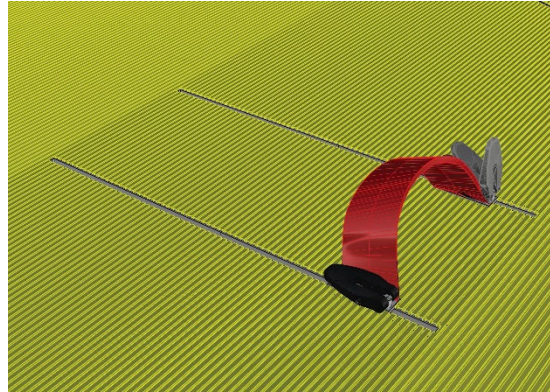


Prototype foot strap design considerations for surf lifesaving inflatable rescue boats: Technical report #7 to Surf Life Saving New Zealand (SLSNZ)



By research team members for TE HOKAI TAPUWAE – REIMAGINING SPORTS INJURY PREVENTION

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Table of Contents

Acknowledgements.....	2
Contributors statement.....	2
Abstract	3
Foot strap design considerations.....	4
Standing position.....	5
Aussie position.....	5
Foot strap prototyping	6
Camlock adjustment concept	6
Quick release/pressure release clasp concept	6
Raised foam pad concept	6
Prototype 1 EVA pad with strap	7
Prototype 2 Moveable track with cam lock.....	8

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Contributors statement

According to the definition given by the International Committee of Medical Journal Editors (ICMJE), the authors listed qualify for authorship based on making one or more of the substantial contributions to the intellectual content of the manuscript. Study conception and design [Grobelny, Reay, Diewald, Wilson, Hume, Wooler, Merrett]; Acquisition of data [Grobelny, Reay], Extraction of data [Grobelny, Reay]; Interpretation of data [Grobelny, Reay]; Drafting of manuscript [Grobelny, Reay, Hume]; Critical revision of manuscript [Grobelny, Reay, Hume, Diewald, Wilson, Wooler, Merrett, Smith].

Abstract

Background: Foot straps have been removed from IRBs due to concern they were causing lower limb fractures due to entrapment with rotation during landings.

Purpose: To model possible positions and prototype designs for foot straps in IRBs.

Methods: Strap measurements were taken from the SLSNZ boat in Raglan, then modelled with the alternatives to give an overview of possible placement for one person. Foot strap prototyping was conducted using 3D modeling with an initial EVA material design constructed.

Results: A number of questions were identified that need to be researched to provide information for the design brief including: Can feet be parallel, or is it important for them to be staggered; Does the right foot do most of the work?; Which positions cause injuries?; Without a foot strap, how likely are the feet to bounce up away from the deck in big swell? Three foot strap concepts were modelled: Camlock adjustment; Quick release/pressure release clasp; Raised foam strap. A prototype EVA pad with strap was built. A moveable track with cam lock was conceived.

Discussion: Foot placements needed to be adjustable for varying lower limb lengths. Foot straps need to be adjustable for varying foot sizes. Key priorities for design of the foot strap system include: Minimal fixtures; No hard/sharp edges; Keep boat deck flat without raising foot hold areas; Quick and easy to adjust; Strong enough to handle impacts and weight of crew; Positionable for shortest to tallest crew member; Ability to swap out strap to renew; Corrosion resistant. Review of all the project reports identified that ensuring three points of contact for the crew with the boat was important as a consideration for the phase II design project.

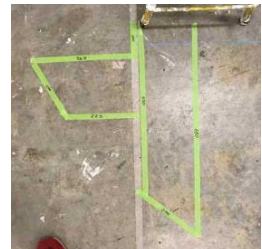
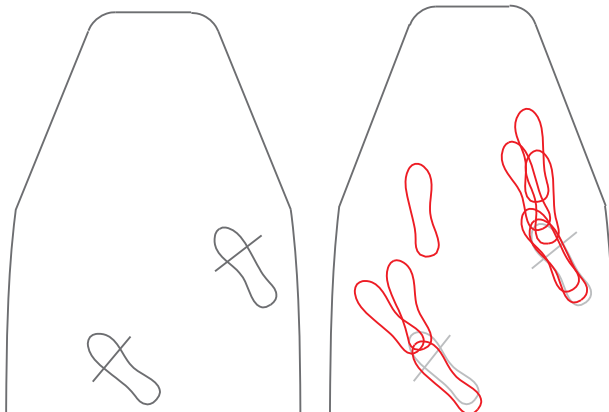
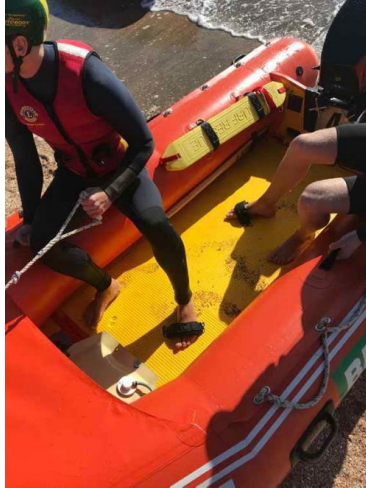
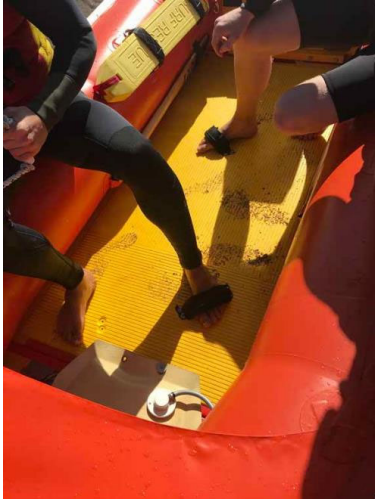
Conclusions: Further testing is needed to assess foot placement as the current positions are not yet researched. Discussion on the pros and cons of the suggested foot strap prototypes is needed followed by construction and in-the-boat testing.

Recommendations:

1. Create a larger design project focused on “How can we optimise the design of the IRB to minimize injury and ensure three points of contact.”
2. Discuss the suggested foot strap prototypes for use in the boat to reduce injury risk.

Foot strap design considerations

We modelled possible feet positions that felt comfortable to suggest/prompt options for alternative positioning or adjustable positioning. It was noted that shorter SLSNZ members struggle to reach the straps in the current position. Strap measurements were taken from the SLSNZ boat in Raglan, then modelled with the alternatives to give an overview of possible placement for one person. Further testing is needed to assess placement as the current positions are not yet researched.



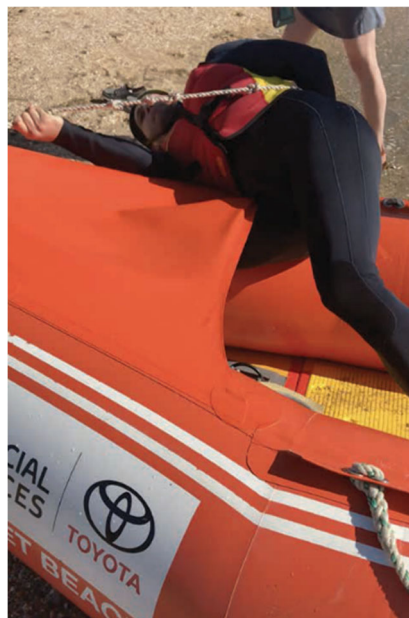
Standing position

- Can feet be parallel, or is it important for them to be staggered as in this shot.
- Is the right foot doing most of the work?
- Is this position causing injuries?
- Is this a specific racing position not used in patrols?
- Without the footstrap, how likely are the feet to bounce up away from the deck in big swell?



Aussie position

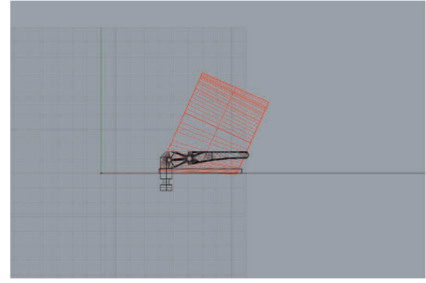
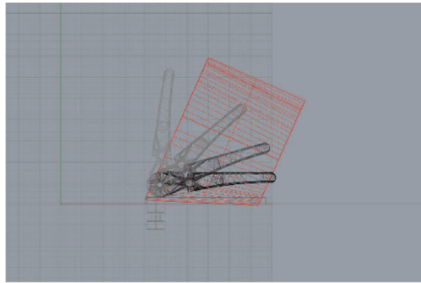
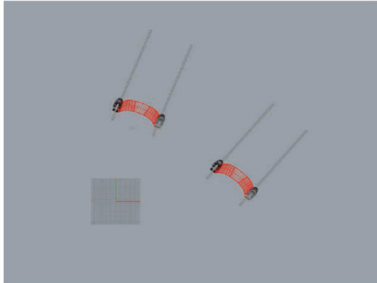
- "Very bad for back"?
- Compulsory race position for some races. Crew tend to hop around when hitting waves.



Foot strap prototyping

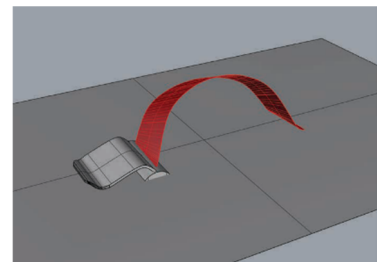
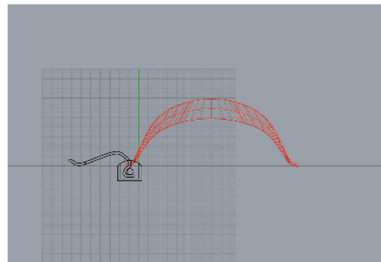
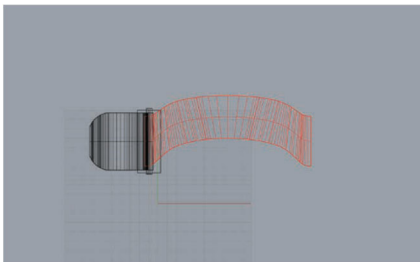
Camlock adjustment concept

- Easier foot strap positioning. Spring loaded lever with accompanied track system.
- Boat integration would add expense and extra time before testing.
- Would need to minimise parts and soften.
- The complexity of this concept may use valuable research time. Will not progress until more injury data are available and a clearer scope is provided.



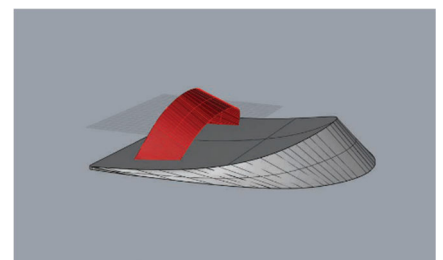
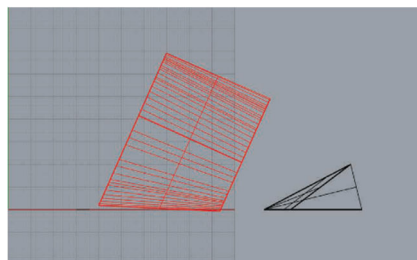
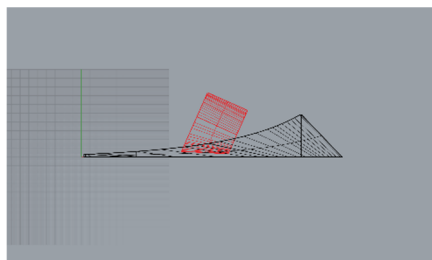
Quick release/pressure release clasp concept

- Main problems would be the differing weight of people on patrol.
- Hard for one system to work effectively for all.
- Adding hard objects to the boat may be problematic causing injuries such as scrapes. Would need softening cover.
- Position would be fixed.

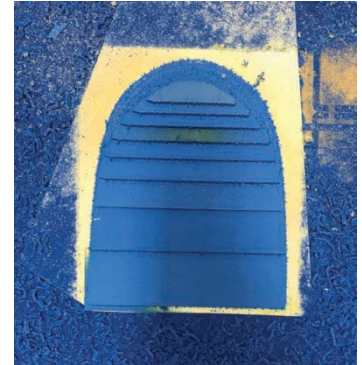
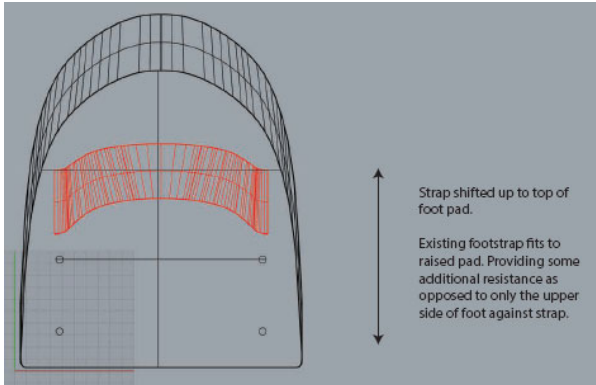


Raised foam pad concept

- Addition of raised foam pad.
- EVA foam, same density as deck grip currently used.
- Does the angle of foot position contribute to injuries?
- Would the incline pad increase risk of ankle sprain injuries?
- Would the incline add to support by reducing reliance on the upper part of foot bracing against the strap?
- Can easily change form to smaller wedge, aiding in foot placement and leverage for foot to push against.

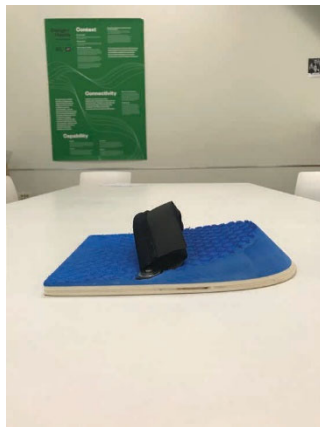
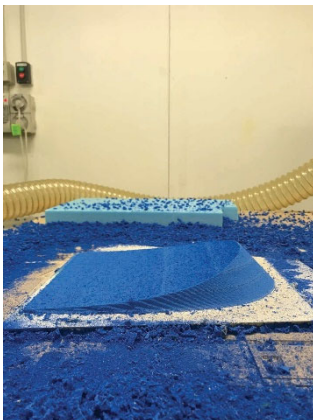


- Some crew reported only pushing their toes under the strap to prevent the foot being caught and injured.
- Combination of pad plus strap dictates position of strap for foot. i.e closer to toes, allowing foot to release easier if crew is thrown by sudden stop etc.
- Idea needs to be prototyped and tested as a starting point for strap development.



Prototype 1 EVA pad with strap

- EVA foam material.
- Density machines into form easily.
- Strap attaches easily through EVA into base material.
- Would need to be tested in place so logistics need to be discussed.
- Form may not as effective as first thought. Prototyping put on hold 5th April until further discussion with SLSNZ staff.
- Better cushioning but potentially too large which could cause sprains.

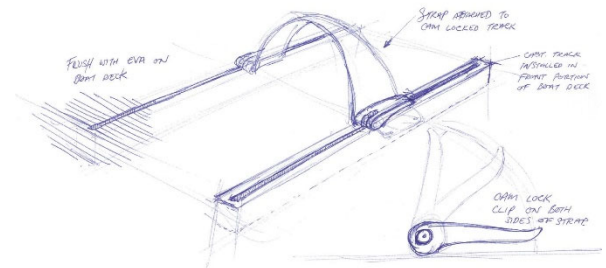


Prototype 2 Moveable track with cam lock

- Concept developed as insights revealed the potential need for a moveable track system to accommodate various strap positions. Differing heights of crew on patrol creates a need to change the strap position to safely fit the crew member. This needs to happen quickly with minimal tools required.
- As a concept there is still much more to explore so changes should be expected if this is chosen for further development.

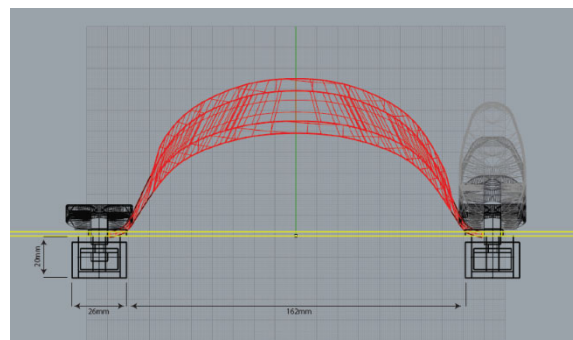
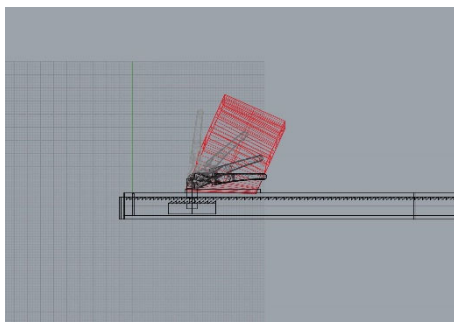
Key priorities for design:

- Minimal fixtures.
- No hard/sharp edges.
- Keep boat deck flat without raising foot hold areas.
- Quick and easy to adjust.
- Strong enough to handle impacts and weight of crew.
- Positionable for shortest to tallest crew member.
- Ability to swap out strap to renew.
- Corrosion resistant.
- Generic clip design to be modified to design brief.



Track system to be flush mounted with deck during or post construction.

- Components can be slid out from back end of track in case they need changing or to remove the strap completely.
- Strength of track to be tested installed, important not to compromise strength of boat deck.
- Locking mechanism to be moved forward on strap to ensure even clamping pressure across front and back of strap.
- Mechanism and track designed to hold even if locking clip comes undone for some reason.
- When foot engages with strap this adds clamping pressure to mechanism.
- Changing position can only be done when foot is out of strap.



Fabrication and testing requirements:

- Further research into existing floor panel. Focusing on materials, manufacturing methods and current strength requirements of panel.
- Determine best foot placement options for crew, short and tall. Crew available during the week to interview and help test.
- AUT Workshop use to produce parts and install tracks.
- Rapid manufacturing technologies to iterate design concepts. Access to a front floor panel for installation.

