THE DESIGN PROCESS
A PRIMER

REV 1_ MARCH 2017

RESILIO**STUDIO**

INTRODUCTION

"Design is basic to all human activities - the placing and patterning of any act towards a desired goal constitutes a design process." Victor Papanek

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"Design Thinking is a mindset... Thinking like a designer can transform the way you approach the world when imagining and creating new solutions for the future: it's about being aware of the world around you, believing that you play a role in shaping that world, and taking action toward a more desirable future. Design Thinking gives you faith in your creative abilities and a process to take action through when faced with a difficult challenge." Design Thinking for Educators

WHAT IS DESIGN?

At its pinnacle, design is "*an interactive, imaginative process for creating something that has never existed before*"[1]. At its core, *design is a process for creatively solving problems*. Design solves problems by:

- Providing function and utility - for example a vessel to hold water, or a battery to store energy.
- Providing a vision and direction for where we would like to be in the future - for example an artist's impression for a future possible state, or a social forum for addressing challenges and identifying solutions.
- Giving form and meaning to actions, objects, environments and conversations - for example a Māori pou acknowledging local history; ancestors and landscapes; creating an infographic to explain a complex social/scientific issue or predicament; planting native species to promote awareness about local ecology; organising a neighbourhood street party; working as placemakers with local communities or as design activists aiming at making change in cultural behaviours and attitudes.

PURPOSE OF THIS PRIMER

- Provide an introduction and overview of the design process.
- Provide a resource that develops a shared understanding and basis for experts and non-design experts.
- Provide guidance for people and organisations wanting to solve problems creatively through a structured design process.
- Provide a set of tools and methods that can be applied to wide range of challenges.
- Offer a wide range of references for people to follow up and explore for themselves.

ASSUMPTIONS

THE DESIGN PROCESS CAN BE APPLIED TO A WIDE RANGE OF HUMAN ENDEAVOURS

A design process typically involves progressing through a sequence of phases that begin by identifying a discrepancy between the current situation and a desired (future) state. This design process involves defining and analyzing the 'challenge', generating concepts, evolving ideas and implementing a solution or solutions that will reduce the gap between the current situation and the desired state. By crystallising this general process down to an essential sequence of phases, it is possible to conceive of a structured process that can be applied to a wide range of human endeavours.

EVERYONE IS CAPABLE OF DESIGN

Designer and educator Victor Papanek observed that "design is basic to all human activities"[2]. We believe that everyone is capable of using the design process to creatively solve real problems. Like any skill, some people are naturally more gifted than others in abilities core to design (such as creativity, empathy/intuition and systems thinking) however it is nonetheless a skill that can be taught, practiced and learnt.

OVERVIEW OF THE DESIGN PROCESS

This resource defines eight phases of design - Initiate; Discover; Interpret; Ideate; Refine; Implement; Communicate; and Reflect and Evaluate.

Each phase has a number of strategies, methods and tools that can be utilised to resolve the issues and opportunities that arise in each phase. The number of design phases and the strategies, methods and tools utilised for any given design process is dependent on a range of factors such as the complexity of the problem, the number of people involved, the time frames under consideration etc. Designers need to recognise which strategies, methods and tools are appropriate to use at what time.

INITIATE

The design process begins by recognizing that there is a challenge or opportunity that needs addressing, i.e. there is a discrepancy between the current situation and the desired state. Once the challenge has been identified and the commitment to address it has been made, the next step involves articulating it in a way that those involved or affected can understand. In this phase the foundations for the design process are established by starting to define the context in which the challenge/opportunity is situated, clearly defining and articulating the challenge, generating a brief, and creating a project plan.

DISCOVER

In this phase of the design process the designers work to enrich and develop their understanding of the challenge. The Discover phase is about gathering useful and relevant qualitative and quantitative knowledge related to the challenge. This knowledge gathering exercise collects material from a range of sources and through a range of techniques including first hand research such as observation, interviewing and focus groups as well as secondary sources including case studies and existing data sets.

INTERPRET

In this phase the focus is on making meaning of the information collected during the Discover phase in order to refine the understanding of the challenge and its context. Through

considered interpretation themes, patterns, insights and opportunities begin to emerge. Understanding the parameters of the challenge and the needs of those most impacted by the challenge is critical to developing effective solutions. A key outcome of the Interpret phase is defining needs and insights and making them actionable by framing them as opportunities, which typically come in the form of written statements, diagrams, maps, insights etc.

IDEATE

Once the design challenge and the context is better understood, constraints and opportunities are framed, and ideas for solutions are generated. The Ideate phase is what people most commonly associate with design - it is the phase where as many ideas as possible are generated and experimented with. At this stage thinking expansively and deferring judgement about possible solutions is essential - no idea is too small or 'out there' at this phase in the process. Ideas can be generated and recorded through a range of mediums including drawings, models, audio/visual recording, written notes etc.

REFINE

This phase is characterized by revision, filtering, selection and honing of the most promising ideas to take forward. Designers develop their leading concepts, refine their thinking and test their ideas further. With refinement comes new discoveries and a designer will often experiment with different iterations and move back through different design phases in rapid succession at this point in the process. Once variations and alternatives on leading concepts have been explored, the concept is fine tuned and prepared for implementation.

IMPLEMENT

In this phase the focus is on executing the design - either in whole or in part. Strategies for implementation vary depending on the nature of the problem and its context. Implementation strategies sit on a continuum between pragmatic and 'sequential', often referred to as the waterfall method, and emergent and 'generative' also known as the agile method. Sequential implementation strategies are based on traditional project methodologies where each phase of the design process is completed before the next phase begins and there is limited opportunity to revisit and reiterate the previous phase once the design has progressed. Generative implementation strategies emphasise developing and testing ideas as soon as possible allowing the design response to emerge through the process. A generative process involves moving throughout the phases of discover, interpret, ideate, refine and implement in rapid succession to test part or all of the proposed solution, in order to learn, reiterate and evolve the design quickly. Generative processes provide less certainty but allow for the process to change emphasis and direction in response to new and emergent discoveries.

COMMUNICATION

Communication is an essential component of any design process. Good design requires designers to communicate, express and test thoughts and ideas regularly and effectively throughout the process, often with a range of stakeholders. Communication involves defining, discussing, telling stories, listening, providing feedback, agreeing and resolving, and presenting ideas and developments during the design process. During the design process visual, oral and kinaesthetic forms of communication will be employed and presentations and representations will be used to communicate a range of information to stakeholders.

REFLECTION AND EVALUATION

As the design process unfolds, new learnings, insights and evaluations are made. These new perspectives can and often do have significant impacts on the design solution being developed. Design is a reflective practice. Documenting, incubating and evaluating the design process involves a wide range of methods for recording and critically reflecting on events, experiences, perceptions and/or feelings, to assess design concepts and practice in relation to the design brief, the project plan, the context, the budget etc. is an essential part of the creative and problem-solving process. Reflection and evaluation is essential to effective learning, for connecting theory with practice, and for forming a platform for creating new knowledge, theories and methods of working. Reflection and evaluation also involve the ongoing identification of personal and cultural biases and blindspots that may compromise the design outcomes and prevent those involved in the design process from recognising or selecting the most appropriate solutions to the challenge.

THE DESIGN PROCESS

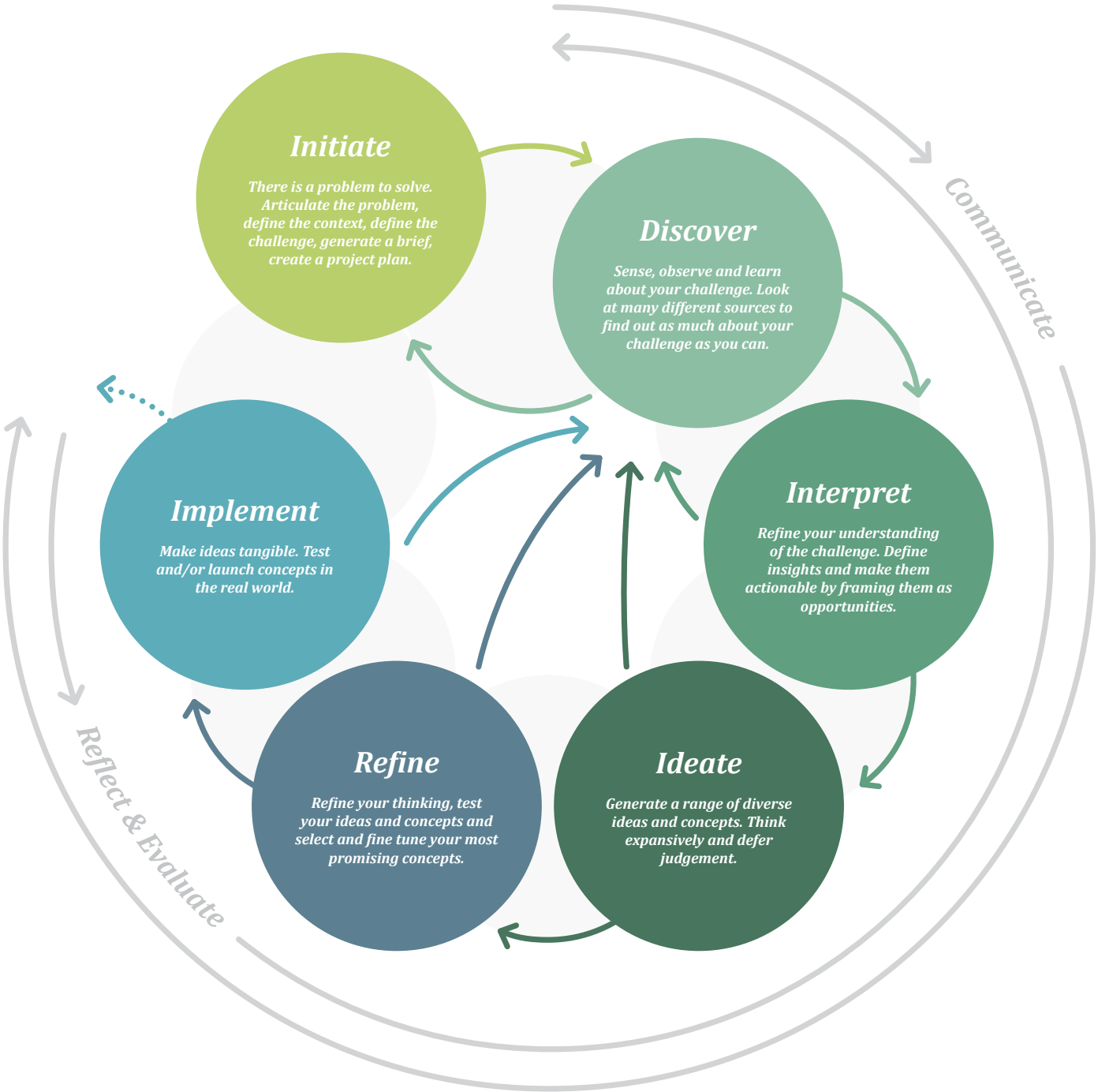


Figure 1_ A graphic representation of the design process emphasizing the cyclical and iterative nature of the design process.

KEY CONCEPTS

ART + SCIENCE

Design involves a fluid integration of the systematic observations and analytical insights of science with the expressive, intuitive, technical skill and creativity of art - design is both analytical and creative.

EMPATHY

Empathy is the ability to understand and share the feelings of another. Empathy fuels connection and understanding. Theresa Wiseman[3] identifies the four defining attributes of empathy as the ability to see the world as others see it, to be non-judgmental, to understand another person's feelings, and to communicate your understanding of that person's feelings.

It is very rare for designers to solve challenges that only impact or affect themselves. Therefore, understanding the points of view, values and needs of others is critical to developing effective real world solutions. Designers need to be able to empathise with other people who are core to the design solution and are likely to have different backgrounds and life experiences than the designers, as well as develop an empathic understanding of the 'natural world' and all its life forms.

COLLABORATION

All design processes are collaborative and it has become clear that working with others is the only way designers can work towards ensuring that the proposed solutions will be socially and culturally responsive and continually implemented. Effective designers foster collaboration among diverse disciplines and constituencies - they feed and support projects and initiatives in which everyone – design professionals and non-design experts alike – are involved throughout the process and have ownership of the solution.

RESILIENCE

The greek philosopher Heraclitus once observed that "change is the only constant in life". Our world in the 21st century is changing rapidly and the challenges are increasing in scale and complexity. Resilience is the capacity of a system to absorb disturbance and reorganise while undergoing change, so as to retain essentially the same function, structure, identity and feedbacks4. Changes can range from business as usual small-scale disturbances through to unprecedented events requiring fundamental cultural transformation[5]. Designing for resilience involves developing solutions that are responsive and adaptive to forces that can be foreseen and also to forces that cannot. This requires an understanding of global, regional and local systems and dynamics affecting the design challenge as well as systems literacy to understand the qualities and characteristics of a resilient system and strategies for achieving them. Designers will need to increasingly adapt and respond to a changing reality and resilience thinking has become a necessary tool in the designer's toolkit.

Resilience thinking and designing for resilience can be enhanced by developing literacy skills related to the '4E's' - Environment, Energy Economics and Equity. These drivers are significant and omnipresent influences on most of the challenges facing society today. Without an understanding of the 4E's and an appreciation of the influences they exert on our world (at a range of scales) 21st century designers risk contributing further to systemic vulnerabilities, failures and tipping points through inappropriate or naive design 'solutions'.

VIABILITY AND FEASIBILITY

Design responses need to respond to more than just the challenge, they must be financially viable and technically feasible. Whether the design is a DIY project at home, a new product for a social enterprise or a business offering a new range of design services, a design must be cost effective to implement and affordable to end users. The design must also be within the technical capabilities of those manufacturing and those using it. There is little point designing something that can not be implemented or is too complex to use.

TRADE-OFFS

Thomas Sowell once observed that "there are no solutions. There are only trade-offs." When one element is optimised in design, it often compromises other aspects of the design solution. The design processes often involves making decisions that trade one outcome off against another - for example, farmers seeking to maximise yield are likely to reduce other valuable traits such as soil fertility and stress tolerance; athletes often must choose between prioritising either speed and agility on the one hand and strength and endurance on the other; and a bridge that maximises lightness and efficiency of materials will typically comprise durability and resilience of the structure. While it may not be possible to reconcile all trade-offs, it is critical that designers are aware and conscious of the choices they make during the design process and attempt to understand the possible implications of choosing to preference one or more outcomes over others.

DIVERGENT AND CONVERGENT THINKING

The design process involves a series of divergent and convergent processes. The divergent phases are typically the Discover and Ideate phases, and involve exploring a wide range of opportunities and possibilities - it is expansive and exploratory. The convergent phases involve evaluating possible options, selecting and making decisions so the project can progress - it involves the narrowing, distillation and refinement of ideas and understanding.

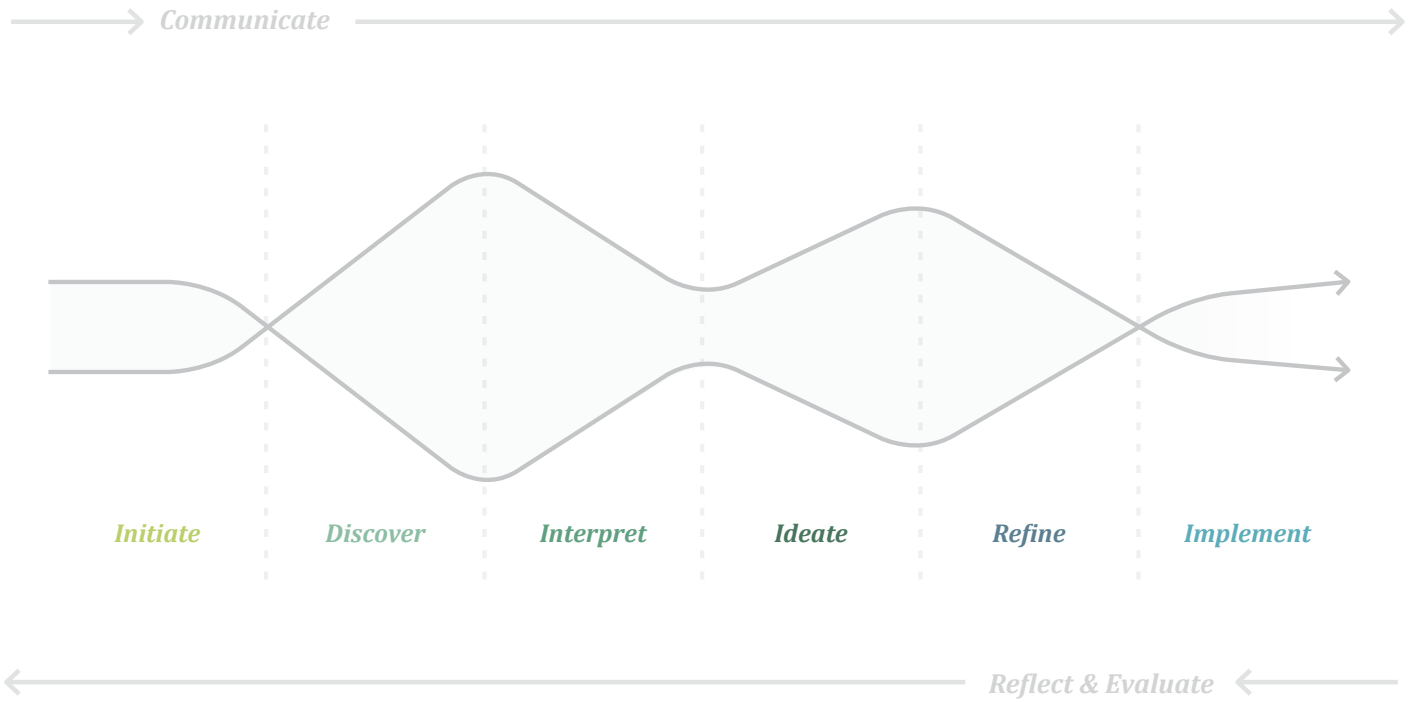


Figure 2_ The design processes represented as a sequence of divergent and convergent phases. Note the Communication and Reflection and Evaluation occur throughout the process.

ITERATIVE + EXPERIMENTAL PROCESS

Design involves experimentation, testing solutions and taking risks. All designers make a lot of mistakes. This is a good thing - every mistake brings with it an opportunity to discover something new about the challenge and the range of solutions to address it. The trick is to manage the experiments and risks so that they are 'safe to fail' and that any failures are seen as opportunities to learn. While the design process typically has a beginning, a middle and an end, it is seldom a linear process. New insights through iteration and experimentation often require that the project brief is reviewed and rewritten to accommodate new knowledge and understanding of the challenge, promising ideas are reassessed or even abandoned, new ideas are created and tested until an adequate solution is reached or, as often occurs in design, the project runs out of time and/or budget and the leading concept at the time is taken forward.

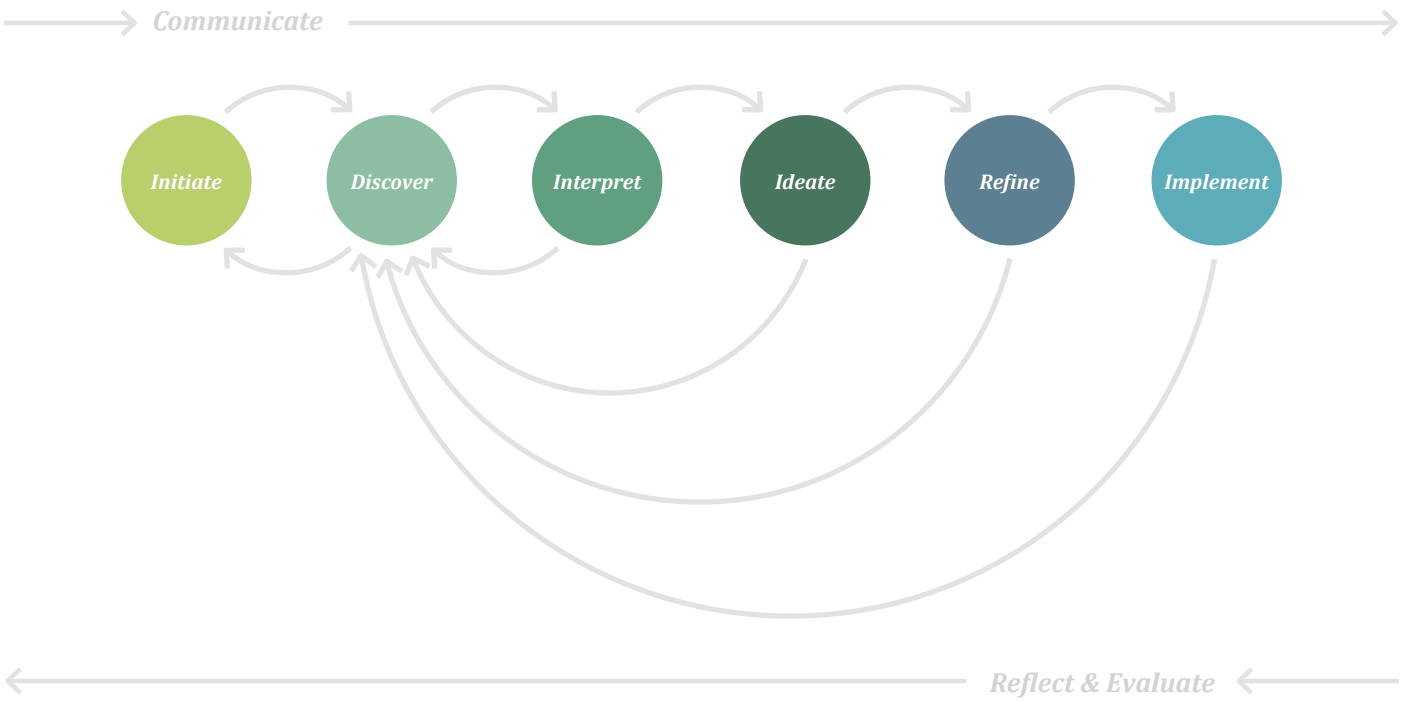


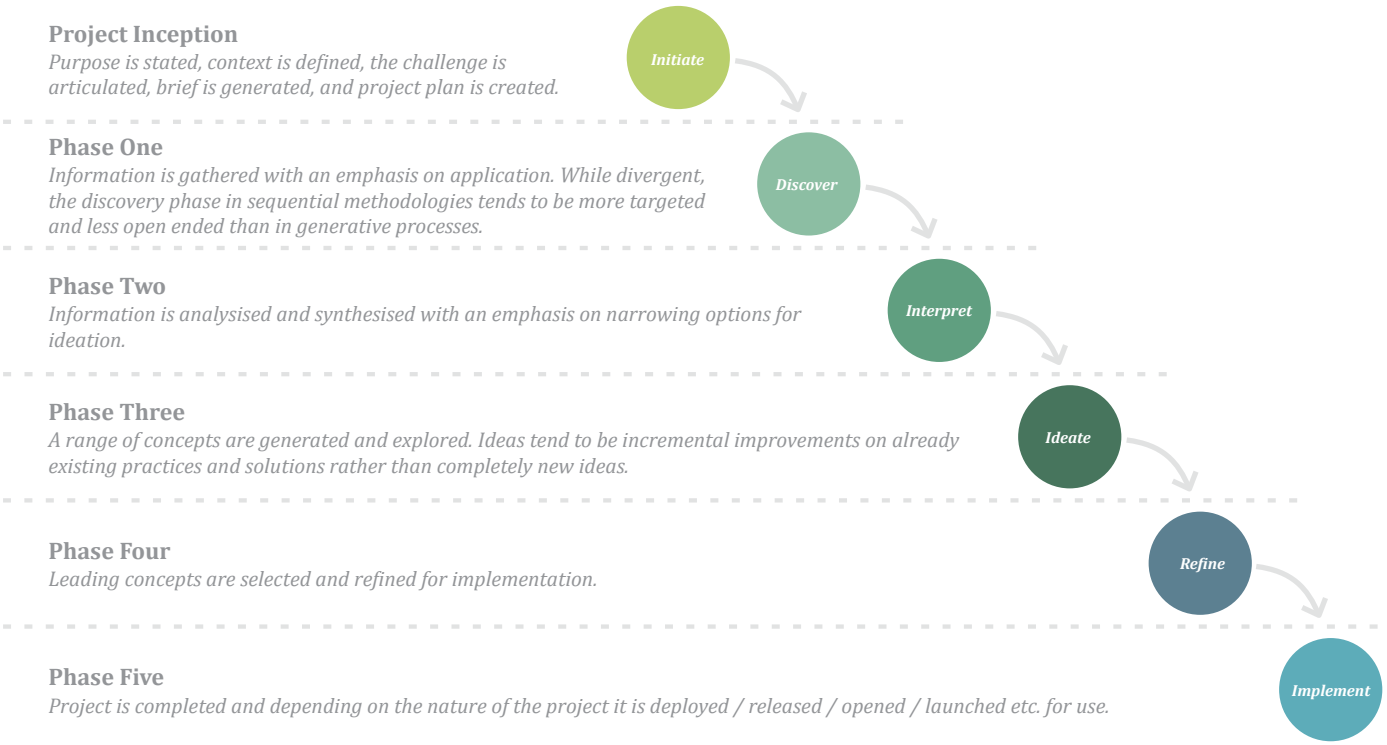
Figure 3_ Discoveries are made throughout the design process. While a designer seldom starts the whole process over every time a new discovery is made, the designer will often quickly interpret the finding, ideate a new or incremental improvement to the existing design and reintegrate the insight into the design. This process can occur in a matter of seconds, or it could take much longer to integrate the discovery into the developing design.

IMPLEMENTATION STRATEIGIES

Strategies for implementing a design have a fundamental bearing on how to approach the design process. Implementation strategies sit on a continuum between pragmatic and 'sequential' at one end and emergent and 'generative' at the other.

SEQUENTIAL

Sequential implementation strategies are based on traditional project planning methodologies where each phase of the design process is completed before the next phase begins and there is limited opportunity to revisit and reiterate the previous phase. This methodology is often referred to as the 'waterfall method' and is best suited to a design process where the output that is being designed is much more known. The design 'challenge' is typically centred around that known output, rather than a challenge which invites a wide and unknown range of design responses. As there are few opportunities to revisit previous decisions, a comprehensive project plan must be created at the beginning of the process and followed carefully. Sequential implementation strategies provide certainty and reduce risk of going over time and/or budget. Sequential implementation strategies are are best used for large and/or complex projects with proven methodologies/predictable and repeatable processes. Projects conducive to this strategy often involve a built outcome or product and often involve multiple 'experts'



Left - Figure 4_ The sequential methodology represented as the 'waterfall' method. Once a phase is complete the decisions are effectively made and the process moves forward with little opportunity to iterate previous phases.

Below - Figure 5_ Example generative process emphasizing testing and iteration throughout the design process and phases.

and/or professionals who contribute toward the design and implementation of the solution. Projects that typically follow a sequential methodology include the design and construction of medium to large scale buildings and infrastructure[6]; the design and deployment of public policy; and the design of technologies such as a car, or medical equipment such as a pacemaker or an MRI scanner. Discoveries are made throughout the process but rather than starting the whole design process over from the beginning or repeating entire phases, insights are interpreted and fed back into the developing design as a new idea or incremental improvement without starting the whole process over.

GENERATIVE

Generative implementation strategies emphasise the development and testing of ideas as soon as possible in the design process. A generative process involves moving through the phases of Discover, Interpret, Ideate, Refine and Implement repeatedly and in rapid succession in order to test part or all of the proposed solution and learn, reiterate and evolve the design quickly. Generative processes provide less certainty in terms of timeframes and budget but allow for the process to change emphasis and direction in response to new and emergent discoveries to complex challenges that need to be discovered through experimentation and iteration i.e. interacting directly with the challenge. Examples of projects and methods that use a generative methodology include software development (often referred to as 'agile'[7]), tactical urbanism projects in the public realm, adaptive ecosystem management, social / innovation labs, design and build homes and gardens, and 'backyard' inventors developing small-scale appropriate technologies.

HYBRID PROCESSES

While sequential and generative processes can be conceived as two ends of a continuum, in many cases a project will sit somewhere along the continuum and incorporate aspects of both. For example, a master plan for a city district, a large park or farm might create an overall vision and general layout and arrangement of uses and forms and organise the site into discrete, manageable areas that can be designed and implemented in sequence or in parallel. Each area in turn could adopt a generative process that tests real outcomes through adaptive management or prototyping processes before implementing more permanent outcomes. Likewise a social enterprise could experiment with delivery strategies for locally produced food to school children as part of larger sequentially implemented policy initiative for health and wellbeing, or designers can test various end user preferences for various aspects of user interfaces for software that is housed within hardware that is developed using more sequential implementation strategies.

Project Inception

Problem is articulated, context is defined, the challenge is articulated, brief is generated, and project plan is created.

Iteration One

Emphasis on discovery, interpretation and ideation. Concepts are tested as quickly as possible.

Iteration Two

Discoveries and insights are reintegrated into new wave of ideation and prototyping of concept.

Iteration Three

Discoveries and insights are reintegrated into new wave of ideation and refinement and concepts are piloted.

Iteration Four

Discoveries and insights are reintegrated into new wave of refinement and project is implemented.

CAPITAL

Capital means different things in different contexts - here "capital" is synonymous with "wealth" and/or "stores of value" - it is how systems and communities accrue and store wealth and energy over time. Responding to the significant challenges of the 21st century outlined above mean that doing less harm is no longer good enough - designers must do 'good' and leave things better[8]. As well as doing things smarter from here on in, designers have a responsibility to actively rehabilitate the historic damage already inflicted on the planet, society and a wide range of communities by increasing the ecological carrying capacity of the environment and building real wealth through all forms of capital – natural, cultural, social, built, knowledge as well as financial.

NATURAL CAPITAL

Natural capital refers to the function, integrity and productive capacity of the ecosystems in a given area. From an anthropocentric point of view, it also refers to the quantity of natural resources available for human utility such as energy, minerals, soils, trees etc. as well as the services a functioning ecosystem provide. These functions include filtering and purifying water and regulating of water quantity, composting and cycling of nutrients, creating and maintaining soils, biological productivity and diversity, pollinating plants and controlling pests, regulating the atmosphere and climate and sequestering carbon. All of life is dependent on, and a part of natural capital - it is the basis of all other forms of capital.

CULTURAL CAPITAL

Cultural capital refers to the stores of wealth built, stored and incrementally added to by a culture over multiple generations and includes things like language, customs, technologies, laws, decision making processes, art, literature and music.

BUILT CAPITAL

Built capital refers to physical stocks such as buildings, infrastructure such as energy, transport, water and communication networks, tools, machines and all technological systems, products and environments. In essence it refers to any uniquely human made environment or artefact. Built capital is developed through the application of the other six forms of capital. Durability, resource and energy availability, and sustainability are important considerations for the development and long term maintenance of built capital.

SOCIAL CAPITAL

Social capital is often defined as the "connections among individuals - social networks and the norms of reciprocity and trustworthiness that arise from them"[9]. Simply put, social capital is the collective ability of a group to work together to achieve something. Social capital includes shared norms, values, attitudes, beliefs and sense of purpose; established roles and social networks supplemented by rules, procedures and precedents; bonds between people in similar situations; bridges between similar people in different situations; as well as links between people of different power or status.

Where traditional communities typically self organise in specific locations connected to a physical place, in the Information Age social capital can include communities of interest that are geographically disparate but share something in common such as an interest in a particular sport or on-line forum.

HUMAN CAPITAL

Human capital refers to the capacity of an individual or population to participate in and contribute to society (often conceived of through the production of goods and/or services). It includes all of the knowledge, habits, skills, experience, social and personality attributes, including creativity accrued by individuals over the course of their life as well as the health of people and populations.

KNOWELDGE CAPITAL

Sometimes called 'intellectual', 'instructional' or 'technical' capital, knowledge capital refers to transferable stores of knowledge that can be utilised to build other forms of capital.

FINANCIAL CAPITAL

Financial capital refers to stores of money in either tangible/physical and/or digital/abstract forms. While money is a form of financial capital, money is not capital in its own right but a mechanism for allocating and controlling other forms of capital[10].

SEVEN FORMS OF CAPTIAL

Figure 6_ From bottom to top - natural captial, cultural captial, built captial, social captial, human captial, knowledge captial and financial captial.

REALMS OF DESIGN

"Everything is designed. Few things are designed well." Brian Reed

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Ecological design is the "design of human settlements that incorporates principles inherent in the natural world in order to sustain human populations over a long span of time. This design adapts the wisdom and strategies of the natural world to human problems. Implicit in this study there is a larger question - what is the role of humanity in the greater destiny of the earth?" Nancy and John Todd

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"Ecological wisdom does not consist in understanding how to live in accord with nature; it consists in understanding how to get humans to agree on how to live in accord with nature." Ken Wilber

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"A sustainable technology is a technology which, when employed productively by humans, results in no loss of ecosystem carrying capacity, resource availability, or cultural integrity" Robert Thayer

The design process can be further explored and adapted to different realms of design - the Biosphere, Sociosphere and Technosphere. It is important to know which realm or realms you are designing in to ensure the most appropriate design lenses, strategies, methodologies and tools are utilised.

THE BIOSPHERE

The biosphere is a term used to describe the realm of life on earth. It includes all the ecosystems of the planet - the animate kingdoms of life including all plants, animals, fungi, protista, and bacteria; the inanimate context for life - the lithosphere, geosphere, hydrosphere and atmosphere; and the relationships and interactions between them. The biosphere is powered by solar and cosmic radiation as well as heat from the interior of the Earth, and left to its own devices, is largely self-regulating. Good practice design in the biosphere can be broadly described as **ecological design**.

Ecology means different things to different people. Here ecology is simultaneously:

a. a scientific endeavour into the natural sciences as well as the social sciences and human ecology;
b. a metaphor for describing our existential understanding of the world; and
c. an applied discipline that utilises ecology and ecological understanding as inspiration and medium for design.

Ecological design refers to an approach of designing with and for the function, health and well-being of the whole living system, incorporates all three of the above understandings of ecology. It requires a reframing of humanity's place and role in the natural order of things to be one of many cohabitants and beneficiaries of an integral and healthy ecosystem, rather than the dominant or priority species in that system. Ecological design asserts that the ecological health and carrying capacity of the places we live are the foundation of health and well-being for the people who inhabit them.

Realms of knowledge most relevant and useful to ecological design include biology, the earth sciences, ecology, evolutionary biology, spatial geography, morphology and local place-based experience and wisdom. Ecological literacy is core to ecological design and there are a range of lenses a designer can adopt to help discover already existing ecological solutions, patterns and principles of biology and ecology that can be applied to design.

LENSES FOR ECOLITERACY[11]

A **naturalist lens** involves looking to nature as naïve inquirer to build general knowledge and understanding of natural patterns and processes and for interest and inspiration.

A **local lens** is essential to help designers see every place as unique. With this lens we might ask questions like:

- How do local species, traditional peoples and ecosystems adapt to local conditions?
- Can local knowledge make sense of observations?

An **ecological lens** helps designers look to nature to understand the interrelationships and patterns in nature as well as foundational ecological principles such as ecological rhythms, stocks, flows, and sinks. Questions designers might ask from this lens include:

- Does this remind us of any other pattern or solution in nature?
- What are the core ecological principles governing the behaviours of organisms in this system?

The **functional lens** allows designers to draw inspiration from how nature solves problems by asking questions like:

- How might nature solve this challenge in other, similar situations or contexts?
- How might nature a resolve / respond to x?
- How does nature resolve / respond to x, given the context / constraint of y and z?
- How does nature solve this challenge?
- How does nature adapt to changes?
- What does nature not do?

Environmental feedbacks can be very slow so it can be difficult to know if the proposed solution has been successful - for example, it takes a very long time for the water in a water catchment to clean once it has been contaminated. Careful observation and monitoring of different environmental indicators is critical - water quality, density and diversity of species, presence of food sources through the year, percentage of carbon in soil etc. While environmental rates of change typically happen very slowly, ecosystems and local environments can change very quickly due to disturbance. Fires can burn through a forest within hours, toxic spills can devastate extensive coastlines or water catchments within days, droughts can transform landscapes over months or years and rising temperatures can change whole ecosystems over decades and centuries.

THE SOCIOSPHERE

The sociosphere describes the realm of human society, culture and psychology - it includes all socio-cultural, political and economic systems and structures that define and influence human behaviours and interactions in any given culture and society, as well as the relationships and interactions between them. All forms of capital are either harnessed and/or created through the sociosphere. The sociosphere requires the biosphere to provide the natural materials and processes that allow humans to meet their needs, work together and create human societies. Designing effective responses to challenges within the sociosphere is commonly described as **social innovation.**

Social innovation is concerned with creating and delivering new ideas, strategies, concepts, organisational solutions, policies, services, products, spaces and communications to meet a social need. Examples of needs that social innovations may attempt to address are equity and inequality, working conditions, education and communication, community development, sanitation, poverty, health and wellbeing. Design in this realm is led by social demands rather than by market and/or autonomous techno-scientific research. Social innovation is often created collaboratively and ideally led by the actors directly involved in the challenge rather than by external experts and/or specialists. It requires designers to understand the importance of cultural, social, behavioural, emotional and environmental contexts.

Co-design is a key feature of effective social innovation. It is a participatory process of working *with* those most affected by the issue under investigation rather than designing *for* them. The role of the design expert in co-design is to facilitate collaborative design processes and support those affected by the challenge to contribute directly to the design of effective interventions or solutions. Those most affected by a challenge could be an individual, a family, a community group, a whole sector of society or a particular demographic.

Realms of knowledge which support social innovation include psychology, sociology, anthropology, linguistics, political science, politics and economics. **Ethnographic Research** and **Empathy Mapping** are examples of methods and tools used in the sociosphere that can provide great insights into community's and individual's wants, needs and perspectives which inform effective social design solutions.

Within the sociosphere feedbacks and rates of change occur across a wide range of timescales - where cultural capital tends to evolve slowly over many generations, social capital can be built over much shorter time frames, or over several generations, and in theory human capital can change very quickly, over years and even months in today's fast paced, globally connected society.

CO-DESIGN

- Means that projects are developed jointly between the designers and those most affected by the issue or challenge.
- Is synonymous with genuine participation and deliberative/direct democracy.
- Requires that the designers' skills and knowledge be integrated with the real world experience of those most affected by the challenge or issue under investigation.
- Requires designers to take the available information to make meaning of the process and to creatively give form to solutions.
- Does not stifle the creative process or dilute 'pure design', but rather actively recognises that the needs, values, and perceptions of those most affected by the challenge are critical to effective design responses.

THE TECHNOSPHERE

The technosphere is a term used to describe the realm of human technology - it includes stone tools, controlling fire, weaponry, fabrics and clothing, cooking and fermentation, musical instruments, boat building and sailing, agriculture, dams and irrigation networks, factories, microchips, genetic modification and engineering, birth control, robotics, synthetic materials, Artificial Intelligence, medical equipment and interventions, computer programmes and viruses, and everything else that comprises the processes and outputs of human technology. The technosphere includes all built capital, uses natural and social capital in its creation and maintenance, and evolves through cultural and knowledge capital. The technosphere is dependent on and a direct result of processes and interactions in the biosphere and sociosphere - human technology requires raw materials, natural processes, genetic information and stored energy, as well as the coordination of human relationships, labour and knowledge to create, maintain and retrofit it. Effective and responsive design in the technosphere can be described as **appropriate technology**.

Appropriate technology refers to the design, construction and application of technologies that are responsive to and 'appropriate' for the specific context in which they are used. The role of the designer is to design technological solutions that are fit for purpose while considering the ethical, socio-cultural, economic and environmental context in which the technology will be used. In practice, this means using the simplest level of technology that can effectively achieve the intended purpose in a particular location. Appropriate technology is typically small-scale - it is simple enough that people can manage it directly and on a local level. This involves making use of local resources, skills and technology that are available to provide for human needs, such as gas and electricity, water, food, and waste disposal while limiting the technology's impact on the environment and requiring fewer resources which can decrease maintenance and reduce overall costs.

Realms of knowledge most relevant and useful for appropriate technology include physics, materials science, engineering, architecture, anthropology, mathematics and chemistry while specific skills include craft, manufacturing, construction, programming and 'tinkering'.

Feedbacks and rates of change of different technologies differ significantly within the technosphere. Built capital such as infrastructure can change over centuries and even over millennia (e.g. Megalithic temples of Malta, Egyptian pyramids, Stonehenge etc.) while other forms of built capital such as single use disposable consumables can change within hours. Feedback from large infrastructure projects for example, also happen at various timescales. User behaviours and collective patterns of use for highways emerge over weeks, months and years while performance and durability feedback might emerge after decades. Feedback on Information Technology through user experience can be received almost instantaneously while the impacts these technologies have on culture and society may take decades or generations to emerge.

> *"Good designers must always be avant-gardists, always one step ahead of the times. They should – and must – question everything generally thought to be obvious. They must have an intuition for people's changing attitudes. For the reality in which they live, for their dreams, their desires, their worries, their needs, their living habits. They must also be able to assess realistically the opportunities and bounds of technology." Dieter Rams*

APPENDICES

A_ GLOSSARY

ADAPTIVE MANAGEMENT

A structured, iterative process of decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

AGILE

A method of design and project management that is characterized by the division of tasks into short phases of work and frequent reassessment and adaptations.

BIOMIMICRY

An approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. The goal is to create products, processes, and policies - new ways of living - that are well-adapted to life on earth over the long haul.

ECOLITERACY / ECOLOGICAL LITERACY

The ability to understand the natural systems that make life on earth possible. To be ecoliterate means understanding the principles of organization of ecological communities (i.e. ecosystems) and using those principles for creating sustainable human communities.

EMPATHY MAPPING

The process of recording and interpreting your observations from an empathic point of view. The purpose of empathy mapping is to see, experience and understand the challenge through the point of view of those directly impacted by or influencing this challenge. Mapping empathic observations allows designers to organise their thoughts in a specific manner centred on the words, actions, thoughts and feelings of the target audience the designer needs to understand.

ETHNOGRAPHIC RESEARCH

The investigation of a culture through an in-depth study of the members of the culture; it involves the systematic collection, description, and analysis of data for development of theories of cultural behavior.

PERMACULTURE

A system of landscape, technological and social design principles centered on simulating or directly utilizing the patterns and features observed in natural ecosystems.

PROTOTYPING

Prototyping is a specific generative strategy that involves testing small scale experiments, 'rapid fire' examples or 'mock ups' of an idea to learn more about the challenge and test and explore possible solutions. Prototyping also provides designers an opportunity to test smaller aspects of a much larger project and/or for collaborators, key stakeholders and end users to experience, test and feedback into the design process early and often.

RESILIENCE THINKING

An approach to managing complex systems which recognises human and natural systems as complex entities continually adapting through cycles of change, and seeks to understand the qualities of a system that must be maintained or enhanced in order to achieve sustainability. It explains why greater efficiency by itself cannot solve many modern environmental, resource, technological and social challenges. Two central themes underpin resilience thinking: Adaptive Cycle and Thresholds.

TACTICAL URBANISM

A design methodology that involves a number of temporary 'design experiments', often described as the 'lighter, 'quicker, cheaper' approach to placemaking. These 'experiments' test the design, programme and arrangement of a public space (such as a street) in a low-cost, low-risk and low-commitment way. The aim is that these experiments are measured for effectiveness and those that work are either left in place, or implemented in a more permanent manner.

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