Design of the Life-ring Drone Delivery System (LDDS) for Rip Current Rescue

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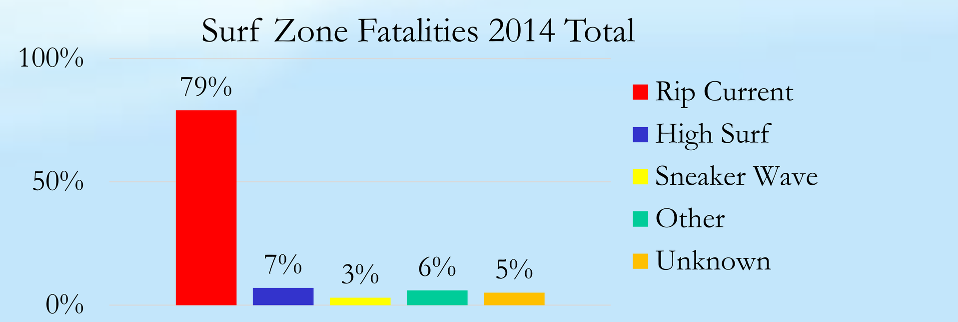
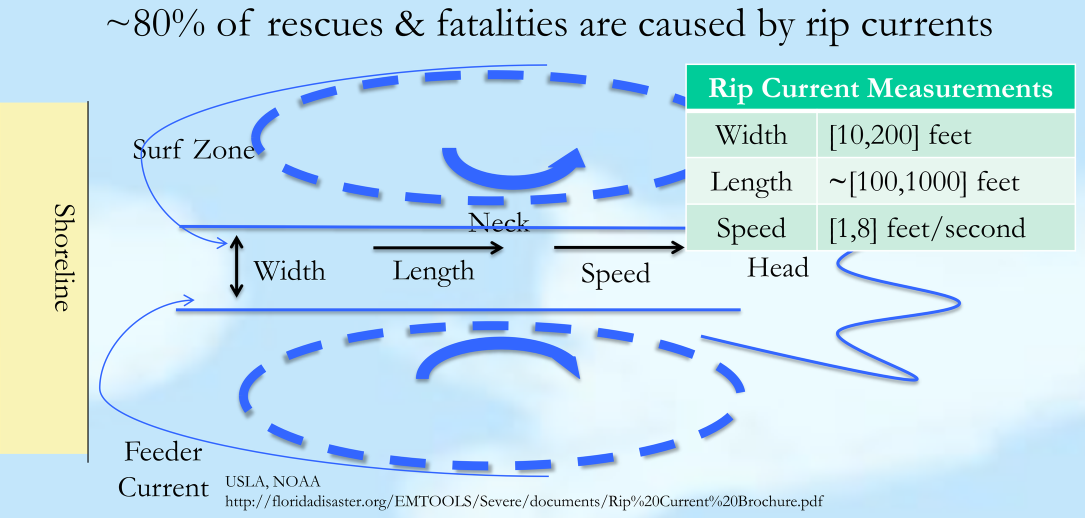
Context

Stick Figures Graphic

~40% of US adults go to the beach each year.



~80% of rescues & fatalities are caused by rip currents



There are ways to escape from rip currents.
Float with current, fight against current, swim parallel to shore

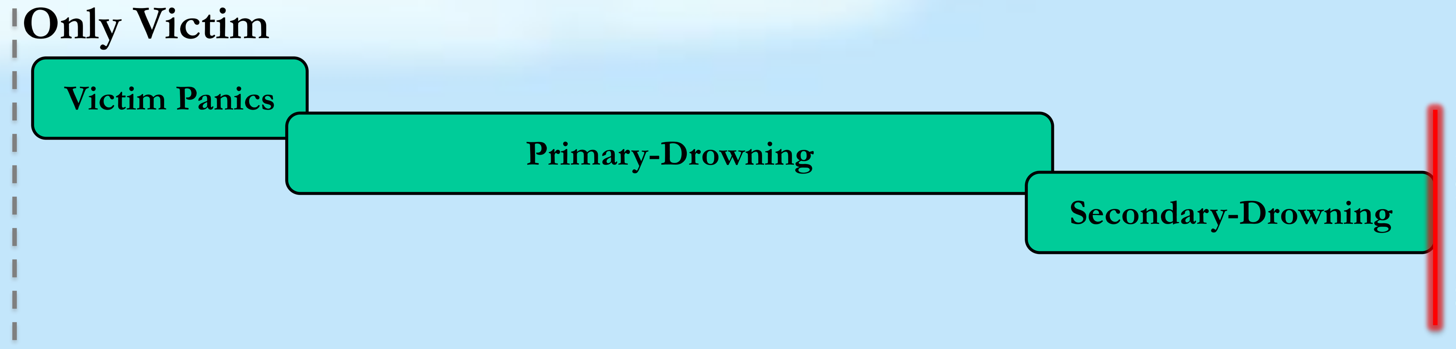
Rip tides are, on average: Annual beach rescues: 81%, Annual beach fatalities: 79%, Average annual fatalities: 51

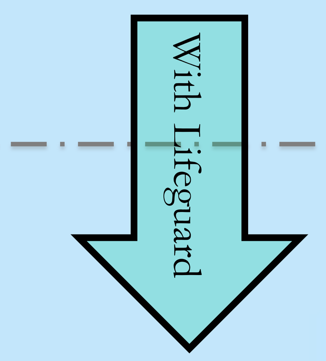
Lifeguards can reach victims in max of 92 seconds, Some victims have survival times as low as 60 seconds.

Rescue Process

victim is caught is a rip current
1. Victim Panics
2. They enter Primary-Drowning
3. Then enter Secondary-Drowning
4. Then die

Only Victim

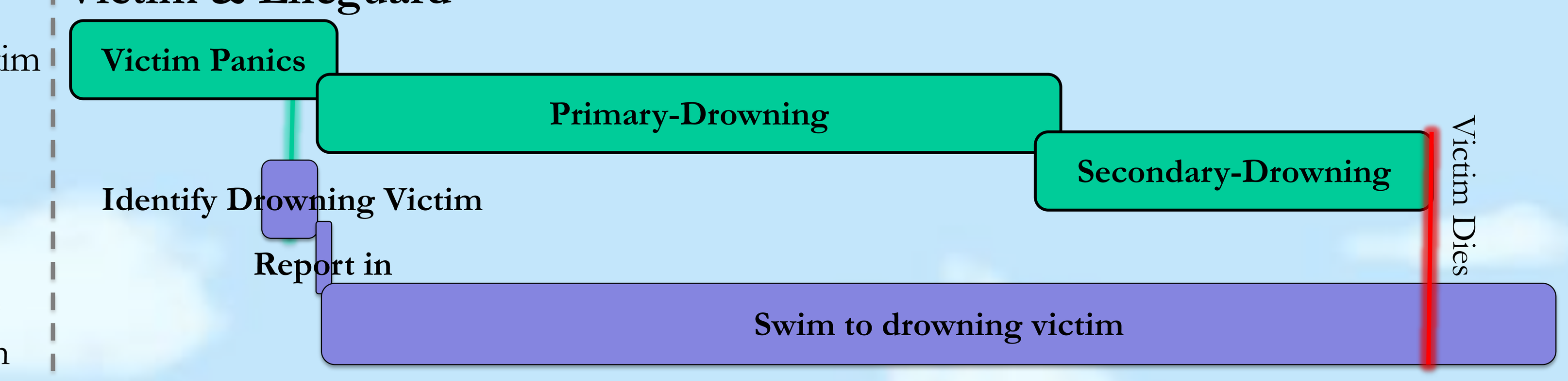


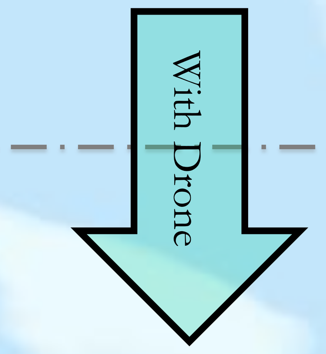


Worst Case scenario!!!

Lifeguard unable to reach victim in time to enact rescue.
1. LG ID's drowning victim
2. Report in noticing victim
3. Swim to victim
   - Worst case, are unable to reach victim before death

Victim & Lifeguard



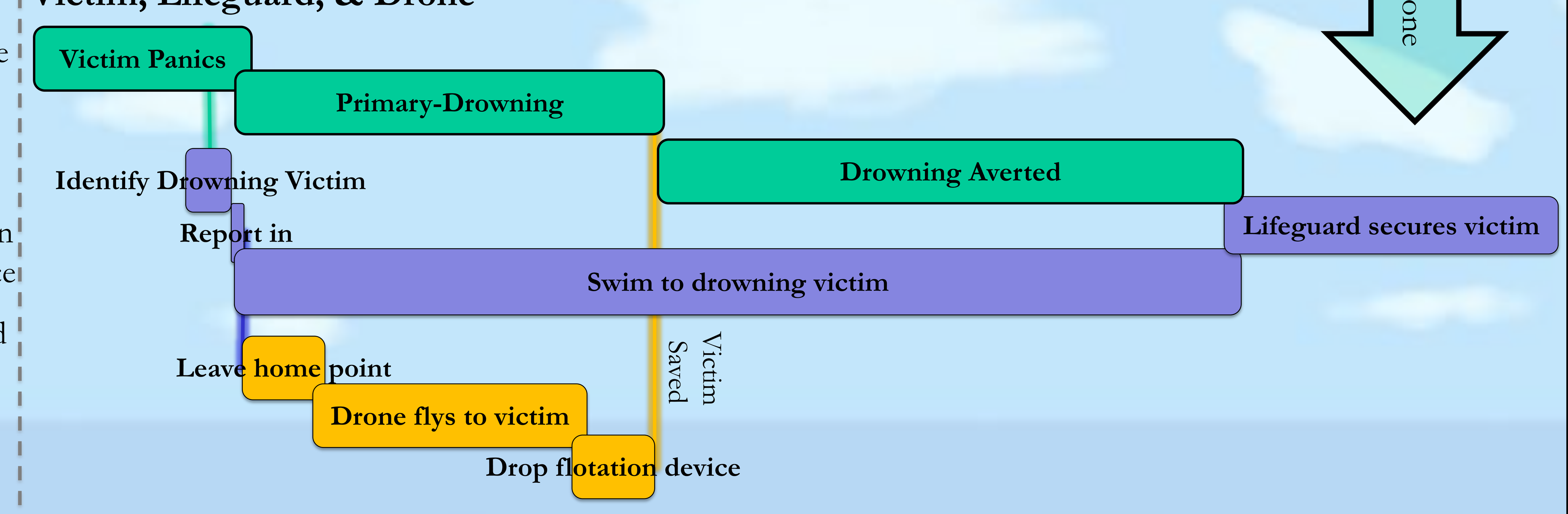


Drone Integration!
(Our drone system will integrate with the report in)

When the report in is received
1. Drone leaves
2. Drone flys to victim location
3. Drone drops flotation device

Victim drowning is then averted and victim can be rescued by lifeguard at their leisure

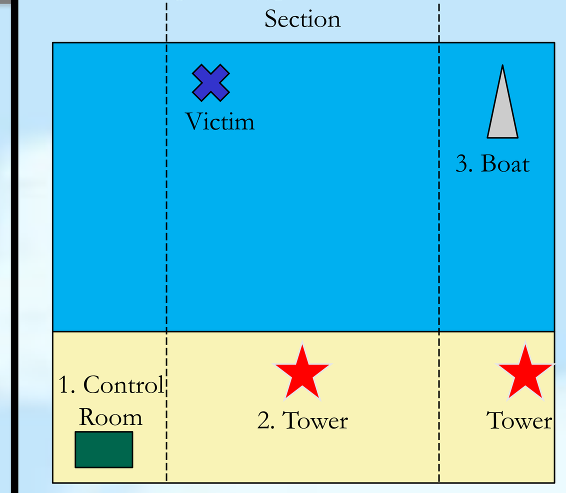
Victim, Lifeguard, & Drone



Alternatives

Set A: Drone Location

Option 1: main control room.
Range of multiple towers.
Easier to charge drone. Safer for the drone.
Option 2: near guard towers.
Range of the nearest towers.
Closer to shore & eyesight of victims.
Option 3: At Sea
Avoid regulatory problems

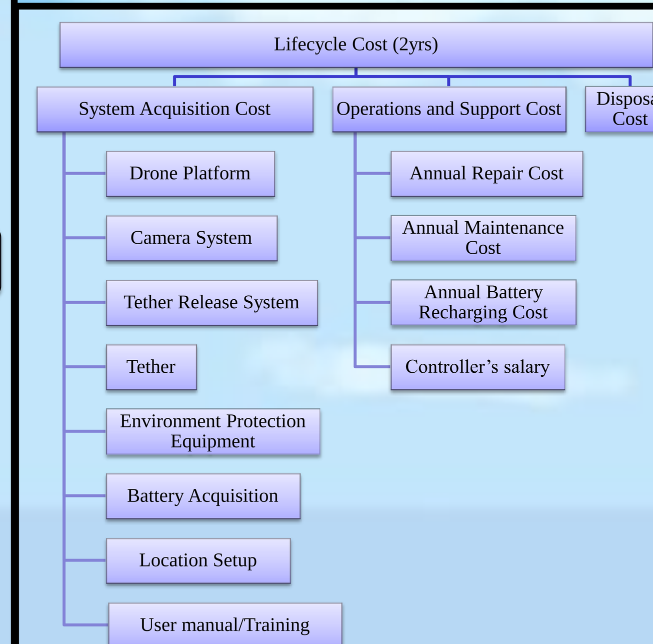


Set Ω: Design of Drone

Motors
Drone Platform
(quad/hexa/octo)
Battery

Flotation device alternatives

Cost & Utility

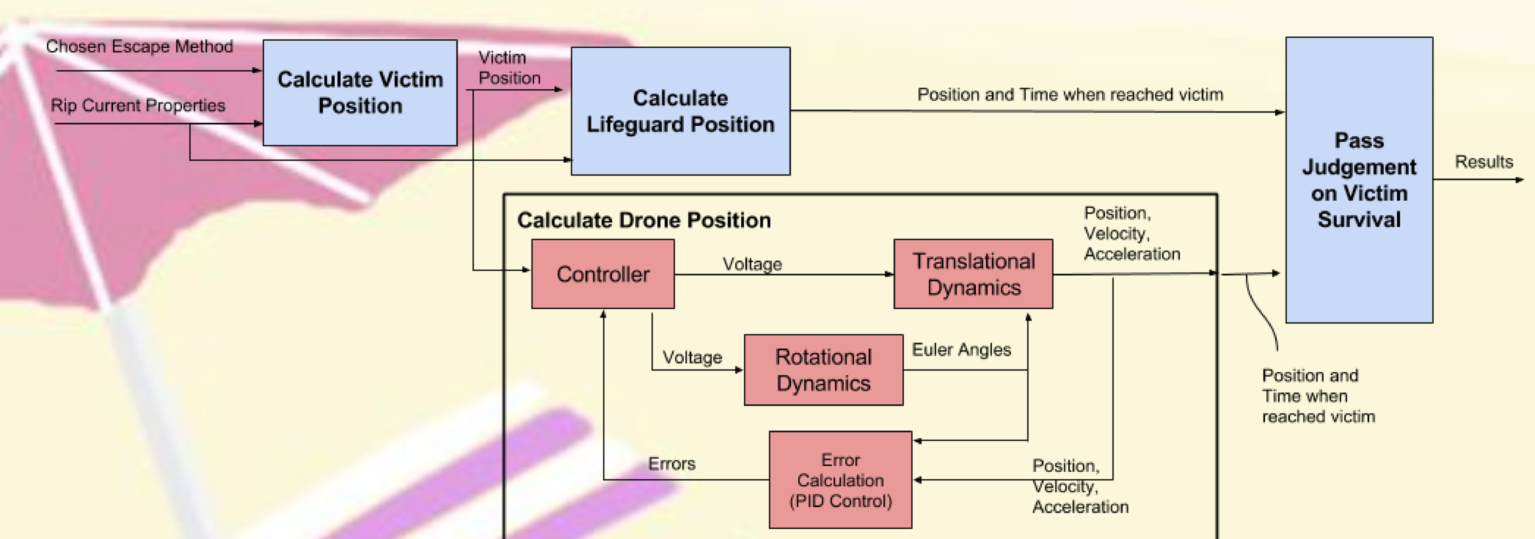


$$u = \omega_S S + \omega_T T_R + \omega_E E$$

S = % lives saved
T_R = mean time to reach victim
E = mean battery energy usage per rescue

Model

Inputs (Random)					Outputs			Baseline		Historic
Rip Current Speed	Rip Current Length	Rip Current Width	Rip Current Y- Position	Victim Escape Method	Base Hex Reach Time	Base Octo Reach Time	Octo 2-ring Reach Time	Lifeguard only reach time	Victim Survival Time	USLA Data on Fatalities/ Rescues
…	…	…	…	…	…	…	…	…	…	
Repeat above for X reps, until % Saved σ ≤ 10 %			Results: ->		% Saved	% Saved	% Saved	% Saved w/0 drone		% Saved



Inputs for Alternatives Analysis (1 at a time) (same reps as before or less reps?)			Outputs (add time to reach as well?)		
Location	Battery Type	Motor Types	Base Hex % Saved	Base Octo % Saved	Octo 2-ring % Saved
3 locations	Use battery equation	Use motor equations			

Results

Graph
Distance from shore vs
Victim position

Graph
Histogram for various paths and locations
Vs
time

Text

Graph
Guarded rescue util
Vs
Cost
And/or
Alternatives avg time to reach
Vs
% saved

Graph
Unguarded rescue util
Vs
Cost
And/or
Alternatives avg time to reach
Vs
% saved

Conclusions & Future Work

Graph
Design alternatives results

Flotation device selection

ne

TEXT

CATSR(logo)

System Engineering & Operations Research, George Mason University

ExpertDrones(logo)