Modern vision in the use of liquid cargo operation simulators

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Abstract. The cargo operation planning, the process of implementation is one of the most difficult tasks carried out on liquid cargo vessels. The chief officer's task is to process a huge amount of information, accurately enter data into a special computer, consistently calculate the stages of the work, and finally the most important is to complete the task in the shortest period of time. In the implementation, less attention is paid to the economic use of cargo mechanisms, their wear, and fuel costs.

Despite the recommendations and strategies for the effective management of cargo operations, modern artificial intelligence has not yet fully replaced the mankind. We offer a modern and effective way to solve problems, such as maritime universities and maritime training center simulator classes' students will search the most effective ways of cargo operation. The collaboration among vessel, university and terminal would be distance in the internet cloud, which provides: the ships' crew work schedule reduction, a wide choice of cargo operations plans, selection of the optimal option, energy-saving, only target use of mechanisms, which finally lead to less wear and tear, fuel economy and, consequently reduction of CO2 pollution in the atmosphere. It will also reduce cargo operation time, thus reducing port and terminal fees. More over this principle of operation will increase the number of qualified personnel in the future and will be used in the future for remote control liquid cargo operations on unmanned vessels of future.

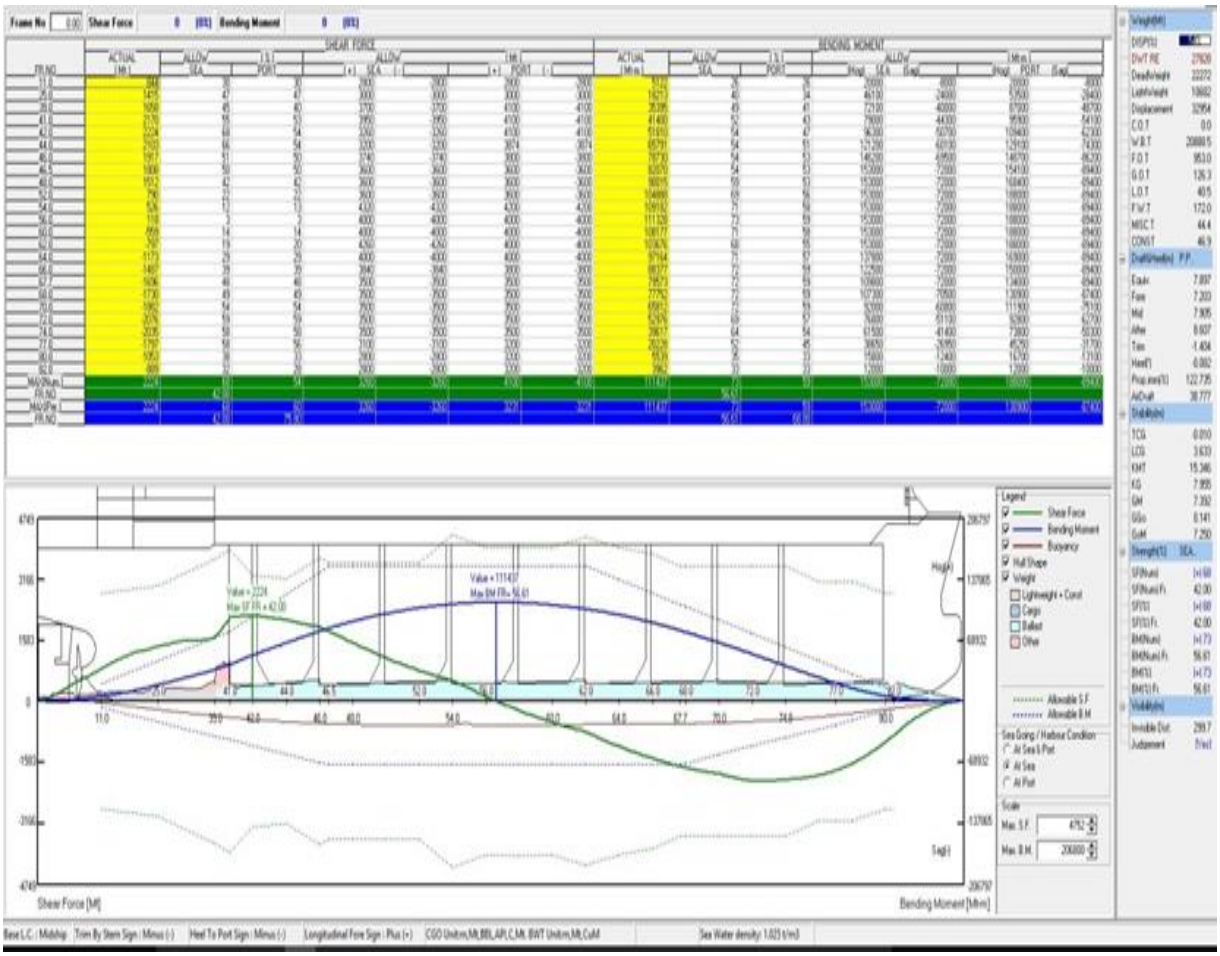
Keywords: Cargo operation, Simulator, E-cloud.

Introduction

Cargo Officer- is the responsible officer for a long list of tasks performed onboard the vessel, such as planning cargo operation, handling and stowage of cargo, the cargo spaces preparation, the ship's cargo gear operation and inspection, to ensure ship's stability during loading, discharging and the sea passage, to ensure the proper handling of cargo, to properly delegate duties to Junior Officers and the operation plan is later sent to the office for improvement.

Upon receipt of the cargo nomination data from the charterers, the cargo officer prepares a cargo stowage plan in which he must take into account various conditions, such as the specification of the loading and unloading ports, Cargo Properties, Environment conditions and requirements for proper cargo carriage. This and many other details should be taken in to consideration and collected before commencement of stowage plan preparation.

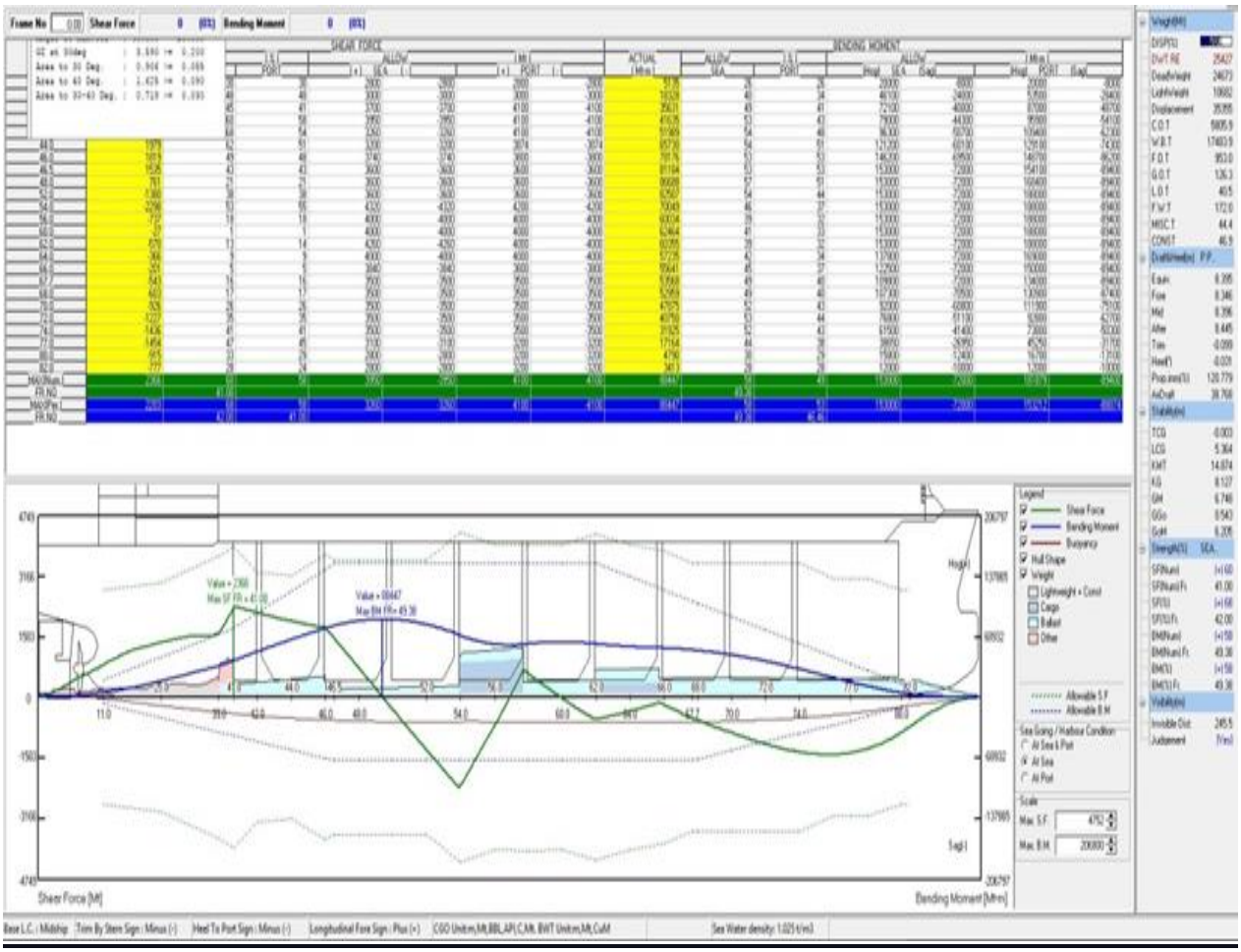
Each tanker has a cargo operations computer program approved by the classification society, in which the officer enters cargo information provided by the charterer. The type of cargo, specific



Sequential load table with a positive load rate

characteristics, quantity, season period, geographical location, port of loading-unloading, ship passage, course details play an important role in the planning of cargo operations, as well as the distribution of cargo in tanks, which makes *almost* all cargo operations unique.

When developing the cargo operation plan, the responsible Officer or Senior Assistant should consider some nuances of the *future cargo* operation which could take several days or weeks to complete. The process of stowage planning is time-consuming and requires processing and numerous calculations. Finally, the plan is completed, the document is sent to the operator's office and the cargo terminal for approval, where along with the approval, the document is corrected as needed. Even after the final version of the plan is approved, it is impossible to change anything in it without going through the full approval procedure.



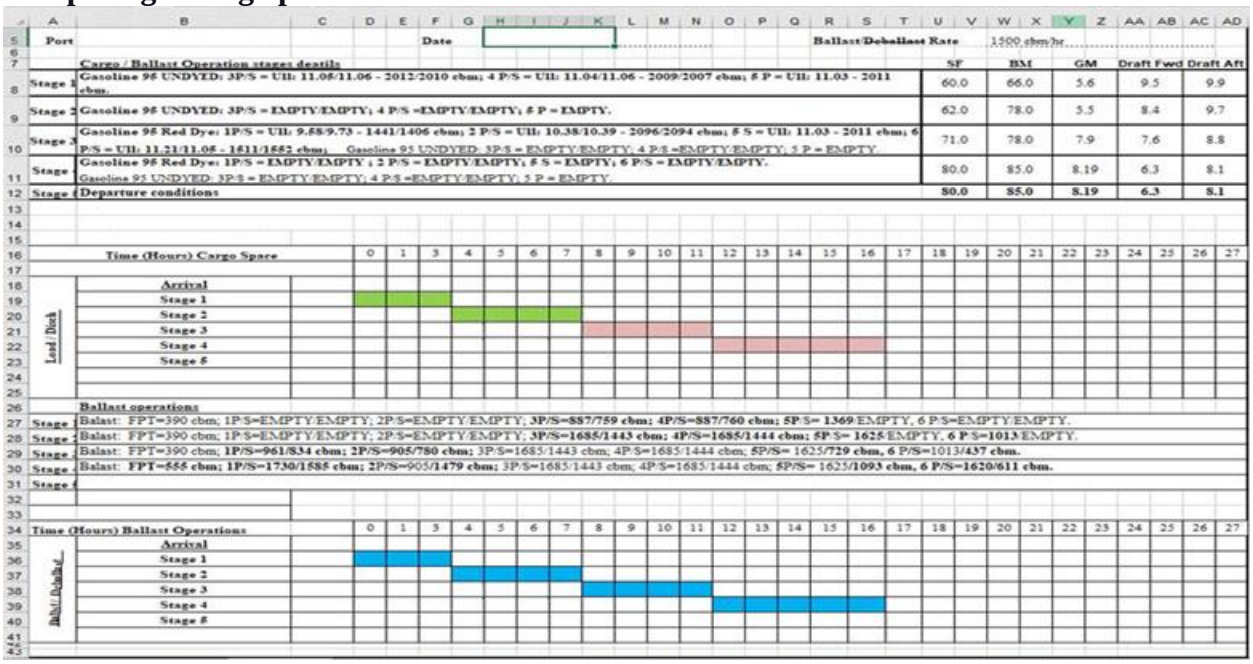
Sequential load table with a negative load rate

Disadvantages of the existing approach

Presented tables above, show that the planning of the ship's cargo operation is one of the most difficult tasks performed by the Cargo Officer. He must process large amounts of information, accurately enter data into a special computer, consistently calculate the steps of the work and the most important is that everything must be done in the shortest time, often under the stress, generally caused by passage, raff weather, time-shifting lags and more other stressful conditions, which make it difficult for the cargo officer to carry out the imposed job.

In the given situation, the chief officer often chooses a more comfortable setting for him to operate the cargo operations machinery, in which less attention is paid to the economy of using the cargo machinery. Due to the working conditions, it is more important for the officer to perform the job in the shortest possible time. Therefore, the mechanisms operate with maximum load from the start of the cargo operation, regardless of the need for their maximum or minimum load at a particular moment. The variability of the load is directly related to the variability of the approved cargo plan, so any change in the work plan must go through the plan approval procedure, which in turn increases the working time, therefore the officer avoids the variability of the load during the work and chooses the short-term non-economic way of loading, where the cargo operation is described in just a few steps, for example as shown in the graph below.

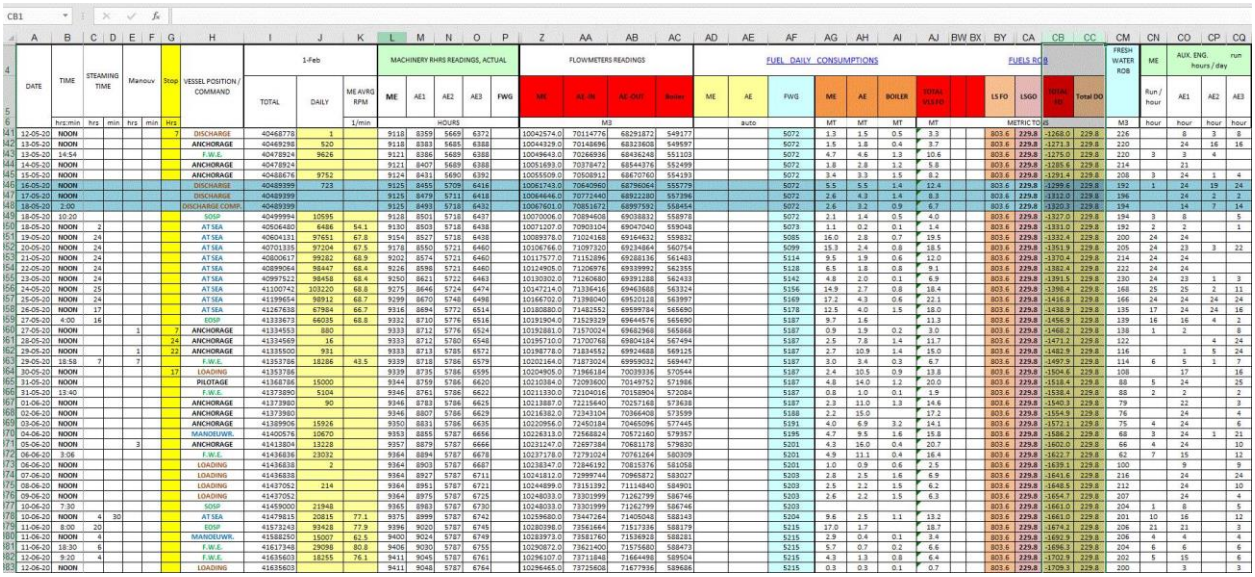
4-step freight/cargo plan model:



The reality on the ship

In 2020, the Chemical Tanker's "MARVIN FAITH" cargo operations comparative studies, the workflow tables' **analyses**, sharply highlighted the shortcomings of the work process on tankers and made us think about ways to improve it.

The data above gives us information about the auxiliary mechanisms, generators, hourly load of the Boilers, Diesel Generators, Diesel driven Hydraulic Power packs and the fuel spent for their work, which are involved in the unloading of cargo.



AD	AE	AF	AG	AH	AI	AJ	BW BX	BY	CA	CB	CC	CM	CN	CO	CP	CQ
		FUEL DAILY CONSUMPTIONS						FUELS ROB				FRESH WATER ROB	ME	AUX. ENG. run hours / day		
ME	AE	FWG	ME	AE	BOILER	TOTAL VLS FO		LS FO	LSGO	TOTAL FO	Total DO		Run / hour	AE1	AE2	AE3
	auto		MT	MT	MT	MT		METRIC TONS				M3	hour	hour	hour	hour
		5072	1.3	1.5	0.5	3.3		803.6	229.8	-1268.0	229.8	226		8	3	8
		5072	1.5	1.8	0.4	3.7		803.6	229.8	-1271.3	229.8	220		24	16	16
		5072	4.7	4.6	1.3	10.6		803.6	229.8	-1275.0	229.8	220	3	3	4	
		5072	1.8	2.8	1.2	5.8		803.6	229.8	-1285.6	229.8	214		21		
		5072	3.4	3.3	1.5	8.2		803.6	229.8	-1291.4	229.8	208	3	24	1	4
		5072	5.5	5.5	1.4	12.4		803.6	229.8	-1299.6	229.8	192	1	24	19	24
		5072	2.6	4.3	1.4	8.3		803.6	229.8	-1312.0	229.8	196		24	2	2
		5072	2.6	3.2	0.9	6.7		803.6	229.8	-1320.3	229.8	194		14	7	14
		5072	2.1	1.4	0.5	4.0		803.6	229.8	-1327.0	229.8	194	3	8		5
		5073	1.1	0.2	0.1	1.4		803.6	229.8	-1331.0	229.8	192	2	2		1
		5085	16.0	2.8	0.7	19.5		803.6	229.8	-1332.4	229.8	200	24	24		
		5099	15.3	2.4	0.8	18.5		803.6	229.8	-1351.9	229.8	205	24	23	3	22
		5114	9.5	1.9	0.6	12.0		803.6	229.8	-1370.4	229.8	214	24	24		
		5128	6.5	1.8	0.8	9.1		803.6	229.8	-1382.4	229.8	222	24	24		

The table shows the hourly load and fuel consumption of the mechanisms involved in the work, although the load experienced by these mechanisms does not necessarily mean that the work

of all of them was fully required from the beginning to the end of the cargo operation. The cargo operation plans studies and data **analyses** showed that the ship spends about 4% of its fuel on unloading operation, which is up to 600 liters of fuel, equivalent to 1056 (kW) kWh of energy. According to the International Certificate of Engine Standard (IAPP), 80,240 mg of NOx-nitrogen oxide was released into the atmosphere, which in addition to the cost also includes excessive air pollution. That is the other side of the coin, which remains practically unnoticed, but if we go deeper into the issue, it is possible to get quite a lot of benefits, both for the ship-owner and for the protection of the ship's crew and the environment.

Difficulty

Despite the abundance of recommendations for the effective management of cargo operations, work strategies, and modern computer software, modernity has not yet developed the artificial intelligence that would use the extensive experience of an officer and the recommendations of the classification society to plan cargo operations efficiently. That is why still all data is entered into the program manually and then a separate situation is processed and analyzed, such as increase-decrease the rate of loads on mechanisms, regulation of cargo flow rate in pipes, pressure and temperature changes in cargo tanks, pipelines, manifolds and others.

Today, on ships, due to lack of time it is impossible for one person to design multiple variants of different cargo operations. The super-modern equipment needs few minutes to compute simulation of cargo operation by the simulator, **but the data entry in software,** takes a long time to calculate the most convenient version for the officer. Time for the chief officer is chronically deficient due to the abundance of tasks assigned to him.

Effective problem-solving

We offer a modern and effective way to solve the problem together, which will help us to divide one big common task (cargo operation plan) into separate small tasks. By sharing these tasks among the executing team members, developing multiple options by the group, analyse cases and find the best way.

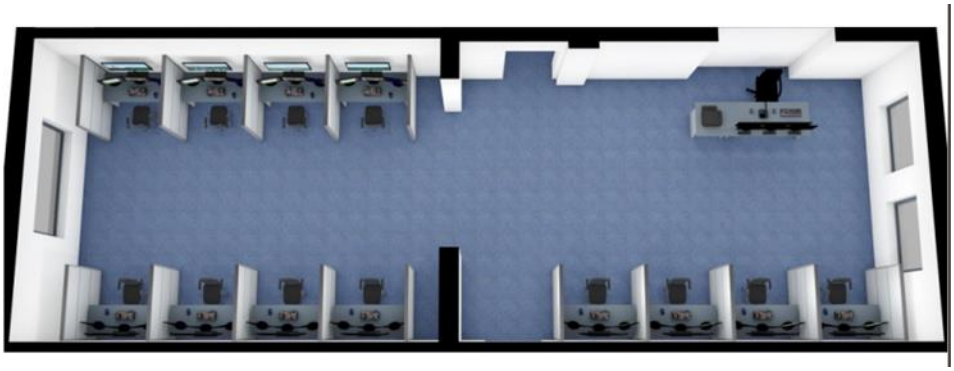
Today all leading maritime universities are equipped with cargo operation training simulators, which are identical to the ship’s cargo operations system. We offer to use the E- cloud for connecting the ship’s cargo operation base with maritime universities/ training centers, where students under the supervision of experienced officers or course teachers will develop/create multiple versions of cargo operations, and software program will choose the most effective one, which significantly reduce the

time to plan cargo operations on a ship, make the process more flexible, transparent and significantly reduces the workload of personnel involved in cargo operations. Target and correct use of mechanisms will reduce air pollution.

Advantages of the new approach

The new approach in cargo operations, simplifying the process of planning a cargo operation, reducing the workload of the Senior Assistant will result in:

1. The busy and fatigue schedule of the senior assistant will be alleviated. The safety will increase and the risk of pollution will decrease.
2. The number of staff working on the cargo simulators at the base of the universities will give us a variety of options for the appropriate number of cargo operations plans, which will be verified and validated under the supervision of a specialist by computer-based criteria. For example, Batumi State Maritime Academy has 12 sits on the simulator, therefore 12 versions of cargo operations will be more efficient than just one that is more tailored to the interests of the senior assistant.



BSMA class model

3. The simulator can be programmed to select the best results. Suppose only the best 4 out of 80 tasks are selected, the results are uploaded to the cloud, the Chief Officer on the ship will see an already prepared plan with all the details such as settings, Cargo gear start sequence and more other details. Processed plans uploaded to the cloud will help the officer to select the optimal modes. At the same time, the Operation Department and Cargo Terminal will be able to see the same information and make adjustments if desired, which are considered online.
4. Choosing a rational option of work will help us to save energy, provide the target use of mechanisms.
5. Economical fuel consumption and consequent reduction of CO2 pollution in the atmosphere.
6. Targeted and correct use of mechanisms will increase their service life and reduce the depreciation costs of these mechanisms.
7. The time of cargo t operations will be significantly reduced, thus reducing the port stay period and terminal fee, which is in the interest of the ship-owner.

Conclusion

The inclusion of maritime universities and training centers in the planning of cargo operations onboard the vessel, will help not only to improve the financial, physical, technical, and environmental issues of the ship-owner but also the implementation of real tasks and the variety of tasks assigned will provide highly qualified seafarers in the future. Moreover, this working principle will be actively used in the future for remotely controlling cargo operation onboard MASS(marine autonomous surface ship).

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