

No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

Assessment Schedule: AS 91363

Demonstrate understanding of sustainability in design

Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria.

Issues from the Specifications

Where a candidate has provided a brief report, the report should not be penalised because of length.

Candidate work in excess of 10 pages must not be marked.

Where a candidate has used a small font markers should make a judgement about where to stop marking. This judgement should be made relative to 10 pages of Ariel font

Where work is illegible, it cannot be marked.

Digital submissions that cannot be read cannot be marked.

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of sustainability in design involves	Demonstrate in-depth understanding of sustainability in design involves	Demonstrate comprehensive understanding of sustainability in design involves
<p>explaining how lifecycle considerations determine the focus for design interventions</p> <p>explaining the relationship between lifecycle design, innovation and sustainability.</p>	<p>explaining how lifecycle analysis is undertaken and how this determines the focus for design intervention</p> <p>explaining how issues identified by lifecycle analysis led to design innovation being applied in the development of a sustainable technological outcome.</p>	<p>discussing the competing priorities and compromises made as a result of lifecycle analysis in the development of a sustainable technological outcome.</p>

The candidate describes and explains how sustainability impacts on design decisions, identifies and explains examples of this within existing products. There is strong reference to the student's own technological practice and includes a high level of independent voice.

Although the Lifecycle was analysed, the discussion of the compromises and dilemmas that were faced lacked depth of knowledge and have restricted the candidate's ability to achieve Excellence criteria.

The submission is seen as being Merit.

Technology Schedule Appendix 1

Markers must exercise professional judgement to decide if a report demonstrates understanding. The following appendix provides guidance for markers making this judgement. A report must use information to demonstrate understanding.

Reports described wholly or substantially by one or more of the statements in the left column demonstrate understanding.

Reports described wholly, or substantially, by one or more of the statements in the right column do not demonstrate understanding.

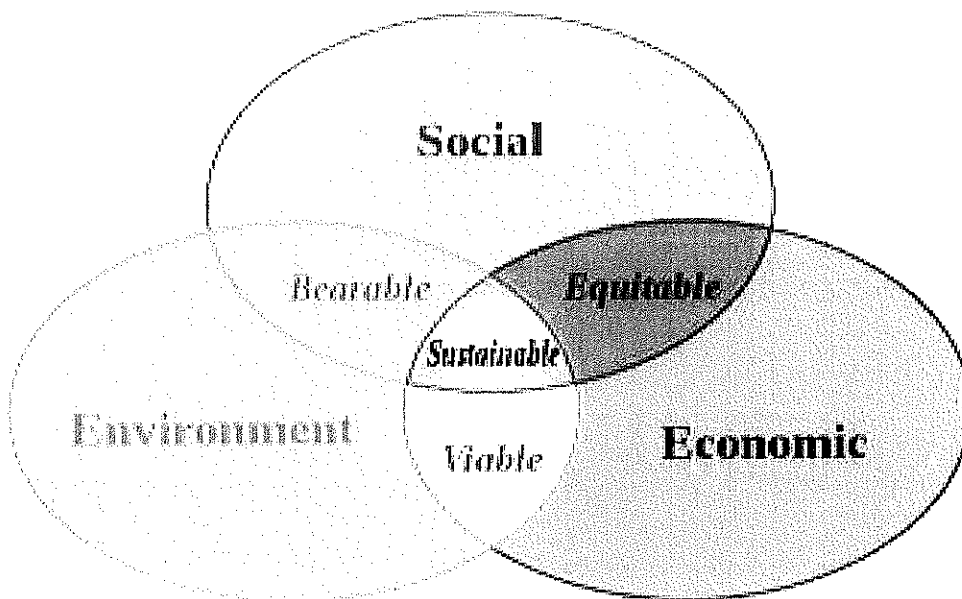
Where the report is made up of both used and reproduced information the marker must decide if the report is successful against the standard when the reproduced information is ignored.

Evidence of use of information	Evidence of reproduction of information
<p>Candidate's report describes and explains the candidate's use, in their practice, of information relating to the standard</p> <p>Information from the candidate's practice, research, the practice of others, and teaching is related to the candidate's technological experiences.</p> <p>The report describes experiences you would expect to come from a course of instruction derived from The Technology Learning area the NZC.</p> <p>These could include but are not limited to</p> <ul style="list-style-type: none"> • testing and trialling within a modelling process • developing a conceptual statement • developing a conceptual design • development of a brief • material selection • refinement of a brief • development of a prototype • development of a one off solution • further examples may be added. 	<p>Information is presented in isolation from the candidate's Technological experiences. It offers nothing or little to suggest the information is related to a course of instruction at level 7.</p>
<p>Information from research, the practice of others, or teaching is reported in the candidate's own voice.</p>	<p>Information is not in the candidate's voice. The word choice, sentence structure, sentence length, punctuation and so on are not what a candidate could be expected to produce.</p>
<p>Referenced, complex research information unchanged by paraphrase is related to other information in a manner that unambiguously constructs meaning. (very rare)</p>	<p>Unreferenced, complex, research information is presented as though it is the candidate's own work.</p>
<p>Where the marker suspects a report is a deliberate attempt to deceive the report should be referred to the panel leader using the Irregular Booklet process.</p>	

Sustainability Report

This report will demonstrate my comprehensive understanding of sustainability in design by discussing the competing priorities and compromises made by businesses when in the development of a sustainable technological outcome. Sustainability is the quintessential factor for humanity's continued existence. It is the ability to continue a defined behaviour for as long as we need without any negative consequences. True sustainability consists of three major factors: economic sustainability, environmental sustainability, and social sustainability. Only once a product meets all three of these requirements can it be truly sustainable. The product I am going to be referring to and analysing throughout the report will be surfboards and the surfboard industry in general. They are known to be harmful on the environment and never break down. Surfers are known as an eco friendly group of people and don't want to cause any harm to their environment. This means that they would be keen on development into eco friendly surfboards to support their way of life. I will also be relating to my project for Year 12 design technology and what I could have done better. My project was an LED surfboard for surfing at night.

Below is a venn diagram contrasting and comparing the three main factors of sustainability.



<http://www.thwink.org/sustain/glossary/ThreePillarsOfSustainability.htm>

Key:

Green - Environment

Red - Economic

Blue - Social

Orange - My LED surfboard project

Economic

Economic sustainability means the product is financially feasible. This includes everything from material costs to sale price and profitability. This is important to the product being sustainable because it means it is affordable to the public and can compete with other non sustainable products. This factor of sustainability is most commonly prioritized over the other two due to corporate greed and for-profit organizations. If it wasn't for the economic factor a lot more products would be fully sustainable. With surfboards, they are typically quite expensive due to the price of materials and expertise required to make them. Having said that, they have no problem selling them at the prices that they are so perhaps they do fit into this category of sustainability.

Environmental

Environmental sustainability is probably the most important factor to a product being fully sustainable. It means that the product effectively leaves no footprint on the environment. When designing a product, this is a very difficult task that very few products have ever managed to achieve. It means that everything in the product needs to be entirely naturally sourced and be able to be safely disposed of without any damage to the environment. This is hard to do because of all the small things that businesses commonly overlook, it's one thing to have the materials sustainable but production and transportation is often more toxic than the materials themselves and can easily be forgotten. The surfboard industry is a horrible example of environmental sustainability as surfboard are made almost entirely out of synthetic materials, from the foam core to the polyester resin used to glass over them. They never bio-degrade, or they take an unfeasibly long time to do so, and they are toxic to make from start to finish.

Social

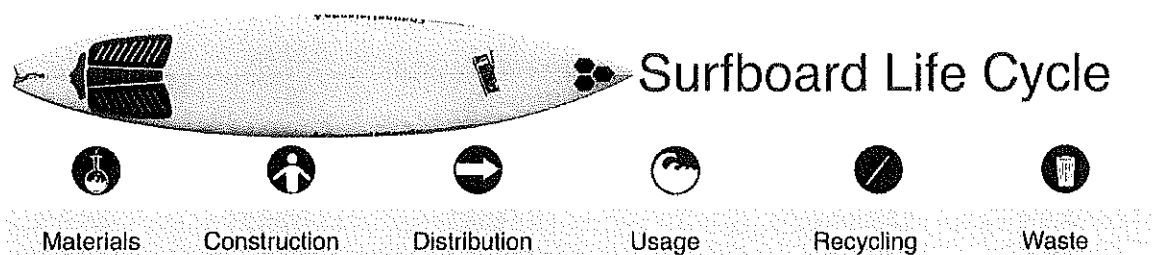
Social sustainability is when the product is easily accepted by and friendly towards the community. This includes but is not limited to product function and aesthetics and working conditions of employees. This is actually more important than most people might think because if the product lacks social sustainability it will not be accepted and people will not purchase the product and it certainly will not be able to compete with other products if no one likes it. The surfboard industry specialises in social sustainability at the compromise of environmental sustainability as most surfboards are extra light and manoeuvrable and look very aesthetically pleasing with the popping white that most modern day surfboards possess due to the toxic materials they use.

After analysing the venn diagram and discussing the different aspects of it, it is visible what aspects take priority for most designers when they are in the design process for a sustainable product. They need to make the product likable by the public so it will sell, and make sure that it is financially feasible. Throughout the process they also need to be aware of the environmental impact they are having and if they manage to do all three of these things correctly, they have a sustainable product. However this can commonly be skewed due to the strong desire for a more economical product. Designers will often place the economical sustainability of a product as most important at the sacrifice of the environmental and social factors.

This means poor working conditions, slave labour-like hourly wages, and toxic cheap materials that leave a huge impact on the environment. This seems to be the downfall of most products when it comes to sustainability, greed.

How lifecycle analysis is undertaken, and how this determines the focus for intervention

A critically important aspect of sustainability in design is the life cycle analysis. It is a diagram that depicts the individual stages of a product's lifespan, from production to disposal. It can be used for any product and can help designers visualise the points in production that are causing problems to sustainability. Presented below is a **linear** life cycle analysis diagram for a typical surfboard.



<http://www.designlife-cycle.com/surfboards/>

Designers go through each individual step of the lifecycle and analyse weaknesses and areas where production could be improved to be as sustainable as possible.

Materials:

The materials for a surfboard are all synthetic, aside from the stringer which is a small sliver of wood that runs down the centre of the board to improve durability and strength. Using synthetic materials means that the boards are light and strong, however they are not eco friendly what so ever. There has been a lot of research recently going into alternative materials to use for surfboard construction that would match the cost and performance (economical and social) factors of current materials. One of the most interesting findings was made by a researcher Stephen Mayfield who has developed a way to make a foam very similar to current materials out of an algae that can be grown easily for production of the foam. It is light, buoyant and white just like a normal PU blank. For the glassing some surfboard companies are starting to use bio resins which are made from tree extracts and are somewhat environmentally sustainable. For the actual cloth there is some research into using natural fibres such as hemp instead of the typical fiberglass cloth. There is much more research needed to be done here before it could be deemed commercially viable. For my project I used an epoxy resin to glass in my LED strips to the board. Epoxy is considerably less toxic than polyurethane however it is not environmentally friendly. I did however use an old second hand surfboard and refurbished it which kept it from going in the landfill. To make my project more sustainable I could have used bio resin for glassing over hemp cloth instead of epoxy and fiberglass.

Construction:

The construction of a surfboard is as follows: First, the raw surfboard blank (chunk of foam) is shaped by hand or machine into the desired shape. This produces lots of

waste and can be harmful to the person shaping. The blank is then coated in fiberglass and resin to form a hard shell around the foam. This process gives off toxic fumes and can be harmful to the person performing this stage if not wearing appropriate safety equipment. Overall construction for surfboards is not too bad in terms of working conditions and surfboards are shaped by people who want to shape them (there are some exceptions, but for the most part, it's okay). For many products however, this stage can be a very bad one, where horrible things happen such as pollution from factories to child labour just to cut costs to make more money. It is a very notorious point in the lifecycle of a product for the social sustainability and environmental sustainability to be **compromised** in order to gain profit. When designing a product it is important to ensure that the construction is sustainable in all ways, not just economically.

Distribution:

Surfboards are very difficult to transport due to their odd shape and fragility. This means that there are lots of extra materials used when packaging them often plastic to protect them from damage during transit. These are single use plastics that serve no other purpose other than to hold the board for one trip. This style of packaging is not unique to surfboards though, almost all products use some form of single use plastic to protect them during shipping. Then there's all the CO₂ emissions that the transporting process gives off getting the product from the factory to the retailers. Overall, the distribution step is **bad** for both environment and economic but is **fantastic** for social sustainability because a much larger portion of people have access to the product. One thing we could do to make the distribution step **better** for environment and economics in the case of surfboards, we could all buy from local shapers and not support the massive corporations who are the primary problem for the distribution stage of a surfboards life cycle. This would mean no single use packaging plastics and much less CO₂.

Usage:

Finally the stage everyone loves, surfing! At this stage and this stage only, surfboards are actually fully sustainable. They don't leak chemicals into the ocean when we are using them, they look awesome and perform well, and they don't need any money spent on them in order to operate. If every stage of the life cycle could be this good in all three areas we would have a fully sustainable practice/product. My LED surfboard falls over here slightly though, as every time I charge the batteries I need to run a new bead of silicone around the compartment which is both wasteful of silicone and expensive if heavily used.

Recycling:

Recycling is when a product is broken into its various materials and those materials can then be reused to make a new product. Usually only a small portion of a product can be successfully recycled and the rest remains as waste so contrary to popular belief, recycling does **not** equal sustainability. Recycling is great and can definitely help towards sustainability but it takes more than just recycling. Most surfboards today have no recyclable capabilities and are therefore put straight into a landfill. However, surfboards are useable for a long time and can be sold on to other people and repaired multiple times before needing to go in a landfill, which helps keep the number of boards in landfills down as people don't burn through them.

Waste:

This is the arguably the worst step for the environment. This is where all of the unused waste is disposed of by either burning, landfilling, or in some cases letting the waste go into the environment uncontrollably. Almost any way of disposing is bad for the environment. Burning releases incredibly toxic chemicals into the air and can cause serious problems like pollution or global warming, but it is a cheap option. Landfill makes massive areas of trash and waste, however it is probably the safest option that we have right now to deal with the countless tonnes of waste we produce. And then there are the cases where waste is left to drift through the ecosystem and destroy everything in its path. This is the worst because it is so uncontrollable and spreads like a plague. A severe case of this is the Bali trash crisis, where tonnes of waste is washed upon the shores of Indonesia causing countless marine life and animal deaths due to the pollution and ingestion of these chemicals and materials. Surfboards are very hard to dispose of as well, as they almost never break down and they are extremely toxic to burn. They sit in landfills for lifetimes before they begin to return to their core elements. This is another drive for people to try to use biodegradable and environmentally friendly materials to aid in surfboard construction.

Competing Priorities

Through LCA I have identified that designers and companies are commonly faced with the problem of having competing priorities for sustainability when designing a product. This means that certain aspects of the venn diagram take priority at the sacrifice of others at different stages of the product life cycle. For surfboards, there are a number of competing priorities that shapers face. Things such as materials used, polyurethane (PU) vs eco friendly foams for example. PU is tested and proven to perform extremely well as a surfboard material, so it benefits the social factor greatly but is hugely taxing on the environment. This is a good example of the social sustainability taking priority over the environmental. This happens all throughout the life cycle, from materials and construction all the way through to disposal. To combat the issue the competing priorities raises designers must come up with ways that can complement both areas affected. Back to the foam example, if designers were able to find an alternative to PU that worked just as well but was environmentally and economically sustainable, they would be improving the environmental sustainability of the product without needing to sacrifice the performance and social aspect of the board. These are the things designers need to consider when designing a product with the aim to be sustainable, and to make sure they are not prioritising one element of sustainability at the sacrifice of another.

How issues identified by lifecycle analysis led to design innovation being applied in the development of a sustainable outcome.

In my research of sustainability in surfboard design, I have come across many new and innovative alternatives to some of the big problems that surfboards have to overcome before they are close to being sustainable.

Firstly, I found a very interesting article about 6 new materials that can be used instead of traditional PU surfboard foam. There are boards made of everything from algae and mushrooms to cork. Some of them are very environmentally friendly and could definitely help when it comes to combating the terrible footprint the surfboard foam has on the environment.

The only other problems that the board need to have solved to make it environmentally sustainable are the glossing materials, cloth and resin.

To replace the resin there are some common Eco resins that are being used more and more frequently by surfboard producers as they offer the same social benefits as traditional PU resins, but they are much safer on the environment. There are a number of boards being made by big corporations like Channel Islands and FireWire that utilise these new bio resins, which is a great step forward.

As for an alternative to the cloth, there seems to be a lack of research going into alternatives to use in surfboard construction. Something that I think would work and will be willing to experiment with could be hemp. Hemp has very strong tensile strength much like fiberglass and can be easily woven into the same cloth density as traditional fiberglass cloth for use in surfboards. I think it would work very well in conjunction with the bio resin mentioned above, and would provide a strong slightly flexible surface. It is also very fast growing and cheap to produce. The only problem I could see with this is that it wouldn't be clear, so the board would be a light brown color instead of the bright white that fiberglass offers. This could impact the social sustainability if people didn't like it.

How I could apply my knowledge if making my own board

After my research on sustainability and surfboards, I would be extremely interested in attempting to make an entirely sustainable surfboard out of the materials I have found. I have put together a quick life cycle for this potential board below.

Materials

I would use an algae based foam as the core, with a locally sourced pine stringer, then I would glass over the whole thing with hemp and bio resin. The result would potentially allow a fully sustainable surfboard that boasts the same performance capabilities as any other short board. The only difference would be that it would be brown but I think people would be willing to get over the color in order to support saving the planet especially because the target audience is surfers. If the brown was a problem I could potentially put a natural dye in the bio resin to make the board white. The hemp cloth is cheaper and than fiberglass cloth and so is algae foam. The bio resin is slightly more expensive than traditional epoxy, but this is compensated for by the other two materials.

Construction

For construction I would not need to wear respirators as the resin is non toxic, and the foam is made of non toxic algae so there is no need. The actual process of making the board stays the same it's just the materials that change.

Distribution

If I were to distribute the boards to people who are not local, I would make sure I use a biodegradable packaging like cardboard or something similar so it is environmentally friendly. It would keep the board just as protected from damage as plastic. For the CO₂ emissions there's not a lot I can do, as soon as I ship it it's in the post's hands.

Usage

The board will perform very similarly to a typical surfboard the only difference is that it might be slightly heavier but not enough to make a big difference. It will be just as durable and last just as long. So overall the social sustainability takes a slight hit here in compromise for the whole process being far more sustainable overall.

Recycling

The board won't be any more recyclable than a typical surfboard and you won't be able to extract materials from a used board to make a new one, which is a bit of a downside but it's not too bad because the whole board is easy and safe to dispose of.

Waste

This is the best part of my board design. The board can be disposed of safely by any method. It can be safely burnt, and it can biodegrade in a landfill.

Conclusion

Sustainability is not something to be taken lightly in this day and age, we desperately need to start enforcing sustainable and environmentally friendly practices in our product designs through life cycle analysis and understanding of the venn diagram. If we don't make a change for the better soon, we will lose the world as we know it. This goes for design in everything from surfboards to vehicles and everything in between.

Hopefully this report has adequately informed and educated you on sustainability and what that means in design, and the compromises that designers make when they are designing a sustainable product. Now that you know what sustainability means and how important it is to our world I hope that you can look out for it in every aspect of your life and make sure that you are always supporting a sustainable movement in any product you buy so you can be a part of a greener earth.