Eco-Design principles identified through an extensive literature review throughout the Project, followed by detailed analyses which synthesised the principles to practices related to design.

Note on project scope

The Project scope was not focused on a comprehensive review of legislative conditions across the various Australian jurisdictions, rather it was to articulate interconnected financial, policy, regulatory, and educational levers for governments and industry to enact to enable design for environmental good. However, it is acknowledged throughout this report that new or revised legislation is likely needed for recommended Project measures to be viable, as linked to various. Through the Project consultation, stakeholders raised concerns about various regulatory barriers. Thus, a thorough regulatory review should be conducted following this Project to determine what needs to be changed across local, state, and federal laws to enable the recommendations for this Project to flourish, which include issues related to (but not limited to); the definition of waste versus resources and how these interact with regulatory mechanisms; enabling design in the circular economy; and mandating various targets that signal change to the design community. Such issues are explored in the main report.

ECO-DESIGN PRINCIPLES

ECO-DESIGN PRINCIPLES

A literature review was undertaken to first establish key Eco-Design principles and then align these to current fields of practice to build a framework for the participant consortium for consultation. Four seminal texts – Lyle (1996), Braungart and McDonough (2002), Van der Ryn and Cowan (2013), and Penty (2019) – were cross-referenced and correlated alongside other significant works in the field to establish overarching Eco-Design principles.

This Project considers 'Eco-Design' as an all-encompassing term to describe any design field that is derived from sustainability-driven intent, aligning with Van der Ryn and Cowan's (2013) definition as "any form of design that minimises environmentally destructive impacts by integrating itself with living processes". Two overarching themes and four key principles emerged.

The themes were:

- Eco-Design delivers 'sustainable material outcomes'; or real-world material outcomes that lead to ecological, economic, and human health and wellbeing (which is typically approached in a results-focused way)
- Eco-Design is derived from 'ethical-value approaches'; or a set of values, ethics, and ideologies that result in sustainability-focused actions, (typically approached in a process-focused way)

The Project focused primarily on the former but considered the latter an important inclusion for further investigation, given it is often difficult to separate physical actions from values and beliefs.

There were several consistent elements underpinning Eco-Design practice that impacted the mechanics of both 'sustainable material outcomes' and 'ethical-value approaches'. The most pervasive is the need for a whole-systems approach that accommodates multiple scales with through-lines for dynamic scalability (i.e. cell, organ, organism, species, ecosystem, planet, universe). Other high-order themes include; fostering regenerative circular material flows without waste or toxicity; dematerialising product design; designing entire product life cycles up-front; taking ownership of big issues and working collaboratively together to solve them; ethically decentering humanity in preference for whole systems wellbeing; and recognising the importance of designing for the needs of specific locality and place when designing for ecological wellbeing. These helped frame the four key Eco-Design principles.

These Eco-Design principles are:

- Principle 1: 'Regenerative design - transitioning from designing 'like' to 'with' nature'
  - This means collaborating with nature to preserve, promote and regenerate ecosystems, society and culture, paying particular attention to accommodating diversity in each bioregion and place
  - This requires transitioning from current eco-efficiency practices that aim to reduce resource use and toxicity, to emerging eco-effectiveness practices that actively collaborate with natural systems for positive returns. Importantly, Eco-Design aims to collaborate with biological systems from the outset, rather than retrofitting biological principles to existing industrial practices
- Principle 2: 'Think in systems and design for life cycles'
  - This means having a long-term, integrative whole systems perspective and approach to design, recognising that each element at every scale is intrinsically intertwined with every 'other' (e.g. cell, organism, ecosystem), across life cycles
  - This requires practices that embrace complexity, diversity, and scale in transparent and collaborative approaches
  - These practices should concurrently develop products, systems, and services to encourage sustainable material use, interdisciplinary collaboration, product customisation, repairability, and emotional attachment for product longevity
- Principle 3: 'Zero waste - Move from a take-make-waste model to circular economies'
  - This means eliminating the concept of waste and removing all toxicity at every life cycle stage
  - This requires circular design practices as represented by Braungart and McDonough's model of the 'cherry-tree' (Braungart & McDonough 2002), which encourages closed-loop total-systems approaches for regenerative circular material use, where waste in one cycle becomes nutrient in the next
- Principle 4: 'Making better design choices - Ethical design for collective wellbeing'
  - This means making ethical design choices that bring about the highest possible total well-being, inviting everyone to be involved in designing an abundant and secure future together
  - This requires both a common understanding and ethical integrity for both designers and consumers, designing as custodians of the environment, society, and culture and making transparent decisions that ensure the greatest long-term common good

Four Eco-Design principles in brief

The following sections briefly expand on the above principles. Please see Part C for a Glossary containing an expanded list of terms (each with a corresponding definition) from reviewed literature during the Project, a table of Acronyms with full terms, as well an overview of the literature review method applied during the Project.

Eco-Design principle 1

Regenerative design: transitioning from designing 'like' to 'with' nature

It is clear current design for sustainability approaches are not delivering the results needed for long-term ecological wellbeing. While there are still some gains to be made in developing more efficient processes, there is a need to transition from an eco-efficiency mindset (or, designing efficient industrial ecosystems that regenerate *'like'* nature's systems) to one that brings about eco-effectiveness (or, collaborating *'with'* nature to re-create waste-free biological systems) (Penty 2019). The following two sections outline the difference between the two, discussing past current, and emerging technologies and approaches.

Eco-efficiency (less bad)

Eco-Design to date has largely focused on improving resource efficiency and reducing toxicity, investigating ways to make more from less. Design for Environment (DfE), for instance, encourages designers to construct products with (more) sustainable materials and processes; for example, using minimal adhesives in manufacturing, minimal packaging throughout the supply chain, and are recoverable at the end of their useful life (Fiksel 2009). Light weighting products also improve resource efficiency by directly reducing the number of materials in products and their associated production and raw material extraction processes (Lewis et al. 2001). Further, increasing the intensity of use over a product's life cycle, extending usable product life, or delaying end-of-life (also known as EoL), makes better use of resources (Allwood 2012). Delaying end-of-life can be achieved by increasing product quality and function, repairing when components fail rather than replacing and reusing and/or up-cycling at end-of-use (Allwood 2012). Timeless and emotionally durable design helps delay end-of-life by increasing a product's perceived value and engaging the user in an emotional bond that endures (Chapman 2009).

Lyle (1996) advocates replacing current linear throughput systems with cyclical flows at sources, consumption centres, and sinks, continually replacing through its functional processes the energy and materials of its operation. At a minimum, products should not exist in isolation but be accompanied by systems and services to deal with entire life cycles with zero-waste throughout every stage. A 'zero waste' approach advocates the consideration of waste from one life cycle as a 'nutrient' for another life cycle or ecosystem (Braungart & McDonough 2002). This can be achieved in both synthetic industrial systems and bio-regenerative systems, but they must be kept mutually exclusive: synthetic systems need to be completely closed-loop to keep non-natural materials out of the environment; bio regenerative systems can be open loop, given bio waste is a nutrient for natural-environment cycles. Both systems require zero toxicity: in synthetic systems, this is especially important for human health and in bio-regenerative systems for ecological health (Braungart & McDonough 2002).

Importantly, whole systems need to be considered when designing low-energy and water-consuming products, with savings to be considered across the whole life cycle, from raw material extraction through to end-use and end-of-life (Kobayashi 2006; Wong 2009). This aligns Eco-Design principles 1 and 2. Further, whole systems need to be scrutinised at multiple scales, reflecting the influence of large scales on small, and vice versa, collaborating with nature wherever possible to produce designs with the greatest level of internal integrity and coherence (Van der Ryn and Cowan 2013). Biomimicry strongly advocates whole systems thinking, emulating the complex circularity of biological systems and beneficially evolving with nature without environmental detriment (Beynus 1997). As an eco-efficiency strategy, it comes closest to eco-effectiveness principles.

Eco-effectiveness (more good)

Eco-effectiveness is where industry and society actively collaborate 'with' nature and/ or re-create biology and sustainable design activity here closely resembles waste-free biological systems (Penty 2019). Biodesign, for instance, is a rapidly growing field that expands on the principles of biomimicry to involve living organisms as building blocks and material sources in product design. It collaborates with nature to produce products and systems like organically derived compostable products, energy generators, and organic computers from bacteria, algae, and other organically derived materials (Grushkin 2021). Using nature to directly produce products is particularly appealing in this respect. Waste, for instance, can be used as a regenerative feedstock (as it is in natural cycles) and if suited to the environment it is fed into naturally conserving other resource inputs.

Regenerative design relates to approaches that support the co-evolution of human and natural systems in a partnered relationship, thus building both social and natural capital concurrently (Cole 2012). Biodegradable and bioresorbable electronics, for instance, show promise in tackling toxic electronic waste, particularly given they can be returned to nature at end-of-life rather than needing to be recovered and recycled. Current performance does not yet match existing electronics, but with further research and expanding the number of usable materials, the field is likely to grow (Zvezdin et al. 2020). These developments demonstrate a far more natural, collaborative approach to product design.

'Green economies' (Loiseau 2016) and 'blue economies' (Pauli 2010) both incorporate material strategies to address climate mitigation and adoption of sustainability principles and material outcomes. The green economy as a concept has tended to apply a cost premium for its products which are passed on to consumers, whereas blue economic approaches look for innovations based on every day for little or no start-up investment. Blue economy practices advocate step-change processes where needed, but seek to add value to current processes where possible (Driesenaar 2019). 'Teal organisations' advocate resilient sustainable economies, relying on relationships, cooperation, and common purpose at a local level to tackle local issues for global impact. This tends towards policy aimed at facilitating economies of scope rather than the scale at the outset, with scale-up in socially embedded, adaptable, resilient, rhizomatic, and distributed ways (Laloux 2016).

Eco-Design principle 2

Think in systems and design for life cycles

Thinking in systems requires designers, manufacturers, commissioning customers, and regulators, among many others, to consider the total impacts of every product design within broader natural and industrial ecosystems. The life-cycle of a product is an inventory of total energy, materials, and by-products that go into and come out of, product creation product creation: where designers require a systems-thinking mindset operationalised through tools for ideating, mapping, and coordinating pro-sustainability outcomes (Penty 2019). However, designers and manufacturers are often unaware and/ or not required to do this. Designers need to be grounded in both; eco-literacy, the fundamental principles that govern how living systems work to specific situations and conditions; and pattern literacy, being able to read, understand and generate appropriate, harmonious and enabling products, systems, services and behaviour (Mang 2020). This requires a scalable-systems mindset, or what Van der Ryn & Cowan (2013) term 'scale linking' where designers "integrate our design processes across multiple levels of scale and make these processes compatible with natural cycles of water, energy, and materials" – or a whole systems design approach.

Whole systems design requires life cycle modelling, which includes all processes for addressing societal needs, including materials production through end-of-life management, and links production and consumption activities with a comprehensive accounting of sustainability performance. This provides key metrics that can be used by designers that in turn help stakeholders manage and control the life-cycle impacts of systems they design and guide their improvement (Keoleian 2006). While whole systems tools to negotiate the massive complexity at the heart of Eco-Design are currently lacking, precedents exist on smaller scales in fields such as life-cycle assessment (LCA) and product service systems (PSS) design. LCA, for instance, has served as a tool for several decades to quantify environmental performance over the entire life-cycle of products, providing analysis of inputs, outputs, and impacts of material streams, toxicity, energy, and water use to provide designers with key data to make better design choices in the design phase (Lockrey 2011). PSS design combines products with services to improve the total user experience (Tukker 2006), but also allows businesses to track products, stay in contact with users, adapt to changing needs over time, and plan for material continuity at the end of life for the circular economy (Morelli 2002). This will become easier as an increasing number of products introduce connective capability through the 'internet of things' (which, on the flip side, poses concerns about net increases in domestic energy consumption). Service design endeavours to design positive user experiences across whole product and production life-cycles, collaborating with users of a service and building relationships between stakeholders to open up communication for the exchange and development of value and knowledge (Kimbell 2009). Services can replace material products as a dematerialisation strategy, particularly where subscription services allow intensification of product use. Digital services can also track and log material flows, energy, water, and toxicity, directly communicating them with producers and end-users and providing transparency.

Product modularity at a component level is a key constituent of adaptable and variable product design, allowing products to be updated according to need, disassembled, reassembled, and reused for multiple applications and separated into constituent parts for recycling at end-of-life (Sonego, Echeveste & Debarba 2018). Given adaptability, repairability and reusability are inherent in many modular systems, it is a desirable constituent of a circular economy. For it to improve product sustainability, modularity needs to be better understood, enabled, and adopted by designers and decision-makers, both in the design-to-production stage, but more broadly by changing the enabling levers such as pricing, regulatory, structural, and behavioural systems.

Eco-Design promotes a symbiosis between culture and nature and empowers individuals at all levels to contribute to the design process by responding to the specific needs of local bioregions (Van der Ryn & Cowan 2013). Open design (Raasch, Herstatt & Balka 2009) provides ways to engage end-users in making a change in their own lives and those around them by being involved in design projects and modifying content to apply more closely to their specific needs, place, and community (Richardson 2016). This can be particularly powerful when sitting alongside distributed local manufacturing, which allows products to be adapted to local culture, knowledge, technology, materials, and ecosystems. Advanced manufacturing technologies and internet connectivity allow a return to localised industry (Kohtala 2015). Much of the necessary tools and processes for the new frontier of 'Industry 4.0' already exist, but a whole systems platform to integrate the parts is yet to be developed (Wu, D et al. 2015). Critical to the success of 'Industry 4.0' are the systems and services at the backend, which if developed to include Eco-Design principles could encourage sustainable, resilient, distributed local, and flexible niche manufacturing.

Eco-Design principle 3

Move from a take-make-waste model to circular economies

The foundations of the circular economy concept have been evolving over many decades through various phases (Blomsma & Brennan 2017; Reike, Vermeulen & Witjes 2018; Winans, Kendall & Deng 2017). These phases represent conceptualisations and terminologies from a variety of fields across academia, industry, government, and civil society centred on the idea that the environmental, social, and economic implications of the linear, or take-make-waste model, are unsustainable. Circular economies are grounded in the idea that the designing of closed-loop processes can retain the material and embodied energy inside a system of use and exchange: thereby reducing the demand for new or virgin resources for production and consumption.

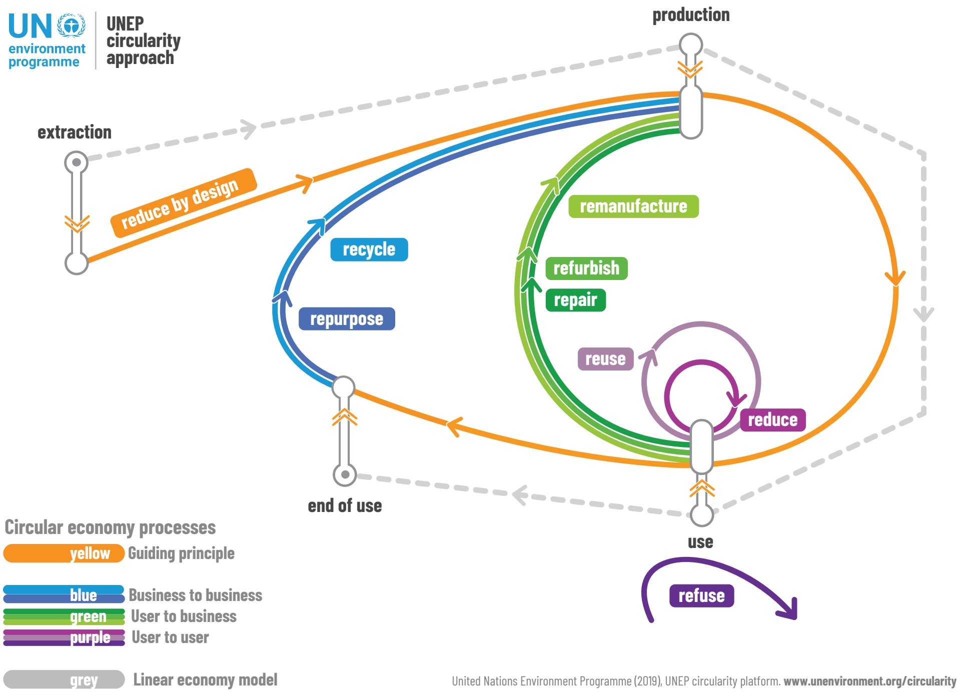
The concept of the circular economy moves away from product-centric design to designing complex scalable systems to support cradle-to-cradle production and consumption (repairing, remanufacturing, repurposing, reusing, and recycling). Broadly speaking it can be defined as a reticulating system in which waste outputs from one life cycle become resource inputs for another, resulting in reduced resource, emissions, energy, and water use. Products are valued not from their specific utility and affordances, but by the intrinsic economic value of their materials, processes, and supporting systems throughout their continual life cycles.

The Ellen MacArthur Foundation (EMF) describes three core agendas for a circular economy, being: design out waste and pollution; keep products and materials in use; and regenerate natural systems (Ellen MacArthur Foundation 2016). For product design, the first two occupy the most immediate challenge in enabling the latter to shift the value of a product from notions of its specific utility to the intrinsic value of its materials throughout various life cycles through the economy. The EMF has undertaken significant work in advocating for, supporting, and disseminating circular economy principles (Stahel 2019). A highly cited organisation in the literature, the EMF tends to present circular economy as an 'alternative growth discourse' (Ghisellini, Cialani & Ulgiati 2016) that sits awkwardly to the 'de-growth' orientations of earlier conceptualisations of circular economy (Boulding 1966; Pearce & Kerry 1990). This orientation to a circular economy, as a means by which economic growth can be underpinned, has been widely picked up by the consulting sector (Hannon, Kuhlmann & Thaidigsmann 2016; Hestin, Chanoine & Menten 2016; Lacy et al.) with the sustainable promise, or potential, of facilitating a 'decoupling' of the requirement of resource use for economic growth (UNEP 2011) – a subject of some critique (Gregson et al. 2015; Lazarevic & Valve 2017).

UNEP's Circularity Platform (see Figure 1) offers a similar model to that of EMF, but it differs in that it attempts to speak directly to the relationships between the actors, and their actions (in the abstract) in the activation of production and consumption loops. In doing so it emphasises the value of specific value retention options in the realisation and maintenance of a circular economy.

The development of the circular economy concept crosses multiple fields and requires design thinking, and cross-disciplinary collaboration, to inform strategies to enable the circulation, and re-circulation of resources in the system to avoid loss. As a complex and evolving model, it; invariably has local and sector-specific characteristics that must be considered closely by design; is enabled through large-scale cross-economy policy levers; and is subject to ongoing debate and redefinition in academic, governance, and industry contexts.

FIGURE 1
UNEP's Circularity Platform (from www.unep.org/circularity**)**



Related circular economy design practices include; design for slowing, closing and narrowing resource loops. Slowing resource loops includes: access and performance models; extending product value models; and classic long life and sufficiency models. Closing resource loops include design for; extending resource value; and industrial symbiosis models (Bocken et al. 2014). Narrowing resource loops consist of; resource efficiency approaches such as design for light-weighting and product/ production efficiency; and design concerning resource value retention options this report for further definitions of these design methods (Reike, Vermeulen & Witjes 2018). For the latter, client or user choices function as shorter loops of value retention which include options to design for; refusal (Bilitewski 2012); reduction (Lieder & Rashid 2016; Sihvonen & Ritola 2015; Worrell & Reuter 2014); reselling / re-using (de Brito & Dekker 2004; Ghisellini, Cialani & Ulgiati 2016); repair (den Hollander, M & Bakker 2012); refurbishment (de Brito & Dekker 2004); remanufacturing (Go, Wahab & Hishamuddin 2015; Lieder & Rashid 2016); and repurposing (Sihvonen & Ritola 2015; Van Buren et al. 2016). Downcycling strategies function in long loops of value retention and include; recycling; recovery; energy (Worrell & Reuter 2014); and re-mining (Cossu & Williams 2015).

Eco-Design principle 4

Making better design choices: Ethical design for collective wellbeing

The previous three principles have spoken to Eco-Design from a material outcomes perspective more so than ethical value approaches. This section speaks primarily to the ethics of Eco-Design, given sustainability is deeply tied to an ethic of well-being for the earth as a whole system. Norman and Draper (1986) approach the ethics of design from a user-centred perspective where designers study people's activity, structures, interactions, and systems, and through theoretical analysis, trial systems, and observing and questioning end users, make informed design decisions. Buchanan (2001) and van der Bijl-Brouwer and Dorst (2017) invite us to take on more political dimensions, basing an ethical design on human dignity and human rights to make better design choices concerning people collectively. Sheehan (2011), Barad (2007), and Fry (2009) ask for consideration of the ethics of design beyond humanity, extending respect, care, and protection to all elements of our planet.

Sustainability requires cultural and end-use behaviour change and Eco-Design needs to foster culturally embedded sustainable behaviour with the combined participation of individuals and communities. This challenge requires an ethical approach through design practice to induce positive cultural change (Mulvenna, Boger & Bond 2017). However, the variabilities of design practice and ethical positions of designers, call for standardised ethics training in design education, industry-standard codes of practice, government policy and regulation, and opens opportunities for ethical consultancy businesses (Fry 2009).

Related design practices include 'people-centred' methods. Design is primarily designed for people, but increasingly, designers are designing with people to better understand the nuances and complexities of individual needs and how they relate to the needs of the broader community. Co-design/ participatory designers – either internal to companies or external consultants – work with people to identify and tackle issues through multiple cycles of listening, exchanging, and reflecting. This can be seen as a process of iteratively infrastructure adaptable socio-material systems through design action (Huybrechts, Benesch & Geib 2017). Participatory practices are often used in design for social impact (see Rittner n.d.) and design for social innovation (see Chick 2012). While not always Eco-Design focused, they almost always aim to foster well-being and can be harnessed to empower citizens to positively change their environments, communities, families, and mental health for the better.

The Project team acknowledges the Western perception of humankind within the context of natural systems and suggests that Indigenous approaches to country, place, and relationships (Moran 2018), and a 'more-than-human' mindset is required for design to become truly sustainable (Gaziulusoy & Erdoğan Öztekin 2019). The Eco-Design literature is clear in calling for humanity to better respect the ecological context. A 'more-than-human-turn' recognises the reciprocal relationships between humans and non-humans in a delicately balanced ecosystem (Forlano 2017). In this respect, there is a call to learn from Indigenous approaches where learning stems from observing and understanding connections between elements within the whole earth system. Indigenous knowledge favour sustainment over consumption, contextualising individuality within place and community for the common good (Moran 2018). This view acknowledges that agency has a 'placial' origin and its unique characteristics should form the backbone of any project (Graham 2009). In this sense, it is important that design translates Indigenous approaches with integrity and respect.

The Eco-Design principles above were used to inform the various 'cross-cutting' influences on design aimed at environmental good explored in the next section. These influences are explored as to how they might be enacted as levers, to activate a pathway from old, linear models of design to the circular, regenerative, systems-based modes of design practice for the future.

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Please note, this is a full list of references from the Project, as cited in the report 'Enabling Design for Environmental Good'.

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APPENDIX

Literature review method

A literature review was undertaken and structured to provide a comprehensive initial knowledge base for the Project.

The review particularly focused on documents and material produced in the last five (5) years. However, older references were also used where it made sense.

The review spanned academic, industry (grey literature) and public policy sources. Data was sourced and reviewed for relevance from company websites, government sources i.e. the Australian Bureau of Statistics, and through databases such as Science Direct and Google Scholar.

In terms of themes of focus for the review, the Project team identified two initial areas as crucial.

Firstly, there is considerable variation in the ability of actors in the Australian economy to influence design decisions, depending on the product or material. Therefore, it was important to define the decision-making process for design in Australia, and as relevant to the various sectors. The Project team researched definitions and benchmarks for Eco-Design principles and related decision structures, for Australia and globally. For instance, the team researched important concepts such as design for environment (DfE), or whole systems design, and looked to identify examples where these principles were applied in practice.

Secondly, the Project team focused on the current context for Eco-Design locally and globally, including cross-cutting factors relating to design practice such as policy, programs, regulations, financing and the wide range of industry initiatives. Jurisdictionally these influences were researched for Australia, as well as casting widely across international activity, including within Europe, the US, China, Japan and South East Asia. The Project team then identified opportunities that were initially evident for design regarding environmental outcomes as related to these cross-cutting influences.

Consultation method

Following the literature review, a detailed consultation period commenced. The Project team conducted this phase as an iterative approach involving key stakeholders, to collate their views about adoption options for initiatives that could enable Eco-Design in various contexts.

A structured approach to consultation was applied, consisting of interviews and workshops. An ethics application to cover the interviews and workshops was prepared and submitted to the RMIT University College of Design and Social Context Human Ethics Advisory Network (CHEAN) prior to conducting stakeholder engagement. Consultation was approved by the RMIT CHEAN.

The Project team held an extensive list of domestic and global stakeholder contacts prior to the Project commencing, which was built upon with input from DAWE, through the literature review, and by way of key stakeholders as the team engaged them during consultation. The database of existing contacts streamlined the consultation process and allowed targeted engagement with high value stakeholders.

Initial stakeholder interviews

Firstly, stakeholder interviews were conducted in August and September 2021 with experts/ personnel from national and global entities, to build an understanding the current state of play of Eco-Design principles and methods, and to seek alignment to global and national policies, regulations, financing, programs and initiatives that are relevant across and to specific sectors in relation to Eco-Design. These interviews helped identify priority opportunities for Eco-Design in Australia from key stakeholders.

Target stakeholders for interviews included people sourced through industry associations, key people at global and Australian companies, leading design practitioners, not for profit personnel, and various leaders within government agencies.

Interviews were based on an approved interview method i.e. approved by the RMIT CHEAN, to provide rigour and consistency, with enough flexibility to allow application to various stakeholder types i.e. semi structured. Participants were provided material for the session prior, including a plain language statement describing the project purpose, potential measures for investigation (a version of the Project report's Figure 4), questions, and consent form.

The initial interviews were aimed at 'early adopter' and 'innovator' type stakeholders who were connected to or cognisant of the cross-cutting themes related to Eco-Design, derived from the literature, to test Project assumptions and build general clarity on opportunities, and sector-based issues. Related to these themes, interview questions included:

- What international developments are you monitoring in relation to Eco-Design and influential measures that are accelerating Eco-Design?
- How is Australia placed to adopt Eco-Design and be competitive in design, manufacture, recovery and optimized resource and investment?
- What the consequences if Australia does not adopt Eco-Design and measures to accelerate Eco-Design i.e. risks of inaction?
- In what product lines/ sectors does Australia have opportunities to lead internationally in design, manufacture, service and recovery aimed at better environmental outcomes?
- What challenges does Australia have to integrate sustainable Eco-Design and processes?
- What changes are required for us to overcome related challenges? Where are we strong, where are the gaps?
- Which international leadership forums are important for engagement of government, industry, education institutions, associations?
- Which sectors do you think are ripe for acceleration in integrating Eco-Design and processes? Which sectors should next be engaged? For what reasons?
- Who do you think are prime influencers and vital thinkers that will assist with this transformation in Australia? Overseas? How? Who might impede and why?
- How would you define Eco-Design?

Initial stakeholder workshops

While interviews allowed for targeted and in-depth information gathering, workshops were conducted in September 2021 to facilitate more holistic perspectives through the interaction between multiple actors within or cognisant of the design decision making process. Various service design methods, tools and activities were carried out as proposed by Stickdorn and Jakob (2012), to enable participants to share their insights and to have an active role in the process of developing insights for Eco-Design in Australia.

An initial workshop was run for 'early adopter' and 'innovator' type stakeholders who were connected to or cognisant of the cross-cutting themes derived from the literature. Participants were provided material for the session prior, including a plain language statement and consent form.

The initial workshop was loosely based on the 'Five whys?', which provides a sequenced chain of questions as per Vullings and Byttebier (2015), which assisted participants to dig below the obvious Eco-Design contexts and practices practiced globally and in Australia, in order to delve deeper into related issues. This workshop provided an opportunity for participants to rethink Eco-Design contexts and practices, and conceptualise how to innovate, improve and/ or support Eco-Design nationally, particularly for cross-cutting themes related to the Project.

Subsequently a workshop was held for each of the target sectors that had been prioritised which are; textiles; buildings; plastics; and electronic goods. Participants were provided material for the session prior, including a plain language statement, consent form, and brief project summary covering Eco-Design principles and cross-cutting themes and sector-based initiatives that exist locally and globally.

In these sector workshops, an inclusive 'common language' was set up first, providing space for various concepts, expectations and needs from the different professional backgrounds of participants, to help them identify issues they could address throughout the workshop. This was particularly focused in explaining the broad range of Eco-Design definitions the Project team were embracing, so those could be included in any discussions.

The four (4) key Eco-Design principles guiding the project (Van der Ryn & Cowan 2013) were explained to participants (that had derived from literature), as previously summarised.

International progress in cross-cutting themes related to Eco-Design, and sector specific initiatives were presented and discussed with participants.

Next an ideal state for Eco-Design for the sector was developed for 2030, keeping the international best practice on cross-cutting themes in mind. This exercise drew upon both stakeholder and systems mapping co-design techniques. The exercise was stimulated with the following questions:

- What is the potential for this sector and supply chain in Australia by 2030?
- What's our growth/ transformation potential?
- What are our competitive advantages, trends?
- How will supply chain, governance and procurers be different for key environmental issues?
- What design practice, actors, and skills will we require for key environmental issues?

Finally, an opportunity blueprint was developed, linking the current local state for the sector to the ideal future state for 2030, mapping how to build a pathway between the two. This exercise was done in groups, and stimulated with the analogy of the development of a rose, linking to cross-cutting themes for Eco-Design with the following prompts:

- Fertilizer – Financial and economic measures: Initiatives by industry and government
- Stem + Bud - Regulations and certifications: Initiatives by industry and government
- Ladybugs – Policy: Initiatives by industry and government
- Bees + Rose – Education and transformation: Training and recognition initiatives

Final stakeholder interviews and workshop

A final workshop and peer review were run in October and November 2021 to engage key stakeholders on the high potential sector-based and cross-cutting opportunities to enable Eco-Design that have emerged from the Project. These stakeholders who had previously engaged in the project, included experts that could speak to local and international movements on cross-cutting themes, as well as proposed sector specific actions and initiatives.