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Surf Rescue Vehicle working with the Royal National Lifeboat Institution (RNLI)

My simple overview would be to create a vehicle capable of successfully being able to rescue lives at sea. It's capability of rough terrain as well as rough surf conditions at sea to prevent the risk of loss of life at sea. Using my primary research of working with the RNLI in my own personal time as well as communicating with current employees within the organization to tackle a problem and successfully create a product that will help save lives at sea. Not only tackling the problem of preventing loss of life but how an automotive designer can help design a vehicle to increase the productivity of saving lives, whilst looking into new alternative energy sources to create a safer and more environmentally friendly future for the next generation. Attempting to design something that not only protects the environment with its powering methods but it's aesthetic and how damaging the product is to the landscape by its design.

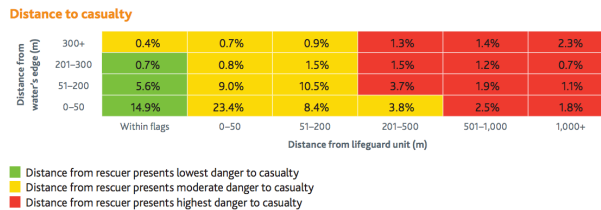
During my own personal time I am currently a volunteer at my local RNLI lifeboat station where this project would have a strong impact on myself and feel passionate about the issues with saving lives at sea. It's where I have decided to focus on solving a problem, which constantly appears during the course of rescue at sea. It's down to



the fact that most vehicles within this organization weren't specifically designed to carry out most tasks required for them to do. They are modified in a way that makes the suitable enough to carry out most tasks in which can be made much easier by creating something that's specifically designed to save lives. The Royal National Lifeboat Institution is an organization all resembles around saving lives at sea where such a demand is increasing every year. It's an organization, which relies heavily on public donation to carry out its purpose. In the year 2017 the RNLI rescued 8,072 people increasing to 9,412 in the following year. The demand for this organization continuous every year relies on its volunteers to give up their own time to help save lives at sea. In 2018 the RNLI lifeguards attended 19,449 incidents on its patrolled beaches and aiding 32,207 people in a variety of incidents. Although the organization relies on donations to keep up this kind of work it simply isn't cost effective to measure the average response time but it's risk assessment process, fitness standards and operational configuration of the lifeguard service are all designed to achieve this strategic performance standard. The RNLI lifeguards work during specific terms aimed mostly at the summer holidays where the footfall of the general public is at its peak where the RNLI lifeboats are on call entirely all year round, twenty-four hours a day, seven days a week. This does not mean that the

lifeguards don't require the specific equipment, which aids them to carry out their work whether it's saving a life at sea, or casualty care shoreside. Their work is priceless and with this it's my intention to looking to design a vehicle suitable of meeting these standards.

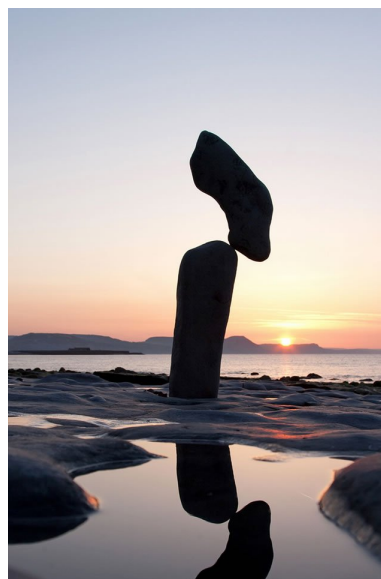
In 2018 the RNLI lifeguard inshore rescue watercraft (RWC) was used 415 times working with its rescue tube which was used 251 times to help aid people in difficulty at sea. Its inshore rescue boat was also used 434 times throughout their working period. Bearing in mind that all these water-based products were used they required the use of a land vehicle to aid the launching process of every time. The RNLI lifeguards have a fleet of 4x4 pickup trucks as well as smaller ATV's to ensure they can speed up the rescue process. As seen in the graph above, the lifeguards have a procedure of setting up safe swim zones for the public, which is constantly monitored by the lifeguards. Now although these areas seem great to some, during the busy periods of summer the beaches along the coast of the UK can be fairly overcrowded with footfall where these swim areas can also get fairly overcrowded which means many will move further along the beach to enjoy the swim. These areas are still monitored but aren't as heavily focused on than the areas in between the designated swimming flags. It shows the largest threat to the casualty is marked in red with the highest percentage on show at 3.7% at a distance of 51-200m from the water's edge and a distance between 201-500m from the base unit.



This means that the distance between them and the lifeguards is a large area to cover. The lifeguards have small ATV's to transport their rescue craft up and down the beach but with the use of two vehicles running under internal combustion engines don't give the best carbon footprint for the environment but the loss of time interchanging between vehicles. This then also requires at most times more than one lifeguard to attend an incident, which is then decreasing the amount patrolling along the beach whilst this incident is under way. This time of year, is known to most RNLI personnel as "silly season" as its units are working tirelessly throughout the days with back to back incidents ensuring the safety of the general public. **[RNLI (2018). Operational Statistics Report. rnli.org]**

Adrian Grey,

Grey as an artist looks to bring creative balance to the world through the medium of balancing stones on top of one another to create beauty sculptures in their natural form and landscape. He talks about the catalyst, a period of dark times and solitude, was to inspire in me an original concept: to build sculptures from naturally weathered rocks and stones that with an improbable composition and simplistic beauty are balanced in a state of equilibrium. It's the simplicity of his work is what inspires him as an artist to pursue his goal and objective to create such beautiful pieces of work. It's all aimed at one goal which is similar to my project of creating a product purely for one thing and that's to save lives at sea. Taking from this is that the aspect of looking at creating something natural that aims at doing one thing with the ability to carry out this objective in the simplest way possible. Further on he then talks about the inspiration he receives from his feelings and reactions from others around him. The encouragement from the people around him helps drive that determination to create such wonders with simple natural stones. The risks by doing so are financial and emotional but the risk is what makes us as individuals feel alive and drives the determination further than ever before. He talks about how balancing stones is performance art in a very pure form which is similar to my own personal project. It's not what you do is better nor worse than something else but the way it helps drive your own determination and makes you perform in your strongest manner. My very own project is to simply create something to save others with only one aim to direct. This meaning that as long as the product performs in doing so regardless of the risks then the feeling of success can be achieved. ***Grey.A (The Pioneer of Stone balancing Art) Stone Balancing.***



Sam Bennett,

Bennett portrays his work in a way of working with nature within a short time frame. He too is an artist in the world of stone balancing whilst also making other sculptures out of stone. He sees debris of nature is his palette of creativity. Bennett was 14 when he started this road of creativity and inspired to become an artist in what he believed was creative art. Over the 12 years of his career in the art industry



foundations of his work near his home in Torbay. He talks about how books of previous artists such as Andy Goldsworthy and it just became a hobby of his and how nature played a big part in his life whilst growing up. He talks about how at times he is up against the clock, against nature when working on beaches. He speaks about the tide and how it will wash away his work in

the blink of an eye but it's just ephemeral nature and that's the key to why he does it. Similar into my own personal objective is to create something to challenge the race with nature. The biggest challenge of saving lives at sea is nature itself and how in a blink of an eye the conditions can change, and this is where the risks increase. It's important to consider nature whilst designing something to save others. He then goes on to say "We live in a world that we are destroying and if I can add something beautiful even for five minutes it brings happiness to people". My project aims at a very similar path to his, it's the ability to pursue a rescue to help others in need. Regardless of the fact that it may only take a few minutes to do so it brings happiness for a lifetime and without doing so would end in catastrophe. To be able to bring happiness to someone through saving a life is impossible to compare or put a price on how important that may be. **Bennett.S (2019) *The gravity defying art that washes away.***

One of the biggest challenges with design in today's era is sustainability. Where the world goes next is anyone's guess. What will the world rely on to power it through the next century? Fossil fuels supplies as we know is depleting day by day with everyone panicking that in 50 years, we will have used that entire supply. So, what can be used to take over from this. Not only the fact that the supplies are depleting but the damage the fuels did to the earth is irreversible. Back in 1997 it was said that new diesel-powered vehicles, although they were using burning fuels to work, they were far less damaging to the environment than petrol cars. Due to the fact of their lean burn meant they were able to get the same performance than a petrol engine working harder. The pollution generated from diesel powered vehicles were over the scale in comparison to petrol. Although petrol itself isn't helpful to the environment its far better for the environment to diesel powered vehicles. This is where newer methods of hybrid powered vehicles began to take the industry by storm where electric motors were used to power the vehicle with a backup petrol engine to help along the way. Thus, generating far less pollution to the environment. Now although this seems to be a great way forward, it's still relying off that supply of fossil fuel. **Khan.S (2017) *Petrol and Diesel Cars. The conversation.***



Back in 1997 it was said that new diesel-powered vehicles, although they were using burning fuels to work, they were far less damaging to the environment than petrol cars. Due to the fact of their lean burn meant they were able to get the same performance than a petrol engine working harder. The pollution generated from diesel powered vehicles were over the scale in comparison to petrol. Although petrol itself isn't helpful to the environment its far better for the environment to diesel powered vehicles. This is where newer methods of hybrid powered vehicles began to take the industry by storm where electric motors were used to power the vehicle with a backup petrol engine to help along the way. Thus, generating far less pollution to the environment. Now although this seems to be a great way forward, it's still relying off that supply of fossil fuel. **Khan.S (2017) *Petrol and Diesel Cars. The conversation.***

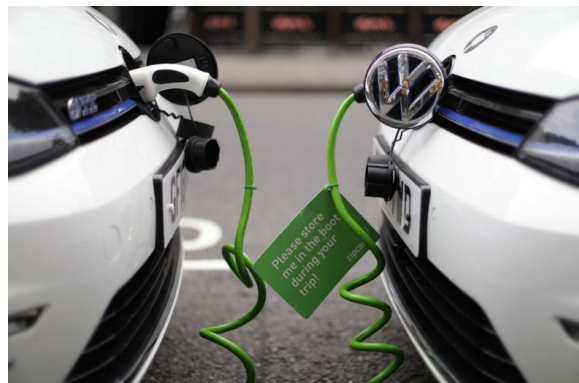
Now with most countries around the EU have implemented a way forward by demanding they are zero emissions by the year 2040. This meaning that petrol and diesel cars will be no more but what will take their place. Electric powered has been the highest priority with an onboard battery using an electric motor to power the wheels thus creating propulsion however it's not very reliable and with today's age of commuting and how the world works, depending on a battery isn't the best way to go. Yes, it's a possibility to charge the vehicle on the way however most don't have time to wait hours upon end to wait for their battery to recharge just to

continue on their way. Most batteries are designed to last around 300 miles of range depending on how the individual drives as well as it's terrain. Now this demand is not enough to please every motorist to transfer to electric due to its convenience. Now if a new battery were to be developed enough to last a much greater number of



miles, this would have a possibility in today's age. Tesla the car manufacturer is on the brink of a breakthrough with this product. They claim they are on the brink of a breakthrough to design a battery that can last around 1 million miles and over its lifetime to only lose about 10 percent of its energy capacity. A new lithium ion battery. **Musk.E (2019) Tesla new lithium ion battery. Wired.**

With the solution above sounding great it would still require to be charged just as any other electric battery would and its range would be about the same therefore there must be an alternative solution. One solution would Biofuel. Fuel such as bioethanol which can be used instead of petrol are made from corn and sugarcane, whereas biodiesel is made from vegetable oils and animal fats. Both of these fuels would replace non-renewable crude oil derived fuels. The best types are second generation biofuels which are produced from sustainable sources. Many consider this to be a great replacement in the medium-term solution. Now many electric cars have brake energy regenerative systems that convert energy normally wasted during breaking into electric energy. This is targeted to increase in the future to be seen in almost every road vehicle. Now heat is another. Two thirds of the energy generated by normal petrol- and diesel-powered vehicles is wasted through heat. Thermoelectric technology which converts heat into electric energy could help reduce waste and is actually under development by several car makers in the industry.



Hydrogen is now a huge possibility with the industry taking the route of electric powered vehicles most have considered hydrogen yet failed to continue developing this source of power. Hydrogen can be used instead of any normal fossil fuel in combustion engines. They give out no harmful emissions, only water this making the environment a better place. Hydrogen is also known to power fuel cells and produce electricity. This solution is considered to be the best alternative fuel in the long term. Its endless supply is what draws this to a possibility in the future alongside the zero emissions generated from this. The only downside to this technology at the moment is that it's rather expensive. **RAC. (2018) Top alternative fuels. rac.uk**

On a personal opinion I strongly believe that electric powered vehicles alone aren't necessarily the way forward. They clearly aren't adapting enough to withstand the demand from users as most don't have time to wait hours for a battery to recharge. Although the technology itself has proven itself to outperform current internal combustion engine vehicles it still hasn't taken the attention away from the users. If this method of propulsion was joined with another alternative source, it may have a strong potential to outperform as well as have the convenience of normal petrol and diesel cars.



The national grid has predicted the future use of electric vehicles and their demand which currently requires more power than can be generated in sustainable measures. A fleet of 35 million electric vehicles will help the United Kingdom to achieve its zero carbon target by storing renewable energy through large battery hubs.

The national grid predicts by 2050, millions of electric cars will rely heavily on solar and wind in order to charge the vehicles in question. The only way system would efficiently work is to accelerate the productivity of electric cars. Fewer than 200,000 of these cars are used in the UK. It's strongly believed that electric cars could hold up to a fifth of the UK solar power produced by our solar panels, and is expected to quadruple that amount over the same period. In order to make these methods more productive it requires far more renewable energy plants to power the vehicles in question. **National Grid. (2019) The Guardian.**

So, what is my major project? I'm targeting at creating a vehicle that will help the RNLI lifeguards carry out their duties to help save lives at sea. The vehicle in question will require the ability to perform well on the road as well as on loose terrain. This vehicle will also be required to adapt in which it can be used on water also. Now this is a challenge in itself to ensure the vehicle will meet the approval of the RNLI as well as my own approval. Ensuring that the vehicle can operate all year round is a possibility but not essential simply due to the fact that the lifeguards only operate during peak summer times. Currently they operate from a lifeguard hut



located on its numerous beaches around the United Kingdom. This meaning that the vehicles themselves can adapt to the different locations and different landscapes. I suppose the main question in which I need to answer is whether there is a demand for a vehicle like this, and in a nutshell the answer is fairly simple. YES. Although they're current vehicles are managing to deal with the tasks given there have been a few draw backs. There's the odd photo of current RNLI lifeguard

trucks captured on its beaches stuck which then ends in the loss of a vehicle. It's not that the vehicle simply can't adapt to its area but down to the fact that those vehicles weren't designed specifically for those tasks. As you see in the photo to the left: It shows an RNLI 4x4 stuck to prove that these vehicles could be either adapted or removed from the fleet with the potential for a new vehicle. The main purpose is that the vehicle can be used to patrol up and down the length of the beach as well as perform short distance surf rescue at sea. The RNLI have an alternative section which is the lifeboats but again these lifeguard units are normally situated at beaches further along down the coast away from the Lifeboat Stations, and with the danger of time at risk this would require the lifeguard to perform some rescues at sea.

The vehicle in question would need to perform ashore as well as offshore. Looking at the fleet of vehicles they currently have ATV's also known as quadbikes for their ashore aspect and jetski's for their offshore rescues. Now if it were a possibility to combine these two vehicles would not only sound a great idea there would be many benefits to this as well. For example, it would speed up the process of launching the vehicles into the sea where traditional methods require an ATV to pull the ski behind and reverse toward the water's edge in order to launch the craft. This meaning it takes time to do so in a safe and manageable way without causing any risks to the user as well as the need for two personnel, one to drive the ATV and one to drive the ski. This would mean there is one less lifeguard patrolling the beach during a rescue. A vehicle that could launch itself would only require one user as well as increase the speed of the launching and recovery. Following on from this it would then lower the running costs as it would only be one vehicle to run instead of two vehicles. In most cases you can't put a price on someone's life therefore the use of two vehicles is worth it, but if a vehicle could outperform or combine the two vehicles then why not? Not only is it the running cost but it's the maintenance of the vehicle itself. There wouldn't be needed to hire certain personnel to work on the ashore vehicle and another for the offshore.



Similar vehicles in the market would be the Gibbs Quadski. It works as an all-terrain vehicle as well as a jetski on water. The vehicle I'm hoping to make is similar in its concept but specifically adapted for the use of saving lives at sea. The Gibbs vehicle is mostly aimed at enthusiasts who want to experience both sides of shore and afloat however it's rather expensive and fairly dreadful to look at. Although it seems a great product it uses traditional propulsion methods as well as traditional tyres which do tend to sink especially due to the weight of the vehicle. The vehicle in question that I wish to make is aimed at aiding other at sea rather than to enjoy the experience. It will require to be nimble at sea as well as ashore this meaning the weight of the vehicle and its overall size. **GIBBS. (2013). Quadski XL. Gibbssport.**



One of the main features it will need to require is a casualty rescue board trailing behind which has proven to be very worthwhile and a useful piece of kit. This piece of equipment is designed rather than to pull the casualty on board the ski which proves to be quite risky especially in surf conditions, but it could cause further damage or risk to the casualty, possibly further cause

damage where a spinal injury may have occurred. By using this method, the casualty simply is pulled on and lies flat on the board. It's the simplest way and most risk effective. In the design itself this will be required to not look as a second thought which is seen in the traditional ski. Instead of it looking like a board that's been attached later on, I propose it to be part of the characteristics of the vehicle.

One of the biggest challenges I have been considering is whether to stick with traditional methods of off-road tyres or slightly more modern technology such as tracked vehicles. The issue with tracked vehicles is that they don't necessarily work all that great on roads where there is a large percentage of wear in the rubber which will make excessive repair costs for the vehicle, yet it proves to be much better off road than a circular tyre. However, the vehicles speed is normally restricted with a track system in comparison to a normal tyre. ***Tracks Vs Tires. (2018) MTD.***

Now most vehicles in the RNLI fleet use normal tyres which have proved to be the best all rounded option. I believe there are multiple options regarding the typical circular tyre shape with adaption to make the tyre better in loose terrain with the ability for them to gain traction much better but again this would cause further



maintenance and cost much more to build. I believe there is a few methods that may work which could be considered. There is a concept that the military have been working with Michelin to create airless tires where they are completely made of rubber and almost impossible to destroy enabling them to be robust in the harshest of conditions although in this instance I personally don't find them to be as beneficial in comparison to other methods. ***Michelin (2019). Michelin & GM unveils airless tires. Newatlas.com.*** The vehicle in question will be mostly on our beaches therefore the use on sand, loose surface terrain. The prospect of using traditional sand tires would be the first point of call although the downside of the high tyre wear once used on tar roads, meaning the vehicle would implement high maintenance costs in comparison to a more all rounded tyre. But as noted throughout my observations, sand tyres are what's currently in use and are not necessarily proving to be the best. ***Tyres. (2013). Wittenburg.***

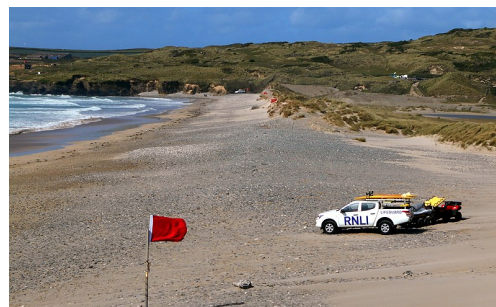
One method would be to follow the road of a “track n go” system. This is a system that allows normal vehicles to drive up and into these track adaptations allowing the vehicle to become a tracked vehicle. Downside to these is that this piece of equipment would be required to be transported around with the vehicle to the beach this meaning excess storage would be needed to carry such device. **TracknGO. (2013). Tracked vehicle systems. Trackngo.com**



The second method would be to consider a product that DARPA (Defence Advanced Research Projects Agency), are working on a system that allows a vehicle to have two methods in one. This means that it works like any other track system in a triangular shaped track for traction on loose ground with the ability to convert into a circular

shape and become a normal tyre. This meaning that the vehicle can be used just as any other vehicle on the road as well as the ability to perform just as well on rough terrain such as sand. Although this technology is still in its prototyped stage, I strongly feel that this will be the option for off-road vehicles in the near future. It's adaptable, robust and convenient. **DARPA. (2018). Tires to Tracks. engadget.com.** I strongly believe that this may be a consideration for the vehicle in question and its ability to adapt would be a great bonus to successfully develop a working vehicle.

The main design of the vehicle is aimed to be a fairly simple design. Due to the fact the vehicle will be used mostly on sand as well as in the sea it will require to be sealed tightly from the inside mechanics of the vehicle to the outside conditions. The vehicle is not something that will be used to gently drive around looking the part, instead it's designed to be robust to complete the rescue in the most efficient way



possible therefore a simple, yet strong design will enable the vehicle to tick the correct boxes. On the other hand, it wouldn't be right to create a design that's an eyesore to the landscape. Yes, they are there for a reason to protect others, but they would still require blending in with the landscape and its surroundings thus meaning bright colours would be a possible no, sticking to traditional colour schemes such as white, yellow and red. Similar to the work of artist Rob Mulholland, Mulholland is inspired to create pieces of art which blend with the natural world. Most of his work is interpreted by life size human cut outs made of mirror polished stainless steel to seek and explore the relationship we as humans have with nature and the world that surrounds us. In such a way of how we question our own individual relationship with our surroundings as the reflections twist and change with movement. Similar to the design language I'm trying to follow, to create a vehicle with a design that neither destroys nor react with the natural world avoiding

an eyesore and something that looks as if it were meant to be there. Of course, the vehicle in itself is an eyesore in comparison to a natural world however to minimize the effect of man-made and nature is a design language to take forward. **Mulholland.R (2019). The Hannah Peschar sculpture garden. hannahpescharsculpture.com**



I have personally observed the way the lifeguard's vehicles are used throughout the day and are typically spent ashore in one idle location for long periods of time until requested to be used. Now this is a plus side rather than them being used to drive up and down the beach wasting fuel and emitting carbon dioxide throughout the day however this draws in a question. If the vehicle is spent throughout the day idle until required, this would mean that they could possibly run off electric powered as they aren't covering large distances and normally return to the specially designed huts along the beach. Then it occurred to me as to why can't

they be electric and return to a central hub to charge their batteries whilst not in use? I looked at products such as the robovac. Now this product is designed to do one thing and that's to clean the floors completely automated. Once its duties have completed it returns to a specially designed hub to charge until needed next time. This got me thinking, why can't this be implemented into my design. Whilst the hub could be part of the hut themselves then why can't the hub itself have solar panels and wind turbines in order to charge the vehicles in question. The lifeguards only work during the summer months which is normally the nicest weather of the year enabling the use for solar panelling. They are also situated near the sea which means the wind naturally generated is stronger than inland areas then a small wind turbine could also be a consideration. **Robovac. (2019). Anker innovations. eufylife.com**

With all the shore side aspects covered it still remains one issue from my observations with the rescue aspect. When the lifeguard skis are called into action, when in the water normally it's just the one person in difficulty but there have been numerous occasions where there are more than one. This meaning that the rescuer himself is required to make those ethical decision of who to rescue first which most of the time is a straightforward decision however this can be a life or death situation. Then why not have a system for more than one person? Although it's only one rescuer on board the ski at any time it's difficult to help more than one person at a time. By using wildlife for inspiration specifically the water striders, they



are known as the insects that can walk on water. It occurred to me that a system of rescuing more than one person would be considered. It would work as part of the ski itself with a retractable arm enabling the casualty not to be pulled from the water but an aid to help them float whilst the rescuer is dealing with a casualty. This takes away the ethical decision away from the rescuer himself. With this kind of equipment on board would mean that it's possible to rescue multiple casualties all at once or aid them until another unit of the lifeguards were to arrive or the lifeboat crew themselves. ***Water Striders. (1936) National Wildlife Trust.***

To conclude the project in itself is to develop a vehicle alongside the RNLI to create a vehicle that helps save lives at sea. The current vehicles in their fleet have been an extraordinary piece of kit but are sadly outdated with the evolution of time and modern technology making them obsolete. The current ATV vehicle works perfectly and will continue to do so for years to come, very similar to the RWC watercraft where it has saved many lives over the years and will continue to do so but a product that can do both would mean there would be less of the current vehicles



and more of the new upcoming products of the future. The number of people and animals the RNLI have saved over the years is climbing every year with more people in need of help it's good to know an organization such as the RNLI is there to help save those lives. To develop a vehicle which can help do so will be a huge benefit to the army of RNLI personnel. It's to create vehicle with one objective in mind and enabling that it can successfully

deliver that service. By following my specific design points to create a vehicle to answer the question in need. In my conclusion I am hoping to create an all-terrain vehicle that will take the RNLI into the next century with new innovative materials and technology and the ability to adapt into a water propelled rescue craft. The future as we know it is driving towards a clean and sustainable world therefore it's out with the old internal combustion methods and in with the new hydrogen fuel celled and electric motors. I strongly believe this is the future of the automotive industry with the ability to outperform any previous vehicles of the past. A vehicle that will speed up the rescue service by removing two separate vehicles into one. Although an adaptable tire seems like the way to go it's still considered to see what a tracked vehicle were to look like similar to the DARPA contraption which was designed to be both.

It must have the ability to have a rescue board to help casualties in the sea but without looking as an afterthought, as if it were part of the design. Although the Gibbs Quadski is already a developed product and is in production, a vehicle in question would make the Quadski obsolete with the new adaption of a surf rescue

vehicle. The vehicle would need to be able to handle in the toughest of conditions ashore as well as afloat this meaning it's design will need to be robust and everything for a reason. It would need to carry the appropriate lifesaving equipment without being an eyesore. Yes, these vehicles are designed to rescue but if they could be environmentally friendly it would be a bonus. Most importantly is the ability to rescue more than one casualty at a time is essential. The ability to remove the ethical decision away from the rescuer is a must and I will ensure that the design follows this strong point. By following the above design points, I am hoping to achieve a vehicle that answers all the questions in which the brief asks. To explore new and innovative designs that takes the design language for years to come. Making previous products obsolete and this the replacement of life saving.

From a personal point of view, I feel very passionate towards a project like this as it's influenced a large part of my life especially since I was sixteen years old when I joined the RNLI as a crew member and continue to do so to date. I have been in those situations of a rescuer and sadly been in some horrific instances also therefore by doing a project like this it's a close part to me and I feel strongly to help develop a product to help aid and save lives at sea. I strongly believe that this project will be a success by using my very own personal research and experiences with secondary research. This project has yet to be developed by others in which I strongly hope that from my very own emotional feelings and personal observations and experience I can develop this product in a professional manner enabling a successful outcome.



Bibliography

Bennett.S (2019) The gravity defying art that washes away

<https://www.bbc.co.uk/news/uk-england-devon-47318521>

DARPA. (2018). Tires to Tracks. engadget.com

https://www.engadget.com/2018/06/25/darpa-reconfigurable-wheel-track/?gucce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&gucce_referrer_sig=AQAAAHxGfeCf_WVIDtx0Ccas5sIaM0rEZms6gWgevJcgtQjX5rr-7Iwj6LMHcY91ThuBjy5aa6xOKxa9AKzeTGkUq0UddGVpAle933nQafPLVo9x2XPx8fF2EVQuGgeRij9ct9GwBa6lHM_et4T-KJkU8afMuizNLmZMeR5adxVTsdIn&guccounter=2

GIBBS. (2013). Quadski XL. Gibbssport

<https://gibbssports.com/quadski>

Grey.A (The Pioneer of Stone balancing Art) Stone Balancing

<https://www.stonebalancing.com/about-my-art/>

Khan.S (2017) Petrol and Diesel Cars. The conversation

<http://theconversation.com/fact-check-are-diesel-cars-really-more-polluting-than-petrol-cars-76241>

Michelin (2019). Michelin & GM unveils airless tires. Newatlas.com

<https://newatlas.com/michelin-gm-uptis-airless-tire/60004/>

Mulholland.R (2019). The Hannah Peschar sculpture garden.

hannahpescharsculpture.com

<http://www.hannahpescharsculpture.com>

Musk.E (2019) Tesla new lithium ion battery. Wired

<https://www.wired.com/story/tesla-may-soon-have-a-battery-that-can-last-a-million-miles/>

National Grid. (2019) The Guardian

<https://www.theguardian.com/environment/2019/jul/11/electric-cars-could-form-battery-hubs-to-store-renewable-energy>

RAC. (2018) Top alternative fuels. rac.uk

<https://www.rac.co.uk/drive/advice/emissions/alternative-fuels/>

RNLI (2018). Operational Statistics Report. rnli.org

<https://www.google.com/search?q=rnli+statistics+2018&oq=rnli+statistics+&aqs=chrome.0.0j69i57j0l4.7091j0j7&sourceid=chrome&ie=UTF-8>

Robovac. (2019). Anker innovations. eufylife.com

<https://www.eufylife.com/uk/about>

TracknGO. (2013). Tracked vehicle systems. Trackngo.com

<http://trackngo.com>

Tracks Vs Tires. (2018) MTD

<https://www.moderntiredealer.com/article/732363/tracks-vs-tires-how-to-know-which-is-best-for-your-farm-customer>

Tyres. (2013). Wittenburg

<http://www.wittenburg.co.uk/OffRoading/Concepts/Tyres.html>

Water Striders. (1936) National Wildlife Trust

<https://www.nwf.org/Educational-Resources/Wildlife-Guide/Invertebrates/Water-Striders>

