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The Australia 2050 Trail Phase 2:
Designing an Interpretive Trail to Raise Awareness about the Importance of Sustainability

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Abstract

The Centre for Education and Research in Environmental Strategies (CERES) is a sustainability center and urban farm located in East Brunswick, Australia. The Australia 2030 Trail, an interpretive trail at CERES, encourages sustainable practices by showing the environmental effects of our lifestyle choices. After fifteen years of use, the trail needed redesigning and updating for current climate change projections. Our team focused on Phase 2 of the Australia 2050 Trail redesign by verifying climate projections from a previous WPI team, evaluating design suggestions, creating a virtual prototype, and designing new illustrated display boards. By testing the design with students and CERES' staff, we found that it successfully communicated CERES' mission and is ready to be implemented.

Acknowledgements

Our group would like sincerely thank the following individuals for their help and support throughout this project:

- To our project sponsors, Shane French, CERES Excursion Manager, and Ian Culbard, CERES Energy Education Coordinator, for their advice and guidance throughout the completion of the project.
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Executive Summary

Climate change is causing temperatures to rise worldwide and is altering the environment, as seen in the influx of extreme weather conditions. Rising sea level caused by climate change is a serious concern in Australia, as 64% of the country's population lives in a coastal city (Australian Bureau of Meteorology, 2012). Humans impact climate change by releasing CO_2 into the atmosphere, initiating the greenhouse gas effect. Scientists estimate that humans have sent a total of 305 billion metric tons of carbon into the atmosphere since 1751; half of these emissions have occurred since the mid-1970s (Sharp, 2007).

Our daily lifestyle choices, including how we get around and consume food, have the power to impact the environment, and it is up to society to make changes to lessen human impact on climate change. Some positive changes we should consider are consuming locally grown food, reducing fossil fuels, and disposing waste properly. Local governments have created organizations like our sponsor, the Centre for Education and Research in Environmental Strategies (CERES), to help the public understand how to make the right choices to benefit the environment.

Through their locally grown food at the organic market, in-house green technology, and most importantly, their educational programs, CERES addresses the issues of climate change and what individuals can do to help mitigate climate change. An interpretive trail activity at CERES, the Australia 2030 Trail (Figure 1), allows visitors to consider lifestyle

Figure 1: The Australia 2030 Trail

choices based on what they want their life to be like in the year 2030. In the interactive trail, *decision boards* depict lifestyle choices, some of which include: where you will live, how will you get around, and how many children will you have. These lifestyle choices are assigned points based on the relative environmental impact of each choice. These points are summed and are connected to a future scenario in the year 2030. These *future boards* illustrate climate change projections in the year 2030 based on the assumption that everyone made the same decisions. This activity allows visitors to see the environmental impact and future consequences of their lifestyle choices. "By identifying connections between lifestyle choices and social and environmental futures," CERES believes that they can motivate visitors and the local community to make positive changes to benefit the future (CERES, 2012).

During the spring of 2014, a group of students from Worcester Polytechnic Institute (WPI) updated the Australia 2030 Trail to the Phase 1 design of the Australia 2050 Trail. The students focused on providing up-to-date, relevant information, as the old trail was built nearly fifteen years ago and was not aligned with current climate change projections. This group delivered a miniature physical model of their design (Figure 2) and supporting activity sheets. They were unable to test the effectiveness of their prototype, giving us a starting point for Phase 2 of the Australia 2050 Trail design.

Figure 2: The Australia 2050 Trail Phase 1 Model completed by a previous WPI team

Goals, Objectives, & Methods

The goal of our project was to continue the design of the Australia 2050 Trail to motivate visitors to change their lifestyle choices with the intention of benefiting the environment. The trail is intended to show individuals that they have the power to make the right choices to a more sustainable future. We are continuing the design into Phase 2 by testing the Phase 1 model, improving the activity sheets, revising the displays, prototyping the Phase 2 design, testing the Phase 2 prototype, and evaluating the test results. We have developed the following objectives to guide us in achieving this goal:

Objective 1: Assess effectiveness of previous trail designs

Objective 2: Develop clear and user-friendly activity sheets with updated content

Objective 3: Design trail boards with updated content considering aesthetics and feasibility

Objective 4: Develop virtual trail prototype and lesson plan

Objective 5: Pilot test the virtual trail and revised activity sheets

Objective 6: Evaluate Pilot Test results

In order to continue the design of the Australia 2050 trail, we first had to assess the engagement, feasibility, and overall effectiveness of the previous trail designs. We began the process at CERES by observing the Australia 2030 Trail lesson three times, seeing exactly how the activity was run by two different teachers. We proceeded with our assessment through a focus group of CERES' teachers about their impressions on the model constructed in Phase 1 design of the Australia 2050 Trail. The feedback from this focus group was used to formulate the Phase 2 design of the Australia 2050 Trail.

Phase 2 design began by revising the activity sheets to be more user-friendly. By adding color and visual aids, the new activity sheets are multi-modal, encompassing different learning styles. The activity sheets were first evaluated by school teachers who had previously experienced the Australia 2030 Trail and then further evaluated in the Pilot Test. Working with our sponsors, Shane French and Ian Culbard, we developed new content to

add to the Australia 2050 Trail based on its importance to human impact on climate change. The point system was updated to include the new questions and better predict future scenarios. We considered feasibility of construction in designing by interviewing CERES' in-house contractors to plan the layout of the boards. Once content and layout was finalized, the new instruction, decision, and future boards were created in the Adobe Creative Suite. The boards were incorporated into a virtual 3D model and images of this virtual trail were rendered from a first-person perspective to be used in our Pilot Test (Figure 3). The Pilot Test evaluated the Phase 2 design of the Australia 2050 Trail with seventy 7th grade students participating in the activity and completing a survey that evaluated the activity. The survey determined whether they understood the activity sheets and decision boards, whether they would change their choices based on their future scenario, and whether the students enjoyed the activity. Their response allowed us to assess the changes in the Australia 2050 Trail design and see if it was an activity that would be ready to be implemented at CERES.

Figure 3: The Australia 2050 Trail Phase 2 Virtual Prototype

Findings & Deliverables

Through all of our tests and observations from the Australia 2030 Trail, Phase 1 of the Australia 2050 Trail, and our updated Phase 2 of the Australia 2050 Trail, we found the Australia 2050 Trail developed during our time at CERES was well received and ready to be implemented. Several findings from the previous designs allowed us to refine the Australia 2050 Trail design:

1. The activity sheets were found to be confusing and needed to be redesigned for simplicity, usability, and engagement.
2. The point system was found to be too complicated and needed to be restructured to better predict future scenarios.
3. Decision board questions lacked relevant information related to human impact on climate change and included too many restrictions on the existing boards.
4. The aesthetics of the decision boards and the layout of the trail did not clearly display the concepts being presented and needed to be updated to increase engagement of the visitors.
5. Durability, maintenance, and cost were all high priorities in creating a feasible design.
6. Presentation of the Australia 2030 Trail by CERES teachers was found to be essential to the educational value of the trail.

After evaluation of previous designs, we reworked the design of the Australia 2050 Trail and eventually tested this updated design through the Pilot Test (Figure 2). The final survey after the Pilot Test showed that 93% of students understood how to use the newly designed activity sheet, and 90% of students had no trouble answering any of the decision board questions. The ultimate goal of the trail is to get visitors to consider their actions and how they affect the environment, thus the most important finding is outlined in Table 1 below. Those with future scenarios more affected by climate change were more likely to answer "Yes, I would change my choices based on my future scenario."

Future Scenario	Number of Students in Scenario	Number of Students who answered "Yes, I would change my choices based on my future scenario"	Percentage who answered "Yes, …"
1 (least effected)	5	1	**20%**
2	16	2	**13%**
3	6	3	**50%**
4	37	25	**68%**
5 (most effected)	6	6	**100%**

Figure 4. Number of Students who answered "Yes, I would change my choices based on my future scenario."

Our project ended with several deliverables for CERES to move forward in construction. We delivered the following materials:

1. Australia 2050 Trail Activity Sheet (.pdf, .indd)
2. Australia 2050 Trail Instruction, Decision, and Future Board designs (.pdf, .indd)
3. Australia 2050 Trail Virtual Prototype Screenshots (.pdf)
4. Australia 2050 Trail Virtual Prototype (.mb, .ascii, .tiff)
5. History of Energy Timeline (.pdf, .indd)
6. Australia 2050 Trail Lesson Plan

With these design files and our recommendations from an informal pilot test with CERES' teachers, CERES will be able to make any final adjustments they wish before construction. The History of Energy Timeline can be incorporated in the Energy Park where CERES sees fit. The Australia 2050 Trail Lesson Plan can be used to guide teachers in running the activity through suggested discussion topics and climate change information to further support the trail content. With these deliverables, CERES can achieve their goal in educating the public on how to make the right choices to a more sustainable future.

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Table of Contents

List of Figures

1 Introduction

Temperatures are on the rise worldwide due to climate change, impacting the species and ecosystems that inhabit the Earth. In a recent study, temperatures in Australia were found to be rising at double the rate over the past 50 years compared to 1910 to 1950 (Climate Change in Australia, 2007). As a result, there has been an influx in extreme weather conditions, some of which include heat waves, droughts, and weather induced fires (Australian Bureau of Meteorology, 2012). Such temperature changes in Australia are causing significant effects in rising sea level and decreasing rainfall, both of which could be detrimental to the population (UN IPCC 5th World Report, 2014). Human behavior directly impacts the environment, and there are changes that we can make in our daily lives to lessen the effects of climate change and have a positive influence on the environment.

By adapting certain daily practices to reduce impact on the environment, society can begin to combat the effects of climate change. According to the Intergovernmental Panel on Climate Change (IPCC), without adaptation, future changes in climate are projected to have substantial impacts on everyday resources, infrastructure, and overall quality of human life (UN IPCC 5th World Report, 2014). In order to make the adaption to a more sustainable world, society needs to modify how we consume energy, purchase food, and dispose of our waste. Australia is one of the world's leaders in consumption of coal per capita, emitting massive amounts of CO_2; however Australia has access to renewable energy technology including wind and solar energy that would greatly reduce these carbon emissions (Australian Bureau of Statistics, 2010). The modern convenience of shopping at supermarkets has caused detrimental effects on the environment as the "food miles" involved in transportation from factories to supermarkets is increasing CO_2 emissions, and the excess packaging of supermarket goods is creating unnecessary waste. Purchasing locally grown and produced food would greatly lessen the "food miles" wasted in the transportation of food and goods. Responsible waste disposal is another daily practice that could be improved upon to reduce human impact on climate change. Australians dump

approximately 7,150 recyclable plastic bags into landfills every minute (Clean Up, 2010). To help the public understand how they can make better choices, the Australian government has enlisted the help of local governments to create organizations like our sponsor.

The Centre for Education and Research in Environmental Strategies (CERES), our sponsor, addresses the issues of climate change and what individuals can do to help mitigate climate change through the locally grown food in their organic market, in-house green technology, and most importantly, their educational programs. CERES created an interpretive trail, the Australia 2030 Trail, which allows visitors to make choices on what they would like in their future, including where they will live, what kind of goods they will buy, etc.. The trail contains a series of *decision boards* and *future boards*. The choices on the decision boards are weighted differently based on their environmental impact, and the sum of those points will connect visitors to their predicted futures in the year 2030 based on the assumption that the entire population made the same choices.

The goal of our project is to continue the design of the Australia 2050 Trail developed by a previous group of students from Worcester Polytechnic Institute (WPI) to motivate visitors to change their lifestyle choices with the intention of benefiting the environment. The previous group began redesigning the Australia 2030 Trail to the year 2050 in the spring of 2014. The Australia 2030 Trail was in need of an update because, at fifteen years old, the trail had become outdated and worn over time. Their project culminated in a miniature physical model of their proposed design with supporting activity sheets. We are continuing the design into Phase 2 by testing their model, improving the activity sheets, revising the displays, prototyping our design, testing our prototype, and evaluating the test results.

The Australia 2050 Trail needs to show CERES' visitors that one person can make a difference and that their everyday choices affect the planet and the people that inhabit it. Our design is intended to motivate visitors to consider the environmental effects of their choices once they leave CERES. We have developed the following objectives to guide us in achieving this goal:

1. Assess effectiveness of previous trail designs,
2. Develop clear and user-friendly activity sheets with updated content,
3. Design trail boards with updated content considering aesthetics and feasibility,
4. Develop virtual trail prototype and lesson plan,
5. Pilot test the virtual trail and revised activity sheets,
6. Evaluate Pilot Test results.

Chapter 2 of this proposal will explain the background research. Section 2.1 explores the effects of climate change specifically in Australia. Section 2.2 discusses the direct effect we have on the environment through our daily lifestyle choices. The Australian government and their established organizations are working towards mitigating these effects on climate change as explained in section 2.3. Specifically, we discuss how CERES is working to educate the public on the effect their decisions have on the environment. We explain characteristics of effective exhibits in section 2.4 as they relate to continuing the design of the trail for groups of students. Section 2.5 delves into designing interpretive trails. In Chapter 3, we describe our methodology, which includes our objectives and our research methods for designing the trail. Sections 3.1 through 3.6 explain our objectives in detail, outlining the methods we used. Section 3.7 describes how we analyzed the data. Section 4 brings together the results of all our tests and observations from the Australia 2030 Trail, Phase 1 of the Australia 2050 Trail, and our updated Phase 2 of the Australia 2050 Trail. This section combines all our recommendations for designing and eventually implementing the Australia 2050 Trail at CERES. Section 5 delivers our final conclusions of the report.

2 Background

Evidence shows that the world's climate is changing, and we cannot maintain our way of life with the rate of environmental change (UN IPCC 5th World Report, 2014).Our daily choices of how we power our lives, travel, purchase food, and dispose of garbage all have the potential to impact the environment. Our project aims to continue the design process of an interpretive trail at the Centre for Education and Research in Environmental Strategies (CERES) in East Brunswick, Australia which educates visitors on the consequences their lifestyle choices have on the environment and how every choice we make can help to reduce human impact on climate change. In this chapter, we will discuss the human effects on the Australian environment in terms of temperature, water deficiency, and sea level. We delve into specific lifestyle choices including energy use, food consumption, waste management, and family size. We explore characteristics of effective exhibits for students and families which will promote discussion, allowing visitors to get the most from the activity. Finally, we investigate interpretive trail design, narrowing our research to continuing the design of the Australia 2050 Trail.

2.1 Effects on Australian Environment

The Earth is a dynamic self-regulating system, but recently the environment has been experiencing irregular fluctuation. The environment is radically changing due to human impact on climate change. This is a problem currently affecting the well-being of Earth's inhabitants (Australian Bureau of Statistics, 2010). The overall consequences of people's daily choices include escalating temperatures, rising sea level, and diminishing water sources (Climate Change in Australia, 2007). This is of particular concern in Australia because of the difficulty adapting to such extreme conditions in a country that is primarily desert and where 80% of the population lives within 100 km of the coast (Tourism Australia, 2014).

2.1.1 Temperature Effects

Climate change, no longer just a hypothesis or a theory, has resulted in rising

temperatures in Australia and across the world (Australian Bureau of Statistics, 2010 & Hughes, 2003). In Australia, the average annual temperature has increased by 0.9 degrees Celsius (1.62 degrees Fahrenheit) since 1950, one of the highest increases in the world (Australian Bureau of Statistics, 2010). The temperature increase is causing Australia's natural environment to change significantly with more temperature outliers on the higher end of the spectrum as shown in Figure 5 (Australian Bureau of Meteorology, 2012). As a result of the high temperatures, weather-induced fire danger has rapidly increased in

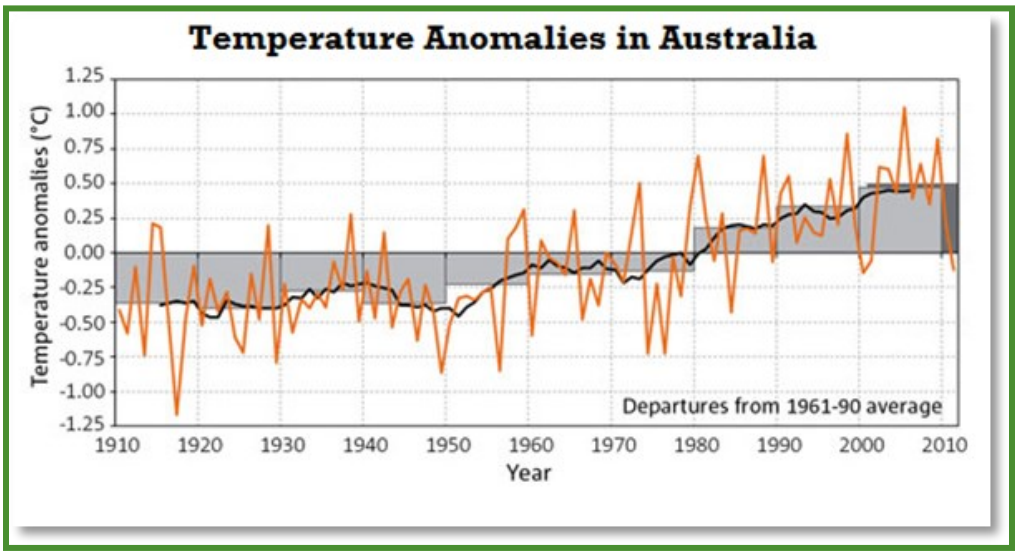


Figure 5. Temperature anomaly trends in Australia over last 100 years (Australian Bureau of Meteorology, 2012)

southeastern Australia over the last 20 years, putting people and the already scarce forests at risk (Australian Bureau of Meteorology, 2012).

2.1.2 Sea Level Effects

Rising sea level is a serious concern in Australia as 64% of the country's population lives in a coastal city (Australian Bureau of Meteorology, 2012). Sea level around Australia has been on its most rapid increase since 1990 (Australian Bureau of Meteorology, 2012). Australia's remote, dry geography influences the majority of the population to live near the coast, leaving the people and major cities the most vulnerable to the rise in sea level. In particular, coastal floods have caused severe damage to the infrastructure of the Australian

shore as well as death to people settled along the coast (UN IPCC 5th World Report, 2014). The damage to the shore from the rise in sea level puts pressure on the economy and well-being of the Australian coast (UN IPCC 5th World Report, 2014).

2.1.3 Water Deprivation

Climate change has a massive impact on the security of Australia's water sources. The availability of water is very inconsistent in Australia from year to year (Beeton, Buckley, Jones, Morgan, 2006). Rainfall is a major source of freshwater for Australia's dry climate however rainfall has decreased over the last 40 years creating a greater dependence on Australia's limited freshwater rivers (The State of the Environment 2011 Committee, 2011). Australia is an arid country and possesses few large rivers; therefore lack of rainfall greatly exacerbates the impact of pulling water from rivers, a practice that impacts populations throughout the entire length of a river. Figure 6 depicts how the rainfall decrease is most severe along the coast around the major cities and farms in Australia.

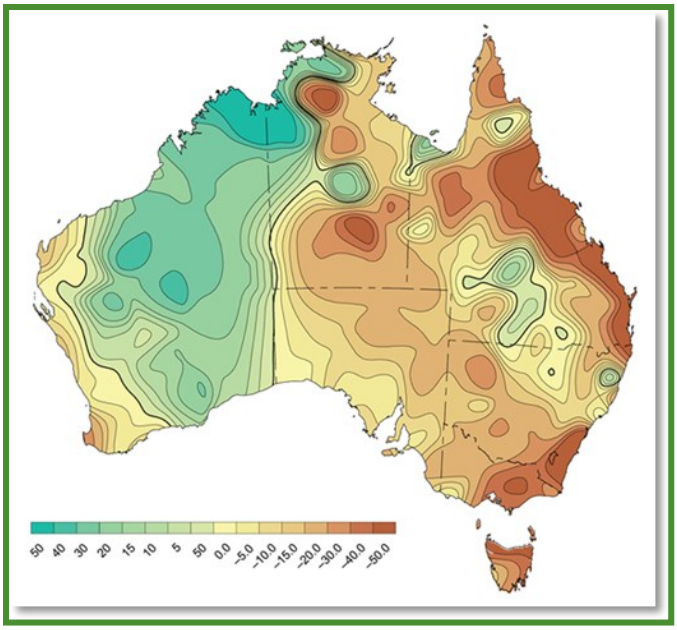


Figure 6. Annual total rainfall trend (1970-2010) in mm per ten years (State of the Environment 2011 Committee, 2011)

The decrease in rainfall has put increasing pressure on the performance and security of agriculture (The State of the Environment 2011 Committee, 2011). Farmers are the leading consumers of water, and water scarcity was one of the biggest issues for farmers in 2010 (Australian Bureau of Statistics, 2010). Water sources will be at a premium for both agricultural industries and households in the future. The following projections show that the consequences of rising temperatures, sea level rise, and water scarcity may be amplified.

2.1.4 Projections of Environmental Effects

The regional climates of Australia are predicted with high certainty to keep changing in the future. Average temperatures are estimated to rise between 0.8 to 1.8 degrees Celsius by 2050 and 1.0 to 2.5 degrees Celsius by 2070 (Climate Change in Australia, 2007). In Figure 7, the temperature difference between the best and worst case scenario projections for Australia's environment shows how drastic the temperature changes can be. The rising temperatures will result in more droughts and brush fires, further affecting livestock, crops, and people (UN IPCC 5th World Report, 2014).

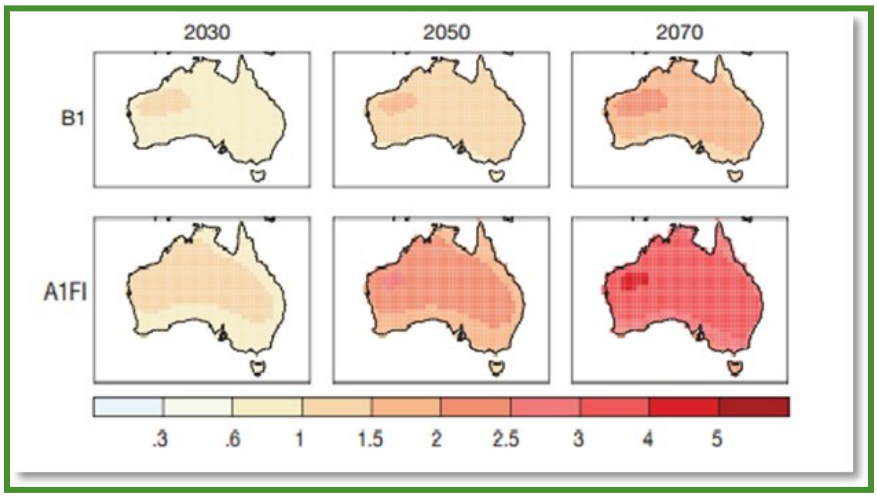


Figure 7. Best case and worst case scenario projected change of annual mean temperature (ºC)

With predicted temperature increases, rainfall is also forecasted to be more variable, eventually causing Australian water sources to be less reliable (Climate Change in Australia, 2007 & UN IPCC 5th World Report, 2014). In scenarios where the temperature rises by 2.0 degrees Celsius, rainfall could decrease by as much as 40% (UN IPCC 5th World Report, 2014). These scenarios would have a significant effect on agriculture, rural livelihoods, ecosystems, and urban water supply, which would increase the need for significant human adaptation (UN IPCC 5th World Report, 2014). In another study of six scenarios, as seen in Figure 3, spanning from an environmentally friendly world to a world that ignores environmental consequences, the latter was almost uninhabitable by the year 2070 due to the lack of vegetation and water, as well as the extremely high temperatures (Climate Change in Australia, 2007). The projections presented can still be altered if better choices are made with consideration to their environmental effect.

2.2 Lifestyle Choices Impacting the Environment

Human lifestyle choices affect the environment, giving us power to choose whether to make choices that benefit or harm the Earth. We all must responsibly consider the choices we make for our energy use, food consumption, waste management, and family size as they have an impact on climate change. Our choices for energy consumption and especially transportation contribute to climate change by forming a "blanket" of greenhouse gasses on the Earth's atmosphere, trapping heat inside and causing the greenhouse effect (Australian Bureau of Meteorology, 2012). This phenomenon has escalated in recent decades due to the increased number of petrol vehicles on the road and the distance that people and products travel (Commonwealth of Australia, 2014). The transportation of food is another massive contributor to CO_2 emissions, as "getting food to our tables is the largest single contributor of human created greenhouse gases....responsible for over 30% of CO_2 emissions" (Sustain, 2014). Additionally, improper waste disposal is hurting the environment by destroying habitats and contributing to the greenhouse effect (Lehmann, 2011). The growing world population is consuming more resources and producing more waste than ever before, making each individual's resource decisions exponentially more important to the future environment.

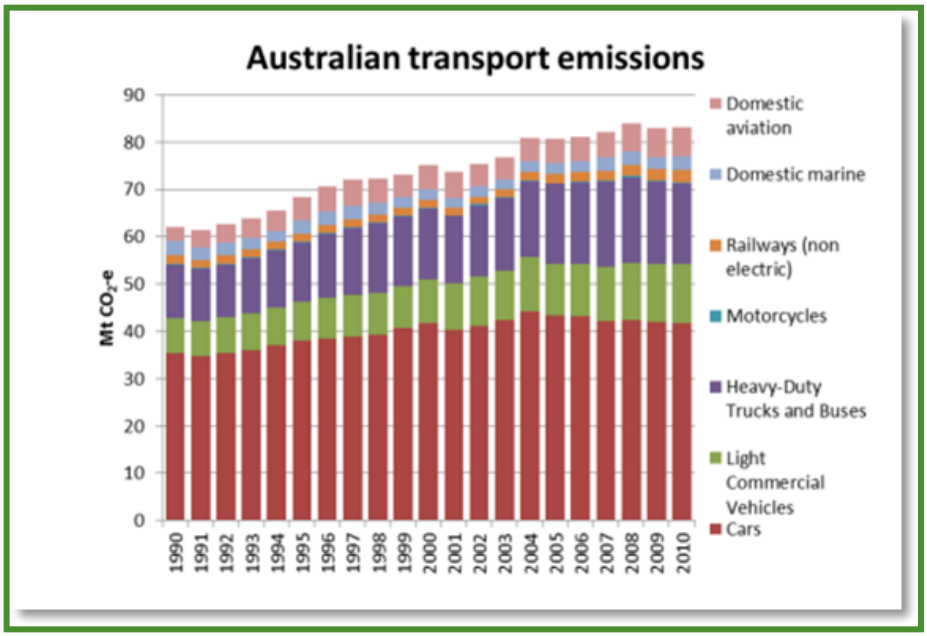


Figure 8. Australian transport emissions from 1990-2010 (Charting Transport, 2010)

2.2.1 Energy Consumption

Great quantities of fossil fuels are mined in Australia, making them easily available to use in both the transportation and energy sectors (Brereton, Franks & Moran, 2010). Australia is one of the leading consumers of fossil fuels in the world, containing 0.3% of the world's population but accounting for 1.5% of the world's greenhouse gas emissions, making the country one of the highest per capita emitters (Australian Bureau of Statistics, 2010). Transportation is a contributing factor as 79.6% of Australians choose to travel by personal car, causing greenhouse gases to be emitted into the atmosphere (Australian Bureau of Statistics, 2010). As shown in Figure 4, Australian transport emissions have been on the rise in the last 25 years, accounting for as much as 16% of Australia's total emissions (Charting Transport, 2010). One solution to reducing these emissions would be driving less, as "leaving your car at home just two days a week will reduce greenhouse gas emissions by an average of 1,600 pounds [0.727 metric tons] per year" (Environmental Protection Agency, 2014). To put this in perspective, that would save 1,600 exercise balls, 0.75 meter in diameter each, full of CO_2 (Natural Resources Defense Council, 2011).

Australian homes and businesses most commonly use coal, oil, and natural gas as energy sources, all of which are greenhouse gas emitters (Australian Bureau of Statistics, 2010). Household energy for electricity and basic necessities such as heat, hot water, ovens, and stoves are most commonly fueled by coal (Australian Bureau of Statistics, 2010). Since renewable energy accounts for only 5% of Australia's energy consumption, there is little emphasis on renewable energy for homes (Australian Bureau of Statistics, 2010). Solar energy is underutilized in Australia especially considering, "Australia has the highest solar radiation per square meter of any continent and consequently some of the best solar energy resource in the world" (Geoscience Australia, n.d.). Australia has the potential to greatly reduce its carbon emissions and effect on climate change through solar energy if the public considers adopting this cleaner renewable alternative.

2.2.2 Food Consumption

The energy used to make, deliver, and package products has an extensive effect on the environment, amplifying the greenhouse effect (Princen, 1999). Emissions created

Figure 9. Landfill in Victoria, Australia (Environment Victoria, 2014)

through transportation of food, as it is brought from the factories to supermarkets to homes, translate to extra pollution in the atmosphere (Seyfang, 2006). These "food miles" can be reduced if consumers buy local food, cutting the energy and pollution associated with its transportation (Seyfang, 2006). Consuming packaged food from supermarkets is more harmful than just the transportation involved with moving it. The packaging of food creates unnecessary waste and could be replaced with alternative reusable containers and bags. Plastic bags can be reused at the supermarket but only 3% of all bags are currently recycled (CleanUp, 2010). Another strategy to reduce packaging is buying in bulk which lowers unnecessary waste and reduces the need to travel to and from a supermarket every week (Environmental Protection Agency, 2013).

2.2.3 Waste Management

Waste management is an important factor to consider in environmental responsibility and reducing the greenhouse effect. Landfills are one of the most common forms of waste management around the world (Lehmann, 2011). In Australia, they are the most popular method of managing waste produced by residents and businesses (Figure 9) (Australian Bureau of Statistics, 2012). Unfortunately, there is a misperception between what can be dumped in the landfills and what causes harm to the environment. Personal items, such as miscellaneous electronics that become obsolete over time, often end up in landfills (Clean Up, 2009). Improper disposal of technology is a rising issue as 99% of Australian households have at least one television (Australian Bureau of Statistics, 2013). Most

Australian households also have at least one computer, if not two, which can correspond to higher volumes of electronic waste (Lehmann, 2011). Electronic waste, or E-waste, is a central problem in Australia's waste management, as some discard environmentally dangerous products without considering the harmful effects (Lehmann 2011). Between the years of 2008 and 2009, only 10% of televisions, computers, and other electronics thrown away were recycled by Australians (Lehmann, 2011). The National Television and Computer Recycling Scheme implemented a program where people could drop off their unwanted technology, knowing that it would be recycled in an environmentally friendly manner (Australian Bureau of Statistics, 2013).While improper disposal of electronics seems to be an obvious environmental concern, organic waste can also have negative impacts on the environment.

Organic waste is a lesser discussed source of greenhouse gasses that can influence climate change. Common examples are sewage sludge, food waste, and yard waste (Lehmann, 2011). When organic materials decompose, they discharge methane gas which gets trapped in the atmosphere and contributes significantly to the greenhouse effect (Themelis & Ulloa, 2007). "Pound for pound, the comparative impact of CH_4 [methane] on climate change is over 20 times greater than CO_2" (Environmental Protection Agency, 2014). By throwing organic waste into the trash, which is thrown in landfills, the natural decomposition process is halted and methane is released into the atmosphere (Californians against Waste, 2014). If treated properly at home, organic waste can safely be converted into compost, creating nutrient-rich soil without producing methane (Californians against Waste, 2014). Our lifestyle choices have the capacity to change the environment, leaving it up to the population to make the right choices.

2.2.4 Family Size

People are both the problem and the solution to climate change (Cohen, 2010). The growth in the population has a direct correlation to the resources needed to sustain it, thus creating a higher demand for basic needs including land, food, energy, and water (Mavropoulos, 2014). Environmental impact can be measured by the product of the

population size and the consumption per person (Cohen, 2010). For example, economically growing countries like China and India will have an increased negative environmental impact in the next several decades because of both their population size and consumption levels (Annenberg Foundation, 2014). If these fast growing nations switch to clean technologies and lifestyle choices, they will reduce the environmental impact of their large and growing populations. Australia's total fertility rate (TFR), the average number of children a woman would bear over her lifetime, has fallen steadily from 3.548 children per woman in 1961 to 1.729 children in 2001 (Department of Immigration and Border Protection, 2014). The TFR was 1.933 children per woman in a 2012 census (Department of Immigration and Border Protection, 2014). This is below replacement level, meaning the population is not replacing itself from generation to generation. Maintaining this steady and low population growth will reduce the amount of resources necessary compared to a larger, growing population. If resources are consumed with environmental impacts as the priority and the population is stabilized, society can positively shape the future of the environment.

2.3 Organized Environmentalism

The national and local governments of Australia are working towards analyzing and limiting the risks of climate change. With policy to decrease fossil fuel emissions, the Australian government has created ambitious yet realistic goals to reduce human impact on the Earth. Organizations have been created to ensure that citizens are being educated regarding the decreasing health of the environment (Casey & Scott, 2003). These organizations are constantly promoting the well-being of the environment and raising awareness for individuals who are unfamiliar with environmental consequences.

2.3.1 Australian Government Action

Australia is creating progressive legislation to reduce its negative impact on the Earth. This is being done by assessing the risks on its economy and land due to the effects of climate change (Australian Greenhouse Office, 2006). Specifically, the Australian government is targeting ways to reduce their coal emissions by moving to renewable energy sources. The Australian government has created the Renewable Energy Target (RET) which

is designed to ensure that 20% of Australia's electricity comes from renewable sources by 2020 (Department of the Environment, 2014). The RET scheme is being implemented on both a small and large scale. The Large-scale Renewable Energy Target creates financial incentives for large businesses to expand renewable energy sources and power stations such as wind and solar farms or hydro-electric power stations (Department of the Environment, 2014). The Small-scale Renewable Energy Scheme creates financial incentives for households, small businesses, and community groups to install energy systems such as solar water heaters, heat pumps, solar photovoltaic (PV) systems, wind systems, or hydro systems (Department of the Environment, 2014). The progress of the Australian government to be more environmentally conscious is being spread to the public through local organizations that raise awareness on climate change and instill action.

2.3.2 Local Environmental Organizations

Local governments bring attention to environmental concerns and form solutions to address climate change (Thomas, 2010). Even though local governments are usually confined to dealing with public and economic issues, they have started to show interest in environmental management (Thomas, 2010). For example, the local coastline governments are constantly concerned with protecting the populated shoreline, as it suffers from pollution and degradation of infrastructure (Thomas, 2010). Another local government body, the Moreland City Council, has funded organizations like our sponsor, CERES (Figure 10), to promote environmental education.

Figure 10. The Centre for Research and Education in Environmental Strategies (CERES)

2.3.3 The Center for Research and Environmental Strategies (CERES)

A non-profit sustainability center, CERES (Figure 10), addresses the causes of climate change and works to educate visitors to facilitate rapid change. Yearly, the organization averages 350,000 visitors including walk-in visitors of all ages and school groups with students from about 5 to 17 years of age (CERES, 2012). With the vision of striving "to be a place where environmental consequences of our consumer culture can be addressed within a philosophy of social justice", CERES has various programs they use in order to spread their message (CERES, 2012). The educational programs include excursions, incursions, outreaches, and training. Excursions are programs for student groups visiting CERES, emphasizing sustainability which "creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations" (Environmental Protection Agency, 2014). The wide array of educational programs that CERES offers showcases how the nonprofit is dedicated to teaching and facilitating rapid change in sustainability.

Our sponsor, CERES, has asked us to assess and test the design of the Australia 2050 Trail. This trail is an exercise in making decisions for your future and seeing the impact that those choices would make in the year 2050. At CERES there is currently the Australia 2030 Trail, which showcases the human impact on climate change in the year 2030. The Australia 2030 Trail was created fifteen years ago and requires updating in information and infrastructure. A previous student group from Worcester Polytechnic Institute (WPI) began designing the Australia 2050 Trail in the spring of 2014. The group heavily researched new climate change projections to extrapolate the data to the year 2050. Their project culminated in a miniature physical model of a proposed design with supporting activity sheets. We are continuing the design into Phase 2 by pilot testing the model, improving the activity sheets, creating the displays, prototyping our design, testing our prototype, and evaluating the test results.

The proposed 2050 trail activity begins with an instructional sign and map of the

trail. Visitors are guided by a CERES staff member to the next board which begins a history of climate change and human effect on the Earth from 1930 to present day. After the brief history, visitors face their first decision board where they choose what they want in their future and mark those choices on an activity sheet. The proposed decision boards include: where they will live, what goods they will buy, how they will get around, what type of foods they will eat, and how they will power their lives. After the sequence of decision boards, visitors come to a display containing a key instructing them how to add up the points correlated to their decisions on their activity sheets. The trail ends with the future scenario boards where visitors will see the projected outcome if everyone made these same choices by the year 2050. The goal of the exercise is to motivate visitors to make conscious choices for the benefit of the environment. By seeing the outcome of their choices, visitors may change their future lifestyle decisions.

2.4 Educational Exhibits

The CERES 2050 trail must be designed for group learning, which means getting student groups to engage with each other and learn together. Students generally learn through exhibits by discussing their experiences together and asking questions. The Philadelphia-Camden Informal Science Education Collaborative (PISEC) conducted a program of research and development targeted at improving exhibits to promote this type of learning. PISEC found characteristics of exhibits that are more family-friendly, or foster a stronger interaction within groups of children. Successful exhibits are: multi-modal, multi-user, and interactive (PISEC, 1998).

2.4.1 Multi-modal

In order to successfully increase the visitors' knowledge of the effects that their actions have on the environment, the trail must be multi-modal, encompassing different learning styles. While there are many different types of learning, associative, conceptual, and visual are the most relevant to CERES' mission. Associational learning is the process of "experiencing the words and their related objects or situations together" (Bernard, 1965). Just as its name implies, it relies on being able to associate ideas with experiences. For

example, if it is a person's first time at CERES, they may need to understand certain vocabulary. Perhaps they might not know the exact meaning of "sustainability". It is in the hands of the educator to clearly define the meaning of the word, and link the term and idea to form proper association. Conceptual learning is more complex in that it involves explaining a situation or concept and not just a simple definition (Bernard, 1965). In our situation, the idea of the greenhouse effect is a concept that may need to be taught because it is a scientific cycle of processes that could not be explained with a single definition. In a qualitative study "Educating Young Adults about Sustainable Development" conducted at the University of Nebraska in 2011, the result of a survey revealed that students need visualization to connect what they learn with the environment around them (Lewis, 2011). The trail will incorporate visual learning styles through its eye-catching and informative displays. Appealing to many different educational styles will attract a diverse audience for group learning.

2.4.2 Multi-user

Multi-user exhibits stimulate visitors with social objects which promote communication among groups (Simon, 2010). Designing the trail to be used by multiple people at once will be essential to having an engaging display that will work for the groups that visit the Australia 2050 Trail. Objects initiate discussion among visitors by allowing them to talk about the item in front of them. It is much less threatening to engage with someone from person-to-object-to-person (Simon, 2010). An example of this is how people often say hello to a stranger's dog before engaging with the person (Simon, 2010). Conversation while learning can enhance the thinking process that obtains and stores knowledge (PISEC, 1998). Combining conversation and interactivity with the hands-on approach allows skills to grow (Lewis, 2011).

2.4.3 Interactive

Visitors of exhibits are no longer satisfied with just looking at glass cases; they want a hands-on experience (Caulton, 1998). "Hands-on" implies physical interaction which engages visitors by touch, but it is important to stimulate the visitor's mind as well to be

truly interactive (Caulton, 1998). “Interactive exhibits that allow for touching and manipulating stimulate higher levels of attention-focusing behaviors such as questioning and explaining” (PISEC, 1998). Stimulating minds, the exhibit will develop more questions and visitors will want more explanation on the issues being presented (Cheslock & Schneider, 2003). Hands-on exhibits are more likely to hold visitors attention and retain knowledge (Cheslock & Schneider, 2003). Interactive exhibits enable the participant to retain more knowledge than from simply viewing the material (Cheslock & Schnider, 2003). As explained in Figure 11, retention increases with the hands-on approach. CERES is especially interested in retention because they want the visitor to recall that they have the capacity to change their predicted futures from the activity by making the right choices. Hands-on learning can be incorporated into the trail to leave visitors with this lasting impression.

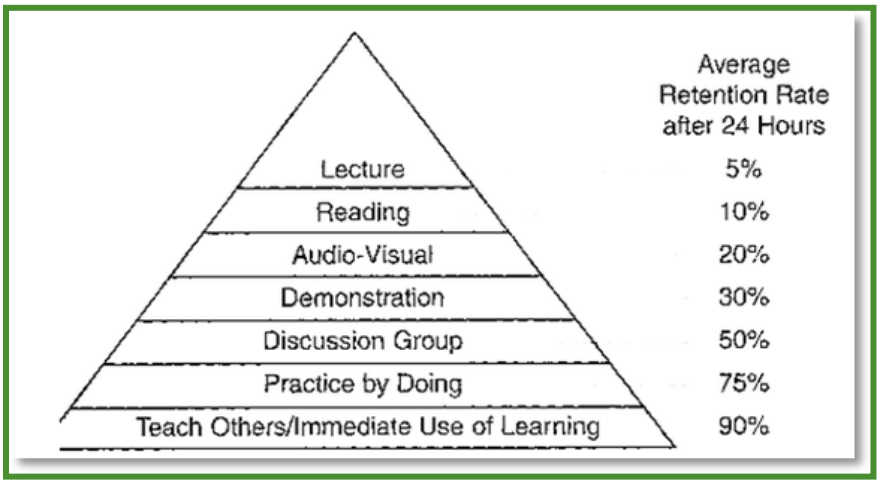


Figure 11. Average retention rate of learning through different learning strategies (Wang, 2004)

2.5 Interpretative Trail Design

According to the American Trails Online Resource, interpretive trails are designed to stimulate visitors’ interest while challenging their imagination to see new perspectives on familiar topics through signs or exhibits. Interpretive trails, such as the proposed Australia 2050 Trail aim to: draw visitors in, capture curiosity, develop an interest, and have the visitor leave with more knowledge than he or she had before (Westrup, 2002). An example of an interpretive trail that accomplishes these goals is shown in Figure 12. Interpretive trails are informative but not always interactive. We plan to include interactive elements in the

Figure 12. Mission Bay trail interpretive signs, San Diego, CA (Macdonald, 2007)

Australia 2050 Trail to keep visitors entertained and engaged. Interpretive trail design research is necessary to understand what makes an informational trail effective. Top tips for successful trail signs and exhibits include being easily understood, maintaining the viewer's interest by being entertaining, and relating the message back into the audience's life, and motivating them to take action (Westrup, 2002).

2.5.1 Understandable

Interpretive trails are designed with the intention of being an educational tool. If the information is not presented in a way that is easy to understand, the visitor will not gain the amount of knowledge expected from the trail. To make an interpretive trail easy to understand, the information must be presented by using eye-catching shapes and readable fonts, and avoiding sensory overload (Westrup, 2002). Part of presenting information clearly is focusing on the visual content. To provide the biggest impact, illustrations and legible text should be combined to engage visitors with the material (Westrup, 2002). Illustrations may be used to help represent a time period, landscape, emotion, or topic being covered by capturing the imagination and explaining ideas without the use of words (Westrup, 2002). Simple font and easy to read formatting must be prioritized so that the message does not become too difficult to decipher (Fielder & Rigby, 2012). Visual representations will be successful if it does not cause sensory overload. Resisting the temptation to fill a board with too much information is an imperative design technique (Westrup, 2002). "Visitors don't have to learn everything there is to know about a subject at that very moment" (Westrup, 2002). Instead, stimulating people to a particular subject and providing guidance for those

who wish to pursue the topic even further is a more effective way of presenting information (Westrup, 2002). Visitors may be discouraged by the interpretive signs if they see that they are completely filled with information. If presented in the correct way, free of excess information, interpretive trails will be easily understood.

2.5.2 Entertaining

Keeping the visitors' focus on a trail is essential in guaranteeing that the information presented is making an impression. To captivate their interest, information needs to be displayed in the form of entertaining, sequenced stories, instead of lecture form (Westrup, 2002). In the same way that sensory overload may negatively impact the learning process, trying to force multiple stories on one sign is just as ineffective. It is necessary to divide the stories into multiple, smaller ones, as telling one piece of material at a time helps convey the message effectively (Westrup, 2002). This can be done, for example, by placing information on one interpretive sign of the trail followed closely by another sign with more information on the topic further down the trail. By doing so, people will be able to understand and absorb one concept before moving onto the next sign (Westrup, 2002). This division of material is also a powerful tool in guiding visitors down the path, as it is possible to entice the visitors to move from one area to another by using the different signs as "visual magnets" (Westrup, 2002). Keeping the topic entertaining is crucial to educating visitors on how their lifestyle choices affect the environment. By tying these entertaining qualities together and relating the trail to the visitor's life, a greater impression will be made.

2.5.3 Motivating

The Australia 2050 Trail must increase knowledge of human impact on climate change, and most importantly, it must influence action to be taken for the benefit of the environment. We want the new proposed trail to continue CERES' education efforts, while motivating the visitors to change their daily choices. The action visitors take cannot be artificially engineered; they must take it upon themselves to integrate the knowledge gained once they leave CERES. Easing the visitors into taking action gently and at the right time will produce more effective results (Copple & Sigel, 1984). In Kretz's "Climate Change: Bridging the Theory-Action Gap", he argues that remedying ignorance is not enough to

3 Methods

The goal of our project was to continue the design of the Australia 2050 Trail to motivate visitors to change their lifestyle choices with the intention of benefiting the environment. The trail is intended to show individuals that they have the power to make the right choices to a more sustainable future. We are continuing the design into Phase 2 by testing the Phase 1 model, improving the activity sheets, revising the displays, prototyping the Phase 2 design, testing the Phase 2 prototype, and evaluating the test results. We have developed the following objectives to guide us in achieving this goal:

Objective 1: Assess effectiveness of previous trail designs

Objective 2: Develop clear and user-friendly activity sheets with updated content

Objective 3: Design trail boards with updated content considering aesthetics and feasibility

Objective 4: Develop virtual trail prototype and lesson plan

Objective 5: Pilot test the virtual trail and revised activity sheets

Objective 6: Evaluate Pilot Test results

In this chapter, we will discuss the methodologies used to complete each objective, and why we chose them.

3.1 Objective 1: Assess effectiveness of previous trail designs

Our project began with assessing previous trail designs so we could move forward with Phase 2 of the Australia 2050 Trail design. Preliminary designs were provided by a previous group of students from Worcester Polytechnic Institute (WPI). Our team met with the Phase 1 group to get some explanation on the choices they made in their design and ask about any obstacles they faced. The scoring system of Phase 1 of the Australia 2050 Trail had been changed to symbols instead of numbers like the Australia 2030 Trail, and we asked what led to this decision. We also inquired why they eliminated the immigration and population questions. To assess the previous designs, we ran a pre-pilot program to

determine what adjustments must be made. First, we surveyed WPI students with the existing questionnaire for the proposed Australia 2050 Trail (see Appendix B) and received 105 responses. The rationale behind interviewing students at WPI was that they were easily accessible and could offer early feedback. The questionnaire results were intended to give us perspective on how CERES' visitors might answer these questions. When analyzing patterns in the WPI students' results, we looked for insight into whether any of the questions were hard to understand. Once we arrived at CERES, we walked through the Australia 2030 Trail and defined any obvious issues.

The first week at CERES, we watched the Australia 2030 Trail in action with three different school groups to gain context on how the trail is presented by CERES' teachers and to hear students' reactions to the trail. During the first observation of the Australia 2030 Trail, we participated in the activity itself along with a group of year 9 students to test the usability and engagement of the trail. Ian Culbard, a CERES teacher, led this observation group and allowed us to see the context in which the lesson is presented. In the next observation, we were able to see a different teaching style as a different CERES teacher, Adrian Whitehead, taught this lesson. The second group consisted of year 8 students, and we chose to not participate in the activity but strictly observe. We focused on watching the flow of the activity and students' participation and understanding of the material. The final observation was another group of year 9 students, and we chose to just take notes of the overall presentation of the material by Ian to see the consistency in the lesson. We made a point to speak with the teachers of the school groups and get their contact information, so they could give us feedback on our design further into the project. These teachers were a valuable resource as they had experienced the Australia 2030 Trail first hand and could give us an expert opinion on the educational value of our design.

Next, we continued the assessment of previous designs by testing the Australia 2050 Trail Phase 1 model with a focus group of CERES' teachers (see Appendix C). CERES' teachers were the best participants for this focus group because they have insight into what CERES wants to see in the activity as well as the context of the Australia 2030 Trail. We

had one focus group with four CERES teachers, Ian Culbard, Marty Kendall, Arwen Burch, and Nick Scott. Our team asked the focus group to give their opinion on the point system moving to symbols and the elimination of immigration and population questions. We also initiated discussion about the future scenarios decreasing to only five in the proposed Australia 2050 Trail compared to the twelve scenarios presented in the Australia 2030 Trail. We originally wanted to test the model with students and school teachers, but thought it would be hard for them to understand the model and correlate it to the activity sheet without having seen the Australia 2030 Trail.

3.2 Objective 2: Develop clear and user-friendly activity sheets with updated content

Based on consensus in the focus group and WPI student survey feedback, the trail's activity sheets were updated in content and presentation to be more easily understood and visually stimulating (see Appendix D). The content was revised with the intention of making the activity simple, with maximum educational value. If students were lost in the questions, they would not be able to see the bigger picture of the activity, that their lifestyle choices make a difference to their future. We posed additional decisions in the activity based on their environmental impact and their importance to CERES. We redesigned the graphics of the activity sheets and tested if this made them more visually stimulating. In addition, we explored design features to make the activity repeatable and more environmentally friendly.

We surveyed school teachers who had previously experienced the Australia 2030 Trail to get an expert opinion on the educational potential of the activity sheets. Seven school teachers who we had previously interacted with were contacted. Five of the teachers answered with their perspective on the overall impression of the activity and provided us with outside opinions (see Appendix E). Conversing with teachers while they were at the Australia 2030 Trail and explaining our project allowed us to connect with them and get better feedback. We asked the teachers about the students' over all experience, teaching methods to incorporate in the lesson plan, and what they particularly liked or disliked about

the updated activity sheets. The survey results were used to make final adjustments to the activity sheets, which were later pilot tested (discussed in Objective 5).

3.3 Objective 3: Design trail boards with updated content considering aesthetics and feasibility

After content was finalized, we updated the displays of the Australia 2050 Trail to match our redesigned activity sheets. The displays were designed to be logical, durable, and entertaining in order to successfully contribute to the activity. We designed the boards keeping in mind that proper exhibit organization is essential in understanding the information being presented. The choices displayed on boards throughout the trail are designed to be clearly read by all visitors. We intended the boards to be placed logically, first with an instruction board, followed by lifestyle decisions, and lastly possible future scenarios. The layout of the Australia 2050 Trail boards was determined through many conversations with our sponsors, Shane French and Ian Culbard. Many spaces at CERES are multi-functional and in designing the layout of the Australia 2050 Trail, we had to consider that space in the Energy Park is used for many activities.

Before arriving in Australia, we conducted an informal interview with Betsy Loring, Director of Exhibits at the EcoTarium, in Worcester, Massachusetts, as she showed us some interactive exhibits (see Appendix F). We were connected to Betsy through the Interdisciplinary and Global Studies Division (IGSD) at WPI because she had previously worked with WPI groups and was part of designing a local interpretive trail. In this interview, we obtained expert opinion on how to effectively display information and build exhibits that are engaging and durable. Asking about her experiences and different characteristics of good exhibits, Betsy gave us a lot of information to work with. We discussed the Australia 2050 Trail activity, and she provided us with many ideas of how to make our design more interactive and game-like.

Once we began initial planning of our trail layout, we had a semi-standardized interview with CERES' in-house contractors Martin Johansson and Renato Colangelo about feasibility of implementing our design and potential materials we could recycle (see

Appendix G). We needed to understand any restrictions or regulations that must be considered in making a practical design that CERES could implement. We chose to conduct a semi-standardized interview so that questions could be reordered as the conversation progressed. We also wanted to give our group the chance to ask additional questions since some answers may be more fully elaborated on with additional follow-up questions (Berg & Lune, 2011). Since the trail will be exposed to weather, it was necessary to design for durability in order to ensure a long life-span. We asked about materials that are long-lasting and what materials we could reuse from the Australia 2030 Trail. Most importantly, we inquired about any concerns they had with our plans to get a sense of any unforeseen issues that could arise in the implementation of the Australia 2050 Trail.

3.4 Objective 4: Develop the virtual trail prototype and lesson plan

Once we finalized our improvements to the Phase 2 design of the Australia 2050 Trail, we moved forward into prototyping. Prototyping allowed us to test and revise our ideas by visually representing the trail for others to evaluate. The previous WPI group constructed a miniature physical model of their concept to present their ideas, however they were unable to test their design. It would have been difficult for them to test their model since the boards were very small, and visitors would not be able to experience a first-person view of their design. We created a virtual model of the Phase 2 design of the Australia 2050 Trail (Figure 13) in order to simulate the trail to visitors in a first-person

Figure 13. Australia 2050 Trail Phase 2 Virtual Prototype

perspective. Creating a virtual tour was ideal as CERES did not have a budget at the moment to construct a full-scale prototype.

First, in a 3D modeling program (Autodesk Maya), we modeled the Energy Park including the landscape and existing permanent fixtures (solar panels and solar shelter) to approximately life-size proportions. Details, such as grass, shrubbery, and fencing, were also added to the scene in order to achieve a realistic environment. Next the instruction, decision, and future board frames were modeled in the scene to the portions of the current Australia 2030 Trail boards. We used the Adobe Creative Suite to make the Phase 2 Australia 2050 Trail board designs (see Appendix I), that were applied to the board frames. The board designs were intended to appear modern and easy for the visitors to complete the activity. This method tied into the skills of one of our team members, Daniel Driggs, an Interactive Media & Game Development (IMGD) major. His skills were very important in being able to create a useful and visually appealing trail model. Accommodating for the large amount of time and resources put into this prototype was crucial to completing this project on time and to the best of our abilities.

We wrote a lesson plan as an aid to CERES' teachers in explaining the Australia 2050 Trail, but it is not a mandatory guide that needs to be followed step-by-step. CERES' teachers have their own presentation styles, and the lesson plan is intended as a guide to make sure the bigger-picture of the activity is illustrated to the students. Using the lesson plan from Phase 1, we updated it reflecting our new content and incorporated teaching methods learned through the teacher survey from Objective 2.

3.5 Objective 5: Pilot test the virtual trail and revised activity sheets

After the prototype was completed, we created a PowerPoint presentation of the prototype. We rendered the scene into a series of images to replicate the movement through the Australia 2050 Trail prototype. These images were incorporated into a presentation where each slide contained one rendered frame, and the slides were animated to give the frames a smooth transition to simulate what it would be like to walk through the trail.

Incorporating these frames in a PowerPoint allowed us to control the view of the participants in the Pilot Test and give them a high quality image of the boards to complete the activity with ease. The Pilot Test was intended to determine if this design could be implemented into its final, full-scale state by CERES. By testing the prototype, we were able to measure the overall success of Phase 2 of the Australia 2050 Trail design, make improvements, and give recommendations for the future.

The Pilot Test consisted of seventy students (split into three groups) in year 7 participating in the virtual trail while filling out the activity sheets and answering an exit survey upon completion. We prepared the Pilot Test (Figure 14) by showing Ian and Shane our PowerPoint of the prototype and preparing Ian to run the test by reviewing the lesson plan (see Appendix Q). Five students in each of the three groups were equipped with laminated activity sheets to see if the experience changed with a different material sheet since the laminated sheet allows student to easily change their choices. We began the Pilot Test by giving the students a view of the current Australia 2030 Trail and explaining our project preamble in a short video (see Appendix A). Then, Ian started the activity by asking questions to engage students and facilitating discussion while we observed. Ian asked the students what they want in the future, where they want to live, and where will those materials come from, explaining the implications of those choices. Next, the virtual trail presentation led students through all the decision boards while students recorded the points related to their choices on their activity sheets. We paused at each decision board so that the students had sufficient time to answer the decisions and record their points on their sheets.

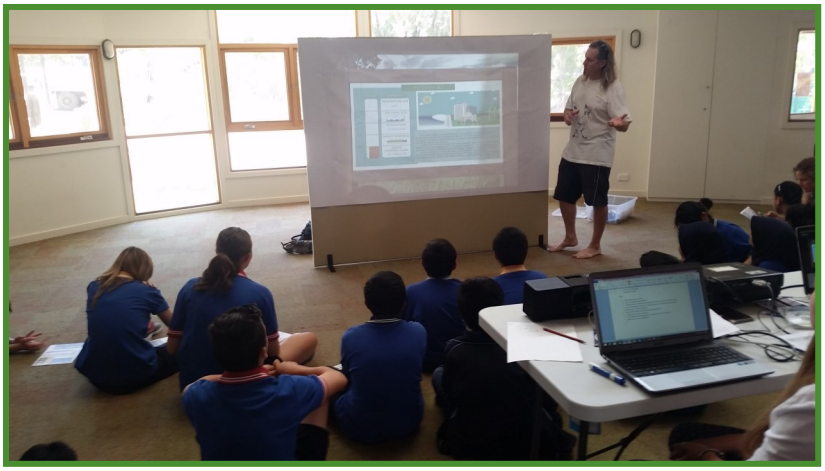


Figure 14. Australia 2050 Trail Phase 2 Pilot Test

Our group observed the discussion between students and answered any questions that arose in order to see any immediate issues in our prototype. After completing the activity, students answered a short survey that asked them if they would change their lifestyle choices based on their predicted futures (see Appendix O). We also asked their overall impression of the activity and if they had any difficulties with either choosing the decisions or completing the activity sheet. A survey was effective in this situation because we had a large group of participants that could give us a pattern to draw conclusions from in our evaluation. Once we received enough information based on the test groups and exit surveys, we analyzed the effectiveness of the Phase 2 design of the Australia 2050 Trail.

3.6 Objective 6: Evaluate Pilot Test results

Our final objective was to evaluate the Pilot Test and feedback from CERES' staff in order to properly assess the success of our proposed Australia 2050 Trail design and apply adjustments to it as needed. First, we synthesized our observations made during the student Pilot Test. This analysis helped us gauge the initial reactions to the trail, helping us improve our design. Furthermore, we analyzed the exit survey results, looking for trends and codes to assess how the trail performed. The survey results gave us insight on any remaining issues or causes for confusion. We focused on three main categories: intuitiveness, entertainment, and overall impression of the Phase 2 design of the Australia 2050 Trail as these are the characteristics of successful interpretive trails according to our background research. We believed that these categories would be crucial in the development of our trail, as successful interpretive trails must be easily understood, maintain the viewer's interest by being entertaining, relate the message back into the audience's life, and motivate them to take action (Westrup, 2002).

We had a brief informal pilot test with CERES' teachers to see what they thought of the activity and if they had any final recommendations for the future. The test was run in a similar fashion to the student Pilot Test in that we used the same presentation of our prototype. There were six teachers present in this test, including Nick Scott, Subik Baso, Sarah Buelow, Julia Roebuck, Michelle Forrest, and Kat Young. The CERES' teacher test

differed in that it was more of an open discussion of the new material. We took the opinions of the CERES teachers and wrote them into our recommendations for the future. CERES can use these recommendations if they wish to modify the design before construction.

We concluded our work at CERES by interviewing our sponsors, Shane and Ian, on their final impressions of Phase 2 of the Australia 2050 Trail design. This was very important for us to gauge how well we had done in delivering this design to CERES. Shane and Ian provided a lot of feedback on our design as well as other ideas they hope to see possibly incorporated in construction.

3.7 Data Analysis

Throughout our project, we complied and sorted our data into qualitative and quantitative categories. Most of our data was qualitative because the majority of our methods are observations and interviews. In order to analyze our qualitative data, we synthesized the information and organized it by topic to find patterns and compare similarities and differences in feedback. Summaries of these discussions and interviews are included in our findings to give further information. The quantitative data from our surveys from the first WPI questionnaire, teacher opinions on the activity sheets, and the virtual trail Pilot Test were analyzed for trends. With these results, we drew conclusions on the success of our design.

The next chapter outlines the findings of our project based on evaluation of previous designs as well as the feedback from testing the Phase 2 Australia 2050 Trail design. Included in these findings are further recommendations for CERES to consider before construction.

4 Findings & Recommendations

This chapter brings together the results of all our tests and observations from the Australia 2030 Trail, Phase 1 of the Australia 2050 Trail, and Phase 2 of the Australia 2050 Trail. We used this information and additional comments found through interviews and surveys to develop and evaluate the best design for the Centre for Education and Research in Environmental Strategies (CERES). We present the findings from research and testing, followed by our recommendations.

4.1 The activity sheets were found to be confusing and needed to be redesigned for simplicity, usability, and engagement.

We observed the original Australia 2030 Trail activity sheet in action during our first two weeks at CERES. The activity sheet was simple in design as seen in Figure 15. CERES' visitors fill in their corresponding point values for each question and total their resource "R" points and population "P" points separately. Then, they go to the "Your Future Awaits" board and find their future scenario by matching their "R" and "P" points on the table. The sheet has many positive qualities in terms of its simplicity and usability but could be more colorful and engaging based on comments from students and teachers during our observation.

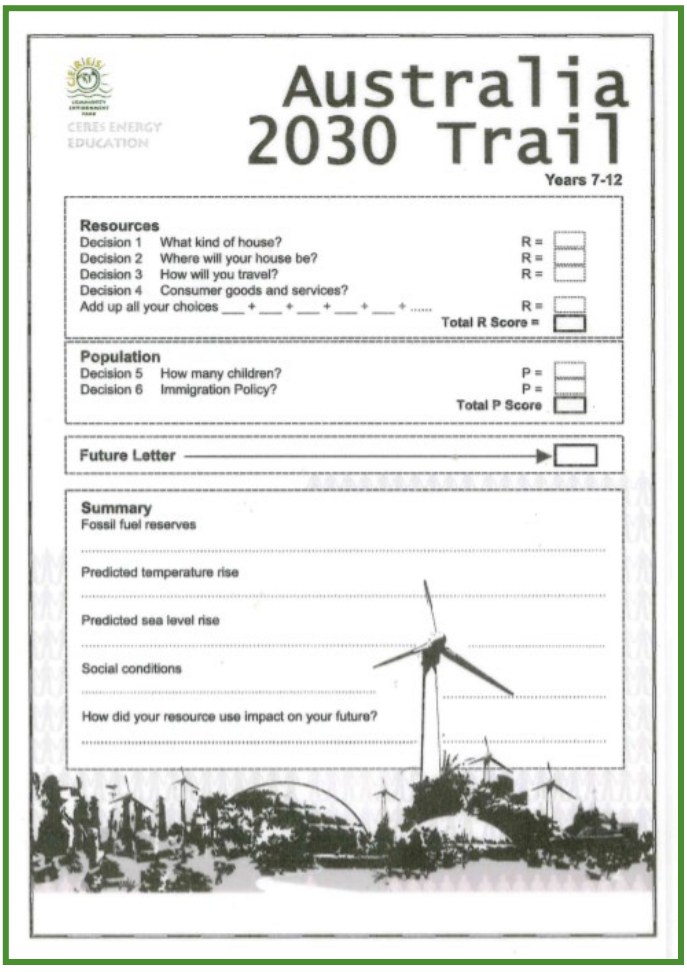
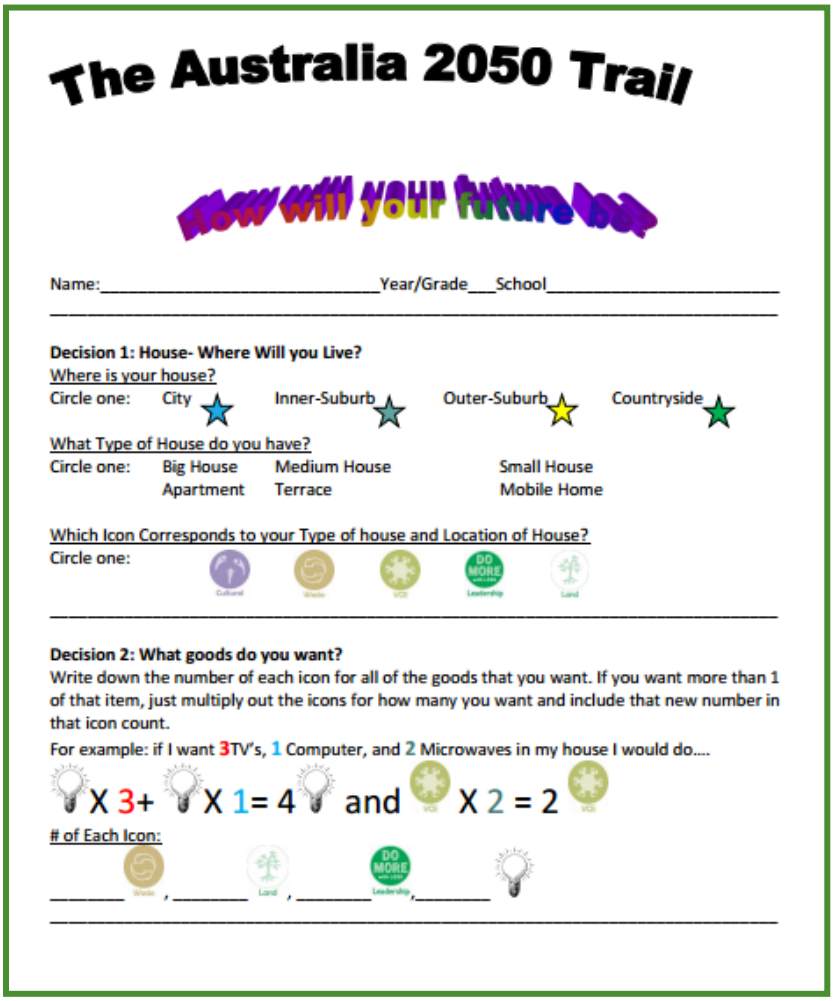


Figure 15: The Australia 2030 Trail Activity Sheet



The Australia 2050 Trail

How will your future look

Name:_____Year/Grade___School_____

Decision 1: House- Where Will you Live?

Where is your house?

Circle one: City Inner-Suburb Outer-Suburb Countryside

What Type of House do you have?

Circle one: Big House Medium House Small House
Apartment Terrace Mobile Home

Which Icon Corresponds to your Type of house and Location of House?

Circle one:

Decision 2: What goods do you want?

Write down the number of each icon for all of the goods that you want. If you want more than 1 of that item, just multiply out the icons for how many you want and include that new number in that icon count.

For example: if I want 3TV's, 1 Computer, and 2 Microwaves in my house I would do....

X 3+ X 1= 4 and X 2 = 2

# of Each Icon:

_____, _____, _____, _____

Figure 16: The Australia 2050 Trail Phase 1 Activity Sheet created by a previous WPI group (Page 1 of 3)

The first group of students from Worcester Polytechnic Institute (WPI) created another activity sheet (Figure 16) for the Phase 1 Australia 2050 Trail design, which improved aesthetically with added color but declined in its usability from the added symbols. The first group changed the scoring on the activity sheets to be represented by symbols instead of numbers to eliminate bias so visitors would not choose the lowest point options. We asked the CERES staff what they thought about the activity sheets during our focus group of the Phase 1 Australia 2050 Trail model and specifically if they liked the symbol based scoring system to eliminate bias. Arwen, a CERES teacher, mentioned,

> "I haven't actually found that [bias] to be a problem when I teach the class…So if this makes that more complicated, I would just go back to numbers personally because from my experience that is not an issue."

We explained our concern for confusing visitors by using symbols to represent the

environmental impact of choices and losing sight of the value of their actions. Ian, another CERES teacher, added that he agreed with Arwen, and if the symbols make the activity too complex, it's not a good tool to convey the idea that different choices have a different amount of environmental impact. We asked the focus group to explain more why they believed bias was a "non-issue" because the first group who designed the Australia 2050 Trail spent a lot of time developing a system to eliminate bias. Arwen elaborated, that people do not want to cheat. She thought that it is not worth catering for the one person in the class out of one hundred who tries to cheat. She ended her explanation by saying, "this is just complicated looking at it [the activity sheet], not even reading it…just do the numbers, I would." Since usability was the most important characteristic of the activity sheets, we found that having symbols on the sheet instead of numbers was decreasing the educational value of the activity. The Phase 1 Australia 2050 Trail activity sheet was also three pages long, which seemed wasteful, working against CERES' mission of reducing waste.

From the feedback of the focus group and evaluation of the previous designs, we redesigned the activity sheets keeping in mind that they needed to be simple, usable, and engaging. The new activity sheet (Figure 17) includes boxes to record scores for all six decision board questions. Those boxes marked with an "R" watermark are resource points. There is a "Resource-O-Meter" where visitors can color in all their resource points to visually see how many resources they are using. The "What's your Future" section is where visitors multiply their resource points "R" by their "Family Points" to get their "Final Total". The "Final Total" is then filled into the "Future Bar" where visitors see what future scenario they fall into. The sheet is colorful and leaves enough space for visitors to easily record and add their points together. One more idea we incorporated in the design was making the sheets reusable by laminating them and using dry-erase markers to record answers. If the activity sheets are laminated, visitors can change decisions to improve their scenarios and reduce the waste involved with printing sheets for every visitor that participates in the activity.

We evaluated our redesigned sheets through a survey of teachers who previously

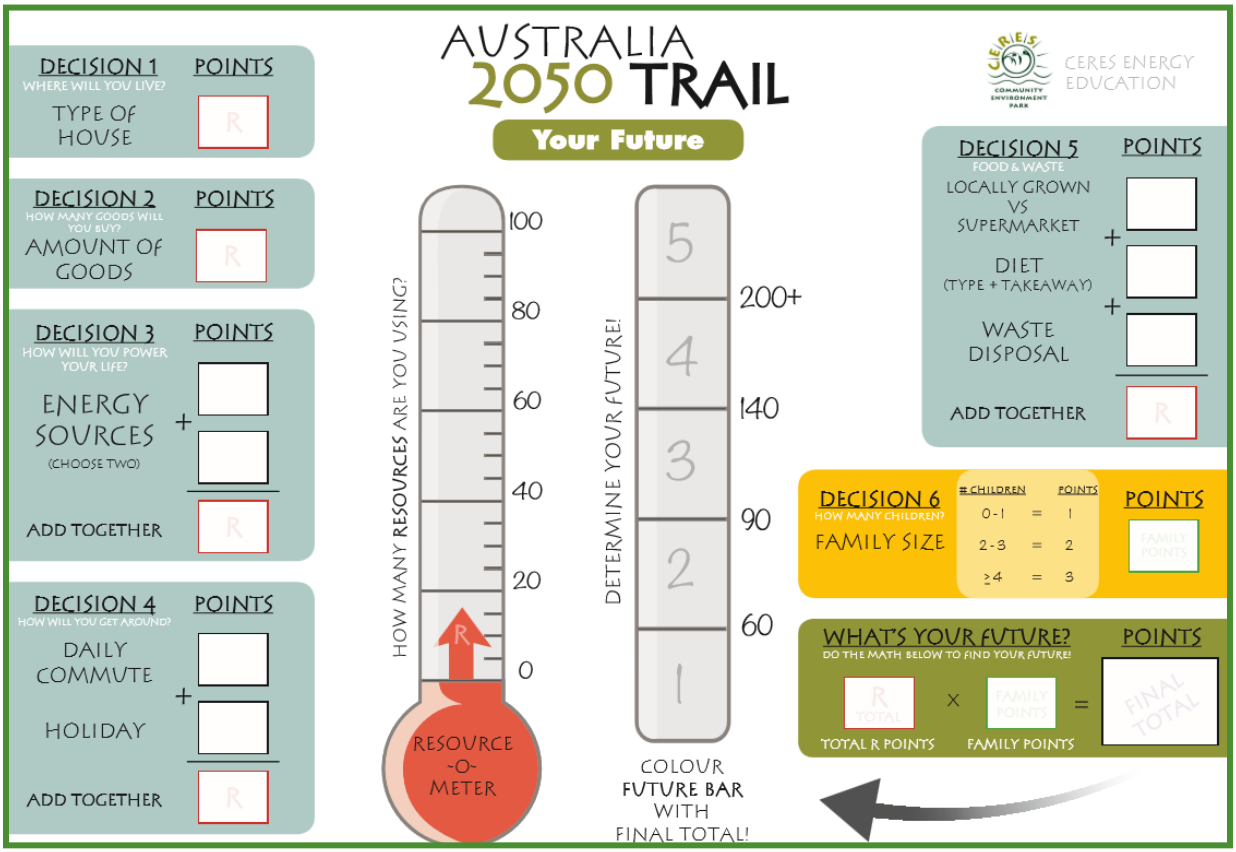


Figure 17: Australia 2050 Trail Phase 2 Activity Sheet

visited the Australia 2030 Trail. Four out of five teachers preferred the new activity sheet and thought the sheet was more clear and colorful. The sheet (Figure 17) was further evaluated during the Pilot Test of seventy students in year 7 (7th grade). Our survey included a question asking if the participants had any trouble completing the activity sheet. Sixty-two students out of the sixty-seven who answered this question said they did not have any trouble completing the activity sheet.

We gave out five laminated activity sheets to all three groups in the Pilot Test to see if usability increased with a different material. The logic behind incorporating laminated sheets was that it reduces waste, is an easier surface to write on than paper, and students could easily change their answers if they made a mistake. We found that the students without laminated sheets were having trouble recording their decisions and were poking holes in their paper. Students with the laminated sheets were erasing and changing their

choices with ease, while those without, were crossing out their choices to fix them. Many students wanted to use the laminated sheets over the paper ones, showing the benefit of incorporating them to make the activity more fun and engaging for the students.

Some other findings that emerged from our Pilot Test about the activity sheets were related to how participants recorded their answers and used the space on the sheet. A few students were confused about writing in a box with a resource "R" watermark. Some students were writing beside or around the box, but those with the laminated sheets wrote over the watermark without an issue. We believe that those with paper sheets did not write over the "R" because it would have been difficult to see their points written in pencil. That is why it was not an issue with the laminated sheets because those with markers could easily write over the watermark. To add up their points, students used the extra space on the sheet to do their addition or used the "Resource-O-Meter" to add their points as the activity progressed. We noticed students who did not use the "Resource-O-Meter" had more difficulty adding their resource score together at the end, supporting our idea of visually displaying the resources to add them up. Students noticed that, as they were adding their "R" points to the "Resource-O-Meter", it was filling up quickly and understood that they were using too many resources too early in the activity.

We recommend that CERES uses the activity sheets included in this report and laminate them for reuse. For the best results and easiest cleanup, have visitors use fine point dry-erase markers to record their points. From an informal test with CERES' teachers, we found some possible suggestions for the future including having a space where visitors can write down what choices they picked and also using the back of the sheet for more information. There were many ideas for the back of the activity sheet, ranging from showing the possible future scenarios to showing all the decision questions.

4.2 The point system was found to be too complicated and needed to be restructured to better predict future scenarios.

Phase 2 in designing the Australia 2050 Trail involved verifying the updated information gathered in Phase 1 of design. Through research and evaluation of the

Intergovernmental Panel on Climate Change (IPCC) and the Commonwealth Scientific and Industrial Research Organization (CSIRO), we verified the information from the five future scenarios developed by the previous group of WPI students who designed Phase 1 of the Australia 2050 Trail. By contacting the previous group, we discovered that the scenarios were based on research, but the point values assigned to the decisions and scenarios were arbitrary. One of the students commented,

> "We didn't have much time to completely review our scoring system and determine what would work the best, so we used symbols with scores at the end. The numbers were just kind of chosen, nothing specific or any certain reasoning behind them."

We felt that this was an issue because the number of points should depend on their environmental impact. The Phase 1 Australia 2050 Trail scoring system assigned over fifty possible points to choosing all the goods and only six points to choosing the largest home. The sum of the points should be the environmental effect of each decision coming together to shape the future scenario and should in no way be arbitrary. Therefore, based on research we ratified the points to be weighted to the amount of environmental impact of each choice (see Appendix H).

The allocation of the points for each decision is thoroughly explained in the lesson plan (see Appendix Q). For decision one "Where will you live?", homes that use fewer building materials and are located closer to the city have less environmental impact and therefore had fewer resource points. For decision two "How many goods will you buy?", three different lifestyles with increasing amounts of goods were shown and the lifestyle with the most goods had the highest resource points. For decision three "How will you power your life?", renewables were rated with significantly fewer resource points than non-renewables and each of the energy sources were weighted against each other with coal having the highest resource points and wind having the lowest. For decision four "How will you get around?", resource points were allocated based on the amount of emissions per person for each method of transportation. For decision five "How will you consume food and dispose waste?", locally grown food had fewer resource points than food purchased

from the supermarket. Diets with more animal products have more of an impact on the Earth, thus more resource points. Finally, waste was considered in the last question and more resource points were earned for choosing to throw everything in the rubbish bin without recycling. For decision six "How many children will you have?", larger family size translated to a higher value for the "Family Points". To incorporate the sum of the resource points and "Family Points" together, we decided to multiply them because, through our research, we found that the environmental impact can be measured by the product of the population size times the consumption per person. This product is the "Final Total" that determines what future participants fall into.

There are five future scenarios, with future one being the least effected by climate change and future five being the most. The Pilot Test showed that students were falling into all scenarios with majority falling into scenario four. Of the seventy students, there were five students in future one, sixteen students in future two, six students in future three, thirty-seven students in future four, and six students in future five (see Figure 18). As expected, most of the students (70%) ended in future three or higher. At the end of the Pilot Test, students answered a survey for that evaluated the activity and the survey allowed us to see if they understood the material. The first question of the survey asked students to circle their future number, and the second question asked, "Would you change any of your choices based on your future?" The survey results showed that those with higher future scenarios were more likely to answer that they wanted to change their choices (Figure 18). We found

Future Scenario	Number of Students in Scenario	Number of Students who answered "Yes, I would change my choices based on my future scenario"	Percentage who answered "Yes, …"
1 (least effected)	5	1	**20%**
2	16	2	**13%**
3	6	3	**50%**
4	37	25	**68%**
5 (most effected)	6	6	**100%**

Figure 18: Number of Students who answered "Yes, I would change my choices based on my future scenario."

that there is a direct relationship between high futures and desire to change choices. This outcome supports the overall goal of the activity because students did consider the impact of their decisions and wanted to change them after seeing the repercussions of their choices.

We recommend that the Australia 2050 Trail include the point system we developed as it fairly represents the environmental impact of our daily choices. After the Pilot Test, we think the threshold points for each of the five scenarios are reasonable since students were falling into all five futures. If CERES' staff observes that too few visitors are falling into any of the futures after further testing, we recommend adjusting the threshold points.

4.3 Decision board questions lacked relevant information related to human impact on climate change and included too many restrictions on those decisions.

We found that the decision board questions for Phase 1 of the Australia 2050 Trail had been changed from the questions of the Australia 2030 Trail. The population and immigration decisions of the Australia 2030 trail were eliminated in the Phase 1 design of the Australia 2050 Trail. Phase 1 of the Australia 2050 Trail incorporated more options and restrictions in choices to make the activity more realistic and educational. We found that some topics were not covered in the decision boards that CERES wished to incorporate including purchasing local food, properly disposing of waste, and limiting take away foods.

The group of students who worked on Phase 1 of the Australia 2050 Trail design chose to eliminate the population and immigration decisions from the Australia 2030 Trail. The previous group said, "through interviews people suggested that younger kids can't really determine that type of thing [population and immigration] at this point and don't understand the immigration policies." Through our focus group with CERES' teachers, Nick Scott, Marty Kendall, Arwen Burch, and Ian Culbard, we got a lot of feedback on these two decisions. Nick agreed with the Phase 1 Australia 2050 Trail group and said that immigration did not make much sense in the activity. Nick thought it was a shame to lose population as well though. Our sponsor, Ian, agreed with Nick's feeling on losing

population and noted, “Population is massive…The entire piece and everything we do at CERES is human impact and human impact in a bigger population is unsustainable. It’s really everything.” Furthering the discussion about adding the population question back into the activity, Marty said it was a fairly simple question that could be answered easily and will not impact the length of the lesson. The conversation concluded with everyone agreeing that population is the most important thing in terms of human impact and should be incorporated in our updated design.

From our survey of WPI students using the Phase 1 decision questions, we found that students were not reading the questions thoroughly. The restrictions regarding the types of energy available depending on which type of house they owned were ignored. We reduced the amount of restrictions for both the “How will you power your life?” and “How will you get around?” decisions. At our sponsors’ request, we included two restrictions on “How will you power your life?” board since they want visitors to understand that it is not feasible to power a large home or a home filled with many goods by just renewable energy sources alone. We added a note that those who picked to have a large home or many goods must choose at least one non-renewable source of energy. Those who picked to have both a large home and many goods must choose two non-renewable sources of energy because of their energy requirement.

With these new restrictions, we decided to reorder the decision boards to logically go through the activity. The first two decision boards are now “Where will you live?” and “How many goods will you buy?” respectively with the third decision board being “How will you power your life?” because the restrictions depend on the previous questions. This will allow the visitors to go from question to question intuitively without getting confused.

Our sponsor, Shane French, expressed a need for incorporating food and waste into the activity as these small daily choices add up to a huge environmental impact. A question was added to ask whether visitors wanted to purchase locally grown food or food from the supermarket. The next added question asked what type of diet the visitors will have and how many times per week they will have takeaway. The last added question asked how visitors

will dispose of their waste. During our focus group, Ian mentioned adding the topic of waste into the activity as he thought it would be a good thing for visitors to consider and it would not hurt to have extra questions. These questions were evaluated in the Pilot Test and eight students noted that they wanted to change their food and waste choices based on seeing their future in the activity. Eight students specifically noted that they will reconsider their food and waste choices once they leave CERES.

We found that the consumer goods board from the previous trail designs incorporated too many options and took too much time to complete in the activity because visitors were asked to pick each individual good they would like to have. Through our WPI student survey of the existing Phase 1 Australia 2050 Trail decisions, we observed that almost everyone picked every good available. In a conversation with CERES teacher, Adrian, we found a solution to presenting this decision by depicting three different lifestyles based on the amount of goods. This would save time and effort for the visitors because they would only have to make one choice instead of adding each individual good one-by-one.

We recommend that CERES uses the decision and future board information we developed for the Australia 2050 Trail. The new boards include relevant information related to current climate change projections which was a huge improvement from the Australia 2030 Trail information that is vastly out of date. Possible suggestions given to us by CERES' teachers after they tested the boards include adding a question that asks about the frequency of eating meat and adding more methods of transportation. These questions could help make the activity more realistic in terms of representing an individual's impact on climate change; however we did not want to overwhelm the visitors with too many options.

4.4 The aesthetics of the decision boards and the layout of the trail did not clearly display the concepts being presented and needed to be updated to increase the engagement of the visitors.

Phase 1 of the Australia 2050 Trail improved the overall aesthetics greatly by adding

color and images to symbolize the information being presented on the trail. In our observation of the Australia 2030 Trail, teachers noted that the pictures needed color and that the images were too close together on the future boards, not clearly displaying all the concepts presented. A teacher specifically said, "I think the information boards are also in need of a re-vamp."

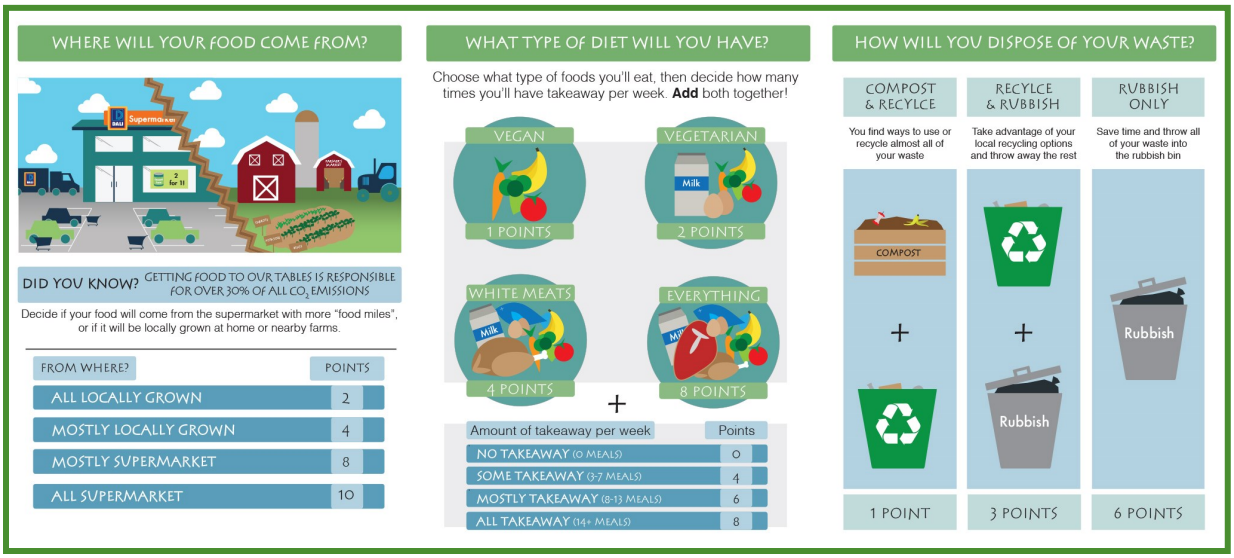


Figure 19: New "Decision 5: How will you consume food and dispose of waste?" Board

In designing the trail boards using Adobe Creative Suite, we found that simple and clear graphic images would be the best way to convey the ideas on each decision board and fit with the CERES theme (Figure 19). These simple graphics are modern in appearance and will less likely age like a photograph or illustration of another style. Adding more images allowed us to reduce the amount of text and say more with pictures rather than words. We understood that these pictures must be straight forward in meaning after our interview with Betsy Loring, Director of Exhibits at the EcoTarium. She explained that a challenge in her job is that exhibits can often be misinterpreted and change in meaning. For example, one display at the EcoTarium showed pollution balls moved by rainfall into runoff. The exhibit was sometimes misinterpreted when the pollution balls started in the clouds and people perceived the display to be about acid rain. We wanted our images to be very straight-forward and not likely to be misinterpreted. During the Pilot Test, most students relied

heavily on the pictures and did not always read the text, further demonstrating the importance of using clear images to convey the concepts of the trail.

We found the future scenarios of the Australia 2030 Trail were not straightforward in conveying the concepts, and the images were too complex and crowded, making them hard to interpret (Figure 20). In our observation of the Australia 2030 Trail, we noticed that students were not noticing all of the information presented on the future boards. A teacher said it would be better if the futures were presented in a narrative. We took this suggestion in forming the futures in the Phase 2 design of the Australia 2050 Trail.

Figure 20: Australia 2030 Trail Future Scenario Board

Our design included a summary of the climate change data, a picture depicting these changes, and a narrative to bring visitors personally into the future. Based on the Pilot Test, the scenario boards were successful in showing the progression of the five scenarios. The pictures illustrated a range of futures, from a world with no pollution and lots of renewable technology to a world filled with smog and oil rigs. We found this helped students realize the difference between each future scenario in the Pilot Test.

The shape of the Phase 1 Australia 2050 Trail decision boards were found to be well suited for displaying information. Each decision in the Phase 1 model included three or four panels with the two side boards angled inwards towards the viewer. This allowed each board to be multi-user because there is room for many visitors to be engaged in the activity, which would provide them with the optimal trail experience. We found the future boards employed a similar style, except they were bigger, curved boards as opposed to flat, angled ones. The

rounded shape was not feasible to build and restricted the amount of visitors who could view each future. We decided to make the future boards flat and angled in a hexagonal shape so that visitors could easily view each future and compare them as well.

We recommend that CERES uses the boards we have designed. Our results showed that our displays were effective in engaging students in the activity and were successful in communicating the idea that we have the power to choose our future. Receiving a great deal of positive feedback, the boards are ready to be implemented on the Australia 2050 Trail. We will provide CERES with all the files, so they can view and edit the boards.

4.5 Durability, maintenance, and cost were all high priorities in creating a feasible design.

In Phase 2 of the Australia 2050 Trail design, our group prioritized feasibility of construction to ensure this design was ready to be implemented at CERES. Currently, the Australia 2030 Trail infrastructure is simple in design and easy to maintain. CERES' staff noted in our Australia 2050 Trail model focus group that these two things must be considered in the design of the Australia 2050 Trail. In terms of maintenance, Ian said, "the shear simplicity of the '2030' is its greatest benefit". Designing for feasibility of construction, we looked into regulations we must consider as well as how to add shrubbery to reduce street noise. We also wanted to reuse as many materials as possible to reduce the cost of this project and lessen resource use, while ensuring durability of the boards for years to come. Finally, the board location was decided based on how CERES wanted to use the space.

During our CERES staff Phase 1 Australia 2050 Trail model focus group, the teachers agreed that the model is something they could see at CERES, however there were many points raised about the durability of this design. Ian mentioned that durability is critical and he questions the durability of this setup to endure years and maintain appearance. The Phase 1 Australia 2050 trail design had many features that would not be protected from the elements. Nick added, "People will unfortunately create some damage… intentionally or unintentionally. It has to be really robust." To accomplish this, Nick raised

the idea of adding overhangs made of recycled wood. In our interview with CERES' contractors, Martin and Renato, we asked what materials would be best for durability and what materials are already available. Martin believed that the Australia 2030 Trail had lasted fairly well at fifteen years old, and we should use cypress pine again. They also suggested we do not paint the cypress pine because the wood has a natural weather resistant seal. Martin and Renato said there is not a lot of extra cypress pine available at CERES, but they can strip the posts from the Australia 2030 Trail and reuse them in construction of the Australia 2050 Trail. We designed the decision boards to have the same dimensions as the existing Australia 2030, keeping in mind the possibility of reusing materials. Martin also suggested we reuse the Plexiglas for the boards to save a large amount of money.

Besides maintaining the boards, CERES' staff mentioned that maintaining the grounds area around the trail is also critical in the design. Since the boards on the Australia 2030 Trail are very simple and set up along the edge of the area, cutting the lawn is incredibly easy. Keeping this in mind, we designed our boards to be similar to the existing Australia 2030 Trail for ease of mowing. After our interview with CERES' contractors, Martin and Renato, we decided that having grass under this trail would be the easiest to maintain overall, since the boards would be easy to mow around and there would not be any weeding necessary unlike a mulch path. A paved path was also considered but it did not fit the look or feel of the trail.

Another suggestion made during our interview with Martin and Renato was to make the boards easy to disassemble so the content could be updated as time passed. The existing Australia 2030 Trail boards must be taken apart to remove the sheets behind the Plexiglas. Renato said, "that's not very user friendly is it?" They suggested we create a mechanism like a picture frame to remove the information sheets. To help with keeping debris out of the board, Renato added, "maybe keep a little space in between the boards and the Plexiglas, aerate a little bit, if anything does get in and drops to the bottom." Martin and Renato showed us boards in the rotunda, another educational area at CERES. The boards were easily changeable because the front pieces of wood around the frame could be unscrewed.

These boards also had extra space between the Plexiglas and the back board, reducing mold and allowing debris to fall to the bottom of the board. These practical considerations helped improve our design so construction of the trail will last for years to come.

At Shane's request, we arranged the boards along the outside of the Energy Park in our prototype (Figure 21). He requested that the boards be placed in a way that allowed for more open space for large groups to move around and eat lunch. We decided to add shrubs along the fence in the prototype in order to reduce street noise and give the trail a more natural look. Reducing street noise was suggested in our CERES' staff focus group and was not considered in previous designs. We also considered regulations at this point because two meters is required between the boards and the fence, so this seemed like the perfect area to add the shrubs. Another regulation we designed around was allowing 1.6 meters between all objects to allow for handicapped accessibility. Considering all these regulations ahead of time made our design much more practical for eventual implementation at CERES.

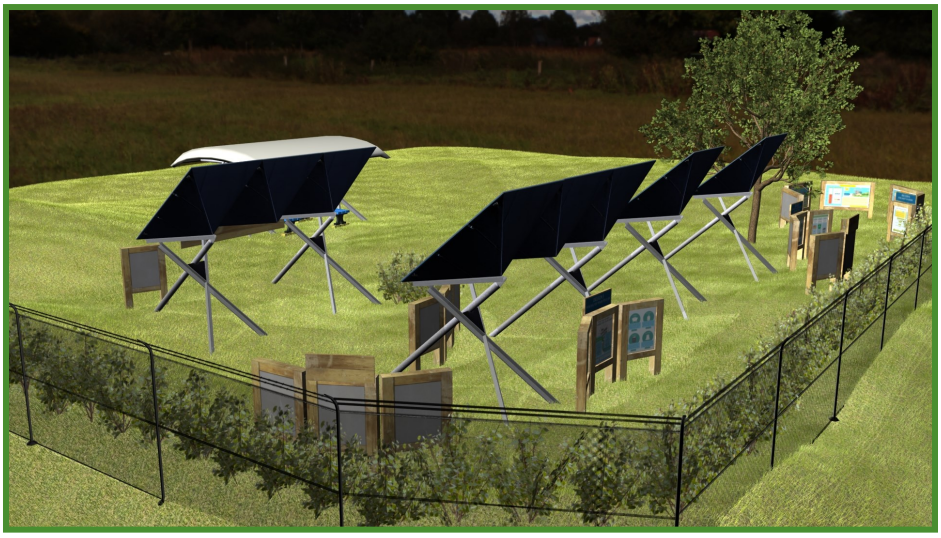


Figure 21: Australia 2050 Trail Phase 2 Virtual Prototype Layout

We recommend that CERES begin construction of the Australia 2050 Trail as laid out in our virtual prototype. An additional suggestion we have is for CERES is to plant slow growing shrubbery around the fence and trail boards in order to reduce the amount of work needed to maintain the space.

4.6 Presentation of the Australia 2030 Trail by CERES teachers was found to be essential to the educational value of the trail.

Through the observations of the Australia 2030 Trail lesson and our Pilot Test of the Phase 2 Australia 2050 Trail design, we noticed that every activity at CERES is greatly dependent on the presentation given by the CERES teacher. Concepts are connected by the teacher and every detail added or lost in the lesson can change the student's take-home message. We found the discussion portion before and after the Australia 2030 Trail activity to be the moment where CERES could take an activity, connect it to the students' lives, and initiate action. We developed a lesson plan to help guide CERES' teachers in running the Phase 2 design of the Australia 2050 Trail. This lesson plan is a reference that does not have to be followed step-by-step but can be modified as CERES' teachers see fit since many teachers vary in style.

The first few days at CERES involved getting some context on how the trail is presented to student groups. We observed three groups year 8 to 9 on the Australia 2030 Trail. Two of the activities were conducted by Ian and one was conducted by Adrian. We made sure to see two different teachers to see the variation in the lesson. The first and third Australia 2030 Trail observation groups were conducted by Ian. We found that his discussion before the activity got students to think about how they will form their future. By asking students their ideal job and how many kids they would like to have, students began to think about their lives in the year 2030. He then asked who wants a house or a car and where those materials will come from. We found this to be a great way to introduce the idea of resources and how everything we use comes from the Earth. Giving the class some independence to go through the decision boards on their own allowed all of the students to be able to see the boards and do the lesson at their own pace. To wrap up the activity, Ian instructed students to stand in front of their futures, giving a visual representation of how the class answered their decisions. To begin the final discussion, Ian asked who liked their

future revealing that most did not. We found that a great way for the students to end this lesson in a more positive way was to ask what they want to see in their future. Students answered they wanted land, water, energy, income, space, clean air, and a manageable population. To initiate action, Ian asked how we can have these positive things in our future and challenged the students to make choices to achieve those positive futures. Ian effectively explained the take-home message that we all have the power to make the right choices for a better future. While observing the second group with Adrian, he explained another concept - that the choices you make as an individual impact the future and other people. The future is not determined by one person's choices but the sum of everyone's choices. We thought this was an important thing to mention as the future scenarios convey the future if everyone made the same choices, so it is not up to one person to shape the future but the entire population. Observing two different teachers allowed us to see the variation in styles at CERES. Both presentations gave the same take-home message, that we all have the power to make the right choices to a better future, but Ian and Adrian highlighted different details of the activity. We kept this in mind when developing our lesson plan. We provided many suggested topics to go over, but the lesson plan is intended as a guide and does not need to be strictly followed.

The Pilot Test further showed the importance of having CERES' teachers explain how to complete the activity and what this activity means. Students can get a future from the activity, but without a CERES teacher to explain what this future means and how students have the capacity to change these futures, part of the lesson would be lost. We incorporated most of the instructions from the lesson plan developed in Phase 1 of the Australia 2050 Trail design, but tailored the lesson plan to fit with our new point system and decision boards. We found that resources were more properly explained in the updated Australia 2050 Trail design because the idea was explained in the beginning of the lesson. Since students wrote their points in boxes labeled with an "R" watermark and added their resource points separately from the "Final Total", they understood that all these materials they are consuming are resources. The "Resource-O-Meter" also allowed students to visually

comprehend how many resources they were consuming.

We felt that the students were successfully engaged in the material as eleven of the students noted in the comment section of the survey following the Pilot Test that the activity was fun. The average rating that students gave the activity, on a scale of 1 to 5 (with 5 being really fun and educational) was a 4. Most importantly, the question pertaining to whether students will be reconsidering their choices after leaving CERES resulted in 67% of students saying yes, they will be reconsidering. We found that they understood the concept being taught by CERES' teachers because they understood that their choices needed to change in order to achieve a more sustainable future.

We recommend that CERES uses the lesson plan provided in this report to run the Australia 2050 Trail as it is outlined in a fashion similar to how the Australia 2030 Trail is currently being operated. The similarity was shown to be useful by Ian's ability to adapt to the new material quickly for the Pilot Test and will allow CERES to implement this lesson plan efficiently with the other teachers.

5 Conclusions

From our final interview with our sponsors, Shane French and Ian Culbard, we conclude that the Phase 2 Australia 2050 Trail design is ready to be implemented at the Centre for Education and Research in Environmental Strategies (CERES). Both our sponsors agreed that we have successfully taken the concepts developed in Phase 1 of the Australia 2050 Trail design and simplified them into a functional activity that is ready to be in-place at CERES. Expressing how much we accomplished, Shane said that our designs are printable and ready to be used, something they did not expect us to achieve. Feedback on the final decision boards included that we were successful in pairing back the choices to an honest and usable form. There are a lot more items that could have been included, but our choice to simplify the activity was recognized and made the activity effective for both students (year 5 to 10) and adults. When asked what else they would like to see in the design, both Shane and Ian noted they would like more tactile, 3D elements included, but they understood that the design delivered was more feasible to construct at CERES because of its resistance to weather. Their final note on the design was that they were very excited for the opportunities it can bring to CERES. The ability to take the Phase 2 Australia 2050 Trail prototype and use it online really excites Shane and Ian as it gives CERES the chance to reach to a larger audience.

Our project includes several deliverables to aid CERES in moving forward with construction. We are delivering the following materials:

1. Australia 2050 Trail Activity Sheet (.pdf, .indd) (Appendix D)
2. Australia 2050 Trail Instruction, Decision, and Future Board Designs (.pdf, .indd) (Appendix I)
3. Australia 2050 Trail Virtual Trail Prototype Screenshots (.pdf) (Appendix N)
4. Australia 2050 Trail Virtual Trail Prototype (.mb, .ascii, .tiff)
5. History of Energy Timeline (.pdf, .indd) (Appendix R)
6. Australia 2050 Trail Lesson Plan (Appendix Q)

With these items, CERES will be able to make any final adjustments they deem fit. We suggest at least one classroom set of the activity sheets (about twenty-five) should be printed on standard A4 paper and laminated for reuse. Dry erase markers should be purchased to accompany these laminated sheets. The instruction, decision, and future board posters should be printed at a print shop and laminated to ensure durability. The dimensions of the decision and future posters are outlined in Appendices J and L respectively, and the appropriate files have been given to CERES to easily print them. CERES can then begin disassembling the Australia 2030 Trail and reuse any materials that are salvageable for the construction of the Australia 2050 Trail. The dimensions of the decision and future board frames are illustrated in Appendices K and M respectively. These drafts should be given to CERES' contractors, Martin and Renato, to begin construction. In order for CERES to view the layout of the Phase 2 Australia 2050 Trail, we provided them with screenshots of the virtual trail (see Appendix N) as well as the original files if they wish to further edit the trail prototype. An optional History of Energy Timeline suggested by the Phase 1 group of the Australia 2050 Trail and requested by CERES can be implemented into the Energy Park where CERES sees fit. We recommend not necessarily including the timeline in the Australia 2050 Trail, in order to not disrupt the thought processes of placing ourselves in the year 2050. The timeline file has been delivered to CERES and is depicted in Appendix R. We attached the lesson plan in Appendix Q, which should be given to CERES' teachers to review before running the Australia 2050 Trail.

The final deliverables, outlined above, will assist CERES in motivating visitors to improve their lifestyle choices with the intention of benefiting the environment. After completing the activity, we want visitors to see that they have the power to make the right choices for a better future, thus initiating action to mitigate climate change as visitors leave CERES.

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Appendix A – Preamble

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting interviews, surveys, and focus groups with the Centre for Education and Research in Environmental Strategies (CERES) to gain feedback on our efforts to redesign the Australia 2050 Trail. This research is giving our group valuable information on how to refine the trail, and your participation is greatly appreciated. Our ultimate goal is to motivate visitors to improve their lifestyle choices with the intention of benefiting the environment and your insights will be extremely useful.

Your participation in this study is voluntary and you may withdraw at any time. If you would like, we would be happy to include your comments as anonymous. If interested, we can send you a copy of our final report if you leave us with your email address.

Appendix B – Australia 2050 Trail Phase 1 Decision Questions sent to WPI Students

Where is your house?

- City
- Inner-suburb
- Outer-suburb
- Countryside

What type of house do you have?

- Big house (only in outer-sub and countryside)
- Medium house (not in the city)
- Small house
- Apartment (only in the city)
- Terrace
- Mobile home

What goods do you want?

- Dish Washer
- Washer
- Dryer
- Refrigerator
- Central Air Conditioner
- Heater
- Microwave
- Stove/Oven
- Pool
- Hot Water Service
- Other
- Electronic toys/Entertainment
- Computer
- TV
- Game Console
- Tablet
- Cell Phone
- Camera
- Cable
- Blu-Ray/DVD
- Other

How will you get around?

- Bus
- Train
- Tram
- Bicycle
- Foot
- Other (Skate,Scooter,etc.)
- Eco (solar, hydro, electric)
- Semi- Eco (Hybrid)
- Non-Eco (Petrol)

How do you plan on traveling for holidays?

- Plane
- Boat
- Car
- No traveling

What type of food do you plan to eat?

- 100% locally grown/ 0% packaged
- 86% locally grown/ 14% packaged
- 71% locally grown/ 29% packaged
- 50% locally grown/ 50% packaged
- 43% locally grown/ 63% packaged
- 29% locally grown/ 71% packaged
- 14% locally grown/ 86% packaged
- 0% locally grown/ 100% packaged

How often are you going to eat animal based products?

- None (Strictly Vegan)
- Infrequently (Lacto- vegetarian)
- Almost infrequently (Vegetarian)
- Often
- Very Often
- Always

How will you power your life? Large house: maximum of 2 sources from the renewable and 2 sources from non-renewable, Medium house: maximum 2 sources from renewable or non-renewable, Apartment: maximum of 1 source from renewable or non-renewable

- Solar (renewable)
- Hydro (renewable)
- Wind (renewable)
- Geothermal (renewable)
- Biomass (renewable)
- Coal (non-renewable)
- Natural Gas (non-renewable)
- Petrol Oil (non-renewable)
- Nuclear (non-renewable)

Appendix C – Focus Group Notes on Australia 2050 Trail Phase 1 Model with CERES Teachers

Date of Focus Group	*October 29, 2014*
Location of Focus Group	*WPI team room in the Quarry Hut*
Number of Participants	*4 total – Nick, Ian, Marty, Arwen*
Category of Group	*CERES teacher*
Moderator Name	*Tim Biliouris*
Asst. Moderator Name	*Jenny Eastaugh, Ash Nagpal, Dan Driggs (secretary)*

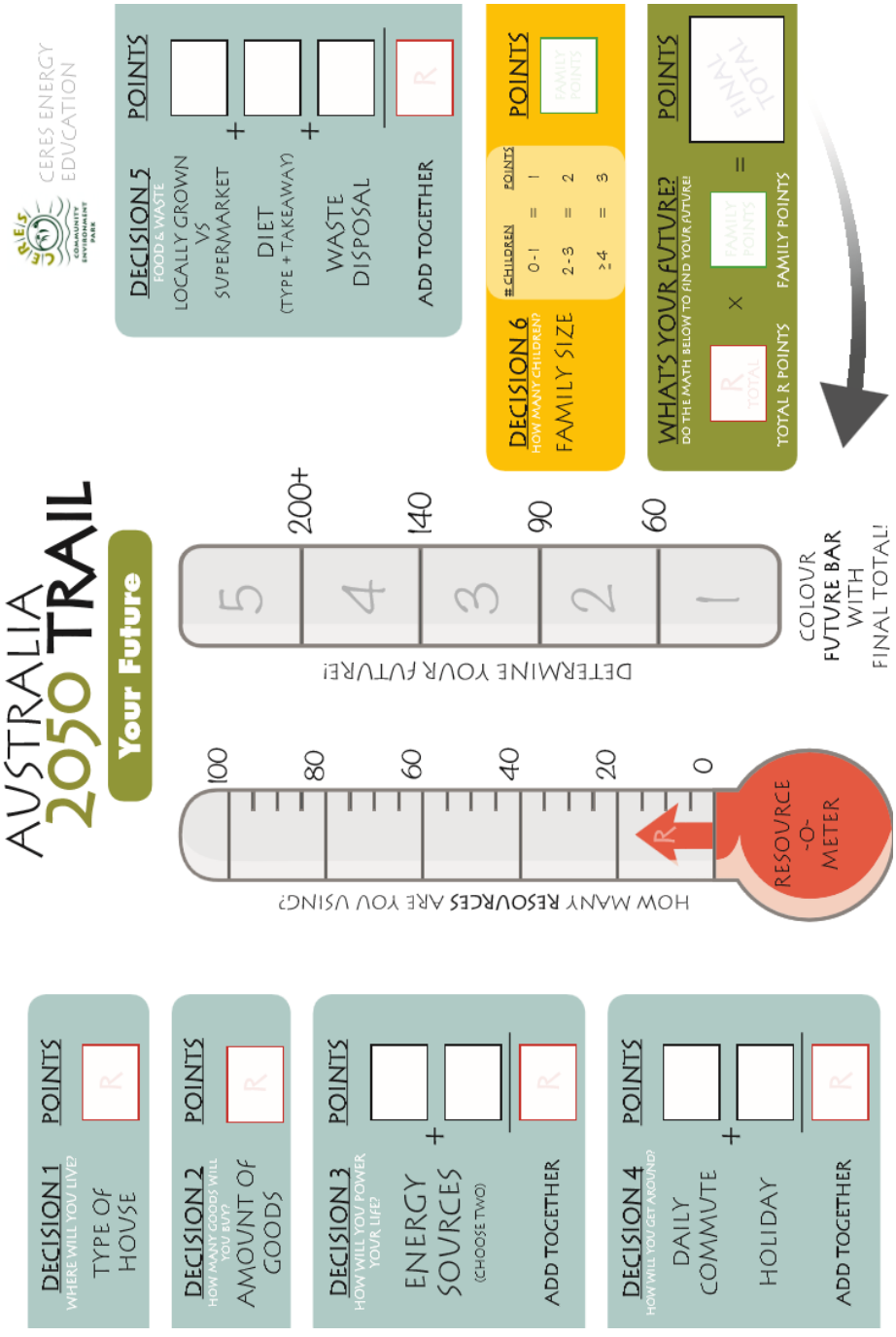
Brief Summary/Key Points	Notable Quotes
Is the 2050 model something they could see at CERES? • Nick said it is definitely something he could see at CERES • Nick noted issues of durability and sound as the busses in the afternoon are loud • Ian said that the durability of the trail is critical • Nick noted that we need to think about how we can maintain the facility	**Tim** - "Could you picture this at CERES?" **Nick** - "I'd reckon it'd be great!" **Nick** - "Include a space where you can sit in a group…It's nice to have a space where you can get out of the weather without having to totally leave" **Ian** – "Durability is critical" "I questions the durability of this setup to endure years and maintain appearance" **Nick** – "People will unfortunately create some damage… intentionally or unintentionally. It has to be really robust" **Nick** - "We have to think about spaces and how we could actually…you would actually maintain the facility" in terms of how we would mow **Ian** – "The shear simplicity of the '2030' is its greatest benefit" **Ian** - "It needs a bit of protection like the market with the overhang using recycled wood to give it a bit of protection.

Incorporating different age groups	**Nick** - "In terms of design we want secondary and tertiary students to be able to go back through." **Marty** – "If you could simplify and make a senior sheet and a junior sheet, you could make the senior one as complex as you like" **Arwen** – "One thing we talked about having was a flip-chart" **Ian** – "People are always looking for something to interact with or something to do beyond just buying veggies"
Tim asked about the issue of people cheating or beating the system • Non-issue • Symbols over complicate the sheet and do not influence student's choices • Move back to points for clarity • Could modify scoring system to show how good your choices are by category • Point update	**Arwen -** "I haven't actually found that to be a problem when I teach the class. Nobody thinks 'I want a lower score'. Everyone gets really high scores. So if this makes that more complicated I would just go back to numbers personally because from my experience that is not an issue." **Ian** – "That's part of the teaching of it - if you give it all away at the beginning you'll skew the results. You want people to go in open to their decisions." "I agree with you [Arwen], if it makes it complex then it's not a tool to convey the idea." **Arwen** – "People don't want to cheat. They get the low scores anyway and if they do it's one person in the class. It's not worth catering for the one person in the class out of 100 who try to cheat". "In a way that's good if they're thinking about the activity." **Ian** – "You want them to go back through not cheating but modifying [their answers]." **Arwen** - "This is just complicated just looking at it [the activity sheet], not even reading it." "Just do the numbers, I would."
Point Update • Weight factors proposed - Ian agreed	**Marty** - "Maybe when you add up sheet with the scores instead of just saying your values and sums you could have a table with what's your waste score your water score out of you know, this way they could identify their scores with how well they managed their housing or how well they managed their food choices" **Ian** – Considering point factors in the weighing system, Ian agreed. "A greater concept of what really makes a difference." **Ian** - "I do have a feeling that this a bit complex" in regards to the symbol point system. "You need to maintain the concept as you follow through with the sheets" So that you know which of your choices are good and which ones are bad

Virtual trail concept • Introduced by Ian • Potentially use in meantime before 2050 is constructed	**Ian –** "It has been brought up that we completely abandoned the whole concept of a physical thing and just do it online like an eco-footprint calculator. We could completely scrap the whole 2050 physical display and create an online resource that schools can pay to use. They come to CERES and get a code." "It has big capacity to deliver as a concept". "I do like the idea of a physical thing as well. I'd be very sad if that was scrapped." Idea from Ian - Be able to download the activity sheet if you're a CERES member to promote membership (38:30)
Sheet update • Materials • Re-usable	**Ian** – "Laminated sheets seem to work pretty well." "We need a set of 30" "Dry erase would be much better than the water base because the water base ones get quite messy. We have quite a number of programs that use them." "We actually have to wash it off". Too much time to setup for CERES stuff - 24:30 "Laminate so we can erase" **Marty** – "Combine into one sheet for a smaller footprint" **Nick** – "have the ability to go back through"
Adding/Removing Questions • Agree with losing immigration • Add back population • Add waste question • Common issues with questions	**Nick** – "Immigration didn't make much sense. To me it would be a little bit of a shame to totally lose population." **Ian** – Create a disclaimer for how you would dispose the packaged food - 27:30 "It would be a good thing for them to consider" [in regards to waste disposal] "It wouldn't hurt to have the extra questions." **Ian** - "Population is massive. This is all because of population. The entire piece and everything we do at CERES is human impact and human impact in a bigger population is unsustainable. It's really everything" **Marty** – "It's a fairly simple question that could be answered easily, what family size you want." "It's not going to impact the length of the lesson." **Ian** – "It's the single most important thing in terms of human impact" "I get the concept of immigration being put down." **Ian** - "There's two things that catch them out; one where there are 17 choices and realizing that you can choose every one. And like I said the last one, the cross references."

Final impressions from Ian • Doable especially with potential funds • Possibly in next 12 – 24 months	**Ian** - "It's not to say that this is how it is" ---- Freedom to move past model **Ian** - "That's part of the project; it's to assess the value of this and the usability... the functionality." **Ian** - "I do like this...and especially having the covers over it." In regards to the tech heavy museum displays **Ian** - "As soon as we go down that road we have lost our uniqueness" in regards to technology **Ian** - "The more I sit here looking at this the more I think 'yes, it's quite doable" "We've recently received a pretty substantial grant for energy education."

Appendix D – Australia 2050 Trail Phase 2 Activity Sheet



Appendix E – Questions for School Teachers on Australia 2050 Trail Phase 2 Activity Sheet

1. **Do you think your students enjoyed the 2030 trail and understood the message it was trying to convey about how their choices shape the future?**
   - I think so - BG
   - The students did enjoy the trial. They were able to dream big and see what their choices would do to the environment. It was interesting that some would change their decisions to have less impact on the environment whilst others were going to still make the same choices. it would be interesting to see if in future they actually followed through either way. - PK
   - Yes. It was simple to follow and provided a clear message - JF
   - Yes and no. The ideas behind the activity were great, although the subtle variations between each future (A, B, C, D, E etc) were a little bit unclear for the students. This meant that they were unable to fully grasp the fact that their choices have the potential to change the outcome for the planet. – MH
   - Yes - KD
2. **Does the trail relate to subjects taught in your class?**
   - Not a great deal as I teach maths. They are dealing with quantities and numbers. - BG
   - Currently the students are involved in a 'CIVIC' project and this is looking at the seven values that the school has. The aim is to look at these values and give them more meaning by seeing what the broader community does and 'how' the students can make a difference in our own school environment. - PK
   - Indirectly; it ties in with the school's city curriculum. We have also discussed issues around the future and sustainability - JF
   - We toured CERES as part of a cross-curricular project that students are currently completing with Humanities and English. Next year I hope to incorporate Science and Maths into the project. The trail would relate to Humanities and Science very well. - MH
   - Yes - KD

3. **What are some strategies to you use to reinforce lessons taught in your class?**
   - Questioning and tests. - BG
   - When students are back in the classroom they need to come up with a proposal using the 7 school values. They need to use their findings and data collection from their various excursions to support their proposal. Eg Respect for their environment. (Value) Checking that lights are switched off in unused classroom. (Proposal) Data collection and excursion to CERES as an example of what the wider community can be involved in, in order to make a change. - PK

- Feedback - peer and self - JF
- Here are my ideas for strategies for the trail: 1. Students start by writing down/ describing their perfect future world. What do they want for the economy? What do they want for the environment? What do they want for their quality of life? What do they want in terms of population growth?) You could even have this activity done with tick-boxes that correspond to the outcomes of each future (e.g.) 2. Students fill in their 'scores' for each category 3. Students find their corresponding future and have to record the key attributes of this future on their sheet (i.e. They have to fill in 'Average population age', etc...). This would enable them to take home a summary of their 'future'. 4. Students return to the large group and compare futures. They should have to line up in order and then articulate the differences between theirs and others' futures. - MH
- Use of YouTube clip "The Story of Stuff"; discussion of eco-footprint, food miles and statistics on waste. Also looked at biomes and food security. - KD

4. **Do you think the attached sheet is better than the one used during the activity in terms of its clarity and presentation?**
   - It certainly looks clearer. - BG
   - Yes Easy to see without having too many instructions. - PK
   - Not really. It is a bit more complicated to look at, less self-explanatory. More detail though. - JF
   - Yes - far more visually appealing. I think the information boards are also in need of a re-vamp and would be happy to have a look at new designs if you need some teacher input. - MH
   - Yes. - KD

5. **What do you particularly like or dislike about this new sheet?**
   - It is a bit brighter and clearer. - BG
   - I like that it is simplistic and easy to understand. - PK
   - It is less clear than the original. - JF
   - The colours/design. It looks far more modern. On the back of the sheet, it would be good to have space for them to a) Describe their perfect future world and b) Summarise key aspects of the future they ended up with. Good luck! - MH
   - Colour and layout is engaging and encourages different thinking strategies. Temperature graph communicates the 'hot' issues of resource use and management. - KD

Appendix F – Interview with Betsy Loring, Director of Exhibits at Worcester EcoTarium

1. **What was your role in the implementation of the EcoTarium's trails?**
   She came into design half-way during the prototyping stage. She had to consider the durability of the trail and especially resistance to insects. Beverly Surrelll, another EcoTarium employee, created the exhibit text "labels". Betsy stressed the importance of these labels in framing perception of what we are looking at and showed us a few examples.

2. **What were some of the main challenges when designing this trail?**
   Weather was a challenge. Considering the reset of mechanical exhibits was another challenge. The reset of the device could change the meaning as shown in the run off pollution display. The pollution balls went into the clouds making them appear as possibly acid rain instead of having them appear washed off the street with the rain. Another example of changes in perception was a label that said "save the plants" people misread as "save the planet" and thought the exhibit was somehow space related.

3. **What are some key characteristics of a successful interpretive trail?**
   Incorporating families, parents get involved by reading text while the kids do the sensory activities.

4. **What have you incorporated in past designs to make them interactive?**
   We explained our project and Betsy gave us some ideas.
   - Idea to subtract elements when you make a better decision
   - If you choose a big house, they should physically carry more
   - Balance object on ruler so they can only hold so much
   - "Gamify" the activity to add a competitive element

Appendix G – Interview with Martin and Renato, CERES contractors

First, we presented our virtual design in its current state and walked up to the trail

1. **Do you think this design is feasible? What should be our main concerns?**

   Martin and Renato said our design seems feasible but we should highly consider maintenance of the grounds. We discussed different options for the ground including grass, mulch, and pavement. A grass path would need regular mowing, a mulch path would need weeding, and a pavement path would not fit with the look or feel of the trail. Martin said, "Well in terms of maintenance, putting a mulch path in would certainly look good but that is a lot of maintenance. Weeding it and topping it if you do mulch. Right now we just come in mow it every now and then." They concluded that a grass path would be best option to keep the trail low maintenance.

2. **What regulations should we consider in design? (Handicap accessibility, distance from fence, etc.)**

   When asked about our idea to start between the solar panels, Renato replied, "Yeah it makes sense, it makes a lot of sense to walk through." Jenny asked if there is enough room to walk through considering handicapped accessibility, and Renato said, "I think so."

   Ash asked if there are there any regulations with how close you can install shrubs inside the fence, and Martin answered, "Not really, we are actually meant to have two meters of green space around the boundary and CERES itself."

3. **What materials should be used to ensure durability?**

   Since the current trail has lasted fifteen years, Renato suggested we used the same material – cypress pine. Martin and Renato added to we should not paint it as the wood has a natural weather resistant seal.

4. **What materials are available already and could be recycled for this project?**

   Renato said there is not a lot of excess cypress pine to use. Martin suggested we re-use the Plexiglas for the boards which would be easy considering our design uses the same board dimensions. One more recommendation from Renato was to strip and recy-

cle some of the old posts.

5. **How long would this take to do approximately?**

   Martin and Renato approximated it would take 3-4 days to make the boards and 3-4 days to put them into place.

6. **Final recommendations and concerns.**

   We asked Martin and Renato if it would be easy or even feasible to move the Energy Spark trailer, and Martin said, “yeah it’s on wheels so I don't see why not”.

   We inquired if the posts which previously held up a shade sail would be movable at all since we wanted to place future boards in that area. Renato said, “They are pretty much concreted in. So you will have to basically cut it off”. Martin said it would be “easier to design around it” with which we agreed. This also lets us easily have a covered area if we attached a sail back on top.

   While discussing the boards Martin and Renato noticed they have to be taken apart to remove the sheets behind the Plexiglas. Renato said, “that’s not very user friendly is it”. They suggested we create a mechanism like a picture frame to remove the information sheets. To help with keeping debris out of the board, Renato said, “maybe keep a little space in between the boards and the Plexiglas, aerate a little bit, if anything does get in and drops to the bottom”. The showed us boards in the rotunda, another educational area at CERES. These boards had that extra space between the Plexiglas and the back board and they were easily changeable because the front pieces of wood around the frame could be unscrewed so that the materials inside could be updated. Martin said they are really easy to maintain, “Take a few screws out.. take out debris out and you’re good”.

Appendix H – Australia 2050 Trail Point System

D1 - Where will you live?		D2 - How many goods will you consume?		D3 - How will you power your life?	
Choose a Home	**R Pts**	**Pick 1 of the following lifestyles**	**R Pts**	**Pick 2 Energy Sources**	**R Pts**
City- Small House	10	Minimal Goods	10	Renewable - Solar Power	4
City - Terrace	9	Moderate Goods	15	Renewable - Hydro Power	4
City - Apartment	8	Many Goods	20	Renewable - Wind Power	2
Inner Suburbs - Medium House	14			Renewable - Biomass Power	4
Inner Suburbs - Small House	12				
Inner Suburbs - Terrace	10			Non-renewable - Coal Power	15
Outer Suburbs - Large House	18			Non-renewable - Natural Gas Power	10
Outer Suburbs - Medium House	16			Non-renewable - Petrol Oil Power	12
Outer Suburbs - Small House	14			Non-renewable - Nuclear Power	12
Countryside - Large House	20			**Restrictions**	
Countryside - Medium House	18			Large home = at least one non-renewable	
Countryside - Small House	16			Many goods = at least one non-renewable	
				Large Home and Many Goods = 2 non-renewables	

D4 - How will you get around?				D5 - How will you consume your food and dispose of your waste?					
Commute	**R Pts**	**Vacation**	**R Pts**	**Where will your food come from?**	**R Pts**	**What type of diet will you have?**	**R Pts**	**How will you dispose of your waste?**	**R Pts**
Self (Walk, Bicycle, etc.)	0	Plane	12	All Locally Grown	2	Vegan	1	Compost + Recycle	1
Bus	12	Cruise Ship	9	Mostly Locally Grown	4	Vegetarian	2	Recycle + Rubbish	3
Train/Tram	9	Car	4	Mostly Supermarket	8	White Meats	4	All Rubbish	6
Electric/hydro/ solar Car	9	Local	0	All Supermarket	10	Everything	8		
Hybrid Car	12					PLUS			
Petrol Car	18					No take away	0		
						Some take away (3-7 meals)	4		
						Lots of take away (8-13 meals)	6		
						All take away (14+ meals)	8		

D6 - How many children do you want to have?	
Family Size	**Family Points**
0 - 1 Child	1
2 - 3 Children	2
4 or more Children	3

What's your future?	
Total **R** x **Family Points** = Final Total	
Future Scenario	Final Total
1	0-59
2	60-89
3	90-139
4	140-199
5	200+

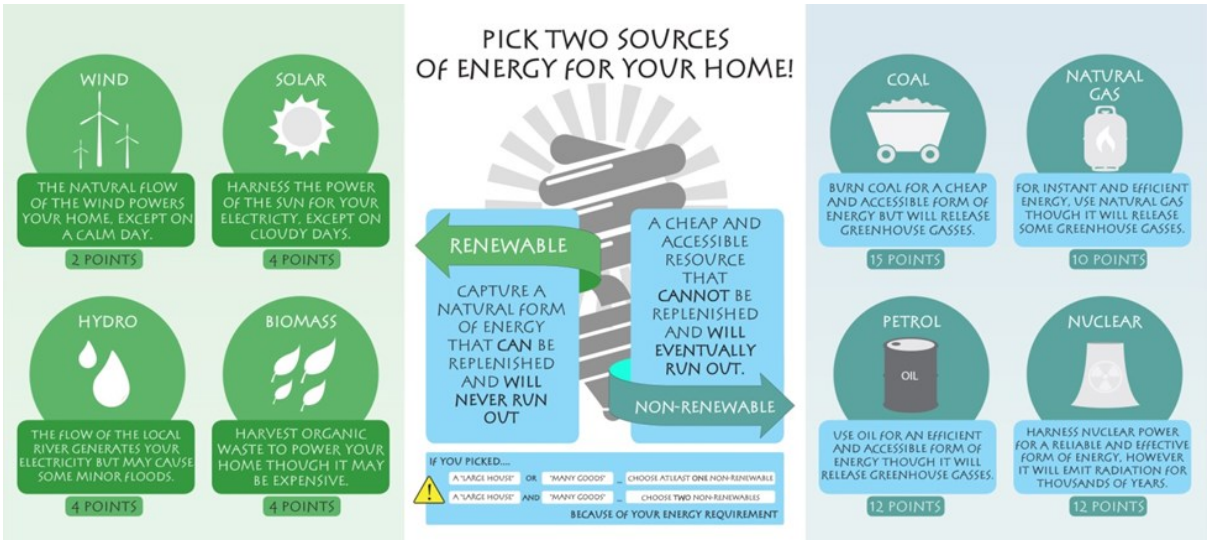
Appendix I - Australia 2050 Trail Phase 2 Instruction, Decision, and Future Board Designs

Instruction Board

Decision 1 – “Where will you live?”

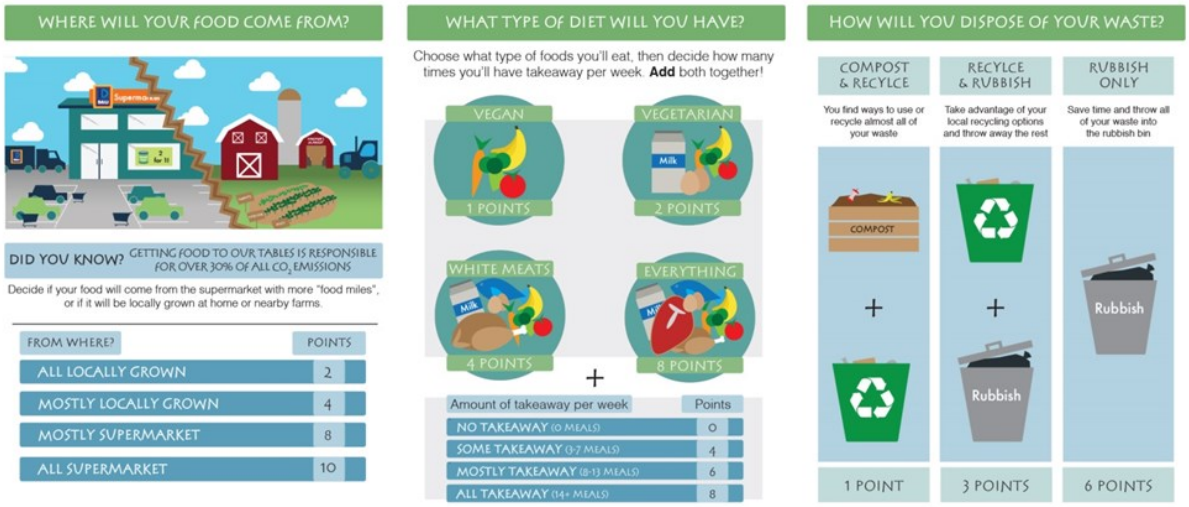
Decision 2 – “How many goods will you buy?”

Decision 3 – "How will you power your life?"

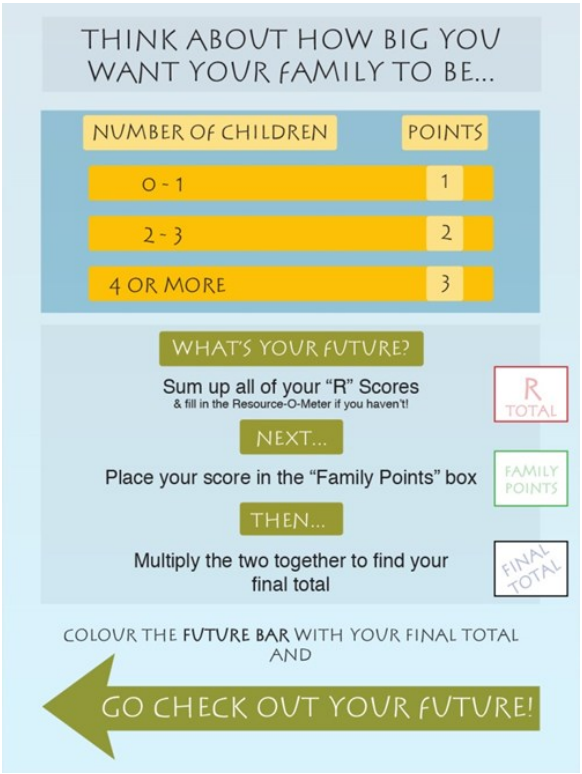


Decision 4 – "How will you get around?"

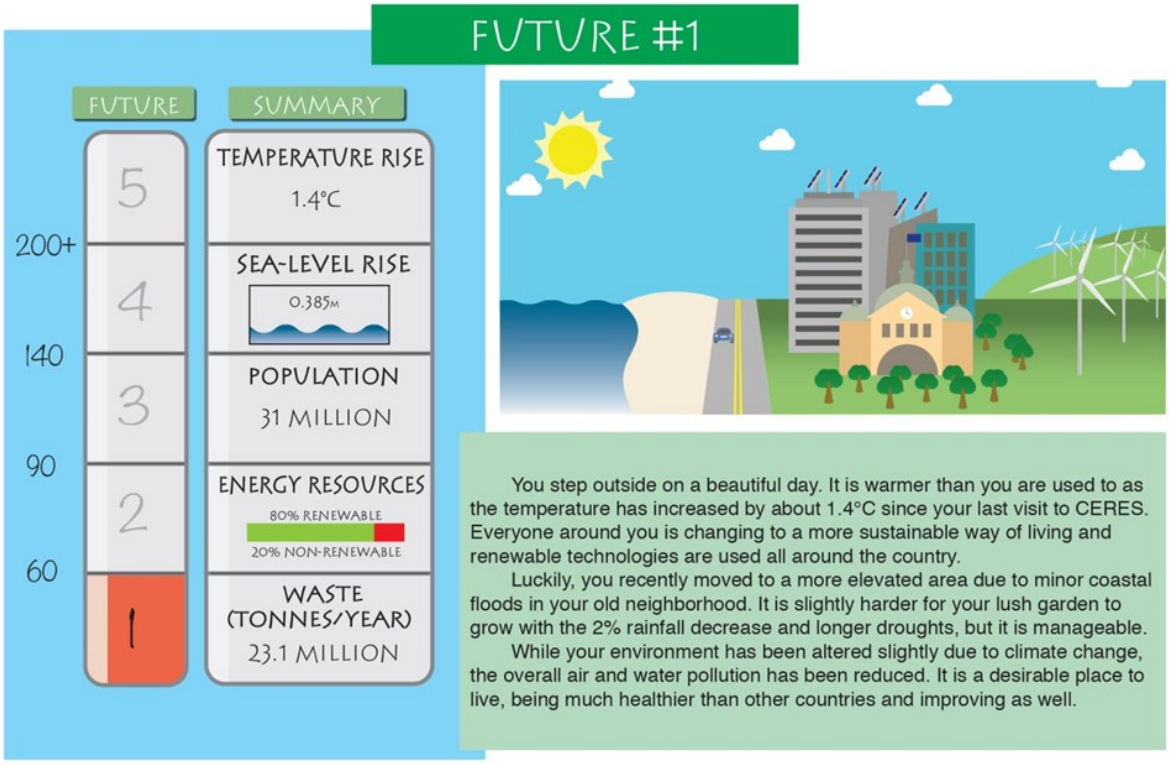
Decision 5 - “How will you consume food and dispose of waste?”



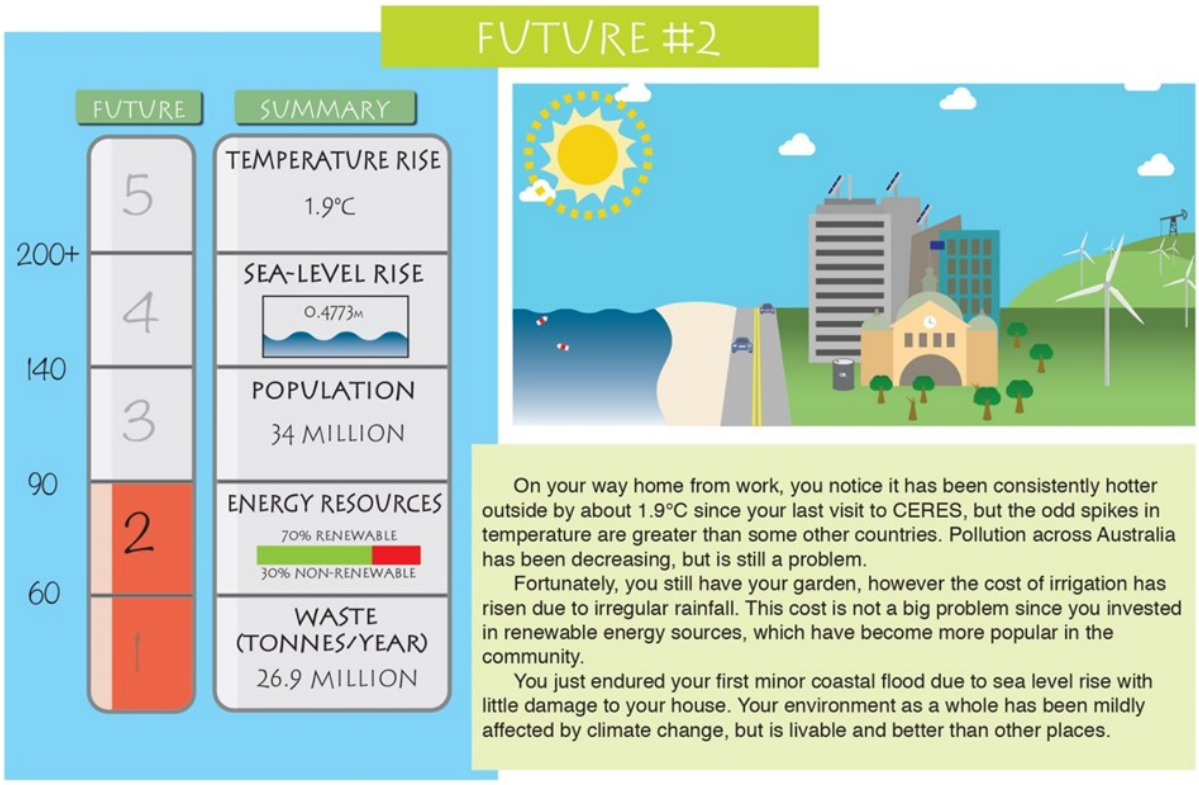
Decision 6 – “How many children will you have?”



Future #1


FUTURE #1
FUTURE
SUMMARY
5
4
3
2
1
200+
140
90
60
TEMPERATURE RISE
1.4°C
SEA-LEVEL RISE
0.385M
POPULATION
31 MILLION
ENERGY RESOURCES
80% RENEWABLE
20% NON-RENEWABLE
WASTE (TONNES/YEAR)
23.1 MILLION
You step outside on a beautiful day. It is warmer than you are used to as the temperature has increased by about 1.4°C since your last visit to CERES. Everyone around you is changing to a more sustainable way of living and renewable technologies are used all around the country.
Luckily, you recently moved to a more elevated area due to minor coastal floods in your old neighborhood. It is slightly harder for your lush garden to grow with the 2% rainfall decrease and longer droughts, but it is manageable.
While your environment has been altered slightly due to climate change, the overall air and water pollution has been reduced. It is a desirable place to live, being much healthier than other countries and improving as well.

Future #2

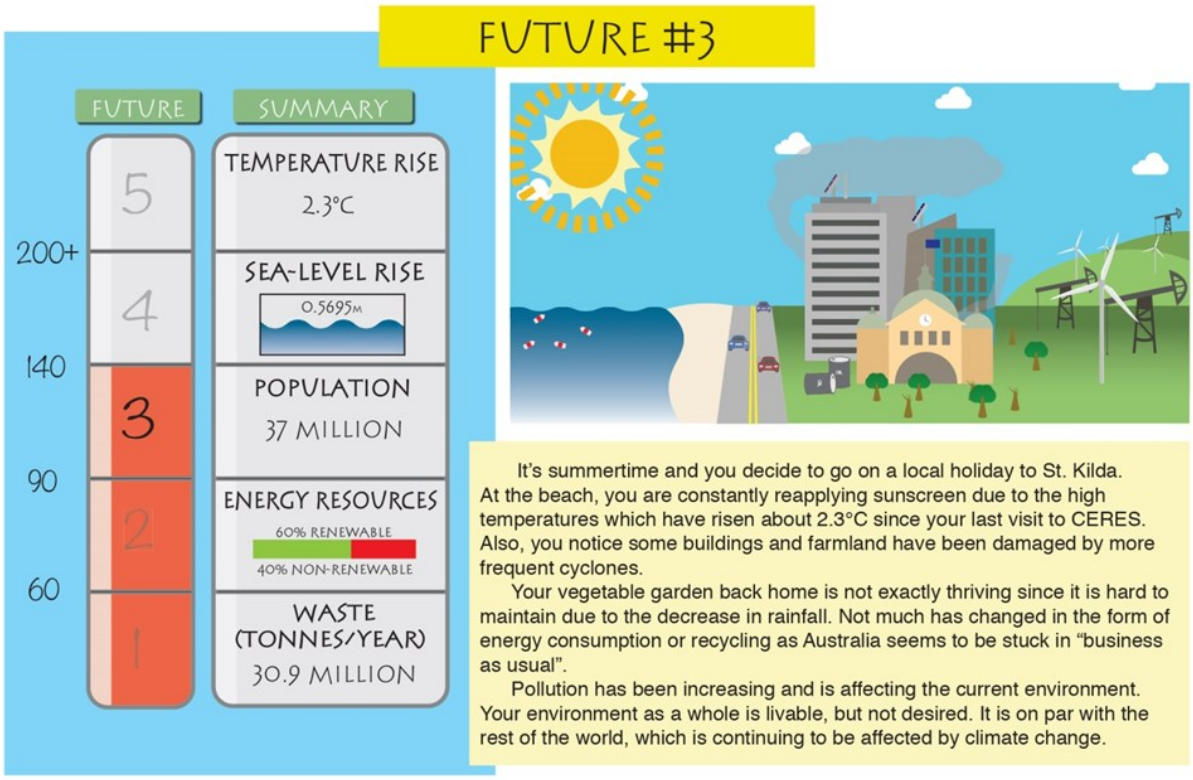


On your way home from work, you notice it has been consistently hotter outside by about 1.9°C since your last visit to CERES, but the odd spikes in temperature are greater than some other countries. Pollution across Australia has been decreasing, but is still a problem.

Fortunately, you still have your garden, however the cost of irrigation has risen due to irregular rainfall. This cost is not a big problem since you invested in renewable energy sources, which have become more popular in the community.

You just endured your first minor coastal flood due to sea level rise with little damage to your house. Your environment as a whole has been mildly affected by climate change, but is livable and better than other places.

Future #3

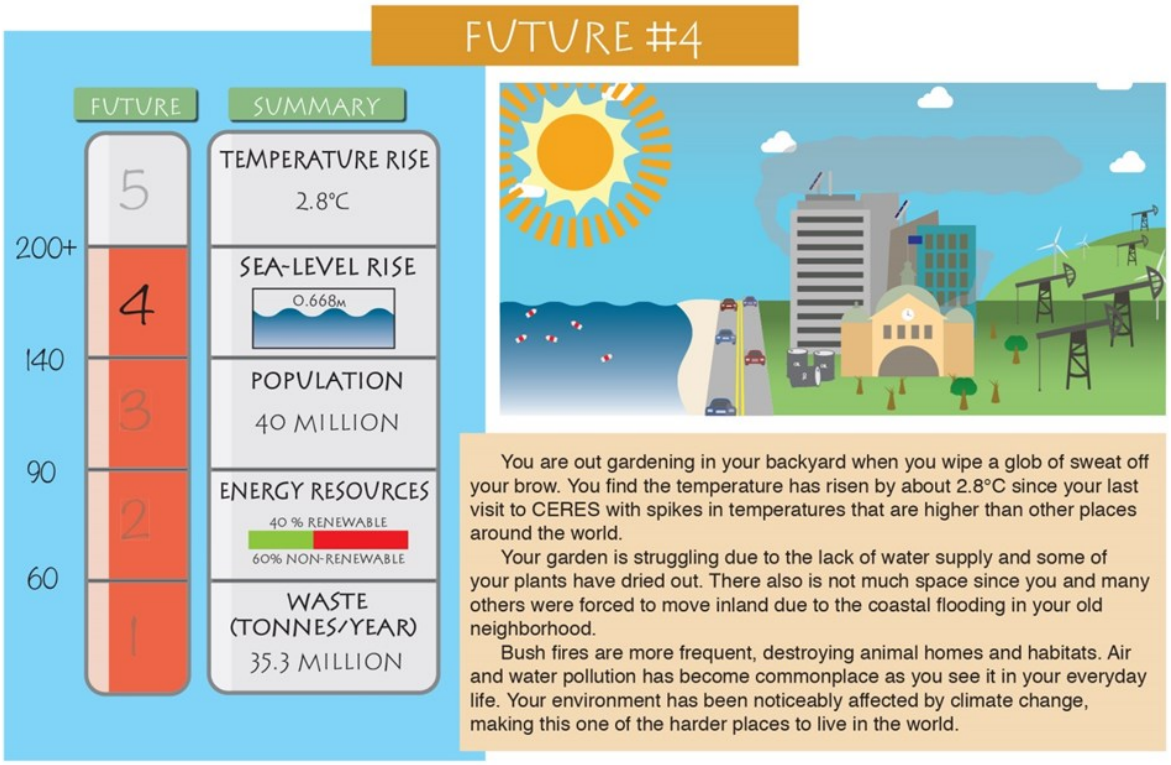


It's summertime and you decide to go on a local holiday to St. Kilda. At the beach, you are constantly reapplying sunscreen due to the high temperatures which have risen about 2.3°C since your last visit to CERES. Also, you notice some buildings and farmland have been damaged by more frequent cyclones.

Your vegetable garden back home is not exactly thriving since it is hard to maintain due to the decrease in rainfall. Not much has changed in the form of energy consumption or recycling as Australia seems to be stuck in "business as usual".

Pollution has been increasing and is affecting the current environment. Your environment as a whole is livable, but not desired. It is on par with the rest of the world, which is continuing to be affected by climate change.

Future #4

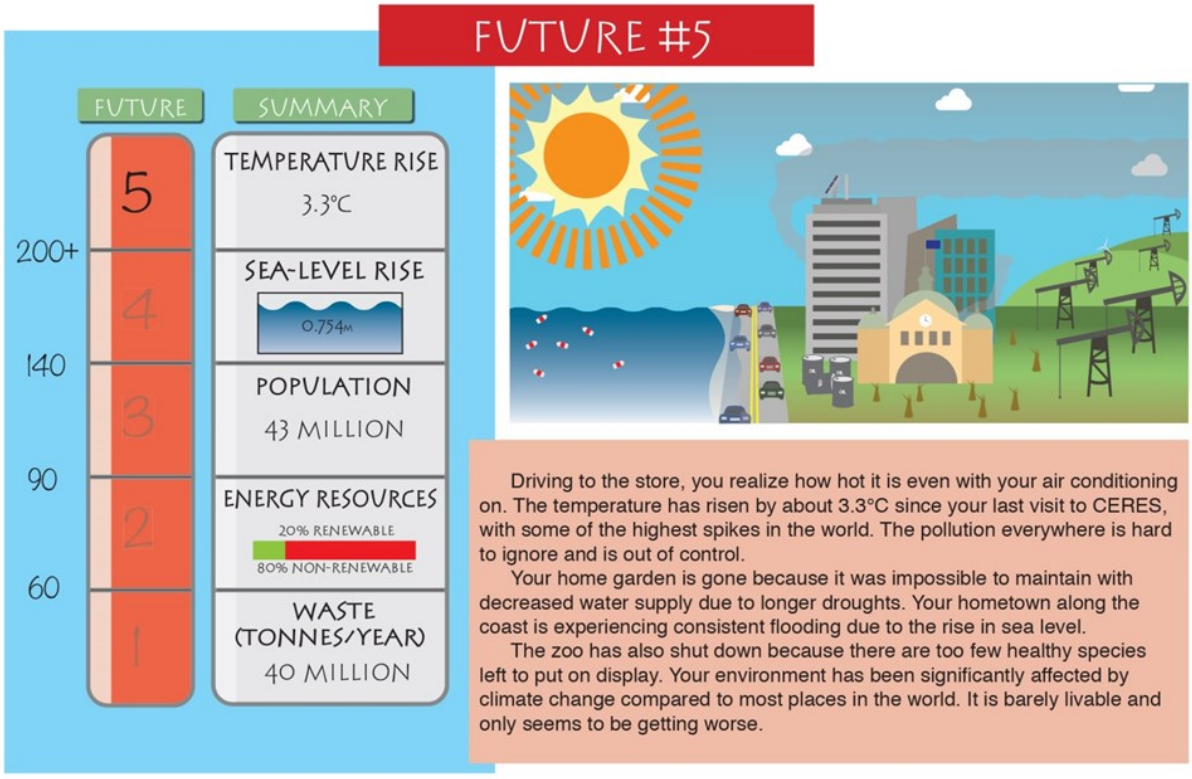


You are out gardening in your backyard when you wipe a glob of sweat off your brow. You find the temperature has risen by about 2.8°C since your last visit to CERES with spikes in temperatures that are higher than other places around the world.

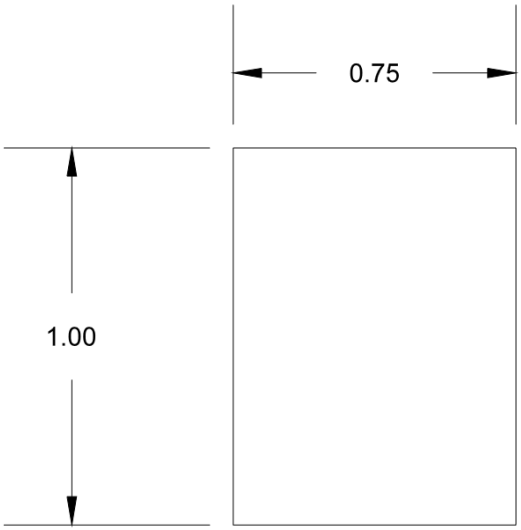
Your garden is struggling due to the lack of water supply and some of your plants have dried out. There also is not much space since you and many others were forced to move inland due to the coastal flooding in your old neighborhood.

Bush fires are more frequent, destroying animal homes and habitats. Air and water pollution has become commonplace as you see it in your everyday life. Your environment has been noticeably affected by climate change, making this one of the harder places to live in the world.

Future #5


FUTURE #5
FUTURE
SUMMARY
5
4
3
2
1
200+
140
90
60
TEMPERATURE RISE
3.3°C
SEA-LEVEL RISE
0.754M
POPULATION
43 MILLION
ENERGY RESOURCES
20% RENEWABLE
80% NON-RENEWABLE
WASTE (TONNES/YEAR)
40 MILLION
Driving to the store, you realize how hot it is even with your air conditioning on. The temperature has risen by about 3.3°C since your last visit to CERES, with some of the highest spikes in the world. The pollution everywhere is hard to ignore and is out of control.
Your home garden is gone because it was impossible to maintain with decreased water supply due to longer droughts. Your hometown along the coast is experiencing consistent flooding due to the rise in sea level.
The zoo has also shut down because there are too few healthy species left to put on display. Your environment has been significantly affected by climate change compared to most places in the world. It is barely livable and only seems to be getting worse.

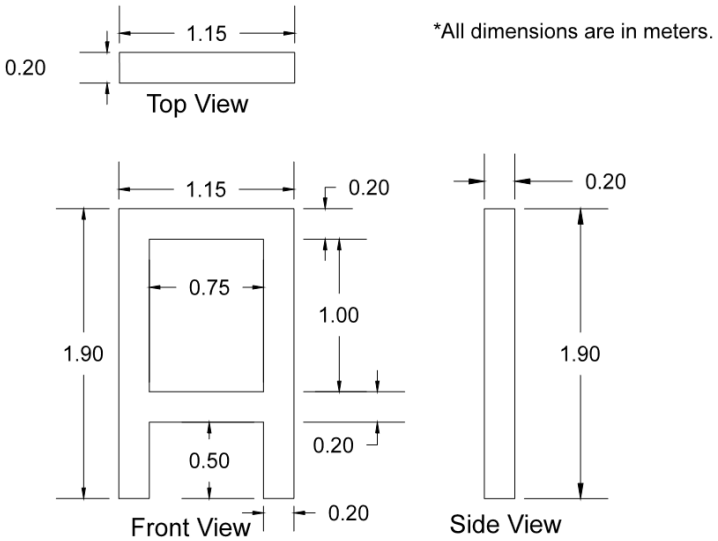
Appendix J - Australia 2050 Trail Phase 2 Trail Decision Board Poster Schematics



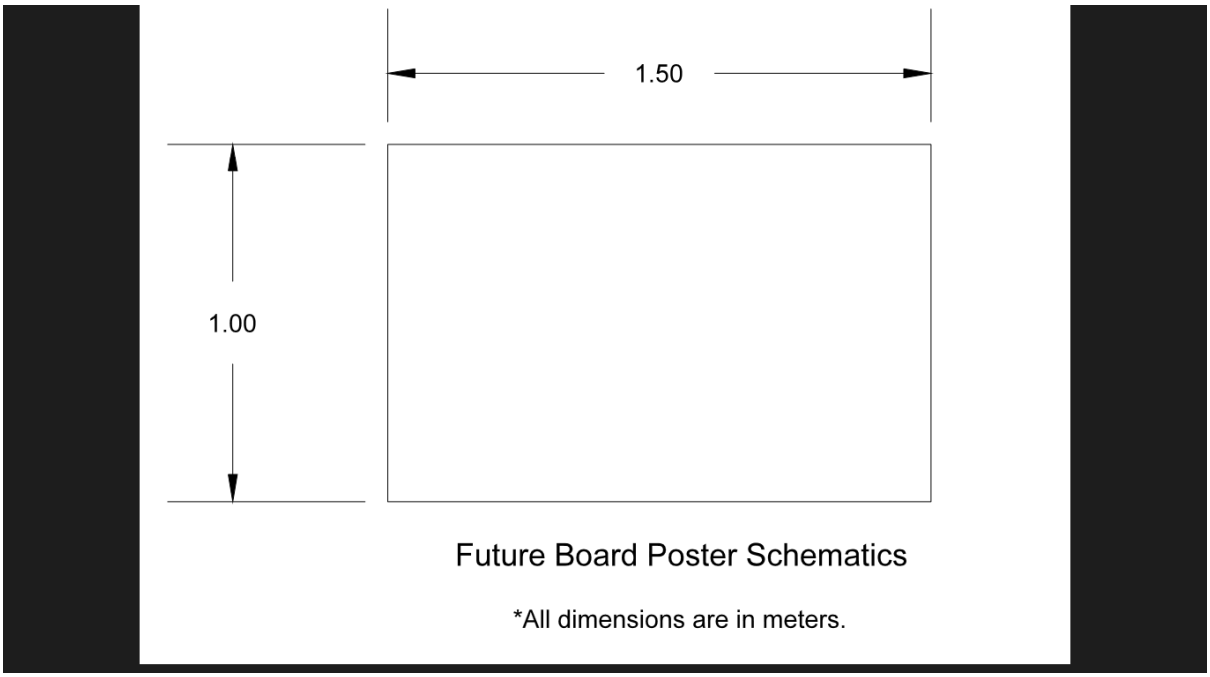
Decision Board Poster Schematics

*All dimensions are in meters.

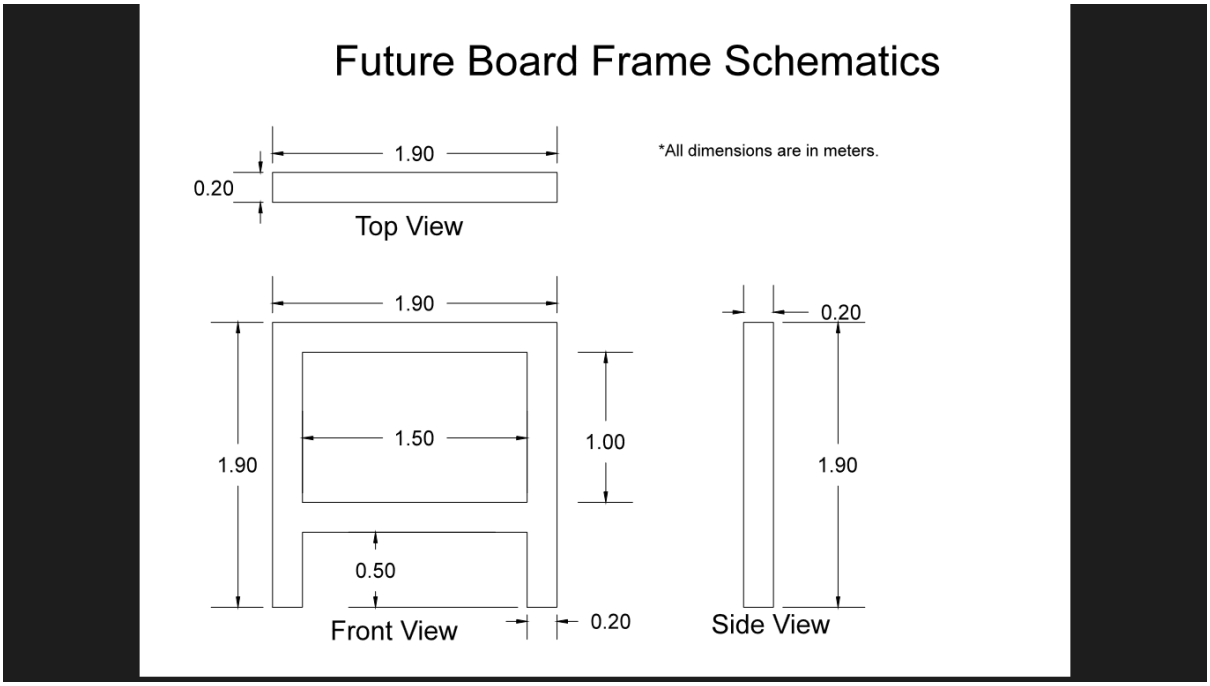
Appendix K - Australia 2050 Trail Phase 2 Trail Decision Board Frame Schematics



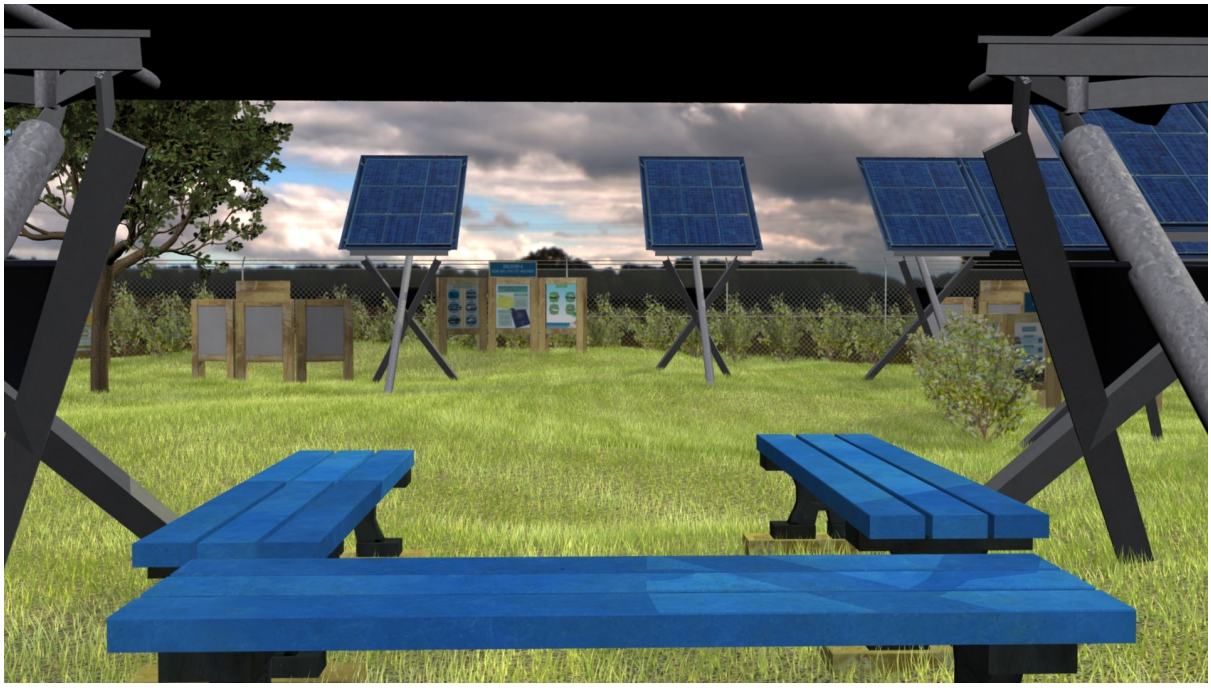
Appendix L - Australia 2050 Trail Phase 2 Trail Future Board Poster Schematics

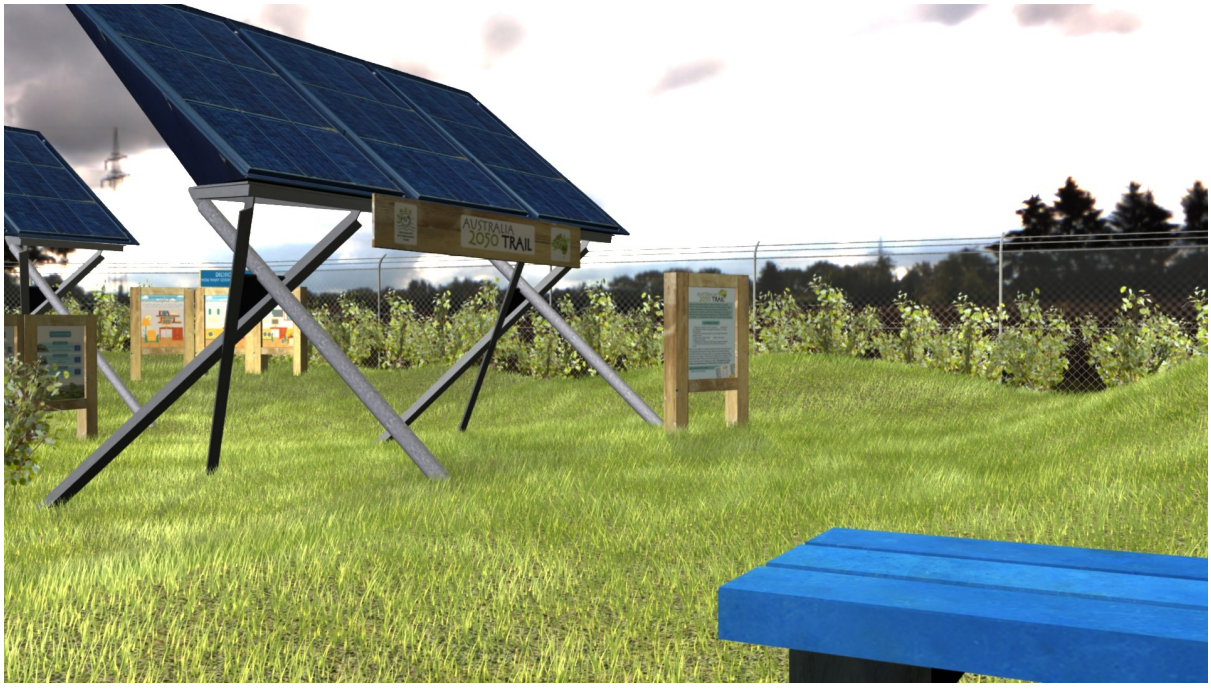


Appendix M - Australia 2050 Trail Phase 2 Trail Future Board Frame Schematics

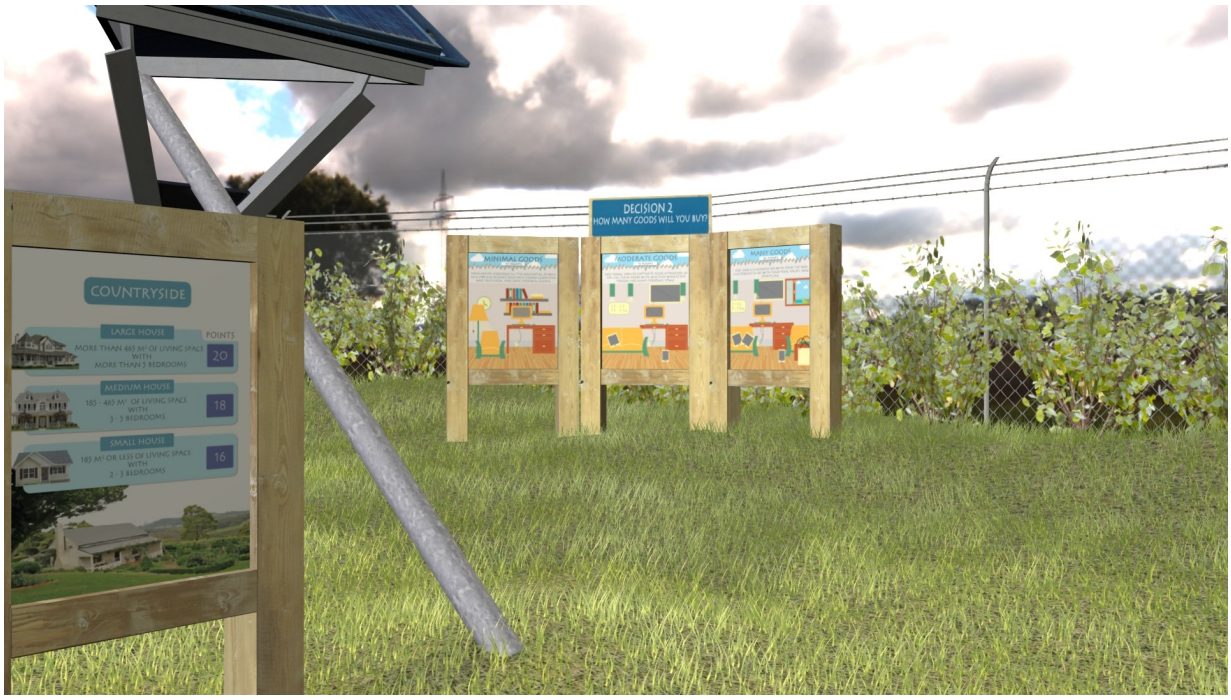


Appendix N – Views of the Australia 2050 Trail Phase 2 Prototype





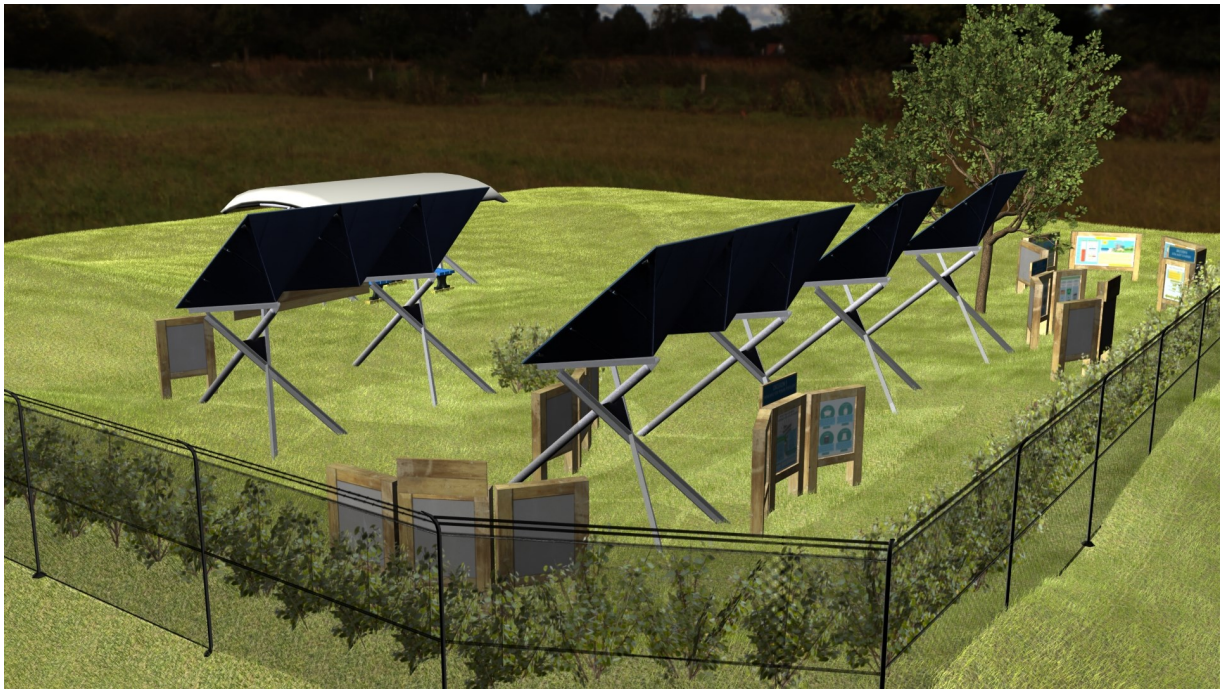

AUSTRALIA
2050 TRAIL
DECISION 1
AUSTRALIA
2050 TRAIL
INSTRUCTIONS


DECISION 2
HOW MANY GOODS WILL YOU BUY?
COUNTRYSIDE
LARGE HOUSE
POINTS
20
MEDIUM HOUSE
18
SMALL HOUSE
16


DECISION 4
HOW WILL YOU GET AROUND?
DECISION 6
HOW MANY CHILDREN?
DAILY COMMUTE
THINK ABOUT HOW YOU WILL TRAVEL...
HOLIDAY


DECISION 5
HOW WILL YOU CONSUME FOOD AND DISPOSE WASTE?
DECISION 6
HOW MANY CHILDREN?
TRAIN/T
9 POIN
BUS
12 POIN


LL YOU DISPOSE OF YOUR WASTE?
RECYLCE & RUBBISH
RUBBISH ONLY
Take advantage of your local recycling options and throw away the rest
Save time and throw all of your waste into the rubbish bin
Rubbish
Rubbish
3 POINTS
6 POINTS
DECISION 6
HOW MANY CHILDREN?
THINK ABOUT HOW BIG YOU WANT YOUR FAMILY TO BE...
NUMBER OF CHILDREN
POINTS
WHAT'S YOUR FUTURE?
NEXT
GO CHECK OUT YOUR FUTURE!



Appendix O – Australia 2050 Trail Pilot Test Survey

Australia 2050 Trail Survey

Thank you for completing the activity. Please answer these questions to help us bring the trail to CERES.

1. Circle your future: 1 2 3 4 5

2. Would you change any of your choices based on your future?
   Yes / No If yes, what would you change _____

3. Will you reconsider your choices once you leave CERES?
   Yes / No If yes, which ones _____
   If no, why not _____

4. Did you understand how to complete the worksheet?
   Yes / No If no, what was confusing _____

5. Did you have trouble answering any of the decisions?
   Yes / No If yes, what decision _____ and why _____
   _____

6. Rate this activity on a scale of 1 to 5, 5 being really fun and educational: 1 2 3 4 5

7. Comments and/or suggestions:_____
   _____

Appendix P – Australia 2050 Trail Pilot Test Survey Results

Would you change any of your choices based on your future?	Did you have trouble answering any of the decisions?
43 out of 64 students answered Yes 67%	60 out of 67 answered No 90%

Did you understand how to complete the activity sheet?	Average Rating of Activity on a scale of 1 to 5, 5 being really fun and educational
62 out of 67 answered Yes 93%	3.963235294

Future Scenario	Number of Students in Scenario	Number of Students who answered "Yes, I would change my choices based on my future scenario"	Percentage who answered "Yes, …"
1 (least effected)	5	1	**20%**
2	16	2	**13%**
3	6	3	**50%**
4	37	25	**68%**
5 (most effected)	6	6	**100%**

Appendix Q – Australia 2050 Trail Lesson Plan

Australia 2050 Trail Lesson Plan

The following lesson plan is intended as an aid to CERES teachers in running the Australia 2050 Trail. This guide is a reference that does not have to be followed step-by-step but can be modified as CERES teachers see fit. For the best experience and take home message we recommend following this lesson plan.

Program(s) & focus:

- Sustainability Program
- Climate Change Program
- How can lifestyle choices impact the future

Key messages:

- Sustainable consumption
- Identifying connections between lifestyle choices and social and environmental futures
- Current impacts of climate change
- Why is climate change changing so fast
- Adaptation and Mitigation
- Interrelationships, change
- What lifestyle choices can you make to have a better future?

Equipment:

- 2050 Trail Activity Sheet (laminated) - Activity sheets consist of five decisions that sum to your total resource "R" points, a thermometer (Resource-o-meter) to colour in your "R" points, one decision with your "Family Points", a "what's your future?" calculation box to find your "Final Total", and the "Future Bar" that is coloured in with the final total to directs you to a future scenario
- Dry-erase markers
- Erasers or rags

Process / Content:

****Optional Preface – History of Energy Timeline (Appendix O)****

1835 – Population: 113 thousand; Event: Thomas Davenport built the first practical electric vehicle powered by a battery.

1860 - Population: 2.2 million; Event: A coal-powered manufacturing boom of automo-

biles, textiles, and other developments across the world.

1935 – Population: 6.7 million; Event: The world's largest hydroelectric power plant, Hoover Dam, is constructed in Arizona, U.S.A.

1978 – Population: 14.4 million; Event: The world's first solar-powered village was installed in Arizona, U.S.A., providing power for water pumping and residential electricity to 15 homes until 1983.

2006 – Population: 20.8 million; Event: The largest offshore wind turbine, called Repower, capable of generating 5 megawatt of electricity, was first installed in the North Sea.

Part 1: Introduction

- We are going into the future to the year 2050. How old will you be in 2050?
- Some kind of guided visualization into the future, techniques vary, e.g. asking students to close their eyes and imagine themselves at the age of __, in the year 2050. What will they be doing at that age?
- Students start to share their thoughts about how they envision their lives/jobs/houses/ families etc. Use these responses to link into an introduction the idea of resource use.
- What do we mean by 'resources'? Fossil fuels, materials for living, etc., where do we get our resources and what are some of the impacts of using them?

Part 2: Decisions

- Explain the Australia 2050 Trail as an activity for students/visitors to choose what want in their future. Gather all students/visitors in a group and hand them each a laminated activity sheet and a dry erase marker.
- **Possibly start with Decision 6 – Number of Children to get students/visitors thinking about their future family size. The activity sheet illustrates their family "F" points based on the number of children they want. Have them record these "F" points on their activity sheet for decision 6. **
- Using Decision 1 as an example, read out the possible locations and type of houses for students/visitors to choose from. Next, have students/visitors write down the number of points for their desired home and colour in the resource-o-meter for all decisions with resource "R" points.
  - If the group seems to be struggling with the activity, continue as a group to Decision 2.
  - If the group seems to follow the activity, explain that decision 6 is a family question and is not included in the resource-o-meter. Once they have completed all 6 decisions, they multiply the sum of their "R" points and their "F" points to get their final total. The final total is coloured into the Future Bar and their corresponding future scenario will be shown.
- Decision 2: For decision 2, have students choose one of the three different lifestyles pic-

tured. These pictures illustrate the amount of goods they wish to consume. The lifestyles range from "minimal" with only basic comforts to "luxurious" with a pool and a boat. Record the points for their desired good consumption on their sheets and add the "R" points to the resource-o-meter.

- Decision 3: For decision 3, explain that they have two sources of energy to choose for their homes. Record the points for those two choices and add them together for the "R" points. Continue colouring in the resource-o-meter with these "R" points. Note that those who chose the large house or many goods must choose at least one non-renewable source due to their energy requirement. Those who choose both a large house and many goods must choose two non-renewables.
- Decision 4: For decision 4, visitors/students choose a method of transportation for getting to work and a method of transportation for going on holiday. Have students add these two values together to get their "R" points. Keep colouring in the resource-o-meter with this value.
- Decision 5: For decision 5, visitors/students choose their desired food consumption and waste disposal methods. The three questions include: where will their food come from, what type of diet will they have, and how will you dispose of your waste. The points for these choices are added up and recorded on the activity sheet. The sum of the choices again is coloured in on the resource-o-meter.
- Decision 6: If they didn't answer this question first, ask students/visitors how many children they would like to have. The activity sheet illustrates their "Family Points" based on the number of children they want. Have them record these "Family Points" points on their activity sheet for decision 6.

Part 3: Future Scenarios

- To find their futures, students/visitors multiply the sum of their resource "R" points by their "Family Points". This product will be their final total. Have students colour in the Future Bar with their final total and their scenario number (1 – 5) will be shown.
- Direct them to the future scenario boards
- Let the students go to the different enclosed future scenarios and tell them to walk in and observe the details of their future. They should also examine the other potential futures.

Part 4: The Wrap up

There are many ways to facilitate this discussion and the focus will vary depending on the group, what you want to focus on depends on the program being undertaken (sustainability, energy, etc.). Try to focus on two or three key points first, and then you can build a more developed discussion.

Some Suggestions:

- Bring students back to the circle & begin discussion by summarizing the different futures of the class – this can be done by asking students to stand in front of their future
- Ask students to share what they thought was the most shocking/intriguing thing about

their future and why?
- Ask students what future they want to be in
- Ask them what choices they would change after doing the activity

Some discussion topics may stem from this:
- Sustainability: What does 'sustainable' mean? Why is sustainability important for our future? Did you think your future was sustainable? What choices could you change to ensure a sustainable future?
- Where will you live: How does where you live affect the environment and other decisions like transportation and food consumption
- How many goods will you have: What are the most important things in life?
- How will you power your life: The reality of having a large house or many goods means having a large energy requirement that cannot be solved with a roof full of solar panels
- How will you get around: What transport method did you choose and why?
- How will you consume your food and dispose of your waste:

Many of these decisions they made on the Australia 2050 trail are decisions they will make in the future, therefore it is important that you 'bring it back to their level' and leave students with take-home messages that they can begin doing immediately. Reiterate key points you focused on/students discussed. This can be done with thought provoking questions

Suggestions:
- Do we know for sure how the future will turn out?
  - Discuss previous worst-case predictions for climate change & how climatologists predicted present day
  - Explain these scenarios can change with time
  - 2050 can have a huge effect on 2100 either stabilizing or exponentially increasing climate change
- What are the connections between our choices and our future?
- How can we change our decisions to achieve a better future?
- What can we do today/this week to achieve a more positive future? e.g.:
  - Transport – e.g. small car/no car, riding bikes/walking, public transport, car poolin
  - Housing – e.g. switch to 'green energy', use less energy at home, shorter showers (can link with Eco House activities)
  - Energy & resources use – e.g. 4 R's, sustainable consumption, buying local products
- Recap the connections between these changes and a better, more sustainable future

Part 5: Continuation of the Australia 2050 Trail Lesson
- If there is time remaining after completing the discussion, send your group through the trail again to see what future they would get if they adjusted some of their decisions.
- Once time is up, connect students/visitors to the virtual trail. Students/visitors can down-

load another activity sheet and complete the activity again using the virtual trail video.
- Have students write down what choices they want to improve

Point Explanation

- **Decision 1 – Where will you live?** Homes that use less building materials and are located closer to the city have less environmental impact and therefore fewer resource points.
  - "Cities, for their part, have been trumpeting their green credentials. Mayor Michael R. Bloomberg of New York has made much of his plan to reduce carbon emissions 30 percent by 2030. (Already, the average denizen of New York City produces 7.1 metric tons of greenhouse gases each year, according to statistics compiled for the city government, compared with 24.5 metric tons for the average American)" (Williams, 2008).
  - "Writing in the National Geographic, Robert Kunzig, the science journalist, makes the case: 'Their roads, sewers, and power lines are shorter and so use fewer resources. Their apartments take less energy to heat, cool, and light than do houses. Most important, people in dense cities drive less. Their destinations are close enough to walk to, and enough people are going to the same places to make public transit practical. In cities like New York, per capita energy use and carbon emissions are much lower than the national average'" (Harris, 2013).
- **Decision 2 – How many goods will you buy?** This board illustrates three different lifestyles of increasing amount of goods. The "minimal" lifestyle was 10 points with all the necessities as well as a few electronics such as a shared computer and TV. The "moderate" lifestyle with 15 points has many electronics per person and many personal items. The "many" lifestyle is a luxurious life with top end electronics, pool, yacht, and sports car, earning the option 20 points.
- **Decision 3 – How will you power your life? W**ind has the lowest resource points with only two because it is affordable and has little disruption of ecosystems. Solar has 4 resource points since it is an abundant source but can have issues with its high cost and need for supplemental energy on cloudy days. Hydropower is also 4 resource points since there are no emissions and it is a very reliable source. The drawback with hydro power is the potential for floods and changes to the environment. Biomass is a very powerful renewable source but it has some emissions earning it 4 points. For non-renewables, coal has the highest point value at 15 points as it has a high environmental impact from mining and burning. Petrol is 12 points because it also high $C0_2$ emissions. Nuclear has less greenhouse gas emissions but is still 12 points because of the radioactive waste and other safety concerns. Natural gas is the cleanest-burning fossil fuel with 10 points (Society of Petroleum Engineers, 2014).
- **Decision 4 – How will you get around?** Flying is the worst environmentally speaking with 12 points because of the emissions put into the atmosphere per person. While flying CO_2 emissions are generally into the high atmosphere, and this is thought to have a greater greenhouse effect than CO_2 released at sea level (Carbon Independent, 2007). A cruise also has emissions but most importantly there is a large amount of waste and damage to ocean life giving it 9 points. A car has a fair amount of environmental impact with 4 points because of the emissions per person. The local holiday is no points because of the option to take public transportation.

- **Decision 5 – How will you consume food and dispose waste?** Buying food from a local farmer's market versus food from the supermarket can greatly benefit the environment because of the "food miles" and packing that go into food from the supermarket. We allocated 2 points for buying all farmer's market food, 4 points for mostly farmer's market food, 6 points for mostly supermarket food, and 10 points for all supermarket food. Diets with more animal products have a higher effect on the earth. Eating red meat has a huge environmental impact because of the amount of space and resources that go into raising a cow. Finally, waste was considered in the last question. Composting and recycling all waste is the best for the environment and throwing everything into the rubbish is the worst.
  - "Food in the U.S. travels an average of 1,500 miles to get to your plate. All this shipping uses large amounts of natural resources (especially fossil fuels), contributes to pollution, and creates trash with extra packaging. Conventional agriculture also uses many more resources than sustainable agriculture and pollutes water, land, and air with toxic agricultural by-products. Food at the farmers market is transported shorter distances and is generally grown using methods that minimize the impact on the earth" (Center for Urban Education about Sustainable Agriculture, 2014).
  - "According to the United Nations, animal farming globally causes more greenhouse gas emissions than all of the cars, lorries and planes in the world put together, and the effect is increasing. It is also the biggest contributor to greenhouse gas emissions caused by the food system, which itself is responsible for just under a third (up to 30%) of all global emissions…To make room for more plants we should all eat less meat (especially red meat and processed meat) and fewer products of animal origin – like dairy products and eggs - both to improve our health and reduce the damage we are doing to our environment" (Sustain, 2014).
  - "Composting organic materials that have been diverted from landfills ultimately avoids the production of methane and leachate formulation in the landfills. Compost has the ability to prevent pollutants in storm water runoff from reaching surface water resources" (Environmental Protection Agency, 2014).
- **Decision 6 – How many children will you have?** Choice in family size will decide how big the futures population will grow. The amount of resources used is directly related to the size of our families.
  - "A third perspective is expressed by saying that any environmental impact (I) is the product (mathematically and causally) of population (P) times affluence (A, economic product or consumption per person)" (Cohen, 2010).

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Appendix R – History of Energy Timeline