RESEARCH REPORT FOR

DESIGN CONCEPTS 1

Rescue Vehicle

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Module: THD1226
Tutor: G Stockton
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Major Project Brief

Name: Rescue Vehicle

Brief Number: 1

Type of Transport Solution: Amphibious vehicle

Launch Date: 2016

Market:

Research into Nature disasters has highlighted the three main types: Tropical storms, earthquakes and flood. In addition to this, the major locations were these are most damaging are in the North American region and the Asian continent. As there is a higher population in Asia, the vehicle will operate in this particular area. This vehicle will be owned and operated by Aid groups that operated in the area hitherto mentioned location. As a result of this, the vehicle will need to meet there specifications.

Project Overview:

Concept 1 aims to bring first aid, medical assistance and water supplies during times of crisis. The vehicle will be designed to deal with difficult terrain and incorporate amphibious capabilities to meet the problems of today's situations. The vehicle will also serve as a transport for those in need of medical attention. The purpose of this vehicle is to meet the growing property damage and effects on peoples life's from natural disasters as a result of population increase. Natural Disasters affect more people and course more damage than man-made disasters. Therefore the vehicle will be design for these scenarios. It will be manufactured for today's market to be on sale by 2016. It will also be designed with the future in mind to meet the rising threat of these disasters.

Project Considerations:

A vehicle has to be affordable for aid organization and need to be efficient and relatively simple to operate with low maintenance. The vehicle should be able to rescue people from flood water without the need of recuse craft. This will save valuable time which can mean the difference between life and death. Communication is vital. There are problems with communication today which causes delays in the aid operation.

- Needs to be able to be transported by air to disaster location. Width needs to be no larger than coach size for example to allow vehicle to fit into cargo plane
- Meet the operating aid organizations specifications
- Adequate aid supplies
- Prepared to deal with a variety of scenario
- Be able to deal with inoperable supply roads. Divert to rough terrain and water.

Contents

1. DESIGN CONCEPT 1

1.1 PRIMARY RESEARCH

The conductions of questioners would be meaningless for this type of research as the data collected would not be of any relevance without traveling to an effected area and conducting research there. The natural disaster area is challenging to find qualitative data and quantitative data would not show the true facts.

Ryan Sinton <ryansinton@googlemail.com> Nov 21

to information

My name is Ryan Sinton. I am a final year transport designer at the University of Huddersfield. An area that I am researching is a rescue vehicle to help aid efforts during natural disasters. I have determined through research that natural disasters cause the most damage and lose of live; the three main types being Earthquakes, tropical cyclones and general floods.

I was wondering if you could tell me any information such as general issues/drawbacks that you may have found with current rescue vehicles used in and improvement which could be make. Also, in your opinion, are there any limitations with the current, vehicle and rescue methods that a new vehicle could solve? This information may be vital for the development of the concept. If you have anything else to add please feel free to do so.

Sincerely,
Ryan Sinton

Figure.1 R, Sinton (2013)

Figure 1 is an email sent to the Red Cross. Its purpose was to ask question and to obtain a response from the agency in regards to the types of vehicle they use for natural disasters and problems they may have with current technology and existing vehicles. Figure 2 is the response to this email. The response did not have much significance as its instruction was to contact the local office with this query. The local area office deals with the small area in which it is located and not rescue support for the Asian continent in which the report forces on.

Many thanks for your email and interest in the British Red Cross.

You will need to contact your local office with this query. The details of your local office are:

Yorkshire

The British Red Cross provides a wide range of services throughout the Yorkshire area.

Carrick House
Thurston Road
Northallerton
DL6 2NA

01609 772186

Naeem Khan
Information Resources

Figure.2 N, Khan (2013)

INTERVIEW OVER SKYPE WITH MEDICAL STUDENT.

Michał Wasiak; a 5 year medical student at Medical University of Warsaw, Poland.

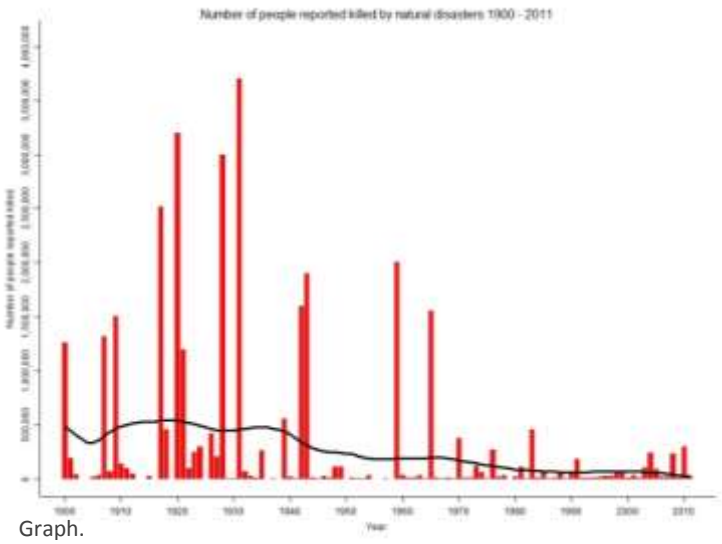
Michal has experience will medical practises and understands what the essential equipment to use when working with limited space. As part of his studies he works in the hospital for two days of the week, were be acts in a doctors capacity and assists in surgeries and other medial functions.

IMPORTANT FEEDBACK FROM DESIGN REVIEW BY MICHAŁ.

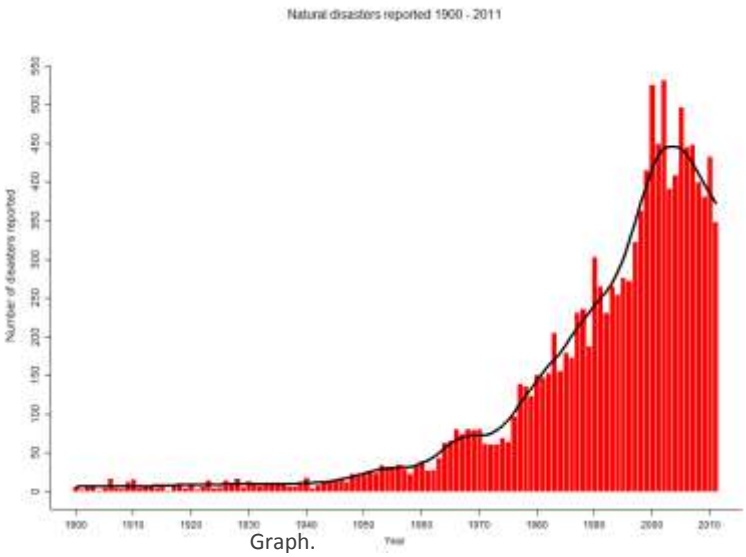
- *"The overall design its good. A good idea that could work."*
- *"The opening for the cabinet shouldn't be glass but a synthetic material"*
- *"The cabinet should continue down the work counter. Wasted space underneath and could be a hazard from the edges of the unit."*
- The operating theatre*: "all operating theatre and tables have the same layouts."*
- *"Good that it is separated from the rest of the medical section."*
- *"Needs a table for tools. Well fixed for sergeant and nurses equipment."*
- *"Curtain for separating the theatre from the rest of the medical area."*
- *"Need slues/ flood gates for a sterile environment."*
- *"The sinks position needs to be moved."*
- Flood gates section: *"sterile gloves and gown."*
- *"Needs ultrasonography machine- not so big and lighter than X-ray."*
- *"Needs flat screen TV on a swinging arm to see operations and medical data. Endoscopy can be used with this TV."*

This is all importance information and the alterations and improvements will be implemented if this vehicle design is advance any further from the concept stage.

1.2 SECONDARY RESEARCH



Graph.



Graph.

Graph.1 above show the Number of deaths by natural disasters from 1900- 2011 are decreasing even though Graph.2 shows that the number of people affected by natural disasters is increasing.

With the increase of natural disasters as a result of climate change; today's existing rescue vehicles will not be able to handle the amplified demand and the extreme conditions of the situation. As a consequence, they cannot cope with the increased number of victims.

> *Nature disasters account for the biggest majority of disasters in the world. The three main types of (natural disasters) that cause the largest economic damage: earthquakes, tropical cyclones and general floods. (Kron et al., 2012: pp. 544–545).*

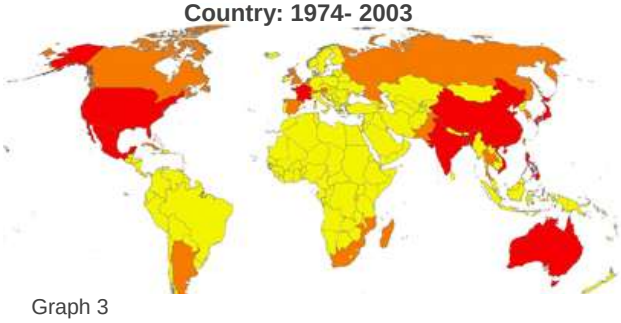
The table and graphs below classify the regions of the world were the vehicle will be most needed. They show the two main hotspots were natural disaster are more frequent: American and Asian continents.

Continents that have seen high (red) disaster rate of Windstorms, Floods and Earthquakes 1974- 2003

Disaster Types	North America	South America	Europe	Africa	Middle East	Asia	Australia
Windstorm Disasters							
Flood Disasters							
Earthquake Disasters							

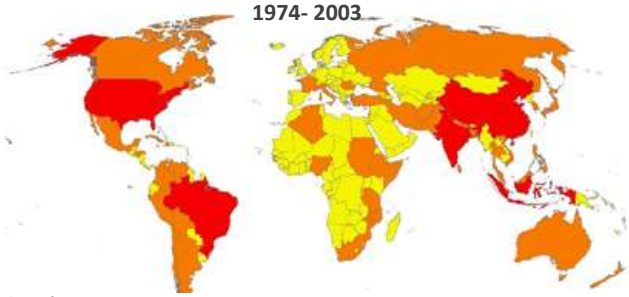
Table 1

Number of Occurrences of Windstorm Disasters by Country: 1974- 2003



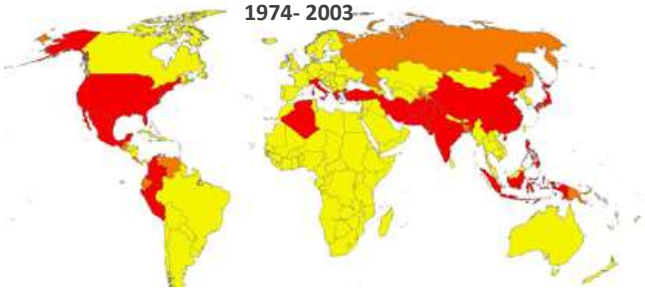
Graph 3

Number of Occurrences of Flood Disasters by Country: 1974- 2003



Graph 4

Number of Occurrences of Earthquake Disaster by Country: 1974- 2003



Graph 5

Countries in the identified areas:	Left hand drive (drive on right)	Right hand drive (drive on left)
Eastern Asia	**Population**	
China	1,338,100,000	
Japan		127,400,000
Korea (North/ south)	71,700,000	
Mongolia	2,800,000	
Taiwan	23,200,000	
Northern Asia		
Russian Federation	141,900,000	
South-Central Asia		
Bhutan		700,000
India		1,188,800,000
Maldives	300,000	
Nepal		28,000,000
Sri Lanka		20,700,000
South-East Asia		
Brunei Darussalam		400,000
Cambodia	15,100,000	
Lao PDR	6,400,000	
Myanmar (Burma)	53,400,000	
Philippines	94,000,000	
Singapore		5,100,000
Thailand		68,100,000
Vietnam	89,000,000	

Table.2

Countries in the identified areas:	Left hand drive (drive on right)	Right hand drive (drive on left)
North America	**Population**	
Canada	34,00,000	
Mexico	112,000,000	
United States	313,000,000	
Central America		
Belize	300,000	
Costa Rica	4,600,000	
El Salvador	6,200,000	
Guatemala	14,400,000	
Honduras	7,600,000	
Nicaragua	6,000,000	
Panama	3,500,000	
South America		
Argentina	40,500,000	
Bolivia	10,400,000	
Brazil	193,300,000	
Chile	17,100,000	
Colombia	45,500,000	
Ecuador	14,200,000	
French Guiana	200,000	
Guyana		800,000
Paraguay	6,500,000	
Peru	29,500,000	
Suriname	500,000	
Uruguay	3,400,000	
Venezuela	28,800,000	

Table.3

There are over three billion inhabitants in Asia (excluding the Middle East) and over nine million inhabitants residing within the American continent. Therefore, the main region to focus will be Asia more people are likely to be affected by natural disaster here. From the table of the Asian countries it is clear that there is and almost even split between left or right and hand drive countries and population. Consequently, there needs to be two versions of the proposed vehicle; one for the left and the other right side of the road.

The Rescue vehicle can help in relief efforts as a result of a natural disaster(s). Presently, most rescue vehicles in use today were not designed specifically for rescue. They have been modified to fit the purpose. This leads to problems. These vehicles were originally designed for a different use and not initially intended for the unique situation. With the constant increase of these disasters; more and more issues may occur.

> *"Disaster causes damage to channels of resource distribution. Develop a system of storage and distribution that would be least disrupted by roadway, rail, sea and air distribution of resources." Kumar, (2012, p.10)*

If the vehicle can overcome this distribution of roadways by either going off road or diverting through rivers and flooded land, then aid will arrive sooner and more people can be helped quicker.

In a report by Kumar, 2012, he states that the worlds capability to react to these disasters or being stretched. A new solution will be needed in order for aid groups to have the ability to deal with these events.

> *"The world's capability to respond to these large scale disasters is already being stretched, and with increasing population growth steps need to be taken by governments and aid groups." Kumar, (2012, p.3)*

> *"In Japan, the vast majority of people were not killed and the greatest damage was not caused by the earthquake itself, for which Japan is well prepared, but by the ensuing tsunami, for which it is not. It would have been possible but extremely expensive to protect Japan's coastline against waves of such height." Neumayer, E., (2013, P.3)*

According to Neumayer, the cost for this type of infrastructure is too expensive of most government to implement, a different situation is required. If the communications and warning systems are improved and then integrated into a fleet of reasonable affordable vehicles; then they will be able to reach affected area quicker than the response times of current rescue vehicles.

Equipment for rescue vehicle:

I.V. supplies, Burn kit, Paramedic bad x 3(First in equipment), Towels/ Foil, Linen, Airway management and drugs, Oxygen unit (control panel and suction unit), Disposable gloves, Cardiac monitor/ defibrillator unit (portable)

Img.16

1.2.1 EXISTING VEHICLES & CONCEPTS

This is a broad look at the different modes of rescue vehicle from land, air and sea. Img.17 is actually concept camper van. I included it in this mood board because of the functionality and how it makes the most out of a small space. Img.18 Mercedes-Benz G-Wagon LAPV 6.X Concept is an armoured patrol vehicle which can transport cargo of 1.3 tons. Img19 in an amphibious Rescue Craft helps deliver to flood and cyclone affected areas. (Student project) Img.20 Robotic disaster rescue vehicle. Img.21 The GHE-O Motors RESCUE off-road vehicle can deal with tougher terrain than most vehicles. Img.22 is a vehicle to evacuate people from tall buildings (student project). Img.23/24 is an all-terrain, 8 wheeled vehicle with different type of uses and attachments. Img.25 amphibious rescue craft. (Student project) Img.26 Hummer rescue vehicle. Img.27 Matra Rescue Vehicle. Img.28 Sealegs Unveils Amphibious Rescue Craft. Img.29 Tokyo fire department rescue robot finds person. Img.30 Hovercraft for ice rescue. Img.31 Amphibious helicopter.

Concept 1

Rescue Vehicle

Img.3

Img.2

Img.32

LARC V - (Lighter, Amphibious Resupply, and Cargo) features:

•Built 1952- Ex-military

•Construction: Aluminium

•Speed land: (high range) 50 km/h

•Speed land: (low range) 13 water: 14 km/h

•Length: 1007 width: 305 height: 310 cm

•Weight: 9500 load: 4550 kg

Rosloot H, (2011)

GHE-O leading competitor features:

•All-terrain and weather.

•Capacity: 11 people.

•620L water tank pneumatic pillows on wheels for a better floating on water or snow

•Petrol 340 to 500bhp, or diesel 218bhp or 304bhp

•Weight of 3.2T

Fox News, (2013)

EDAG Amphibian Lifeboat- (amphibian quad)

•For flood victims

•Room for 10 people

•Can carry 910kg

•Retractable Wheels

•Land or water

•Small and easily transported to intended area.

•Shallow draught

"The hull of the boat is based on the catamaran principle, guaranteeing greater stability."

(worldcarfans, 2007)

Img.33

Img.34

Hummer Rescue Vehicle

- A very adaptable platform for different situations. Not amphibious and cannot deal with extreme terrain and conditions; has small passenger capacity.

Land Rover-Emergency Service

- A very adaptable platform for different situations and uses. Not specifically designed for rescue and emergency situations; just adapted to meet the need.

1.3 CONCEPT DEVELOPMENT

Img.42- rendered front 3 quarter

Img.43- rendered rear 3

Img.42 final render 2. Photoshop render using underlay. Everything created from scratch. To create the cloud effect I made a custom brush (which is actually a bubble effect brush) lowered the opacity and flow. Then add grey colour, blurred and stretched image.

Img.43 final render 3. Photoshop render using underlay. (Created in a similar way to Img.23) Everything created from scratch. To create water I used the 'render- clouds' filter. The next step was to stretched and added perspective to it. Then 'filter- chrome effect' which makes it looks like water. I created the reflecting by saving the water layer as an adjustment file then add a distortion to the reflection to make it flow with the water layer.

1.4 DESIGN PERFORMANCE

The design needs to reflect strength and reliability. With this the design needs to seem approachable. The vehicle cannot be too dominating and overpowering; people in a state of panic are highly alert and constantly on edge. If the vehicles appearance looks dominating, at that point the rescue situation will appear more dangerous than it may actually be.

3.5 TECHNICAL PERFORMANCE

Technical aspects such as handling, suspension, drive train, and vehicle set up and the technology needs explained.

Amphibious: The vehicle will use this capability to rescue people from water. Of the problems identified was the time it takes to rescue someone from water. Using a boat and then transferring them to an ambulance. The vehicle will carry out both tasks. See img.00 and img.00 below.

Img.44

Img.45

Drinking water supply (water, salt and sugar solution) + saline (sterile water)
First aid and immediate medical assistance with moderate equipment
Crew of 3: driver, 2 medics
Stretchers x 6 approximately
General debris clearing and rescue equipment: cutting tools, winches, breathing equipment

Communications: one of the most important parts of any operation. This is often disrupted, creating delays and miscommunication.

1.6 USER PERFORMANCE

The vehicle would either be owned by the local government of the affected area or by rescue organizations such as the Red Cross. Therefore as well as the rescued users, the vehicle also needs to take into consideration rescuer users too.

The way the users interact with the vehicle needs to be thought about. Considerations need to be recognized for the use of doors; how the work and how the will work on the water. Detect any problems which may hinder the functioning of these doors.

The way the space is used is a huge part of this design. The users need a lot of easily accessible equipment, however, this equipment's needs to be stored correctly to maximize the limited space.

Maintenance and ease of access to the drive train and marine equipment is vital. In operation in difficult conditions, the vehicle will need to be well maintained to ensure the optimal functioning level. Hatch ways in the cabin the expose the engine bay and marine equipment are needed in order to guarantee this requirement.

1.7 RECOMMENDATIONS & FUTURE WORK

Clarification on the drive train, vehicle size, weight and cost needs to be evaluated. A vehicle spec is necessary to illuminate this. The space needs to be designed for the passenger's interaction. The placement of equipment, desks, work stations, switches etc. all these fundamentals elements need further investigation.

Recommendations	Future Work
Design a vehicle for purpose. Not like today's solution of adapted vehicles.	Use gathered data to show how this is needed.
Be able to right itself if capsized. If the vehicle could be designed to not capsize but there is always the change of a second storm and a large enough wave can capsize any vessel.	Research existing technology on this subject.
Appeal to the aid organization that will use it. Needs to meet their requirements.	Use the contacts. The aid organization can give insights into their requirements from a rescue vehicle. This will give the vehicle substance and reliable prof for its design.
Vehicle needs to be able to avoid closed supply roots (MSR)	Look into how rescue vehicles at present deal or hindered by this scenario.
Needs low centre of gravity. For stability on land and water.	Look into existing vehicle and water specific vehicles
Internal medical section stays level even if vehicle roles over.	This idea might be overly complicated and may be abandoned.
Needs good ground clearance. For avoiding debris and traveling though flood water.	Identify the optimum height.
All-wheel drive for mobility over debris.	Gather data on this area.
Adaptive active suspension will keep all its wheels firmly to the ground and provide good traction.	Look into existing technology and learn how it can be used here.
Water proofed diesel engine.	Research drive train and other components required for an amphibious vehicle.
When roads are damaged due to flooding and landslides, supply roots are stopped and aid is postponed. The vehicle should be able to travel off road and rough terrain and water if needed to avoid this problem.	How is this possible? What weight will this add to the overall weight of the vehicle?
Adequate equipment for rescue required	Investigate specific equipment, how and where it will be stored in the vehicle.
Vehicle should be able to treat more people at once then current vehicles.	How many casualties are helped with in a given time frame?
Need to look at boat safety requirements	Obtain correct documents on this matter to make sure the vehicle meets the specifications.
Amphibious capabilities	Investigate- the CAMI Terra Wind Amphibious Motor-coach

TECHNICAL REPORT THD1342

RYAN SINTON

Contents

1. Vehicle/ Product Statement and Package Drawings

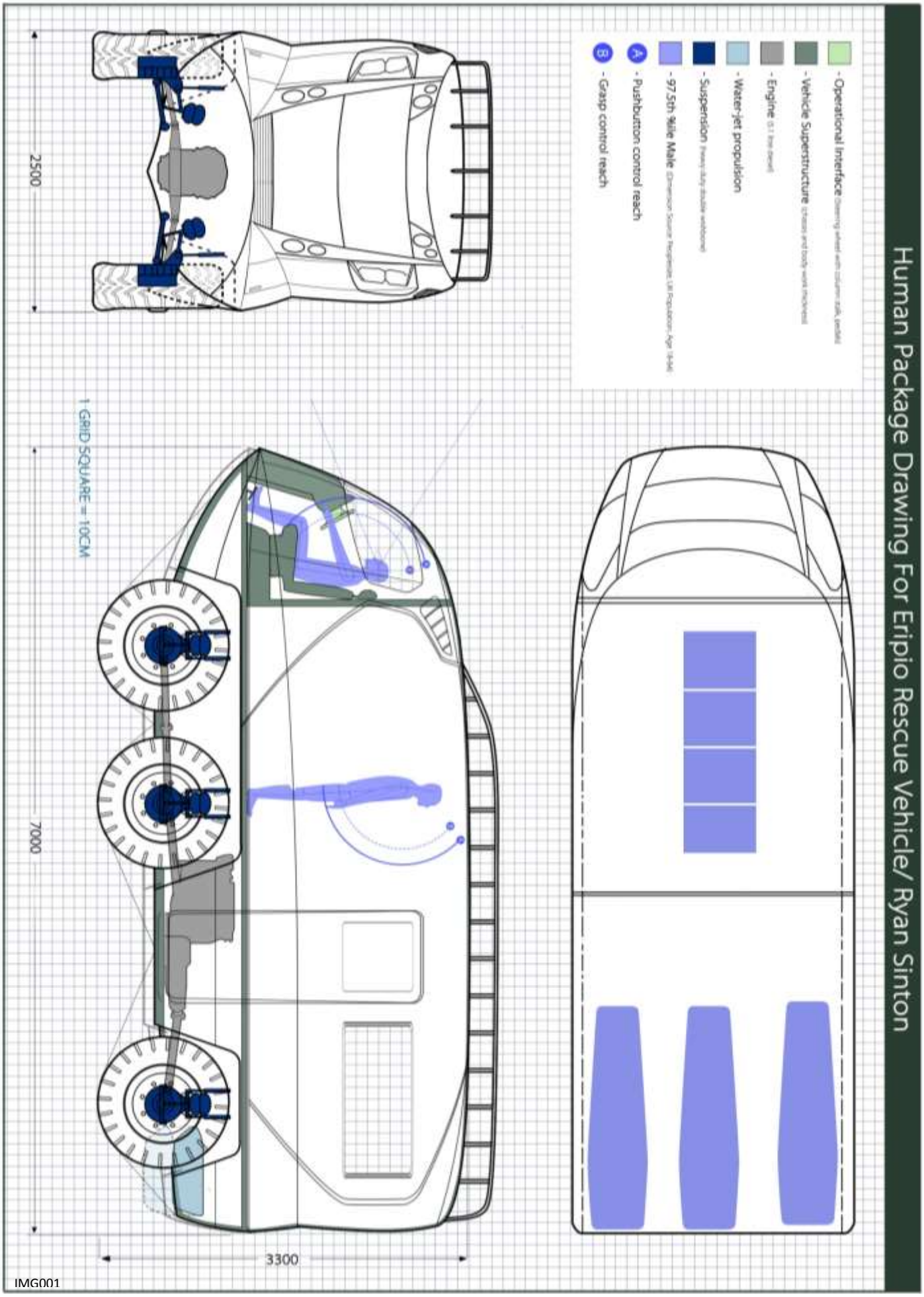
1.1 Product Statement

This vehicle will be design to bring aid: fresh water supplies, medical assistance and evacuation of casualties of natural disasters. It will have a crew of three: a driver/medic and two additional medics. The vehicle will be designed to deal with difficult terrain; having off-road and amphibious capabilities to overcome current problems of inoperable supply roads and flooded land. The vehicle will be manufactured for today's market, to be ready by 2017. It will also be designed with the future in mind to meet the ever increasing severity of these disasters.

1.2 Vehicle Specification

Specification sheet	
Product Name:	Eripio
Model Specifications:	
Fording Depths (m):	Fully amphibious
Engine:	5.1 litre Diesel (OM 934 LA - 5.1L Engine, standard) (option)
Water propulsion:	Water-jet (Hamilton HJ212)
Chassis:	6x6 or 8x8 hull-chassis combined
Ground clearance:	0.5m
Tyre size:	P365/70/R18. Overall diameter: 116cm, section width 36cm
Suspensions:	Heavy duty double wishbone- hydraulic shock absorbers and air ride (allows vehicle to lower to allow ease access when in situ)
Vehicle Dimensions:	
Length:	7m, standard (8.4m, option)
Height:	3.3m
Width:	2.5m
Hull dimensions:	
Waterline Length:	6.7m, standard (8.1m, option)
Draft: (height- to waterline)	0.8m
Beam (width at waterline):	2.3m
Performance:	
Total Vehicle Weight:	4.55 tons (4.8 tons, larger option)
Land speed:	70mph
Water speed:	30 knots

TABLE001


Human Package Drawing For Eripio Rescue Vehicle/ Ryan Sinton
- Operational interface
- Vehicle Superstructure
- Engine
- Water-jet propulsion
- Suspension
- 97.5th %ile Male
- Pushbutton control reach
- Grasp control reach
2500
7000
3300
1 GRID SQUARE = 10CM

IMG001

2.1 Design Objectives

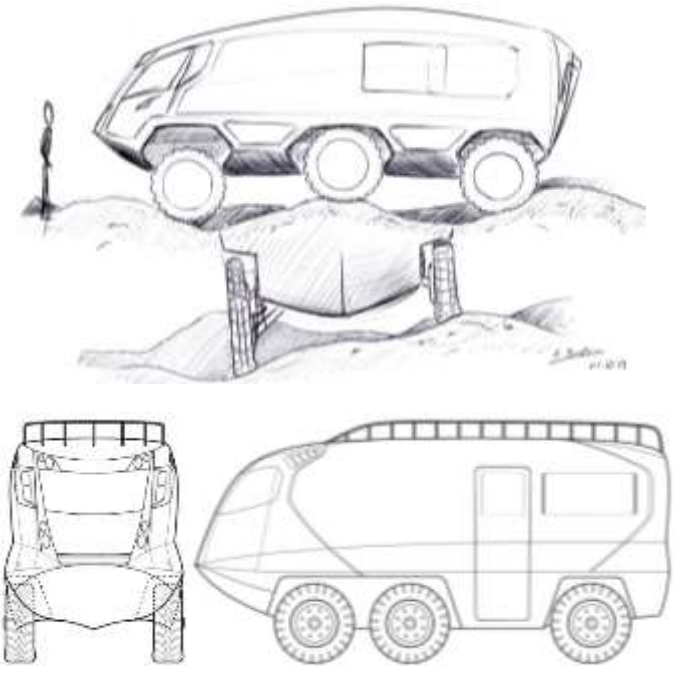
The objectives for this program are to design a vehicle that will aid in rescue at a natural disaster site. The vehicle will be a first response/first in vehicle and thus must provide initial medical supplies, first aid and fresh water to help relief efforts before air drops arrive. The vehicle must be able to provide a basic operation room to treat casualties on site. The operating table, chair and equipment needs to be able to fold away and the interior wall slide to one end of the vehicle. This is for when the operating room is not in use, creating more space for casualties. The vehicle should be able to carry 6 casualties on stretchers or 20-30 non-critical casualties when the stretchers are folded away.

To overcome the delays in current rescue operations as a result of damage or inoperable roads, the vehicle will have off-road and amphibious capabilities. With this capability, rescuers will reach the site faster. The vehicle will also be able to save casualties from water which would speed up rescue time; from boats to stretchers then land vehicles will be reduced to just the one vehicle.

2.2 Design Development

The original aims of this project were to design a vehicle that could reach a natural disaster site; supplying victims with first aid and medical assistance. The vehicle's aim is to bring this aid even if the roads were inoperable. The vehicle was intended to overcome problems with today's rescue vehicles by speeding up rescue time through diverting around the obstructions, traveling off-road and on water.

IMG001 and IMG002 show the original sketch and the final design.



The major changes that can be noted from these images are firstly the wheel placement. The vehicle was always intended to have six-wheel drive, but the middle axle has been repositioned forward. If the axle was positioned in the middle the wheels would be dragged when turning corners, causing loss of traction and wearing to the tread. Secondly, it improves the hull design. This new orientation of the wheels reduces the wheel arch cut outs in the hull from 6 to 4 which lessens the amount of drag cause by these cut outs. Thirdly, it helps the vehicle when exiting and entering the water. If the vehicle had just 2 wheels at the front, the front of the vehicle would dip underwater and also the vehicle may ground out. However, with 4 wheels at the front, the vehicle has more ground clearance and the traction will be improved as well. A test has been conducted to demonstrate this. (See sketch model on page 10)

Other changes:

- With the wheels repositioned, there was room for a side door which allows for extra access to the rear of the vehicle.
- The overall profile has been improved to maximise interior space while still keeping its distinctive look.
- The wheel size has been sized up to give the vehicle more ground clearance which also adds more buoyancy in water through the increase of air in the tyres.
- The overall size has been reduced to make the vehicle more manoeuvrable so it will comply with the regulations of the country the vehicle will be operating in.

The sketch model was created using the package drawing dimensions; the scale of the model is 1-31. The model is constructed from foam board; the hull has had a plastic layer glued to its surface to make it watertight. The tyres have also been wrapped in plastic to seal in the air; simulating tyres.

The displacement of the model was calculated to allow it to have the optimum buoyancy in the water. Coins were used as ballast in the hull of the model. The stability in the water was achieved by adding or removing these coins until the draft was at an acceptable level in the water.

In theory, this test model proves that the vehicle will work and float on water.

2.3 Design Evaluation

	Has the vehicle meet the original goals	Max 10%
1	Amphibious capabilities	10%
2	Proving First aid, medical supplies	9%
3	Improve upon existing rescue vehicles: off-road/amphibious	9.5%
4	Be able to transport more casualties and victims than other vehicles	8.5%
5	Have an internal section which remain level when the vehicle is rocking on water	0%
6	Have 6 wheel drive	10%
7	Carry food and water supplies	5%
8	Be an adaptable platform for other uses and organizations	10%
9	Small theatre for operation and compensate for damaged hospitals or long distance	10%
10	Have a crew of 4-5 doctors/medics	8%
		Total
		80%

3. Technical Description

3.1 Drivetrain

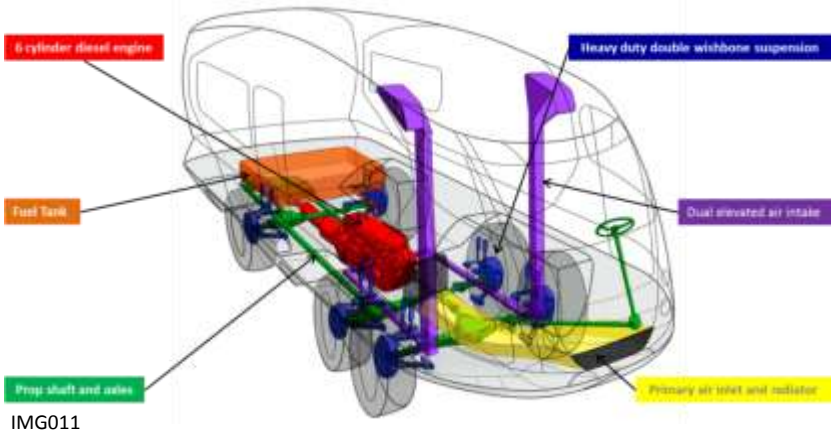
Engine:

The engine will provide power to all six wheels (all eight Wheels- for 8.4m version). When in water the engine will drive the water jet unit.

OM 934LA- 5.1 Litre diesel engine (OM 936 LA- 7.7 Litre diesel engine- for 8.4m version). These engines are from Mercedes-Benz. The engine is used in their new Otego. The engine comes in seven power ratings from 15 kW (156 hp) to 220 kW (299 hp). It has been designed to improve fuel efficiency and to maximize driveability. The engine also has low noise, low emissions and had 5% more fuel savings than previous models to meet Euro VI standards. As this vehicle is intended for water a marine conversion or the marine equivalent will be required.

The engine will be situated centrally and as low as possible on the chassis to maximize stability and the performance of the vehicle when in water. The power will be distributed to the two forward axles and the real axle evenly. (Information on the engine sourced: mercedes-benz.co.uk)

The engine cooling will be provided by a snorkel on either side. (See IMG001). The main grill will be used primarily as a water vent. When in water the bow wave enters this vent, it will pass through a sealed section between the hull and the engine. This vent then leads directly into the water jet unit situated at the rear of the vehicle (see IMG001 and IMG013).



IMG011

(Note: this is an earlier iteration of the drivetrain. Minor changes have be made: the main being

Suspension:

Heavy duty Double wishbone will be used. This type of suspension is often used on off-road vehicles for its ability to keep the tyres glued to the ground in spite the uneven surface. The suspension element will be provided by two side action telescopic shock absorbers attached to the upper control arm and a torsion bar on the lower control arm. (For detailed drawings and images of the suspension see appendix 2). Air ride suspension will also be integrated with the main suspension units to provide the vehicle with adjustable ride height, allowing the vehicle to lower (when stationary) for easier access. The suspension is attached to the outer hull to minimize the number of openings in the hull. This reduces the amount of sealing points needed to maintain water tightness. The hull is a steel construction which is integrated with the chassis so it will be strong enough to support the vehicle and suspension mounts.

This suspension type is on use on an existing vehicle which has been used for reference and inspiration for its undercarriage assembly. The Russian built BTR is a military transport vehicle. The vehicle is amphibious and has a boat like hull. The original vehicle was built in the 1950s. The latest iteration in use today, the BTR-90, has hardly changed from the original concept proving it is an excellent platform to refer on. (For a technical drawing showing the BTR's suspension, hull configuration and overall view see Appendix 3).

Water Propulsion:

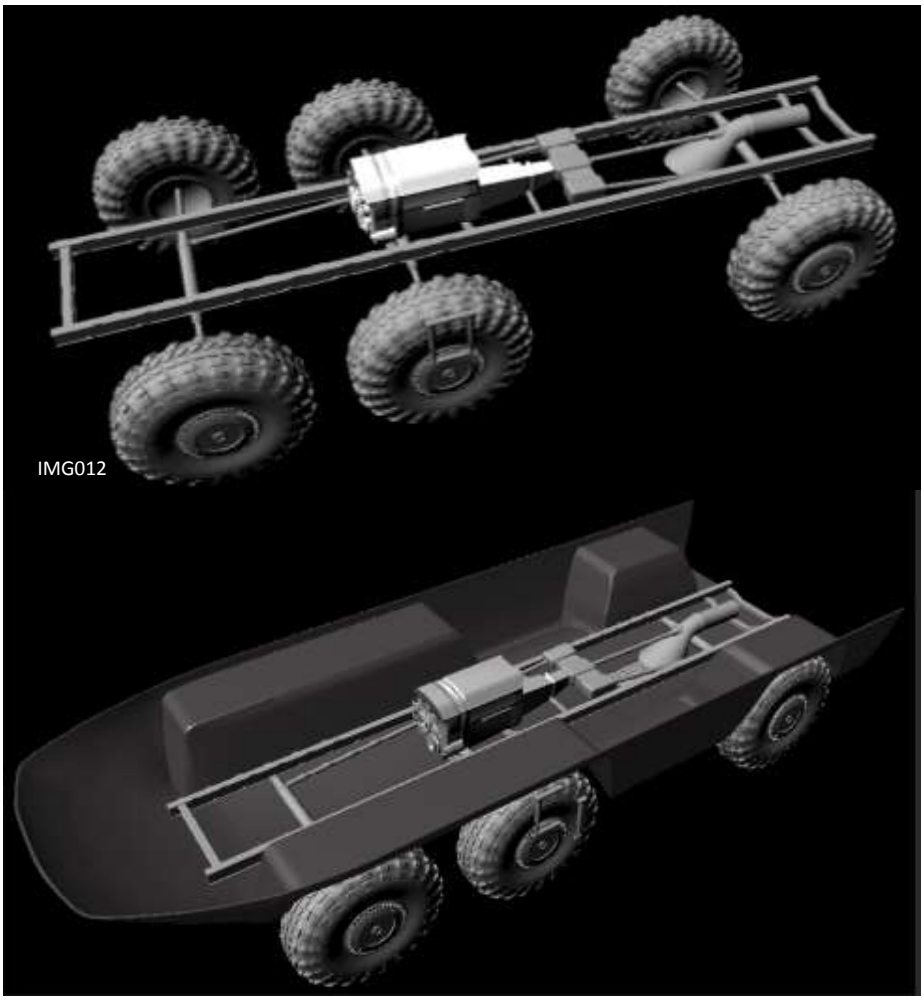
A water-jet unit will provide the propulsion while in water. A water-jet system has several advantages over the conventional prop and rudder system: they make the vessel easier to control, they can make the vessel move sideways for docking and they produce more speed while using less power than conventional propulsion systems.

The Hamilton water-jet, HJ212, will be installed in the transom of the vehicle. The water-jet draws water from beneath the vehicle through a hydrodynamic intake screen and into the pump unit. Inside the unit, the impeller accelerates the water which then creates a powerful Jetstream. The stream then gets split and forced out of two steering nozzles. The water-jet is equipped with hydraulics to control these nozzles for steering and reverse functions. The water-jet and hydraulics are driven by the engine mentioned above.

The water intake screen for the unit is situated on the bottom of the hull so there is little chance debris will enter. However, at low speed debris could enter, reducing performance. If this happens it can the cleared by turning the engine of and waiting for the blockage to float clear or reversing the impeller to force out the debris. The unit also have a screen rake that can be activated from the

driver's seat. If this doesn't work there is an inspection panel on the unit that can be reached when in the vehicle. This will allow you to clean the blockage by hand insuring the engine is switched off first. (See Appendix 4 and 5 for diagrams of the water-jet).

(Information of the water-jet unit sourced: hamiltonjet.co.nz)



Hull-chassis:

The chassis (seen in the basic image above) is combined with the hull to utilise the strength both components. The steel thickness of the hull will be (7.4mm) on the sides and (20mm) reinforcement at the bow and bottom of the keel. The chassis has two longitudinal steel channels with six cross-members combining the two main halves together. Torsional stiffness for the chassis is irrelevant as it is mounted inside the hull which is rigid. (See Appendix 6 for existing vehicle hull configuration)

The body sub-frame is mounted to the chassis and the hull so mounting points will need to added to both components. (Information on hull thickness, souse: yachting and boating world- ybw.com)

The suspension is mounted the outside of the hull like on the BTR-80 (See Appendix 2 and 3)

Prop shaft:

The shafts can be seen in IMG012. There are three prop shafts; for the front axle the rear axle and the water-jet unit. The engine is central for balance. The power is sent back into the distribution unit which then divides the power evenly. A gearing system in this unit allows the power to be sent forward.

Axle/ steering and wheel set up:

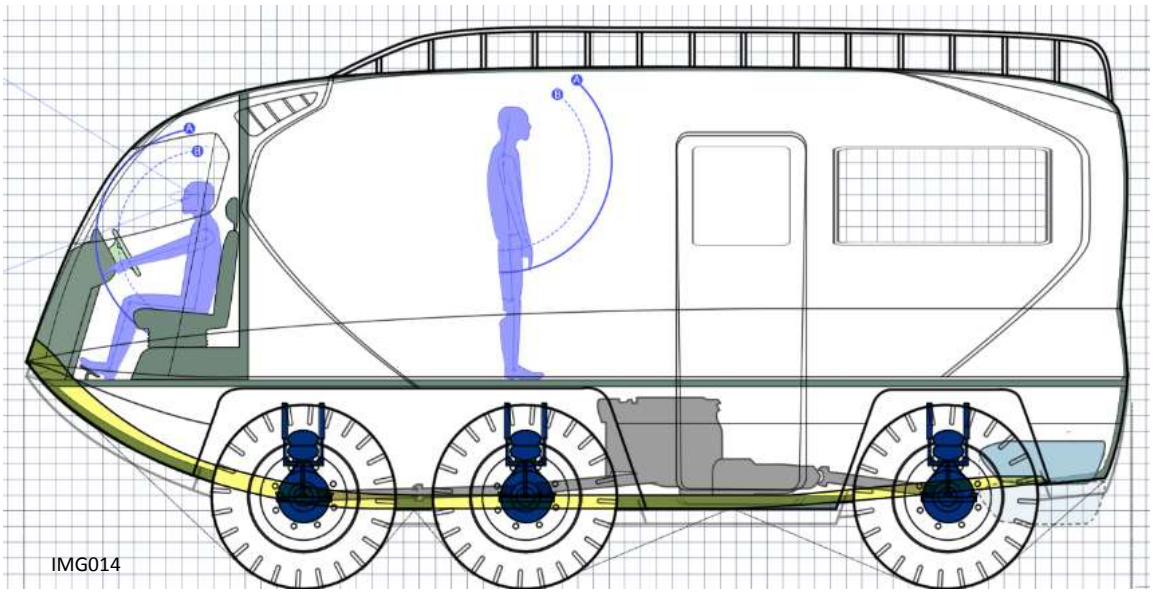
There are three axle; two at the front and one at the rear. Having two at the front gives more stability and ground clearance when entering/exiting water. The front two axle's wheels are steerable. This stops the middle axle's wheels from being unnecessarily worn when turning.

The vehicle will have variable drive. This will allow the vehicle to distribute power to the wheels were most needed, giving it better traction and manoeuvrability. It will also cut fuel consumption on existing vehicle by up to 25% thus reducing emissions.

Each axle has rubber and steel flanges which will form a waterproof seal over the opening pints in the hull. These flanges need to be greased to keep dust and water out. In addition to this, gaskets will be inserted between the flanges. They have an inner layer of cork to keep moisture out and stop grease from escaping. (Information waterproofing, source: How it's made: amphibious vehicles)

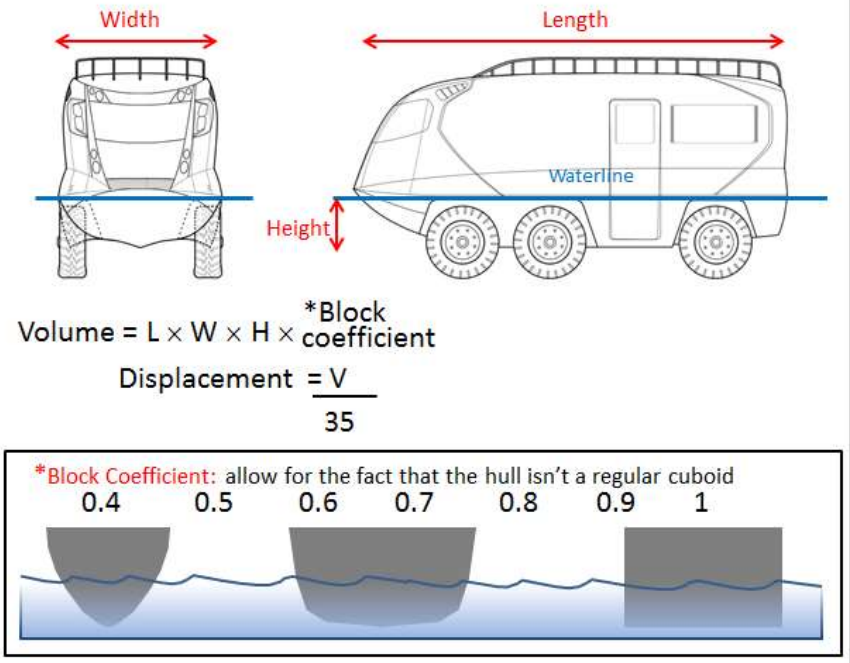
Air-intake:

The intake is located on either side of the vehicle. They are as high as possible to avoid water injection. The air-intakes can be seen indicated in purple on IMG011. Also on this image a water cooling intake can be seen indicated in yellow. The water passes through a sealed channel which runs underneath the engine and then links with the water-jet unit. The image bellow shows the water intake channel.



IMG014

4. Production / Manufacturing Considerations



Volume of the vehicle bellow waterline and weight of vehicle

Length – 22.11ft
Width – 8.2ft
Height – 2.2ft
Block coefficient – 0.5

Volume =
$22.11 \times 8.2 \times 2.2 \times 0.5 = 199.43\ ft.^3$

Displacement (weight) =
$199.43 \div 35 = 4.55$ long tons (UK)

This is only an estimate. Different factors may change the final outcome such as the weight of water. Sea water is heavier than fresh water.

The diagram proves in theory the vehicle will float. Without conducting sea trials will a full scale prototype; the floating capabilities can only be theoretical.

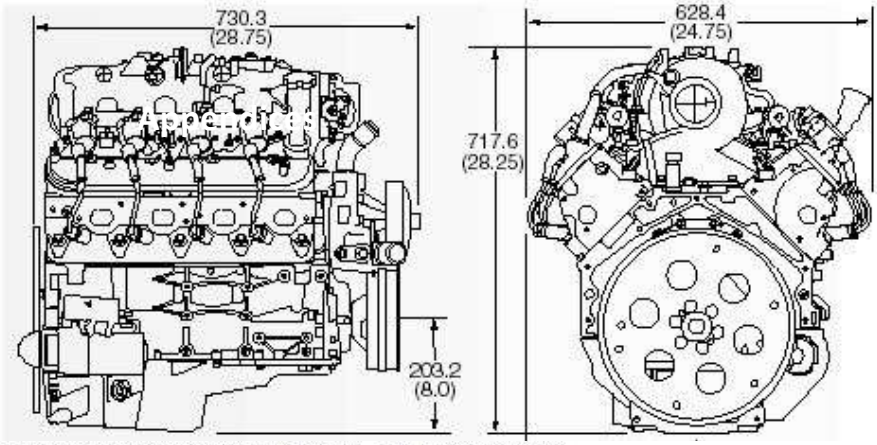
The hull (which also incorporates the chassis) will be manufactured from steal. This will give strength to the superstructure and provide a strong defence from debris in the water. The steel thickness will be (7.4mm) on the sides and (20mm) reinforcement at the bow and bottom of the keel. This will increase the stability and strengthen the front from impacts. (Information on hull thickness, source: yachting and boating world- ybw.com)

Once the hull has been welded and water tightness confirmed; the next stage is to construct the main bodywork frame and installing the engine, prop shafts and axles. The suspension is attached to the hull were the axles are located. To keep waterproof seal were the axles and suspension goes through the hull rubber and steel collars known as flanges will be used. They will be greased to lubricate them and keep water and dust out. (Information waterproofing, source: How it's made amphibious vehicles)

The main body will be an aluminium monocoque construction. This will reduce the weight and improve the centre of gravity. The main weight will come from the steel hull, the engine and other drivetrain elements which are all situated low in the vehicle.

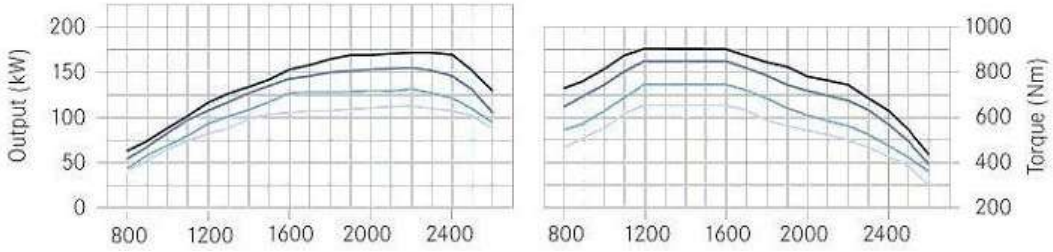
Appendix 1

OM 934LA- 5.1 Litre and OM 936 LA- 7.7 Litre diesel engines



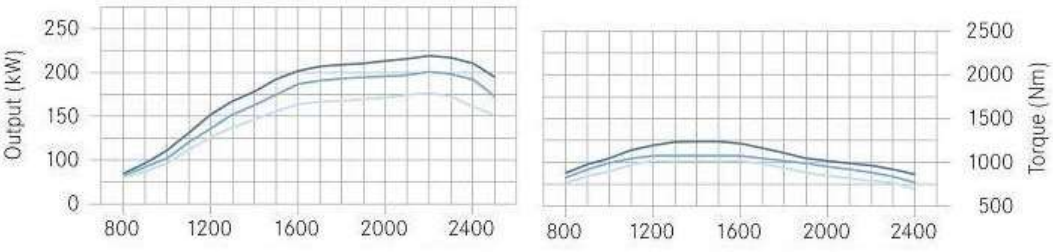
The performance curves for the new Atego OM 934 LA - 5.1L engine are shown below.

Nominal Rating	160	180	210	230
Displacement (l)	5.1	5.1	5.1	5.1
Cylinder Arrangement	R4	R4	R4	R4
BlueTec 6*	■	■	■	■
Maximum Torque - Nm at 1200 - 1600 rpm	650	750	850	900
Maximum Power – kW (hp) at 2200 rpm	115 (156)	130 (177)	155 (211)	170 (231)



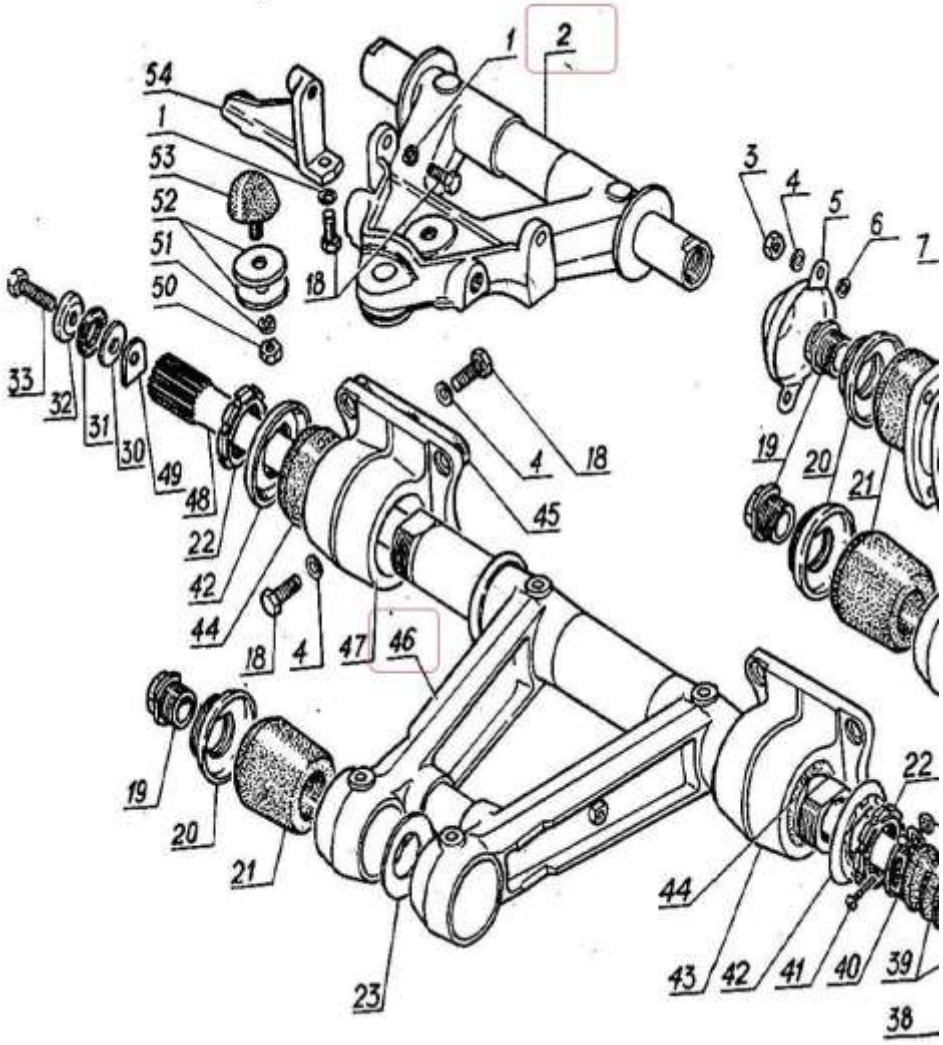
The performance curves for the new Atego OM 936 LA - 7.7L engine are shown below.

Nominal Rating	240	270	300
Displacement (l)	7.7	7.7	7.7
Cylinder Arrangement	R6	R6	R6
BlueTec 6*	■	■	■
Maximum Torque – Nm at 1200 - 1600 rpm	1000	1100	1200
Maximum Power – kW (hp) at 2200 rpm	175 (238)	200 (272)	220 (299)



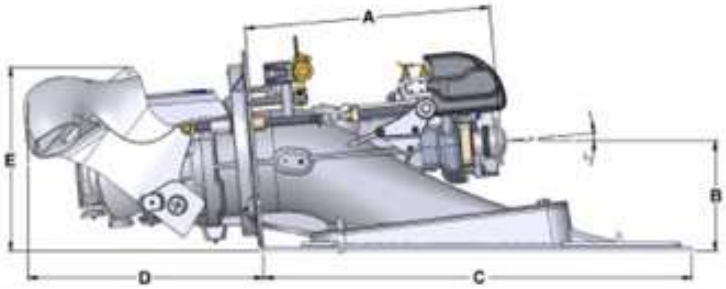
Appendix 2

BTR-80 Suspension



Appendix 4

The Hamilton water-jet

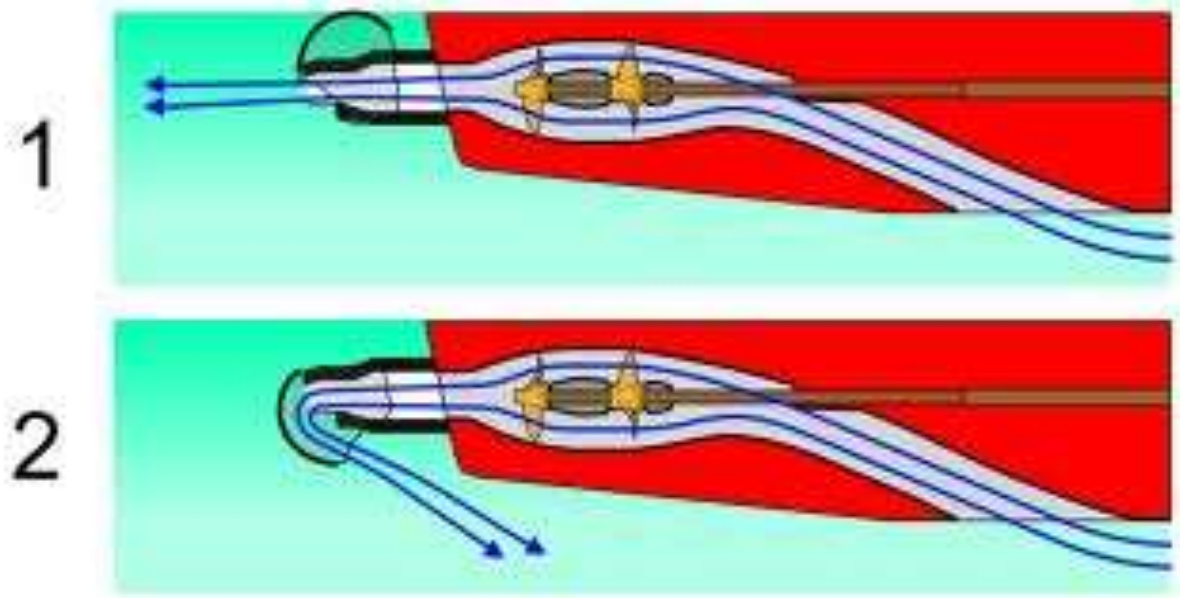


Layout and dimensions shown are indicative only for initial design purposes, based on jets with standard 5° intake block.

Consult HamiltonJet for more detailed information.

Jet Model	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	Intake Block (kg / lbs)	Dry Weight (kg / lbs)	Entrained Water (kg / lbs)
HJ212	450.3[a]	221.2	762	609	440	386	450	7 / 15.4	75 / 165	17 / 37
HJ213	413	249	762	609	420	386	450	7 / 15.4	84 / 185	17 / 37
HJ241	424	284	829	705	491	431	502	10 / 22	104 / 229	26 / 57
HJ274	570	302	1100	710	548	470	608	22 / 48.5	152 / 335	35 / 77
HJ292	681	330	1180	750	550	495	608	26.4 / 58	187 / 412	45 / 99
HJ322	866	371	1380	835	637	550	680	37 / 82	260 / 573	62 / 137
HJ364	937	420	1634	901	701	621	747	62 / 137	408 / 899	79 / 174
HJ403	1053	474	1723	1080	752	690	803	72 / 159	638 / 1407	110 / 243

NOTE: *[a] – HJ212 "A" dimension is to the end of a splined shaft. May be close coupled.*



Appendix 5

HJ212

The Ultimate High Thrust Marine Waterjet for Trailerable Boats

Design Specifications

The Hamiltonjet 212 is designed to be the best all-round waterjet propulsion unit available, offering reliability and durability, ease of use and maintenance, and, most of all, high performance across a wide range of applications and boating situations. The 212 delivers excellent efficiency across the speed range while maintaining a high resistance to cavitation.

Steering

A JT type steering nozzle directs the jetstream to either side for precise control with minimal loss of thrust during a turn. Control is via a push/pull cable system but a manual hydraulic system may be installed as an option. This nozzle can be rotated to adjust vessel trim if required.

Reverse

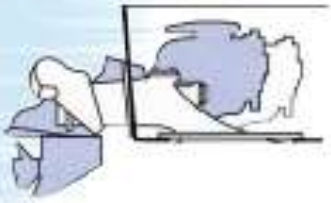
A manually operated split duct astern deflector reverses the jetstream while maintaining high thrust and efficiency. The deflector locks in any position between full ahead and astern. By working steering and reverse controls in unison, thrust can be obtained in any direction for 360° manoeuvring ability, even at zero speed.

Efficiency

The advanced impeller, intake and nozzle design of the 212 make it an extremely efficient propulsion option. The waterjet can be direct driven by a wide range of engines, saving the weight and cost of a gearbox as well as eliminating power loss to improve performance and fuel consumption.

Compact Installation

The 212 has been designed for close coupling to the engine near the transom, maximising usable space within the boat while keeping weight low for stability. The steering/astern deflector arrangement reduces overhang beyond the transom. And of course, being a waterjet, the 212 has no underwater appendages exposed to damage in shallow waterways, or posing any risk to swimmers.



Simplicity

The 212 waterjet is supplied as a single packaged module, ready for easy installation. Engine alignment and controls set-up are simple, and an inboard inspection hatch allows access to the interior of the waterjet. For routine servicing the unit can be dismantled from outside the boat without disturbing the hull seal.

Appendix 6

REPLACEMENT DESIGN STUDY

FOR

LIGHTER AMPHIBIOUS RE-SUPPLY CARGO 5 TON

Amphibious Vehicle LARC V

The LARC V is a lightweight, aluminum hulled, terratired amphibious vehicle having moderate water speed and good surfing ability. This vehicle is not suitable for swampy terrain and is not mobile in heavily irrigated terrain. It is suitable for transporting cargo from ship to shore, to beaches, or up fairly wide rivers and canals to semiprepared landing areas.

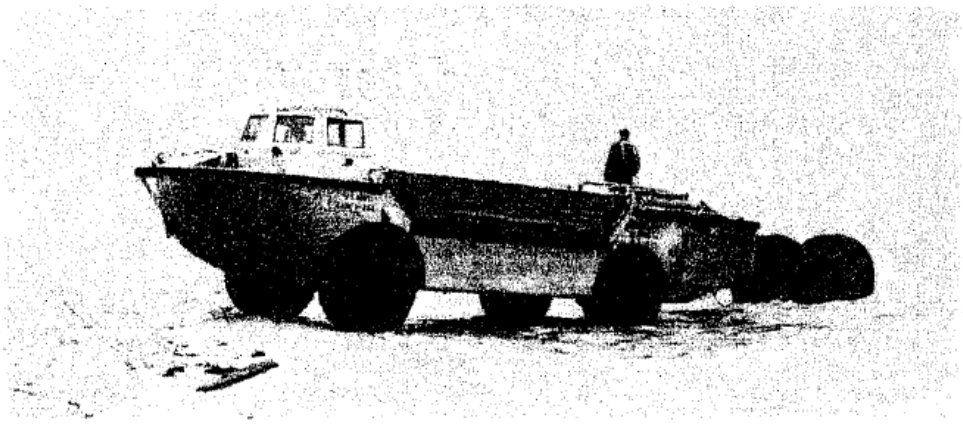


Figure G-1. Lighter, Amphibious, Resupply, Cargo, 5 Ton (LARC V).