# *The design of 'Mini' solo offshore race yachts in relation to fatigue and sleep*

**Research Dissertation**

**June 2006**

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## Abstract:

The purpose of this paper is to analyse the development of solo offshore yacht racing, the main related risks and ways to reduce them. Focusing on the *Mini Transat 6.5m* class and how it fails to address these issues. The irony is that while this international solo entry-level class yacht should be encouraging sailors to pursue the discipline of solo offshore racing it is actually the wettest, hardest, most uncomfortable yacht afloat. (Sayer 2006) These "skiffs on steroids" Bray (2002) are 6.5m long, by 3m wide and designed to race solo across the Atlantic.

From the information review, sleep deprivation emerges as the common theme that causes the greatest risk prompted by excessive fatigue and exposure. Racing single-handed is an increasingly accepted discipline of offshore yachting events and perhaps the last frontier of human isolation and endurance in extreme terrestrial sports. It provides a great commercial platform for sponsorship; the image of the lone sailor against the sea captivates and entertains the public -especially when they require rescuing…

The specialist design of these craft pushes the envelope in keel, hull, rig and sail design to create extraordinary powerful, light and fast yachts. "Exhaustion is constantly around in the massive dinghies that are today's single-handed racers. These are complicated, temperamental boats. Simply gybing them takes 20 minutes, what with all the shifting of sails, redistributing of water ballast, et cetera." Rousmaniere (2003). Therefore the weakest-link is still the (human) sailor...

Thus I propose in this paper titled: *The holistic design of 'mini' solo offshore race yachts in relation to fatigue and sleep* to examine and argue that by reducing exposure, fatigue and basically designing the ergonomics of the Mini 6.5m yacht around the ability to easily maintain a polyphasic sleeping pattern will ensure the skipper is alert, safer and able to sustain higher average boat speeds, thus increasing their chances of podium success and ultimately media exposure for the sponsor.

# 12.0.0 Appendix

## Glossary

The following is an explanation of all the esoteric nautical terms:

**Amidships** The middle section of a boat.

**Bow** is the front of the boat or the 'pointy end'.

**Close hauled** is when you have the sails trimmed right in and the boat is pointing roughly 35 angle to the wind so that you are 'beating to windward' or 'hard on the wind'.

**Deck** the flat surface which you walk on which is on top of the hull

**Footing** is when you are cracked just of the wind so you aren't close-hauled but sailing about 60 from the wind and going as fast as possible.

**Pointing** when you are close-hauled you are trying to get to windward in the shortest distance physically possible so you are constantly pinching if you like so not to luff but to fet as high as possible.

**Port** is the left hand side of a boat.

**Port tack** is when you have the wind blowing from the left side and the boat.

**Heeder or Knock** are terms used when close hauled usually and when the wind is coming from a certain direction in shifts back and forward so that it can luff your sails or let you point higher.

**Heeling** is what a yacht does naturally leaning away from the wind direction.

**Hull** the actual boat which floats on the waters surface.

**Keel** is positioned under the hull and is made from steel and lead to counter react the pressure on the sails by the wind.

**Mainsheet** is a rope that controls the mainsail.

**Mainsail** is the biggest sail which is hoisted up the mast.

**The Rig** includes boom, mast and all standing riggingn.

**Running** the point of sail when the boat is sailing with the wind direction

**Reaching** the point of sail when the boat is sailing across the wind direction

**Sails** are the engine room of the yacht, usually made from Dacron which drive the boat forward with the wind.

**Starboard** side is the right hand side of the boat.

**Starboard tack** is when the wind is blowing from the right hand side of the boat.

**Stern** is the back end of the boat.

**Tacking** is when you alter course and the bow goes through the wind and you end up going in the opposite direction.

**Gybing** is the opposite to a tack and is when the stern passes through the wind.

**Jib** is the sail on the front of the boat.

**Luffing** is when the boat is pointing to close to the wind and the sails flap.

**Leeward** is the opposite side to where the wind is blowing from.

**Windward** is the side that the wind is blowing from.

## List of Illustrations

## Acknowledgments

I would like to acknowledge
sleep deprivation requires courage
a very tough way to survive
no matter how hard you may try
but it's a far greater attraction
than writing a dissertation…

Would like to thank:
the interviewees who were interviewed
the tutors who tutored

**'So long and thanks for all the fish' Adams (1979)**

Credit: Martinez,T.

### 1.1.0 Objective

The objective of this paper is to extract a suitable design brief from problematic issues arising in the chosen research topic. By realising the issues 'somebody should do something about this' and designing a solution will ensure that the problem is removed for future stakeholders.
The successful execution of this research dissertation will allow graduation from the culmination of four years study in the area of Industrial Design. Armed with this in-depth problem solving ability, one wishes that as professionals we can contribute to a safer, healthier, greener future...

### 1.2.0 Topic Definition

This topic was reached from the initial topic of inquiry; *'holistic management of sleep and sail trim for solo yacht racing; sleep deprivation in extreme environments'*. Through the research process this was refined to the final form. It is intended to explain the risks involved when racing solo offshore. Within the context of fatigue and sleep deprivation using examples from all classes of solo racing yachts. Armed with this analysis, it will be applied to Mini Transat 6.5m yachts with the prospect of re-designing one around these priorities under the final title: *The holistic design of 'mini' solo offshore race yachts in relation to fatigue and sleep.*

The majority of the research comes from the 'Open 60' solo racing scene. This is because the Open 60 is a substantially larger professional class of racing with mainly professionals steering them, supported by large budgets and extensive trial and testing of ideas. The Mini Transat class on the other hand is an amateur class with a lot less information available. There is a substantial trickle up and trickle down of design ideas and goes on between the two classes, the Mini being the feeder class of skippers to the Open 60s and other high performance solo racing yachts (Boyd 2004). Not dissimilar to what occurs in the high-octane world of motorcar racing; between go-carts, Formula 4s and Formula 1 car racing.

### 1.2.1 Topic Boundaries and exclusions

Refining the topic took considerable time, researching all aspects to increase the prospect of finding a void to resolve with a Design brief. To assist with this, keywords are required to direct this research since the topic has been refined. These have been identified in the topic definition and boundaries. The strict boundaries are set by the following:

Solo offshore yacht racing

Affordable offshore race yachts

Design of open class ‘box rule’ yachts

solo racing events

Risks involved

*extreme environments*

Reducing exposure

*sleep deprivation*

Managing the Yachts performance

maintaining performance

*sail trim*

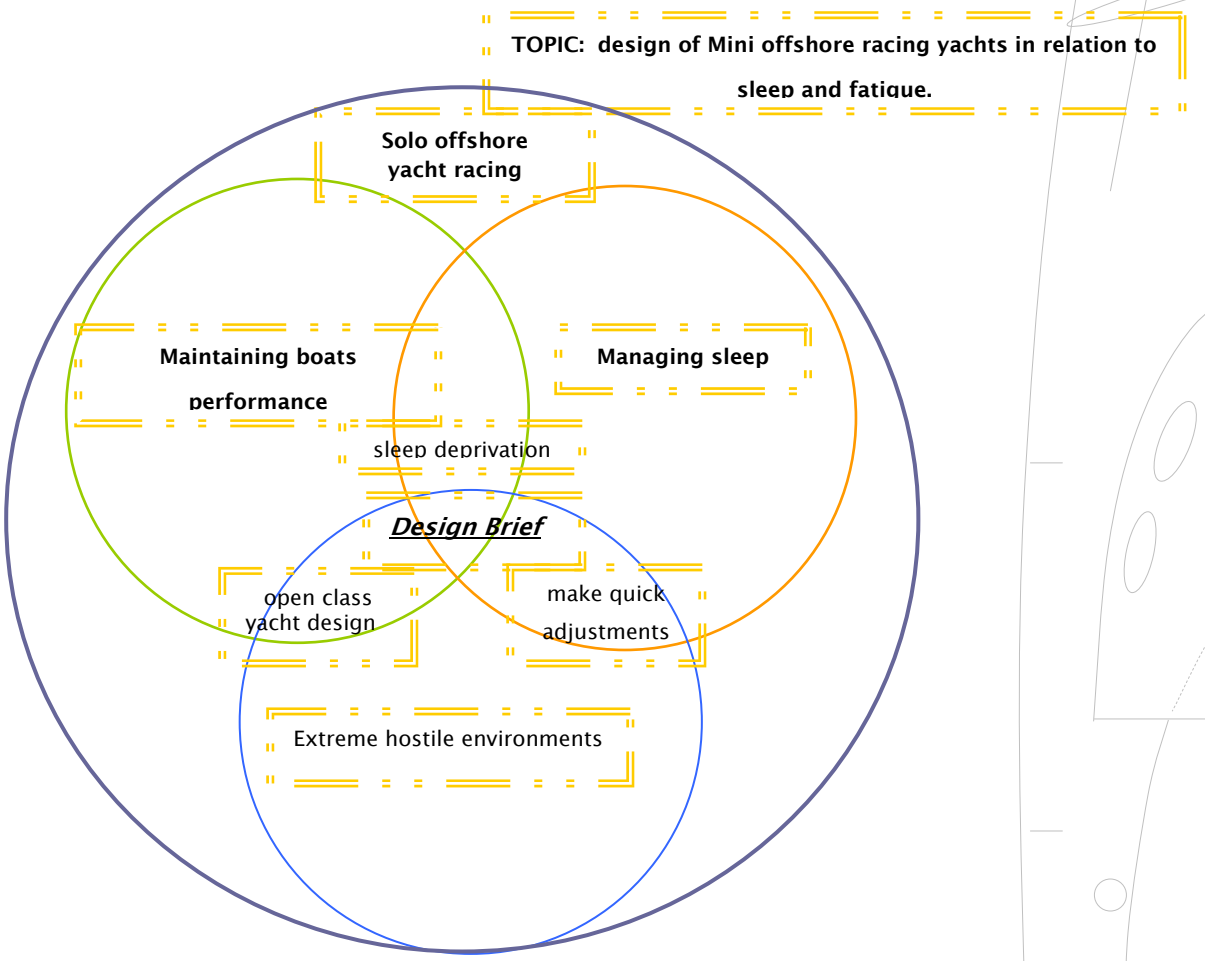
cockpit ergonomics of small yachts

Managing personal performance

sleep patterns

### 1.2.2 Context of topic flow

**Extreme Hostile environment =solo offshore yacht design =fatigue =sleep deprivation =design brief to resolve.**




### 1.2.3 Personal interest in topic

More than anything this topic choice comes from a lifelong passion for sailing and an indelible desire to join the ranks of solo sailors who race

across the Atlantic and around the world. If I'm not racing skiffs or yachts of a weekend, I'm cruising around solo on my own yacht. I have been working in a yachting industry for the last 10yrs including; as a sailing/race coach, sailmaker, rigger, boat builder, yacht maintaining –currently a 60' race yacht, and coastal delivery/charter/race crew with thousands of miles experience on some of the most extreme offshore yachts currently afloat in Australia.
Continued in Appendix 'G'

### 1.3.0 Information Retrieval Strategy

Despite my vast experience and knowledge of the topic area, many auxiliary information retrieval strategies have been used. As Primary research is the 'richest' source, many experts in the field were drawn upon. Followed by Journals which were the most prolific source, books and online articles were used to supplement this information. As part of the sleep deprivation study I conducted an experiment on myself by maintaining a polyphasic sleep pattern for a duration of time and maintained a 'sleep log' to record the results.

#### Interviews

Learning from first-hand accounts was key to the successful digestion of the main issues facing solo racers. A full description of the 5 interviews and the questions asked can be found in the Appendix. A total of 15 professionals from the yachting fraternity contributed to the topic.
Some of the questions asked or brought up in conversation were:

1) What have been your experiences in racing solo offshore?
2) What priority did you place on sleep management?
3) Did incidents become uncontrollable when you were sleep deprived?
4) How successfully did you maintain a polyphasic sleeping pattern?
5) What tricks did you use?
6) How often did you oversleep?
7) How important is personal comfort to you?
8) Did you rest in the cabin because it was the only available spot?
9) How often would you nap on deck in the cockpit?
10) How much is price a limiting factor when you began the sport?

#### Journals

The secondary source of up to date information from pre-checked and reliable sources. Over 50 journal articles have been cited, the majority of theses were from the publication 'Yachting World' with articles by

journalist James Boyd. The pre-eminent international yachting publication, it provided up-to-date articles about what was happening in the solo yacht racing arena.

### Books

The most reliable source of information, although the most time consuming to filter and find nuggets of relevant info -providing greater admiration of the web for its search ability and time saving. A total of 30 odd books were found to have helpful insights

### WWWeb

The third most current source available, although the information source is substantially less reliable than print media, it still provided the essential information. I subscribed to interest groups and forums on solo offshore racing placing threads in hope of starting a 'global conversation' on the topic with varying degrees of success. Over 10 websites provided great information, and was the best source for images from the European racing scene.

### Personal experiment

Throughout a period of weeks during the semester I practiced and maintained a 'polyphasic sleeping pattern'. I put myself through this sometimes torturous experiment to gain first hand knowledge of what sleep-deprivation feels like and how to balance it with regular cat-napping. Possibly the most revealing element of the entire research period, it placed all that I had already read on the topic into context and gave me a greater depth of understanding of the mindset that it puts solo sailors in. A sleep log was maintained to record how I progressed and what was revealed observations which can be read in the Appendix C.

### Personal experience

A total of 2600 nautical miles were sailed during the Information review period for this paper around the East Coast of Australia delivering race yachts to different States. These unique experiences provided an insight into the risks, environments, fatigue and exposure that offshore yachtsman encounter. Plus the time spent on board allowed long discussions with the crew about this topic area.

I also took the opportunity to sail on two of the three Mini Transat 6.5m yachts in Australia. Further reinforcing the incredible stamina and that solo yachtsman have to endure in order to race this class. Although I

acknowledge that I'm the most fallible source and can too easily unconsciously bias the outcome.

### 1.4.0 Project Management

The strategy plan is to follow up on the key aspects of the refined topic and researching within the boundaries. Sailing is such an immense field, what I have refined the topic down to has taken some time already and considerable discipline. The priority will be to complete all interviews first; this is far more efficient than wasting days researching an area, when a professional may have the answer instantly.

The Project plan can be found in the Appendix B.

**Stage 1: Preparation:**

- Mindmap – going through all the keywords of the topic and listing all the seemingly disparate related aspects, ideas and how they all tie together.
- Developing Topic Definition – judging what has the most interesting prospects for a tangible product for Major Project. Refining the topic area towards goal.
- Write Topic Definition – finalise the topic definitions
- Topic Refinement – further research into topic, reading books, journals, web pages on the topic and professionals in the industry.
- Writing Project Plan– identify and access all tasks that will need completion in chronological order, allocating time and schedules to these tasks

**Stage 2: Information Review:**

- Information investigating and gathering – further research through areas defined above
- Categorise Research – place information into defined areas and organise
- Topic Research– further research in interviews and specific case studies, trials of sleep deprivation

**Stage 3: Evaluation:**

- Evaluate Research – go through and discard information not necessary for research and find important and relevant information
- Market Analysis– look at the area of topic and analyse if there really is a market for the design brief from the outcome of the dissertation
- Prepare design brief– from research, form a design brief that solves problem.

**Stage 4: Final Report:**

- Edit draft– bring together of all research, information form a draft of final
- Evaluate Draft – re-read draft report in light of Stage 3 feedback. Evaluating each area and its importance within the research dissertation.
- EDIT, EDIT, panic, EDIT
- Re-write Draft Dissertation – finalise ideas, reread and finalise report
- Submission of FINAL REPORT: 4.59 pm, Tuesday 13th, June 2006

Credit: MacArthur

## 2.1.0 Overview

### 2.1.1 Background to solo racing

Solo yacht racing is a relatively recent development in comparison to fully crewed racing. The first pioneer of solo yacht sailing was in 1901 with American Joshua Slocum in his infamous yacht 'Spray', stopping in many ports as he sailed slowly around the world. The challenge of a solo non-stop circumnavigation was still deemed impossible until the late sixties. The first 'race' to see who could actually make it around the world non-stop was only achieved in 1969 by Englishman Robin Knox Johnston in his 44' ketch "Suhaili' (Knox-Johnston 1969) and only 87 other individuals have raced successfully around the world since.

The first solo race across the Atlantic was started in 1960 by Blondie Hasler "one man, one boat, one ocean", now called The Transat race. Since then amateurs and professional interest in solo sailing has flourished, Single-Handed Oceanic Racing became a discipline of its own in the sailing world such as Olympic sailing or the America's Cup (Mothes-Masse 2002). From Atlantic crossing races in a 6.50 metres or in a 60' multihull to races going around the world, the performance search is the same and all skippers and boats are at the top of marine technology.

French are by far the most dominate nation in the solo offshore racing, culturally they revere a 'tall poppy', whereas it is seen as elitist by Australian culture and something to be shot down (Hildebrand 2006). Public interest in solo racing in Europe, especially France is nothing short of phenomenal. Just a race start can attract 250,000 people to watch at a port, then the sailors progress is followed by millions on television (Vincent 2006), they simply adore the solo yachtsman's bravery.

## 2.1.0 The solo yachtsman

The type of sailor that is attracted to the solo yachting scene are not like footballers, cricketers or basketball athletes, but genuine heroes and characters (Rousmaniere 2003). Not only do they have to fight hard to raise funding, prepare their boats and get to the start line, but must continue to fight against fatigue, masochistic adversity and the often extreme weather and risks (Bunting 2004). Which presents the question – why do they do it? The single-handed oceanic racing offers sensations, joys and difficulties that cannot be experienced in any other environment – the simple satisfaction of trying to sustain the jobs of 6 people on their own.

On a fully crewed yacht its possible to maintain a 24/7 watch system, with the crew taking turns to rest and sail. "Solo yacht racing is one of the best models of 24/7 activity, brains and muscles are required, If you sleep too much, you don't win. If you don't sleep enough, you break." Stampi (2000). Maintaining boat and body at maximum efficiency –if there was a mantra, it would read "Sleep before you're tired, eat before you're hungry and change before you're cold" Sayer (2004). The solo sailors Seamanship skills are normally built from years of fully crewed racing. There are mix of Amateurs and Professionals.

### 2.3.0 Amateur to professional

All solo sailors start out as amateurs and like most sports, if they can achieve good results, a sponsor can be attracted. Although in comparison to fully crewed racing, solo racing is for little financial return and publicity, but nonetheless can provide for a relatively modest living (Henderson 2006). Although the vast majority of sailors are 'amateurs' with a day job to supports themselves. Examples of how many amateurs an professionals race solo can be seen from the solo Trans-Atlantic race entry lists with approximately 50-50 ratios (Yachting World 1996).
There are many aspects to the solo yachting market which will be further explored in section 6.5.0. The biggest limiting factor for a young amateur is to find an affordable boat or class to begin racing in.

### 2.3.1 Affordable solo offshore race yachts

An 'Affordable yacht' is usually an oxymoron, especially in the realm of racing yachts. Compared to other sports, sailing does require a lot of gear, special clothing, hardware and sails. "The commercial reality of swanning around the world in hi-tech race yachts is that someone has to come to the party with you" (Hildebrand 2006) Insofar as a financial partner that is capable of funding the daring endeavour to race-solo-nonstop-to the finish. This requires a well maintained, preferably new race yacht that has been custom designed for the task. "If you want to race an Open 60, anything in the region of $1-3 million dollars is an acceptable budget for a campaign. (Bunting) 2004.

Thus a smaller, amateur, cheap yacht is required for the beginning solo sailor. An entry level affordable race yacht will be closer to the region of $30,000. The Mini Transat 6.5m class is the only international class that provide this. "Many sailors see the Mini6.5m yachts as a way to compete economically in the top league" Le Pen (2001).

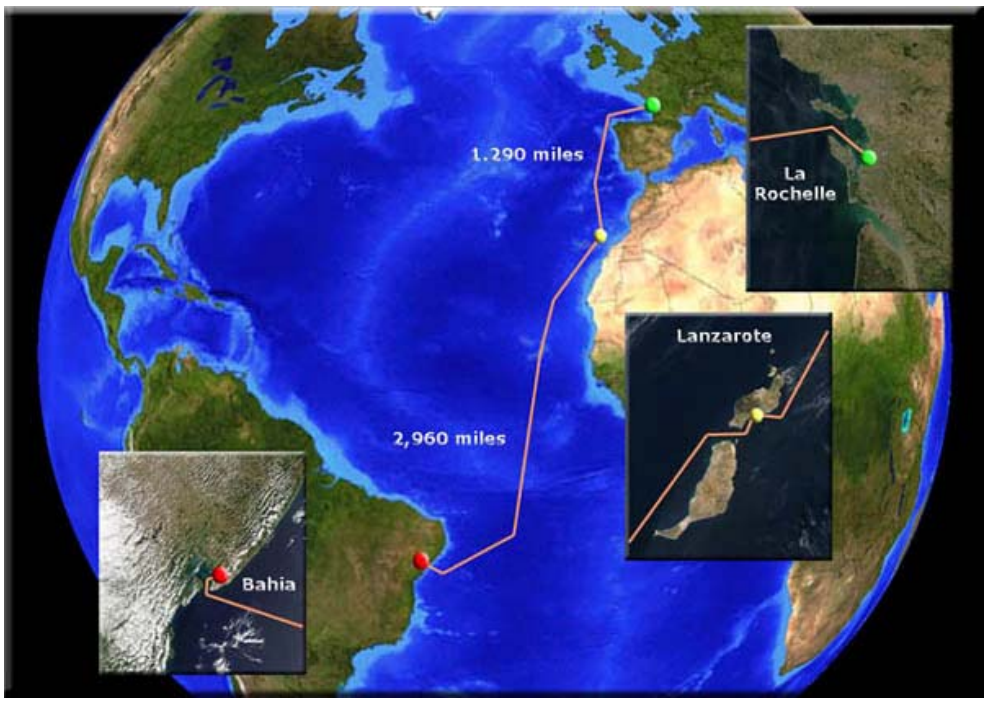
### 2.3.2 The Mini Transat 6.5m Class

The Mini 6.5m 'box rule' class was created by Bob Salmon in 1977, as an antithesis at a time of gigantism; big solo racing boats up to 236 feet! and big budgets. Now, over 30 years later the Mini 6.5m is "the world's premiere 'pocket-singlehander for amateur, low-cost solo offshore racing" Carpentier (1998). It was simply a revolution in the yacht design field at the time -the only limits was the length of 6.5 metres long. This approach has evolved into what is commonly referred to as an Open 'box rule' and is now applied to all categories of monohull solo racing classes. Although the terms Open and Box appear as a contradiction, it simply means that the designer is free to create what they like, within the dimensional 'box' of basic dimensional restrictions (length, beam, draft et cetera). Thus encouraging new ideas to be tried and tested. Some of the most radically innovative ideas in the last 20yrs having come from open class box rule designed solo yachts. "Prototype Mini6.5m designs are a scaled test-bed for new ideas and innovations, which have a trickle-up effect to their Open 60 cousins. Canting keels were pioneered in the class 10 years ago - before they were seen on any other type of yacht (McGoldrick 2006).

Typical of what a Mini 6.5m looks like. Credit: Mills Design

### 2.4.1 Mini Transat racing circuit

An extensive racing circuit exists for Mini 6.5m yachts, all the coastal racing the skippers compete in is mandatory preparation courses for qualification of competitors for the big bi-annual Trans Atlantic race; the Mini Transat race. "The race is a 4300 nautical miles of 'hard core' racing 21' skiff like boats, Cabins resemble the interior of washing machines (size included!), no bunks, no sleeping bags, freeze dried food, and the ocean -a wonderful race" MacArcthur (2004).




Mini Transat race course; Credit: Pipof, 2004

As seen above The Atlantic remains the main 'racecourse' for solo racing, large numbers of young competitors are attracted to the Mini Transat ocean race because of its low cost and as it's an entrée to the professional single-handed oceanic racing. "The French regard this as a stepping stone; a training ground for the bigger races." Sayer (1999). Participation has increased to reach the record number of 70 on the starting line in 1999, but also the worst retirement record, only 38 boats finished that year. "My first Mini Transat race was the hardest thing I've ever done." Sayer (1999)
So, in a total of 13 editions of the race there have been 616 competitors participated, 455 finished placed, 157 retired and four Skippers declared lost at sea (Mothes-Masse 2002).

"Bad weather and lack of sleep take their toll and Mini sailors have been known to suffer hallucinations as a result. For this reason to race these

boats is as much about handling basic needs and emotions as it is about handling the boats" Le Pen (2001).
Despite their very small size, the ability of the design and the hull integrity of the class is very seaworthy and suitable to the task of crossing oceans. Adherence to the strict class safety rules is maintained by stringent checking of building and fitting out.

Tens of countries are represented in the racing –a stepping stone for many household names in solo racing including Michael Desjoyeaux, Ellen MacArthur, Loick Peyron, Isabelle Autissier (all sailing superstars in Europe).
"Mini 6.50 in Europe is becoming a big big event. More than a 200 boats racing, many more trying to enter the races are on waiting list but organisers are overwhelmed. It is time to share this success with other countries." (Vincent 2006). What is most obvious in the entry lists is the distinct absence of Southern Hemisphere solo races in comparison to our Northern Hemisphere counterparts. The last Two-handed Trans-Tasman only received 5 entries (Drury 2000) –a similar race in Europe would attract up to 50. To date no Australian has actually finished the Mini Transat race, despite several attempts (McGoldrick 2006).

### 2.5.0 Summary of solo offshore yacht racing

There is a strong trickle down and trickle up effect of design ideas from the small classes like the Mini 6.5m to the larger Open 60s classes and visa versa. The *Mini Transat* is the race, Mini or Mini 6.5m is the yacht type. Now an accepted, almost mainstream sporting discipline The Mini Transat 6.5m class is ideal for amateur interests. "Mini racing' is popular sport by any standards" Carpentier (1998). The class boasts 500 boats in Europe, but the enthusiasm is yet to reach Australia. Clearly there is a need to develop a solo racing culture in the Southern Hemisphere with affordable Mini 6.5m yachts. What the Northern and Southern Hemisphere races do share is the extreme environments that they are set on.

Credit: Martinez, T.



# 3.0 Risks Involved

### 3.1.0 Risks from extreme environments

"On the sea there are only two levels –on the surface or under. And she does not care on which level we are" Jones (1980). There is not a more extreme environment than the ocean –it is untameable. A spectacular backdrop for solo racers, whose quest for adventure and competition outweighs the life threatening risks faced. While competition and adventure attracts competitors, the high risk environment of the open ocean turns them away, ending in retirement, dismasting, keel failure and occasional tragedy. Solo yachting takes on the full force of nature – the ever changing often extreme environment from calms to raging storms and waves the size of tower blocks, heat and humidity to biting, driving blizzards. (Jones 1980)

Heavy weather is the most regular and ominous risk –measured by barometric pressure a typical low depression system of around 990hpa is a great attraction to solo sailors as they head toward them in search of stronger wind and wave conditions. 15–25 knots is an ideal medium to high range of wind, where the boat is at its peak performance with maximum sail area set. The boats speed is high, which makes for a lot of spray and water over the decks, rest begins to become difficult –but these are the average conditions experienced (Sayer 2004).

As the wind reaches over 40 knots things can start to get out control very quickly, sails are reduced to bare minimum storm sails. "Traditionally solo skippers would maintain a constant sleepless vigil in heavy weather" Stampi (1999). Wave heights start to build considerably; the boats motion can be quite violent. The most extreme conditions that mini sailors have to contend with is 60 knots –otherwise measured as Force 10. "In these rare, but extreme conditions the waves begin to tower about the boat, you're just in survival mode with no sails set –just bare poles (rigging) causing very violent boat movement –you can be thrown around inside the boat if not wedged in a tight spot Sayer (2004). "Just hours after the 60 competitors in the 2001 Mini Transat start set off from La Rochelle… three boats had lost their rigs and two suffered rudder damage," 24hrs later the first boat was abandoned after being rolled and dismasted.(Le Pen 2001)

Capsize is the worst case scenario in Heavy weather and not an uncommon occurrence in 60 knots. The great advantage that monohulls have with their keel and lead ballast is there ability to 'self–right' in the event of being capsized by a large wave.

Hitting a submerged object and sinking is a more uncommon, but unavoidable situation. Thousands of jettisoned shipping containers litter the worlds oceans. Every big storm leads to container ships losing more, they lurk just below the surface until they eventually sink, but presently a heinous risk. Unassuming whales also present a similar problem.

Being hit by a ship is also a major hazard; despite Maritime law enforces that crew must maintain watch from all navigating vessels. Although this is meaningless when the solo racer is catnapping and an oncoming ships crew goes off to make a cup of coffee –collisions still regularly occur.
"He was hard on the wind but laying down the coast. Exhausted after sailing through the previous night, he went down below and set his egg-timer for a 15 minute nap. He woke 25 minutes later. He had slept through the alarm but some change in the boat's motion had woken him." looking out of the cockpit hatch, the stern of a huge ship was moving away –they had missed each other by meters." Hayter (2004)

Radar is the only detection method available for ships, although Mini Transat competitors are not allowed them. In most conditions it takes a freighter ship approximately 20 minutes to reach you from the horizon. That determines the amount of sleep you can take in one go. "Coville learnt this the hard way... waking up in a big shadow to find his spinnaker brushing itself on the bulb of a freighter – a crash gybe saved his boat and probably his life" Sayer (2004). These threatening instances occur more often in thick fog, typical off the Atlantic coast.

Some proponents prefer to stay awake all night and cat nap through the day, based on the belief that ships don't maintain crew keeping watch on the bridge. A basic analogy related to road use numbers and safety for all the discussed aspects is that ships are like cars and cyclists are like solo sailors –the most vulnerable and prone to an accident…

In the event of an emergency and the sailor in distress in able to alert authorities, based on the history of successful rescues, the likelihood of them being close to land is minimal. The Mini-Transat rules only allow limited Communication from VHF and HF radios. Really the only thing a solo yachtsman can do is activate their EPIRB and await help. If disaster strikes while the skipper is inside the yacht, a mandatory escape hatch is fitted to all Open class yachts to allow escape if necessary.

### 3.2.0 Risks from boat failure

The risks involved in racing across oceans are many, and can be terminal for both Skipper and the yacht. Reliability is the key, in some of these events, just finishing is an achievement. The yachts are designed and constructed to create the lightest strongest structure possible, which predictably results in gear and hull failure. These risks are well calculated, but occasionally unavoidable. "On our own, when things go wrong, they usually go very wrong and take hours of work and energy to put right. This is the stress of solo racing in its extreme" MacArthur (2006)

Hull structure failure is the more rare, but the most serious. Delimitation is one form of hull failure, where the bonding between the foam core and carbon skin fails. Carbon fibre is the most ubiquitous material used in solo open design ocean racing yachts, but it has its limitations. Seamanship plays a big part, just allowing the yacht to leap uncontrolled off waves in a storm with no attempt to slow her down will guarantee gear damage, hopefully before the hull is.
Electronic failure can lead to loss of control of the yacht. It is a regular problem with salt and water permeating into the wiring system onboard. The most annoying aspect is the limited ability to navigate, communicate or maintain maximum performance.

Hitting a whale or debris at speed can cause the rudder blade to shear off unless a 'kick-up' design is fitted. In which case it will automatically rotate backwards if contact is made avoiding breakage. The worst case scenario of hitting an object is damaging or even breaking the keel. Cases of keel failure have almost exclusively reported that they hit 'something' not long before it eventually falls off. Somewhat catastrophic -it can ruin your entire day.

Rig maintenance while sailing is essential to avoid any unforeseen breakages, it is important to inspect while sailing, but means having to climb the mast -alone. The mast is the most dynamic element on the yacht and carries huge loads. While breakage is normally due to a fitting failing, it can also be caused by 'stupid' mistakes caused while heavily fatigued. Normally occurring at night time when a sense of direction and bearing is harder, 'wiping-out' can occur if the skipper doesn't react quick enough. The end result sees the yacht laid down on its side with the sails flapping, the sea. When this occurs in heavy weather the flapping and trawling the sail through the water leads to severe sail damage, occasionally unrepairable (Sayer 2004).

### 3.3.0 Risks from sleep deprivation (personal failure)

Sleep deprivation is the standout cause for accidents, damage and occasional fatalities for Solo Ocean Sailors –as without sleep one simply cannot function properly, leading to poor decision making and allowing avoidable risks to occur (Bunting 2000). Fatigue is the constant enemy of the solo sailor, lack of sleep is something they are fighting all time. "Sometimes he lost the battle to stay awake and woke, submerged and pressed against the leeward lifelines of the cockpit following a crash gybe in a wind change." Hayter (2004)

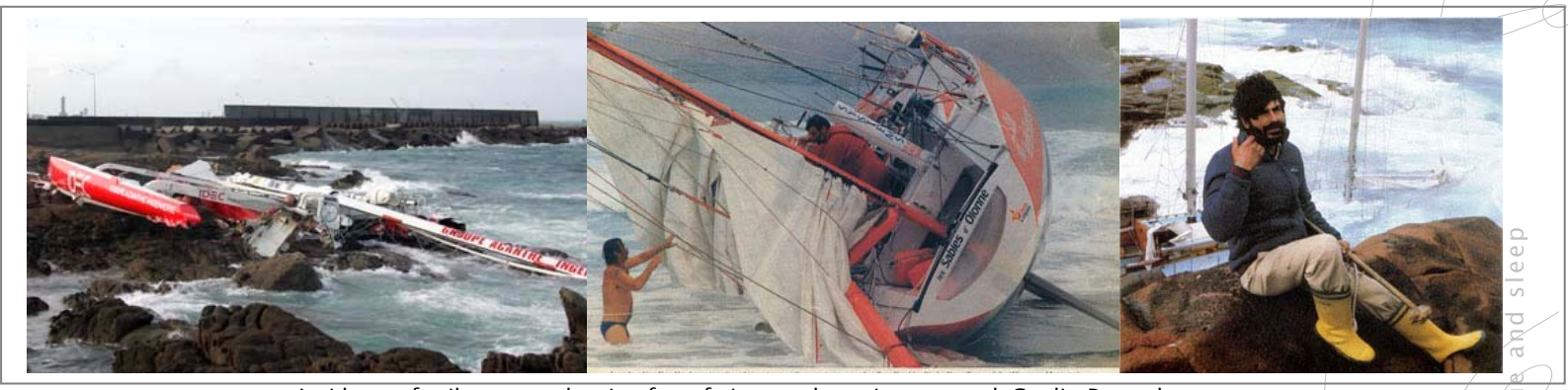
"Humans will become excessively sleep deprived is they have not slept for 36 hours or more" Stampi (1999). Just one hours sleep in these situations can make potentially life-saving difference. It is not surprising that sleep deprivation has been used as a form of torture by most military forces in the world. Its ultimate side-effect is hallucinations. "when you start making two cups of tea for your imaginary crew you know its time to get some sleep…" Adams (1997). In a 2003 race, solo sailor Conrad Humphreys imagined he'd handed his boat over to one of his shore team and went down below, took off everything, folded his clothes neatly and got into his sleeping bag. He woke several hours later, leapt out (stepping over clothes swilling around the floor) and found the boat running rampant at 28 knots still under spinnaker.

Exhaustion affects people in odd ways, other solo racers like Mike Golding claims he doesn't hallucinate, but does lose focus "I have mantras to drive myself through it, my 2004 Transat race mantra was "My name is Mordechai Vanunu and I have committed no crime!" This may sound bizarre when one is fully alert, but the problem is nothing seems too strange to the sleep deprived "I've written some strange entries in the log book, where I woken up to fill in the log, but have no idea what I'm writing about or why even I'm here!" White (2005) When severely deprived of sleep and rest, people endure short bursts of microsleeps – where the brain shifts uncontrollably from wake to sleep for up to several minutes (Stampi 004).

Falling overboard is possible a solo sailor's deepest conscious fear. A chilling reminder of what can occur was after the 1999 Mini Transat Race when a competitor was lost, but his yacht found a week after the finish with his harness and wet weather gear turned inside-out trailing behind in the boats wake. A similar incident happened to Australian Nick Maloney, but he actually survived to tell the tale –four days into racing in the Mini

and reached the point of such gross fatigue “I couldn’t come back from it, and I ended up making really silly decisions, and I put the boat into a dangerous situation and I was hit by a big wave and knocked off the boat” Moloney (2003). He ended up underneath the boat hanging on the end of his tether for so long with a broken arm that he began to inhale water.

The worst case scenario of sleep deprivation is over-sleeping, failing to wake up to an alarm -this can lead to sailing onto rocks or beaches. Some clear examples are illustrated below of competitors racing in a round the world race. The left image is of French competitor Desmond Hampton after sailing over 18,000 miles he was about 120 miles behind the leader and pushing the boat hard through Bass Strait and up the coast of NSW. “He had gone down for an hours sleep and was a victim of the simplest accident that can happen in solo racing: he overslept.” Peacock (1984) washed onto the rocks of Gabo Island on the Southern NSW coast.



Incidents of sailors over-sleeping from fatigue and running aground. Credit: Peacock

Jean Luc Van de Hede (middle image) met a similar fate on a Wollongong beach in similar circumstances in 1994. Deep sleep is harder to wake from. Many sailors train themselves to wake up after 30 minutes or so, before they enter it. "As I hadn't managed to get any sleep for a long time, when I did fall asleep, it was very deep," he says. "I think it must have been one in the morning and I immediately radioed a mayday ...I didn't think for one moment that the boat had turned in towards the coast." "This is entirely typical," Stampi (2004) "Immediately after the event, the person starts to relax and the effects of sleep deprivation will surface and cause accidents. We see this type of accident every day."

“In my early morning slumber it was frighteningly real. As if in the dream scenario I too was half asleep, only at the last moment did I equate Shockwave’s proximity to the rock with disaster. I suddenly woke up, when I heard a huge crash, when the boat came down in the breakers between a six-metre-high rock to my left and another one to my right. I was stuck there in the middle.” Joyon 2004)

### 3.4.0 Summary of risks involved

The singlehander's most intractable problem, according to round the world solo sailor Mike Golding, is sleep management, which is a euphemism for getting by on almost no sleep at all. "sleep is absolutely vital to a single-handed sailor because so much hinges on it. Lack of sleep begins to eat away at your health and ultimately its going to effect your safety because someone addled and sleep deprived is liable to make mistakes or errors of judgement in what can be quiet a dangerous environment" Bunting (2006).

Maintaining sleeping patterns is the only main method to avoid sleep deprivation, therefore minimising risks. Reducing fatigue and exposure also will further reduce the need for extra sleep, thus being able to push the yacht harder for longer. Currently the only place to rest is inside the boat because the cockpit is so exposed to the elements. One cannot to react quickly or avoid a bad situation if you they are inside and cannot see. Only being able to rest in the cockpit in a sheltered area will the skipper sheltered, but still able to observe and react. Although in severe weather with violent boat movement, it may be necessary for the skipper to physically strap themselves in, like a rally car seat.

T - SAISON 2004 - SKIPPER : MICHEL DESJOYEAUX
T / EFFETS MER

Credit: Stichelbault, B.

### 4.1.0 Maintaining performance from (inside) the yacht

There are many tasks to be done from inside the yacht while racing, navigating is the most important and regular of these, although very mentally challenging and demanding while fatigued and under pressure. Normally there is a dedicated table to do this from called a *navigation station* where an array of electronic displays allow them to pinpoint their position, with technology like GPS. Although in such a small interior space such as a Mini Transat 6.5m, it normally is done 'on the fly' on any available surface. Whether cruising or racing, long distance offshore sailing also requires the daily maintenance of a 'ships log' a thousand-year-old tradition that actually performs a similar task not indifferent to a Black Box flight recorder. The recording of the Latitude and Longitude (via GPS), Barometric pressure, the yachts heading, speed and wind conditions.

Communication is via VHF (Very High Frequency) and HF (High Frequency) radio, by tuning into the weather forecast updates and using the Barometer the skipper can plan their Weather Routing. Skippers 'hunt' low pressure weather systems. A low pressure system (below 1020hpa) is an indication of strong wind, but below 990hpa and your in serious storm territory (Cassell 2006). The limited communication and weather forecasting are the allowed the only devices allowed under Mini Transat rules in the interests of keeping costs down for the sailors. "So for the Mini-Transat, I just look at the weather really well before the start and sail that way for the first 5 days, after that its 'We're here, the finish line is there -sail towards that as quick as you can" Sayer (2004).

Although there is a lot of weather that can be planned for by simple observing the state of the sky -but the changes need to be seen, and to be seen the skipper must be awake. claims Mike Golding; top solo round the world yachtsman. "You nod off for a minute and there's a windshift and before you know it the boat lies over with the mast in the water" Golding (2004). Variable conditions are the most physically demanding due to all the sail adjustment that has to be done on deck "A cloud would come and sometimes it would have wind and sometimes it wouldn't. Often they'd change the wind direction by 40 degrees and we'd have to gybe to make the most of it" Sayer (2004). Once everything inside the yacht is settled and the course being sailed is confirmed its up to the skipper to maintain the yachts performance from on deck.

### 4.2.0 Maintaining performance from (outside) on deck

Physical fatigue from exposure to wind and waves is constant while on deck, in heavy weather it has been liken to standing in front of a fire hose, ice cold, relentless spray, unable to feel ones hands and feet, enduring relentless pounding as the boat scales and slams off roller coaster sized waves. Contrasted with the mental fatigue of windless days trying to escape the stifling, dripping heat of the sun; knowing that the nearest competitor has found a zephyr of breeze and is creeping ahead (Maloney 2006). "Racing hard and keeping the boat sailing fast single-handed can be extremely tiring, but the longer skippers spend driving their boats, the faster they go. However they are only human and can only go with out sleep for so long before the can become sleep deprived, start making poor decisions and potentially end up in serious trouble" Boyd (2000).
So between navigating, steering and trimming sails to maximise the boats performance and place on the racetrack, the skipper must allocate time to comfortably sleep.

The default position when on deck is sitting and steering -because its important that the skipper is able to see clearly, it normally means they are always in the most exposed position to the wind and waves. "Every time I didn't duck quickly enough, the wave would just flop all over me" (Hayter 2004). Too much steering causes excessive exposure and sleep deprivation. 'Autohelm' steering is the main technological breakthrough that has allowed solo sailors to pursue and advance the sport. The skipper is able to take the required amount of rest and leave the yacht to steer 'on its own'. The electronically controlled autohelm steering is set for a desired point of sail, can be set to either compass course of wind direction to a constant point of sail. When the angle of the wind relative to the course of the boat (apparent wind) changes, this change is registered by the anemometer, which feeds back to the autohelm to return the boat to the selected point of sail keeping the boat from gybing or backing its sails causing damage or breakage to boat and gear.

It important to design and setting up the boat so it's easy then you don't get tired so quickly and you'd be prepared to make sail changes" Bakewell-White (2004). Once the sails are set the sails to that course one fine tune steers around sails if there is a temporary change in wind direction. If a permanent change, then the sails must be re-trimed.

### 4.2.1 Sail trim and Physical demands of Changing sails

Constant sail trim is crucial, the area/size of sail set must be suitable to the wind strength changes, sheeting angles must be changed with the fluctuations in wind and course direction. Not unlike a racecar where the accelerator and brakes must be applied every second, only a full crew who are watching and trimming the sails can maintain maximum boat speed. This is not possible when racing on your own on a 60' yacht at 3am 100miles from the nearest land. "Today sleep deprivation is more likely to occur when the skipper is trying to get the most out of the boat on light or variable conditions, because of all the sail changes." Stampi (1999)

There are several aspects that have been refined to make the job of a solo sailor easier to manage the yacht to the highest efficiency. The design and cut of the sails are such that they can deal with a lot larger wind range and wind angle than your typical grand prix fully crewed yacht. Although once that specific wind angle and strength has changed substantially the sail MUST be reduced in sized by reefing. The ability to handle all this by only one person is why cockpit ergonomics are so important. "I tended to sleep more in heavy weather, as light weather requires more sail changes." MacArthur (2004)

Dragging oneself on deck after sleeping soundly in the foetal position for the last 35minutes requires a lot of self motivation. "It's just a killer having too many sail choices when you're very tired" MacArthur (2004) "you're asking yourself maybe you'll be faster with this other sail up? If you think that three times in three hours you'll generally be slower because you've slowed down during the changes"

Solo skipper hanging on while changing sails Credit: MacArthur

### 4.3.0 Summary of managing yachts performance

The skill in racing fast boats single-handed is a complex one. Firstly, skippers must find the correct level of compromise between driving themselves and the boat to the maximum, while maintaining the minimum of risk. Normally in a fully crewed race a boat is pushed to 100%. Single-handed the skipper has to find time to sleep, eat, drink, navigate, look at the weather forecast, communicate with the shore and a multitude of other tasks and whenever they focus on these rather than trimming or steering, the boat will not be sailing at the optimum. "Sometimes you have to leave the boat on it's own. So the most frustrating thing is you cannot drive it to the full potential." Fauconnier (2004)

Managing sails requires the most effort, and a lot of efficiency is lost from tired muscles. The ability to alert the skipper only when a sail requires attention and trim instantly without making the skipper move too far from their resting position from above or below decks is intriguing. It is perhaps better for the skipper to catnap on deck. Sitting in the cockpit gives the best visibility to avoid risks, but too exposed. Thus a protected area in the cockpit is the ideal solution.

ANT - SKIPPER MICHEL DESJOYEAUX - THE TRANSAT 2004
/ EFFETS MER

Credit: Desjoyeaux

### 5.1.0 Aspects of psychological and physiological performance

The mind and emotions play a huge part to succeed while competing solo. Fits of depression and negative emotions can be exacerbated by excess fatigue and not enough sleep. “you wouldn’t believe how important it is to maintain a positive mindset and motivation to keep driving the yacht, being wet and miserable is defiantly not conducive to this!” Maloney (2005). The maintenance of the desire to succeed no matter what obstacles or problems are presented is help enormously by feeling fresh and alert (Vincent 2006) “Yesterday I was quite depressed actually, I don’t know why… frustration of making a lot of sail changes, which just made me tired. I was much better once I’d stopped changing sails, had something to eat and got some sleep Maloney (2003).

Managing Diet and high energy levels is also an important factor in maintaining performance with a well-planned diet. Energy required for expenditure comes from calories in the food eaten, on land a daily calorie requirement is around 1700. The minimum calorie intake required by a solo sailor to maintain their energy levels is 2800 calories. Trying to satisfy this is a challenge in itself and could be the basis for an entire thesis. Cooking ability dictates that mostly dehydrated food is eaten, although the water required to cook it is too great a weight penalty for some skippers. Thus Muesli bars are a good option for races not longer than 3 weeks. Short term stimulant drugs like caffeine are used but not a sustainable method to remove fatigue –the only way is to manage sleep.

### 5.2.0 Managing Sleep while racing

#### 5.2.1 The importance of sleep discipline

Sleep is an essential biological process to regenerate parts of the brain and body. Claudio Stampi, a sleep expert and director of the Chronobiology Research Institute in Boston, Massachusetts, has spent years training long-distance solo sailors including British yachtswoman Ellen MacArthur to manage her sleep discipline and cope with sleep deprivation. "If you sleep too much, you don't win. If you don't sleep enough, you break." Stampi (2003) Sleep management is a really hard thing to practice, one must wakeup three/four times in the middle of the night to navigate, requiring mental arithmetic. “It's about being able to wake up and instantly being able to solve a problem” White (2005).

“Not managing your sleep when you are sailing solo is a cardinal sin because, initially it will have a detrimental effect to your decision making, it will start to effect your health very quickly and it will almost certainly effect

your demeanour and attitude towards whatever your doing. The problem with sailing solo is that feels like it's a continual round of fixing things, adjusting things, manoeuvres, navigation, and it's the never ending list, you absolutely NEED your 4-5 hrs total sleep" Golding (2005). There is no magic formula when it comes to overcoming sleep deprivation -just good management (Stampi 1999). After periods of extended wakefulness or reduced sleep, neurons may begin to malfunction visibly effecting a person's behaviour (Stampi 2003). Certain stages of sleep are needed for the regeneration of neurons within the cerebral cortex while other stages of sleep are used for forming new memories and generating new synaptic connections (Stampi 2003).

### 5.2.2 The sleep cycle

Sleep is a biological state that is caused by the discharge of specific neurons in certain parts of the brain. It involves an alternate cycle of non-rapid eye movement (NREM) and rapid eye movement (REM). NREM sleep restores energy and releases hormones for growth and development, whereas REM sleep is important for memory and learning. The cycle consists of 80 minutes NREM followed by 10 minutes of REM. This 90 minute cycle is repeated 3 to 6 times during the night (Stampi 2004). The five stages of sleep, including their repetition, occur cyclically. So a person may complete five cycles in a typical night's sleep.

**Stage 1** sleep, a light slumber or drowsiness, a 50% reduction in brain activity occurs and may last for five to ten minutes.

**Stage 2** is the onset of real sleep, during which the heart rate slows and body temperature decreases. At this point, the body prepares to enter deep sleep.

**Stage 3** is a deep sleep phase leading to a more intense **Stage 4**. These stages are known as slow-brainwave, or delta. A deep sleep that is most highly restorative "The grogginess that results from waking up from deep sleep is called sleep inertia and may last for up to an hour," Stampi (2004).

**Stage 5** REM sleep is distinguishable from NREM sleep by changes in physiological states, including its characteristic rapid eye movements, heart rate and respiration speed up and become erratic, while the face, fingers, and legs may twitch. Intense dreaming occurs during REM sleep as a result of heightened cerebral activity. It is generally thought that REM-associated muscle paralysis is meant to keep the body from acting out the dreams that occur during this intensely cerebral stage. The first period of

REM typically lasts 10 minutes, with each recurring REM stage lengthening, and the final one lasting an hour (Stampi 2004).

### 5.2.3 Monophasic vs polyphasic sleep

Western culture is based entirely on a 'monophasic' sleep pattern; that is a single sleeping period of 6-9hrs every 24hr period (Klien 1999). Another option is a 'polyphasic' sleeping pattern where 'catnaps' of 15-20 minutes are taken regularly to maintain a total waking state of 19hrs comfortably every 24hrs, Dr Claudio Stampi is the world expert and pioneer of this technique and has been studying it for over 15 years. Stampi claims "Sleep charges your battery more at the beginning of the sleep cycle than at the end, so if you take more naps you are recharging more efficiently, because you take that first big charge frequently." It is believed by advocates of polyphasic sleep that after undergoing controlled sleep deprivation during an initial adjustment period, the brain will start to enter the essential sleep stages much more quickly, as a survival strategy. Once this adaptation is learned, a comfortable and sustainable equilibrium of sleeping in only naps can be established. Solo sailors have adopted this technique as *de'rigeur* to enable constant trimming of the yacht, Astronauts, pilots and military personnel also use this technique during extended crises. Civilian use of polyphasic pattern is unusual, but reportedly some of the most remarkable figures through history who have include; Buckminster Fuller, Thomas Jefferson and Leonardo DaVinci and Michelangelo.

It is worth mentioning that anthropological studies conducted in active tribes have found highly polyphasic sleeping cultures. Although they have very different ways of life, both the Temiars of Indonesia and the Ibans of Sarawak have similar polyphasic sleep-wake behaviours. As do the Spanish with the archetypical 'siesta' (Quadens 1983). According to Stampi, this method is successfully adopted by 85 percent of the animal kingdom (especially in dogs and cats) particularly in those living in dangerous environments. He views it as a strategy of choice in maintaining acceptable levels of alertness under situations of continuous work.

## 5.3.0 Polyphasic sleeping patterns

### 5.3.1 Analysis of polyphasic sleep

Polyphasic sleep is just REM, so as soon as your head hits the pillow, you get 20 minutes of REM, you're good to go for another 4 hours. This basically means you have to eat really healthy and get a full day's/week's rest every couple months or so to 'reset' your system. "Just the process of falling asleep and waking up again within a 10min period can feel

incredibly refreshing" Stampi (2004). This sleep-wake system appears to show a high level of flexibility in terms of sleep timing and duration. Although everybody has a 4hr 'ultradian' rhythm in addition to a circadian 24-hour cycle. The body has normal highs and lows cycles called circadian rhythm lows. The most dramatic low time is between 2 A.M. and 6 A.M (at 4AM), all people feel their deepest dip in energy and have most propensity for sleep, regardless of sleep debt or sleep times. The second rhythm low is not as dramatic in presentation and occurs between 2 P.M. and 6 P.M. Thus at surmise that 4-hour cycles, beginning at 4AM would be the ideal intervals catnapping at: 4AM, 8AM, 12PM, 4PM, 8PM, 12AM.
"If you fall behind in your sleep, you might feel fine for a day or so, but it's just not sustainable to run much below 4 hours, You learn from experience that you bag your sleep when you can, and you don't linger around watching the rosy sunset. Golding (2006)

Some sailors treat sleep scientifically calculating their daily ration and working out what they need. Solo sailor Conrad Humphries takes a different approach by not measuring time or setting alarms completely letting his body dictate according to its natural tendencies described above. The longest he would sleep at one time was two hours, though he and reached about five hours a day. Most of his naps were about 20 or 40 minutes long, and he had an unusual method of regulating it. If he wanted to nod off for 20 minutes he would lie with his head on the generator box. If he wanted 40mins, he would sit at the navigation table seat. And if he needed a longer sleep, he would sleep on a flat shelf either side of the nav table. "I occasionally would have to say, to hell with this, I have to sleep - but that only happened twice in the race" Humphries (2003) .

Stampi also advocates the 'zombie strategy', where in the middle of a catnap, a skipper has the ability to get up for a few minutes, check the sails, even take a reef and go back to sleep without fully waking up. "The zombie strategy allows the skipper to drop quickly back into a deep sleep, the level at which human batteries are recharged fastest" Stampi (1999)
"The zombie state is acceptable for actions which require minimal though power, but for jobs where higher functions of the brain are required such as navigation, strategy or repairs the skipper should be fully conscious.

### 5.3.2 How body type effects cat napping times

There are two types of people: morning people, or "larks," and evening people, or "owls." The distinction is important for anyone trying to adapt to sleep deprivation. Larks, Stampi discovered, are better at the regular 20

minute burst of sleep, taking short naps but are not as efficient late at night, and prefer a more regular routine. Owls, on the other hand, appear to be excellent at coping with highly irregular schedules, but prefer longer naps like a few 45 minute naps. Only 5 minutes can make a huge difference between waking up refreshed and revitalised or groggy and still tired. There is also a period after sundown when neither Larks or Owls will like to sleep –possibly an ancestral instinct to remain awake after dark to prepare for the dangers of the night.

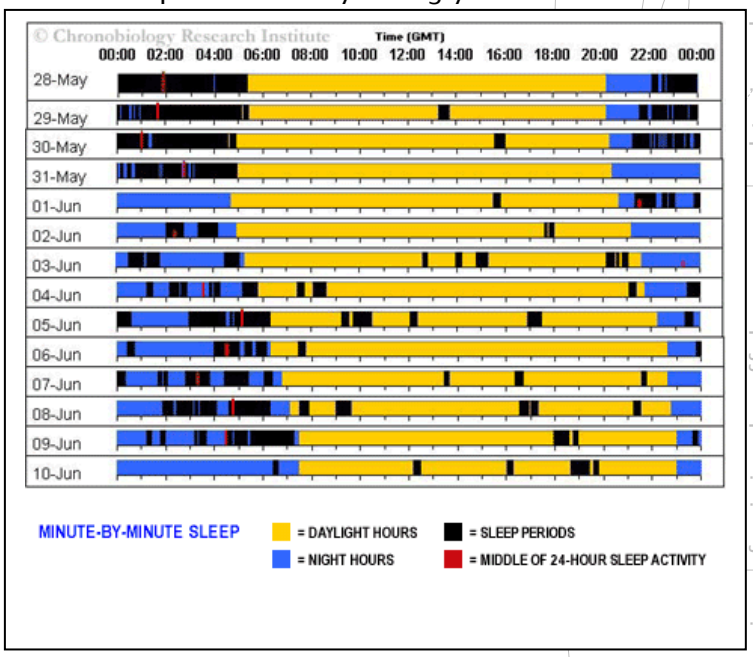
"When sailing around NZ and in the first leg of the race, he had sailed through the day and taken his sleep in the early hours of the morning when the cold and his body's natural clock encouraged it." Hayter (2004)

Mike Golding is an owl, and during the 1998 Around Alone, only 23 percent of his sleep time was devoted to naps of less than an hour. Ellen MacArthur, in contrast, is more of a lark and tends to spend 60 percent of her sleep time in naps shorter than an hour (Boyd 2003). Despite the different styles, both Golding and MacArthur sleep about the same amount while racing, between 4.5 and 5.5 hours on average in every 24—the minimum amount, Stampi believes, on which humans can get by. "Individual skippers vary greatly when it comes to how much sleep and when." So its knowing when to take ones catnap and for how long that is key" Stampi (1999) Catnaps of 20, 40 or 70 minute phases amounting to 4.2hrs are ideal. (Stampi 2000) normally takes 3 to 9 days to adjust, average being 7 days.

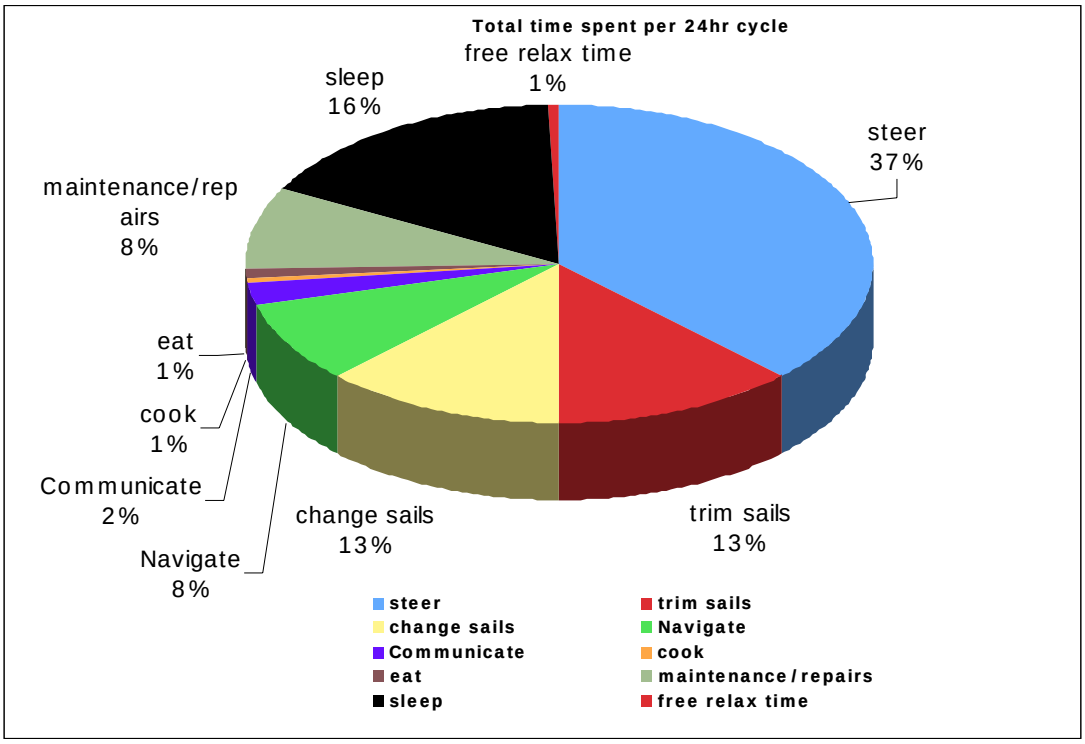
25 minute range is probably ideal, but variable to person to person.

Over time, the time in which it takes you to fall asleep decreases dramatically. As a result is skippers work to familiarise themselves with their optimum sleep retains. "you learn from experience that you bag your sleep when you can" Golding (2005)

The Chart right is from research by Dr Stampi, using a solo skipper who wore a wrist band with a watch sized accelerometer measuring movement of the skipper versus movement of the boat. (Stampi 2004)



The chart below is of a typical daily routine per 24hr cycle for a solo sailor based on the suggested sleep and diets to make a total of 4 hrs sleep every 24hr cycle (Stampi 2003).




| Activity | duration 24hrs |
|---|---|
| steer | 9 |
| trim sails | 3 |
| change sails | 3 |
| Navigate | 2 |
| Communicate | 0.5 |
| cook | 0.15 |
| eat | 0.2 |
| maintenance/repairs | 2 |
| sleep | 4 |
| free relax time | 0.15 |
| Total: | 24 |

### 5.3.3 Falling asleep on command

To maintain a polyphasic sleeping pattern, sleeping on command becomes an important skill and requires a conducive environment to do so –not entirely in a noisy, wet, cold, hostile environment like that of an offshore race yacht. Relying on the fact that one is quite tired already –but not yet totally sleep deprived, it is surprising how willing the body will just 'switch off', just by laying back in a comfortable position is normally enough (Maloney 2004). Crude sensory deprivation tools are effective method, ear plugs and something to cover the eyes is often enough. Comfort plays a large part as well, explained by 21yr old solo sailor Hannah White found

she can't sleep unless her hands are warm. "Luckily, after our previous experience I remembered to bring some 'sleeping gloves'! They are forbidden from going outside, because for really good sleep performance they must be dry (then you have really nice dreams)" White (2005)

All people fall asleep with tense muscles, their eyes moving erratically. Then, normally, as a person becomes sleepier, the body begins to slow down. Muscles begin to relax, and eye movement slows to a roll. By establishing a routine can remind the brain and metabolism to allow resting, so 20 minutes before planning to catnap sleep, having a snack of high protein will help sustain ones hunger longer and one will have a more uninterrupted sleep (Sayer 2004). The use of mind skills developed and advocated by solo sailor Nick Maloney is a strategy not dissimilar to meditation where he could be asleep within 3 minutes. "I developed the skill of catnapping, start by confusing your mind and racing, the first thing you try and do is push any job list out of your mind and then you confuse your mind with scattered thoughts, and you start falling asleep. You can fall asleep quicker and quicker and quicker" Maloney (2004).

### 5.3.4 Forcing/Waking up on command

Mike Golding and Chris Sayer have a 120 decibel car alarm wired to a timer in their cabins which is normally enough to wake them. Although occasionally when they are seriously sleep deprived they can actually sleep through this literally deafening noise. Seven to eight hours sleep is all that is required to recover from sleep deprivation according to Dr Stampi.

In the same respect sleeping for 20 hours straight does not allow one to then stay awake for five days …When we do not get enough sleep, our body will physically try hard to make us sleep and psychologically we crave it.

There is antidotel evidence from NASA trials in 1986 that suggest the use of very bright UV light can 'trick' the brain into waking up. The release of Vitamin D from contact with the UV light is enough to wake a person up from REM sleep. Although no conclusive tests have been found.

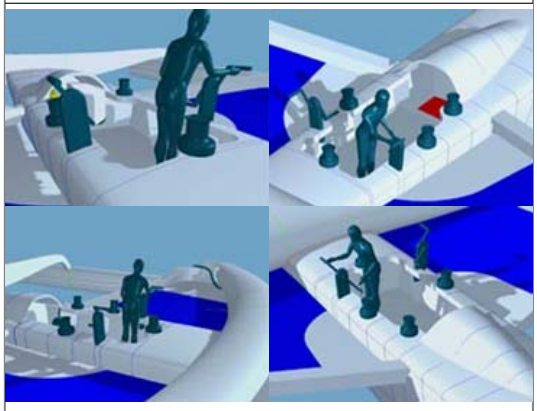
A great example as described by Claudio Stampi

Spanish surrealist artist Salvador Dali would catnap in his favorite chair with a silver spoon in his hand –as he fell asleep his body would fully relax within 15–20mins and he drop the spoon. The reverberating sound of the spoon on the tiled floor was enough to startle him awake again…

### 5.5.0 Summary of managing personal performance

Racing hard and keeping the boat sailing first single-handed is extremely tiring. The longer skippers is driving their boat, the faster they go. However they are only human and can only go with that sleep for so long before they can become sleep deprived start making for decisions and potentially end up in serious trouble. Sleep deprivation is the result of excessive fatigue, thus it is an important aspect and is done by good sleep management.

"Learning to cope with lack of sleep is one of the greatest demands on the solo sailor. Efficient sleep is vital to ensure that a skipper remains at peak performance" Boyd (1999). One thing seems sure, the body cannot stock sleep as you can stock energy. Sleeping techniques are different for every one, they depend on our sleeping cycle. We can improve our sleep quality by knowing ourselves. On a boat the difficulty is to fall asleep amid a noisy and moving surrounding which keeps them alert. Efforts have to be made to relax in a hostile environment.



Credit: Nigel Irens Design

### 6.1.0 Existing Mini 6.5m Designs

The following is a market analysis of just some of the 630 Mini 6.5m yachts currently afloat. Over 380 photos of these boats have been viewed through this research process and presented are just some of the main problems associated with the current designs.


Credit: Jmliot

The above images are of typical positions while sailing Mini 6.5m, it is clear all skippers are in a very exposed position, yet it is the default position they spend the longest sitting in as discussed in Chapter 4.2.0. Similar to ergonomics, the handling ability of a yacht refers to the response to the wind and waves compared to the amount of human interaction or trim required. This may be in the form of ease of steering, ease of sail trim, how far it is to reach and complete a task –regularly several at once when solo sailing. Handling ability is largely determined by the layout of the design. The layout of hundreds of Mini Transat yachts are almost all the same.

### 6.1.1 Poor layouts and Access of existing Mini 6.5m Designs


Credit: Pipof

As discussed in 4.2.1, the sailor needs to continually check and trim sails –very awkward from the position as seen in picture at left, if they are trying to catnap. Then if the skipper does have to go on deck, it requires a lot of muscle effort to pull oneself out of the companionway hatch –plus there's nothing to grab onto – another aspect that increases fatigue.

Credit: Pipof

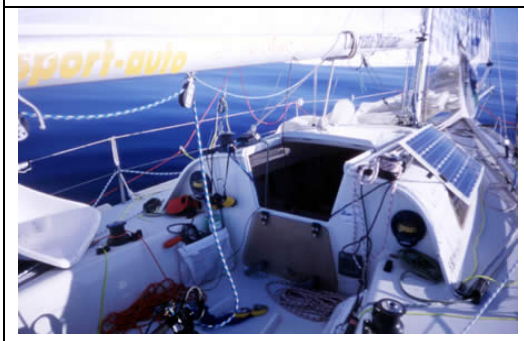
"Unlike most boats, where the solution to go below decks and recover for a while wasn't such a great option" "First you had to wiggle through the awkwardly mounted hatch" Hayter (2004)
The Mini at left and below is typical in hatch design offering no shelter from water rushing down the deck.

Credit: Pipof

Ones experience is small race yachts is that you have to be small to sail one! Naval Architects are closer to and Engineers than to Ergonomic or Anthropometric specialists and as such pay little attention to the sailors needs when designing. Often when a new yacht is launched it goes through a phase of moving fittings –even winches to suit the way the crew sail the boat. "In the past I've actually ripped off or broken fittings because I've pulled them at the natural angle for me, but the wrong angle for the installed fitting" Bower (2004)

Credit: Pipof

Overall, the experiences solo sailors have of sailing a Mini that they are impossible wet and very awkward to move around. "Designed predominantly for downwind work, all the Minis are pretty wet to sail. With such vast rigs to drive them, and such short waterlines to support them, keeping the bow up is a real problem." Bentley (1997)
French sailor Sam Manuard had been below decks when his mini rolled over. With water pouring in, he couldn't shut the hatch because of the ropes washing in.



Credit: Pipof

## 6.1.2 Possible sleeping positions


Credit: Pipof

"Hence I find resting in the cockpit far less stressful, but comfort is not part of the designers priorities and what the images left illustrate so clearly. As the boat pitches in a wave and buries the bow, water cascades down the deck and into the cockpit. Thereby soaking the sailor in the picture (also know this from experience!)

Credit: Falconi

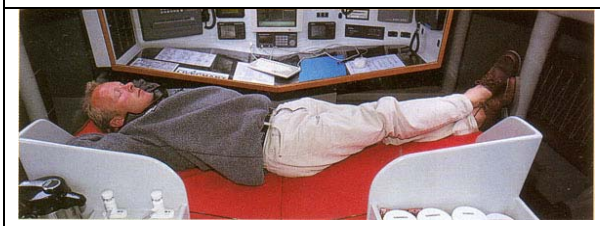
"Sleeping has proved virtually impossible – just ten minutes perhaps, before I wake shivering, I've been wearing a survival suit since –but its damp and humid within.


Credit: Pipof

"Frustrated with two wet kites below meant wet sleeping quarters" Hayter (2004)

"–when I went below to escape the cold…carbon fibre construction heightens every sound; every splash of water against the bow is amplified"

Credit: Pipof

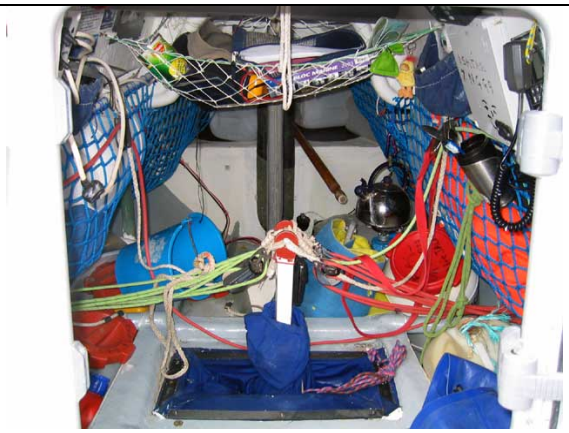


Credit: Pipof

Mike Golding likes to take his catnaps in his bunk, although he occasionally at the chart table in his Open 60. "I like to get my boots of and put a sleeping day ran me to get me warm. It helps me sleep. He says , he complained that there are few comfortable place to sit on his boat and to this reason is getting some back rest made the chart table. Golding (2000)

## 6.1.3 Wet Cramped interiors of Minis

All images, credit: Voorneveld, L



**Why its better not to sleep in the interior:**

"the (canting keel) contraption of pulleys and ropes that controls the swing keel was right in front of you as you entered." Hayter (2004)

"The space was basic, less than basic, and there was always a puddle of water on the floor"

"There was no basin, no toilet, no galley

"whenever I was down there I couldn't wait to get out"

Hayter (2004)

Not so clear in the images above is the fact that the Mini6.5m boats are built from carbon fibre, providing an extremely stiff hull structure. Although have you ever taped on a drum? The noise in a carbon boat is like living inside one! Every little noise is amplified into a cacophony of sound –but you cannot see anything –because the carbon finish is black with little natural light or portholes.

Although the 3D image of this Mini design may appear cavernous, once its full of wet sails and all the gear for three weeks racing, there is nowhere dry lefy to catnap comfortably

Credit Lombard (2000)

### 6.1.4 Mini Designs that have acknowledged this is a problem

Credit: Martinez

This image illustrates one designers attempt to address these issues, albeit unsuccessfully – there is still a very exposed cockpit area –with waves able to wash unhindered all the way down the deck.

All in all making the sailing experience wholly uncomfortable and tiring, further adding to the need to rest or sleep.

"Comfort on deck is now something of a priority, with most boats sporting some kind of a chair. Some use high-tech racing car seats; others manage with cut down garden chairs!" Bentley (1997)


Credit: Pipof

"However the main concern has been to keep the boat simple to sail –the boat is designed for long races where maximum concentration is not possible all the time." Mills (2000)

"looking at the boats dockside, a shows as many different solutions as there are designers thinking about the problems." Bentley (1997)

Credit: Pipof

"one solution is to feature rounded gunwale, deck edges to assist aero and hydrodynamic efficiency." Bentley (1997)

## 6.2.0 Attempts to resolve exposure in other solo class yachts

Credit: Stichelbault, B

A great use of polycarbonate to provide substantial protection of the Steering position. This French design is off a 60' trimaran

Credit: Pipof

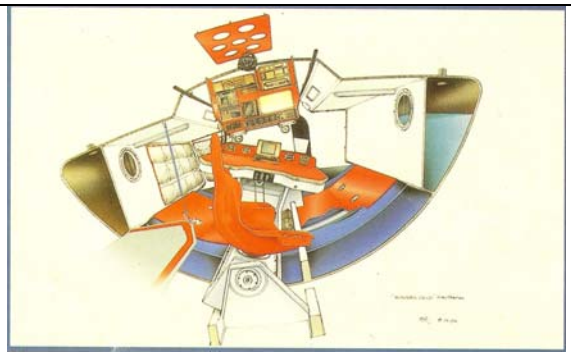
Similar to the objective stated above, but presenting a lot less windage resistance. Closer in appearance to a pill box gun turret. The wave will simply crash ontop of the skipper –no protection form the sun or rain either.

This French design is off a 60' trimaran

Credit: Pipof

Complete protection is assured with polypropylene dome. The design first appeared in the the 1970's with the advent of plastics. One can look out, but can't do much about what's happening.

This English Design is off an Open 40.



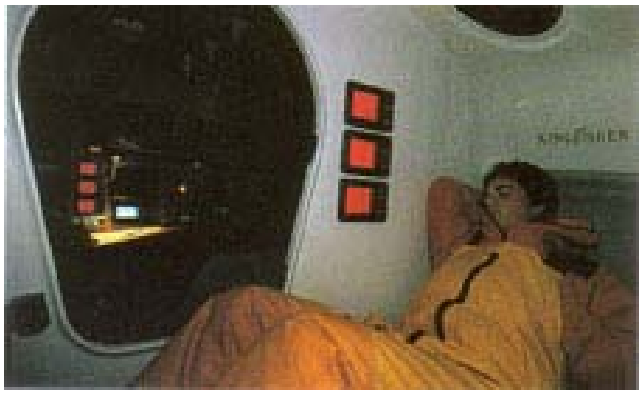
Credit: Hunter Marine

A novel approach, with a cantilevered free swinging accommodation area that always remains level despite the heel of the yacht. maintain level platform so not to upset the skipper… Not practical on a small Mini6.5m

An American design is off an Open 60'.

### 6.2.1 Satisfactory compromise

All Images Credit: MacArthur, E.



Design for improved sleep management can be resolved by sleeping in a 'in between' area is the best compromise. This design feature has only be tried on Open 60s. For comfort, she has two camping pillows, one for her bunk, the other for the cockpit.

The benefits of a 'cuddy' are clear from the dramatic images left.


One can sleep on deck while being completely protected. Almost like an architectural balcony.

### 6.3.0 Extent of the solo yachting market

#### 6.3.1 Domestically

Domestically there is only three in Australia. The solo racing culture simply does not exist due the lack of suitably designed yachts available. The fact that there is only three in Australia is both an advantage and disadvantage.

#### 6.3.2 Internationally

There are already 630 Mini Transat yachts afloat in the Northern Hemisphere. With an average of 20 new yachts being built per year. If a new design was created, there is a lot of potential there.

#### 6.3.3 Usage Rate by Customers

Again, the only real high usage rate exists in the Northern Hemisphere where Mini racing scene is very popular. Sailors will actually live on the boats during the summer racing season campaigning them around the West Coast of France and around the Mediterranean (Sayer 2004).
Although for the other nine months of the year the boats are normally taken out of the water to undergo repairs and refits.

#### 6.3.4 Potential Customers Now and Future Expectations

What type of person does solo offshore racing attract? "Adventurous, self-motivated, strong/fit, Adrenaline seeking/good risk calculation, Male or Female. 20-50yrs, you need: talent first, second The ability to tolerate the pain the sleep deprivation. Third is hours under sail; fourth, is technical knowledge." SailWorld (2002).

A very conservative only about 1000 people pursue it at top-level internationally. Only 2% are female. This figure is based on the number of solo offshore races. As can be viewed in 3.2.17, the scene is completely dominated by the French. (www.seasailsurf.com)

This target market of 20yrs – 30yr old male females beginning their career in solo racing. Then there is the more recreational 40 yrs

The French also like to cruise this type of boat "The first buyer who came to look at my Mini was a French guy who wanted to use it for cruising!" Bower (2006) He owned one in France, and there was a strong community of cruisers in old Mini race yachts.

If a new design allowed the ability to lounge in the cockpit promotes a laid back cruising -A cheaper fibreglass version could be built to satisfy this market.

### 6.3.5 Likely Percentage Uptake- Market Penetration

Would sailors be interested in such a class if they were designed to be easily sailed and allow polyphasic sleep? Considering that there is nothing like this in existence in Australia or for that matter Europe, the answer would have to be yes.

Unlike the record industry where 'Platinum' status is achieved by selling 1 million albums, in the yachting industry record Platinum status is regarded as selling 50 boats! If anything, yacht design is closer to architecture,

Although why should this detract from being pursued as a project? It is still a problem, putting lives at risk that needs to be resolved

### 6.3.6 Size of market segments in respect to shorthanded sailing associations and members.

Communication is continuing between SSAA (Shorthanded Sailing Association of Australia) and SSANZ (shorthanded sailing association of New Zealand) about interest parties within these associations –once a list of contacts of interested parties is assembled, then discussions can begin about construction of a mould and number of potential boats built.

It has been suggested that this may be in the region of 9 boats. An astounding figure for the local market, although this is very dependent on a max price range of $45,000.

The market can broken down to three main segments:

1. the young amateur intending to turn professional sailor; relying on sponsorship dollars to fund their interest.
2. the single amateur already with a professional career; able to satisfy their sporting interests –could also take up triathalon
3. the older, married amateur already with a professional career; always had a desire, now with the financial freedom to do so.

### 6.4.0 Product issues

### 6.4.1 Importance of Aesthetics and visual appeal

With the intention of selling the design to European markets, aesthetic distinction is a key marketing tool. Visual aspects will predictably only be appreciated to the esoteric yachting literate market, with aesthetic cues otherwise lost on a general public that regards boats 'as all looking the same' (Vinvent 2006). Yachts are inherently beautiful objects.

### 6.4.2 Transport issues

Transportation of the built Mini Transat Design would require a 10 tonne truck for distances across land up to 5000km. Transportation to another country would require a 9'6" high by 40' shipping container.

### 6.4.3 Price Range

With the market demand for a cheaper introduction model, the price would have to capped at $45,000. Which for a yacht capable of offshore racing is remarkably cheap compared to what is available on the market. The only way to achieve this price is by exploiting cheaper labour wages and workplace health and safety laws by building the yachts in Vietnam, Indonesia, Malaysia or China. There are already yacht building facilities in these countries, but strong ethical questions remain.

### 6.4.4 Market expectations and Behaviour towards Product

Expectations are toward a very high-quality product, capable of surviving the extreme environments that it will be raced through. Fill this market niche by establishing a Southern Hemisphere Mini6.5m Association and designing a One Design entry level Mini6.5m yacht that is affordable and appealing to the Australian, New Zealand North American and European markets. The findings from the research will ensure the ergonomics and performance of the yacht is conducive to polyphasic sleep, reduces fatigue levels, easy to handle, high performance, which in turn makes it safer to race around the East Coast of Australia.

### 6.4.5 Benefits Desired/ Offered by New Product

Enable skipper to maintain a polyphasic sleeping pattern In a comfortable position as all angles of sail and heel. Provide protection from spray and breaking waves.

### 6.4.6 Product Life, Turnover and Upgrade Options

Expect a competitive lifespan of 15-20yrs before it is superseded.

Once the yacht reaches this point, it can be used for a further 50yrs for cruising.

### 6.4.7 stakeholders

- Primary owner: Solo sailor who will be racing the designed yacht
- Secondary owner: Sponsor who will financially contribute to the campaign
- Other craft at sea: Ships that have to navigate around the racing yacht
- Boat Builder: Construction integrity as specified
- Transporters: Ability to easily move on land, overall size while towing
- Natural Environment: Minimising harmful effects from construction

### 6.4.8 Legislation

There is no legislation as such, but a race committee conducts an intensive measurement and testing protocol upon each Mini Transat yacht

Lloyds Ship register and other regulatory authorities only applies to vessels above 24m.

International Occupational Health and Safety legislation must be considered when specifying construction techniques if the yacht is to be built in different countries.

### 6.4.9 How the design will affect the current and future Mini Transat racing scene.

The launch of this new design locally and internationally in light of the design brief would see a great increase in the comfort and ability to maintain a polyphasic sleeping pattern. As the sailor is protected and snug in the cockpit area, they are able to maintain a watch for oncoming ships between their 20 minute catnaps. If something does occur, as they are already on deck, the sailor can quickly react to the situation. The ease at which the design allows thereby makes the yacht more accessible to more sailors intending to take up solo racing. The greater value of the layout would see a higher demand, thus maintaining high re-sale value for the owners.

### 6.5.0 Summary of market analysis

Humans are great adapters –but we shouldn't have to, especially in the middle of the ocean… Design is compromise, and from the experiences as described there is great scope to study and solve these problems.

Currently the only place to rest is inside the boat because the cockpit is so exposed to the elements. One cannot react quickly or avoid a bad situation if you they are inside and cannot see. Only being able to rest in the cockpit in a sheltered area will the skipper sheltered, but still able to observe and react. Easily access the sail controls is a must –it is not uncommon for skippers waking up to the boat being on its side because of a wind shift when they were asleep.

The new Mini Transat 6.5m design will satisfy beginning solo sailors comfort expectations. As described in section 2.0, the sailors attracted to shorthanded racing are not your average social club sailor, but someone who desires to 'take it to the next level'. There are close comparisons to endurance sports like triathlon, in the same vain as a new entrant to the

sport does not expect it to be easy, they do expect that the equipment gives concession to their personal ability and comfort.
Once a sailor 'graduates' from the Mini Transat racing circuit, they can expect to attract sponsorship to pursue larger solo racing classes like an Open 40, Open 50, Open 60 or Open 60 trimaran –the latter being the pinnacle –Formula 1 of offshore solo racing –attracting the most sponsors and financial reward.

As per market analysis, this feature has been designed into these larger craft, as there is the luxury of space the designer has. Although there is nothing available in the very small size range of 21 foot yachts like the Mini 6.5m.

The geography of main market will be the Northern Hemisphere; Primarily France, England, Spain Italy where there is already a strong following of the class. There is strong market potential in North America where the class has just been established in 2005.

# 7.0 design for the environment



Credit: Weizen, S 2001, Oil on canvas

### 7.1.0 Environmental impacts of yachting

#### 7.1.1 The notion of sustainability

"Any notion of Sustainability is apocryphal –what are we trying to sustain – if we as a society wish to sustain this current stage in Western development then I don't want a bar of it" (Suzuki 2003) A seemingly aggressive assertion by environmentalist David Suzuki in a 2003 book launch is actually an argument for a reduction in consumption by 'Factor 10' or even 'Factor 20' proposed by Enzo Manzini in his 2000 publication. Which promotes a reduction of 10-20 times the level of consumption the West is responsible for –were does that leave yachts? Although sailing itself is a pollution free activity actually hides the fact that during construction and maintenance of yachts causes the greatest impact on the environment. The plethora of chemicals used alone is disturbing, almost all the materials used in high-tech racing yachts such as Mini6.5m are petrochemical based.

#### 7.1.2 The over-reliance on petrochemicals

Oil and petroleum based products are the basis for this 10 times reduction in consumption. "It's extreme –everything is carbon fibre!" Vincent (2006) There is actually NOTHING on a yacht that doesn't have a petrochemical extract in its manufacture. Although this is no different to other contemporary products like cars and houses, it's still a disturbing problem that is yet to be properly addressed properly. Fortunately unlike other Western products, yachts do have a considerable –even enviably long life-span –even if 99% of that is spent stationary, not being used. There is substantial effort to maintain and prolong its useful life, mostly motivated by the owners pride in its appearance. The European Union have been the first to recognise this and are addressing in new legislation on environmental impacts like the Directive on Integrated Pollution Prevention and Control (IPPC 1996.

#### 7.1.3 Environmental impacts from operation/sailing

The ecological footprint of constructing a yacht is massive compared to its user-life. The romantic image of a yacht slowly plying the oceans as the sun sets behind it is largely tarnished when one considers the huge impacts of yachts on the environment. Racing yachts consume disproportionate amounts of toxic chemicals and materials to construct, by shear volume of waste compared to the volume of the yachts hull, from my experience it could be suggested that its about 5-1. Thereby amassing a huge ecological backpack for the yacht, the embedded energy is equally

high. This is an indelible aspect that deserves as much time and effort to resolve as ergonomics, marketing or any other area.

When a Mini6.5m yacht is at sea, it is completely autonomous. Power generation is a big deal, so solar panels are the most used system, the choice of about 400 Mini 6.5m yachts (Sayer 2004). So in that respect they have minimal environmental impact, when used with gel or glass fibre batteries that have longer cycle times, user lifetimes and do not contain the levels of lead like the old type of batteries did. An Ethanol fuel-cell is also a very low impact, but high cost non-impacting power generating source. Now available in a box the size of a desktop computer, specially designed for the harsh marine environment.

Product stewardship is a very obvious way forward, and only by enforcing this legislatively could the onus be placed on the manufacturer to take steps to reduce environmental impacts from 'cradle to cradle'. Although once a homogonous structure like a yacht hull is completed the only way to destroy it is by shredding. This does not and should not occur -there simply is not the volume of yachts to justify it. What does occur is a racing yachts lose there competitiveness through age, they are sold onto other owners who convert them for cruising sailing.

## 7.2.0 Construction methods + materials

### 7.2.1 Environmental impacts of yacht construction

There are a large range of construction methods and materials currently in use to build racing yachts. Yachts are built to last, the sailor needs absolute confidence in the integrity of the hull structure when facing a storm. Historically we have relied upon the forests to supply industry bountiful amounts of timber for Oak square riggers, any wonder why there is so little forest left in England.

The timber of choice for much of the 20th Century has been Red-cedar, being harvested extensively. It is still an excellent choice in hull construction, it has terrific physical properties as well as being relatively light and strong compared to modern composites. Although it has to be coated and glues with toxic epoxy resin systems to reassure that it resists rotting or moisture absorption.

Plywood is also a very viable option; the greatest advantage is the ability to construct the hull around the frames without the need for time-consuming moulds to be constructed beforehand.

Fibreglass is regarded nowadays as a farily 'cheap and cheerful' option. (Dibley 2006). Although it requires a male or female mould to be constructed in order to apply the cloth and resin to the desired shape over

a foam core. Kevlar/Carbon Fibre is the only choice in order to be competitive race yacht. Although it also requires a male or female mould to be constructed in order to apply the cloth and resin to the desired shape. The use of resin is largely wasteful as one must mix a enough to complete the job hance there is always a surplus. Trying to be 'efficient' by mixing an exact amount is simply not possible, not mixing enough resin will jeopardise the lay-up process and risking thousands of dollars worth of materials and labour. (Dibley 2006)

### 7.2.2 The spread of carcinogens from resins

The health impacts can be severe if the correct health precautions are not taken when using composite materials and resins. SP systems, the largest supplier of composite resins and materials follow EU legislation by listing warnings on there packaging; Birth defects, respiratory effects and cancer are just some of the major health effects caused if there is negligent use during the handling of the products in its pre-cure wet state. There is ongoing studies as to the long-term health effects of such products post-curing and the gradual 'leaching' of the materials surfaces that ongoing skin contact can promote. As these materials and processes have only been developed in the last 20 years, no conclusive evidence is available.

## 7.5.0 Technologies to reduce environmental impacts

**Pre-preg carbon** fibre is a 10 year old material manufactured with the Epoxy resin pre-impregnated within the cloth. It must be stored at refrigerated temperatures. It then can be laid over a mould and baked in a large oven. This liquefies the resin, and sets the cloth solid into the desired shape. There is no wastage of epoxy resin, although extra energy is required to heat the oven and cook it for a set period of time. To further removed weight from the product, a vacuum pump is set up to force excess and resin to be absorbed by a layer of off cloth. The other great advantage is that the workers don't have to handle the resin in its wet state. The biggest limiting factor is the cost

**Resin infusion** is a recent development from New Zealand, whereby a carbon fibre Cloth is laid over the mould then using vacuum pressure, the exact amount of epoxy resin is then sucked through the Cloth. Again, like pre-preg, the greatest advantage is the minimum wastage of epoxy, and unnecessary worker contact.

**Split-moulding** is a technique that actually constructs the yachts hull and deck complete in two halves, split down the centreline. The greatest advantage is a more efficient, less material intense join between the two halves, compared to the traditional approach of the hull joined to the deck. As well it promotes a 'tumblehome' organic sheerline and deck profile, which has great hydro/aerodynamic advantages. (Larsson & Eliasson 2000)

### 7.3.0 Summary of design for the environment

Although fanciful notions of sustainability and 'green' materials from other manufacturing industries is slowly infiltrating the yachting industry, there are processes and materials available now to reduce the environmental impacts. Above all, a yachts hull must be built to survive the extreme nature of ocean storms, so being built to easily dissemble is simply not safe. Yachts are a custom product that only borrows analysis techniques from Industrial Design which defines itself as designing mass-producible products -but developing a product just on the basis that thousands of units can be sold is next to criminal. Are we as designers not just aggravating the environmental problems by lubricating industry to just pump-out and sell what will just become future landfill? (Papernack 1985).

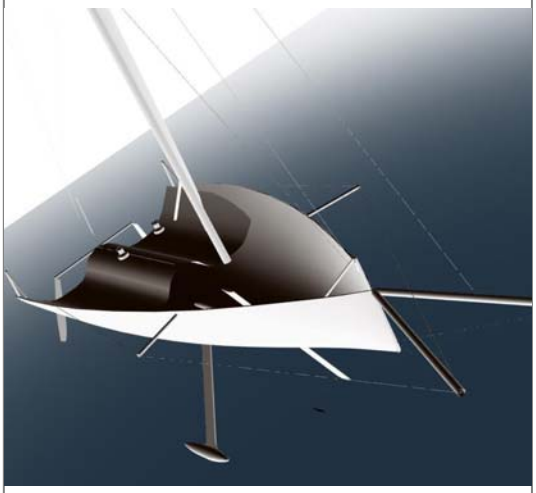
In comparison to other sporting activities like deep-sea fishing where fish are being killed and diesel/petrol is being burnt, solo racing is a far less impact-full sport. Still, the ecological footprint of a Mini Transat 6.5m yacht and its life-cycle is simply enormous -but not as large as a cars in comparison. The volume of yachts built to a new design like the proposed design will only be close to fifty boats at max, before it is superseded in 10 years time. Using split-moulding, resin infusion construction would reduce the impact marginally. Building out of plywood would have even less environmental impact -but that would not lead to a competitive yacht -and they are simply not going to sell at all. (Vincent 2006)

Credit: Luke Chueh

### 8.1.0 Argument based on information review and Market Analysis

As the project fulcrum, the analysis from the literature review in terms of how it will inform the design brief would indicate that the designed solution to the problems presented is actually a matter of affording the same level of protection from the elements while cat-naping as a yacht twice the size. By reducing fatigue and exposure, it reduces the main risk of sleep deprivation. Removing risks will promote a new Mini6.5m design as a more acceptable proposition to a wider range of sailing amateurs willing to take up solo racing. This will suit the local market in low volumes and then for export to European markets in higher volumes. The 630 odd different Mini Transat 6.5m designs already afloat almost completely ignore this issue -'why hasn't anybody done anything about this'? This is an open niche waiting -I can design for this market niche.

# 9.0 design brief



Credit: Tim Harrold

### 9.1.0 Objective

***Design a Mini Transat 6.5m solo racing yacht around the ability to easily maintain a polyphasic sleeping pattern,*** while still being able to quickly keep watch and easily access the sail controls.

### 9.2.0 Design features

- Develop a One-Design Mini Transat 6.5m Design around the priority of affording the skipper as much protection from exposure as possible, with an inside-outside 'cuddy' area that is protected by the weather, but allows visual of the rig and easy access to sail controls.
- affording the skipper as much protection from the elements
- The ability to lie down in this area is important, but it must be comfortable with the ability for the skipper to strap themselves in if necessary in severe weather.
- The Design must fit within the Box class rules (available online)
- Lightweight structure, with an efficient and powerful sailplan.
- Sail trim controls of large mainsail roach when reaching
- Aesthetically racy, appealing to a broad age range – Just the look of it should get the juices flowing…
- Affordable (around $45,000)
- Allow competitive 'one-design' fleet to be established locally
- The design needs to be so exciting that the owners will want to start an Association to organise racing each other.
- There size means that its possible them easily in a 40' high-top container for export to European markets. So it can't be beamier than 2.95m.

### 9.3.0 Design proposal 1 (sketches 1-5)

The urgent gut reaction to 'duck' behind something when faced by a breaking wave is experienced even by non -sailors. Thus by providing a barrier in the form of a 'double' cabin the skipper is afforded shelter from the spray. Plus is allows easy access inside the yacht through dual companionway access. As well this a fabric seat is provided that allows the skipper to catnap in a recline position, while on deck. (sketch 2)

Although in heavy weather with the open hatch so close to the edge of the hull presents too large a risk for water ingress when the yacht is laid horizontal or rolled over. A good start, but too great a compromise is required to resolve this design.

### 9.4.0 Design proposal 2 (sketches 6-9)

Although the first proposal addressed the need for shelter it couldn't adequately within the size limitations of the class (Only 3 metres max beam). Perhaps would be feasible on a larger yacht perhaps. This brings us back to a more conventional cabin design. Although by designing it with all the sail controls centralised allows the skipper to quickly and easily make adjustments when they wake from a catnap. If the overhang is large enough, they can actually rest/sleep underneath, both providing protection in the heat of the tropics and rain and spray of a storm.

### 9.5.0 Design proposal 3 (sketches 10-13)

By designing a continuous large half-round feature through the entire cockpit, it marries all the ideas into one pleasing organic form. It not only allows easier movement inside the yacht in preparation for an escape out the back of the boat in an event of a rollover. It provides the skipper with the opportunity to lay down in their natural slump of the body, using the natural heel of the yacht while sailing to keep them secure in a resting or sleeping position. This is called a 'bum-cleat' to hold the skipper in place and prevent them from slipping down the tilted deck -normally between 5-35 degrees. As well, the form always provides a sturdy surface for the sailor to stand on while in the cockpit.

The great advantage of this deck shape is that by using a split mould construction it will use the full advantage of composite materials and compound curves strength to produce a simple, light, organic tumblehome aesthetic.

A full-size 1:1 mock-up will be required to completely explore the ergonomics of this design.

# 10.0.0 Conclusion

The information review is indeed vast, consuming two whole months, a lot of reading and writing, typing, deleting and refining. The exercise has given the project a vastly more substantial justification for a potential design brief. From the evaluation (section 8.0) of the information review, it can be concluded that the being able to easily maintain a polyphasic sleeping pattern while racing solo is the most essential aspect to reduce risk . Designing a Mini around this would increase their popularity in the Southern and as easily be adopted the Northern Hemisphere where this type of sailing is already very popular.


Credit: Luke Chueh

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Credit JMloit

# 11.1.0 appendix a

### 11.1.1 Information retrieval strategy

Despite my vast experience and knowledge on the topic area, I intended to use experts form the field as my primary source of information, followed by Journals, books and online articles to supplement the information. To assist with this, keywords are required to direct this research since the topic has been refined.

I also subscribed to interest groups and forums on solo offshore racing. Placed threads in hope of starting a 'global conversation' on this topic I am fascinated about.

Mind maps are ideal.

### 11.1.2 **Mind map** Mind map matrix; keywords to assist research

The matrix below is the result of an extensive mind map to list as many relevant details relating to the topic area. Many require further study to grasp the full extent of the topic, which will be completed during the course of the semester and lead to a more fruitful brief for 'Major Project'. There are actually many crossovers within the details below, hence the interest in a 'Holistic' approach.

| | |
|---|---|
| Sleep deprivation: | Extreme environment: |
| Sleep patterns | Far from rescue |
| Monophasic vs polyphasic | Safety |
| 24/7 endurance | Clothing -warmth |
| fatigue | Communication limited |
| Diet | Southern Ocean |
| cooking ability | Force 10 winds |
| 2800 calorie intake | Rough sea-state |
| tired/emotional decision making | Calculating risks |
| sleeping positions | Fearful emotions |
| 5 sleeping phases -'cat-nap' vs REM | Night time visibility |
| Efficiency loss from tired muscles | Radar use |
| Sail trim: | Sailing/Racing solo: |
| Sail wardrobe | Seamanship skill |
| Sails designed for wide wind range | Navigating |
| Mechanical advantage | Weather routing |
| Roller furlers | Communication |
| Winches | CDMA, Satphone |
| 'coffee' grinders | Autohelm steering |
| cockpit ergonomics | yacht design |
| feedback mechanisms | monohull/multihull |
| 'tell tales' | suitability |
| electronic instruments | sea-worthiness |
| anometers | construction |

### 11.1.3 Proforma of Literature Review

| Theme /issue | Type of Information resource | Resource details | Abstract & Rationale for inclusion |
|---|---|---|---|
| **Solo racing risks** | **Book** | Hayter, R. 2004, Oceans Alone; Chris Sayer's solo adventure on the high seas, Harper, Auckland | Details about solo racing risks |
| | **Journal** | OCEANIC SUB-COMMITTEE – 10 November 2002 Item 3.(b) Single-Handed Sailing<br>A paper by Alan Green – 15th August 2002 | Details about solo racing risks |
| | **Journal** | Boyd, J, (1999) 'Is Mini sailing reckless?' p24 Yachting World -Dec | Question safety of Mini Transat racing |
| | **Human Resource** | David Adams | Veteran of 3 round the world races |
| | **Internet** | http://sor.fr.ee/viewforum.php?f=2 | Discussion group, with threads about solo racing risks |
| | | | |
| **Offshore racing** | **Book** | Illingworth, J. 1969, Further Offshore, Adlard, London | Details about offshore racing |
| | **Journal** | Boyd, J. (2000), 'Alone Across the Atlantic', Yachting World p69 | Details about offshore racing |
| | **Human Resource** | John Hildabrand Tom Braidwood | Details about offshore racing |
| | **Internet** | www,yachtsandyachting.cpm\news | Details about offshore racing |
| | | | |
| **Early experiences in solo racing** | **Book** | Knox-Johnston, R. 1969, A World of My Own, Cassell & Co, NY. | Account of first man to sail around wortld non-stop. |
| | **Journal** | Bray, A. (2005), 'The pioneers of Solo', Yachting World p115 | Early pioneers of solo racing |
| | **Human Resource** | David Adams | Depictions of pioneers in solo racing |
| | **Internet** | www,yachtsandyachting.cpm\news | Details about offshore racing |
| | | | |
| **Contemporary solo racing** | **Book** | MacArthur, E. 2003, Taking on the world, Penguin, London. | Details racing solo offshore |
| | **Journal** | Boyd, J. (2000), 'Alone Across the Atlantic', Yachting World p69 | Details racing solo offshore |
| | **Human Resource** | Chris Sayer | New Zealand solo yachtsman, 3rd in 1999 Mini Transat race. |
| | **Internet** | http://sor.fr.ee/viewforum.php?f=2 | International forum on Shorthanded Ocean Racing |

| | | | |
|---|---|---|---|
| **solo racing events** | **Book** | Marchell, E. 1995, The complete book of Sailing, Adlard, NY | Lists solo racing events |
| | **Journal** | Boyd, J. (2000), 'Alone Across the Atlantic', Yachting World p69 | Details about offshore sailing |
| | **Human Resource** | Nick Maloney | Has raced round the world 3 times both in fully crewed events and solo. |
| | **Internet** | www.seasailsurf.com.fr | Lists solo racing events |
| | | | |
| **Running a solo yachting campaign** | **Book** | Goss, P. 1999, Close to the Wind, Harper, London | Biography of famous solo yachtsman Pete Goss, sailing his boat and rescuing a competitor in the Southern Ocean |
| | **Journal** | Pearce, G. (2003) Powering around alone, Seahorse, pp56-59 | Post-race Review of 2003 Vendee Globe race |
| | **Human Resource** | John Hildabrand, Darkhorse Yachting Pty.Ltd. | interview with professional yachtsmen and raceboat manager |
| | **Internet** | www.offshorechallanges.com | UK based professional solo racing skippers managers |
| | | | |
| **Navigating and weather routing** | **Book** | Couts, C. 1980, Blue Water Yacht Navigation, Cassell, Sydnry | Navigating |
| | **Journal** | Orrell, J. (2000) Where are we now? Australian Sailing, pp35-40. | Aspects of navigation |
| | **Human Resource** | Adriane Cahalan | Aspects of race navigation |
| | **Internet** | http://sor.fr.ee/viewforum.php?f=2 | International forum on Shorthanded Ocean Racing |
| | | | |
| **Sail trim** | **Book** | Norths trim-U guide | How to trim sails |
| | **Human Resource** | Tim Slatter, Sailmaker North Sails | Priorities of sail trim |
| | **Internet** | www.Northsails.com | Priorities of sail trim |
| | | | |
| **Extreme environments** | **Book** | Performing in Extreme Environments by Larry Armstrong | Physiological and psychological aspects of performing in extreme environments. |
| | **Journal** | Schoene, Dr R. (1999) Natural born leaders; Extereme sport atheletes Interview, BMW pp104-107 | TBA |
| | **Human Resource** | Jacques Vincent | Successful racer, and been rescued from Atlantic |
| | **Internet** | http://sor.fr.ee/viewforum.php?f=2 | Physiological and psychological aspects of performing in extreme environments. |

| | | | |
|---|---|---|---|
| **Safety at Sea** | **Book** | C A Marchal.1996, Seaworthiness –the forgotten factor, 2nd, Adlard Coles | Safety Issues relating to the design of contemporary race yachts |
| | **Journal** | Nivelt, Bernard. (1998) Let Science provide the solution; post-analysis of Open60 disaster in the Southern Ocean, Seahorse, #87, pp50-53. | post-analysis of Open60 disaster in the Southern Ocean |
| | **Human Resource** | Trevor Mitten | Yachtmaster 5 and Ocean Master 1 qualifications |
| | **Internet** | http://sor.fr.ee/viewforum.php?f=2 | International forum on Shorthanded Ocean Racing |
| | | | |
| **risks involved in solo sailing** | **Book** | Jones, T. 1980, Adrift, MacMillan, NY. | Accounts of solo sailing risks. |
| | **Journal** | Buguit,F. (1998) sleep and stress; exercise and exposure to extreme environments Canada Physio, p 10-16. | Accounts of solo sailing risks. |
| | **Human Resource** | Andrew Henderson | Professional yachtsman, been rescued 3 times from sinking yachts… |
| | **Internet** | http://sor.fr.ee/viewforum.php?f=2 | International forum on Shorthanded Ocean Racing |
| | | | |
| **sleep deprivation** | **Book** | Stampi, C. 1992, Why We Nap: Evolution, Chronobiology and Functions of Polyphasic and Ultrashort Sleep, Birkhauser, NY. | Study of sleep in extreme environments. |
| | **Journal** | Buguit,F. (1998) sleep and stress; exercise and exposure to extreme environments Canada Physio, p 10-16. | Study of sleep in extreme environments. |
| | **Human Resource** | David Adams | Has successfully raced while sleep deprived. |
| | **Internet** | http://sor.fr.ee/viewforum.php?f=2 | International forum on Shorthanded Ocean Racing |
| | | | |
| **Sleep management** | **Book** | Stampi, C. 1992, Why We Nap: Evolution, Chronobiology and Functions of Polyphasic and Ultrashort Sleep, Birkhauser, NY. | Dr. Claudio Stampi teaches endurance sailors how to perform better on minimal sleep. The secret, he says, is learning how to power-nap. |
| | **Book** | Strughold (1981) Your Body Clock, Fergus, NY | About your body clock |
| | **Journal** | Zimmermann, T. Miles to Go Before I Sleep, Outside Magazine, April 2005, Page 12-17 | A strong introduction into human biological rythems, metabolisms and sleeping |
| | **Journal** | Tietzel, Amber J. & Lack, Leon C. (2002) The recuperative value of brief and ultra-brief naps on alertness and cognitive performance. Journal of Sleep Research 11 (3), 213-218. | A strong introduction into human biological rythems, metabolisms and sleeping |
| | **Journal** | Boyd, J, (1999) 'Dr Sleep reveals his findings on sleep deprivation on the solo sailor' p85 Yachting World -July | perform better on minimal sleep. The secret, he says, is learning how to power-nap. |
| | **Human Resource** | Jacques Vincent | Has successfully raced while sleep deprived. |
| | **Internet** | http://www.stevepavlina.com/blog/2005/10/polyphasic-sleep/ | About sleep deprivation and polyphasic |

| | | | |
|---|---|---|---|
| **Steering while sailing solo** | **Book** | Hayter, R. 2004, Oceans Alone; Chris Sayer's solo adventure on the high seas, Harper, Auckland. | Solo sailing steering systems |
| | **Journal** | Catalyst | Developments in auto-steering |
| | **Human Resource** | David Adams | Raced around solo |
| | **Internet** | www.xs4all.nl/~blvrd/html/autopilots.html | small boat autopilots |
| | | | |
| **Yacht Design** | **Book** | Lars Larsson & Rolf E. Eliasson, 2000, Principles of Yacht Design, McGraw-Hill. | Various texts on the physics and how to design a yacht. |
| | **Journal** | Kiling, S. & Hunter, D. 1998, Yacht Design Explained, 1st, W.W. Norton & Co. | Yacht design details |
| | **Human Resource** | David Lyons | Successful local Yacht designer |
| | **Internet** | www.yachtdesignrescource.net | Access to every available yacht design WebPages |
| | | | |
| **Cockpit ergonomics** | **Book** | Nicolson, I.1999, Boat Data Book, 4th, Aslard Coles, Suffolk | Principle dimensions of yacht ergonomics |
| | **Journal** | Cockpit design of the future TBA | Discussion of Principle dimensions of yacht ergonomics |
| | **Human Resource** | John Hildabrand | Expert yachtsman, |
| | **Internet** | www.sailingsource.com | Discussion of dimensions of yacht ergonomics |
| | | | |

# 11.2.0 appendix b TIME MANAGEMENT PLAN

## 3.2.5 Project management

Key; Planned: Actual: Milestone: Gone Sailin (Not in Sy

| ACTIVITY | MARCH | | | | | | | | | | | APRIL | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F | S | S | M | T | W | T | F |
| | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| **Stage 1 Define Topic:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Collect thoughts from last 4 years! | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| List merits and levels of interest in each area | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Look at who I know in each field of specialty | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Submit Stage 1** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Prepare Information for Stage 2** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Develop mind-map of connections** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Define boundaries and limitations | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Highligh the areas of investigation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Begin information Retrieval Strategy to guide entire project | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Informal chats with friends in pro yachting scene | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Interview with John .H. From Darkhorse Yachting, Sydney. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Interview with Andrew .H. From Darkhorse Yachting, Melbourne. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Organise a sail on fast offshore yachts | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Submit Stage 2** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Begin collection of research for stage 3** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| What systems solo sailors to handle the yacht | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Types of yachts designed that race solo | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| The actual size of the market globally | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Legislation and insurance clauses on racing solo | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Improve my real-life experience of Sailing solo/shorthanded | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Gather Information on sleep deprivation:*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sleep patterns | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monophasic vs polyphasic | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24/7 endurance | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| fatigue | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Diet | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| tired/emotional decision making | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| sleeping positions | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 sleeping phases -'cat-nap' vs REM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Gather Information on Extreme environments:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Safety | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clothing | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Communication limited | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rough sea-state | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Calculating risks | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| risk calculation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Night time visability | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Radar use | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Gather Information on yacht racing solo:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seamanship skill | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Navigating | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Weather routing | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Communication | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Autohelm steering | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| yacht design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| suitability | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| sea-worthiness | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| construction | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Gather Information on Sail trim:** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sail wardrobe | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sails designed for wide wind range | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mechanical advantage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Roller furlers | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Winches | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cockpit ergonomics | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| feedback mechanisms, analog vs digital | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| electronic instruments that improve handling | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Initial thought on possible conclusions and reasoned arguments** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Outline issues in the gathered research and begin to list the references | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Examine how each item of literature relates | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Conduct Market Research** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Existing products on the market to assist sailing solo | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Existing systems and processes used to race solo | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Problems in the areas of products/systems/process | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| International standards which the equipment must attain. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| List and identify other all relevant stakeholders | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conuct surveys | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Doocument Market Research and Analysis** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Evaluate all Material to Date** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Outline a Brief** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Justify design brief | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| List possibilities | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Develop further | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Finalise design Brief | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Read Suggested Readings | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Gather Information for Design-For-The-Environment** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Analise appropriate manufacturing processes, materials | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| possible by-product and recycling, pollution and | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| emissions, techniques and ways of reducing environmental impact | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Improve knowledge of conducting a complete lifecycle analysis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Prepare Draft edit of Dissertation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Submit Stage 3: Draft Dissertation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Evaluate Feed Back** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Freak out** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Final edit of Dislocations** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Submit Stage 4: Final Dislocation...** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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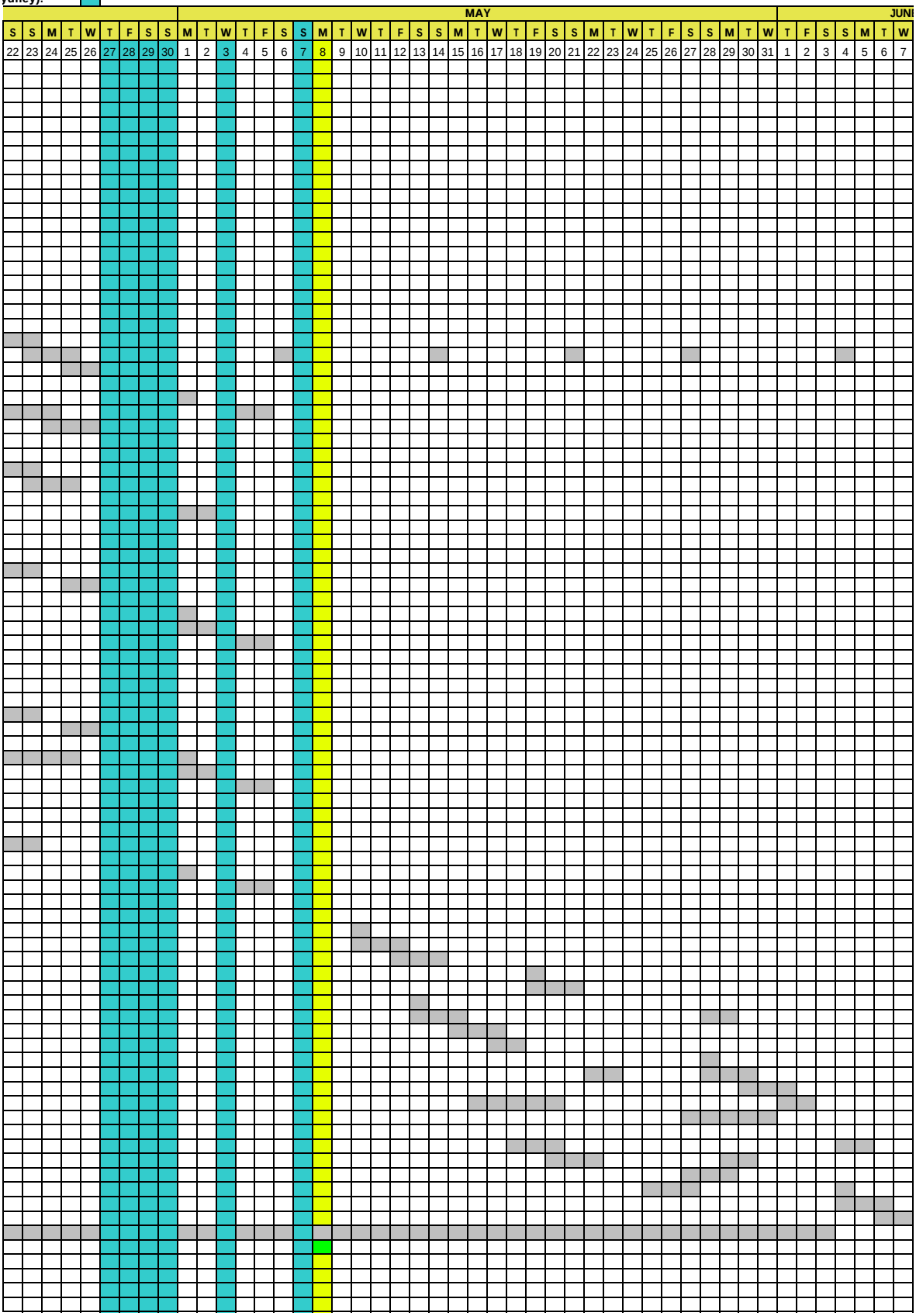
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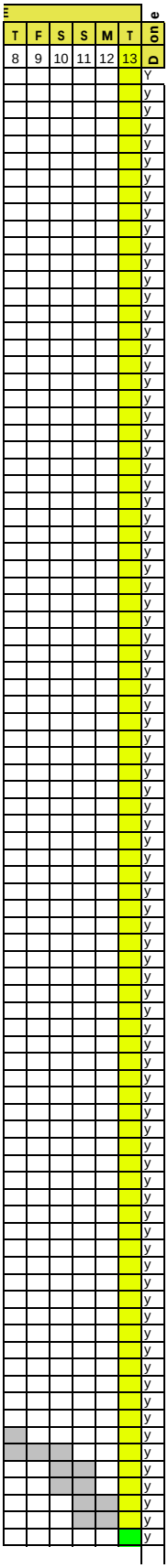
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# 11.3.0 appendix c

### 11.3.1 Access to people and resources

Sydney Short-handed sailors, members of the local and International yachting community that I have personal contact with. The professionals I know in the local yachting industry are my colleges and friends and if I don't know someone, then someone I know will... It's actually a pretty small scene that runs on all the usual gossip and friendship a small community provides. I also know quite a number of professionals who live around the globe and are only an email away. Plus there is a number of quality online sailing community forums that can provide extra assistance.

### 11.3.2 Interview plan & results

The sailors interviewed were only competitive solo racers who have experienced pressure while trying to sleep and maintain maximum boat speed. While sailors like Kay Cottee are admirable and easy to contact, they are essentially cruising sailors in comparison and as such slept for longer periods during their trips. Relying on a default set of questions is not appropriate when I already know a lot of the background of the interviewees, and as such must generate an original series of questions for each expert interviewed. The following is a list of members of the yachting community I met and interviewed; some lived overseas and will have to rely on email: There is not a transcript for everyone that was approached, as that in itself would be a whole other thesis... Rather only key discussions have been recorded.

| Name: | Professional Experience: | Types of Questions asked: | Contact: |
|---|---|---|---|
| John Hildebrand | professional yachtsman and maxi yacht project builder manager | Setting a solo race yacht up | In Person |
| Andrew Henderson | professional yachtsman, rigger and boat builder | Setting a solo race yacht up | In Person |
| David Adams | Australian Round the world solo yachtsman, winner of 1996 BOC around the world race, Open 50 class 2. Author | Racing solo and sleep deprivation | email |
| Chris Sayer | New Zealand solo yachtsman, 3rd in 1999 Mini Transat race. | Racing solo and sleep deprivation | Email |
| Phil Bower | Mini Transat 6.5m yacht owner and solo sailor | Racing solo and sleep deprivation | In Person |
| Ellen MacArthur | #1 Top around the world yachtswoman, Author | Racing solo and sleep deprivation | Email |
| Nick Maloney | Australian Round the world solo yachtsman | Racing solo and sleep deprivation | In Person/ Email |
| Jacques Vincent | one of the worlds top French shorthanded and fully crewed yachtsman | Racing solo and sleep deprivation<br>What's the racing scene in Europe | Email |
| Tom Braidwood | Mini Transat 6.5m yacht owner, and round the world | Racing solo and sleep | In Person |

| | | | |
|---|---|---|---|
| | yachtsman | deprivation | |
| Rob Drury | amateur short-handed yachtsman, winner of the 1999 two-handed Melbourne to Osaka (Japan) race. | Racing solo and sleep deprivation | In Person |
| David Lyons | Australian Yacht Designer of rating and open class yachts | Designing Box Rule yachts | Email |
| Ben Dibley | professional boat builder | Building cost efficient race yachts | Email |
| Drew Springet | Commodore of the Short-handed Sailing Association of Australia (SSAA) | Levels of interest in a one design mini offshore race yacht | In Person |
| Steve Ashley | Commodore of the Short-handed Sailing Association of New Zealand (SSANZ) | Levels of interest in a one design mini offshore race yacht | Email |

#### 11.3.3 making time to meet them

The very nature of this project research is obviously on the water and as such, the professionals that need to be approached spend most of their time on it. This topic area requires total immersion in the field. There is no better way than to sail offshore on some of the most elite yachts in Australia. Thus the only way to interview some of them is by spending time in this professional environment by sailing with them as they deliver race yachts around the Australian Coast.

The first of these interviews was conducted while sailing from Sydney to Adelaide on board the 2005 Sydney to Hobart race winner Wild Oats, a 30m canting keel 'super maxi'. Despite the light winds it was a terrific trip, with 9 crew in 'delivery mode'. A good example of what can occur when a helmsman lapses in concentration while steering a yacht of this size was when the crewman steering went 'in irons' head to breeze. With the 10 tonne 5.5m keel canted at 40 degrees the yacht immediately capsized -mast horizontal with the water! After 5 minutes the situation was resolved and we were back on our way.

**first Interview**

## : John Hildebrand

The following is the transcript from the interview I conducted with John Hildebrand, a yachting industry professional on the 20.3.06. I avoided using a dictaphone as I have found from previous experience they can evoke different responses, plus there's the laborious task of translating them. Thus I've opted to rely on hand written notes.

**Q1: How long have you been involved with the marine or yachting industry?**

A1: Well, about 15 years ago I made the seachange from Alice Springs outback mechanic to a superyacht bluewater charter crew.

**Q2: What is your experience with solo sailing?**

A2: Well typically when we are cruising the yacht is sailed 'short-handed' that is with 2-3 crew where 6 would be better, its actually easier. But nothing competitive. My main experience has been preparing a yacht for fellow Aussie Nick Maloney for his around the world racing campaign for the 2003 Vendee Globe race. I was Boat Captain and basically responsible for his safe racing around the world. I Project managed the whole refit in Cowes, England.

**Q3: To what capacity did you work with Nick as he raced around the World?**

A3: He would call me on the Satellite Phone everyday. Relating all his maintenance issues -which I could fix plus all his emotional troubles and concerns -which I couldn't! I was actually emotionally drained after the calls, and after only 2 months of these nightly phone calls I began dreading receiving them! Especially when his keel fell off!!

**Q3: Did you know of Nick Maloney's capacity to perform while exhausted before he left?**

A3: A sports research company in London actually requested they use Nick as a Guinea Pig and test his limits in a range of exposure, cardio-vascular and sleep fatigue tests.

**Q3: How did the fleet of solo sailors deal with severe weather risks?**

A3: There was one sailor that scorched through the fleet in one particular storm -
But it turned out that he couldn't pull his sails down, so he was just shut up inside allowing the boat to do its own thing...

#### 11.3.4 second Interview

### ; Andrew Henderson

The second interviewee was international yachtsman Andrew Henderson, and was conducted on the 2nd of April 2006 while sailing up the East Coast from Melbourne to Brisbane aboard a 50' race cat in just 4 days -a very fast trip. Averaging 22knots for some periods. And fortunately had access to the onboard navigating laptop to work on this paper. Quite a novelty sitting in a small cabin 'off-watch' (1.5hrs on watch, 1.5hrs off) while the boat hurtled along, sometimes in 35-40 knots of wind with 5m seas. We sailed with only 3 crew, so the watches did allow some sleep deprivation to be experienced, I would occasionally catch myself mid-micro sleep nodding off while steering at night, alone on deck...

1) What have been your experiences in racing solo offshore?
2) What priority did you place on sleep management?
3) Did incidents become uncontrollable when you were sleep deprived?
4) How successfully did you maintain a polyphasic sleeping pattern?
5) What tricks did you use?
6) How often did you oversleep?
7) How important is personal comfort to you?
8) Did you rest in the cabin because it was the only available spot?
9) How often would you nap on deck in the cockpit?

10) How much is price a limiting factor when you began the sport?

### 11.3.5 Third interview

## : Jacques Vincent

The following is an extract from email contact I have initiated with top French yachtsman Jacques Vincent, who resides in La Rochelle. Currently racing two-handed on 60' trimarans around the Atlantic in the European Summer. I sent him some general questions relating to the topic:

20.4.06

Hi Tim, nice to read some news from you....It reminds me of good summer times.

Your questions are interesting, don't know if I can answer them all -but heres something.

Lots of tests on sailors and research and articles are about sleep deprivation. I have to have a look. 'solo racing sleep deprivation and sail trim' Is sail trim an other topic of your project ? or do you relate it to sleep ?

One thing seems sure, you (the body) can not stock sleep as you can stock energy. Most of the research is about how to be rested spending the less amount of time sleeping. Sleeping techniques are different for every one. they depend on our sleeping cycle. We can improve our sleep quality by knowing ourselves. On a boat the difficulty is to fall asleep amid a noisy and moving surrounding which keeps us alert. efforts has to be made to relax in a hostile environment.

I am quite enthusiastic to see how you manage to do what you like and to learn as well more about it all. Mini 6.50 in Europe become a big big event. more than a 100 boats racing, many more trying to enter the races are on waiting list but organisers are overwhelmed. It is time to share this success with other countries.

Are you on for the next sydney-hobart ?

I will try to get you interviews about solo sailing and sleep.

Cheers

Jacques

5.5.06

Hi Tim

thanks to keep me informed about your projects. The only place I could see myself living is in Australia so I loved geting news from my dream place.

There is so much sailing going on at the moment here, it is insane and drives me crazy as I can't do it all and have to commit to a few.

I have more info about sleep research. Ellen MacArthur did some studies under the control of doctor Claudio Stampi, a chronobiologist. She used a small monitor that she wore on her wrist. This device was recording the motion of the body (may be the blood pressure or pulse ??) and they could tell when and for how long she was deep asleep. This helped her sleep strategy for the Vendee Globe in 2001. Please do more research on internet.

Laurent Bourgnon (famous swiss-french solo racer, winner of many top solo events) was the guinee pig for some experiment at sea as well during racing figaro solo. He has been wearing a few "electrods" on his head and wired to a monitor he was carying in his pocket. Quite more unconfortable than a wrist monitor but may be more accurate and detailled. i'll know more about

My friend Thomas Coville, skipper of 60' trimaran Sodebo [redacted] top secret....It would be cool to have you involved some how, I am meeting Thomas this afternoon as well and will mentioned your name and will mention your studies about sleep and trim. I saw the design of the cuddy and this is much like what you recommend.

Keep learning, keep sailing and keep away from bars !

Cheers

Jacques

#### 11.3.6 Forth interview

### : Nick Maloney

The fourth interview was with Australian round the world solo yachtsman Nick Maloney. The questions will be about Racing solo and sleep deprivation:

**Q1: How do you prepare for sleep deprivation?**

A1: Nick Moloney: My preparation, I've been working on sleep deprivation now for four years, and how I developed the skill of catnapping, was by interrupting my normal daily routine over a period of three days, I would go to bed normally on the first night of the routine, and set my alarm clock for an hour 40-minutes, wake up throughout the evening, open up my laptop, start it from a full shutdown, enter a job that was relevant to the job list on the boat, shut it down completely, set the alarm, an hour and 40-minutes in, go to sleep, and run this cycle all through the normal evening, and you'd be fighting to get to sleep by the end of it, because the first few times you go to bed and you're thinking about the job list and then the alarm goes off and you haven't actually slept. So you start confusing your mind and racing, finding ways of getting to sleep. So the first thing you try and do is push the job list out of your mind and then you confuse your mind with scattered thoughts, and you start falling asleep. You can fall asleep quicker and quicker and quicker.

**Q6: What's the longest you have had to stay awake?**

In 1999 Australian Nick and it was my first attempt to sail solo across an ocean. I was in a boat 21-feet long, very, very small, and it was a situation where I started the event full of determination, and four days down the track ended up with a terrible mixture of determination and gross fatigue. And I got to a point of such fatigue I couldn't come back from it, and I ended up making really silly decisions, and I put the boat into a dangerous situation and I was hit by a

big wave and knocked off the boat. To cut a long story short, I was trying to hang on to the boat and broke my arm in that situation, and ended up underneath the boat, harnessed, I'm hanging on the end of my tether and I was under the boat for so long and the duration was so long, it was longer than I care to remember."

I put it down to bed seamanship. He said. One should not sleep for that length of time. All single hammers are totally responsible for their own safety and welfare. It was my fault. No one can take the responsibility away.

**Q1: What are some key elements of offshore sailing?**

A1: Well, it's the same old idiom; 'Change before you're cold, eat before you're hungry and sleep before you're tired'

**Q3: What is it like racing under pressure?**

A3: Like any job that you are paid to do, you do the best you can with the resources you have at hand. "A big thing about coming out of a storm is that you can make more miles than you can going in, everyone presses all the gears to the max going in because you're all fired up. But by the time you've been through a storm you're knackered and relived, and you want rest. You're frightened of putting sail up before it's right to put it up."

"So there's a tendency to skip a gear, to shake two reefs out rather than one, and that's really bad. If you can go out like you came in, taking a sail to its minimum and then changing to a sail that's slightly over the top you'll gain." "it's not nice, recovering from one battering and outing yourselfd through another, but that's what you have to do."

### 11.3.7 Fifth interview

## : David Adams

The fourth interview is yet to occur. It will be with Australian Round the world solo yachtsman, winner of 1996 BOC around the world race in the Open 50 class 2. David Adams. The questions will be about Racing solo and sleep deprivation:

11) What have been your experiences in racing solo offshore?
12) What priority did you place on sleep management?
13) Did incidents become uncontrollable when you were sleep deprived?
14) How successfully did you maintain a polyphasic sleeping pattern?
15) What tricks did you use?
16) How often did you oversleep?
17) How important is personal comfort to you?
18) Did you rest in the cabin because it was the only available spot?
19) How often would you nap on deck in the cockpit?
20) How much is price a limiting factor when you began the sport?

# 11.4.0 appendix d:

## Tim Harrold's polyphasic sleep log 13th May -28th May 2006

| Date | Times | Rest | comments |
|---|---|---|---|
| Sat 13.5.06 | 0 | 0 | -no sleep for 36 hours,<br>-as a primer |
| Sun 14.5.06 | @ 10.00am -10.30am | 30mins | 1st catnap<br>time to fall asleep: 3mins<br>-wokeup feeling fantastic |
| Sun 14.5.06 | 12.50pm -1.20pm | 30mins | 2nd catnap<br>-time to fall asleep: 5mins<br>-perhaps like being hit by a bus<br>by 1.50 felt fantastic |
| Sun 14.5.06 | 5.10-5.30 | 20mins | Slept on the toilet… |
| Sun 14.5.06 | 7.30-8.00pm | 30mins | It re-affirmed my inability to go without sleep… try as I might, I need my 7 hrs a night! SO I don't know how that throws me if I try to follow a polyphasic pattern. |
| Sun 14.5.06 | 10.00pm-12am | 2hrs | - a little cold, chilly even<br>-warmth very important |
| Mon 15.5.06 | 3am-8am | 5hrs | Solid REM sleep =) |
| Tues 16.5.06 | 10.00pm-12am | 20mins x4 | so far so good |
| Tues 16.5.06 | 3am-8am | 20mins x4 | -wokeup feeling a little drousy |
| Wed 17.5.06 | 12am-6am | 6hrs | Wired |
| Wed 17.5.06 | @ 10.00am -10.30am | 20mins x4 | In room 246 @ school |
| Thurs 18.5.06 | 12.50pm -1.20pm | 20mins x4 | -better like 'hibernate;' on the confuser as oppoused to 'system shutdown' |
| Thurs 18.5.06 | 5.10-5.30 | 20mins x4 | time to fall asleep: 3mins<br>-wokeup feeling fantastic |
| Fri 19.5.06 | 7.30-8.00pm | 20mins x4 | |
| Fri 19.5.06 | 10.00pm-12am | 20mins x4 | In room 246 @ school |
| Fri 19.5.06 | 3am-8am | 20mins | I feel fantastic<br>Like when you're swinging backward on a chair -on the point of balance… |

| | | | |
|---|---|---|---|
| Sat 20.5.06 | | 20mins | invigorated<br>Motivated |
| Sat 20.5.06 | 8.30 – 12am | 3.5hrs | rest –followed by 24hrs awake |
| Sun-Mon 21-28.05.06 | 7.30 – 7.30am | 12hrs | Reset body clock |
| | **END OF EXPERIMENT** | | |

## Polyphasic sleep Conclusions

I can appreciate what being 'on an emotional roller coaster' is like…

While living on 4 hrs total sleep every 24hr cycle, my mental state seemed to swing drastically from an almost euphoric state of high energy, motivation and drive to deep lows of morose laziness. While I was maintaining a 'normal' monophasic sleep pattern, my emotions were a lot more stable and consistently ho-hum. Tested that 5min nap –I was woken by the alarm. The second 5min nap –wouldn't wake up

The most difficult aspect was the discipline of maintaining the regular catnaps –hard while working in and travelling around a bustling metropolitan environment. Leading me to believe that it would be even harder while racing solo, with so much work required to maintain high boat speeds. Only by having an attractive comfortable spot that you can literally drop down onto and grab a quick 15-20 minute nap could one be strict about their sleep discipline.

# 11.5.0 appendix e

**Continue from section 1.2.3 –personal interest in topic.**

I remember climbing around an Open 50' solo race yacht during a round the world stopover when I was about 10yrs old, talking with the skipper and being completely in awe. Trying to comprehend what it would be like living in the intensely spartan cabin –just a navigation table, bucket and a single burner stove –nothing else. A space that would complement the minimalist ideals of John Pawson –or for that matter a prison cell… It struck me as the ultimate sport and promised that I would do the same –one day. If that doesn't work out I can always try to be a Designer instead… In particularly Yacht design, which has also been the end-game ideal. From the ages of about 7-17, all through school my textbooks were drawing pads for boats with class notes squeezed in the margins... Industrial Design at the time provided the 'path less traveled by' to reach that goal. In the abeyance the inevitable experience of Uni has changed that worldview of Yacht Design to merely creating floating egos for the elite few who have more collective capital than the entire African continent. Wasting finite petroleum products and creating masses of toxic landfill just to build something the Polynesians got right the first time around 3500 years ago… Having said that I can't escape the fact that "work is for people that don't know how to sail" anon. So its back to boats in the interim until I find a Nobel prize winning solution to the worlds problems.

I personally find nothing more satisfying than escaping alone offshore, being completely autonomous. You are entirely self-reliant upon your own skill and calculation. Although sleep for me is a barrier to this world. I'm a disturbingly heavy sleeper and relish the laziness of dozing through the snooze alarm during a relaxed morning. Although I do my best thinking and generate the most breakthrough ideas when I'm sleep deprived –its possible my most dreaded sensations –that 'have I just been run down by a truck emotion feeling after only an hours sleep.

## 8.2.0 Personal Reflection

From a personal viewpoint, I would just like to use this space to express some of my reflections on the last 3 months of research. I actually really enjoyed this topic and was quietly ecstatic as I tapped away on the keyboard at 3am reading the research on a topic that intersects what I plan to do for the next 10yrs or more. How I would of sustained interest in my primary topic choice of pre-fab housing I don't know.

Plus this now provides a perfect excuse to 'draw boats' next semester…

I seemed to live in a paradox, I had a deep interest in the topic area and wanted to do it justice vs my inherent laziness to just do enough… SO as I would write 'just enough' I would then spend hours eitingove.

# 11.6.0 appendix g

## Aspects that were emitted from the dissertation body, but I can't bring myself to delete...

### One design

One design yachts are a cheaper alternative to prototype or 'one-off' designs.
Every aspect of the boats must be the same, which allows the skill of the skipper to shine over how much money they can spend. There are similar European examples, although only the French Figaro30 class has been specifically designed to offer solo and two-handed racing. Racing around the West Coast of France, the Figaro circuit provides a proving ground for budding professional solo sailors.
The Mini Transat racing has a one-design division called the 'Pogo' class.
As there is large investment in the tooling of high production moulds for one design classes, Any poorly designed features are unable to be changed. And to change any aspect requires consent of a proportion of the owners – a very awkward task.
That is part of the attraction of slightly more expensive open development classes –all recent innovations can be incorporated into the design.

Auxiliary aspects of solo offshore yacht racing:

**2.3.1 Classes of solo racing yachts**

Open 60 monohull
60' foot long, can use any rig configuration, ballast systems like canting keels and water ballast very demanding to sail
Open 50 monohull
50' foot long, can use any rig configuration, ballast systems like canting keels and water ballast very demanding to sail
Open 40 monohull
40' foot long, can use any rig configuration, ballast systems like canting keels and water ballast very demanding to sail
Open 30 Monohull
30' foot long, can use any rig configuration, ballast systems like canting keels and water ballast very demanding to sail
Mini 6.5m
21' foot long, can use any rig configuration, ballast systems like canting keels and water ballast very demanding to sail
IMOCA 60' trimaran
60' foot long, can use any rig configuration, the most elite and demanding yacht to sail in the world.
IMOCA 50' trimaran
50' foot long, can use any rig configuration, very demanding to sail

### 2.3.2 racing yacht design

Still regarded as a ‘black art’, the principles of modern race yacht design have not changed much its inception over 130yrs ago (Larrison 1998). The contemporary sailing landscape features thousands of variations in the types of monohull sailing boats.

'Yacht designers, like architects, and Industrial Designers merely provide the ideas for Engineers and Naval Architects to massage into reality.” –Owen Clarke, yacht designer (2001)

monohull vs. multihulls

Historically Multihull craft are actually multihulls; the Polynesians pioneered this with their Proa craft 1500BC. They also developed a form of celestial navigation. An amazing fact is that Western civilisations did not experiment with multihulls until the 1870’s. There was a large increase in interest in the 1960’s with many catamaran and trimarans being designed and built through North America and England. Their primary attraction is that they are significantly faster in most conditions than monohulls. This is achieved by reduced displac

**“So long and thanks for all the fish” Adams D (1979)**