Minerva Canada's James Ham Safe Design Awards Contest

Fisherman Emergency Locater (FEL)

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Introduction

Modern day commercial fishing continues to be an inherently risky industry to work in. In fact, it's so risky that the risk of dying in fishery is higher than in any other industry in the United States. When analysing the causes of the high risks, the most common forms of injury and fatality in commercial fishing are found to be due to drowning and falling overboard. Finding a person floating in the vast open sea still proves to be a major challenge today. Therefore, through implementing a new alert system with position finding capabilities, the response time before rescue will be significantly reduced allowing for more successful rescue efforts.

Background

Fishing is an inherently risky industry. Although standards and precautionary measures are in place in order to prevent fatalities in most regulated fishing industries, notably in the United States, the number of deaths in fishing is still an astonishing 31 times higher than all other U.S. workers.

Looking at data from the *National Institute for Occupational Safety and Health*, or NIOSH (which maintains the Commercial Fishing Incident Database); from 2000-2010, it's estimated that 545 commercial fishermen died while fishing. These accidents can be broken down by causes as follows:

- 279 (or 51%) of the fatalities occurred after a vessel disaster (E.g. sinking, capsizing, fire)
- 170 (or 31%) of the fatalities occurred when a fisherman fell overboard
- 56 (or 10%) of the fatalities resulted from an injury onboard
- And 40 (or 8%) of the fatalities occurred while diving or from onshore injuries

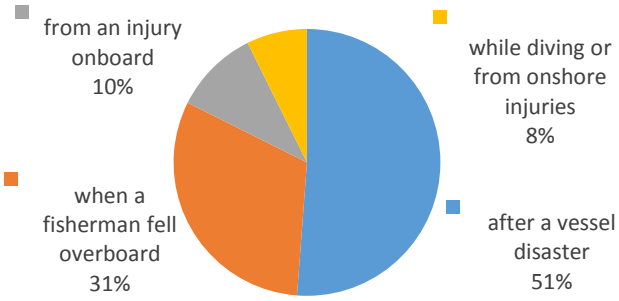

Figure 1 - Fishermen's Deaths by Causes (2000-2010)

It is also worthwhile to note that fatalities in small fishing operations are often not reported, meaning that the real percentage of fatalities that occur could be much higher. Furthermore, in Canada things are not that much different. In fact, the *Transportation Safety Board of Canada* (TSB) has released a report stating that, on average, there has been 14 deaths each year in the fishing industry between 1999 and 2010, with a similar breakdown of causes as the above. Through our research, we found that the main factors that inhibit rescue efforts are:

- Poor visibility due to weather
- Person drifting away
- Delay in sounding the alarm
- Unconscious person in the water

In the case of a man overboard on a vessel, someone has to notice and sound the alarm in order to notify the rest of the crew about an emergency. Depending on the weather conditions, doing so often puts hundreds of meters of distance between the ship and the person in the water. Furthermore, the problem continues to be challenging as there's no way to find that person expect by literally looking for them using the naked eye. Thus, finding a head in sea in the dark and stormy night becomes more like finding a needle in a hay stack!

It is impossible to prevent against falling overboard due to reasons like high variability, harsh working environment, and fatigue. It is however very possible to speed up and increase the success rate of the rescue once falling overboard occurs. The idea is to have an emergency alarm trigger with position finding capabilities on every fisherman. If any of them fall overboard, the emergency alarm on the vessel automatically activates by receiving a direct signal from the device. Moreover, the device also allows his position to be visible on existing technology on the vessel and to nearby ships. Thus everyone on the vessel would be notified that someone is in emergency, as well as what their exact current location is, efficiently directing rescue efforts.

From *Figure 1*, we believe our device could help reduce the *first, second, and fourth* reasons significantly. In other words, we're hoping that our design would eliminate roughly 90% of the deaths that occurred from 2000 to 2010.

Device Overview

As mentioned above, the idea is to have an emergency alarm trigger with position finding capabilities on every fisherman on any vessel. The idea takes cues from similar existing technology, like the Nike+ FuelBand & GPS equipped watches, which track down user's sports and health activities. The difference, however, is that our device instead:

- Is not limited to being worn as a watch,
- Has both GPS & Bluetooth 4.2,
- Integrates with the existing AIS system the vessels use,
- Has an emergency alarm trigger for the Vessel,
- And is tailored for fishermen and the harsh sea conditions.

Figure 2 – Nike+ FuelBand

Device Functionality

Currently, commercial fishing vessels use a system called *Automatic Identification System,* or AIS for short, which allows the vessels to transmit and receive their coordinates using satellite in order to communicate locations between each other. The GPS module on our device is obviously used to track down the fisherman using satellite in case of an emergency. But more importantly, it's also

used to transmit that fisherman's location on the same AIS system to his vessel, and any other ships nearby him. This means that not only are ships now seen on the radar, but also any person in the water in an emergency situations, maximizing his chances of being saved.

By default, the GPS is turned off in order to save battery. Instead, low power Bluetooth 4.2 is how the device will stay connected with the vessel bridge as long as the fisherman is onboard. In case of an emergency onboard, the Bluetooth is also used for locating the fisherman in order to aid him. The vessel will be equipped with Bluetooth receiver(s), connecting the device to the vessel's existing alarm system. Also, a portable small monitor in the bridge will show the location of the injured fisherman onboard of the vessel in the case of an emergency.

Moreover, the emergency alarm trigger will be a button on the device, which will allow the fisherman (say *John Smith*) to manually notify his colleagues of his emergency.

In order to explain the idea better, let's walk through the 2 different imagined scenarios:

Scenario A

1. Fisherman *"John Smith"*, falls overboard,
2. Bluetooth connection with the vessel will break due to being off range,
3. Immediately the vessel's emergency system goes off, & the GPS on the device automatically wakes up transmitting "*John's"* location in the sea to the bridge through AIS,
4. The small monitor in the bridge will also start flashing "*Emergency: John Smith overboard*". This way, both the bridge & the crew will know immediately that "John Smith" is in trouble & would go help him.

Scenario B

1. Fisherman *"John Smith"*, gets injured onboard,
2. The injured "*John"* presses on the emergency button on his device,
3. Immediately the vessel's emergency system goes off, & the Bluetooth module on the device transmits *"John's"* location on the vessel to the bridge,
4. The small monitor in the bridge will start flashing "*Emergency: John Smith injury*". This way, both the bridge & the crew will know immediately that "John Smith" is in trouble & would go help him

It's also worthwhile mentioning that each device will have the information of the fisherman carrying it; thus when in emergency, it's known who's in danger. This will simply be done when each fisherman signs off their device at the beginning, each device will be crossed off to a fisherman in the system. The sign up could be done through any computer or smartphone, and is reversible.
Lastly, we're calling the system the *Fisherman Emergency Locater*, or simply FEL (appendix B).

Risk Analysis

To ensure that the device does not introduce any new risks or hazards, a risk analysis was performed on our design. A couple of minor risks were found, some of which were solved in the design, and some which could be easily avoided if communicated properly.

Firstly, being an electric device, it will be powered using a battery. Looking at existing similar technology, like Nike+ FuelBand & Garmin's GPS Smartwatch, those watches run up to 7 days and 24 hours respectively. However, we are not constraining ourselves in size as much as these watches. FEL will thus include at least double the battery – which means up to 14 days on one charge. The remaining risk with the battery running out could easily be resolved as the fishermen regularly charge their FEL every 2 weeks or so, as part of their regularly scheduled vessel maintenance.

Secondly, we initially had designed FEL to be worn on the arm. However, after watching videos of the daily routine of commercial fishermen, we found that it could result in discomfort when worn while working, depending on their environment & conditions. Our design thus changed to be more modular in the sense that the device could be worn in any of the following ways (appendix C):

- Worn on the arm, like a watch,
- Clipped on directly to belts or shirts,
- Attached to their lifesaving jackets,
- Worn around the neck like a necklace,
- Strapped around the upper arm, like the running cellphone holder.

Thirdly, fishermen are often working with heavy harvesting equipment, fish, and a lot of physical hits from everywhere. The device will thus be cased to avoid any hits that could unintentionally trigger the alarm. Moreover, the casing will be strong and waterproof to protect all the components from the harsh salty water of the sea, minimizing any failures to them (appendix B).

Fourthly, having both GPS and Bluetooth on every fisherman could be a privacy hazard, since the technology could theoretically be used to track them down & their work. Thus, FEL will not give any access to location in any way to any user unless it's in the case of emergency only.

Lastly, since our design includes introducing a new addition (FEL) to the existing AIS technology, there's always a risk in them not working nicely together. However, from our research with marine engineers in the field, we know it's theoretically possible to implement. Since this has never been done before, the next step really is to start building and testing the design to figure out if there will be any issues between them.

Business Case

Technology

The cost breakdown of an electric prototype for the FEL would be the following:

- Bluetooth 4.2 module - $20
- GPS Module - $52
- Arduino board - $35

Thus, the full price of FEL's electric prototype would be estimated to be less than $107. However with the casing and everything else, we will assume that each FEL unit will cost $130 per person. Ideally this price would be a lot lower in production given that electronics naturally have a lower cost when in production phase (more units mean lower cost per unit). In addition, the Bluetooth receiver on the vessel and its location monitor are estimated to cost a onetime overall fee of less than $100 per vessel.

Thus, for comparison reasons, let's say the all-inclusive total cost per person would be $150.

Injuries/Fatalities

The cost of Injuries and fatalities to fishing companies and insurance companies is a significant expense in the operation of the fishing industry. There is a 31 times higher risk of dying on the job in the fishing industry than in any other industry in the US, and this is represented in the extremely high insurance premiums these companies must pay (higher than any other industry). Using numbers for the cost of an average fisherman's death cost in North America ($944,000), and the average 14 deaths per year in Canada, we arrive at an estimate of $13,216,000 for the total costs of deaths per year in Canada alone!

Comparison

When we compare the cost of equipping every fisherman in Canada with FEL, with a liberal estimate for the number of people working in the fishing industry (50,000 people), we find that the total cost of equipping the entire industry is:

$150 per unit * 50,000 people = $7,500,000

That's half the cost of fatalities! In other words, even if these bracelets save half the lives of the workers that would normally die, FEL would be cost effective. This also does not include the reduction in insurance premiums. Coupling all this with the potential of saving up to 90% of the deaths as mentioned before, it becomes an extremely logical solution what FEL has to offer.

References

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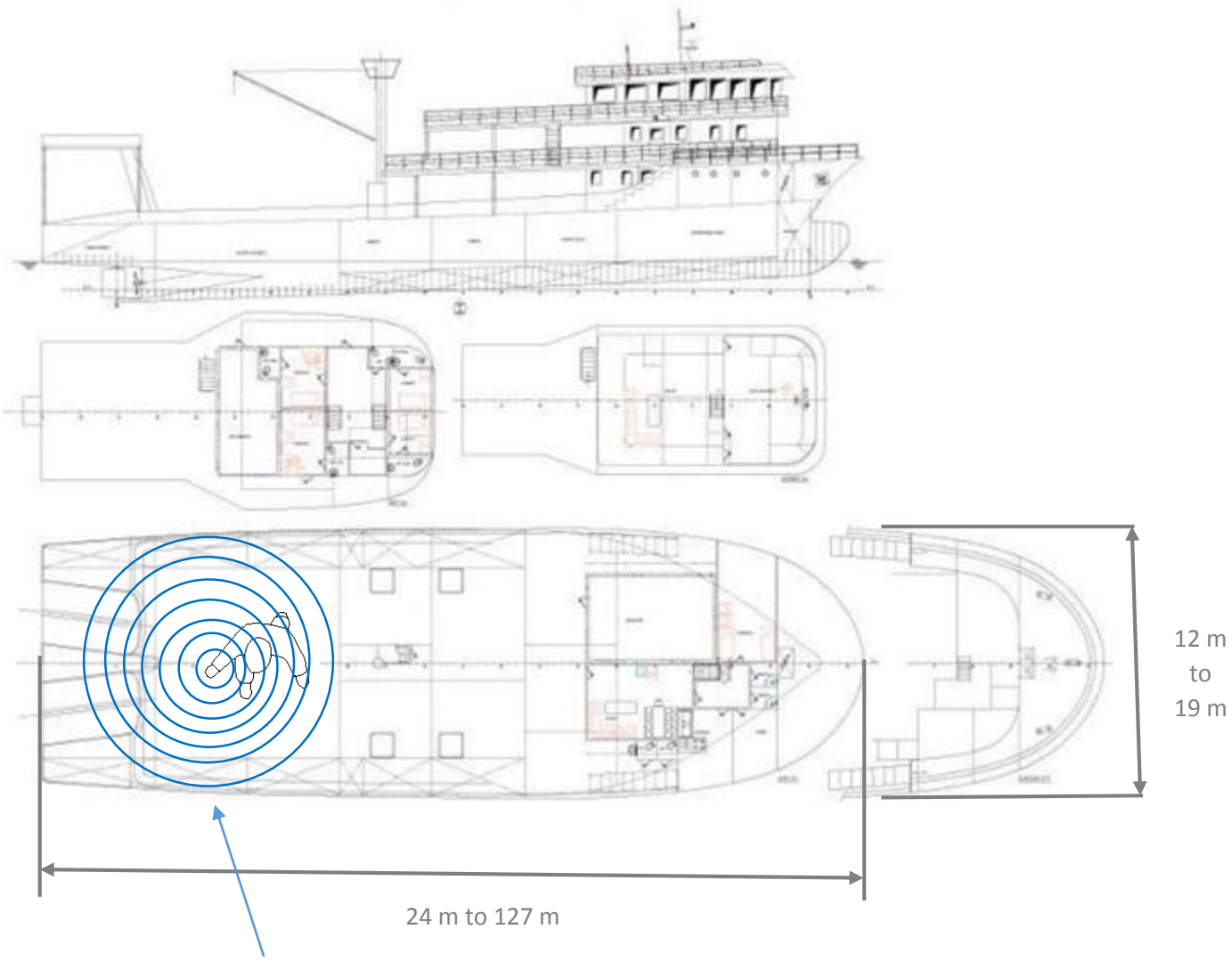
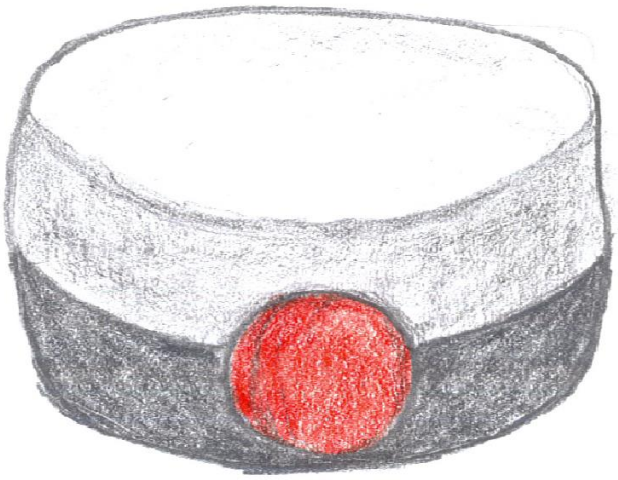
Appendix A – Average Vessel Sizes



Bluetooth coverage compared to the width of a vessel. Depending on the vessel size and shape, the number of Bluetooth receivers would be added to the vessel to cover its full length as well.

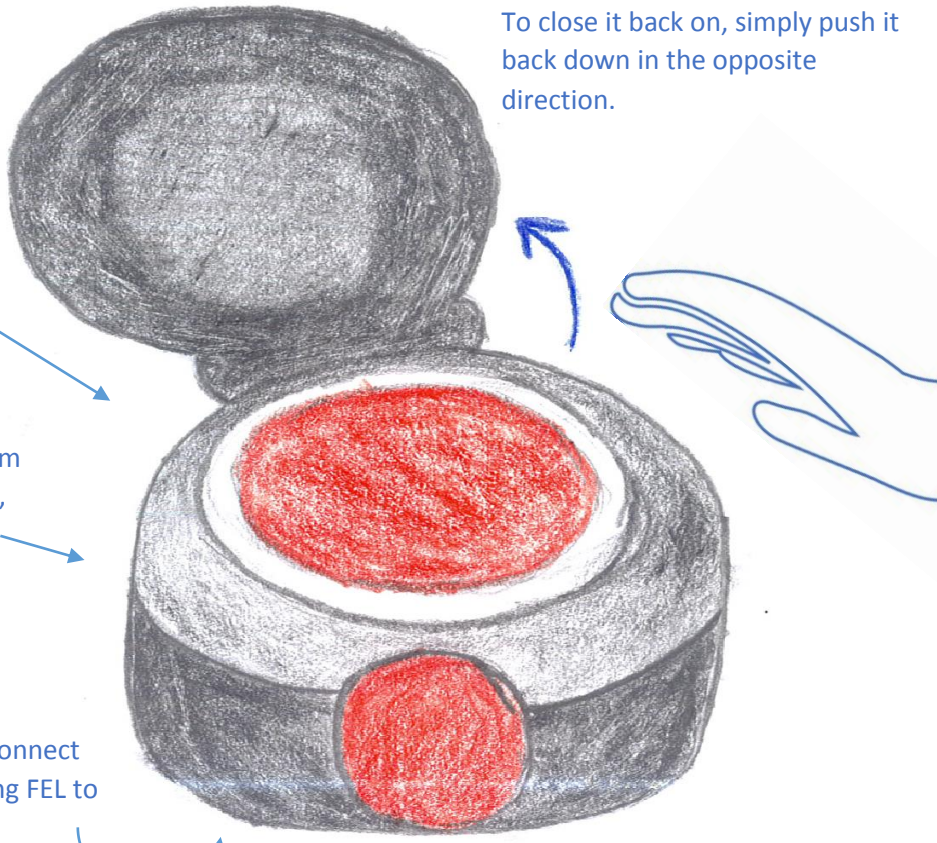
Appendix B – the Fisherman Emergency Locater (FEL)



This will be the default (closed) position of the FEL. As shown, the top half (which opens up) will be clear, to be able to see the emergency button inside.

This is how the top half will open. To close it back on, simply push it back down in the opposite direction.

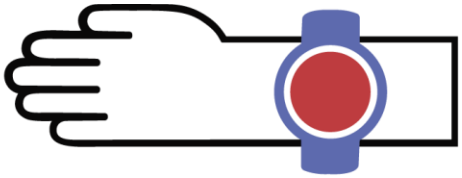
Pressing on this red button (top) will automatically open the top case, which will enable the fisherman to press on the emergency button (below)



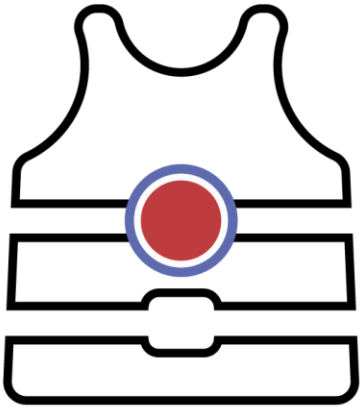
All the electronics will be enclosed in this bottom half. The whole case is completely waterproof, designed to withstand the harsh salty sea conditions.

The bottom surface has clips that connect to the different accessories, allowing FEL to be worn in the different methods mentioned (appendix C)

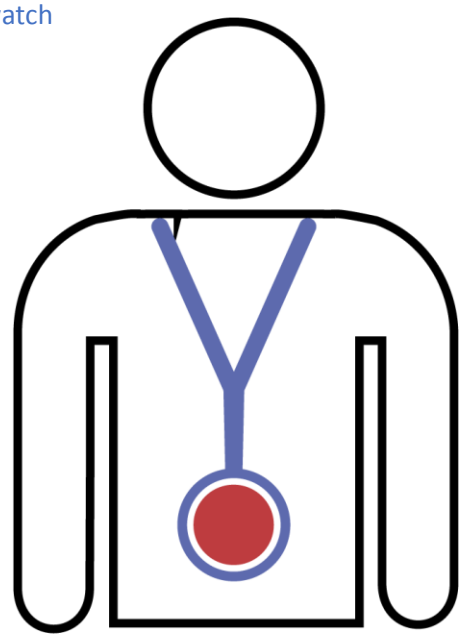
Appendix C – Different Methods of Wearing FEL



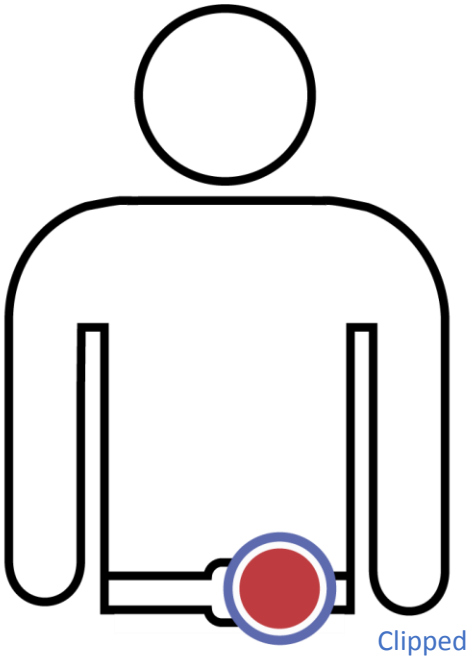
On the wrist like a watch

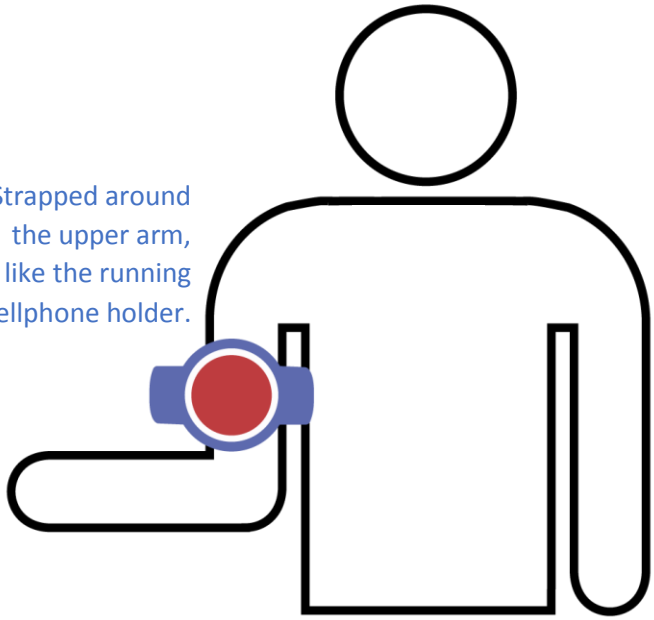


Attached to their lifesaving jackets



Worn around the neck like a necklace





Strapped around the upper arm, like the running cellphone holder.

Clipped on directly to their belts or shirts