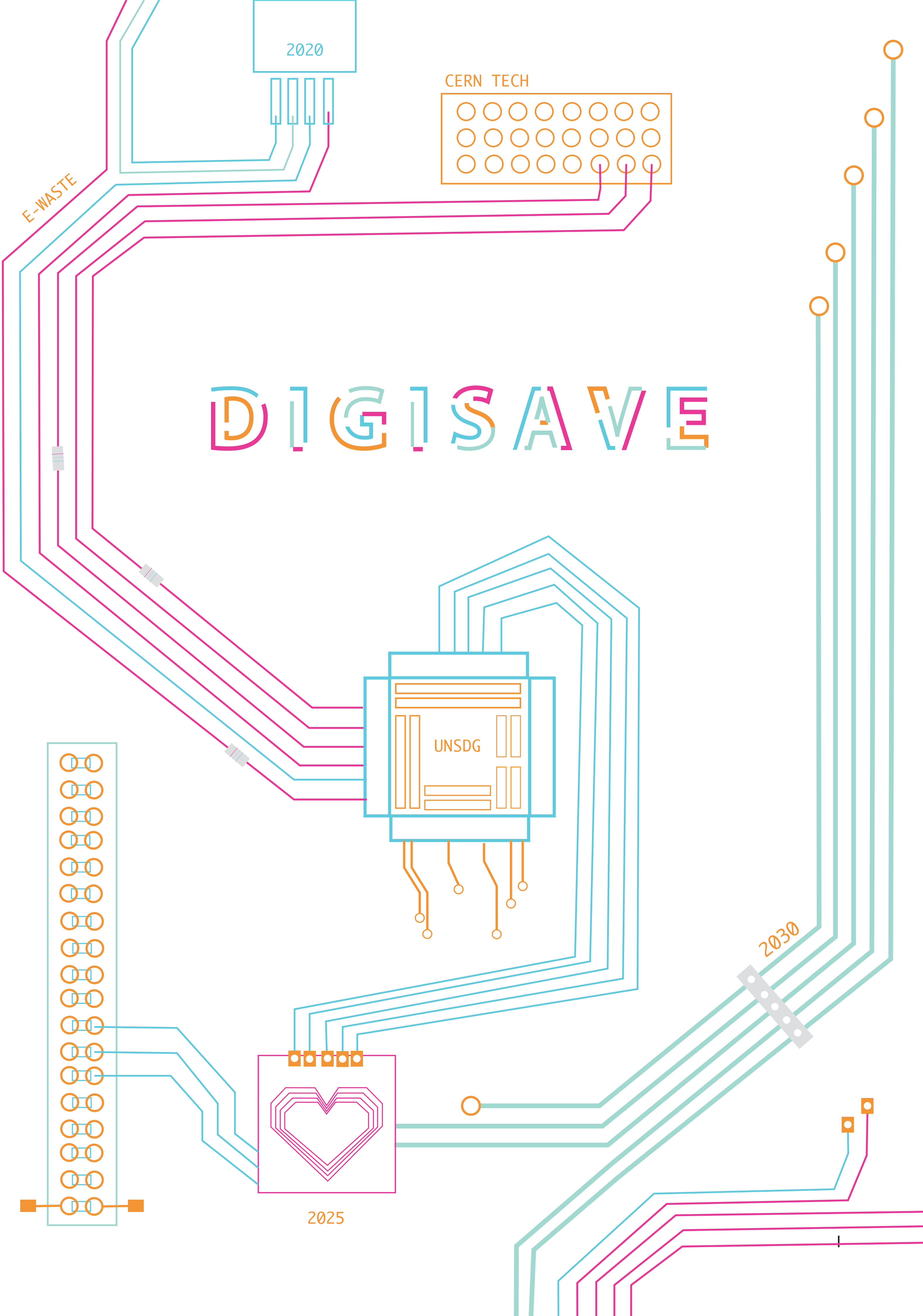
DIGISAVE



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EXECUTIVE SUMMARY.

Electronic Waste:

With a consumerist culture, personal devices such as phones, laptops and tablets are commonly purchased and become obsolete within a few years. Unfortunately, not all electronics are disposed of correctly; often placed in household rubbish or left unused to gather dust. Incorrect disposal of electronics waste poses a threat to public health and the environment due to the potentially harmful chemicals and materials contained within electronics. However, one of the biggest issues is waste of resources. When an electronic device is sent to domestic landfill rather than recycling, it represents a waste of the precious metals used in its manufacture. If managed properly these precious materials can be repurposed towards a diverse range of applications, including the manufacture of new devices."Electronic waste (e-waste) as a waste stream is growing up to three times faster than general municipal waste in Australia." [1]

The project:

In collaboration with CERN Ideasquare we are challenged with tackling e-waste (electronic waste) in Australia. As per project brief, our design solution should feature CERN technology and be in accordance with UN Sustainable Development Goal #12; Responsible Production and Consumption. Our goal is to 'design a more responsible way of managing the disposal of electronics in Australia with a strong focus on metal recovery and value'. Towards this aim, we have developed Digisave; a conceptual model for an organisation, responsible for overseeing the implementation of the Australian Responsible Electronic Consumption Scheme (ARECS). ARECS is a 2030 strategic plan for the reduction of e-waste in Australia and re-design of the electronic retail environment. The three major stages of ARECS are all closely tied together in the same aim, to provide a sustainable infrastructure to for the responsible consumption of electronics for future generations.

THE NOW. ELECTRONIC WASTE.

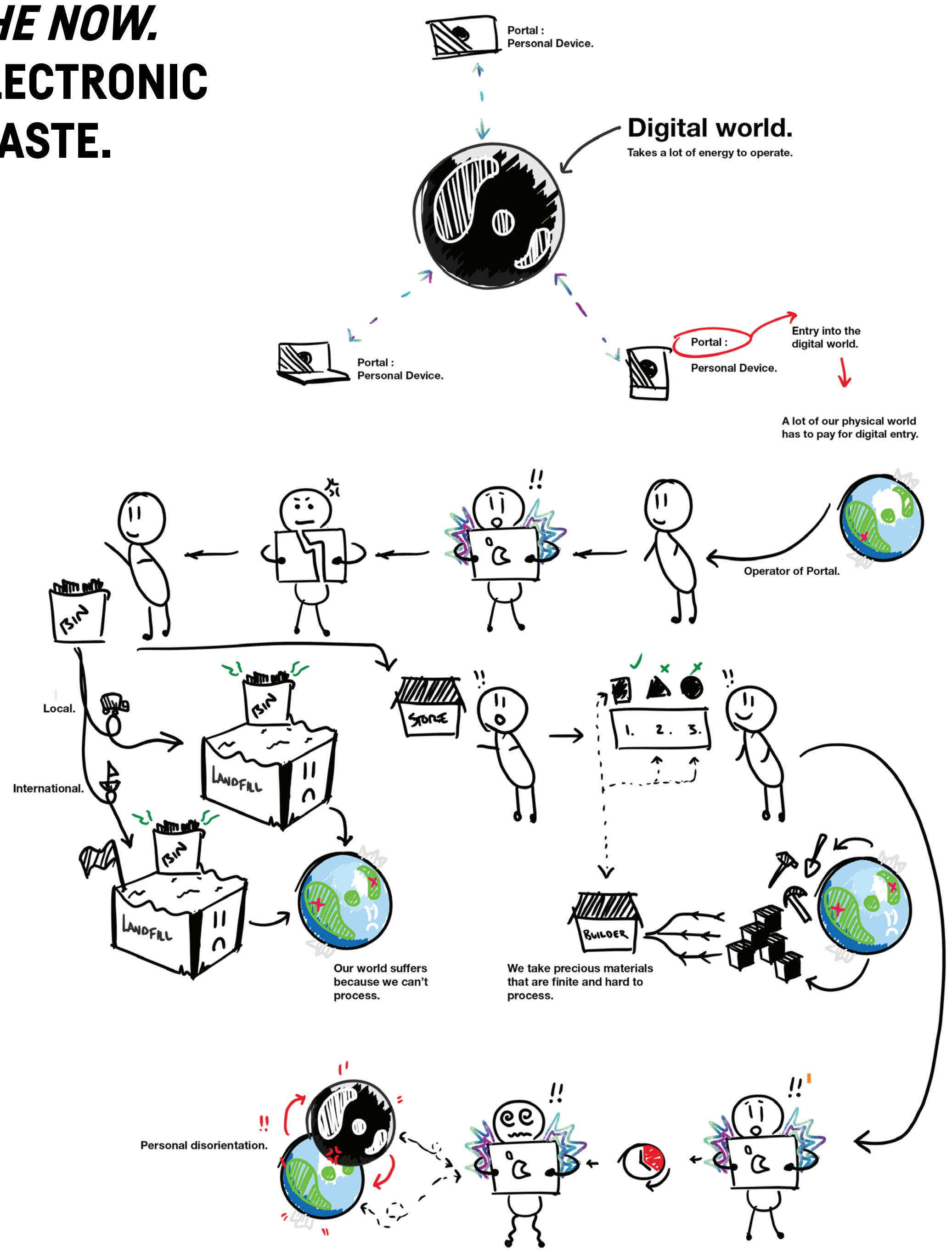

figure 1.

Electronic waste and Consumers

A driving factor behind e-waste is the behaviour of the consumers (figure 1). When a new technology is launched into the market, many consumers are driven by a desire to keep up with the latest technology, regardless of whether their currently owned devices are functioning and fulfilling their current needs. This is fuelled by a consumer culture whereby our belongings represent social status and wealth. In 2013 approximately 268 million tablets and 1.4 billion smartphones were in cycle across the world. [2a].

BACKGROUND: ELECTRONIC WASTE

E-waste is a loss of resources

Many of the metals and components contained within e-waste can be recycled and used to create new electronic devices and infrastructure. Unfortunately, when sent to landfill, e-waste represents a loss of resource; many containing highly valuable resources such a platinum. As a result, to compensate for this loss more mining of our natural resources is undertaken; severely depleting our already dwindling supply. Many of the metals and components contained within e-waste can be recycled and used to create new electronic devices and infrastructure. Unfortunately, when sent to landfill, e-waste represents a loss of resource; many containing highly valuable resources such as platinum. As a result, to compensate for this loss more mining of our natural resources is undertaken; Rare earths are difficult to mine and require a lot of energy to extract small amounts. Most of the rare earths are produced as a by product from core metals such as alumina and iron.

There is value in processing waste in Australia, approximately US$170 million annually is currently lost due to exporting waste rather than processing waste locally. [2b] E-waste processing is currently a growing sector in Australia, with annual growth of approximately 9% for the past five years. [2b]

“587,000 tonnes of e-waste was generated in Australia in 2014 with 10 % exported for reuse, 65 % collected for material recovery, and 25 % ending up in landfills”[2b]
“The presence of precious metals such as gold, silver and palladium as well as copper and iron/steel represent a significant part of the resource recovery value. The potential metal recovery value for Australian e-waste was estimated at US$ 370 million, with major contributions from iron/steel (29%), copper (26%), and gold (24%).” [2b]

Waste management is a large industry, although this shows there is wealth within our waste streams. Large amounts of e-waste has ended up in landfills and from this we propose a concept to recover and reuse materials in future product streams. Due to large amounts of e-waste being dumped in landfill and the materials contained within, there is value around removing these from landfills.

Hazards of E-waste

There are numerous potential hazards that incorrectly managed E-waste creates. The materials contained within e-waste cause risk to human and environmental health when allowed to leech into soil or pollute air and water.

Materials contained within E-waste and their humans effect:

- Lead: Intellectual impairment in children, can damage nervous, blood and reproductive systems.
- Mercury: May damage the brain and central nervous system, particularly during early development.
- Cadmium: Known Human carcinogen. Linked to kidney bone issues.
- Brominated Fire Retardants: Linked with Thyroid and Estrogen problems as well as Behavioural issues in children.
- Beryllium: Linked with Lung disease and possible human carcinogen.
- Polyvinyl Chloride (PVC):
- Chromium: A highly toxic material and known human carcinogen
- Arsenic: Known Human carcinogen.

Environmental Effects

- Water: Once e-waste is disposed of, heavy metals and chemicals contaminate the soil, and seep through this soil and contaminated the groundwater which eventually runs into larger bodies of surface water. Many communities around the world depend of surface and groundwater. Many forms of aqua life such as fish and plants, die due to these chemicals and materials entering these waterways. This also has effects of humans and animals which drink the contaminated water. [3]

- Air: Individuals in developing countries often scavenge through landfills in order to make a living. From this burning of e-waste occurs to sort out precious materials from non- recyclable materials. To expose the copper (valuable material) from wires, open air burning is popular and effective, although by doing this contaminants are spread into the air. These include heavy metals, hydrocarbons and dioxins. [3]

- Soil: Similarly to how water is contaminated by the soil, the soil is also under pressure from e-waste and another way these contaminants enter humans. Plants that grow in these areas are affected as well. From crops in nearby areas also absorb these contaminants, are harvested and then consumed by humans and animals later down the track. [3

CURRENT INITIATIVES

Banning E-waste in Landfills

There are plans to ban e-waste from Victorian Landfills, with e-waste growing three times faster than general municipal waste which puts Australia’s environment and waste management infrastructure under pressure. [4]

“ Analysis performed on the flow of e-waste in Victoria projects the amount of e-waste generated in Victoria will increase from 109,000 tonnes in 2015 to approximately 256,000 tonnes in 2035.” (Department of Environment, Land, Water and Planning, 2017)[4]

“For these reasons, it is important that e-waste is well managed. A package of proposed measures has been developed to reduce e-waste from landfill, increase resource recovery and support jobs and investment in the recycling sector.” [4]
What are the resistors?
China no longer wants our waste
Consumer culture and obsolescence
Manufacturing restrictions
State of landfills.
Landfill policies, and current closed/open landfills, observations.

Current e-waste management

Managed by the Department of Energy and Environment, the Product Stewardship Act 2011 and the National Television and Computer Recycling Scheme (NTCRS) are the main government initiatives managing the recycling of e-waste. However, a number of not-for-profits organisations, often funded by co-regulatory agreement operate within this space. These include mobile muster and specific programs offered by Planet Ark. However the current e-waste disposal options place a lot of responsibility on consumers to take initiative and seek proper channels leading to a resistance amongst consumers. Current advice given by Plant Ark illustrates this and the lack of consistency in e-waste disposal across Australia. Consumers are encouraged to:

- Safely store them in a dry place until there is a scheme collection point available
- Find out if your local council has a recycling option for computers or televisions
- Check the brand name of the equipment and contact the manufacturer to see if they offer a recycling program
- Offer old equipment to your friends or family
- Ask second-hand shops or charities if they could make use of them.

OUR PROPOSITION

Digisave.

Digisave is a conceptual model for an organisation, responsible for overseeing the implementation of the Australian Responsible Electronic Consumption Scheme (ARECS). Digisave is to be funded through co-regulatory agreements under the Product Stewardship legislation and National Television and Computer Recycling Scheme. Digisave is intended to build upon existing infrastructure whilst providing greater reach for awareness of e-waste and scope for the responsible management of e-waste. Thereby, allowing for more accountability to be placed with manufacturers, retailers and consumers of electronic goods.

ARECS is a 2030 strategic plan for the reduction of e-waste in Australia and re-design of the electronic retail environment. ARECS does not seek to take technological devices away from consumers but rather grow a sense of respect for the resources that go into these possessions and promote a sense that we are custodians of them.

Founded on the principle that Australia is capable of managing our own electronic waste in a responsible ways, ARECS seeks to tackle e-waste management from a number of directions including policy, retail and landfill management. Rather than targeting consumer behaviour directly we wish to make is it easier for them to become responsible electronic consumers.

ARECS goals include:

Promote legislation towards reducing e-waste

- Fund advertising campaigns and promote e-waste recycling channels
- Promote landfill mining operations
- Fund R&D of sustainably designed electronic products in Australia
- Re-define the electronic retail environment

These goals have informed the development of a 2030 strategic plan which includes three stages; 2020, 2025 and 2030. Each stage represents tackling a different resistor to the responsible management of e-waste. The first, 2020 proposes for legislative reform tackling legal and political resistors. 2025 focuses on mining existing metals in landfill to target ineffective recycling practices. Our 2030 scenario aims to propose a sustainably designed product that along with other initiatives will help redefine the electronic retail environment; tackling a detrimental consumer culture.

To ensure the successful implementation of our 2030 scenario, we must first consider a number of factors such as culture, economics and law and how they will negatively and positively impact acceptance or success of an entirely new electronic waste infrastructure. With a proposed solution specific to the context of Australia, we must consider what are the current resistors to effective management of the disposal of e-waste and propose appropriate methods to navigate these hurdles. Beyond tackling current resistors to e-waste, our aim is to foster an environment whereby recycling habits, consumer culture and infrastructure support a sustainable consumption of electronic waste.

Value Proposition

The implementation of the ARECS will provide:

- More metal resources, therefore less stress on the natural environment
- Prevent further pollution to the natural environment from e-waste
- Provide a frameworks for the future of e-waste management
- Develop a more conscious consumer landscape
- Launch an Australian Sustainable Electronics industry

DIGISAVE:
HOW IT FITS.

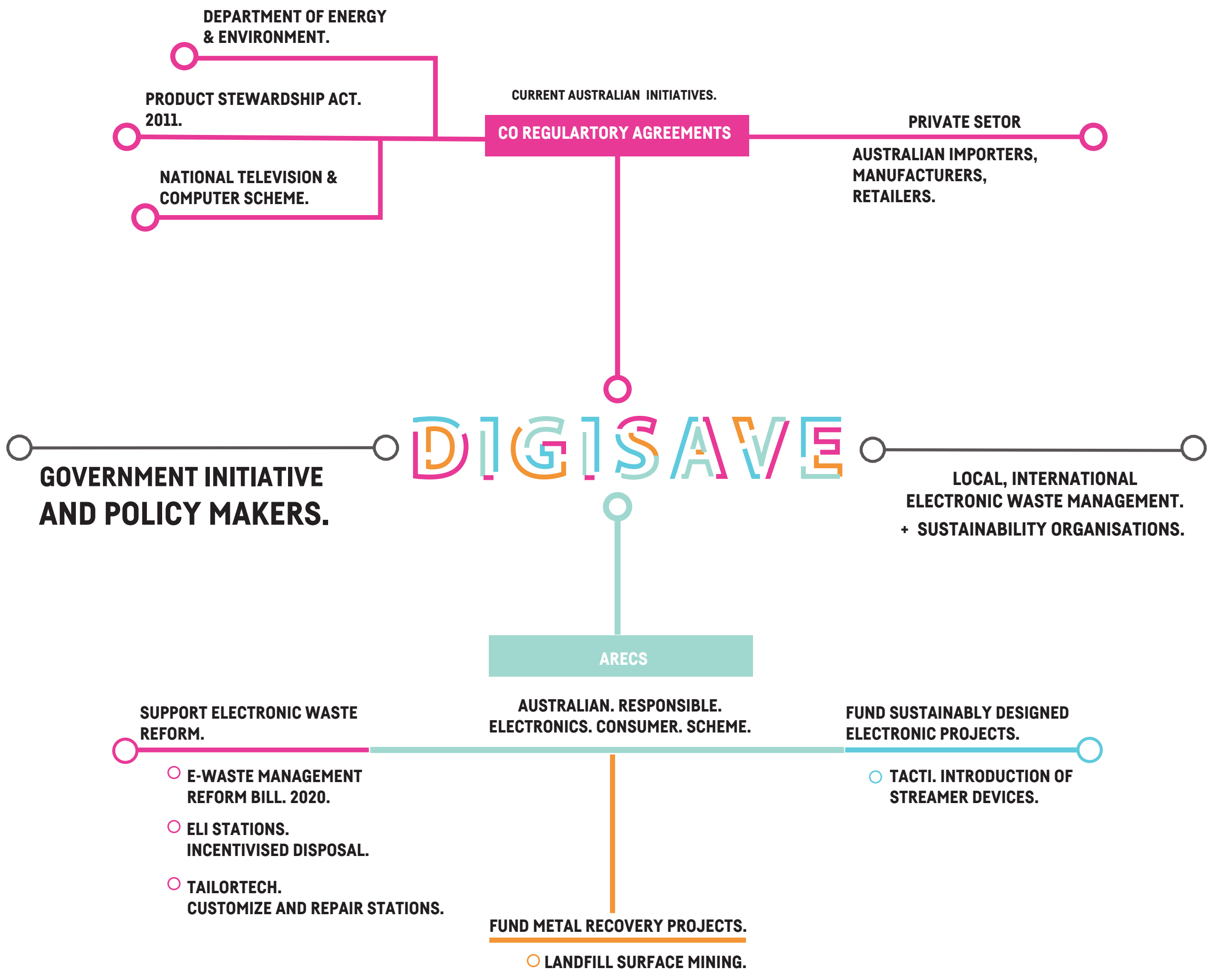

figure 2.

Digisave to pave the way.

The systems map (figure 2) illustrates how the developed conceptual model fits into current initiatives and processes. We foresee ourselves as the connecting bridge between the scattered and overloaded information streams, as well as providing future conceptusl models that will aid in the construction of a sustainable electronic environment.

A SIMPLE TIMELINE.

Timeline for implentation

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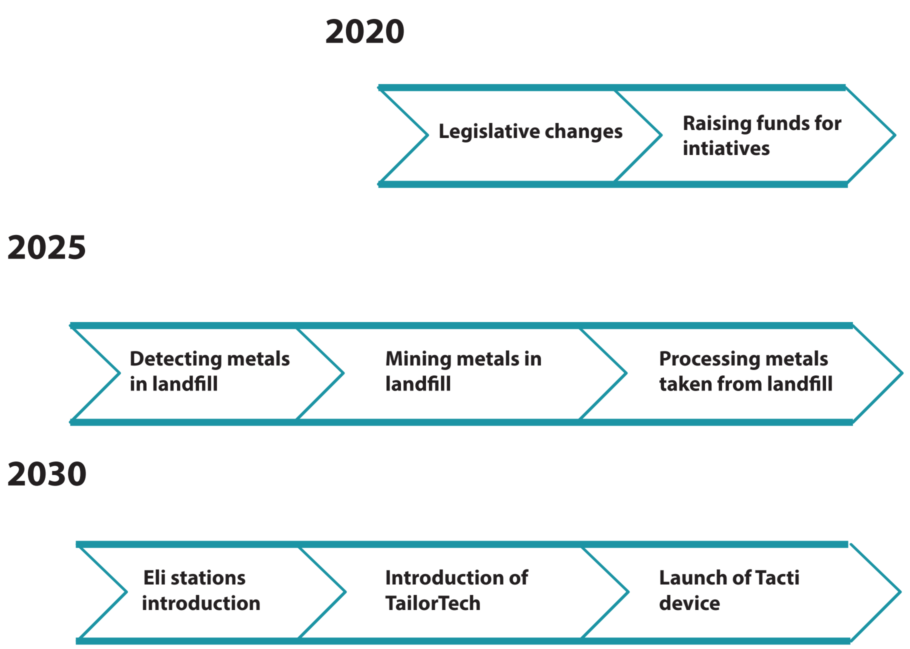


figure 3

2020: LEGISLATION CHANGES.

Description

Towards the aim of reducing e-waste we have developed a plan for legislation to mandate more responsible disposal and purchasing patterns. Current legislation to manage e-waste includes the Product Stewardship Act 2011 working in combination with the National Television and Computer Recycling Scheme. “Product stewardship is an approach to reducing the environmental and other impacts of products by encouraging or requiring manufacturers, importers, distributors and other persons to take responsibility for those products.” The Product Stewardship Act 2011 operates primarily on co-regulatory product stewardship which involves requiring some manufacturers, importers, distributors and users of products to be members of co-regulatory arrangements approved by the Minister which require outcomes, specified in the regulations. These required outcomes are funded by the manufacturers, importers, distributors involved in these co-regulatory agreements. We wish to build upon current legislation to develop a move that requires a deeper level of responsibility from both government and manufacturers, importers, distributors and users of products. Legislation was chosen as a foundation for cultural and infrastructural changes to the way we manage e-waste due to its unique ability to effect multiple stakeholders.

Electronic Waste Management Reform Bill 2020

The following is a Bill for an Act to reform the current disposal and management methods in place for the handling of electronic waste (e-waste) working towards a 2030 vision of drastically reduced e-waste. Electronic waste, or e-waste, is a term for electronic products that have become unwanted, non-working or obsolete, and have essentially reached the end of their useful life. These reforms are intended to be processed by under the National Television and Computer Recycling Scheme, Product Stewardship Act 2011 under the governance of the Department of Energy and Environment. This department would be responsible for overseeing the implementation of the Electronic Waste Management Reform 2020. The purpose of this bill is to mitigate the environmental and health impacts suffered by the disposal of e-waste both in Australia and within nations receiving e-waste. The Electronic Waste Management Reform bill will address limitations and Product Stewardship Act 2011 and provide further guidance to the responsible management of electronic products and their disposal. This bill applies to liable parties and Electronic products as specified in the Product stewardship criteria of the Product Stewardship Act 2011. This bill proposes a full ban on exportation of e-waste for overseas processing, changes to product warranty laws to enable consumer’s greater freedom for repair and customization, funding to train an electronic repair workforce and funding for the production and design of sustainable products within Australia. Furthermore, this bill imposes the requirement for all all retailers of electronic to provide fair access to e-waste disposal. Integral to the bill is funding for mining and processing of pre-existing e-waste and metals within Australia’s landfills. Ultimate aim of reducing e-waste production within Australia.

Goals of the Legislation

- All e-waste must be processed locally (2020)
- Fund the detection, mining and processing
- All retailers electronic must provide e-waste (phone, tablet, PC) disposal units. (direct accountability)
- Incentivise repair and customisation.
- Incentivisation of design for disassembly
- Changes to warranty. Reduced control
- Funding for the Research and Development of Sustainable Electronic Products within Australia. Under the Sustainable Electronics Scheme
- Incentivised disposal for consumers
- Private company funding for training and incentivisation for repair

2025 : LANDFILL MINING

2020 Detection Phase:

This phase centres on mapping closed and open landfills within Australia to gain an insight into metals which lay below the surface. We aim to obtain data on buried metals and triangulate their location to recover these at a later stage. By using a Ground Penetrating Radar (GPR) (figure 4), which is a non-destructive method of scanning the surface, we are able to formulate a three dimensional model of the landfills and what they contain. By attaching this to human controlled land based drones (figure 5) we ensure the safety of the operators, the drone can be remotely controlled on the landfill premises to collect data.

This data can be used to pinpoint locations of valuable waste that has been disposed of incorrectly; included in this group is electronic waste which contains various amount of recoverable metals and other materials. This data enables the opportunity to obtain and recover fully recyclable items that would have otherwise gone to waste; giving them a new life after recovery. By using the CERN technology Root, we will categorise this data efficiently for the future stages of this project. This process man be undertaken wide spread across Australia with categorisation of data into importance and material contents.

Rear view : GPR unit.
figure 4

Human Controlled Land based drone. figure 5

Detecting metals and its value

Ground Penetrating Radars are a cost effective and non destructive method of collecting data of the soil. This technology is commonly used to detect pipes and leaks, buried objects, archaeological sites, concrete mapping and foundation footings. [9]

“Ground Penetrating Radar is currently the only non-destructive technology able to locate both non-metallic as well as metallic subsurface utilities.” [9]

It works by sending an electromagnetic signal into the ground and measuring the return rate and strength of the signal when it returns to the antenna. There are both high and low frequencies; high frequencies allowing a more accurate image but shallower total depth, whereas the low frequency can penetrate the medium further but also has greater loss of data [10]. GPR can also detect variation of different materials through mediums which it detects through based on signal strength, therefore making this technology useful for the detection of materials within the landfill. [11].

Depth of this radar system depends on the materials which it penetrates, generally this form of detection is designed around shallow detection, although recent developments within the mining industry, these GPR's have been able to achieve depths of 200 metres and are able to provide a three dimensional mapping of the detected zone[12]. This has been used been used for mineral exploration. Compared to other material detection techniques, GPR is more economically viable. In the mining industry this technology was able to reduce the costings by 50% in comparison to drilling [12] therefore making this technology economically viable for this detection phase of landfills. This is also not a large scale infrastructure, for shallow ground inspection a device can be simply pushed around by human power, other deep penetrating ground radars are larger and require a larger item to push them around.

“DGPR (Deep Ground Penetrating Radar) is a new surveying technology that achieves over 10 times the resolution to a massive depth of 200m in less than 1/10th of the time, reducing required explorative drilling costs by over 50%.” [10]

“GPR is used worldwide for mineral exploration. The most common use is exploration for fluvial deposits of gold and diamonds as well as beach deposits of titanium and iron-rich heavy minerals.” [11]

2025 Recovery Phase:

In this phase we aim to recover the materials detected within the landfills in the previous stage. This process involves various techniques and equipment in order to retrieve the materials identified in the data sets.

Using containment zones

The first step is to isolate the area by using an "containment area" (figure 6) to avoid potentially harmful materials from leaking outside of the boundaries of the landfill zone. This containment zone will also trap any landfill gases which pose potential risk of harm to humans and the environment. Landfills also produce gases which can be collected, processed and burnt to generate electricity for the grid or other uses. Within this containment zone we aim to do this process as way to power the operations which continue on the site. From the disturbances of the landfill due to recovery of materials, this gas will be released from this process, therefore lower the need to have wells installed into the landfill.

Within these zones is the beginning of the recovery operation, so from the data we collected from the previous phase; metals within the landfill we are able to concentrate our efforts towards which areas contain the highest metal content. With the data gathered from the previous phase, retrieving materials from the ground can be more or less focused on certain areas depending on concentrations below the landfill's surface making the entire process.

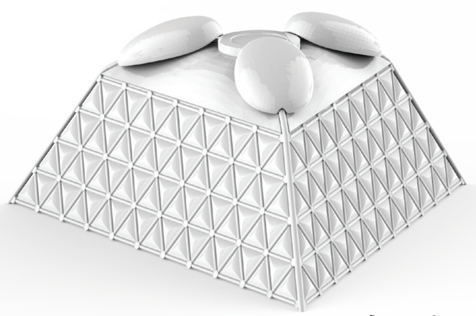


figure 6

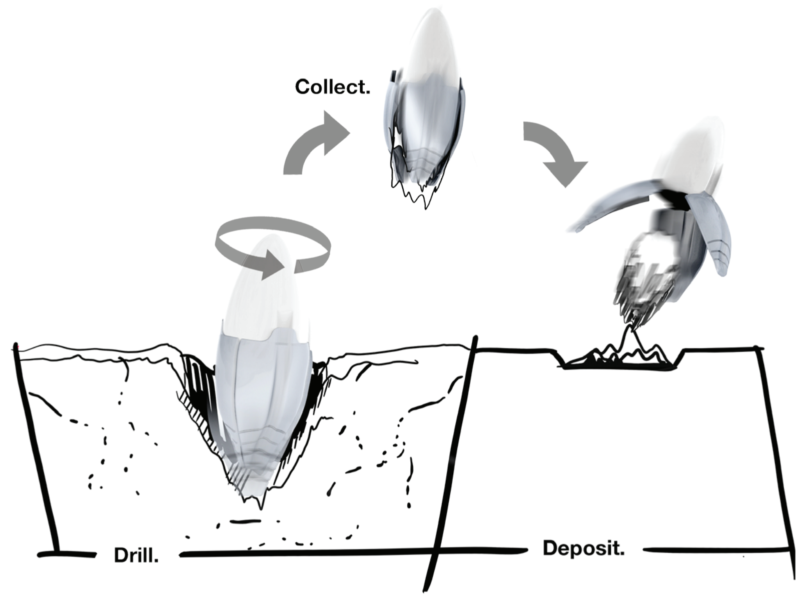
Autonomous mining vehicles

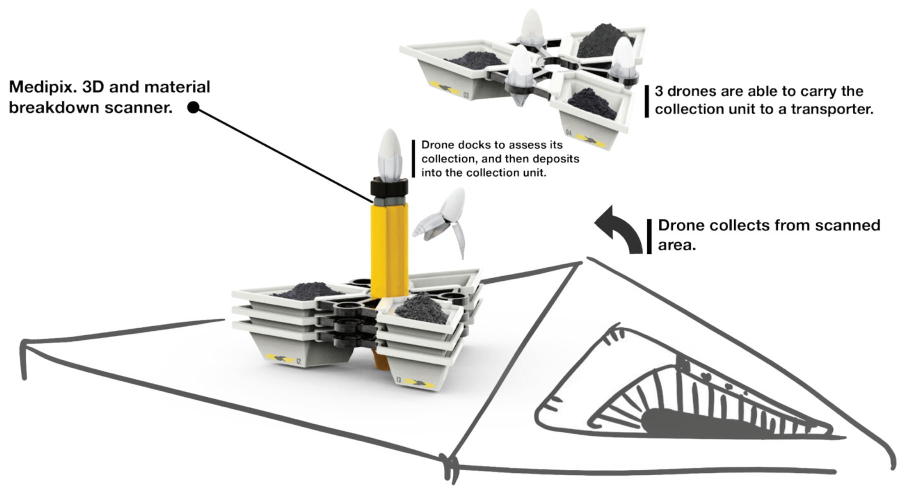
Autonomous mining and equipment will be used in the process and controlled from an off site control room. This system had become more of trend within the mining industry and means greater efficiency and operations continuing around the clock. The offsite control rooms removes the need for machinery operators which reduces reduces the human risk from exposure to deadly materials. With Australia's large mining industry, their equipment and techniques could be applied to this scenario. Adapting these techniques to landfill metal recovery is viable option for mining companies and also gives them a new area to work within, creating more jobs.

Use of Drones

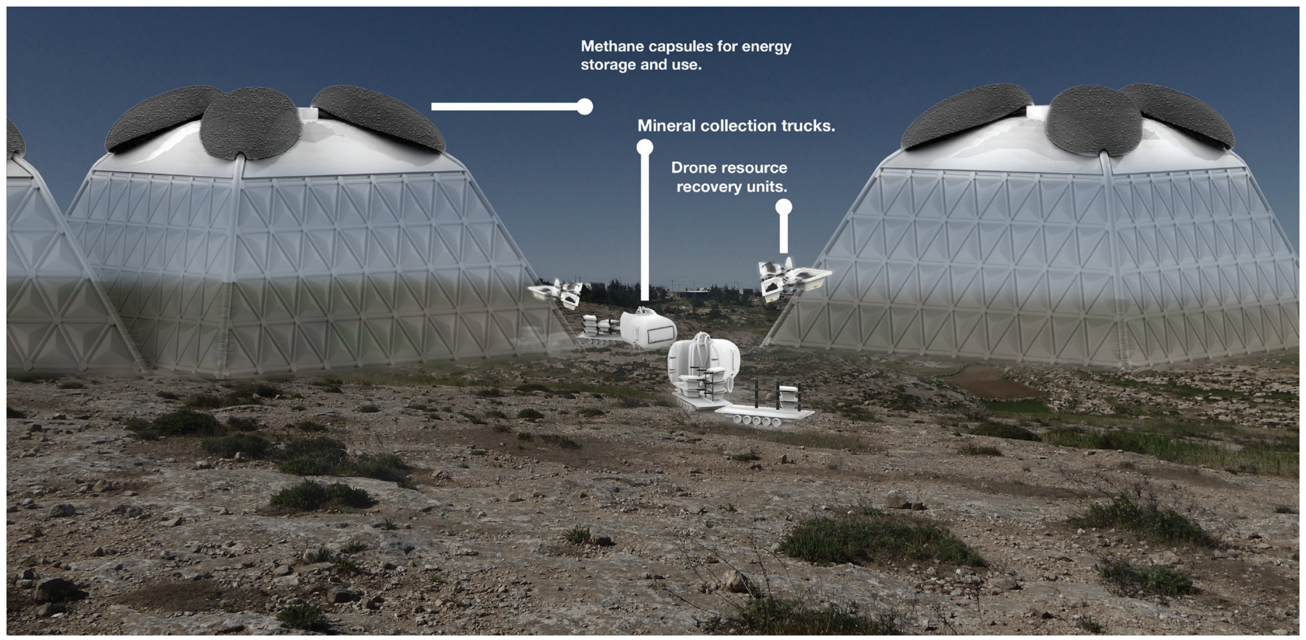
Drones will be used throughout the process of recovery and sorting phases as well as continuing with data collection to cross reference and update the findings from the the initial detection. These drone are designed to obtain hard to reach areas or areas where minimal materials are found within the landfill. These are equipped to drill and clamp onto waste to retrieve it out of the ground to be sorted. From this recovery method it moves into the sorting areas, where the waste is sorted into categories.

The drones now dock within a waste metal separating unit, this process can sort out and determine material compounds to then sort them into waste categories, for example common metals (aluminium and steels) and complex materials (E-waste) .Material and Component detection is an important process after retrieving these components. By using X-ray Technologies such as X-Ray Fluorescence (XRF) along with CERN Medipix we can determine the compound of metals and categorise this data. This can be split up into different categories and classes of metals to then be processed, recycled or repurposed. The value of this is to increase the efficiency of material processing and is aimed to reduce the material losses therefore increasing the useable materials for future products.





Deposit process.



MET'S (Mining equipment transsfer)

Based of the data from the previous step of the detection phase, using conventional methods of recovery such as excavating and stepping down landfill are used to collect larger clusters of metals. Using METS (Mining Equipment Technology and Services) we are able to figure out the best techniques for recovery, this is used as Australia has a large mining industry and techniques from this may be applicable for metal recovery from landfills. For smaller operations, a series of drones are used in order to recover lost materials. These drones are equipped with segmented drill mechanism and are able to collect materials using this same mechanism. These are also equipped with GPR and XRF devices to cross reference the data which was collected in the previous step. These drones are later docked into a sorting area where waste is scanned and categorised.

The hazards of landfill

Due to landfills containing vast amounts of hazardous materials, containing these in an enclosed area as a protocol is important. There are several health effects associated from materials in landfill. "Within landfills there are numerous amounts of hazardous materials which have been linked to health effects such as cancer, birth defects, reproductive damage, chromosomal changes, heart defects and the list continues." [13] Therefore keeping these materials in a contained area is essential to ensure no one is at risk and irreversible damage. which have been linked to numerous health effects such as cancer, birth defects, reproductive damage, chromosomal changes, heart defects and the list continues." [13] Therefore keeping these materials in a contained area is essential to ensure no one is at risk and irreversible damage.

"The capture and use of methane for energy recovery provides a means of reducing greenhouse gases and generating a renewable energy source." [16]

XRF technology use

X-ray technologies have been used to determine material compositions. X-ray Fluorescence is a process of determining the composition of materials and has multiple uses. It is also a mostly non-destructive form of material composition detection. Handheld XRF Devices are available and are currently being used in numerous areas which include:

- Mining
- Cement production
- Metallurgy and quality control
- Ceramic and glass manufacture
- Field analysis on geological environments [18]

"XRF is an acronym for x-ray fluorescence, a process whereby electrons are displaced from their atomic orbital positions, releasing a burst of energy that is characteristic of a specific element. This release of energy is then registered by the detector in then XRF instrument, which in turn categorizes the energies by element." [19]

Using landfill gass as resource.

Another main factor around the containment zones surrounds landfill gas generation. Landfill gas occurs when organic matter decomposes, which mainly consists of 50% methane and 50% carbon dioxide [17]. Due to the large amounts of methane in landfills, power generation is a consideration for the containment zone.[14] Methane is damaging to the environment, although during combusting the methane is converted to carbon dioxide which is a less potent greenhouse gas [14] which makes it a viable option for power generation. Normally landfills contain a system of wells which are directed into the ground, although once landfill is disturbed, methane is released, therefore making these wells less ideal. With gas being trapped within the containment zone, it is able to harvested, store within the top bubbles and create energy for the mining operation or put back into the grid.

CERN Technology use

To manage the total operation, C2MON from CERN is a highly scalable technology which will be used for used for monitoring the operations of the mine and the equipement. This will ensure problems are detected as well as maintaining operation efficiency. This technology is being used to monitor the Hadron Collider but can be scaled to monitor the machinery and equipment used in our landfill mining operation.

Using CERN Medipix3 we can determine the compound of metals and categorise this data into similar materials, therefore sorting components. It uses a Computer Tomography (CT) and pixel detectors to determine compositions and categorise these into similar materials. Both XRF and Medipix3 are used in the sorting stage of this process to ensure at later stages we categorise similar materials for efficient processing. The sorting zones work via drones which dock into the centre pillar, where a combination of these forms of x-ray technology and Medipix scan the contents which has been pulled out from the landfill. Once detected the drones remove themselves from the area and place the contents in a container where these can be sealed to ensure no waste is lost.

E-waste processing streams.

After pulling filing the containers full of recyclable waste, these are loaded onto a Autonoumous collection Vehicle (ACV) (figure 7) where they deposited at the correct processors, for example electronic waste may go to a hydrometallurgical processor and more common metals to their correct smelters. Value of component detection.

Electronic components have a range of different materials, this is also the issue surrounding processing. By determining the materials which lay within the waste and their composition, waste can be sent to the correct processors to be able to obtain the most materials from processing and reduce the amount of losses from processing.

Even before the hydrometallurgical (a chemical process of dissolving materials in acid baths and sorting the baths after dissolving) in or to retrieve process of processing e-waste it is estimated 20% of precious metals are lost due to mechanical force of crushing e-waste [19]. Imagine the opportunity to crush only crush certain components which would could be more efficient in this process and reduce the number of loss by half.

Another method of e-waste processing is the pyrometallurgical process (incineration of Electronic waste to retrieve materials). This process cannot recycle any plastics as they are used to fuel the process, and from this creating hazardous gases. Iron and aluminium is also difficult to process as this created oxides which are extremely difficult to process at a later stage [20]. If only certain products containing less of these materials were sent to this style of processing, the losses and recovery of materials would be increased. The value of detecting components within this waste is that we are able to categorise this more effectively for processing, then from this being able to sort out the electronic waste to ensure the greatest return of materials.

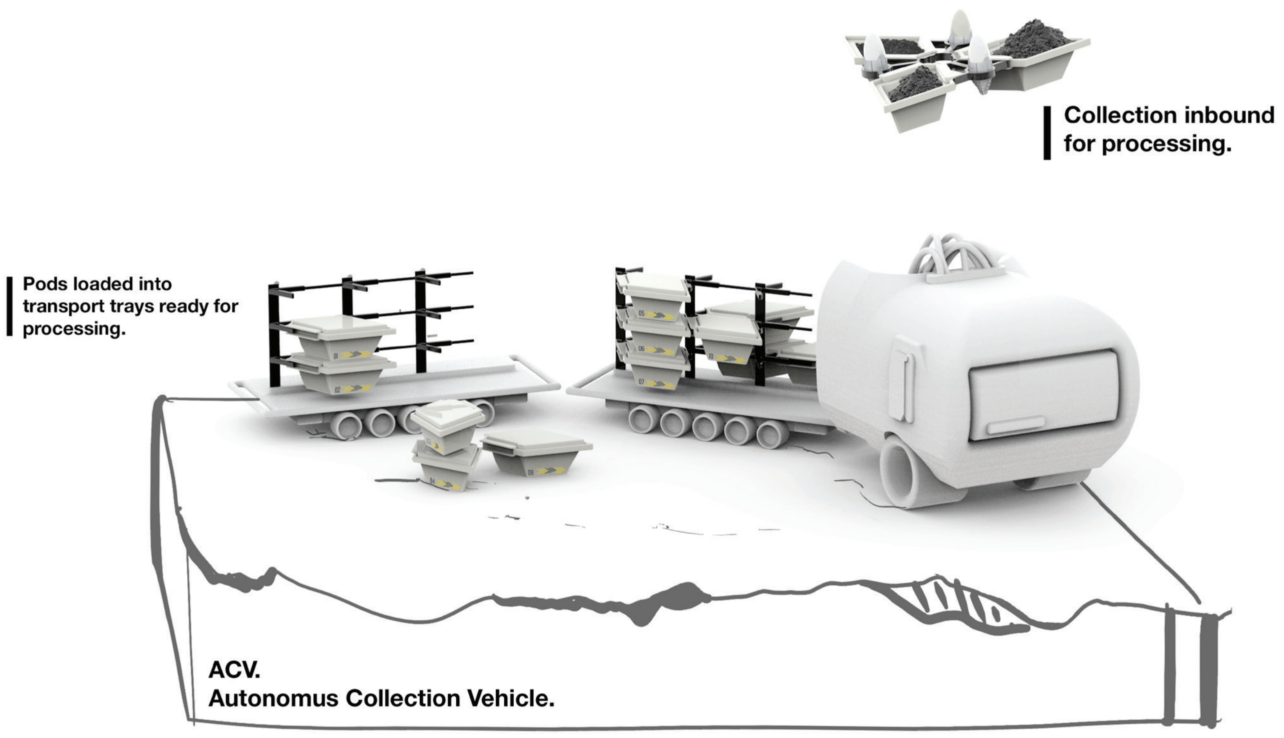


figure 7.

Close the loop on metal waste.

From these processes metals will be recovered rather than wasted, thus closing the loop on our metal resources. Whilst there will always be some level of lost materials in the production of electronics through the manufacturing, disposal and recycling limitations we ensure that components within electronic devices feed back into the system where possible.

2030 CONSUMERS AND RETAIL

Close the loop on metal waste.

Part of the AREC scheme is a strategic vision to transform the retail landscape in Australia by 2030. Our aim is to make the retail space a centre for information and choice whereby consumers feel empowered to take ownership of their personal devices and the maintenance thereof (figure 8). Whilst current trends illustrate a growing dependence on the online retail environment, we hope to turn this around and promote the physical retail environment as this provides a central hub whereby the purchase and care of a device might be achieved all in the one space. We want to inform consumers so that they might become more conscious and connected to how they interact with the electronics they use in their daily lives. To achieve this vision we have targeted three areas; information and awareness, e-waste disposal and device longevity.

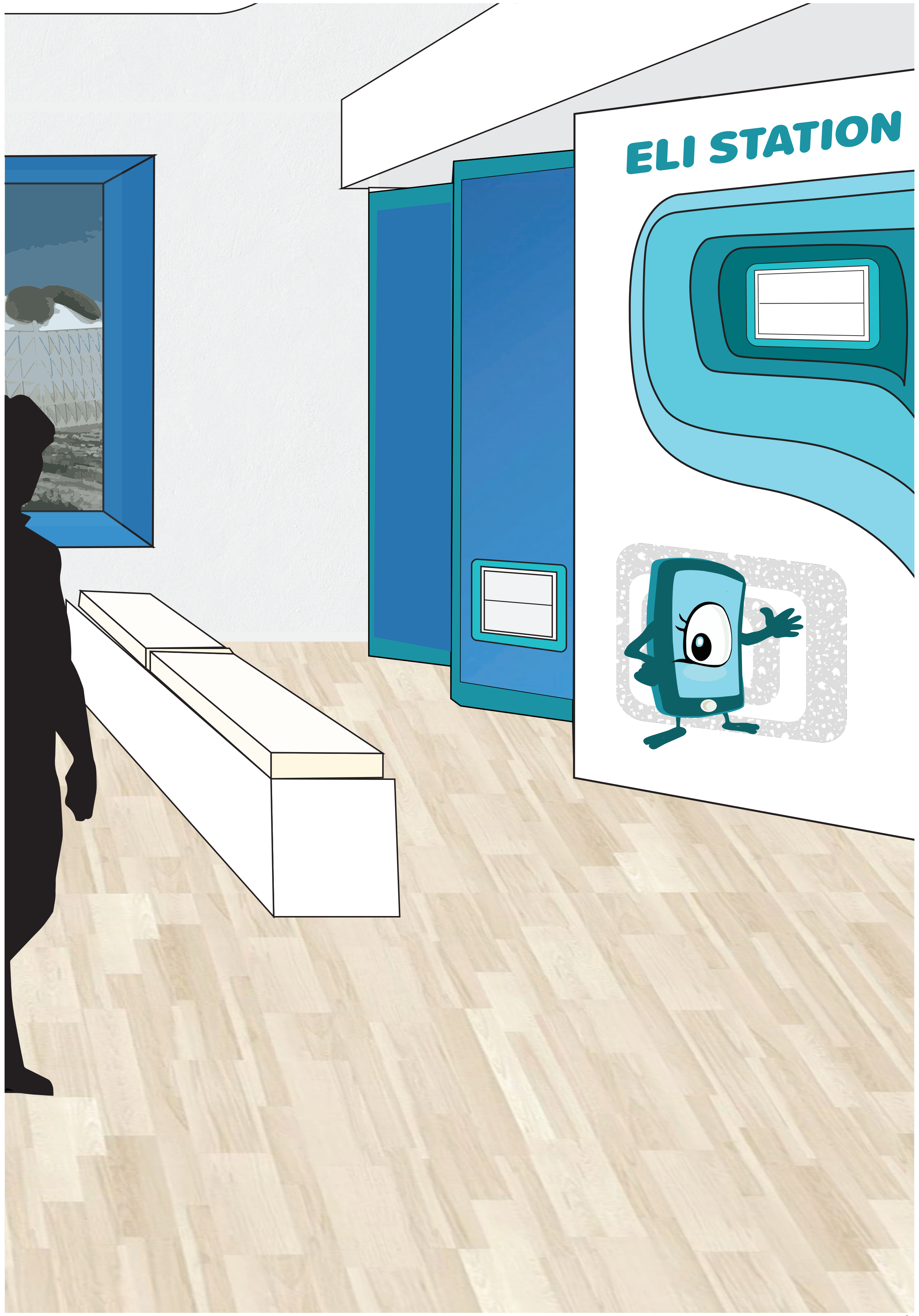
Through Eli and product information screens we will inform consumers on:

- Which products are more sustainable
- Which devices suit consumers specific needs
- The impact personal electronic devices are having on natural resources
- Inform consumers of obsolescence ratings

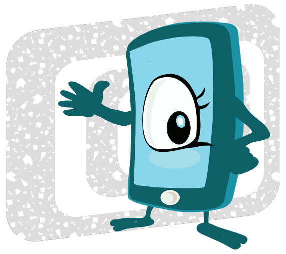
Through Eli stations we will:
- Collect electronic waste for further processing
- Encourage repair of dysfunctional devices

Through TailorTech we will:
- Prevent devices with minor damage or obsolescence from being sent to landfill
- Encourage more consumer consciousness and stewardship with their personal devices

figure 8.



ELI STATIONS :



Description

With a simple, anthropomorphised almost childlike visual design, Eli is the friendly face of e-waste management under ARECS. This is intended to be the main public brand consumers familiarise themselves with and act as a communication and education tool. Eli provides information on obsolescence ratings of devices, sustainable products and how consumers can dispose of their e-waste or unwanted electronics more responsibly. This will be achieved through a number of channels including in-store information kiosks, online and print material. Eli will help users select new devices and personalised features according to their specific needs. Aside from a communication tool the Eli brand is also attached to Eli stations; a waste management system that operates similarly to existing organizations TechCollect, Drop zone and MobileMuster (http://recyclingnearyou.com.au/ewastescheme/). The Eli Stations acts as disposal bins for personal electronic device waste whereby the e-waste is sent for further processing and recycling. Consumers simply bring their e-waste the Eli Station kiosks located in retail stores around Australia. Via the Eli touch screen interface consumers enter basic info about the device they are disposing of and place it into a small collection portal when done.

Value Proposition

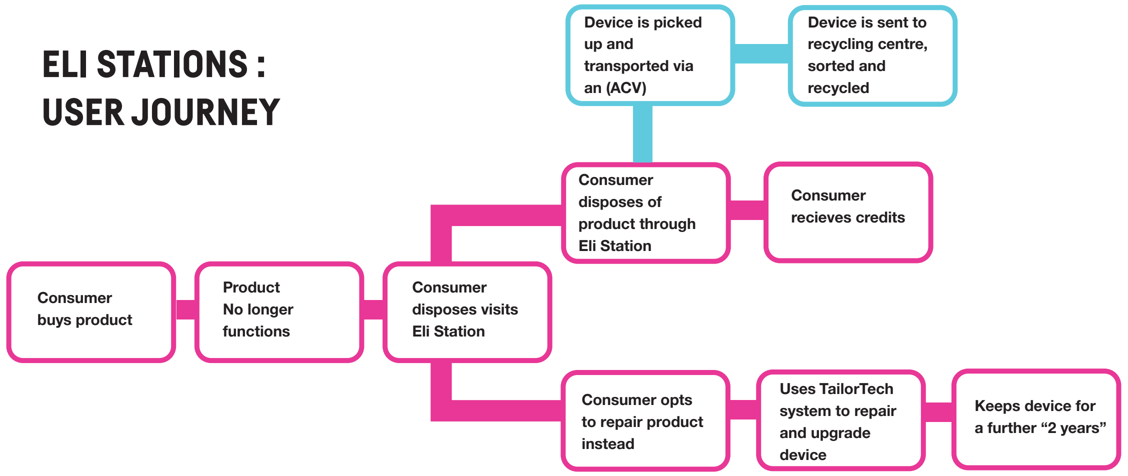
However, Eli Stations seek to centralise e-waste recycling of all personal electronic devices to one national system. The unique offering of this waste management system is the application of Medipix technology which will directly sort e-waste on the spot to allow for more efficient recycling. Autonomous collection vehicles (ACV) will then collect the waste using the most efficient route to deliver recycling centres hus reducing the greenhouse footprint of transport.

To assist in the aim of reducing e-waste, the Eli Station will give an assessment of the repairability of the device being disposed of and offer advice as to the what could be done to extend its lifespan or functionality; attaching an estimate of repair costs and value after repair. This directly feeds into the TailorTech system; located on the same premises this provides an easy transition between the two systems.

Incentives

One of the most important components is user incentive includes store discount. After disposing of devices at Eli Stations consumers will receive store credits that can then be used to purchase new devices or to be used to pay for repair and customisation through TailorTech.

ELI STATIONS : USER JOURNEY

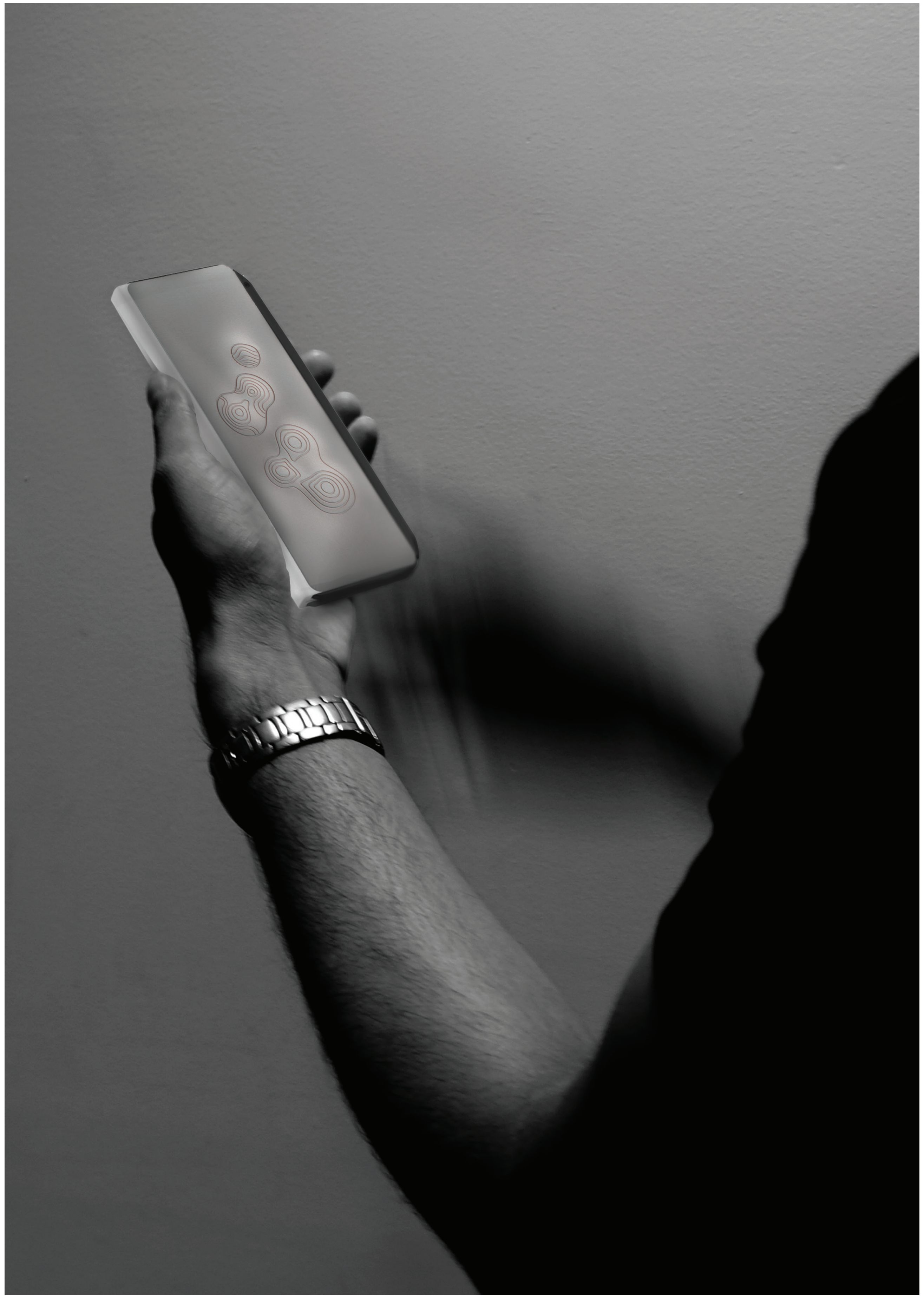


TAILOR TECH

Changes to warranty specified in the Electronic Waste Management Reform Bill 2020 along with a changing retail landscape will allow for TailorTech to emerge as a national repair and customisation service. Backed by AREC, TailorTech is intended to be a trusted resources for consumers, tech literate and novices alike. With devices designed for disassembly and customisation such as the 'Tacti' device making the maintenance of your personal electronic devices easier.

To repair or customise, a consumer needs to simple enter their customisation or repair requirements via a touch screen or inform a service person. They may place their device through a collection portal at the TailorTech kiosks and wait a short period for their device to come back. The purpose of this service is to make it easier for consumers to extend the lifespan of their personal devices and therefore produce less e-waste.

TAILOR TECH



2030: TACTI

INTRODUCTION.

This concept of the device of the future sets a conceptual direction for electronic devices in the future, and reducing electronic waste without totally eliminating consumer access to personal electronic devices. Technology use and devices have increased dramatically, as well as the size technology, the first computer being the size of a room, nowadays a Smartphone is a fraction of the size and holds more computer power, a trend which is assumed to continue.

Devices currently use the similar components in different scale, therefore this concept proposes that we can limit this componentry into one device, therefore reducing the need to create new device parts for other electronic devices, hence limiting the amount of electronic waste. There are two main parts to this device, this includes the Tacti and the Hollows.

Tacti and how it made (streamer device)
Tacti is a device we call a “streamer”, a device which able to stream and share its processing power across multiple devices which are called Hollows. Whilst consumers buy the most powerful device, how many times have the device been completely maxed out?

Tacti features a projected interface onto a programmable material or shape shifting material screen to include textures into the interface. These technologies have been in development, an example on this is from MIT, where temperature and light can be used to change the shape of a fabric (21). MIT’s self assembly lab is dedicated to the development of programmable material (22). Programmable Materials consist of material compositions that are designed to become highly dynamic in form and function, yet they are as cost-effective as traditional materials, easily fabricated and capable of flat-pack shipping and self-assembly. These new materials include: self-transforming carbon fiber, printed wood grain, custom textile composites and other rubbers/ plastics, which offer unprecedented capabilities including programmable actuation, sensing and self-transformation, from a simple material (23). From this derives active textiles, which is a fabric that has small perforations that reacts to certain wavelengths of colour, resulting in dynamic, shapeshifting forms. (24) Another more abstract form of programmable matter is Claytronics. This theory revolves around devices on the nano or micro scale which combine to create a physical entity. These are known by the name Catoms or claytronics atom, and from could be programmed to create different shapes and sizes. [25] This technology is currently in development and with larger proof of concept (4.4cms wide) was created which moved around magnets. [24] These Catoms may also contain LCD or LED’s [25] therefore being able to create images or screens. By 2030 and developments in these materials technologies could be applicable in the Tacti Device as the user interface. It involves shape shifting and textures as a new the form of experiences.

“These Catoms are the ones that contain sufficient local computation, actuation, storage, energy, sensing and communication which can be programmed to form interesting dynamic shapes and configurations.” [25]

“Hollows” are devices which are the processing power is streamed too, therefore only using small amount of components in order to operate and therefore making these devices easier to create, cheaper and have more freedom. These could take shape as wearables such as an augmented reality device or wrist devices. In terms of workstations and computing, replacing these devices with projection modules to ensure they are still able to function as the required device. For additional processing power these modules could have similar components from the “Tacti” which can easily be repaired or processed easier through retailers.

tacti.

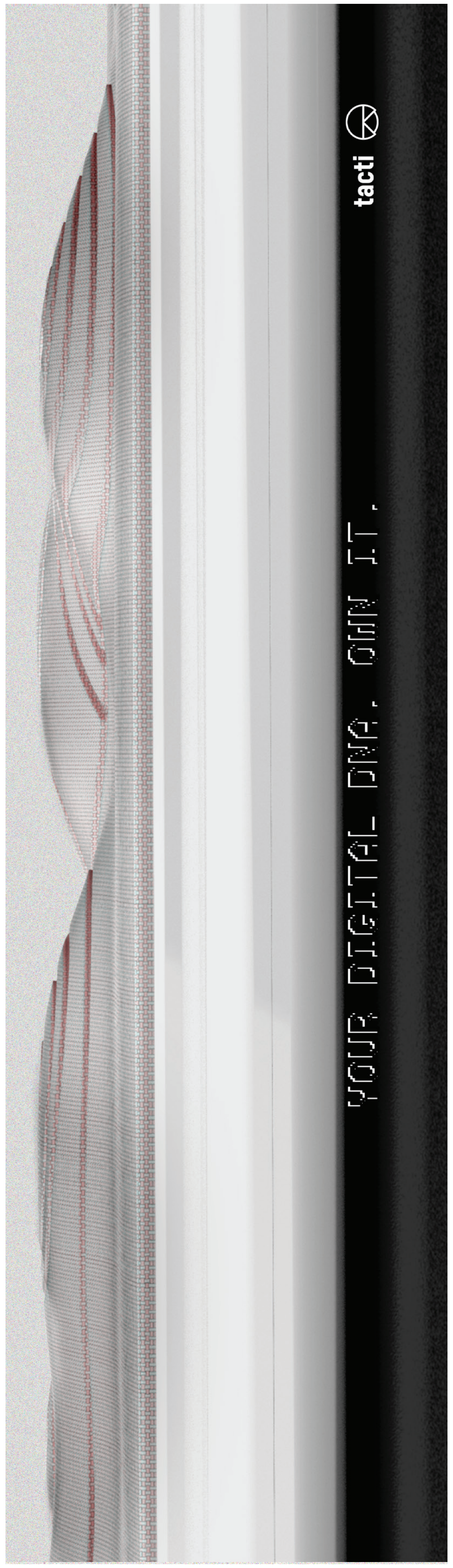
Speak through waves.

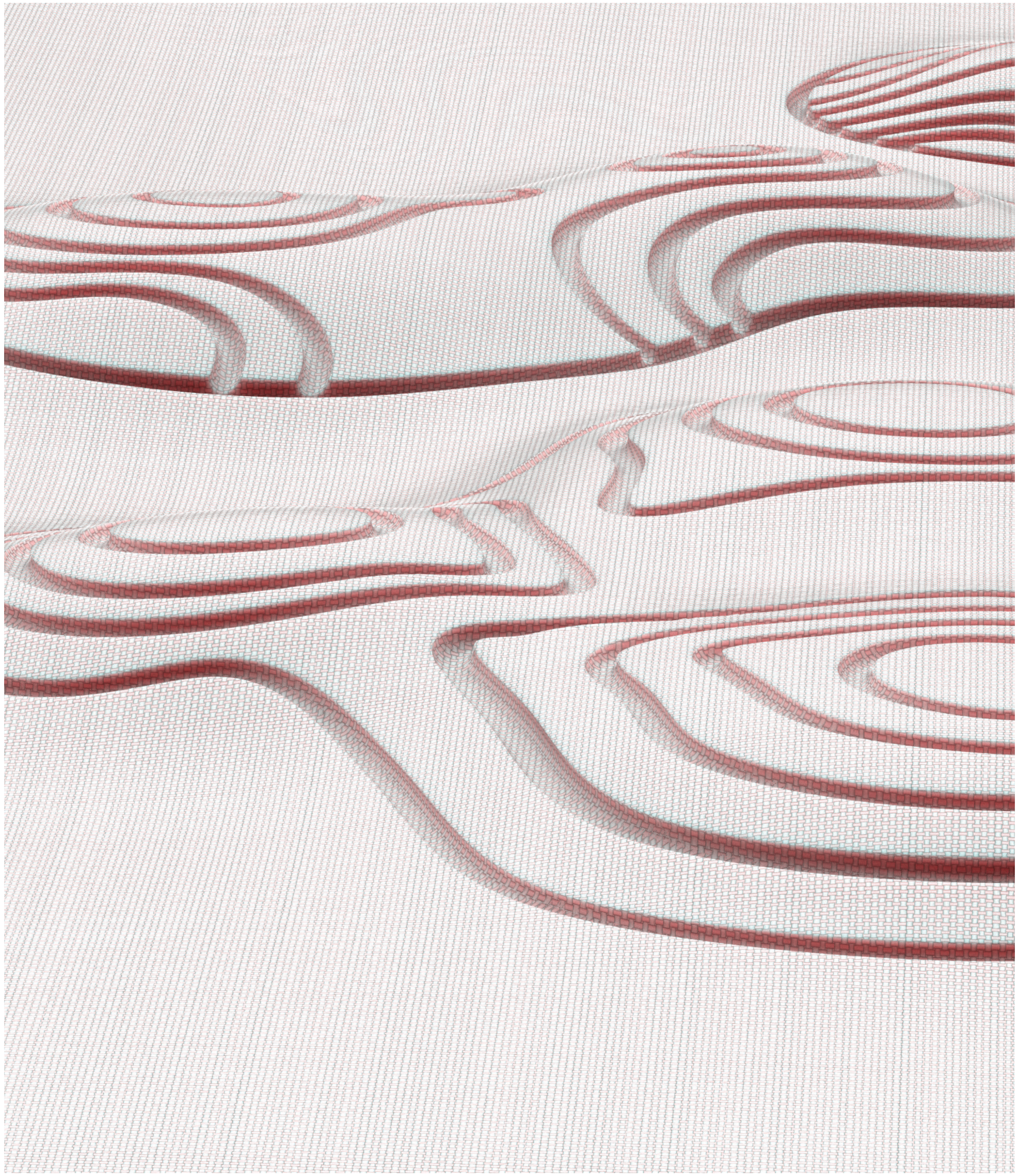
Tacti has a unique surface which we call programmable matter, or to put it simpler, reactive fabric. The concept was born with the idea of the brain; two parts, the creative outlet (enjoyments) and the programmed outlet (your machine thinking).

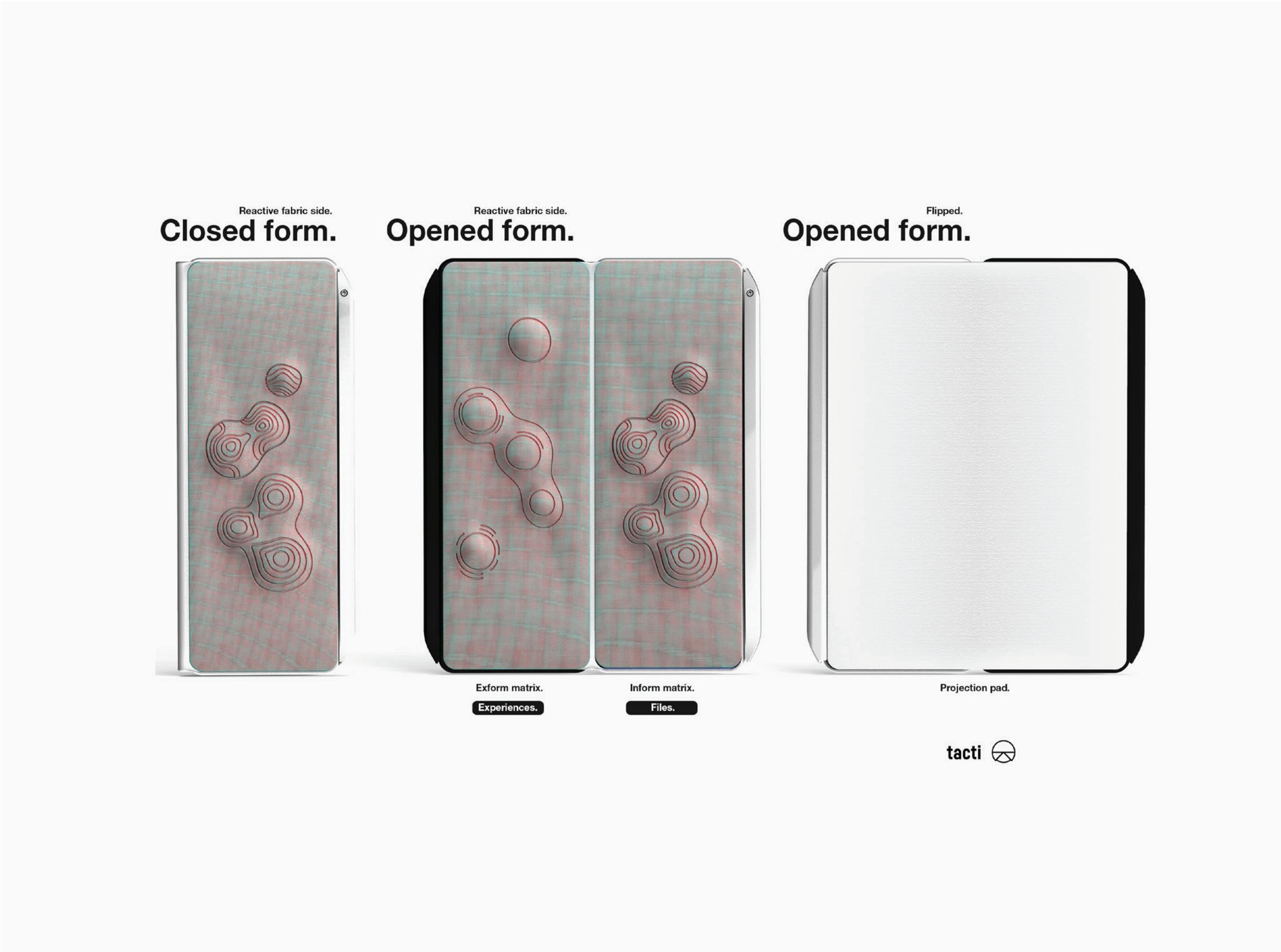
The ultimate goal was to provide digitial presence in a new form that was tactile, and unique to the rhythm data presents itself in software. All this, all whilst encompassing the ability to fit into the legislative framework layed out by digisave.

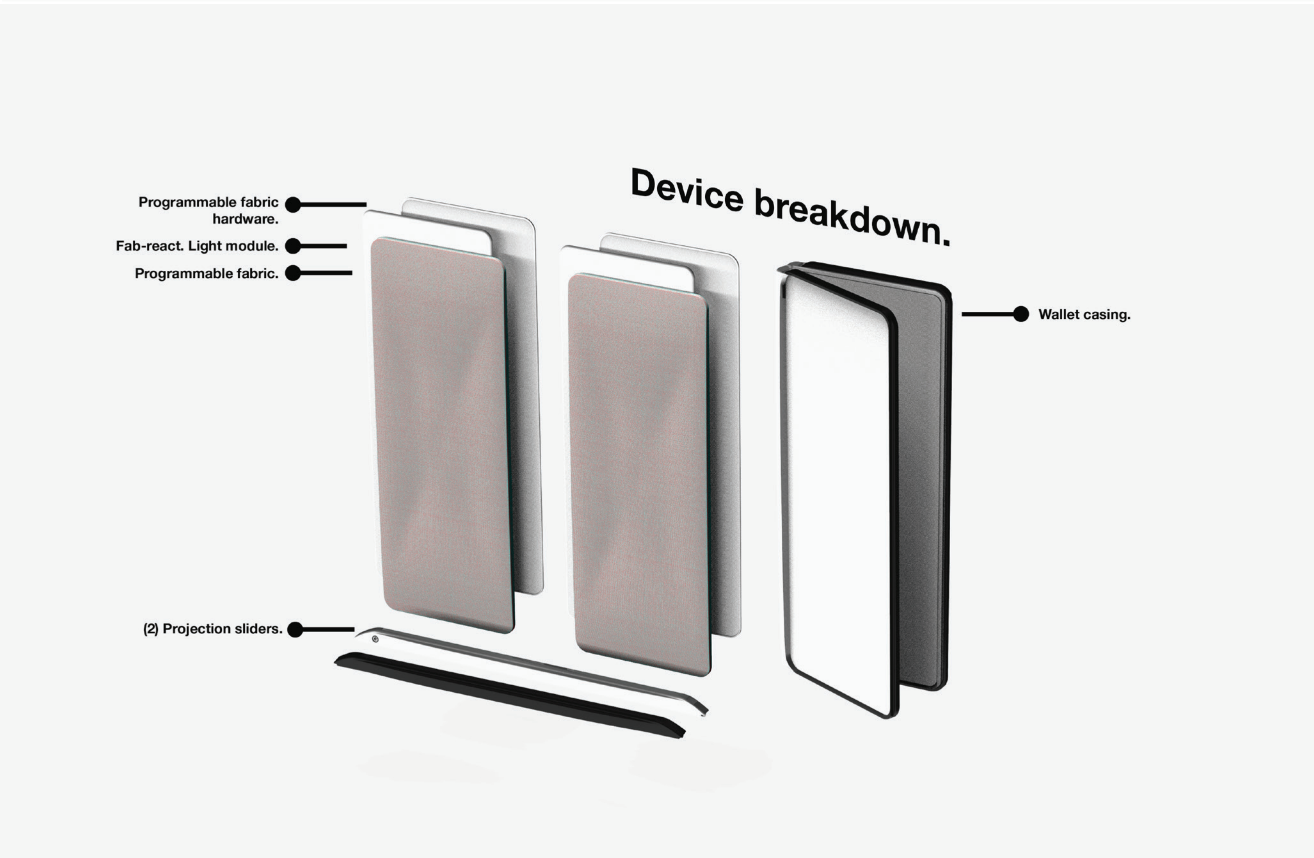
It's a framework that tackles the future vision of the personal device. Will the concept of smartphones evolve or cease completely in the future? Tacti challenges this with a familiar form factor although providing a unique experience through its interaction.

CERN technology (ROOT) can play a part in the programming and sorting of our data. Thier technologies are elaborated on page 36.

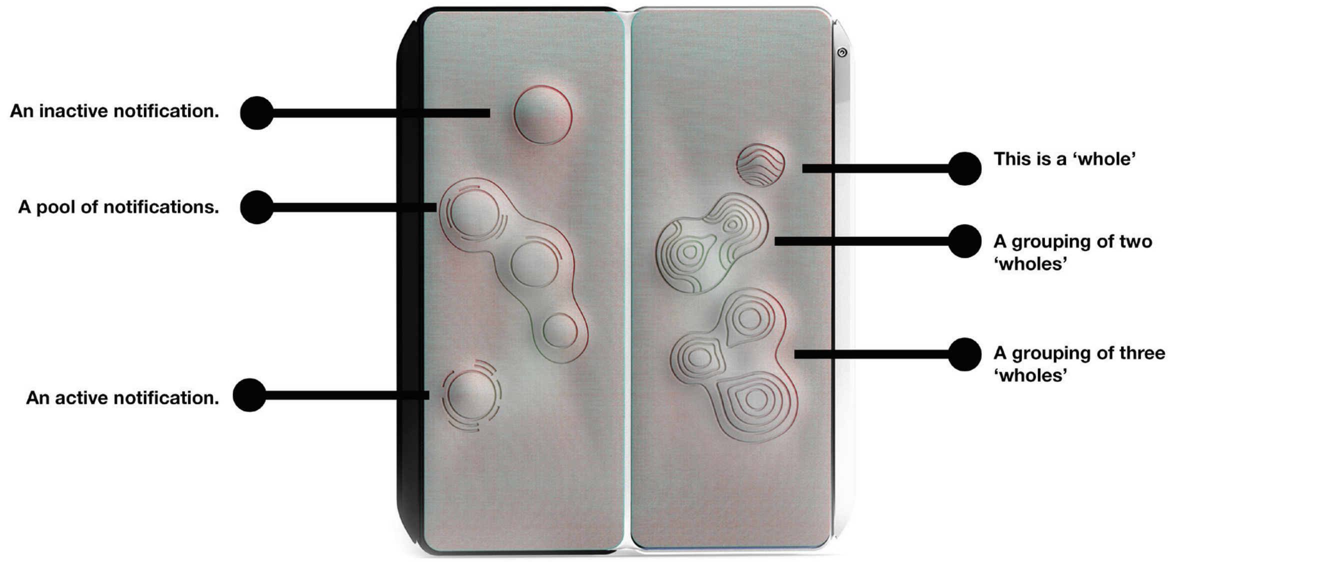




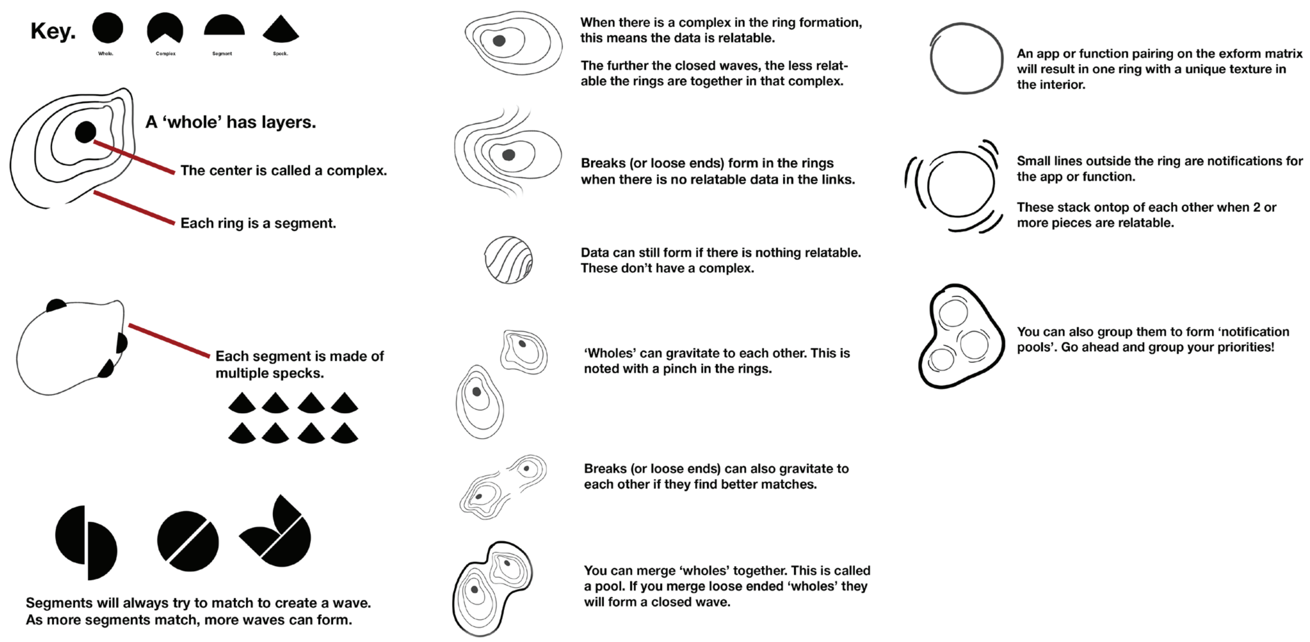




How to read Tacti.



How a wave is made.



A 'whole' has layers.

The center is called a complex.

Each ring is a segment.

Each segment is made of multiple specks.

Segments will always try to match to create a wave. As more segments match, more waves can form.

How to read waves.

Inform matrix.

When there is a complex in the ring formation, this means the data is relatable.

The further the closed waves, the less relatable the rings are together in that complex.

Breaks (or loose ends) form in the rings when there is no relatable data in the links.

Data can still form if there is nothing relatable. These don't have a complex.

'Wholes' can gravitate to each other. This is noted with a pinch in the rings.

Breaks (or loose ends) can also gravitate to each other if they find better matches.

You can merge 'wholes' together. This is called a pool. If you merge loose ended 'wholes' they will form a closed wave.

How to read waves.

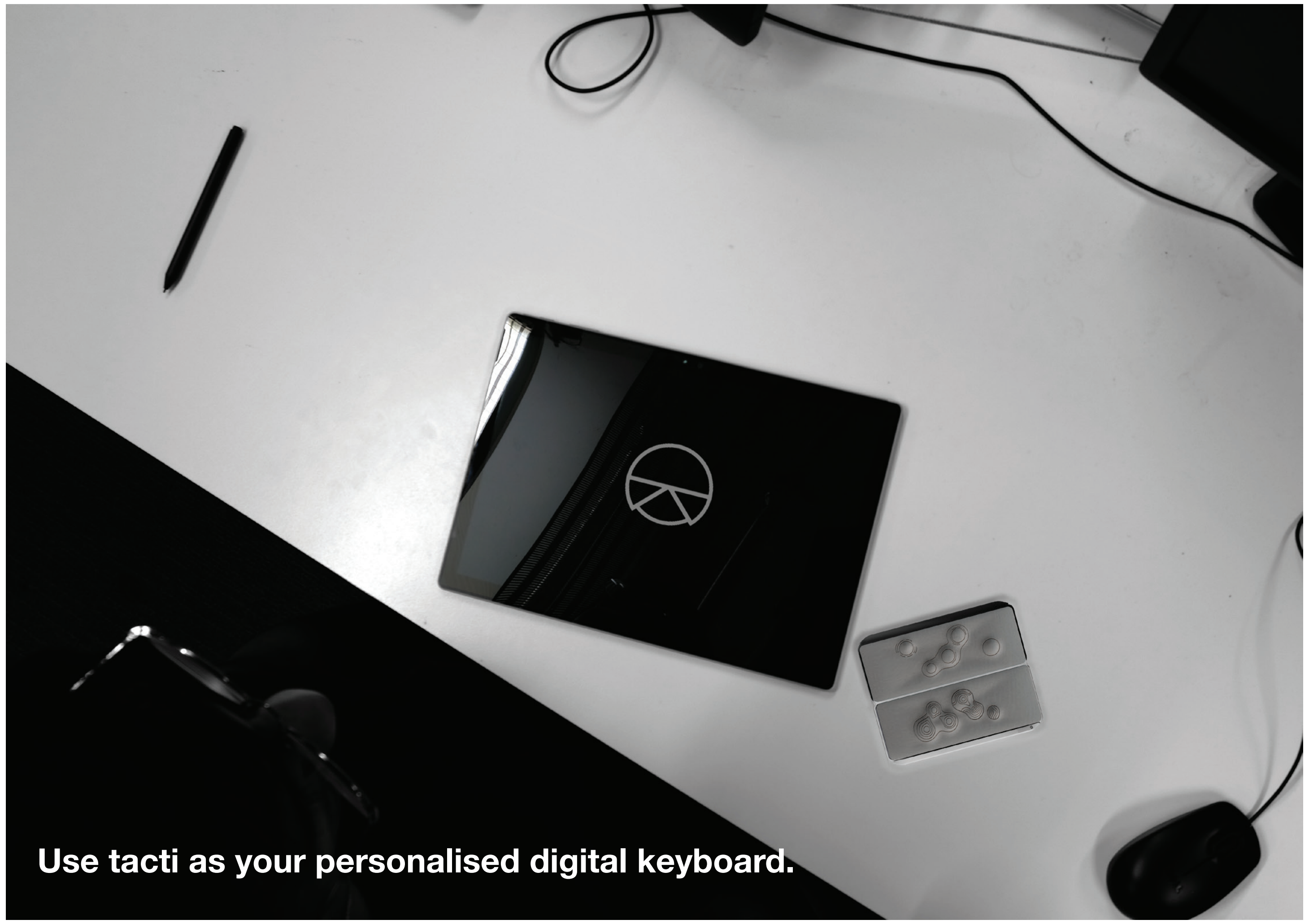
Exform matrix.

An app or function pairing on the exform matrix will result in one ring with a unique texture in the interior.

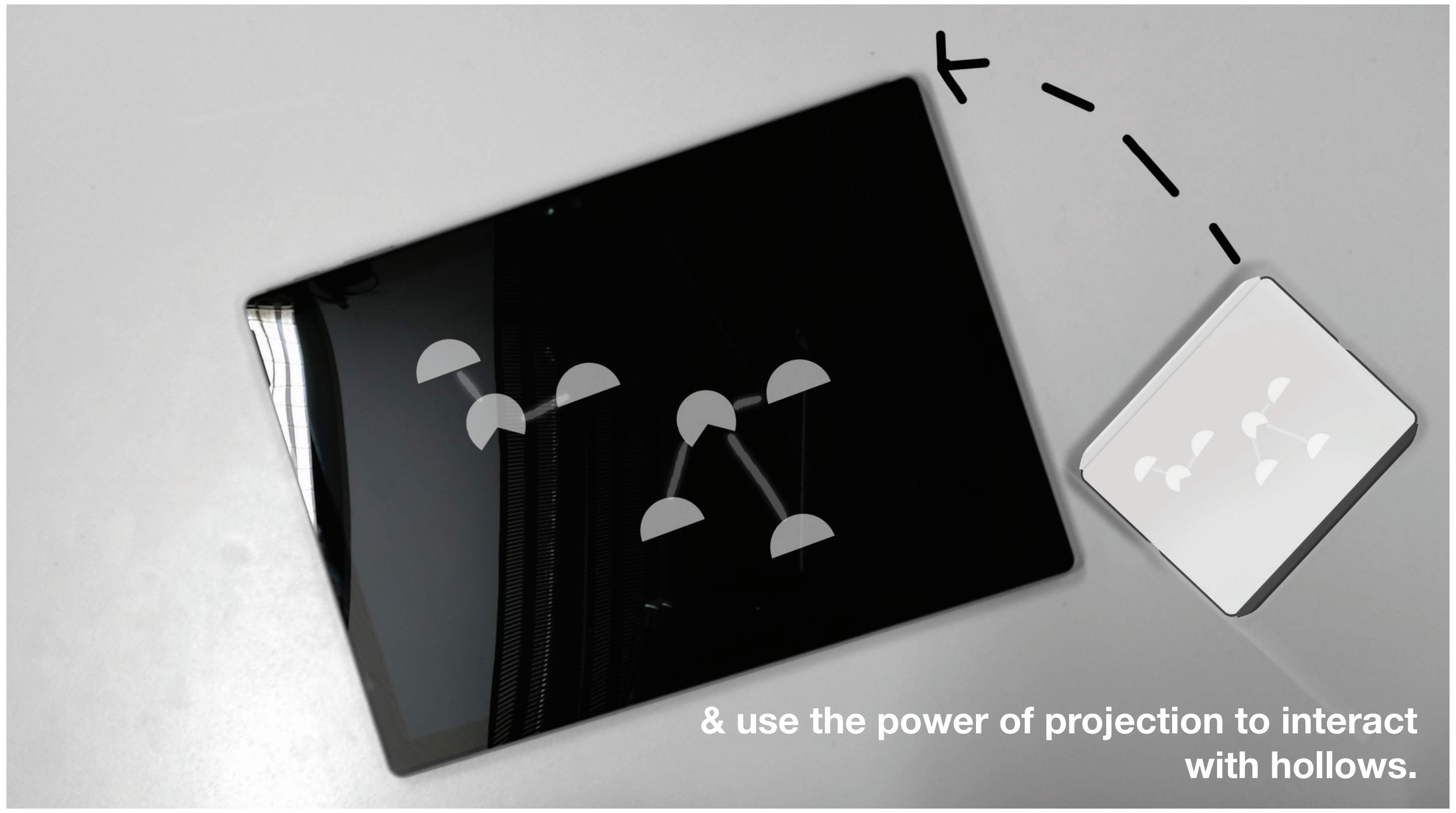
Small lines outside the ring are notifications for the app or function.

These stack ontop of each other when 2 or more pieces are relatable.

You can also group them to form 'notification pools'. Go ahead and group your priorities!



Use tacti as your personalised digital keyboard.



& use the power of projection to interact with hollows.

SUSTAINABILITY AND MODULARITY

INTRODUCTION.

The support for sustainable devices has been explored through the theme of modularity, this underpinning the majority of the environmental benefits. Modular, well known to ecologists, has been a term that's been used and put to practice since the 1970's, where speculation led ecologists to believe that modules can better contain perturbations, therefore showing higher resilience against external damage [28]. Modular has seen many personal devices, the most notable is from the concept 'phoneblocks' [29] where you have a device broken down into its core hardware components for full customizability. In the essence of it, it is a pocketable desktop computer; miniaturized. Google provided us with the hope that the concept was achievable with the ARA project. However, the project never reached completion, (30) and the same with a similar modular phone concept called puzzlephone [31]. The only company to follow through with the theme of modularity was Motorola, with its z force doid which had interchangeable backs that would give the user additional power and/or benefit.

The ultimate goal for modular concepts it to provide a device ecosystem that allows users to avoid the constant cycling of personal devices when only one broken or faulty component. However, its fail points lay in the thoughts that…
It produces more waste (and now miniaturized)
To have to carry a set of hardware components incase you wish to change your device features
Consumers prefer to purchase a device whole, rather than have to change and learn about components. Companies like to sell and promote consumer culture, and vise versa, consumers like material. Perceived brand value, and how it adds to a consumers profile/personality.

Companies may realize that they may run at a loss supporting such a vast ecosystem on their devices. It's just easier to give consumers what they want. Modular has tried to make its mark with the "techiest" ways possible; this being concepts around hardware. It also relies on the fact that we perceive personal smartphones to still exist in its current form in the future. With how rapid and miniature technology is becoming, it is definitely a valid assumption to hope that modular hardware personal devices can become a thing, though given the multiple unsuccessful attempts and consumer traction, there needs to be other ways of providing a modular personal device ecosystem. Tacti suggests modularity be in the form of programmable material, where machine learnt data sorting and user experience drive the theme of modularity. It's difference is that we perceive the personal device to tackle a different form and function in the future. It all begins with new ways to visualize our digital data; "digital personalities"; thereby providing a new way to interact with your digital data; in a modular way, bringing another dimension to an otherwise flat piece of shiny hardware. The following is the theories and models that have brought tacti to fruition.

APPLIED THEORIES

Ourselves and touch.

How our physical body interacts with the world is fundamentally connected to our thinking, Psychologist Josh Ackerman in one of his studies revealed that the physical qualities of objects people touched—their hardness or softness, heaviness or lightness, roughness or smoothness—tilted people's judgments toward those same abstract qualities. [32]. To further this point, a study by one of Akermans co-authors; John Bargh, suggests in his publication in 2011 that the feeling of loneliness can be mitigated by an experience of physical warmth [33]. Given these findings, touch and perception of touch play important roles in the appraisal of information, and is a passive tool that can transmit certain emotions; through colour and shape.

Model: Human technological Design.

Alison Guy provides 5 themes that if adopted in some form, would bring about socially beneficial and useful technological products. These are broad thoughts, though are essential pointers during our search for the future personal device. In summary, the themes suggest… (34) to feel natural: Current technology has the habit of fixing the now and producing new problems. We continue to enter its this cycle, and by definition, we call this 'line filling'. Humane technology suggests that your tech should be a partner, and works in sync with our bodies and instincts. It uses our senses in new ways, not dulling or stripping them, and is able to adapt to local conditions; environments. Humane technology realizes that we are not one size fits all. [33].

Revival of Human Intuition: Humane technology

Humane technology is able to revive senses and push them in new directions, by challenging it with new physical artifact mediums. Because of this, humane technology will allow us to return to a more natural and more attuned way of living. [34]

Human Values for Development: It should take human values as a cornerstone of its development. The simpler the solution, the better the outcome. The development of humane tech should consider the fact that any new device will be nested within a rich network of social actors. [34]

Resonate with Human sensors: Humane technology should take what humans value as a key factor during technological development. This is supported with the thoughts around "information decoration" , which attempts to expand the digital interface beyond the flat screen of a computer or cell phone. Humane technology recognizes that humans are sensory organisms, made to live in a rich three-dimensional environment. (34)

Empowerment: Humane technology should not aim to replace the human mind and body. Rather, it should be used as a tool to augment existing capabilities. Humane technology doesn't outsource people, but instead empowers them. (34)

Visuals from the ages.

Visuals are a large part of communication, and to show its depth in history, 3000 rock carved images from 4000 B.C. to 600 B.C in Sweden and Russia have been analyzed by scientist Mark Sapwell and his team, concluding that that the sites functioned like an "archaic related stories version" of social networks where users shared thoughts and emotions and gave stamps of approval to other contributions. [35]

What this suggests is that we are steep in the practice of knowledge transfer through visuals, providing artifacts for humans to appraise. What we can question here is how far have we come in visual knowledge transfer, especially in the field of personal device electronics (eg: smartphones, tablets, laptops); one of the most common forms for technology used today. Australia remains one of the leading global adopters of the smartphone and 88 percent of Australians now own one, with market growth being driven by older generations [36].

Information Decoration.

Flat and rectangular is what we use to inform ourselves from a mass variety of media outlets. They've become fundamental to how we operate in the physical world, the streamlined use of screen based technology has evolved us to feel dependent of digital artifacts, even though we cannot feel or touch them.

The merging of virtual and physical spaces is an inevitable development, and we should welcome it. For centuries, people have been utilizing decorative patterns, indoors and out, with the aim of improving and giving an identity to the atmosphere around them. [25]

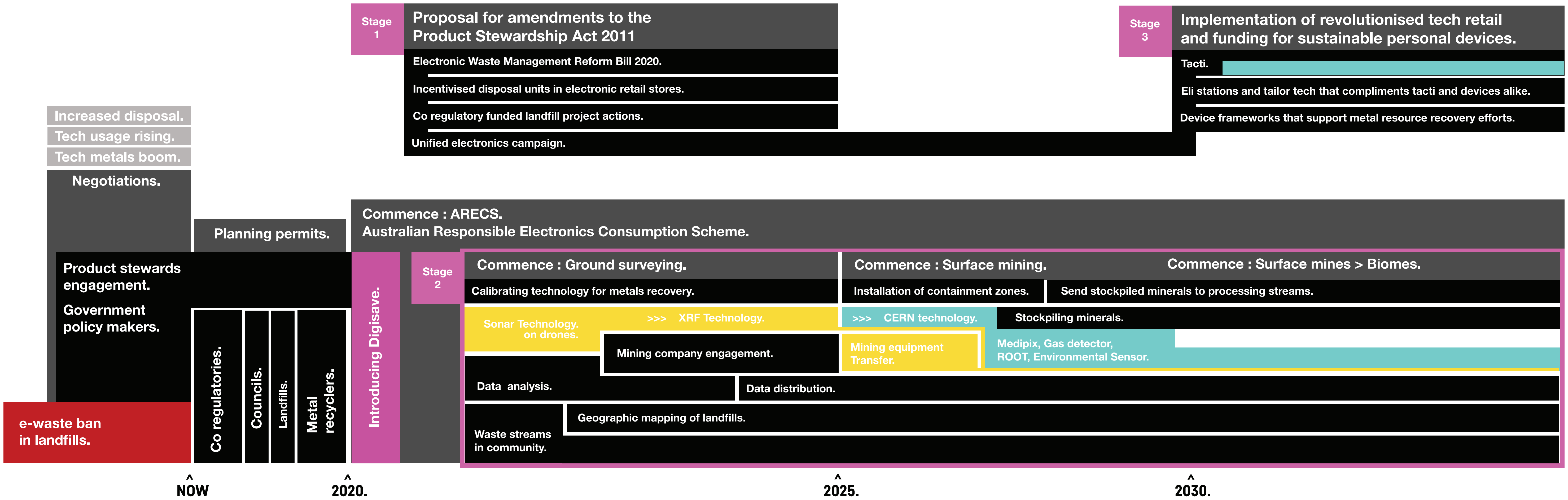
We humans have evolved precisely to attend to information at the edges of our field of attention, and when necessary transfer it to the center ourselves. [25] Our environment was previously made up of objects; now it consists of information [25].

The goal of information decoration is to provide genuine, tactile experiences away from pieces of glass. To go as far as using colour and texture to embody certain information streams in organically shifting ways during interaction would open a whole new experience in the personal device category. Googles current efforts in material design suggests this [37], an effort to emulate colour sense and touch sense response into devises feeling like paper.

IMPLEMENTATION PLAN

The folloing mapping is a timeline of events that relate to the 3 stages of the ARECS scheme. Stage 1 and 3 represent the customer/individuals frontend role in our system and stage 1 involves the back end of processes.

This is all based of the events following the ban on e-waste in landfills.



CERN TECHNOLOGY

MediPix3

This is a semiconductor detector readout chip connected to a semiconductor sensor. It acts as camera once the shutter which takes images based on the number of particles hit the pixels. Medipix3 also permits colour imaging. [38] The use of Medipix3 is being used within the mining concept as part of a separation technique. This is able to separate different materials used in components and from this gain better separation techniques for sorting electronic and metal waste. The ability Medipix3 technology to visualise materials through colour provides the benefit of determining similar materials from complex structures. This will benefit the sorting of e-waste which is commonly comprised of a complex mix of components and materials. [38]

(figure 9) below shows a read out of MediPix3, it shows the layer of detail of 3 materials. The first image shows the materials together as the human eye would see it. The other image showing the Medipix3 data copper being red, cadmium green and perspex blue.

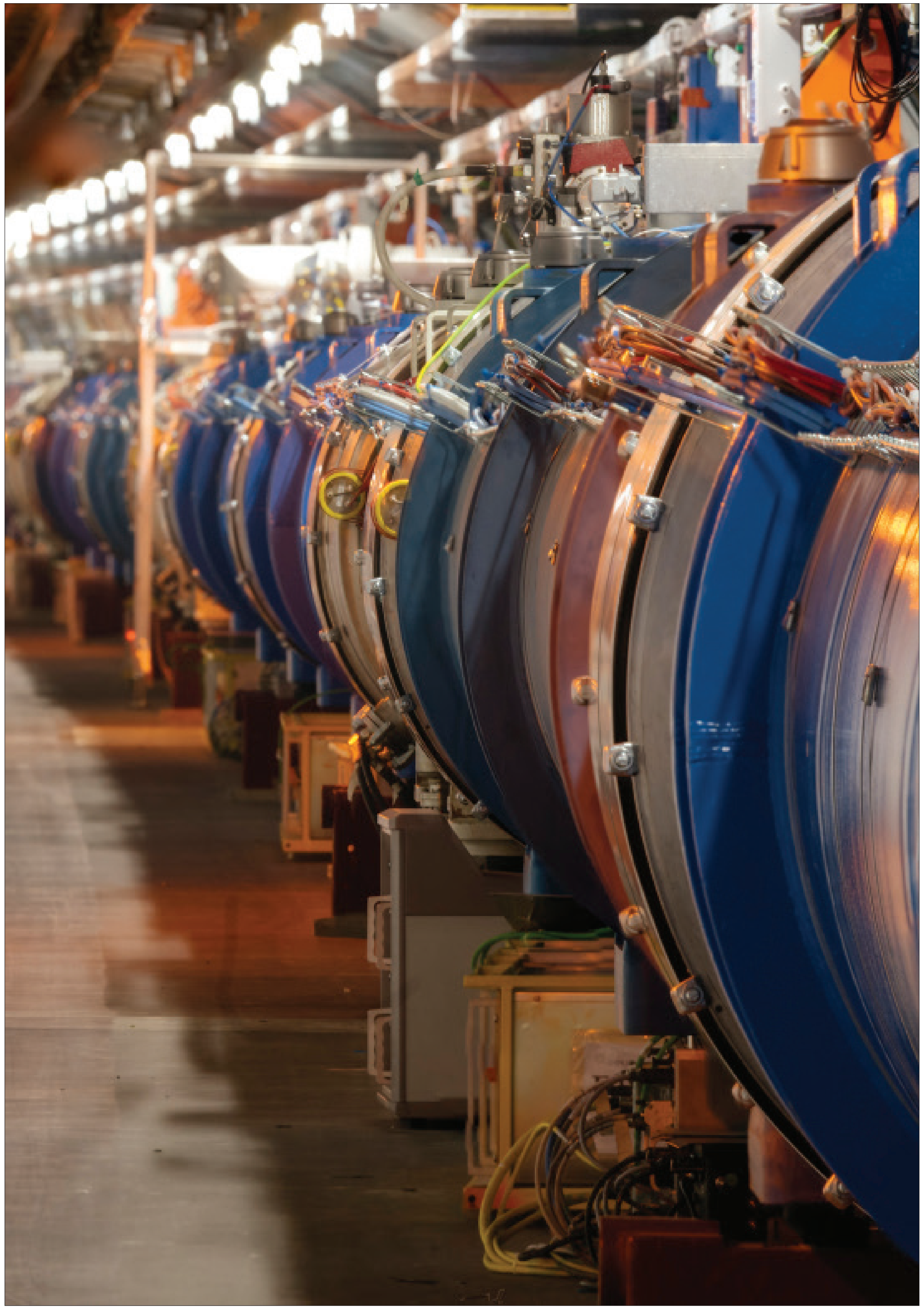
figure 9.

C2MON

This is a diverse data acquisition framework based around infrastructure monitoring and controlling at CERN, although this is a scalable framework meaning it has the ability to monitor larger or smaller operations. C2MON and its data is able to be displayed on simple dashboards and has the ability to monitor sensors and equipment. [39] This is split into two categories, TIM TIMVIEWER. DIAMON is used for monitoring equipment and this provides an CERN Control Center operators with data around errors, maintenance and performance, therefore applying both of these frameworks to monitor our equipment is beneficial to the efficiency of the recovery operation.

ROOT

This is a general purpose framework which provides object oriented sets of tools with the functionality to analyze and handle larger amounts of data in an efficient way. [40] It also defines data as objects, with specialised storage methods which are used to gather separate attributed of a selected object, without going through the bulk of data collected. [41] These framework also provides data visualisations such as histograms and other methods making it easier and faster to interpret data. This allows for easier algorithms for Artificial Intelligent systems. Therefore this will be beneficial for data gathering and categorisation for the when the landfills are scanned.



FUTURE CONSIDERATIONS

Future Considerations

As Digisave is based on a strategic plan towards a 2030 vision, it is important to consider trends and variables which may shape the future we intend to implement our project in. Whilst Digisave, through ARECS puts elements in place to alter the future to ensure the success and adoption of our 2030 vision of a transformed electronic retail space, we need to consider and accommodate factors that cannot be controlled.

Global Future Trends

There are already 15 billion devices connected to the internet and it is predicted that by 2020 this number will increase to 50 billion device. [5]
By 2030, the UN predicts that the population will increase to 8.55 billion [6], the current population is sitting around 7.6 billion [7]. The CSIRO Australia 2030 document, they predict that there will be a reduction in ore qualities. [8]

Relevant Future trends

Directly linked to Digisave are a few key areas that required in depth consideration of the present and future trends. These include; Australian Politics and Legislation, Mining industry and Personal Electronic Devices. Investigations into Australian Politics showed an imminent ban on the exportation of e-waste to China. From this we accounted for total bans worldwide in the next 5 years. Product Stewardship legislation research revealed an upcoming review of the Product Stewardship Act 2011, illustrating upcoming changes to electronic waste management.

Mining industry revealed Australian economy will benefit from a second wave of the resource boom driven by growth and urbanisation in developing economies. Personal Electronic Devices research clearly showed development in the areas of flexible screen, projection, AR and VR technology.

Pestle Future Scenario

The Pestle Future Scenario provided a broad overview of how we interpret future trends in Australia. This provided greater scope to consider elements not directly related to our concept but which we considered in the formulation of the Digisave concept. Through this we considered the complexity of how seemingly unrelated events may impact the success of Digisave. The Pestle Future scenario is not a prediction of the future but rather an educated guess based on CSIRO's Australia 2030: navigating our uncertain future and other secondary research. We explored a number of aspects, including: Political, Economic, Sociological, Technological, Legal and Environmental.

PESTLE FUTURE SCENARIO

	2020	2025	2023
Political	External/ overseas manufacture	Fairtrade (Import costs) are lowered non-existent	Local Governments become responsible for technological footprints and waste disposal
	No electronics in landfill	Increase of imported products	National Governments become responsible for value generation (Value from waste)
	No waste exporting between countries	Difficulty producing value of resources to international market	
Economic	Prices for raw materials increase dramatically due to shortages	Personal devices become very expensive due to increased cost of raw materials and metals.	Australian manufacturing industry begins to re-emerge utilising primarily recycled materials
	Mining industry declines in Australia due to raw material shortages, causing economic decline	Economic decline leads to less disposable income - increased resale and refubishment market for personal devices	Mining of landfil for raw metals from electronic becomes a major industry
Sociological	Homes have easily acessible technology systems	Smart Infastructure	Move into virtual spaces
	Growth of technological footprint	Increased of non-disposed technological waste	Combined digital and Physical world information
	Artifical Intelligence dependant generation	Relationship forming between machimne learning sytsems	Complete connection to digital footprints 'digital alter egos'
	Teaching standards/ technology	Hazardous waste poses threat to human health	
Technological	Movement into wearable devices	Technology production slows due to material scarcity	Technology is extremely expensive to create
	Users buying multiple devices	Focus on recycling	A world ruled by VR/ AR
	Development around batteries and storage of power	Repairability becomes major consumer priority when making purchasing decisions	Products scarce due to low materials
	Flexible screens		
	Large technological importantion		
Legal	Legislation changes make it mandatory for co-regularity agreements on e-waste to provide 'fair' access to disposal information	Importation of personal devices becomes heavily taxed	Legislation demands for the collection of e-waste for repurposing
	Co-regularity agreements responsible for funding e-waste impact and correct disposal awareness campaigns	Warranty changes make customisation and repair of personal devices more accesible	Legislation to reduce travel of waste - local community processing
	Legislation makes it illegal to send e-waste overseas. Taskforce created to closely monitor disposal of e-waste in private sector	Obsolence rating system for personal devices in effect (similar to energy star rating). Dictates tax amounts on locally manufactured devices	Legislation to rejuvinate all landfills
		Increased funding for tech producers and designers for development of low environmental impact devices	Legislation bans traditional landfils
Environmental	Landfils banning e-waste	Landfils filling up at alarming rates	Landfills overflowing
	User consumer bahaviour means more waste	Land cleared for waste managment	Heavy metals contaminate soils, air and water
	Leaching of metals into ground becomes environmental threat	Ground water becomes toxic	Levels of metals are extremely rare
	Can no longer send waste overseas, filling up local Australian landfills	Large areas filled with vast amounts of contaminants	Land for development is running low
	Less raw material mining	Serious loss in public health	

BUSINESS MODEL

Key Partnerships

The main partners for the AREC scheme are Co-regulatory Agreements, Department of Energy and Environment, Electronic retailers and other not-for-profit Environmental Foundations such as Planet Ark. The AREC scheme will also collaborate with local government and councils for the implementation of the mining operation to receive planning approval, provide communication to the residents and provide community support.

Funding

2020: The intended funding for the implementation and upfront costs of the Eli Stations is through the Co-regulatory Agreements as specified in the Product Stewardship Act 2011 along an investment requirement of 50% from the retail store they will be housed in. Maintenance will be entirely managed by ARECS with funding provided by Co-regulatories, Government, donations and private donors. Retailers will receive a grant of 35% of the total cost to implement the TailorTech kiosks. Maintenance and running costs will therefore be the responsibility of the retailers.

2025: Minimal Funding for Landfill mining will be provided through ARECS, the rest will be provided by private mining companies. Motivation for mining companies to participate in the project include a decline of the mining industry and need for new revenue streams as well as employment opportunities for miners and geotechnical engineers.

2030: Government Grants for under the Sustainable Electronics Scheme will be used to fund research and development of the Tacti device. For production and launch of the device private investment will be utilised.

Key Resources

2020: The Legislative Bill will require the cooperation of Policy makers, Government workers and government resources.

2025: The land requirements for the Land, location, physical inputs, materials, energy). The location for the this concept which requires the most resource is the landfill mining and recovery process, most of which are operated by councils. To create the dome, building materials need to be consider, these mostly consist of aluminium and clear plastic sheets such as TFE clear plastic sheeting in order to create the containment zones. Although these are designed as temporary structures and can be removed and positioned in a new location. Power to run the processes which operate in the mine is needed, although to reduce costs landfill gases will be collected and stored and burnt in order to generate power, therefore reducing the overall power need. Autonomous mining equipment and drones which can be operated by workers in a control centre are required to ensure the operation runs smoothly are required.

2030: The Eli Stations will require:

- Power in order to operate digital touch screen
- Autonomous collection vehicles (ACV) to collect the waste to deliver recycling centres (maintenance and fuel)
- Portion of a retail space and roadside access
- Materials for kiosk construction

The TailorTech will require:

- Power in order to operate digital touch screen interface
- Skilled repairers, Spare parts and equipment
- Small portion of a retail space and main regional warehouses for parts

Tacti will require:

- Manufacturing equipment and location
- Metals and raw materials
- Distribution channels
- Designers, manufacturers, engineers

STAKEHOLDERS

Meet their needs

EPA - Regulation of Landfill
Digisave will consult and collaborate with EPA to develop the strategies for the management of e-waste such as Eli Stations. In the 2025 landfill mining concept, the EPA will play an integral part in testing for contaminants and assessing potential risk to environment through the process of mining for metals from landfill.

Electronic Manufacturers:
Electronic manufacturers will be engaged throughout the research and development phase of Tacti devices.

Keep Informed:

Retailers:
Retailers will be kept informed throughout the development and rollout of Eli stations and Tailor Tech. Retail stores will be required to invest 50% for the rollout of Eli Stations. Retailers will receive a grant of 35% of the total cost to implement the TailorTech kiosks. Maintenance and running costs will therefore be the responsibility of the retailers.

Tech Assemblers:
Tech Assemblers are responsible for the manufacturing of electronic goods. They will need to be trained in manufacturing methods in accordance with sustainable electronic design.

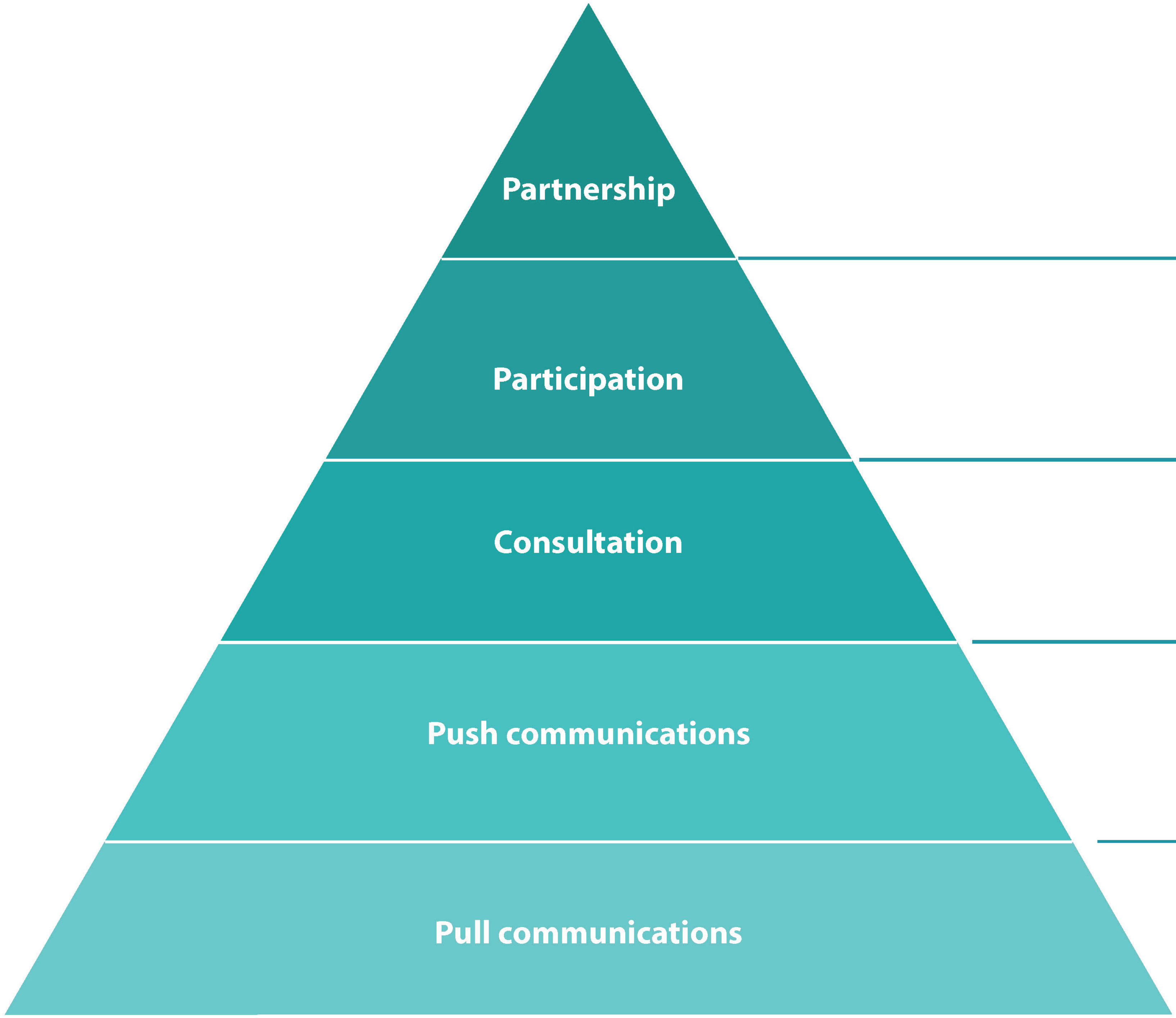
Key Players

Department of Energy and Environment
As part of the AREC Scheme, the Department of Energy and Environment is a key collaborator. The Department will be responsible for overseeing the co-regulatory agreements that fund the scheme. However, this stakeholder will also provide a connection to government and policy. Digisave will employ liaison officers to ensure a strong connection with the Department.

Electronic Waste Recyclers:
Implementing the Medipix3 assisted recycling process will require the existing infrastructure of Electronic Waste Recyclers in Australia. Once the Medipix3 detection and initial waste separation process has been undertaken at a local waste management centre, the sorted metals will be sent to Electronic Waste Recyclers who carry the expertise in the most efficient methods of metal recycling.

Waste Management Centresz
Waste management centres will be contracted and adapted in order to undertake the the Medipix3 detection and initial waste separation process. They will be engaged through local governments.

STAKEHOLDERS: IN ORDER.



•Department of Environment and Energy
•Consumers
•CERN
•Local Council (Waste management and resource recovery)

•EPA Victoria
•Electronic manufacturers
•Metal mining industry
•E-waste recycling channels

•ACCC
•Investors
•Geologists and civil engineers
•Metal smelters
•Environmental scientists
•Department of Health
•E-waste Recycling groups
•CSIRO
•Swinburne Academics
•Marketing and IT contractors

•Tech hobbyists
•Shipping companies
•Educvational Institutions
•Software engineers
•Designers
•Raw material traders
•Tech retailers
•Copywright lawyers

Other potential applications:
•ADF
•Medical
•Educational
•Tech assemblers
•Packaging designers
•Urban Planners
•Telecommunication companies
• Household rubbish collectors

CONCLUSION

How is this solution in accordance with Sustainable development Goal #12?

Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all.

Sustainable Consumption

As part of the 2030 Retail Landscape, Eli Stations are in place to ensure responsible recycling of e-waste, whilst TailorTech tackles planned obsolescence and consumer fashion by offering an alternative to throwing away an aging device.

Sustainable Production

As part of the AREC Scheme is funding for the production of sustainably produced electronic devices built on the principles of long life-span, repairability and incorporating multiple devices into one. Tacti is presented as a manifestation of these principles on top of its unique interactive experience.

Resource and Energy Efficiency

Detection of metals within landfills is key to remove metals which would be classed as waste previously. Without this phase of landfill detection there is a larger drop in efficiency if processing and material recovery from landfills becomes a trend. At this step being able to map out landfills to gain insight about what lies below, the amount of materials and the type. This gives insight into the best ways to recover materials at a later stage and locate the best landfills for recovery.

Recovering materials which would normally be waste and returning them to the product stream is the main value. This fulfills the SDG 12 of Responsible Production and Consumption, where we can create new devices from waste and no having to rely on newly mined materials which are not economically viable and difficult. On top of the recovery process, being able to sort out waste to further reduce the amount of losses from processing, therefore ensuring that maximum resource efficiency is achieved and material stockpiles are increased.

Creating more materials, for more technology, for a longer period of life. From the recovery phase and developing a larger stockpile of materials, although we need ensure that we get the most material from any new technology created. The Tacti as a “Streamer” device lessens the needs for components to be created for each device as this product streams its processing power to other devices. Another framework used in this process is design for disassembly and resource efficiency to ensure these materials return to cycle of production and are reused for devices in the future.

Sustainable Infrastructure

Autonomous operations removes the needs for human operation and from this exposure to potentially hazardous materials as well as human error. This also tailored with the with the data surround the landfills to ensure materials are well planned for the most efficient resource recovery. Detecting materials, sorting them and sending them the correct process method as this is a closed loop which feeds into each other for future generation.

‘Better quality of life for all’.

Eli Stations and Medipix3 assisted recycling work in conjunction to prevent more e-waste entering landfill. This mitigates the risk that e-waste poses to the natural environment and those who reside within it. By preventing contamination into waterways and pollution through air and soil as a result of e-waste, these two elements work towards ensuring human health. Landfill mining provides an opportunity to remediate landfill land and supply a healthier environment.

Value proposition

The three major stages of Digisave are all closely tied together in the same aim, to provide a sustainable infrastructure for the responsible consumption of e-waste for future generations. Each stage of the project is aimed addressing one or more different resistors to the responsible management of electronic waste. Our three stage outcomes represents a triangle of forces between behavioural > technological > legislative change. Given the current state of planned obsolescence, we faced the challenge of tackling consumer perceptions of personal devices, especially perceived productivity and value generation. Developing a sustainable waste infrastructure is becoming increasing important as China no longer wants our waste! “ The Chinese ban, which will be fully implemented early next year, affects an annual average of 619,000 tonnes of materials — worth $523 million — in Australia alone” [42]

We targeted 6 different consumer, societal and manufacturer behaviours that we identified in our research for the concept development. These were:

- Consumer tech fashion and trends
- Planned obsolescence
- Multiple device functionality
- Repair difficulties and warranty
- Usage to need ratio
- Lack of recycling channels

Beyond consumer behaviour, Digisave aims to provide sustainable infrastructure to enable a closed resource loop through landfill mining, improved recycling processes, the production of sustainable devices and consumer access to user friendly e-waste repair and disposal. Digisave will help shape an electronically responsible Australia that will carry through as our technology adapts alongside us in the future.

References

http://www.epa.vic.gov.au/business-and-industry/guidelines/waste-guidance/ewaste-reprocessing-in-victoria [1]

https://engage.vic.gov.au/application/files/9415/0751/7430/E-Waste_Ban_Policy_Package_Summary_FINAL.pdf [2]

http://www.cleanup.org.au/files/clean_up_australia_e-waste_factsheet.pdf [3]

http://www.eterra.com.ng/articles/impacts-e-waste-environment/ [4]

http://www.who.int/ceh/risks/ewaste/en/ [5]
http://atlanticleak.com/uses-of-ground-penetrating-radar/ [6]

http://www.gmservices.ws/blog/ground-penetrating-radar-work/ [7]

http://www.usradar.com/about-ground-penetrating-radar-gpr/faq/ [8]
https
://www.ncbi.nlm.nih.gov/pmc/articles/PMC1637771/ [9]

http://ultramag.com/survey/ultramag-dgpr/ [10]

http://www.energydevelopments.com.au/our-capabilities/landfill-gas/ [11]

http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/methods/landfill-gas [12]

http://www.mdpi.com/2079-9276/3/1/152/htm [13]

https://serc.carleton.edu/research_education/geochemsheets/techniques/XRF.html [14]
http://medipix.web.cern.ch/collaboration/medipix3-collaboration [15]

https://c2mon.web.cern.ch/c2mon/ [16]

https://kt.cern/technologies/root [17]

https://kt.cern/sites/knowledgetransfer.web.cern.ch/files/documents/technologies/root.pdf [18]

http://www.terracotta.org/using-terracotta/cern/ [19]

https://www.bruker.com/products/x-ray-diffraction-and-elemental-analysis/handheld-xrf/how-xrf-works.html [20]

https://www.designboom.com/technology/mit-programmable-material-adapts-to-temptera-ture-02-13-2017/ [21]

https://selfassemblylab.mit.edu/programmable-materials/ [22]

https://selfassemblylab.mit.edu/ [23]

https://selfassemblylab.mit.edu/ac
tive-textile/ [24]

https://www.nextnature.net/2007/10/information-decoration/ [25]

http://www.mooreslaw.org/ [26]

http://science.sciencemag.org/content/357/6347/128/tab-pdf [27]

https://phonebloks.com/ [28]

https://www.theverge.com/2016/9/2/12775922/google-project-ara-modular-phone-suspended-confirm [29]

http://www.puzzlephone.com/ [30]

https://www.psychologytoday.com/us/articles/201303/surface-impact [31]

https://www.psychologytoday.com/us/basics/loneliness [32]

https://www.nextnature.net/themes/office-garden/ [33]

https://www.nextnature.net/2013/02/cavemen-used-facebook-already/ [34]

https://www2.deloitte.com/au/mobile-consumer-survey [35]

https://www.nextnature.net/2007/10/information-decoration/ [36]

https://material.io/guidelines/ [37]

https://www.researchgate.net/publication/305318988_Programmable_Matter_-_Claytronics [38]

https://www.epa.gov/lmop/basic-information-about-landfill-gas [39]

http://www.epa.vic.gov.au/~/media/Publications/755.pdf [40]

https://opus.lib.uts.edu.au/bitstream/10453/121976/1/Wealth_From_Waste_Report_WEB.pdf [41]

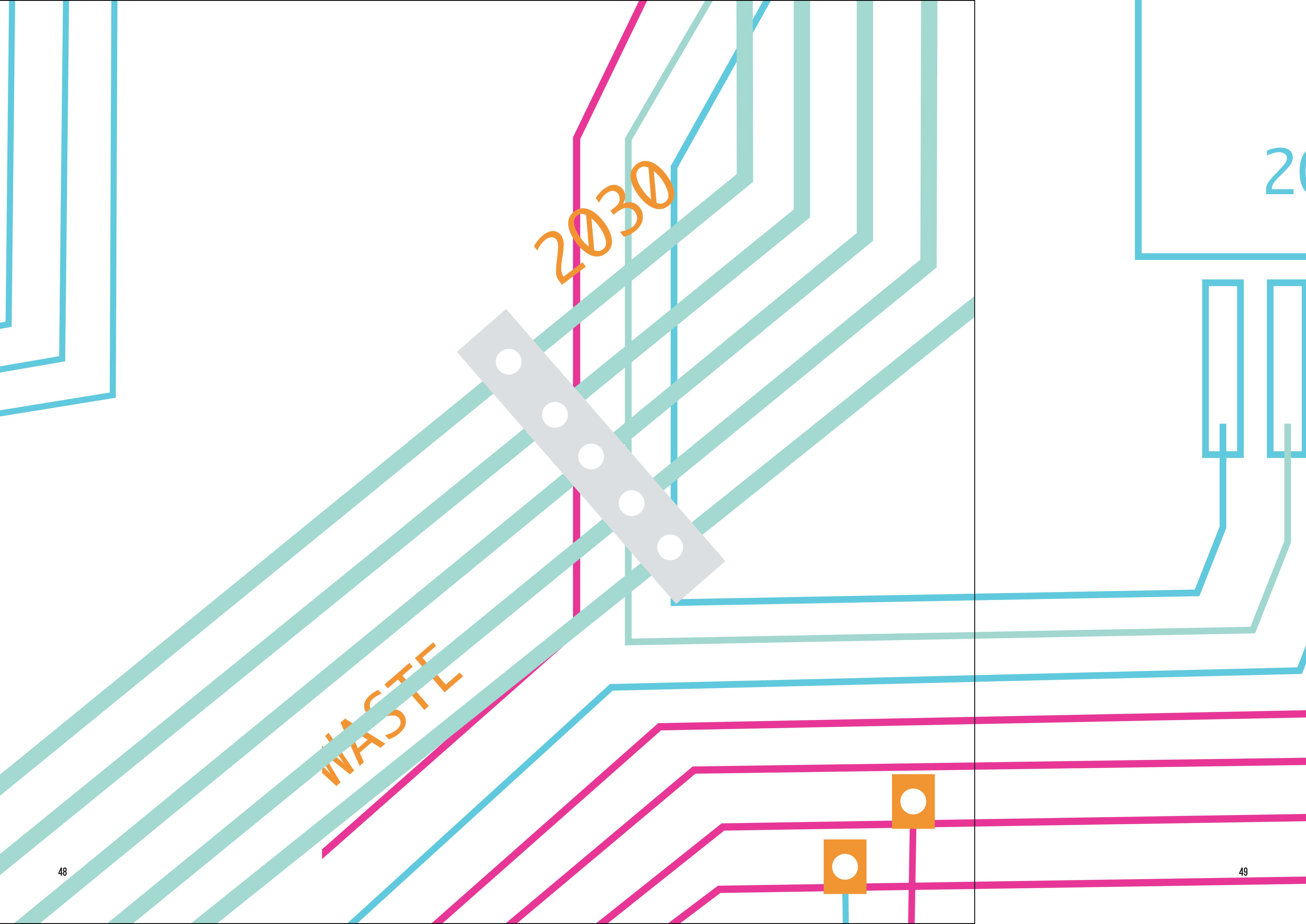
http://www.epa.vic.gov.au/your-environment/waste/landfills [42]

http://www.abc.net.au/news/2017-12-10/china-ban-on-foreign-rubbish-leaves-recycling-industry-in-a-mess/9243184 [43]

https://www.insidewaste.com.au/site/opinion/1050934/future-trends-waste-recycling [44]

https://ourworldindata.org/future-population-growth [45]

http://www.worldometers.info/world-population/ [46]
Csiro 2030 [47]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