**Research Question: What is efficient and creative method for ship drafting?**

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|  | **Source/Evidence/Data #1** | **Source #2** | **Source #3** | **Source #4** | **Source #5** |
| **Citation** | C. Beauleu, S. Gharbi, T. B. M. J. Ouarda, C. Charron, and M. A. B. Aissia, "Improved Model of Deep-Draft Ship Squat in Shallow Waterways Using Stepwise Regression Trees," *Journal of Waterway, Port, Coastal, and Ocean Engineering,* March/April 2012. | R. Ivce and R. Mohocic, "Determining Weight of Cargo Onboard Ship by Means of Optical Fibre Technology Draft Reading," *Traffic & Transportation* vol. 23, pp. 421-429, 2011. | M. A. Merrifield, J. H. Foster, and G. S. Carter, "Ship-based Measurements of Sea Topography " *Geophysical Research Letters,* vol. 36, 2009. | F. Caus, "Measuring The Draft of a Vessel," England Patent, 1985. | H. Maeda, "On the Hydrodynamic Forces for Shallow Draft Ships in Shallow water," *J.S.N.A,* vol. 136, 1974. |
| **Purpose** | 1. To calculate ship draft
2. To estimate a route that will maximize safety and minimize time at sea, specifically in the St. Lawrence Waterway
3. Avoid traffic congestion
 | 1. To use the measurements of ship draft to calculate weigh carried on a ship.
2. To analyze displacement.
3. To evaluate errors attained by the markings used to measure ship draft.
 | 1. To use a radar sensor and GPS simultaneously to read the sea surface height
2. To provide high resolution in 3D mapping
 | 1. Measuring ship draft with the use of a ventilated damping chamber
2. This method will be then used to measure the weight upon a vessel
 | 1. To investigate ship draft in shallow waters
2. To compare hydrodynamic forces of rectangular plates to and circular disks
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| **Why is the study necessary?** | * Accurate ship drafting calculations are critical in determining the safety of the ship, due to the load and shallow waterways.
* Traffic in waterways has increased in the past decade
 | * Current method of ship drafting is not accurate
* In order to decrease error in calculating cargo weight.
 | * Currently the GPS is not able to determine the draft reading at various sea levels
 | * The current method of ship drafting is inaccurate and effects the calculation of cargo weight
 | * The current method of analysis is not time efficient
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| **Methods** | * Using a squat method
* This method incorporates the keel clearance and the cross sectional area of the ship.
* Data collected from 10 different ship that navigated through the St. Lawrence Waterway will create a database
* An analysis of each of the ships factor will be taken into account to create the database
* The database will analyze the area of the ship, weight of cargo, velocity, and ship clearance.
* Stepwise Regression Trees (SRT) will take into account of each of the variables not the type of ship.
* Will be compared to algorithmic models such as RT and Eryuzlu
 | * Optical fiber technology will be used to measure ship draft
* Analyze whether draft reading effect the cargo weight measurement
* Optical fibers will be used as sensor.
* Ship draft will be measured when the carrier is not moving/still.
* Analyze the error the error in ship drafting with the use of draft markers
* Fiber method will allow for readings to be read from onboard a ship
* The signal received from the optical sensor is converted to electrical energy and then will out then output ship draft measurements
 | * By installing a radar gauge to read the seas surface height.
* The data acquired in a 4 hour time span is used for analysis
* In order to eliminate errors due to tide or sloshing a 5 minute analysis is done to acquire more fluid readings
* The GPS will show a 3D location of the ship
 | * The method of a closed ventilated chamber is connected to the water at sea.
* The apparatus is not effected be sloshing that is the norm at sea
* A manometer is used to read the pressure devolved by the gas ducts.
* The pressure calculated will used to determine the level of water the apparatus is below.
* Allows for accurate reading of ship draft onboard a ship
* No longer a need for the draft markers on ships
* The manometer will also be used to calculate the density at various locations at sea.
 | * Carrying out numerical and experimental procedures
* Comparing deep water and shallow water
* Numerical results are based on a linear theory
* The experimental procedure will include motion, wave and oscillation test at the university of Tokyo in a sea keeping basin
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| **Results** | * SRT is not able to determine squat for specific ship such as tankers and container ships
* Squat increases as Froude is increased
* Compared to other models SRT achieved better results.
* SRT showed a more consistent Squat when compared with predicted and observed values
 | * An error in draft measurements with the use of draft markers has a domino effect of errors, such as errors in displacement.
* Draft reading do influence cargo measurement because an error in the readings will the mean draft, which is used to analyze displacement
* Viewed to be cost effective in long haul because it reduces the error in ship draft with use of errors and accurate outputs cargo measurements.
 | * Errors received due to the signals revived from orbiting satellites
* Running the 5 minute analysis reduced the error from 9.3 cm to 8.3 cm
* The method of installing a radar gauge can show internal tides
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 | N/A | * The experimental and numerical results are close I value
* The results of shallow water shows a 10% less draft
* The time is it takes to complete and analysis is on circular disk than that of a rectangular plate
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| **Discussion/Conclusion** | * SRT improves squat prediction
* It can measure accurate ship draft
* Will allow for easier maneuvering through the St. Lawrence Waterway
* Overall will reduce traffic
 | * A majority of cargo weight measurements is due to ship draft readings.
* With the use of optical fiber sensors the accurate measurements of ship draft will reduce financial cost of replacing ships that are damaged due to errors in ship draft.
 | * The cost to install is continuous but the design is simple
* Can be used on any carrier
* The use of both a radar sensor and GPS can display accurate sea surface readings
 | * The use of the apparatus is not restricted to weather or time.
* Reduces the error in ship drafting
* The method will reduce the errors in observational readings with the use of draft markers
* The manometer is multipurpose, it can calculate pressure and density.
 | * The numerical calculation for a circular plate is proved.
* The experimental results showed prediction made in numerical calculation to be true such as pressure.
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| **How can this help my senior project?** | This is helpful because it is similar to AHP. I takes account of important what the user finds important and uses and algorithm to out put information that can be compared.  | This can help with our project because optical fiber is method that is still currently new and inventive and can help guide us when choosing sensors.  | This is useful because of the use of radar if we are assigned a task to implement radar/ sonar for more accurate readings. | I find this helpful because this gives an idea of a method currently out of date but shows room for improvement if used in our project | Upon further reading I do not find this article helpful |