SEDNA

ARCTIC SAFETY & SURVIVAL BOAT

Ben Turnbull - BIND 452 Design Thesis- 2013
Humber College - School of Applied Technology - Industrial Design

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1. INTRODUCTION

1.1 BACKGROUND

With the ice melting in the Arctic marine traffic will continue to increase. Many Natural resources are now being able to be travelled to. With this increase, the Canadian Coast Guard (CCG) will and itself having to conduct more and more rescue missions in this harsh environment.

People who choose to reside in the regions of the Canadian Arctic face one of the most dangerous waters known in the world. Between high waves, sea ice and temperatures that can plummet to -50 degree celsius during the winter months, the environment poses a variety of dangerous situations. Hunters, and fisherman rely solely on the animals in the environment for food. Without having this ability, these indigenous people would have no source of real nutrition. Extreme excursionists venture to these remote regions of the Arctic in order to test their abilities for survival in the toughest of climates.

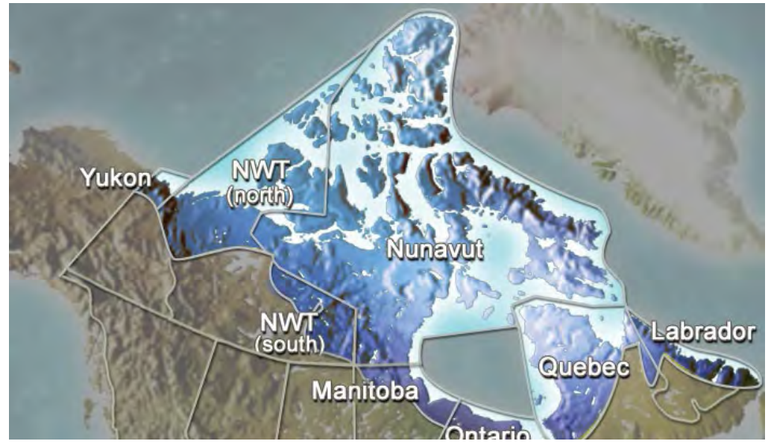
1.2 SOCIAL CONTEXT:

Canada's Arctic makes up over 40% of our landmass and is home to more than 100,000 Canadians. It is an essential part of our national identity and an area of growing importance internationally.

It is a vast treasure that we inhabit and hold in trust for future generations. Northerners, including i ndigenous peoples who comprise 80 percent of the population in some regions, have brought a number of issues to the world's attention. One being; the dangers and challenges posed by climate change.

In the Arctic, temperature has increased at twice the rate as the rest of the globe, and could increase by another 8°C (14°F) by the end of this century. The warming atmosphere along with new weather pattern extremes is causing Arctic sea ice to melt at an alarming rate— 12% per decade.

The furthest northern oceans are frozen all year round, butduring the summer months most of the ice does melt. The waterways still consist of a lot of floating ice. Weather and storms can consists of high winds, high waves and below freezing temperatures.



DEMOGRAPHIC

Northern Canada is first and foremost the homeland of Indigenous communities. Attachment to the land and dependence on local resources (hunting & fishing) for physical and spiritual sustenance are deeply rooted characteristics of their cultural heritage. Each of the Inuit groups and First Nations identities with a traditional territory, shaped by thousands of years of continuous occupation. Their communities are scattered over this immense region, located mainly on major rivers and along the coastline. Many are accessible only by air or seasonal sea and river transport.

In the Yukon, approximately 21 percent of the population of 31 000 are Indigenous; in the Northwest Territories, 50 percent of the 42 000 are Indigenous; while in Nunavut, 85 percent of the 25 000 are Indigenous. In Nunavik and northern Labrador, Inuit and First Nations make up a majority of the resident population. United by a common language, there are some 41 000 Inuit living in 53 communities across northern Canada. First Nations often make up the majority population in another 46 communities. The most startling demographic feature of the Indigenous population is its youth - as many as 50 percent are under the age of 15 years - setting the stage for some important challenges in the near future that will be shaped by the needs of this very young society.

The unconquerable nature of the Arctic and it's unique and fascinating environment creates a longing to explore and experience this part of the world that native cultures have relished for centuries. Many excursionists an extremists look to the Arctic as a challenge for exploration.

LIFESTYLE

The indigenous peoples of the Canadian Arctic continuously harvest a variety of animal species for the means of their food and other products. With the climate and landscape of Canadian provinces such as Nunavut; who only have a few roads there is little reason for expenditures on private automobiles. Household spending on recreational vehicles and associated services, which would include expenditures on boats, outboard motors, snowmobiles and all-terrain vehicles, are all higher in the Yukon, Nunavut and Northwest Territories than the Canadian average.

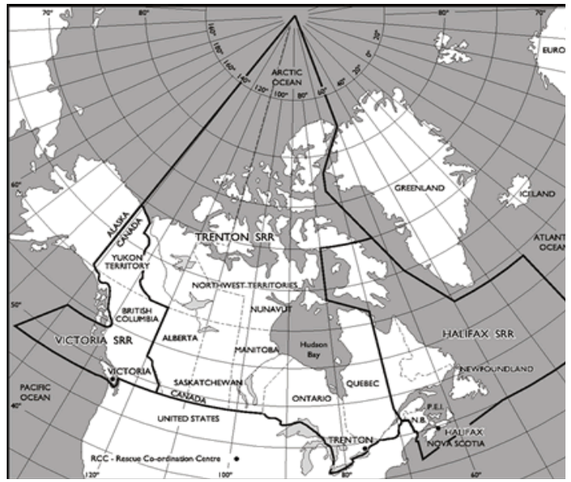
The use of the boats is directed more toward the summer's months (June to September) within the Arctic. The arctic meltdown is increasing the duration of marine travelling months. With this continuous increase in temperature, hunters and fisherman are forced to travel by boat more frequently than in the past because of the melting ice.

Modern day marine traffic within the Arctic has seen an increase in use of modern day modes of travel. People will travel to larger cities and purchase many conventional fishing boats. Lund, Aluma Craft, Polar Craft, Ranger are just a small list of boating manufactures that could be possible used. A popular and frequently used boat is the Freighter Nor-west 22 foot canoe which is equipped with an outboard motor. All of the modes of marine transportation they use are not well suited for their daily travels in the Arctic

ARCTIC SEARCH & RESCUE

The Canadian Coast Guard is responsible for supplying life-saving services for marine distress situations. There are three primary Joint Rescue Coordination Centers in Canada. One in Trenton, ON., Victoria B.C., and Halifax N. S. JRCC Trenton is responsible for search and rescue activities for more than 10 million square kilometers, containing more than half of the recreational boaters in Canada. JRCC Trenton responds to an average of 3090 marine incidents annually. JRCC Trenton is responsible for merely all of the incidents located in the Arctic regions.

Many of the services for Arctic search & rescue are directed at the hunters, fisherman and excursionsts. With the vast distances having to be travelled by these people to catch their prey, they usually find themselves in many predicaments. CCG either receives a call from communities in the Arctic letting them know the fisherman/ hunters have not yet returned. Or, emergency position indicating radio beacons (EPIRB) are set off transporting a 406 MHz frequency that can rely back to the JRCC in Trenton. In most frequent cases the indigenous people set off their rescue beacons because they are more in an uncomfortable situation. The transportation they use are not well suited or designed for the Arctic and also do not supply any type of survival or safety resources in which they can rely on.



1.3 PRELIMINARY PROBLEM DEFINITION

With the increase in Maritime traffic and the environmental changes over the last number of years within the Canadian Arctic region, the Canadian Coast Guard (CCG) will most likely find itself having to complete more and more rescue missions than in the past. With the waters in this region posing as one of the toughest waters in the world, the indigenous populations and excursionists continue to use less than ideal modes of transportation for the harsh climate. The CCG services within the Arctic region are most frequently directed at the fisherman/ hunters/ excursionists because of a lack the preparedness and equipment for use in the extreme conditions in which they find themselves. The existing boats are developed for use in a more southern region where elements are considered to be less extreme. With the vast distances having to be travelled and the long duration of their outings, they usually find themselves in various predicaments to which response time for assistance can sometimes be relatively lengthy. CCG either receives a call from communities in the Arctic letting them know the fisherman/ hunters have not yet returned. Or, through some type of signalling device such as a "spot" beacon or a beacon signalling device which uses a satellite system. The most frequent of predicaments they find themselves in are: a lack of shelter, a lack of fuel, a lack of food, a damaged boat, no sub-power supply, lack of reserve buoyancy and being stranded because of weather and sea conditions. With the existing boats the environment will continuously overpower its users because the vessels they use are not developed and designed for use in Arctic nor as a multipurpose tool. For the most part their current design is one of strictly transportation, the boats do not supply any type of survival or safety resources in which the travellers can rely on. Traveling by these boats requires the user to carry more equipment than would be required if the vessels themselves had more to offer.

2. RESEARCH

2.1 MARKET RESEARCH

The boating industry fluctuates as it is mostly influenced on the status of the economy. The boating industry has expanded into many different sectors of boats. The introduction of new materials, new manufacturing and specific design has expanded the market. The chart below is a breakdown of the current types of boats on the market.

Market Breakdown

2.1 MARKET RESEARCH: OPPORTUNITY SUMMARY

Boat manufacturers usually define their business on gearing towards a specific sector within the industry for example, fishing, recreational, luxury etc. Aluminum manufactured boats have recently seen the integration between luxury and purpose. Many of the fishing & hunting boats have developed into integrating into a luxury aspects into their vessels especially as the size of boat increases

The sector for opportunity in the current market today is trying to establish a new line or style of boats. The market has its purpose built boats for the coast guard and police. Opening up a product line of specialty boats in the market is what my design is looking to do.

2.1.1 TARGET USER

PRIMARY USER:

Indigenous peoples of the Canadian Arctic are divided into the Inuit, Metis, and the Indians. Communities in these ethnic origins continue to rely on resources from the land for their daily nutritional survival

SECONDARY USER:

Nearly half of the residents of the Canadian Arctic today are non-indigenous, and some have lived in the area for generations. These residents are more likely to live in the territorial and regional centers, such as Yellowknife, Whitehorse and Iqaluit. Hunting and fishing are popular with many non-indigenous residents, but the patterns and extent of use are rarely as extensive as they are for indigenous peoples of the region. The terrestrial animals and fish in the Arctic regions attracts many keen recreational hunters, fishers and excursionists.

TERTIARY USER:

The Canadian Coast Guard is responsible for the safety of all marine incidents in Canada. Design is informally reliant on input from the organization. The direction for design is based on creating a safer mode of marine transportation in the region

2.2 MATERIALS RESEARCH

ALUMINUM 5083:

Known for exceptional performance in extreme environments. Aluminum 5083 is highly resistant to attack by both seawater and industrial chemical environments. It can also be anodized for increased corrosion resistance. This alloy was designed for welded structures requiring maximum joint strength and efficiency. 5083 retains exceptional strength after welding. It is not meant to be a machining alloy, but can be machined fairly well with proper preparations. Because of its relatively high magnesium content, the workability rating would only be fair. Aluminum alloy 5083 is an aluminum alloy suitable for cryogenic applications down to design temperatures of -265 F, since alloys of this type do not show the ductile-brittle transition phenomenon.

ALUMINUM 5086:

Another common marine grade aluminum is 5086, a high strength aluminum structural alloy, primarily alloyed with magnesium. It has material properties are very similar to 5083. It is not strengthened by heat treatment, instead becoming stronger due to strain hardening or cold mechanical working of the material. Mechanical properties of aluminum 5086 vary significantly with hardening and temperature. Unhardened 5086 has a yield strength of 17 ksi and ultimate tensile strength of 38 ksi from - 18 to 212 °F.

2.2 MATERIALS RESEARCH

TEMPTROL - HEAT REFLECTING FABRIC:

A patented polypropylene based non-woven perforated fabric metallized on one side. Temptrol® brand reflects 95% of the radiant heat...the major source of heat transfer. With this technology, we can cause anything to retain or reflect heat, thereby remaining warmer or cooler. Applications are limited only by your imagination

Specifications

PRODUCT:	Polypropylene based nonwoven perforated and metallized one side.
WEIGHT:	17.3 lb/MSF
NOMINAL THICKNESS:	10.9 mils
TENSILE STRENGTH:	47.5 lb/in width*
TEAR STRENGTH:	6.0 lb/in width*
PUNCTURE RESISTANCE:	17 lbs **
MULLEN BURST STRENGTH:	55.3 psi*
LOW TEMPERATURE BEND:	-131° F PASS***
WATER VAPOR PERMEABILITY:	87 $5g/m^{224hrs****}$
FLAMMABILITY:	Class B*****
THERMAL PROPERTIES:	Emissivity 0.05***** (Reflects 95% of Infrared Energy)

RUBBER & PLASTICS:

Most rubber and plastics materials lose flexibility and become dangerously brittle in cold regions. But certain classes of these nonmetallic engineering materials are available that remain serviceable even at extremely low temperatures. In addition to crystal structure, factors such as chemical composition, purity, heat treatment and processing variables influence the behavior of nonmetallic materials at low temperatures. In a cold environment most engineering nonmetals actually become stronger, but they lose ductility making them susceptible to brittle failure. The presence of surface defects plays a predominant role in
contributing to sudden brittle fracture.

Rubber and plastic materials are used extensively on modern marine craft, sometimes in areas that can be difficult to examine. Engine gaskets, window seals, control arm bushings, hoses, and similar items need to be manufactured from materials rated for Arctic use. This might require the replacement of some standard equipment and possibly the internal components of equipment .

2.2 MATERIALS RESEARCH

STRUCTURAL COMPOSITES:

Composite materials can be an attractive option for use on Arctic craft due to their potential weight savings, improved corrosion resistance, and reduced maintenance cost. However, at present there is not adequate performance data available for composite materials used for structural applications in the Arctic. When exposed to extreme cold temperatures material properties of composites are altered in counter intuitive ways. Due to their anisotropic material properties, unidirectional tensile strength tends to decrease in all polymeric composites, but off-axis and transverse strength increases due to matrix hardening. Cold temperature matrix hardening will result in an increased stiffness of the entire structure. The increase in stiffness from Arctic temperatures can adversely affect the structural loading dynamics and result in higher stress concentrations of the structural components. Also, depending on the thermal c oefficients of the matrix materials, unequal shrinkage from exposure to extreme cold temperatures can cause residual stress which will result in increased structural stresses and possibly microcracking.

POLYURETHANE FOAM

Polyurethane Foam is used in numerous marine applications. The high strength to weight ratio plus its excellent buoyancy properties makes it an excellent choice as an integral part of the manufacture of boats, buoys, docks, and flotation devices.

The adhesiveness of this product is superb. One cubic foot of a nominal two pound density Polyurethane Foam will support approximately sixty (60) pounds of dead weight in water.

Polyurethane Foam can be sprayed or poured and systems can be tailored to meet most application requirements.

CARBON STEEL

Carbon steels contain trace amounts of alloying elements and account for 90% of total steel production. Carbon steels can be further categorized into three groups depending on their carbon content:

Low Carbon Steels/Mild Steels contain up to 0.3% carbon
Medium Carbon Steels contain 0.3 - 0.6% carbon
High Carbon Steels contain more than 0.6% carbon

Boston Whaler

The Unsinkable Legend:

Built around one thing- foam. Close cell foam does not absorb water and is the foundation of the solid ride of each Boston Whaler. It also provides true insulation to all in-floor fish boxes and coolers.

Unibond Construction:

Unibond construction process bonds the inner-hul with the deck, producing strong unitized assembly. This fusion of deck and hull creats a strong transom which more resistant to cracking

Edge Water

Single Piece Infusion®

In SPI, vinylester resin is vacuum infused into our Penske Xtreme® grid structures and the Deep V Hull laminate in one step. By infusing them together, the resin in the grid cures at the exact same time as the resin in the laminate, making the entire hull bond as one. This process achieves a strength-to-weight ratio greater than on open-molded, polyester boats.

Durability

These proprietary technologies produce self-bailing, Deep V Hull boats with levels of strength, durability and flotation that are unparalleled. EdgeWater's focus on technological advancement and modern construction techniques has placed us well ahead of our competitors and continues to drive our customers satisfaction and their enjoyment of our product.

2.2 MANUFACTURING RESEARCH

Lund

Rugged Construction

I- beam infrastracture creates a straight, true and rock solid hull. The longitudinal construction maintains the alignment of the boat, which allows for the utmost precision.

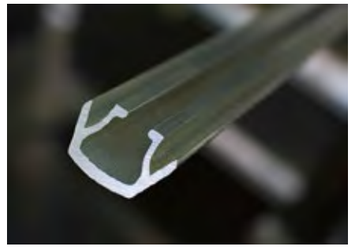
Crestliner

interlocking Tongue & Groove Construction

The keel of each Deep-V Crestliner is constructed using an incredibly durable, interlocking tongue and groove seam construction method, featuring high-grade aluminum extrusions with tongue and groove channels.

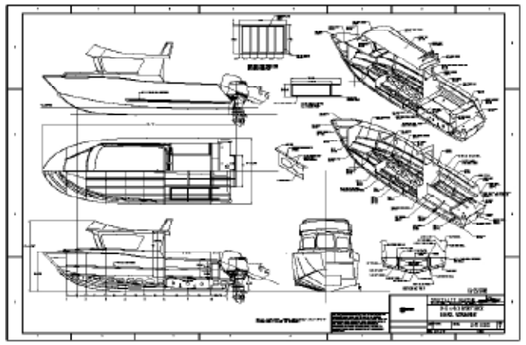
Continous Welding Process

Crestliner uses the most advanced, continuous seam welding process, executed by certified technicians, for unmatched strength and durability. No rivets to work loose and no weak, stitch-welded seams to fail

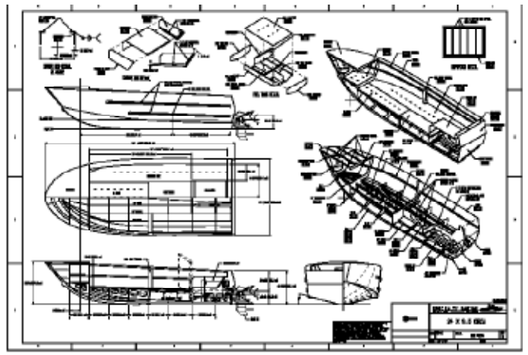


2.2 MANUFACTURING RESEARCH

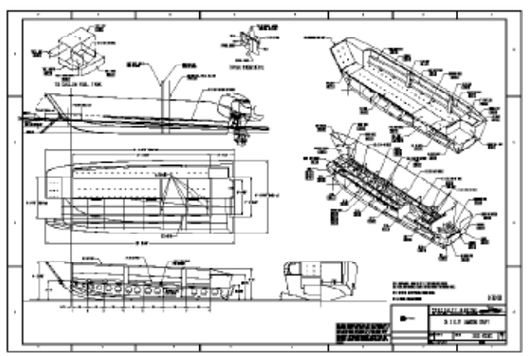
Below are industry approved construction drawings of aluminum boats around the 24` range.
Reference from Specmar Marine Contractors.



Description	Hull 1147 24' "Sportfisher" with a small cuddy cabin and aft deck holds
LOA	24'5"
Beam	8'6"
Weight	3800
$USD	$1,932



Description	Wider version of our Orca with 15 degrees deadrise, diesel I/O power
LOA	24'1"
Beam	9'7"
Weight	4524
$USD	$2,000



Description	Hull 2495
LOA	24'
Beam	9'3"
Weight	3672
$USD	$2,100

2.2 SUSTAINABILITY RESEARCH

RETAINING LIFESTYLE

With the dangers posed by the environmental changes in the Arctic, the Inuit have been forced to examine if continuing their traditional lifestyle will continue to define the culture. Sedna aims to sustain the strong cultural background that defines the Inuit. It focuses on supplying a tool to aid in the challenges faced by the Arctic.

SOLAR ENERGY

The recent expansion of solar technology has branched into the industrial and consumer needs. The major advantage of solar power is that no pollution is created in the process of generating electricity. Environmentally it's the most Clean and Green energy. Solar Energy is clean, renewable (unlike gas, oil and coal) and sustainable, helping to protect our environment.

2.3 TECHNOLOGY RESEARCH: EPIRB

EPIRB (emergency positioning indicating radio beacon) is a small battery-powered transmitting device that is carried on board. As the name implies, it is used only in case of emergency and usually only as a last resort when your marine radio is inoperable or out of range. There are several types of EPIRBs. If disaster strikes, some float free and automatically activate; others must be activated manually. All EPIRB's float and will send out a continual signal for 48 hours. Since EPIRB signals are primarily detected by satellites that pass overhead, occasionally there may be a delay in detection (perhaps an hour) because there is no satellite currently in the area to pick up the signal. EPIRB's can operate on two different frequencies, 406 an 121.5 MHz. The most effective is the 406 MHz EPIRB which can rely both frequencies. The chart to the right breaks down both kinds of EPIRB's.

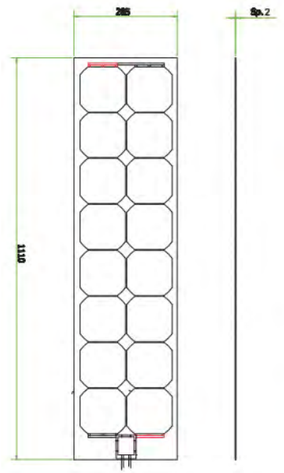
Category I, 406 MHz model	Category II, 121.5/243 MHz model
Global detection - Regional satellite earth station not needed	Regional earth station needed - not available in many ocean areas. Potential for detection by overflying aircraft.
Reliable beacon with low false alarms and high probability of detection.	Beacons often incompatible with satellites. Designed for detection by aircraft. High number of false alarms is typical.
Beacon signal coding and exclusive international use of the 406 MHz frequency band for distress beacons assures a signal received is from an EPIRB - no problem with false alerts from non-beacon sources	High false alert rate due to alerts generated by other transmitters within the 121.5 MHz
1.5 nautical mile accuracy and a second signal provided to use for homing.	10-20 nautical miles accuracy. Search and rescue forces can home on the primary signal.
Beacon is coded with owners name, address, phone, vessel type etc.	No way to know whether signal is from an EPIRB, similar aviation beacon, or non-beacon source. No coded information with signal.
Good ambiguity resolution, i.e. can promptly launch rescue unit to a known position with an alert from a single satellite pass.	Hard to know which of two separate positions calculated with first satellite pass is the beacon location. Usually must wait for a second satellite pass to resolve.

2.3 TECHNOLOGY RESEARCH: SOLAR PANELS

TECHNOLOGIES

The power and reliability of crystalline silicon cells, combined with the lightness and flexibility of modern polymers.The use of lightweight polymer films instead of traditional glass allows new applications for the proven technology of crystalline silicon cells.The careful choice of materials and their thickness creates the right balance between protection of thin photovoltaic cells and the creation of a flexible and light case. Extreme flexibility, as seen in the picture, which will surprise anyone who has handled a crystalline solar cell, normally so brittle that they break under very low stress. The polymers used are also characterized by high resistance to weathering, enabling certification according to IEC 61215 and 61730, a guarantee of long life even under the most extreme conditions, such as on racing yachts where the Solbian technology was applied for the first time.The Solbian product, in its various versions, is a light, flexible and impact resistant PV module, which can even be walked upon. Lightness and flexibility make Solbian modules particularly suited to marine and sustainable mobility applications

ELECTRICAL CHARACTERISTICS	
Peak Power (+/- 5%) - Pmax	51 W
Rated Voltage - Vmp	9.0 V
Rated Current - Imp	5.7 A
Open Circuit Voltage - Voc	10.9 V
Short circuit Current - Isc	6 A
Temp. coeff. Pmax	-0.38%/°C
Temp. coeff. Voc	-0.27%/°C
Temp. coeff. Isc	0.05%/°C
PHYSICAL CHARACTERISTICS	
Lenght	1110 mm
Width	295 mm
Thickness	2 mm
Weight	0.8 kg
Num. of cells	16



2.3 TECHNOLOGY RESEARCH: COMMUNICATIONS

GMDSS

DIGITAL SELECTIVE CALLING (DSC)

The traditional marine radio (VHF/MF/HF) has been enhanced with the addition of a feature known as DSC. This feature enables vessels to automatically maintain the required watch on distress and calling channels instead of the current aural listening watch. A DSC receiver will only respond to the vessel's unique Maritime Mobile Service Identity number (MMSI#), similar to a telephone number, or to an "All Ships" DSC call within range. Once contact has been made by DSC, follow-up communications take place by voice on another frequency.

SATELLITE COMMUNICATIONS

The Inmarsat satellite network provides global communications, except for the polar regions. In areas without any VHF or MF DSC shore facilities, Inmarsat A, B or C terminals are used for distress alerting and communications between ship and shore. Inmarsat provides an efficient means of routing distress alerts to Search and Rescue (SAR) authorities.

SEARCH AND RESCUE TRANSPONDER (SART)

SARTs are portable radar transponders used to help locate survivors of distressed vessels, which have sent a distress alert. They are detected by radar and therefore operate in the same frequency range as radars carried onboard most vessels. SARTs transmit in response to received radar signals and show up on a vessel's radar screen as a series of dots, accurately indicating the position of the SART. In the event that a ship must be abandoned, SARTs should be taken aboard survival craft.

MARITIME SAFETY INFORMATION (MSI)

Maritime Safety Information broadcasts, which comprise distress alerts, SAR information, navigational and weather warnings, as well as forecasts, can be received in three different ways in GMDSS:

-NAVTEX receivers are fully automatic and receive broadcasts in coastal regions up to 300 nautical miles offshore.
-Inmarsat-C terminals receive Enhanced Group Call - SafetyNET (EGC) broadcasts for areas outside NAVTEX coverage.
-HF Narrow Band Direct Printing (NBDP) receivers can be used where service is available as an alternate to EGC

2.4 SAFETY & HEALTH RESEARCH

A preliminary assessment of the safety, health and environmental issues that may affect and inform design

Safety Issues Examined:

Health / Product Safety Concern #1: Overloading of Boat
-Hunters and Anglers at Risk
Health/Product Safety Concern #2: Lack of Proper Preparations
Health/Product Safety Concern #3: Rise in Arctic Marine Traffic
-Causing a Rising Concern for Rescue Response in the Arctic
Health / Product Safety Concern #4: Human Error Cause of Boating Incidents

*Risk Assessment based on the tables, severity categories and the risk matrix (seen below)

Severity Category	Environmental, Safety, and Occupational Health Mishap Result Criteria
Catastrophic	• Could result in death, permanent total disability, or • loss exceeding $10M, or • irreversible significant environmental impact
Critical	• Could result in permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, or • loss exceeding $1M but less than $10M, or • reversible significant environmental impact
Marginal	• Could result in injury or occupational illness that may result in 10 or more lost work days, or • loss exceeding $100K but less than $1M, or • reversible moderate environmental impact
Negligible	• Could result in injury or occupational illness resulting in less than 10 lost work days, or • loss less than $100K, or • minimal environmental impact

		Severity			
		Catastrophic	Serious	Moderate	Minor
Probability	Frequent > 10%	High Risk	High	High	Moderate
	Occasional 1-10%	High	High	Moderate	Low
	Uncommon 0.1-1%	Moderate	Moderate	Low	Negligible
	Remote < 0.1 %	Low	Low	Negligible	Negligible

Health / Product Safety Concern	***Lack of Proper Preparations*** *Hunters and Anglers at Risk*
Report Citation *Author/Journal*	Canada, Newswire. "Transport Canada Boating Safety for Hunters and Anglers- Yukon." Canada Newswire 19 Oct.2011: Regional Business News. Web. 24. 2012
Summary *(Brief summary... Summary or article in Appendices following)*	Boating safety for hunters and anglers With hunting and fishing season well underway, many enthusiasts are out on the water. Most of them are familiar with the dangers associated with these activities and are always careful to respect the **safety** rules. But do they know what to do on board a pleasure craft like a canoe, a launch or a small motorboat? From 2007 to 2010, nearly 40 per cent of boaters who died were hunters and anglers. Most were not wearing a life-jacket at the time Don't overload your boat Overloading a boat is one of the most common causes of **boating** accidents. Before you leave, make sure you don't exceed the maximum recommended load for your boat. It's indicated on the boat's Compliance Notice. Reducing your boat's load will lower the risk of submerging or capsizing, especially in difficult conditions. You should also maintain the lowest possible centre of gravity, and distribute people and equipment so that the boat remains stable. Always use your judgement
Risk Assessment ***Probability*** (estimate): ***Severity*** (estimate) ***Risk Assessment***	Frequent / Occasional / Uncommon / Remote Catastrophic / Serious / Moderate / Minor *Based on the probability and severity, the risk estimate is assessed as* ***HIGH RISK*** *(High Risk/ Moderate Risk / Low Risk / Negligible Risk from RISK MATRIX below)*

Health/Product Safety Concern #2

Product Safety Concern	***Lack of Proper Preparations***
Report Citation *Author/Journal*	Webster, W. Russel. "Avoiding Fatal Error. "Safety Compliance Letter2479 (2007): 6. Business Source Complete. Web. 24.2012
Summary *(Brief summary... Summary or article in Appendices following)*	The article discusses an incident wherein the lack of a advanced preparations contributed to deaths of professional mariners on Lake Ontario near New York. Two U.S. Coast Guardsmen perished in frigid 36-degree water during a nighttime mission. The captain of the boat deviated from the float plan, turning **north** to Lake Ontario to familiarize a new station crewman with the shore's nighttime lighting configuration. The boat overtook a steep wave, tossing the crew of four into the waters.
Risk Assessment ***Probability*** (estimate): ***Severity*** (estimate) ***Risk Assessment***	Frequent / Occasional / Uncommon / Remote Catastrophic / Serious / Moderate / Minor *Based on the probability and severity, the risk estimate is assessed as* ***HIGH RISK*** *(High Risk/ Moderate Risk / Low Risk / Negligible Risk from RISK MATRIX below)*

Health/Product Safety Concern #3

Health / Product Safety Concern	***Rise in Arctic Marine Traffic*** *Causes a Rising Concern for Rescue Response in the Arctic*
Report Citation *Author/Journal*	"Rising Arctic Traffic." Canadian Sailing (2009):10-11. Business Source Complete Web. 24 Nov.2012
Summary *(Brief summary... Summary or article in Appendices following)*	The article discusses the importance of preparedness by the Canadian government to deal with environmental disasters in the **Arctic** waters as cruise ships and vessels plying through the **Arctic** waters **increase**. It suggests changes in the present emergency response program including the replacement of the coast guard's icebreaker fleet and the establishment of better port infrastructure. It also indicates teamwork as the key to an **Arctic** emergency response where everyone in the **Arctic** is involved and know the location of the emergency equipment.
Risk Assessment ***Probability*** (estimate): ***Severity*** (estimate) ***Risk Assessment***	Frequent / Occasional / Uncommon / Remote Catastrophic / Serious / Moderate / Minor *Based on the probability and severity, the risk estimate is assessed as:* ***High Risk*** *(High Risk/ Moderate Risk / Low Risk / Negligible Risk from RISK MATRIX below)*

Health/Product Safety Concern #4

Product Safety Concern	***Human Error Cause of Boating Incidents*** ***Incidents continues through variety of different boats***
Report Citation *Author/Journal*	AS McKnight, et al. 'Human Error In Recreational Boating." Accident Analysis And Prevention 39.2(n.d): 398-405. Social Sciences Citation Index. Web. 24 Nov. 2012
Summary *(Brief summary... Summary or article in Appendices following)*	Each year over 600 people die and more than 4000 are reported injured in recreational boating accidents. As with most other accidents, human error is the major contributor. U.S. Coast Guard reports of 3358 accidents were analyzed to identify errors in each of the boat types by which statistics are compiled: auxiliary (motor) sailboats, cabin motorboats, canoes and kayaks, house boats, personal watercraft, open motorboats, pontoon boats, row boats, sail-only boats. The individual errors were grouped into categories on the basis of similarities in the behavior involved. Those presented here are the categories accounting for at least 5% of all errors when summed across boat types. The most revealing and significant finding is the extent to which the errors vary across types. Since boating is carried out with one or two types of boats for long periods of time, effective accident prevention measures, including safety instruction, need to be geared to individual boat types.
Risk Assessment ***Probability*** (estimate): ***Severity*** (estimate) ***Risk Assessment***	Frequent / Occasional / Uncommon / Remote Catastrophic / Serious / Moderate / Minor *Based on the probability and severity, the risk estimate is assessed as* ***High Risk*** *(High Risk/ Moderate Risk / Low Risk / Negligible Risk from RISK MATRIX below)*

2.4 SAFETY & HEALTH RESEARCH:

Summary

1. Issues raised: ***Overloading of Boats***
   -Hunters and Anglers at Risk

   Risk involved (high/mod/low/negl): ***HIGH RISK***
   Impact on design (hi/mod/low/negl): *High Impact on Design*
   -The design of this type of product can only withstand so much equipment before causing safety threats
   -The risk comes from the need to hull heavier equipment. Necessity for daily use

2. *Issues raised:* ***Lack of Proper Preparations***

   Risk involved (high/mod/low/negl): ***HIGH RISK***
   Impact on design (hi/mod/low/negl): *High Impact on Design*
   -Existing boats offer no source of safety/ survival resource

3. *Issues raised:* ***Rise in Arctic Marine Traffic***
   -Causes a Rising Concern for Rescue Response in the Arctic

   Risk involved (high/mod/low/negl): ***HIGH RISK***
   Impact on design (hi/mod/low/negl): *High Impact on Design*
   -Design should focus on preventing distress situations

4. *Issues raised:* ***Human Error Cause of Boating Incidents***

   Risk involved (high/mod/low/negl): ***HIGH RISK***
   Impact on design (hi/mod/low/negl): *Moderate Impact on Design*
   -Boats are unforgiving while operating them

Safety and Health Summary based on Safety Health Enviroment Report

2.4 SAFETY & HEALTH RESEARCH:

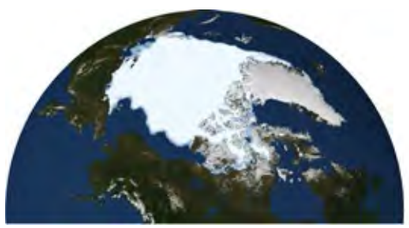
2.4.1 ENVIROMENTAL SAFETY CONCERN

GLOBAL WARMING

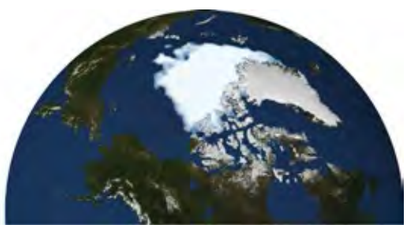
A number of life altering changes has happened over the last years to Inuit societies. Changes explained only by the changes in weather patterns. A number of life altering changes has happened over the last years to Inuit societies. Changes explained only by the changes in weather patterns. Sheila Watt-Cloutier, elected Chair of the Inuit Circumpolar Conference (icc), representing the rights of the Inuit explains the effect global warming is having on safety, "Talk to hunters across the North and they will tell you the same story, the weather is increasingly unpredictable. The look and feel of the land is different. The sea-ice is changing. Hunters are having difficulty navigating and travelling safely. We have even lost experienced hunters through the ice in areas that, traditionally, were safe. The melting of our glaciers in summer is now such that it is dangerous for us to get to many of our traditional hunting and harvesting places," says Watt-Cloutier.

"Plans are well under way to relocate certain communities if need be. Climate change is not just a theory to us in the Arctic, it is a stark and dangerous reality. Human-induced climate change is undermining the ecosystem upon which Inuit depend for their cultural survival. The Arctic is not wilderness or a frontier, it is our home," says Watt-Cloutier

The icc has collected documentation from different Inuit communities that all tell the same story of changes to their environment. The residents of Sachs Harbour, a tiny community in the Canadian Beaufort Sea region, have reported that melting permafrost cause beach slumping and increased erosion.



September 1979



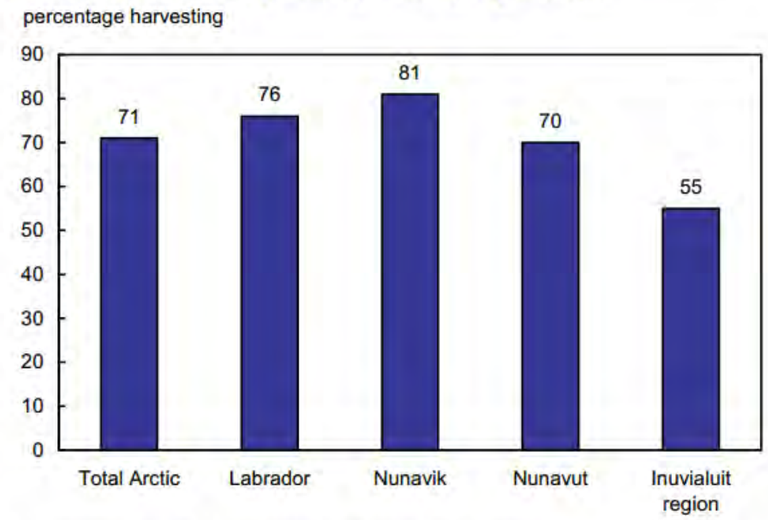
September 2012

2.5 BENCHMARKING

2.5.1 USER PROFILE

Hunters, gathers and fisherman among the indigenous populations of the Canadian Arctic are the individuals responsible for supplying food, clothing, other products and supplying a figure of economy for households and communities. In 2005, the majority of adults in Inuit Nunavut (68%) harvested country food. 80% of men harvested country food compared to 63% of women. Inuit men aged 45 to 54 had the highest level of participation in harvesting country food (90%). Inuit aged 15 to 24 had the lowest level of participation at 65% (74% for men and 55% for women). About 8 in 10 Inuit adults in both Labrador and Nunavik had harvested while just fewer than 6 in 10 of those in the Inuvialuit region had done so. The figure for Nunavut was 7 in 10. In 2001, 49% of adults in the Arctic thought that harvesting activities would not change for themselves or others in their households over the next five years. 21% thought activities would increase. The main reason given by those predicting an increase was growth in the number of hunters, fishers, trappers and gatherers.

Chart 1
Inuit adults harvesting country food by region, 2001



Source: Statistics Canada, Aboriginal Peoples Survey, 2001.

2.5.2 CURRENT PRODUCTS

The current boating industry has a huge variety of different manufactures ranging from Polar, Lund, Chris Craft, Alumakraft, and many more. Specificcally in the Arctic, the Freighter Nor West Canoes are continually popular based on their history in the region. Many of the more well-known manufacturers such as Lund and Alumakraft focus on developing a variety of different models for different use. The product research that was completed tried to categorize different levels of boats that are in current use in the Arctic region. The Lund Alaskan 1800 would be considered a higher end type of vessel in the region. The Alumakraft V16 fits into the middle class range of boat. Lastly, the 24 foot Arctic Freighter Nor-West Canoe is the lower end type of vessel which has been in practise in the region for the longest amount of time. Most common among modes of powering these boats are by outboard engines. There is also the ability to have an inboard and stern drive engine affecting the cost of the boat.

Lund Alaskan 1800

Alumakraft V16

Freighter Nor West Canoe

2.5.2 CURRENT PRODUCTS

The purpose of this research was to determine the benefits and features for a recreational boat used in the Arctic, using the Lund 1800 Alaskan, Alumakraft V16 and the Freighter Nor-West Arctic 24 Foot Canoe boats as benchmarks.

The method behind benchmarking these existing products is the House of Value (Relational Benefits/Features Matrix)

Customer Rqmts (BENEFITS)	Ranking (5 is best)	Technical Rqmts (FEATURES) Hi = 5 pts, Med = 3 pts, Lo = 1 pt: Length	Weight	Capacity	Beam	Horsepower: min/max	Assessment: How well BENEFITS are met: Competitor A Lund 1800 Alaskan	Competitor B Alumakraft V16	Competitor C Nor-West Freighter Arctic Canoe	New Product
Aesthetics (Style)										
Divers-ability										
Cost										
Comfort										
Handling										
Importance ratings for New Product										
Assessment: Comparison of FEATURES	Competitor A Lund 1800 Alaskan	18 ft	1313 lbs	1 lbs	3	5/ H				
	Competitor B Alumakraft V16	1	5 lbs	13 lbs		5 H (max)				
	Competitor C Nor-West Freighter Arctic Canoe		600lbs	5 lbs		-H				
	New Product (to be filled in)									

Rankings: take a survey to confirm

Competitor A: Lund 1800 Alaskan
Price (MSRP): $ 2,

Competitor B: Alumakraft V16
Price (MSRP): $ 5

Competitor B: Nor-West Freighter Arctic Canoe
Price (MSRP): $ 15-

2.5.2 CURRENT PRODUCTS - SUMMARY

Customer Benefits and Their Ranking (from Hi to Lo)

Aesthetics (Style)	3
Divers-ability	3
Cost	4
Comfort	3
Handling	5

Note: This ranking was determined from: personal opinion.
A survey of users/possible customers would be the next step

Technical Features and Their and Ranking (from Hi to Lo):

Capacity	48	Capacity influences	Diverse-ability, comfort
Horsepower (Min/ Max)	57	Horsepower influences	Cost, Handling, Diverse-ability
Length	51	Length influences	Cost, Handling
Weight	54	Weight influences	Cost, Handling, Diverse-ability
Beam	37	Forks influence	Handling

Competitor Product Selection

For *Competitor Product I*, the emphasis was on higher end design which was reflected in the cost of the boat and its horsepower capabilities

For *Competitor Product II*, the emphasis was on middle class which was reflected in the average cost of the boat. Although its horsepower was slightly low it is a lightweight design.

For *Competitor Product III*, the emphasis was on lower end boat that is consistently used within the Arctic. The boat is the cheapest but still pans out as an effective mode of marine transportation. The weight of the boat is solely related to the traditional use of wood as the main material.

Benefits Assessment: Competitor Product

Areas for possible customer benefit advantage were:

- Aesthetics (Style)
- Divers-ability
- Comfort
- Handling

Features Assessment: Competitor Product

The technical features of competitor products was collected and input.

Length:	Competitors varied in size which vary the cost
Weight:	Competitors weight varied – (traditional nor-west canoe weighed a great deal more)
Capacity:	Competitors capacity varies based on size and purpose of boat
Beam:	Wider beams in competitors allows for more stability
Horsepower:	Based on hull/ size of boat of competitors the size of outboard engines varies

2.5.2 CURRENT PRODUCTS - OUTBOARD ENGINE

During the summer months when open water is prevalent, outboards are the most common type of propulsion used in the Arctic areas. The advantages that make outboard propulsion so attractive in the Arctic include the portability of a self contained design, adaptability to different hull types, and the ability to obtain different horsepower engines. One of the major detractions of using outboard propulsion in the Arctic is that the mounting position makes it susceptible to impact damage and in cold weather it is exposed to freezing sea spray and difficult to keep warm. The indigenous peoples of the Arctic are very successful in using outboards to power their small craft. A number of high profile Northwest Passage transits using outboard motors have been successful. In the fall of 2010 a group of boat builders made an 8,000 mile record run in a 36-foot Rigid Inflatable Boat (RIB) powered by three 300 horsepower Mercury outboard engines. Antarctic research stations also have been deploying small craft with gasoline powered outboards for decades in extremely cold conditions.

Using outboards in Arctic condition requires special maintenance procedures. For example, when using an outboard or having an outboard moored in freezing or near freezing temperature, keep the outboard tilted down at all times so the gear case is submerged. This prevents trapped water in gear case from freezing and causing possible damage to the water pump and/or other components. If there is a chance of ice forming on the water, the outboard should be removed and drained completely of water. If ice should form at the water level inside the outboard drive shaft housing, it will block water flow to the engine
causing possible damage. Commercially available cold weather oil should also be used in the motor to provide adequate lubrication.

ADOPTION BY INUIT CULTURE

The Inuit's have been prasied upon for how they have adopted outboard motors. It's a new technology for the Inuit that has made travelling much easier for them. They have managed to rig outboards onto their smaller boats for their daily and hunting needs. The justification for using outboards in the design is due to the availbility in the northern communities. Fixing, repairing and swapping outboards is much easier then having to replace a speciality type of engine. Storage during winter months is done very easily with outboard motors.

2.5.3 CURRENT USER PRACTISE

Hunters, gatherers, and fisherman hunt a variety of different marine and land animals. The marine mammals consist of seals, walrus, narwhals, beluga, fin, minke whales and polar bears. The mammals are hunted for their skin and their large sums of meat. For instance, parts of the narwhal provide as much vitamin C as orange juice does for modernized communities. The land animals consist of caribou, reindeer, moose and musk ox. These land animals are important in local economies as they are used for both food and other products. Marine fish include types such as salmon, Arctic char, northern pike and other species. The fish in the Arctic are a cornerstone for contemporary economic life.

2.5.3 CURRENT USER PRACTISE: PERSPECTIVE OF AN INUIT HUNTER

The following is a portion of comments from a individual who has lived and understood the importance of hunting to the survival of the Inuit culture

"I grew up most of my life in a little town of about 1,900 people called Igloolik, Nunavut. I have been hunting seal as long as I can remember. I still go out with family and friends any chance I get. My family, especially my grandparents taught me how
important it is towards our lives and survival. I'm proud of who I am and that I'm an Inuk (Inuit)formally known as Eskimo.

As a hunter, it is really important to feed our families and families of others. Because there are people who go through hard times even in modern world today. You have to depend on your family whenever there are hard times so sharing meat helps in every way. Especially when you know you are there for them and they are there for you.

My personal experience as a seal hunter, the way I see it in my own opinion, it's really important to go out and hunt seals. It has been passed on to me from my family and people around me. Nothing is wasted and use everything we catch. I often hear people tell me "don't kill what you won't eat or use" and I believe that. I always want to go out seal hunting anytime I can get. Especially during spring when the sun is up 24 hours a day. That is the time when people in the north would go out camping. It's the most beautiful place and time of the year. Whenever we catch a seal we get families to come over to eat. At the same time we get other families to pick up meat. I'd often go to elders and give them meat plus the seal skin. There is no greater feeling good about yourself, when people, especially elders appreciate what you do and what you did for them."

2.5.4 SYNOPSIS: USER PREDICAMENTS TO INFORM DESIGN

- Uncomfortable state
- Lack of shelter
- Stability
- Lack of fuel
- Lack of food
- Weather permitting travels
- Once in water- minutes rather than hours
- Addition of all terrain vehicles
- Lack of alternate power supply
- Placement of spot beacons (EPIRB)
- Lack reserve flotation/ buoyancy – if hull is compromised
- Keel continuously damaged

3. DATA ANALYSIS

3.1 NEEDS ANALYSIS

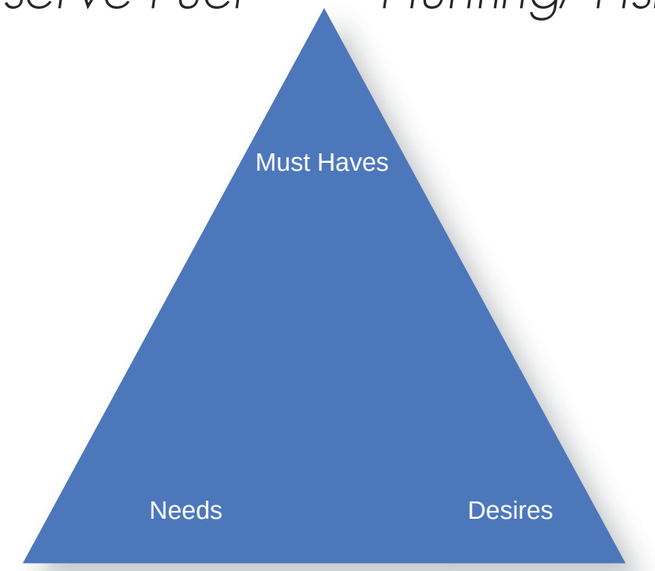
3.1.1 CATEGORIZATION OF NEEDS

Shelter

Reserve Buoyancy

Reserve Fuel

Hunting/ Fishing



Reinforced Keel & Bow

Sub- Power Supply

Efficient Location of EPIRB

Hull Design

Easy Visibility From Air

Heat Source

Storage/ Organization

Personal Vehicle Friendly

3.1.2 WORK FLOW MAPPING

Engine

- Outboard style of engine
-Speed: fairly average 40 km/h
-Cable driven handling


Surroundings

-Boat traveling through both floating and stationary ice
-Obstacle facing getting to the animal that has been shot
-Dangers surrounded with ways in which to move the ice
-Tend to travel very close to the ice, not only ice above the water but also below



Interior

-Several people on board
-Users situated at the front of the boat
-Uncomfortable state
-Limited space
-Adds for more confusion and less organization


3.1.2 WORK FLOW MAPPING

Gear/ Equipment

- Gear of the boat is scattered all around the vessel
-Added container of gas in both observations off to the side, in an unconventional spot (amount limited to small container
-Safety concerns surrounding it being out in the open and not in specific spot
-No apparent source of shelter
-No apparent source of added power supply
-No apparent source of spot/ rescue beacons/ space for it

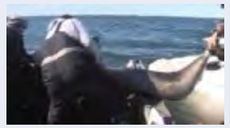
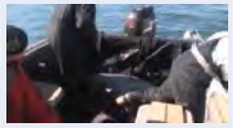

Practise

-Gear used for hunting is a riffle
-Lean over to the side of the boat hoping to rely on having added stability
-Once the game is caught, they tie it off to the side of the boat (video 1)
-Processing animal done right on the ice
-Literally drive the boat right on to the ice for removing lines and hooks from animal
-Uneven surface, and low stability of ice
-Boat “secured” to the ice (rope and hooks into ice)



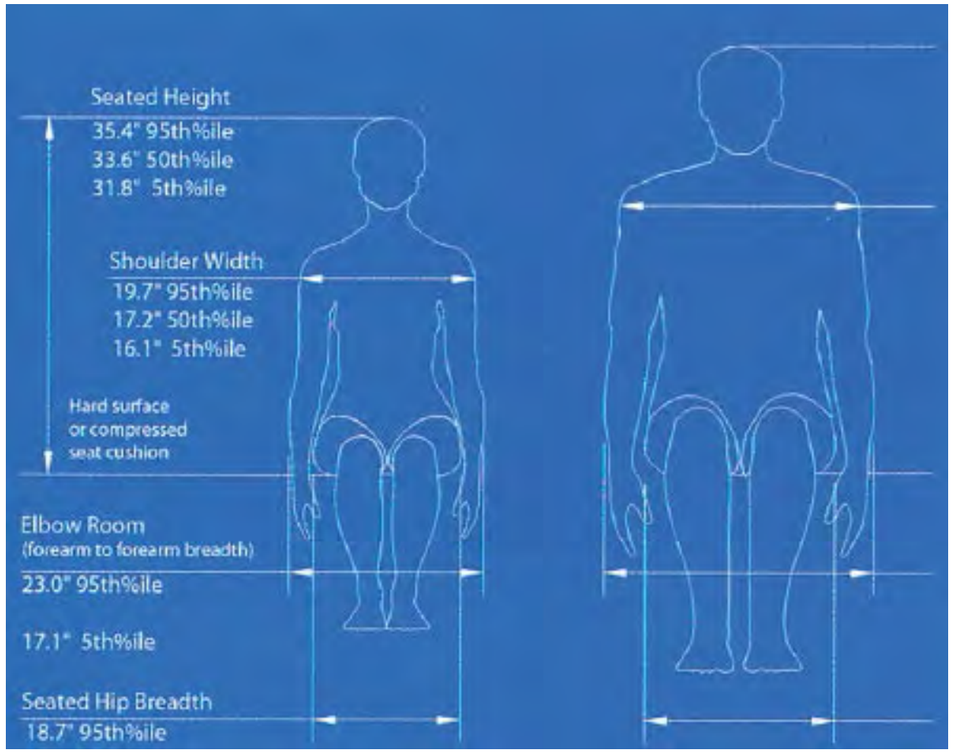

Space/ Storage

-Gear of the boat has no apparent designated space
-The animal is then loaded into the boat
-Area for animal is covered with tarp
-Loading the animal onto the boat is slightly difficult

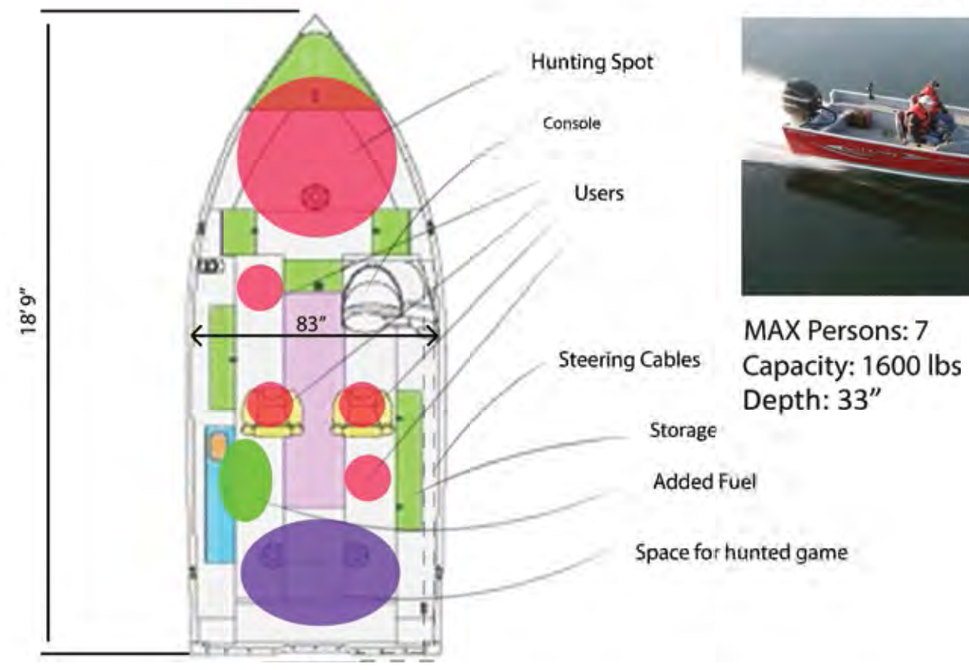

3.2 ERGONOMIC ANALYSIS

Exploration of both women and men from the 95th, 50th, and 5th categorized need to be explored for interior and driver space. Accommodating the equipment, and style of gear and clothing by the users will be considered for development of design



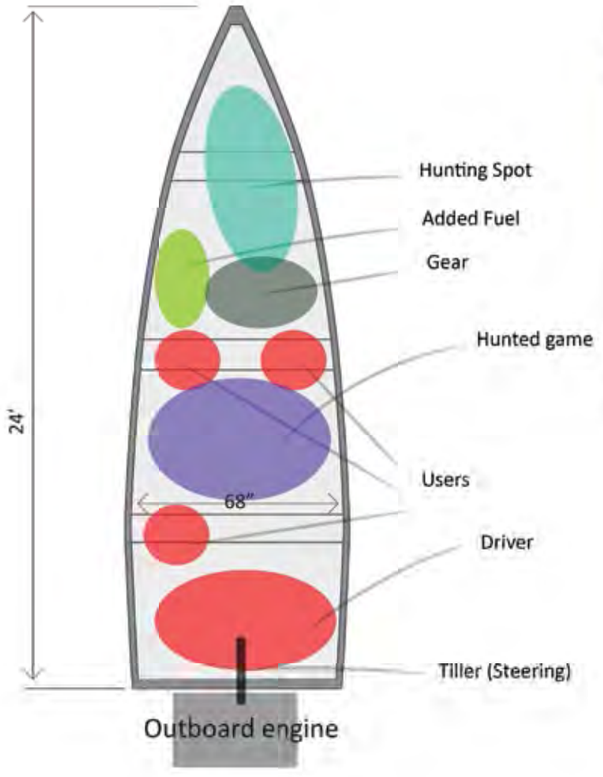
* Further ergonomic evaluation completed in detail Resolution

3.2 ERGONOMIC ANALYSIS: EXISTING USE



1800 Alaskan SS

MAX Persons: 7
Capacity: 1600 lbs
Depth: 33”

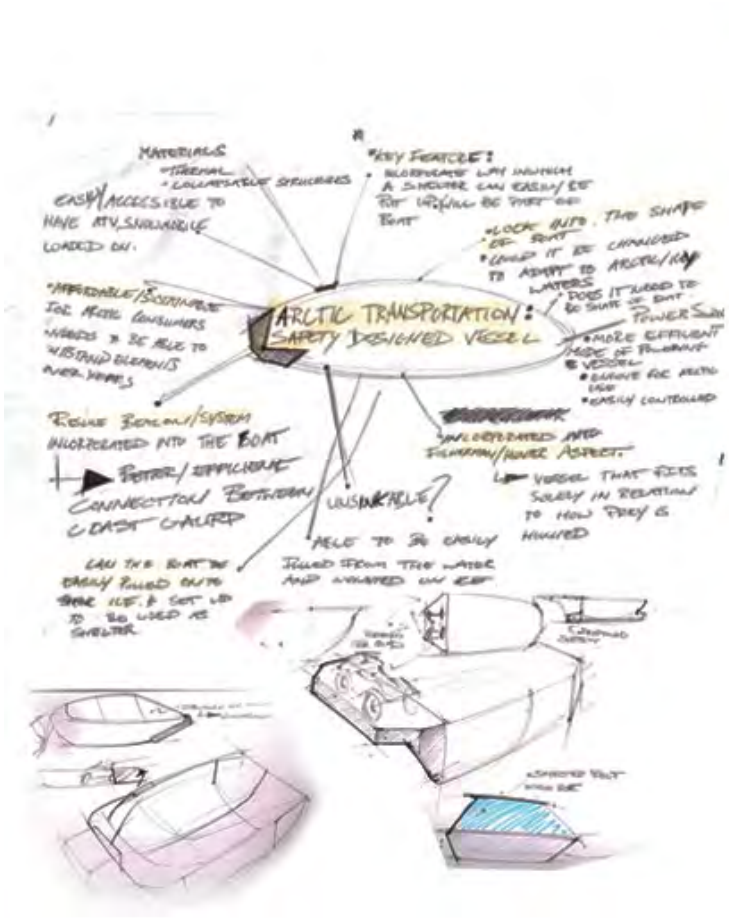


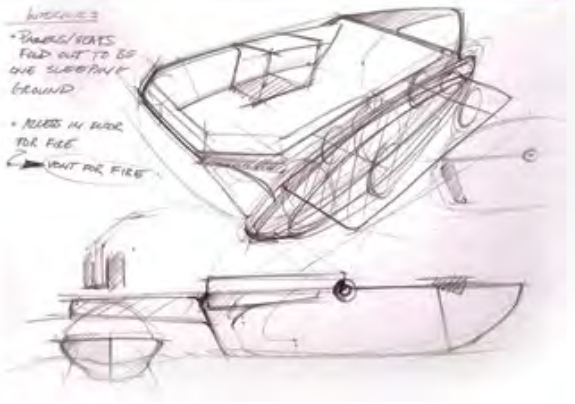
Freighter Nor West Canoe: Arctic 24 foot

Capacity: 5000 lbs
Depth: 26"

4. DESIGN

4.1 MIND MAPPING



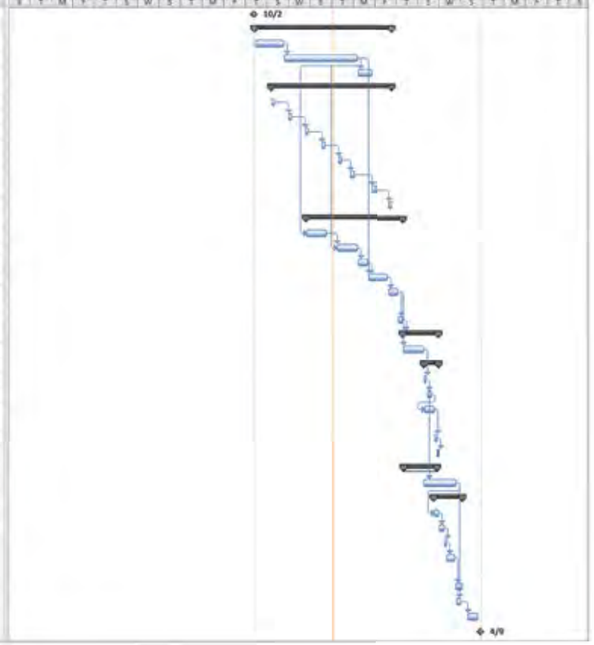


4.2 FUNCTIONAL DESIGN BRIEF

With the analysis of the research conducted, a variety of features and needs have been categorized. The development of the design will address incorporating; reserved gas, shelter, reserved buoyancy, reinforced keel, reinforced hull, interior heat source, sub - power supply, storage & organization. Along with all of the features incorporated into the boat, the interior will focus on adapting to the primary users (hunter) practice. The design will address the major concerns for safety and survival in the environment and adapt to the needs of the users everyday operations.

4.1 PROJECT SCHEDULE

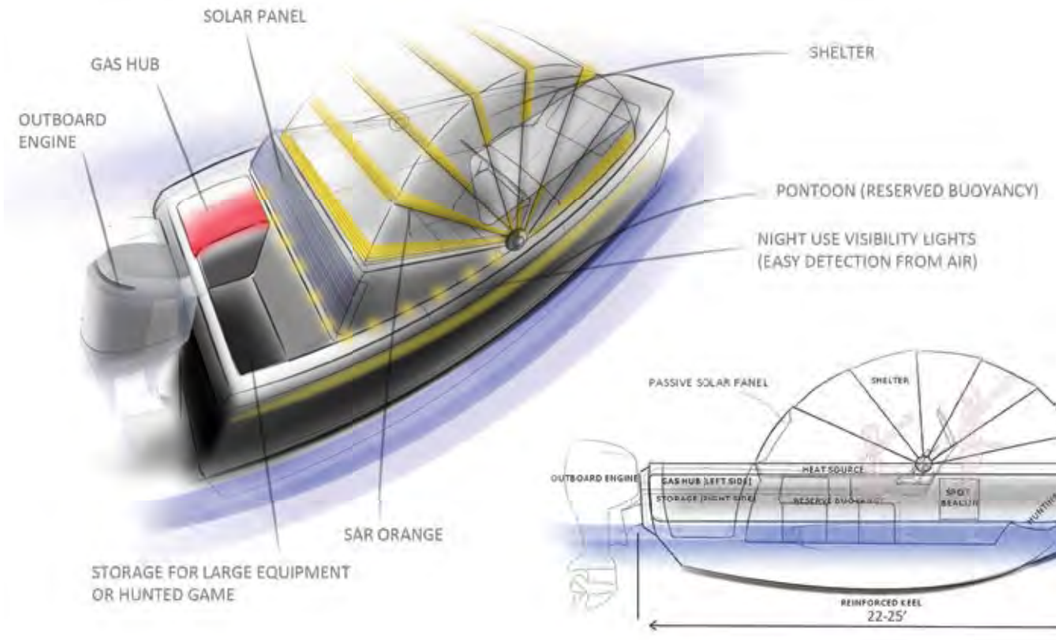
	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Thesis Topic Approval	0 days	Tue 10/2/12	Tue 10/2/12	
2		**Research**	**187 days**	**Tue 10/2/12**	**Fri 1/25/13**	
3		Advisory Identification	40 days	Tue 10/2/12	Fri 10/26/12	
4		Supportive Research	100 days	Fri 10/26/12	Thu 12/27/12	3
5		Other Research	20 days	Thu 12/27/12	Tue 1/8/13	4
6		**Advisor Meetings**	**164.75 days**	**Tue 10/16/12**	**Fri 1/25/13**	
7		Advisory Phase 1	5 days	Tue 10/16/12	Fri 10/19/12	
8		Advisory Phase 2	5 days	Tue 10/30/12	Fri 11/2/12	7
9		Advisory Phase 3	5 days	Tue 11/13/12	Fri 11/16/12	8
10		Advisory Phase 4	5 days	Tue 11/27/12	Fri 11/30/12	9
11		Advisory Phase 5	5 days	Tue 12/11/12	Fri 12/14/12	10
12		Advisory Phase 6	5 days	Fri 12/21/12	Mon 12/24/12	11
13		Advisory Phase 7	5 days	Tue 1/8/13	Fri 1/11/13	12
14		Advisory Phase 8	5 days	Tue 1/22/13	Fri 1/25/13	13FS+2 days
15		**Design Development**	**133 days**	**Wed 11/14/12**	**Sun 2/3/13**	
16		Concept Development	28 days	Wed 11/14/12	Sat 12/1/12	4FS-7D days
17		Design Development	28 days	Sun 12/9/12	Thu 12/27/12	4FS-28 days,16
18		Sketch Models of Design	14 days	Thu 12/27/12	Fri 1/4/13	17
19		Final Design Development	28 days	Fri 1/4/13	Mon 1/21/13	18,4FS+2 days
20		Sketch Model of Finalized Design	14 days	Tue 1/22/13	Wed 1/30/13	19
21		Modifications to Final Desi	7 days	Wed 1/30/13	Sun 2/3/13	20
22		**CAD**	**48 days**	**Sun 2/3/13**	**Tue 3/5/13**	**21**
23		CAD Modeling	28 days	Sun 2/3/13	Thu 2/21/13	20
24		**Scaled Model**	**20 days**	**Thu 2/21/13**	**Tue 3/5/13**	
25		Construct Drawings	3 days	Thu 2/21/13	Fri 2/22/13	23
26		3-D Prints of Model	7 days	Sat 2/23/13	Wed 2/27/13	25
27		Construct Othe Parts of Model	14 days	Thu 2/21/13	Fri 3/1/13	26FS-10 days
28		Prep All Parts for Paint	3 days	Fri 3/1/13	Sun 3/3/13	27
29		Paint All Parts	3 days	Sun 3/3/13	Tue 3/5/13	28
30		**Thesis Requirments**	**44 days**	**Mon 2/4/13**	**Sun 3/3/13**	
31		Report	44 days	Wed 2/20/13	Tue 3/19/13	25FS-4 days
32		**Presentation Boards**	**39 days**	**Fri 3/1/13**	**Mon 3/25/13**	
33		Initial Concept layout	7 days	Fri 3/1/13	Tue 3/5/13	31FS-30 days
34		Development of layout	7 days	Tue 3/5/13	Sat 3/9/13	33
35		Finalized Design of layo	3 days	Sat 3/9/13	Mon 3/11/13	34
36		Information Breakdown for Display	12 days	Mon 3/11/13	Mon 3/18/13	35
37		Completion stage of boa	10 days	Tue 3/19/13	Mon 3/25/13	36
38		Project Edit and Refinements	7 days	Tue 3/19/13	Sat 3/23/13	31
39		Finished Project for Review	14 days	Fri 3/29/13	Sat 4/6/13	38
40		Thesis Submission	0 days	Tue 4/9/13	Tue 4/9/13	



5. DESIGN DEVELOPMENT

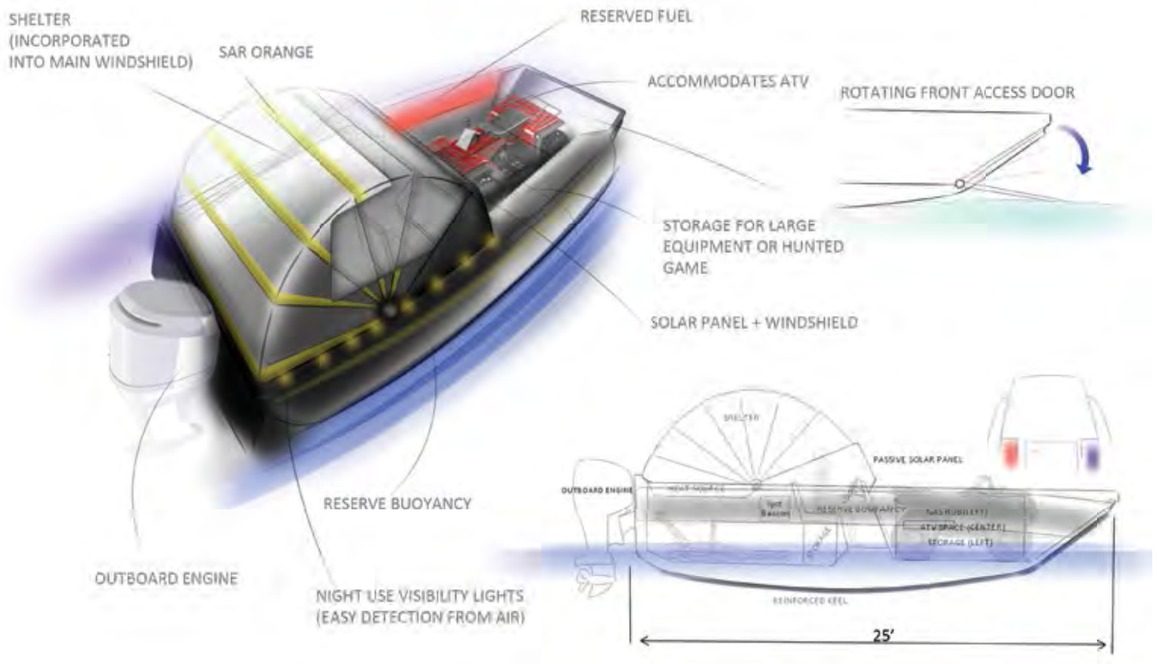
4.1 PRELIMINARY CONCEPT EXPLORATION:
INITIAL SKETCH EXPLORATION

4.1 PRELIMINARY CONCEPT EXPLORATION:
CONCEPT 1



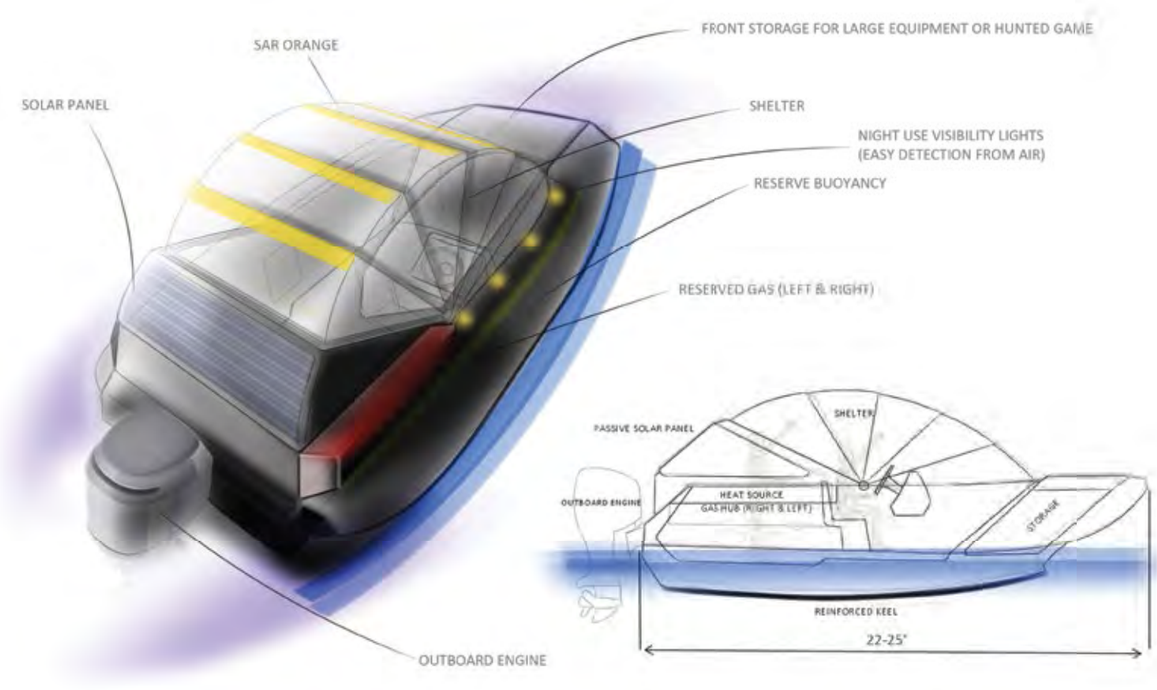
4.1 PRELIMINARY CONCEPT EXPLORATION:

CONCEPT 2

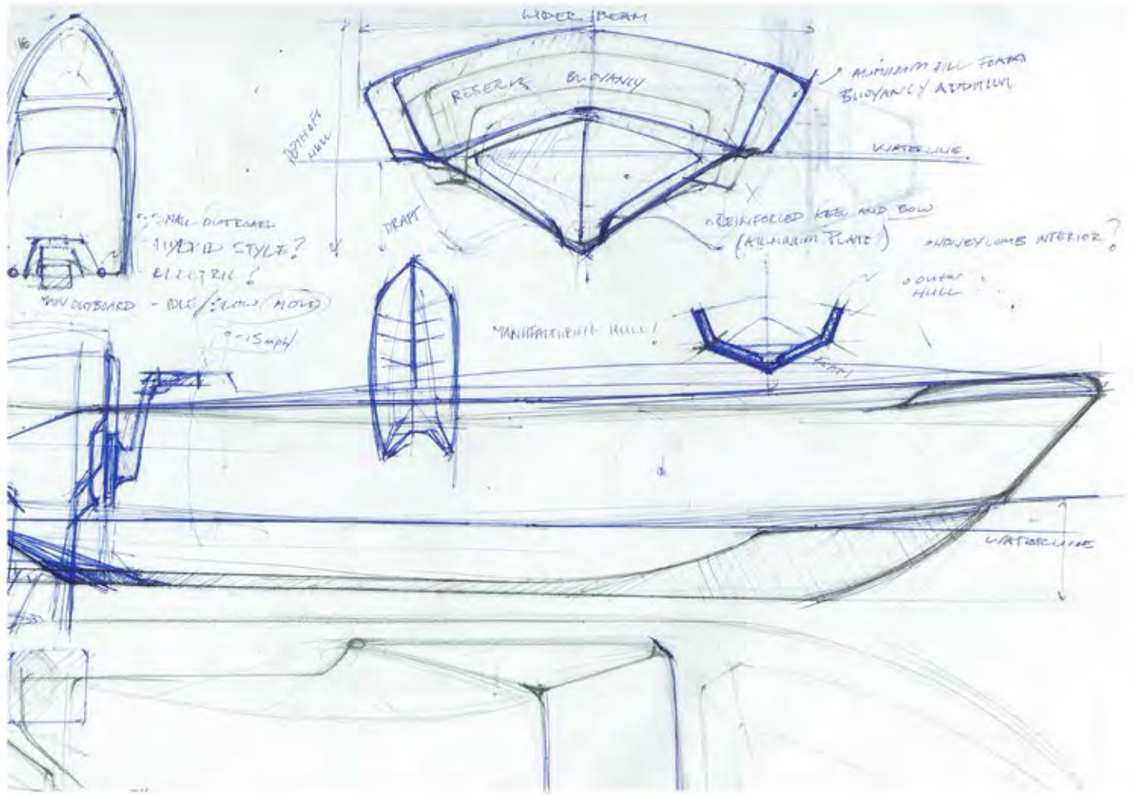


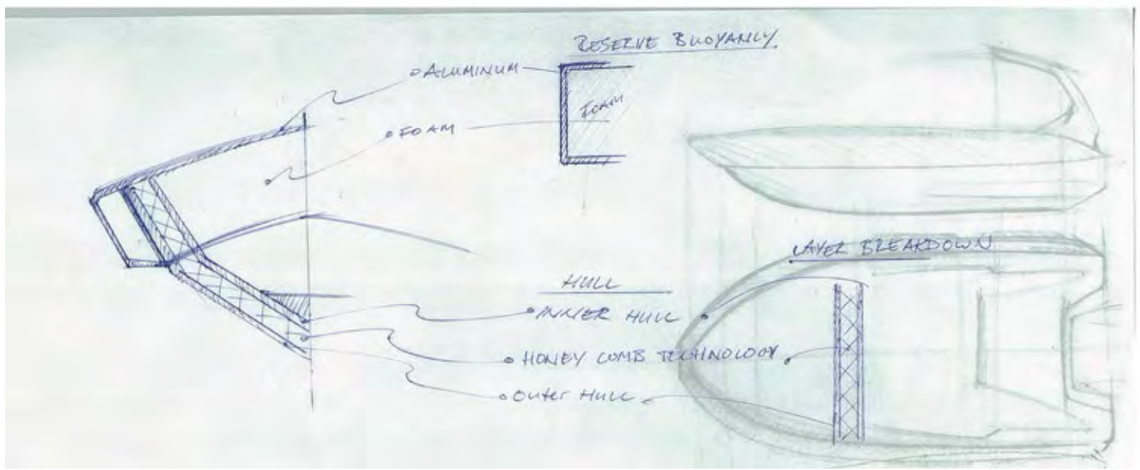
4.1 PRELIMINARY CONCEPT EXPLORATION:

CONCEPT 3

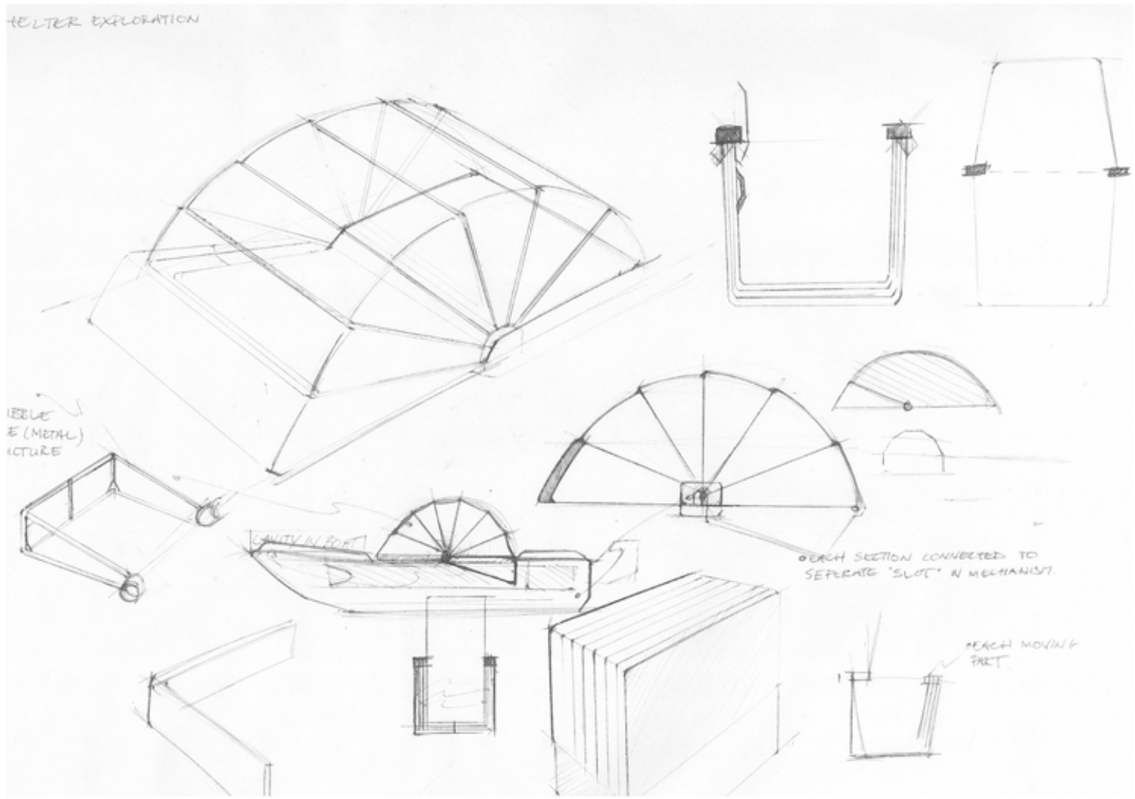


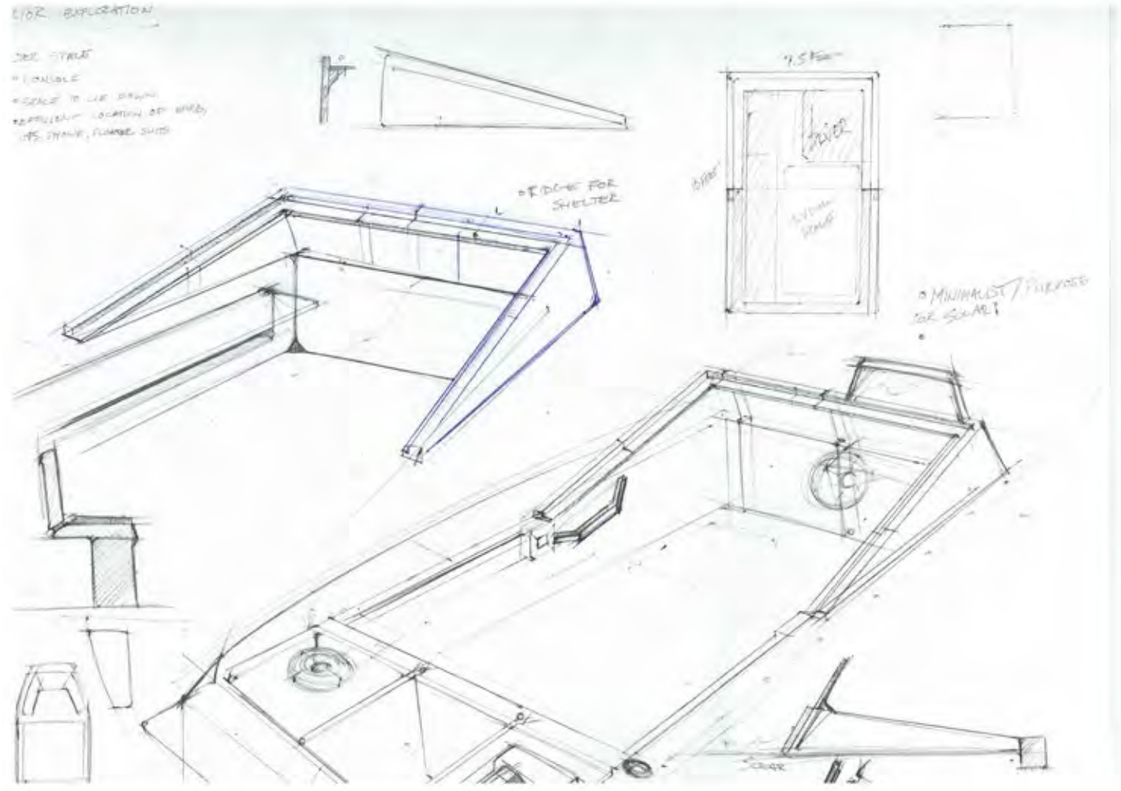
5.2 CONCEPT REFINEMENT: HULL DESIGN

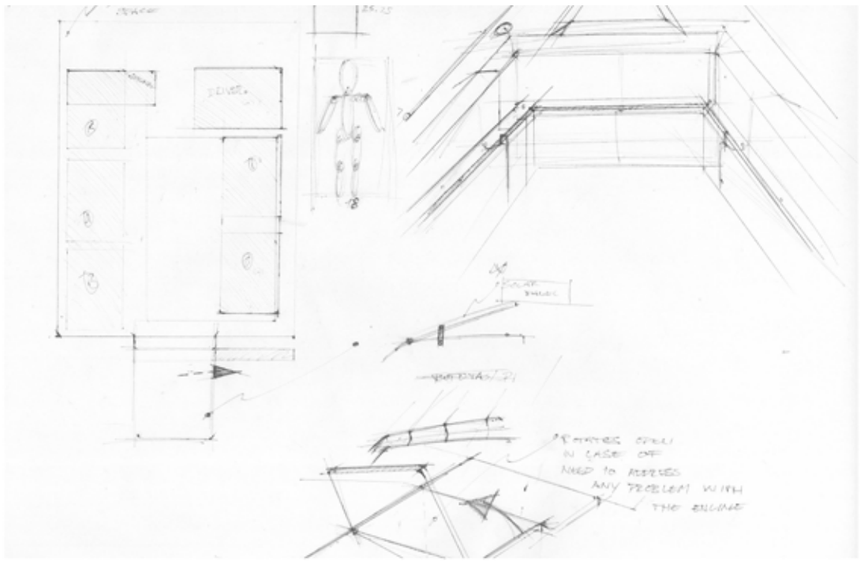




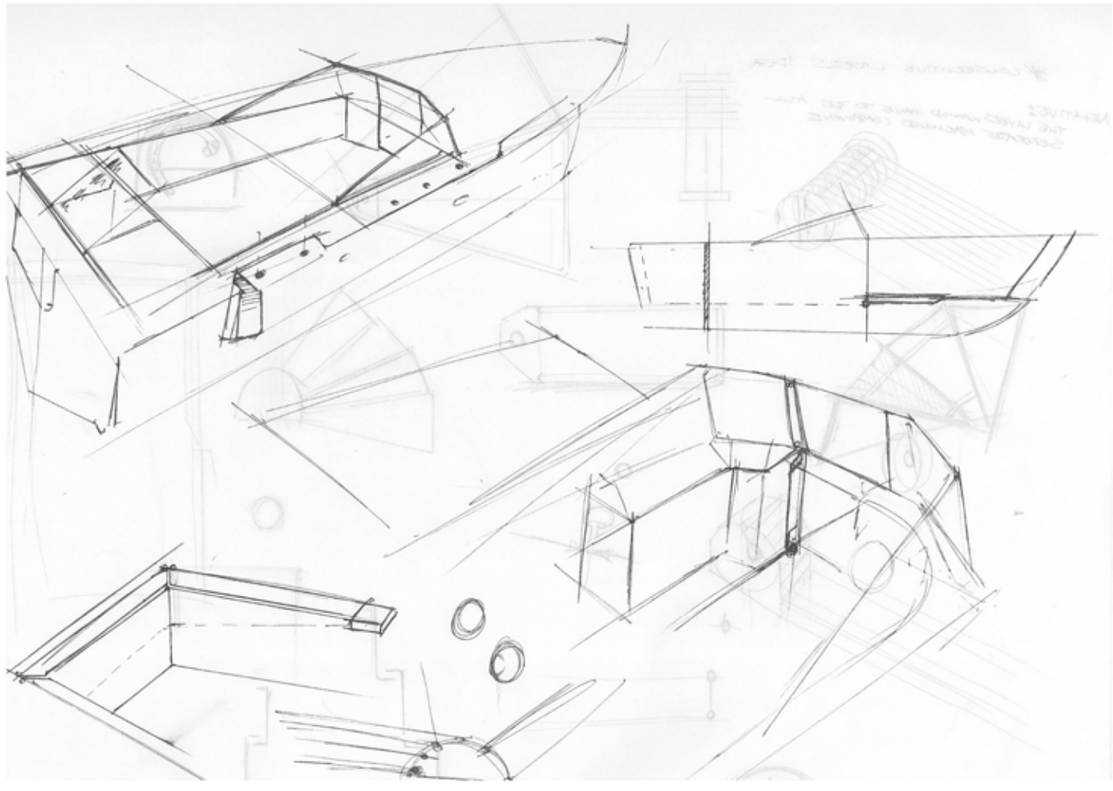
5.2 CONCEPT REFINEMENT: SHELTER



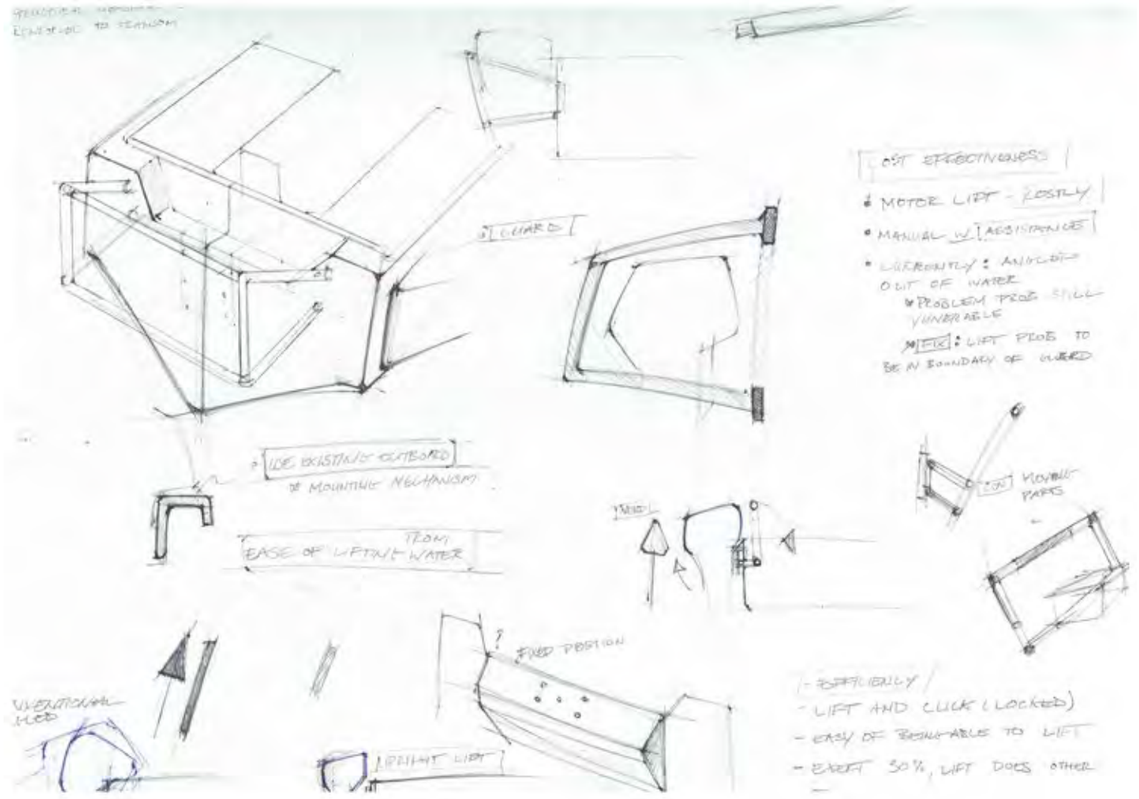




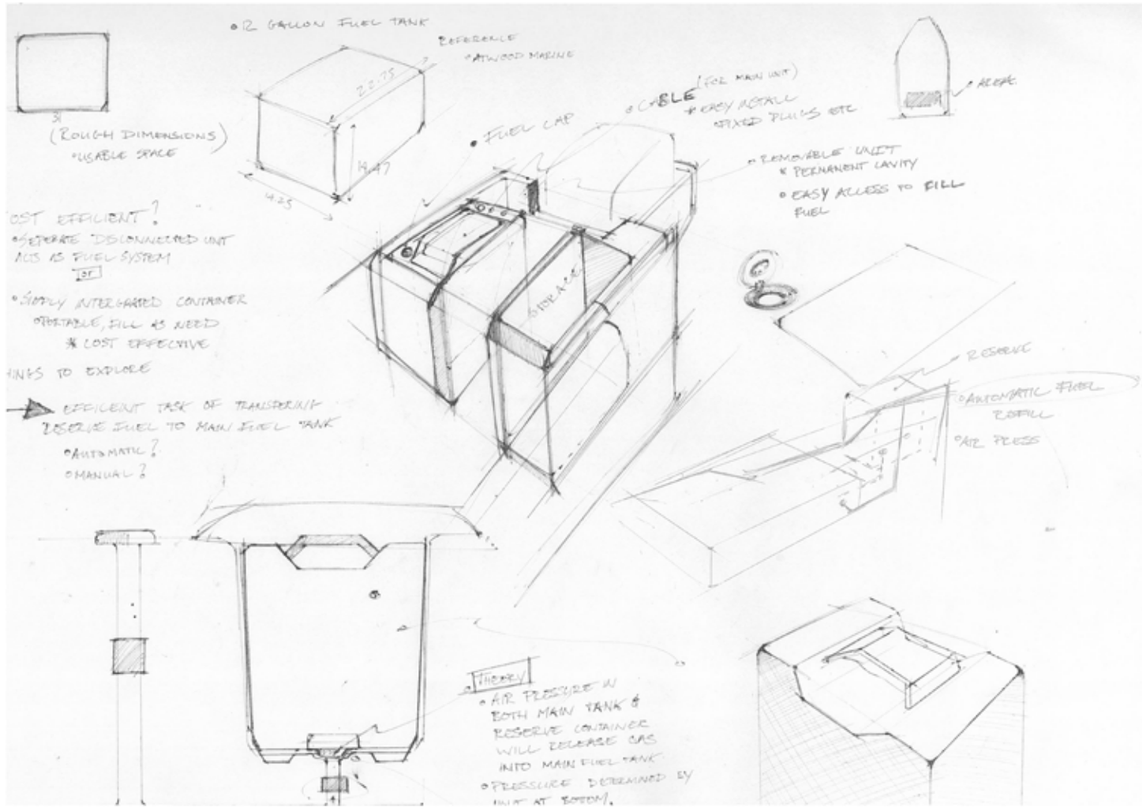
5.2 CONCEPT REFINEMENT: INTERIOR



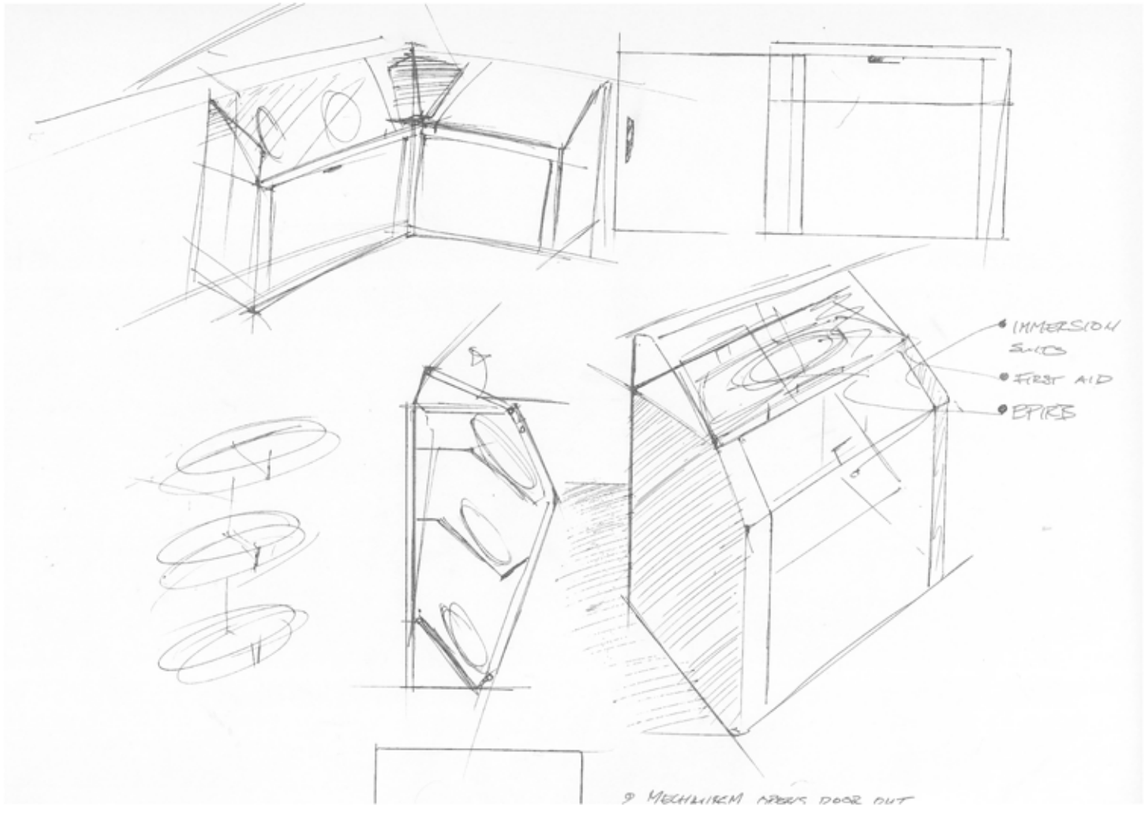
5.2 CONCEPT REFINEMENT: TOWING / ENGINE MOUNT



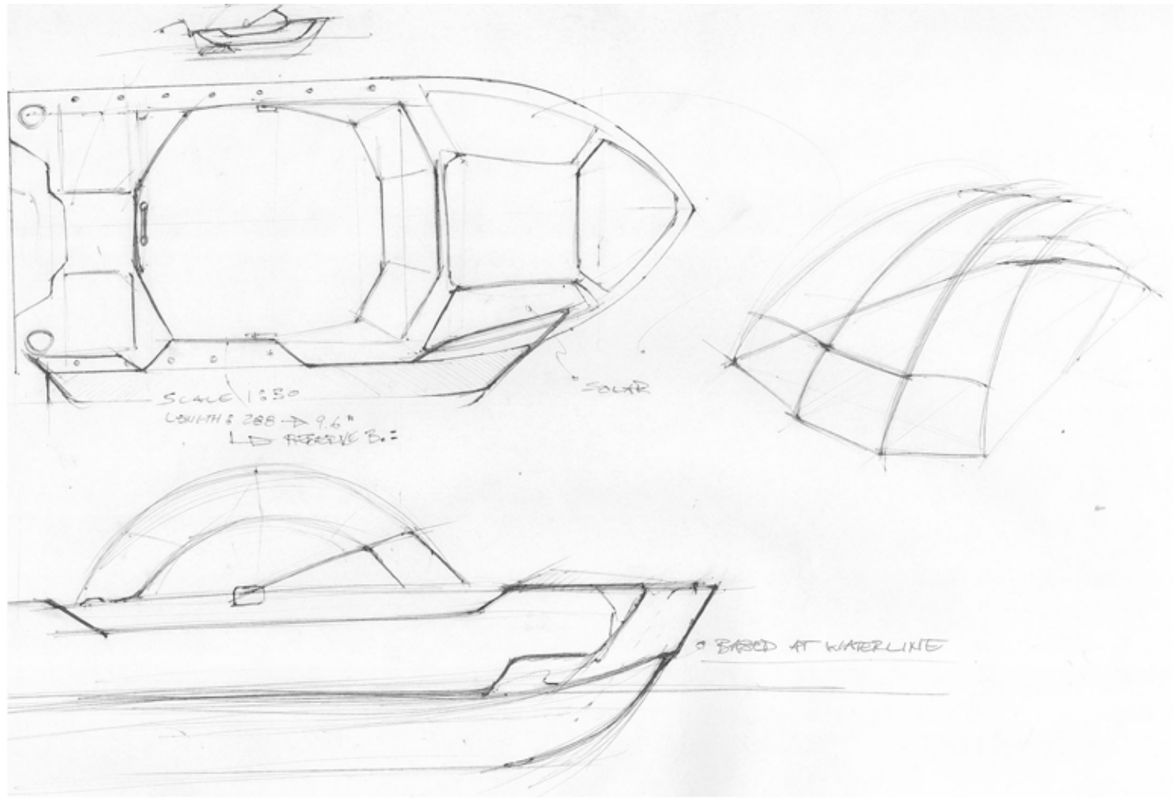
5.2 CONCEPT REFINEMENT: RESERVE GAS



5.2 CONCEPT REFINEMENT: SAFE ZONE

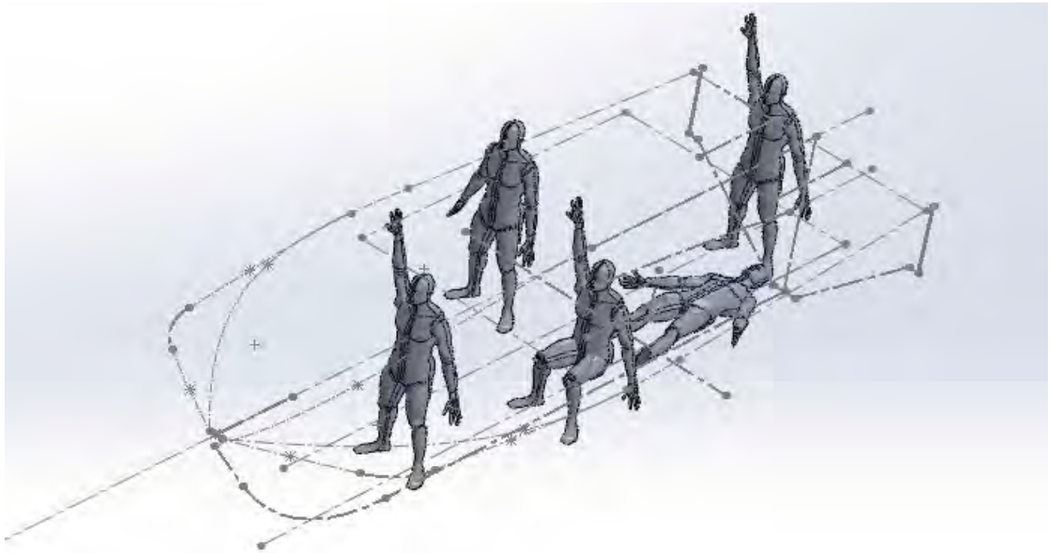


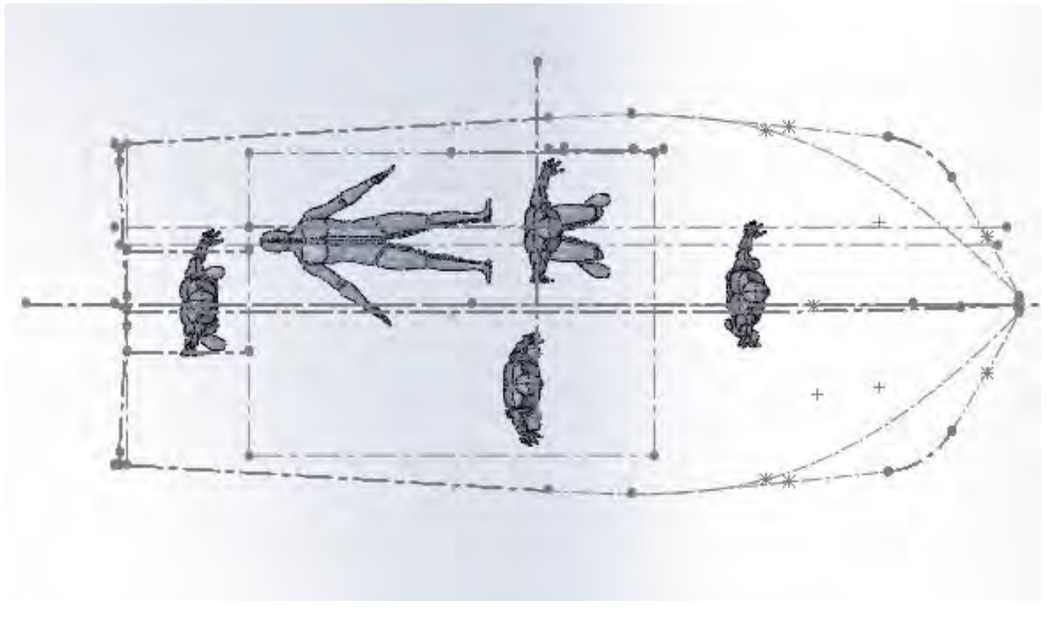
5.2 CONCEPT REFINEMENT: RESERVE BUOYANCY / LAYOUT



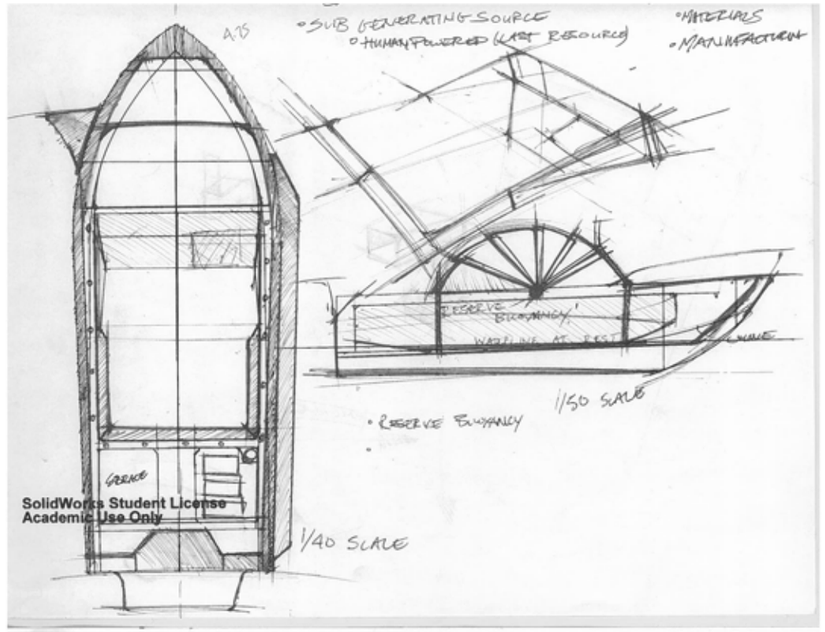
5.3 DETAIL RESOLUTION: CAD ERGONOMIC EXPLORATION

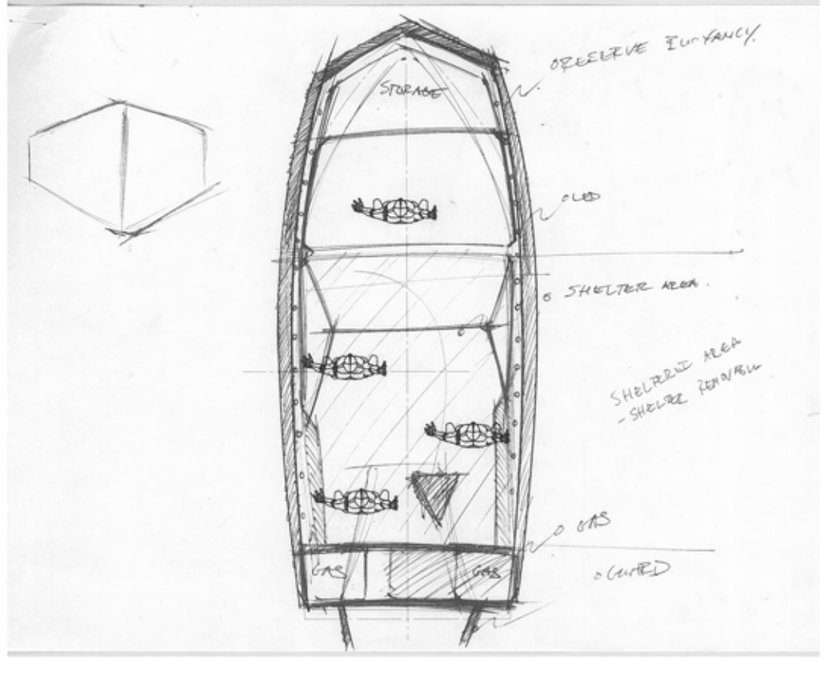
Using an articulated CAD humans reference I mocked up a general shape that the hull design would essentially be. I placed the figures in a variety of different positions; sitting postion, laying down, arms extended etc.



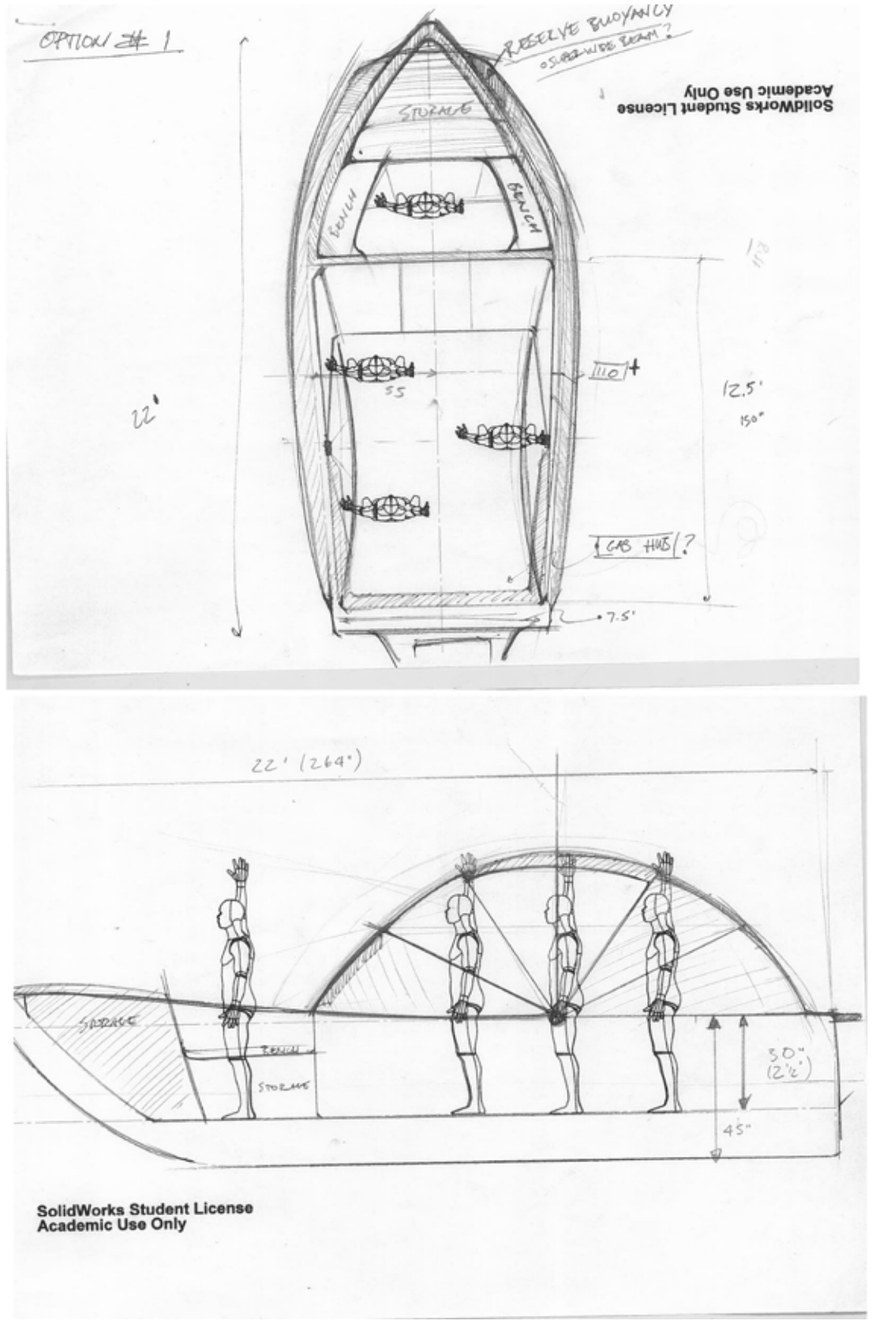


5.3 DETAIL RESOLUTION: LAYOUT



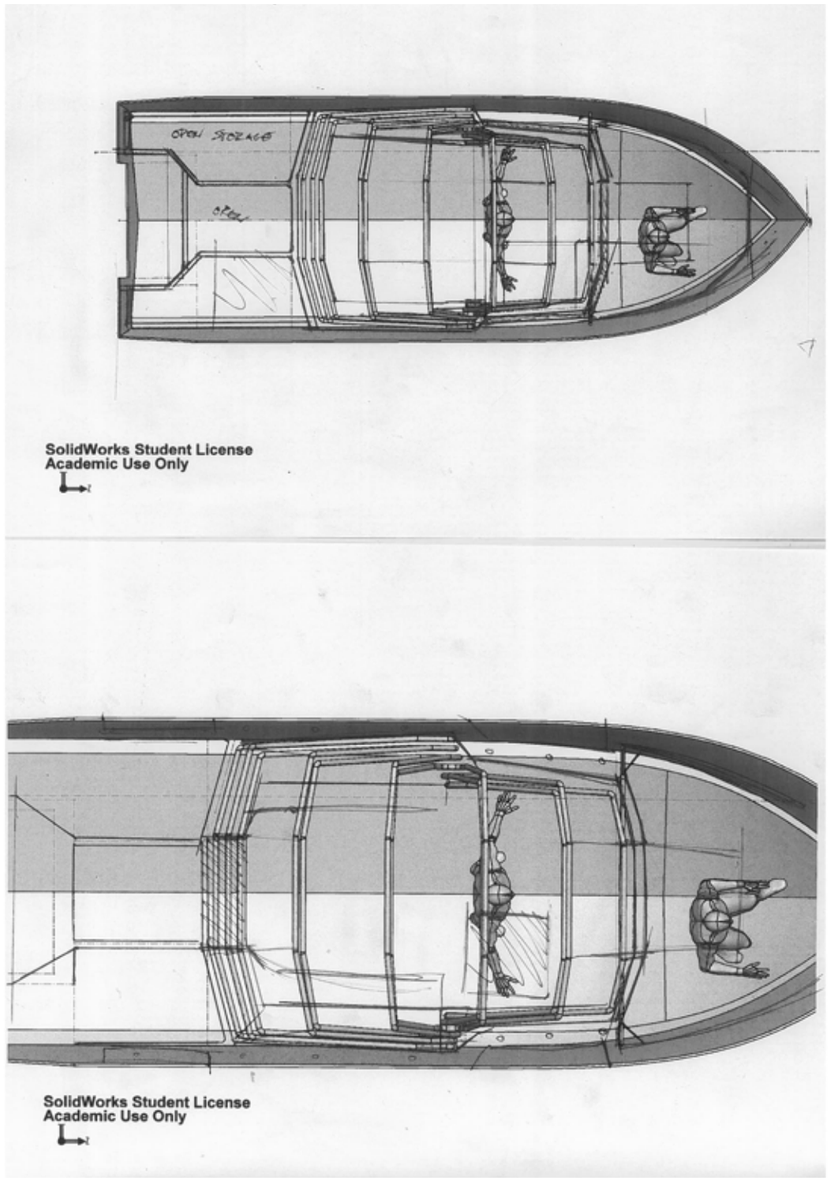


5.3 DETAIL RESOLUTION: LAYOUT

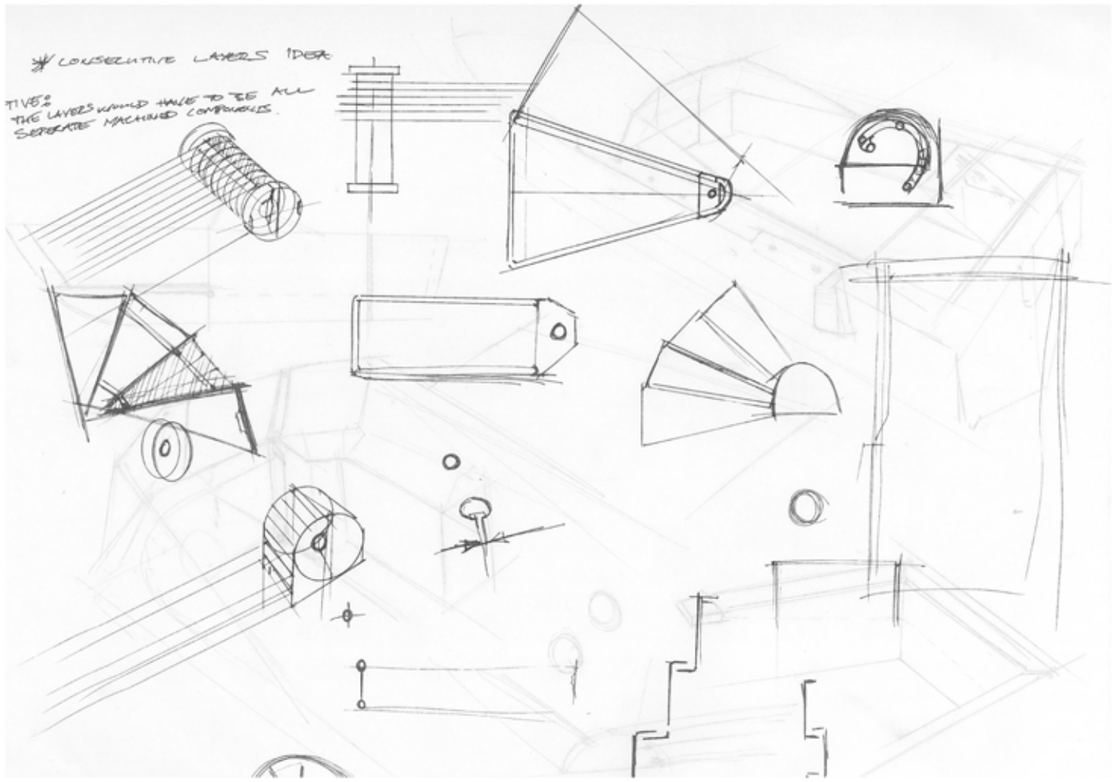


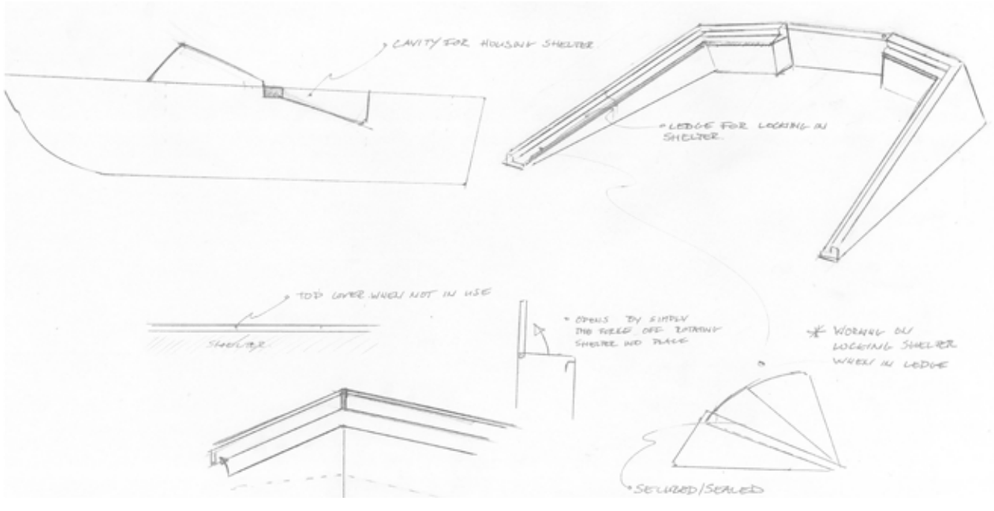
5.3 DETAIL RESOLUTION: REFINED LAYOUT

After refining the overall dimensions through the ergonoomic CAD exploration the layout of the boat was set. From here other details -

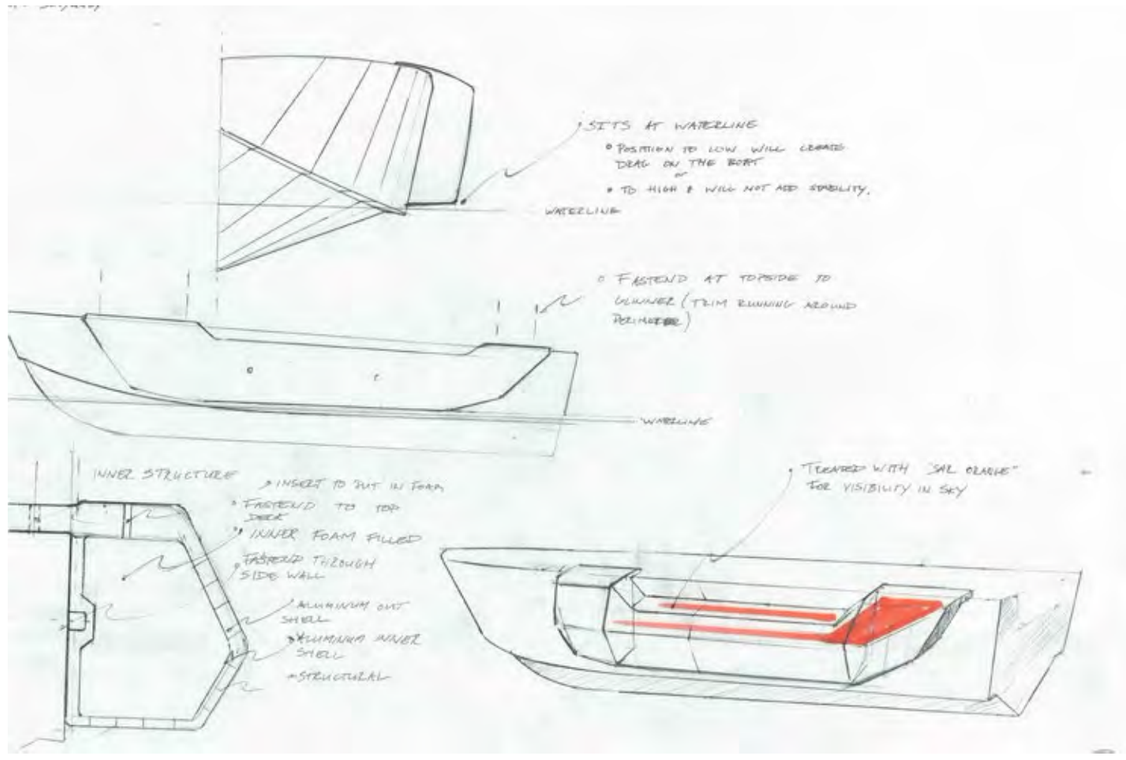


5.3 DETAIL RESOLUTION: SHELTER

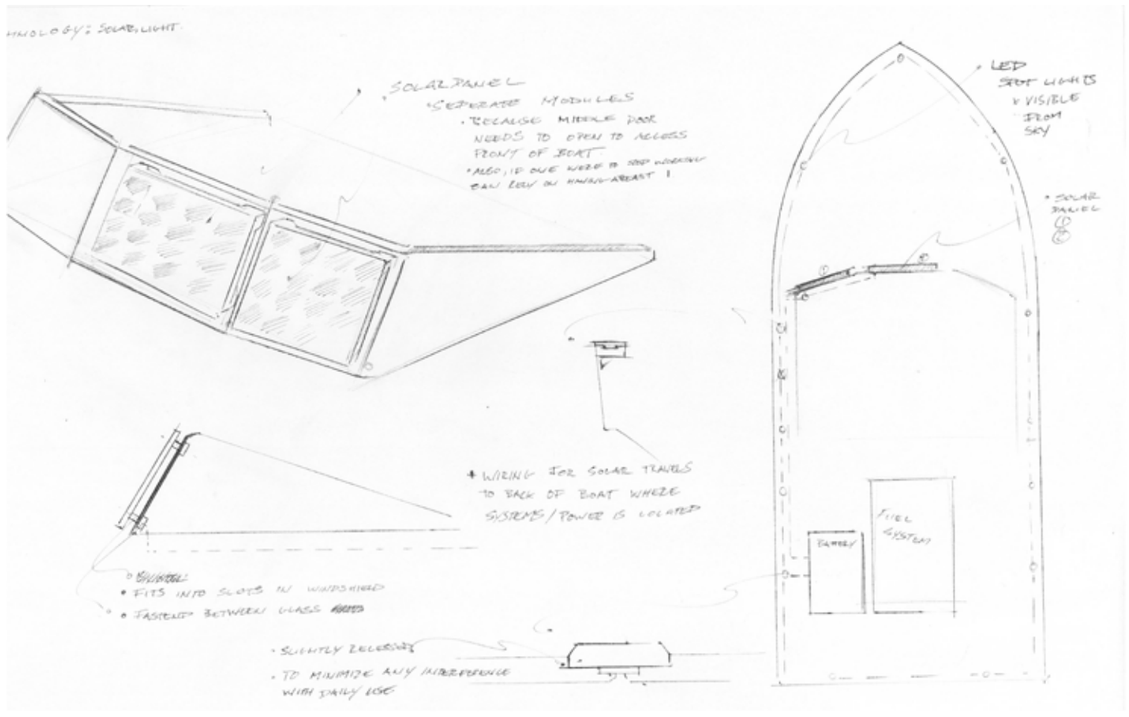




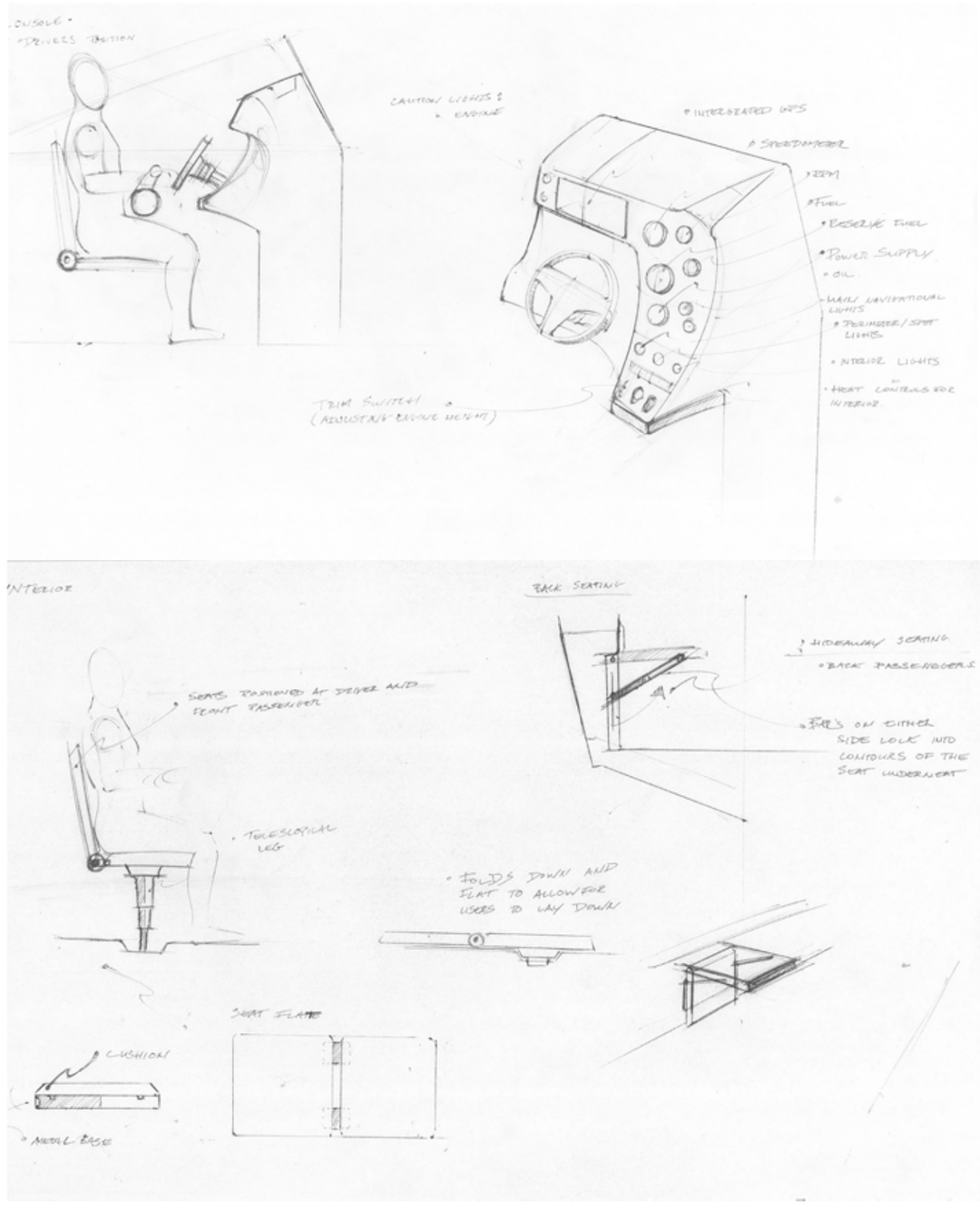
5.3 DETAIL RESOLUTION: RESERVE BUOYANCY



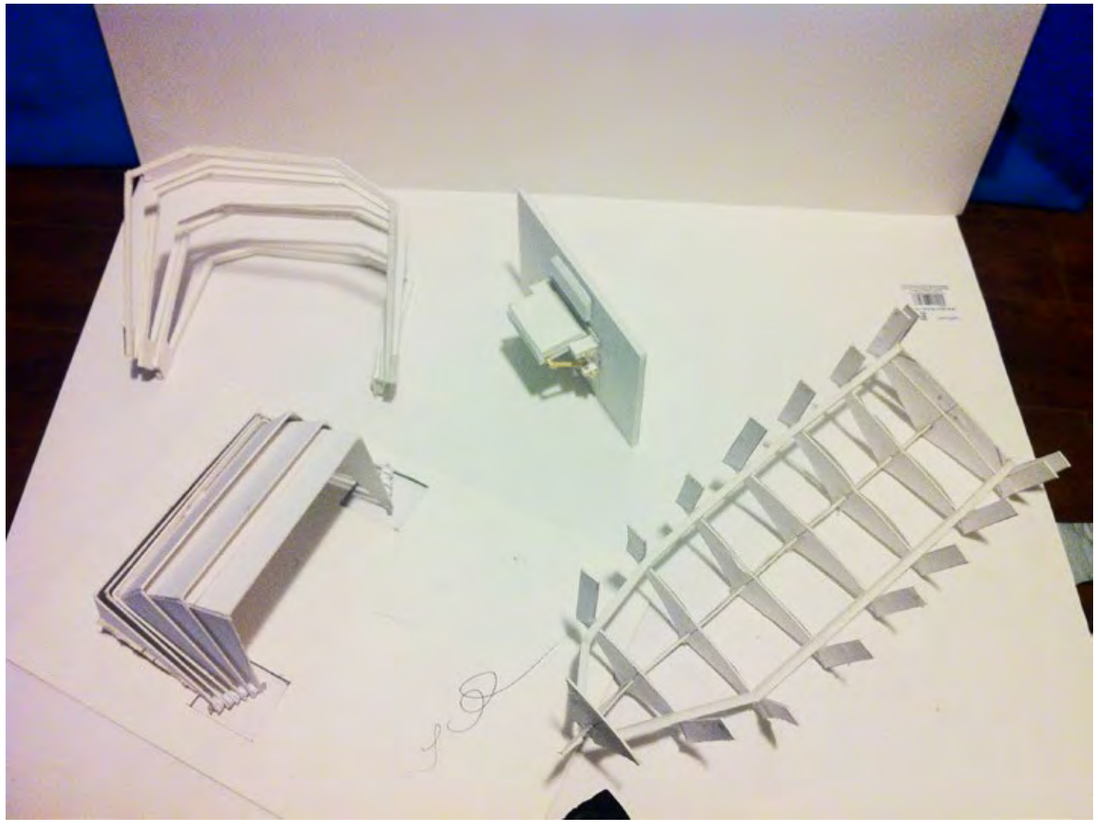
5.3 DETAIL RESOLUTION: SOLAN ENERGY



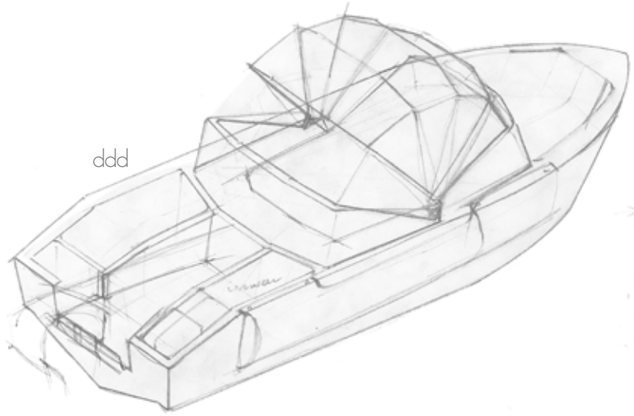
5.3 DETAIL RESOLUTION: CONSOLE / SEATING

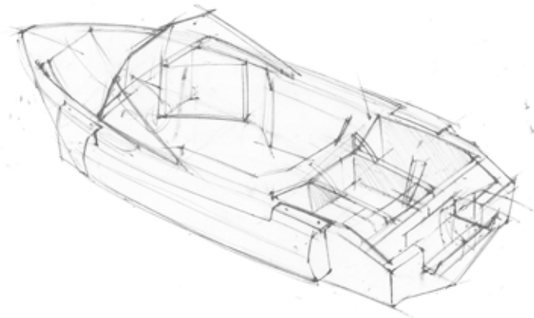


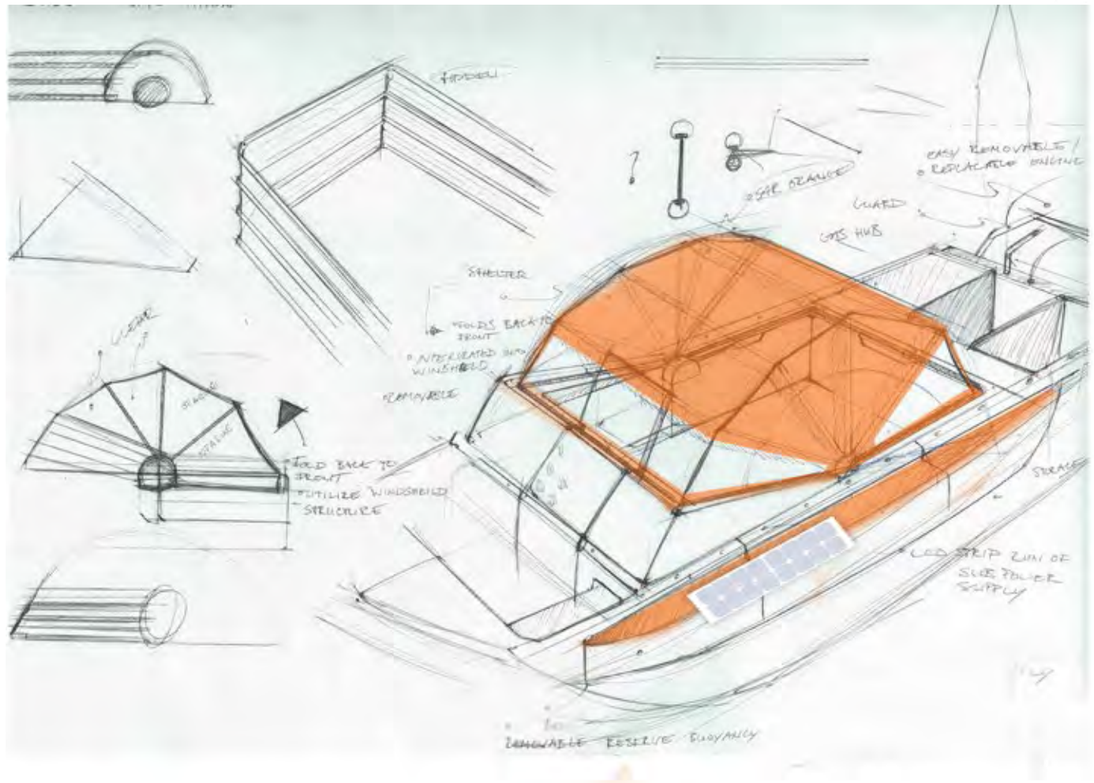
5.4 SKETCH MODELS



5.5 FINAL DESIGN

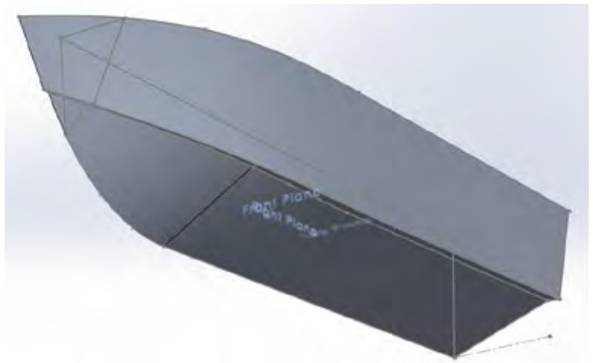


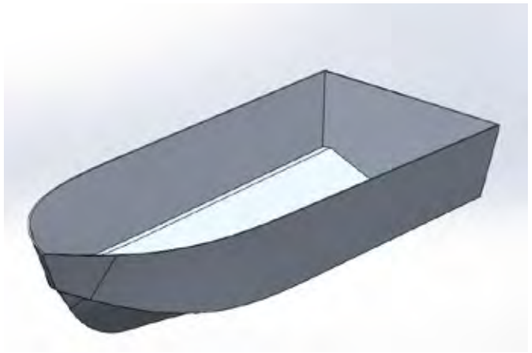


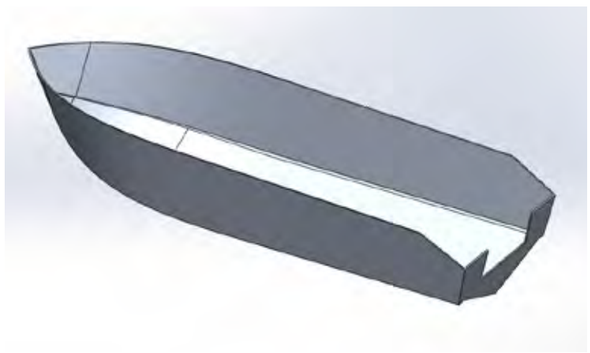


5.6 CAD MODEL

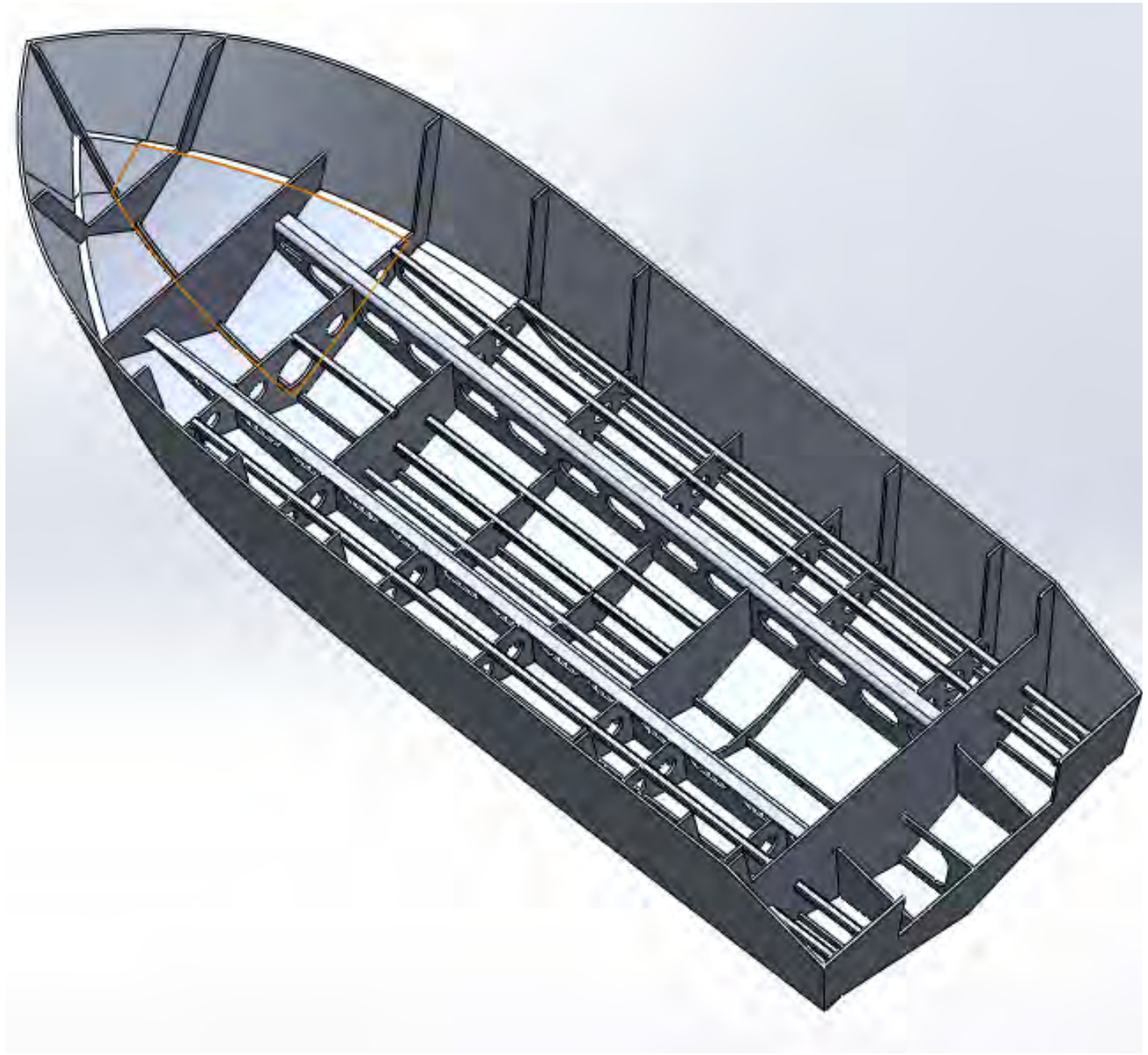
The CAD for creating Sedna was developed using solidworks. The data used to develop features were all derived from research of the materials that I intended to use for my design. My advisor (marine designer) directed me in the proper direction when developing the design of the overall geometry. All of the images that follow are in exact order in how I built the CAD Model.





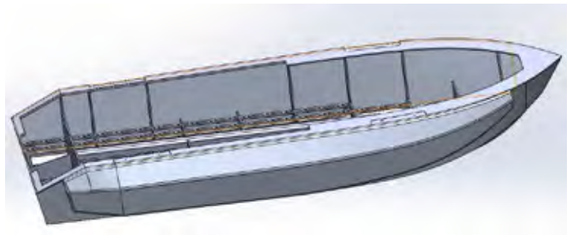


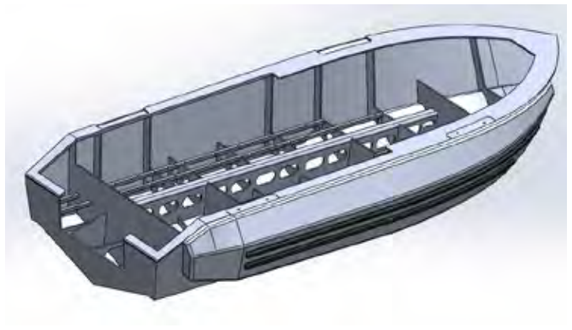
5.6 CAD MODEL

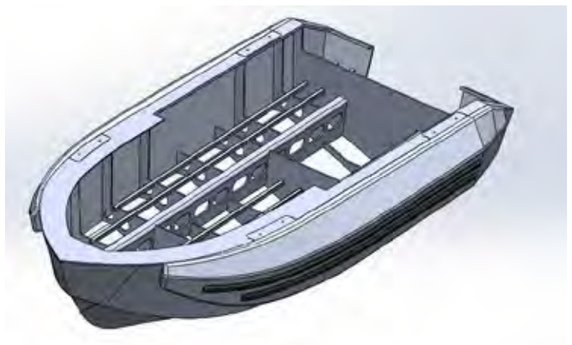


- With the geometry of the hull complete, I modeled the interior structure of the hull. This allowed me to further prove my design from a manufacturing stand point

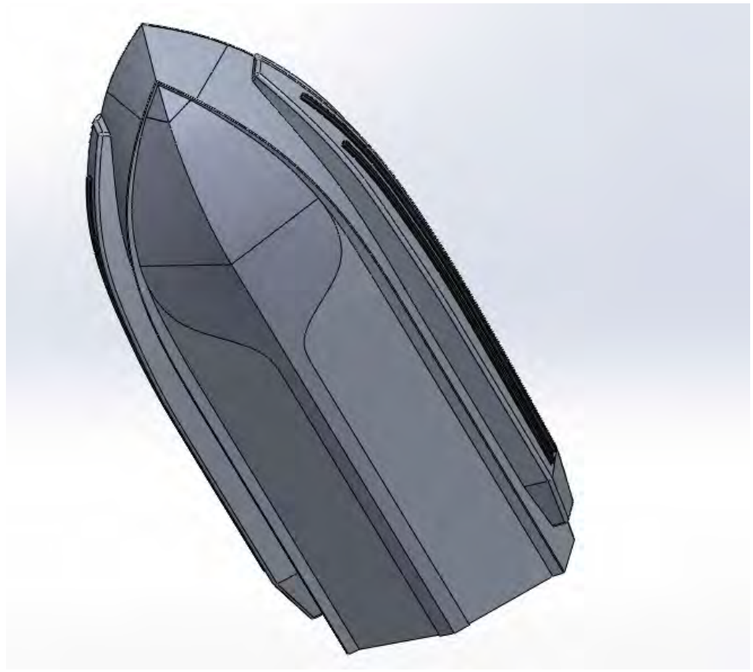
5.6 CAD MODELS



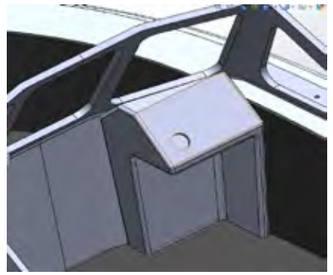


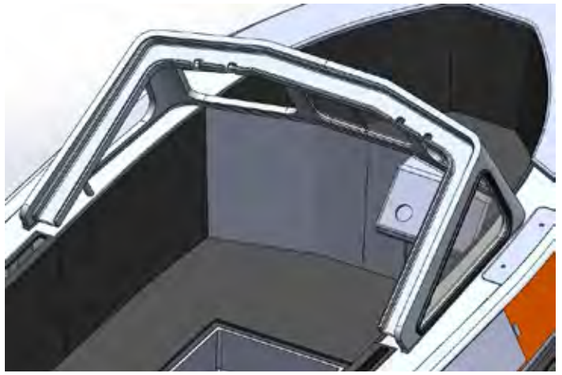


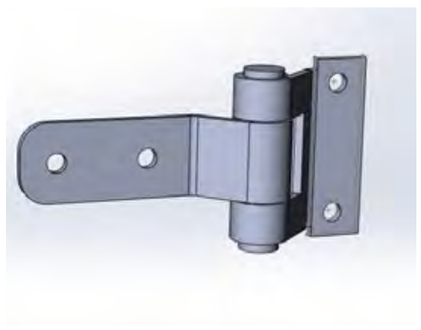
5.6 CAD MODELS



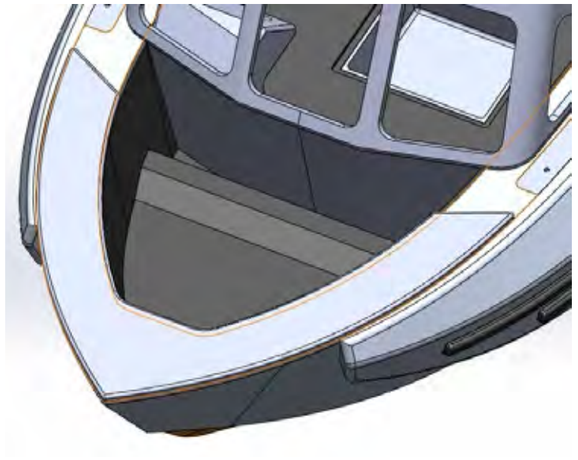
5.6 CAD MODELS

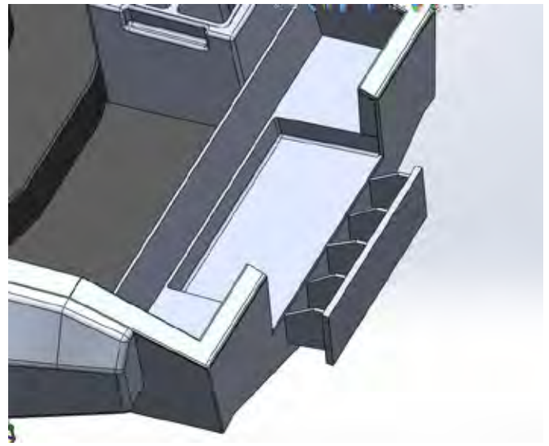


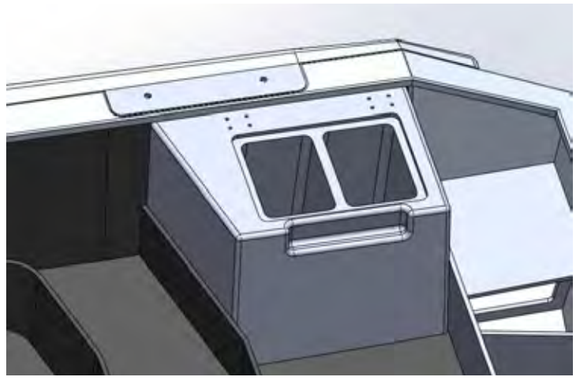


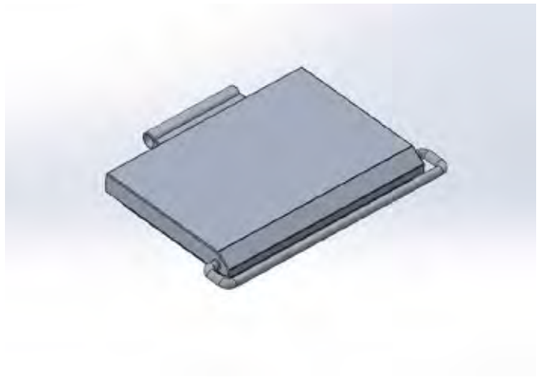


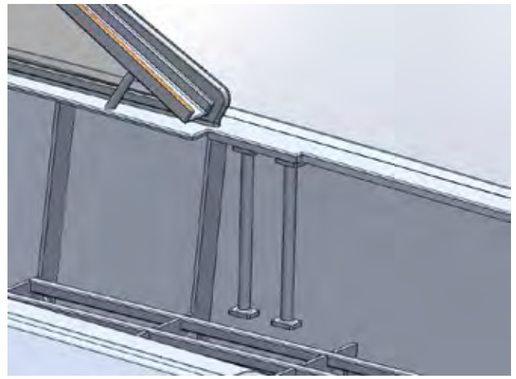
5.6 CAD MODELS

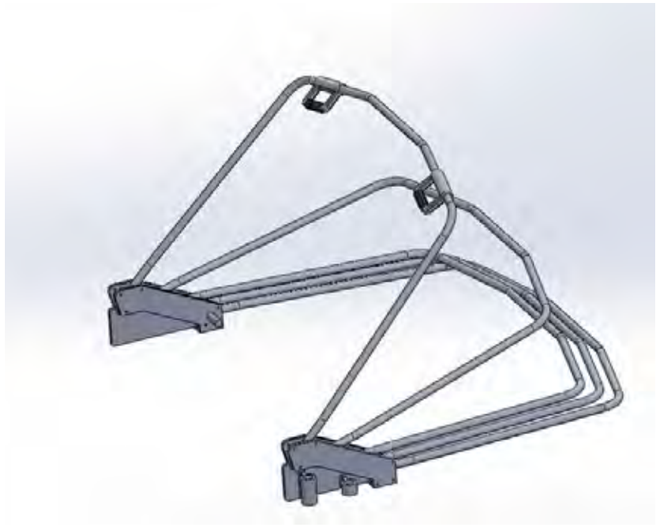


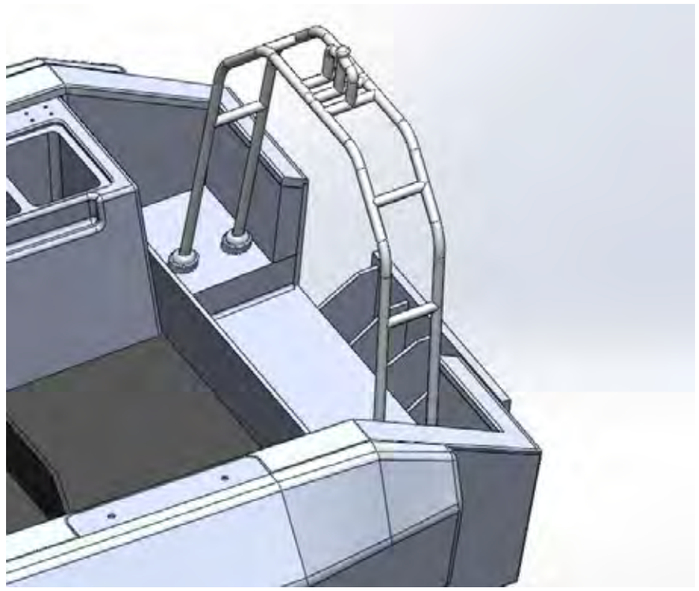


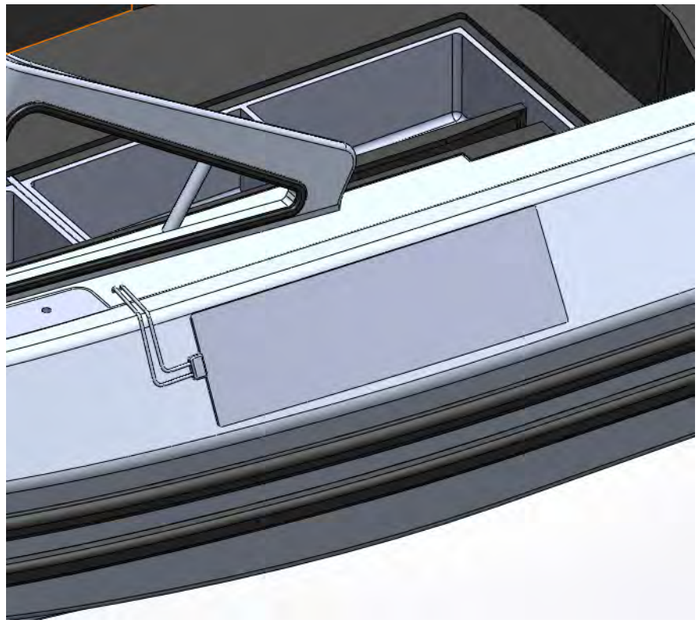


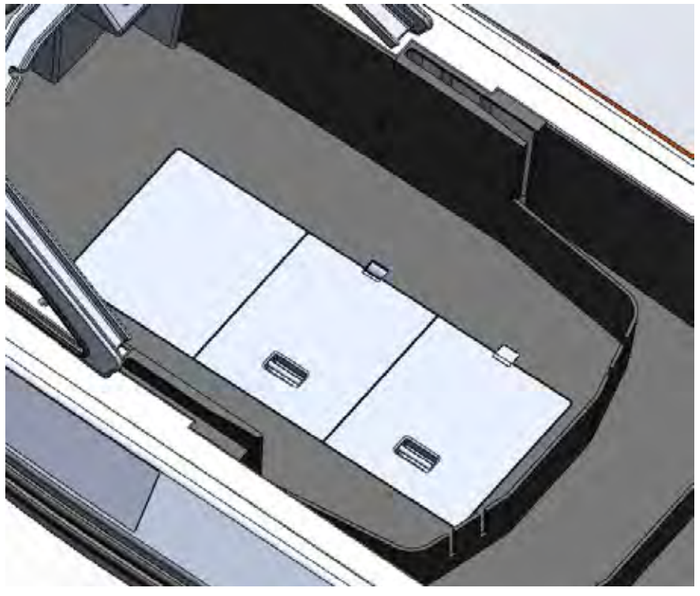




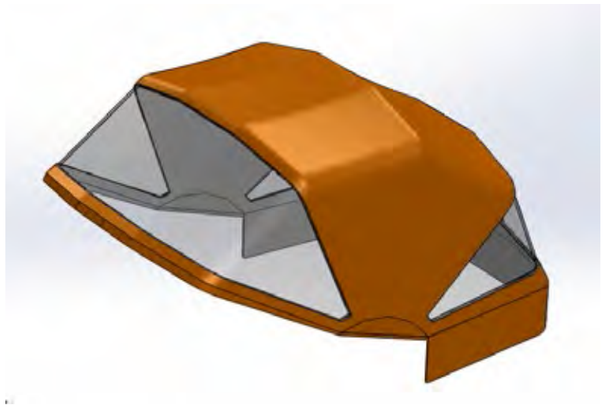


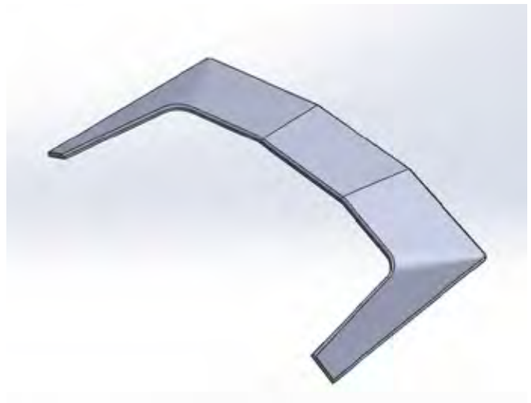


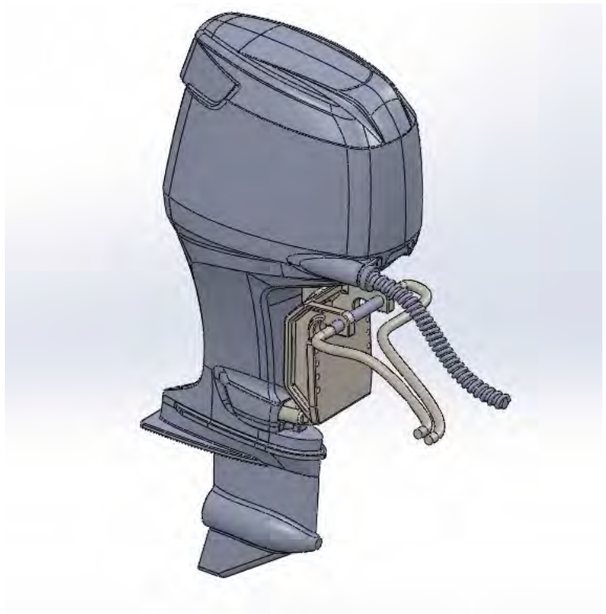




5.6 CAD MODELS





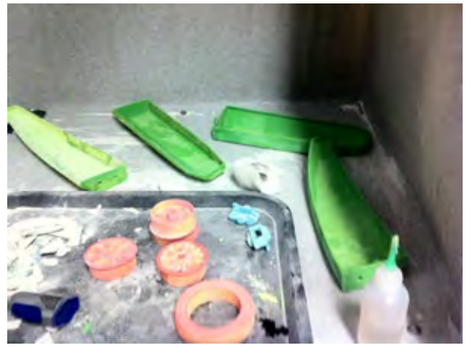


5.6 CAD MODELS: FINAL CAD

5.7 HARD MODEL FABRICATION

The hard model was fabricated at 12th scale. Before starting any building I planned out how I wanted everything to be done. I used a variety of different methods in completing the components for the creating the model.. The following is the exact order in how the model was built.

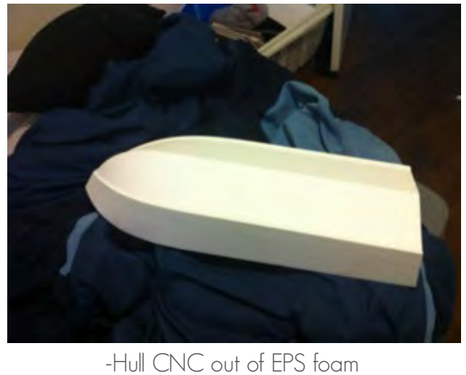
5.7 HARD MODEL FABRICATION



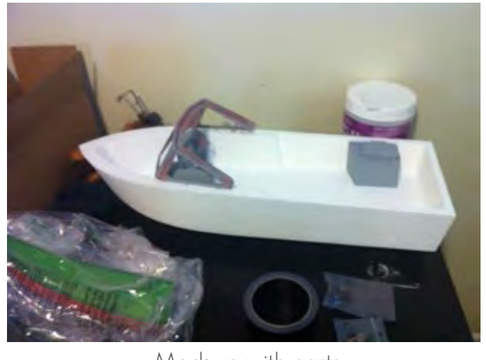
-3D printing of reserve buoyancy

-Primer and spot putty

-3D pritning of several components



-Hull CNC out of EPS foam



-Mock up with parts

5.7 HARD MODEL FABRICATION

-Cut angle out out transom

-Seel foam with wellbond

-Coat surface with smooth on 65-D (Rotocast)

-Bondo surface of hull

-Sanded hull surface

-Spot putty surface

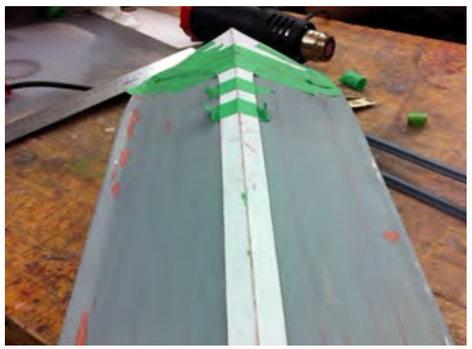
5.7 HARD MODEL FABRICATION

-Filler primer applied the hull

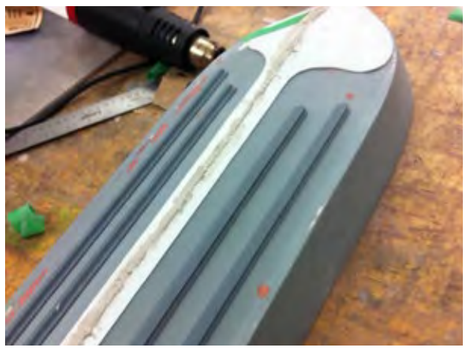
-Sanded filler primer and then applied spot putty

-Cut 1/16" thiick plastic into two profiles

-Glued the two profiles together



-Epoxyed bottom to the hull

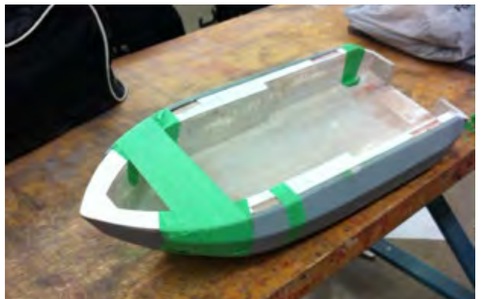


-Cut T plastics extrusions and glued to hull

5.7 HARD MODEL FABRICATION

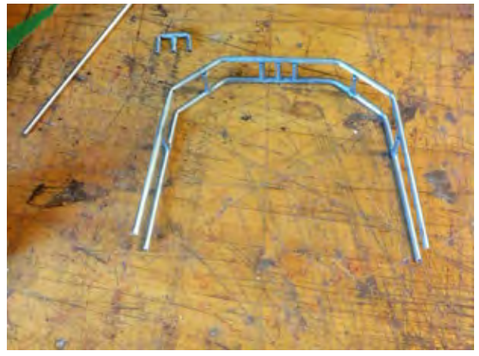
-Cut 1/16" thick plastic for the gunnel

-Glued the reserve buoyancy parts together



-After sanding reserve buoyancy parts, they were epoxyed under tension and let to cure over night

-Spot putty and filler primer the 3D printed parts



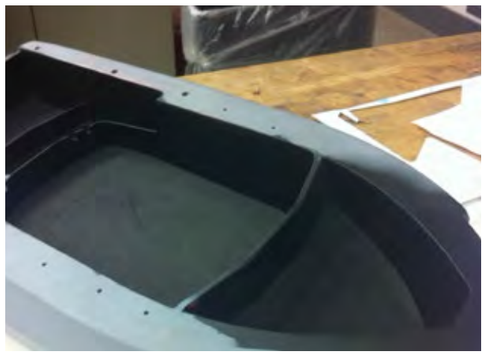
-Bent 1/8" diameter aluminum tubing for several of the details

-Interior walls / bow cut out of plastic and mounted into the interior

5.7 HARD MODEL FABRICATION

-After all parts were prepared, the parts were ready to paint. The interior was completed first

-Interior was sprayed with a matte finsh paint.
-Paper templates were cut out in order to skin the floor



-Using the paper templates, the interior was skinned using black foam sheets

-Interior was masked off to then paint the exterior

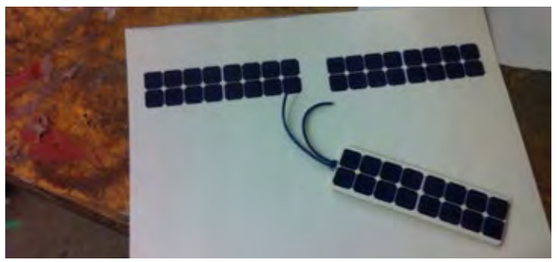
-Masked off bottom extruded keet/ braceplate

5.7 HARD MODEL FABRICATION





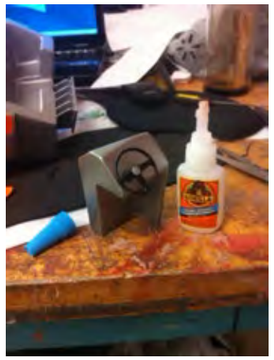

-Used .50mm plastics for clear plastic and orange vinyl for straps

-The solar panels were made from a 1/16" thick plastics and covered with a decal. The wiring came from a pair of old headphones

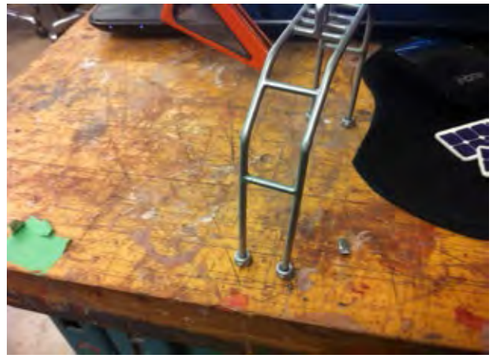
5.7 HARD MODEL FABRICATION





-The clear material for the windows were cut

5.7 HARD MODEL FABRICATION



-Snapping in the plastic for the windshield

-CNC .50" thick acrylic for base
-Drill holes for .50" diamter clear acrylic dowel

5.7 HARD MODEL FABRICATION

-Sanded top surface to a frosted finish

-Painted bottom surface with light white & blue coat

-Mounted clear acrylic rod to designated holes

6.1 DESCRIPTION

Sedna is designed to adapt to the unpredictable environment of the Arctic. The overall layout of the boat is geared not only for everyday use by hunters in the Arctic but also to aid in any survival situation. The features on board Sedna act as a safety system for the user. Input from the Canadian Coast Guard has informally helped with the design in developing a safer, and reliable vessel.

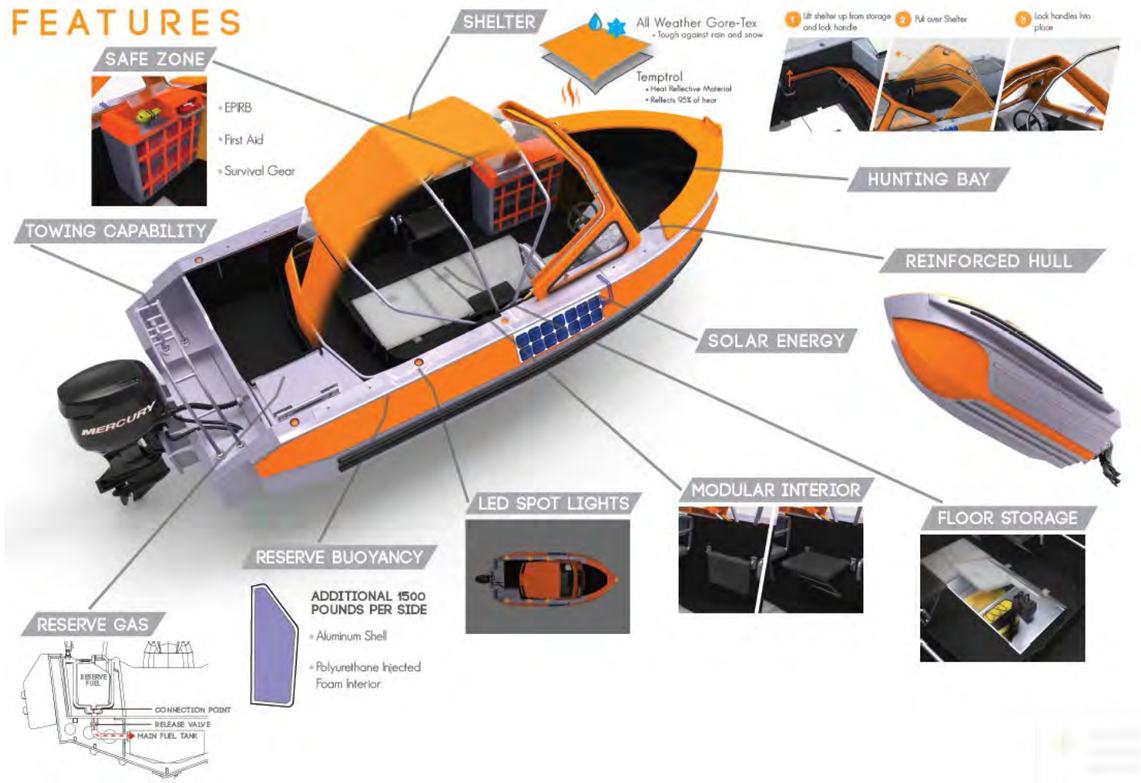
With the main demographic directed towards the Inuit and their hunting lifestyle, the aesthetics are directed for a simple utilitarian look. This also allows for the cost of the overall design to be dramatically less. Sedna incorporates all the features and needs in order for the Inuit to travel safer and more effectively in the Arctic. It's geared not for only everyday use by the user but also as a survival resource in case of an un-welcoming situation.

The main features on board Sedna are as follows:

- Shelter
- Reseve Gas
- Reserve Bouyancy
- Solar Energy
- LED Spot Lights
- SAR Orange Color
- Safe Zone
- Reinforced Bow & Keel
- Towing capability
- Modular Interior
- Accessible storage

The materials used on board Sedna directly relate to the environment and the intended use. The aluminum used for construction utilizes the latest corrosion resistant techniques allowing for a longer lasting reliable hull. Solar energy runs all lights and electrical outputs onboard as well as storing energy in case of a survival situation.

6.1 OVERVIEW



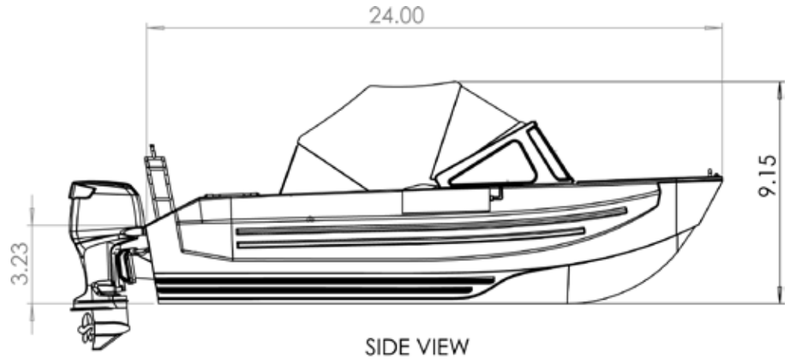
6.2 FINAL CAD RENDERINGS

6.2 FINAL CAD RENDERINGS

6.3 FINAL HARD MODEL

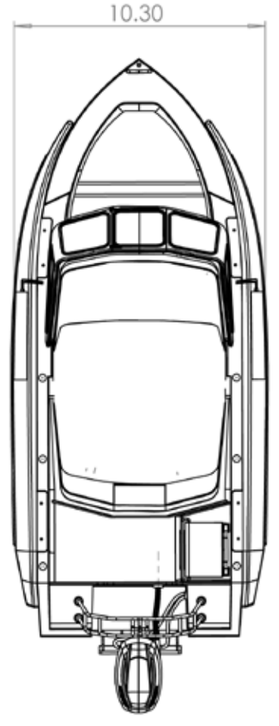
6.3 FINAL HARD MODEL

6.4 TECHNICAL DRAWINGS

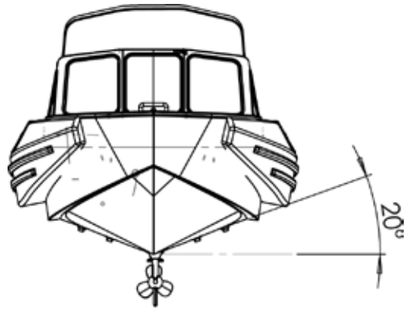


SIDE VIEW

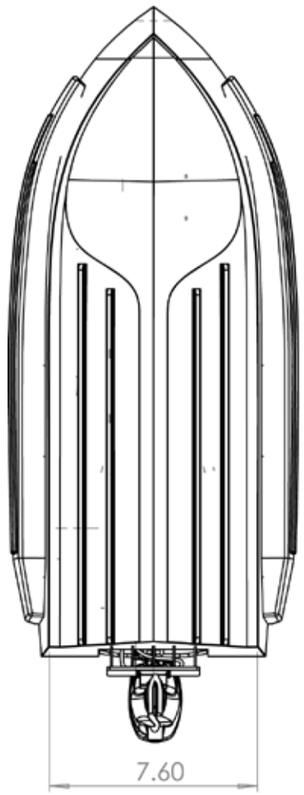
Boat Length: 24'
Beam Width: 10.3'
Chine Width: 7.60`
Transom Height: 3.23`
Fuel Tank : 100 Gallons
+ 2 x 25 Gallon Reserve
Min/ Max Horsepower: 150/300 HP



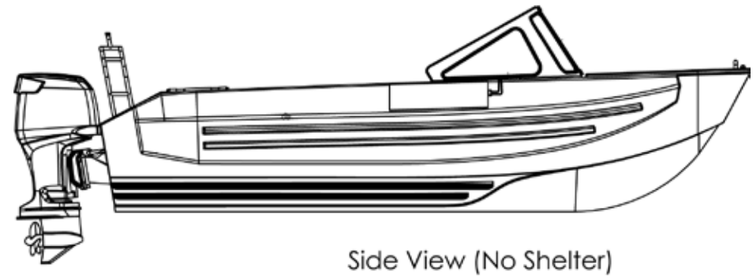
Top View



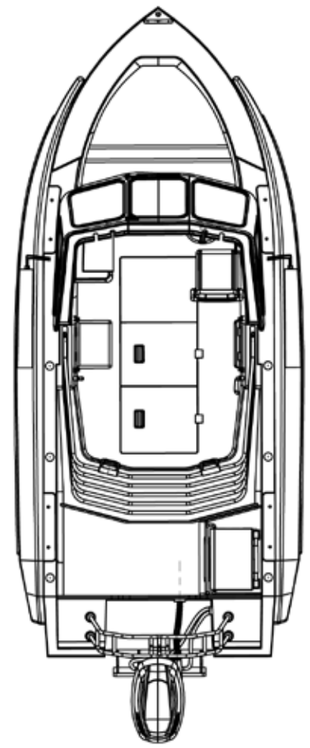
Front



Bottom



Side View (No Shelter)



Top View (No Shelter)

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