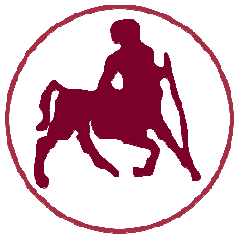
ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ



ΔΙΑΤΜΗΜΑΤΙΚΟ ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ

Πληροφορική και Υπολογιστική Βιοϊατρική

Ροή Πληροφορικής

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Loadicator software

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Abstract - *Loadicator software is very important for the safe navigation of ships. At first, in this paper are presented the type of vessels, their type of cargoes and the functionality of Greek loadicator software, Multiload. There is also an attempt to approach the way, how the chief officers trained in this type of software. A research is carried out on a small sample of officers that leads to useful conclusions about how they deal with these programs. Also from the processing of the answers it is concluded that more importance should be given to their training on the software they use on board.*
Keywords –loadicator; cargo; vessel; Multiload; marine officers training; research;

I. INTRODUCTION

Greece is a maritime nation by tradition, as shipping is arguably the oldest form of occupation of the Greeks and has been a key element of Greek economic activity since ancient times.

Trade was a fundamental aspect of the ancient Greek world and following territorial expansion, an increase in population movements, and innovations in transport, goods could be bought, sold, and exchanged in one part of the Mediterranean which had their origin in a completely different and far distant region. Food, raw materials, and manufactured goods were not only made available to Greeks for the first time but the export of such classics as wine, olives, and pottery helped to spread Greek culture to the wider world [1].

So from the early years seems that the shipping was a crucial thing for the exportations and importations. From that period sailors understood the need for some helpful tools in order to navigate with safety their ships in the sea. Ancients Greeks invented a lot of things among these was the Antikythira Mechanism which was an ancient Greek analogue computer used to predict astronomical positions and eclipses for calendar and as trological purposes.It is a complex clockwork mechanism composed of at least 30 meshing bronze gears.

Nowadays, technology is developing so fast and helped maritime to be more secure and accurate in almost every situation like shipping cargo services.

II. SHIP LOADING AND UNLOADING

A. The types of Vessels divided in groups, according the cargo type

Cargo ships can be divided into six groups, according to the type of cargo they carry. These groups are:

- **General cargo vessels** carry packaged items like chemicals, foods, furniture, machinery, motor- and military vehicles, footwear, garments, etc.

- **Container ships** (sometimes spelled **containerships**) are cargo ships that carry all of their load in truck-size intermodal containers, in a technique called containerization. They are a common means of commercial intermodal freight transport and now carry most seagoing non-bulk cargo.

- **Tankers** (or **tank ship** or **tankship**) is a merchant vessel designed to transport liquids or gases in bulk. Major types of tank ship include the oil tanker, the chemical tanker, and gas carrier. In the United States Navy and Military Sealift Command, any type of tanker used to refuel other ships is called an oiler.

- **Dry bulk carrier, bulk freighter,** or **bulker** is a merchant ship specially designed to transport unpackaged bulk cargo, such as grains, coal, ore, and cement in its cargo holds. Since the first specialized bulk carrier was built in 1852, economic forces have fuelled the development of these ships, causing them to grow in size and sophistication. Today's bulkers are specially designed to maximize capacity, safety, efficiency, and durability.

- **Multi-purpose vessel** (MPV) is a seagoing ship that is built for the carriage of a wide range of cargoes. Examples of these cargoes are: wood, steel, building materials, rolls of paper and bulk cargo. Multi-purpose vessels can be divided into four categories: vessels with and without cargo gear, coastal trade liners and sea-river vessels. Bigger multi-purpose vessels are able to carry different kinds of loading on the same voyage. Smaller multi-purpose vessels do not have this advantage but they are employed to get into smaller harbours because of their limited draught. Because of their varying operating conditions, these ships have complex designs that are difficult to build. Their all-round design must be able to carry heavy loads, large objects and unitised cargo

as bulk cargo. These cargoes can be rolled or lifted on board so this requires different types of loading

- **Reefer ship** is a refrigerated cargo ship; a type of ship typically used to transport perishable commodities which require temperature-controlled transportation, such as fruit, meat, fish, vegetables, dairy products and other foods.

Cargo ships fall into two further categories that reflect the services they offer to industry: liner and tramp services. Those on a fixed published schedule and fixed tariff rates are cargo liners. Tramp ships do not have fixed schedules. Users charter them to haul loads. Generally, the smaller shipping companies and private individuals operate tramp ships. Cargo liners run on fixed schedules published by the shipping companies. Each trip a liner takes is called a voyage. Liners mostly carry general cargo. However, some cargo liners may carry passengers also [2].

B. The types of Cargo that a ship is able to carry out

Marine cargo can be divided into two major categories *Packed/General Cargo* and *Unpacked/Bulk Cargo*. Unpacked or packed is related to the goods itself and of course it affects what ship type that should be used for transportation.

- **Packed/General Cargo**-Further can general cargo be split into their areas of goods: Break bulk, Neo Bulk and Unutilized Cargo.

gear, as well.

Break Bulk – is typically when goods is packed in boxes, bags, barrels, crates, drums & on pallets. Ships used for this cargo is Bulk Carriers or combination ships.

Neo Bulk – is typically lumber, paper, steel, cars & trucks. Ships used here are bulk carriers but also specialized RoRo (vehicle carriers) ships for cars & trucks.

Unitized Cargo – is typically cargo that is packed in containers. In this case it is the container carriers that do the job.

- **Unpacked/Bulk Cargo**– Like the packed cargo the bulk cargo is also split into two areas: Liquid/Wet Bulk and Dry Bulk.

Liquid bulk – is typically petroleum, gasoline, LNG (Liquefied Natural Gas), liquid chemicals, Juice & Wine. Ships used for liquid Bulk are tankers.

Dry Bulk – is typically coal, grain, iron ore, bauxit & cement. Ship type used geared or gearless bulk carrier [3].

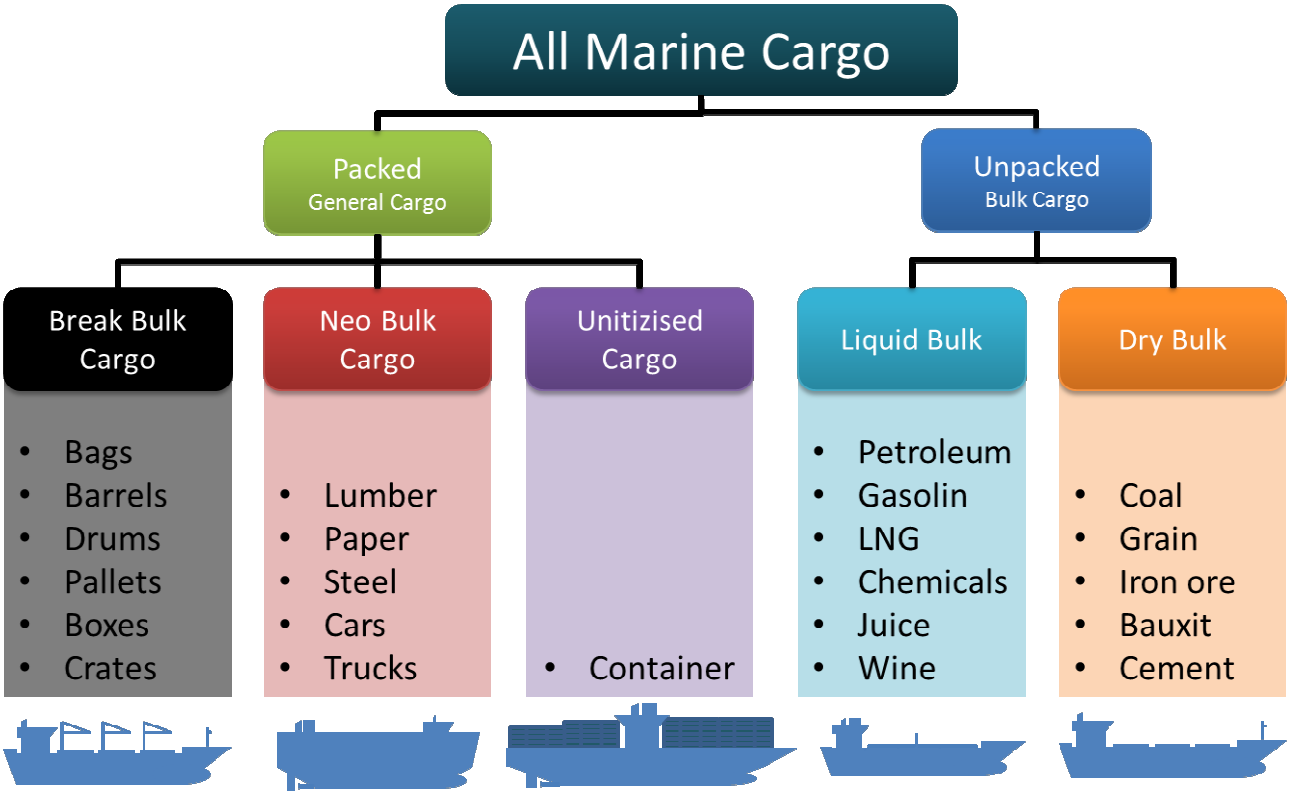

Figure 1

C. *The ship loading/unloading security regulations*

From safety point of view, it is essential to carry out strength and stability calculations of ships during loading operations. To make these calculations by hand without using a Computer is difficult, time consuming and open for mistakes. Since February 1998 International Maritime Organization (IMO) obliged ship owners to accommodate a computer and relevant software application able to carry out strength calculations for bulk carriers having length above 150 m. Afterwards this regulation was expanded on 1st of July 1998 under the scope of the rule coded as IACS UR S1 for all ships having length above 65 m. With the rapid proliferation of personal computers and obligation to make longitudinal strength calculations by computers, ship masters have been willing to use software applications also for stability calculations [4].
The following loading conditions should be taken into account in software calculations:

- Cargo Ships, Container Ships, Roll-on/Roll-off and Refrigerated Carriers, Ore Carriers and Bulk Carriers - Homogeneous loading conditions at maximum draught - Ballast conditions - Special loading conditions, e.g. container or light load conditions at less than the maximum draught, heavy cargo, empty holds or non-homogeneous cargo conditions deck cargo conditions, etc., where applicable - Short voyage or harbour conditions, where applicable - Docking condition afloat - Loading and unloading transitory conditions, where applicable

- Oil Tankers - Homogeneous loading conditions (excluding dry and clean ballast tanks) and ballast or part-loaded conditions for both departure and arrival - Any specified non-uniform distribution of loading - Mid-voyage conditions relating to tank cleaning or other operations where these differ significantly from the ballast conditions - Docking condition afloat - Loading and unloading transitory conditions

- Chemical Tankers - Conditions as specified for oil tankers - Conditions for high density or heated cargo and segregated cargo where these are included in the approved cargo list

- Liquefied Gas Carriers - Homogeneous loading conditions for all approved cargoes for both arrival and departure - Ballast conditions for both arrival and departure - Cargo condition where one or more tanks are empty or partially filled or where more than one type of cargo having significantly different densities is carried, for both arrival and departure - Harbour condition for which an increased vapour pressure has been approved - Docking condition afloat

- Combination Carriers - Conditions as specified in first and second bullet [5].

III. SHIP LOADING AND UNLOADING SOFTWARE

A. *The necessity of information systems in vessels*

Information technology or informatics is the keyword that relates three disciplines, electronics, computer science and telecommunications. What we call information is something which is difficult to define and consequently hard to control. Information as such is now recognized as a wealth – producing resource, like energy. The reason is that information is not only helping to complete a human mental synthesis as in the past, but can be easily inserted for example in a programmable machine tool to produce a specific object or even substitute the human mind in decision making processes [6].

Today's modern ships have many inbuilt systems supported by IT (information technology) resources that feature the latest advances in ship technology, such as propulsion system, navigation system and other systems on the command bridge, ship's cargo control and manipulation system, system of monitoring and management office and flooding protection system, electric power system, ship administration system, etc. The IT resources implemented in ship systems are increasingly taking on central functions in the creation, monitoring, control and implementing of maritime processes. Process modules, called control modules or controllers, are installed in ship systems. Their role is to monitor and control pre-defined operational parameters of the system they are installed in.

Also allow shipping companies and marine equipment manufacturers to offer more competitive prices together with ensured level of reliability and availability of ship systems [7].

B. *The necessity of Loadicator software*

Many ships are now equipped with loadicator systems or a loading computer with appropriate software. It is usually a conveniently sited visual display for the Master and the Loading Officers and is gainfully employed on Ro-Ro vessels, Container ships, tankers and bulk carriers. The system should ideally be interlinked with the shore side base to enable data transmissions on unit weights/tonnages or special stow arrangements. It would also have the capability to provide a printed record of the state of loading and show a visual warning in the event of an undesirable stability condition or overload occurring.

A loading instrument or loading computer can be either an analogue or digital system. Modern loading instruments consist of approved computational software operating on a shipboard digital PC.

The ship's loading instrument is ship specific on board equipment and the results of the calculations are only applicable to the ship for which it has been approved.
The operation manual is an essential part of the loading instrument and should be kept on board at all times. The ship's deck officers should familiarise themselves with the operation of the on board loading instrument [8].

Distribution of the ship's tank weights, stores and consumables affecting final calculations and total displacement would also be identifiable within the completed calculations. The primary aim of the loading computer is to ensure that the vessel always departs the berth with adequate stability for the voyage. If this situation can be achieved quickly, costly delays can be eliminated and safety aspects are complied with.

The data required to complete the stability calculations would need to be supplied by the shore side base with regard to cargo weights. This in turn would be certificated by the driver, for Ro-Ro unit loads, obtaining a load weight certificate authorized from an approved 'weigh bridge' prior to boarding the vessel. Draught information would inevitably come from a 'draught gauge system' for the larger vessel and be digitally processed during the period of loading.

Ship's personnel could expect to become familiar with manipulation of the changing variables very quickly alongside the fixed weight distribution throughout the ship. This would permit, in general, few major changes to the program, especially so on short sea ferry trade routes where limited amounts of bunkers, water and stores are consumed and values stay reasonably static.

Fixed weights are applicable to a variety of units or vehicles and, as such, where units are pre-booked for the sea passage, an early estimate of the ship's cargo load and subsequent stability can often be achieved even prior to the vessel's arrival [9].

The officer in charge should closely monitor the ship's condition during cargo operations to ensure that if a significant deviation from the agreed loading/unloading plan is detected all cargo and ballast operations must STOP.

The officer in charge should ensure that:

- the cargo operation and intended ballast procedure are synchronised.
- draught surveys are conducted at appropriate steps of the loading plan to verify the ship's loading condition. The draught readings, usually taken at amidships and the fore and aft perpendiculars should be in good agreement with values calculated in the loading plan.
- ballast tanks are sounded to verify their contents and rate of ballasting/deballasting.
- the cargo load is in agreement with the figures provided by the terminal.
- the SWSF(still water shear forces), SWBM(still water bending moments) and, where appropriate, hold cargo weight versus draught calculations are performed at intermediate stages of the cargo operation. These results should be logged, for recording purposes, against the appropriate position in the loading plan.

Following a deviation from the loading plan, the officer in charge should take all necessary corrective actions to:

- Restore the ship to the original loading/unloading plan, if possible, or
- Replant the rest of the loading/unloading operation, ensuring that the stress and operational limits of the ship are not exceeded at any intermediate stages.

The modified loading/unloading plan should be agreed by both the officer responsible for the loading plan and the cargo terminal representative. Cargo operations should not resume until the officer in charge gives a clear indication to the terminal of his readiness to proceed with the cargo operation [10].

C. Description of a Greek ship loading Instrument: ***Multiload***

MULTILOAD© for Windows is SMM Ltd is innovative software system to carry out the complex and tiresome ship loading calculations. It is one package of the international shipping market. The software is provided for both onboard and office use and can be installed easily on every operational PC that meets the mentioned system requirements and it is accompanied by analytical guide for installation, training, guidance, as well as prompt support from SMM (UK) Ltd.

Benefits of Multiload

- Specially Designed for Use, by the Master, Chief Officer.
- Reliability, having Major Market Share in Greek Shipping Industry.
- Computer Based Training Availability.
- For easy reference to the User, all information and indications appear in a single window
- There is guidance in a wizard environment about the next steps that should be followed for every option.
- Both Fleet & Ship Versions for Office and Onboard use.

Features of Multiload for vessel and office application

Available as Base Program, a self sustained loading package fully covering

- Class Requirements.
- The Base Program offers 43 functions.
- There are up to 20 MULTILOAD© Options to choose from, if cargoes need extra features or more specialization.

- Full support and free training for masters and chief officers, before they join the vessel.
- Approved by ABS, LRS, NKK, BV, DNV, HRS, etc..

Main Options:

- Draft Survey
- Cargo Loading Sequence with Report
- Air Draft from Hatches
- UR S1A - Local Strength Diagrams
- UR S17 – Single Hold Flooding
- Departure - Arrival Calculation
- Print out of NCB Grain Loading Form
- Print out of Canadian Grain Loading Form
- Print out of Australian Grain Loading Form
- Ship Loading Plan on screen (ship graphics)

Basic Features:

- Fleet Based Program for Office Use
- Import/Export of Loading Conditions by e-mail
- Electronic Dead Weight Scale
- Automatic Shear Force Correction
- Automatic Cargo Distribution
- Auto trim
- Detailed Printed Reports of Loading Conditions, Main Ship Particulars, Max. Allowable Shear Force, Bending and Torsional Moments.
- All Printouts also in PDF format for easy e-mail transmission
- Cargo Split and Auto trim
- Full Stability, Trim, Drafts, Longitudinal and Torsional Strength Analysis
- On-Line Help Utility in Every Screen
- Different colors for different cargo types
- Max. Allowable Shear Force & Bending Moment Values (Seagoing, Port, Alternate Loadings etc.)
- Shear Force & Bending Moment Diagrams on Screen
- Automatic Selection of Stability Criteria
- Plimsoll Marks and Port Draft Restrictions / Fwd. Draft Restriction for heavy weather
- Easy Cargo Definition / Stowage Factors (Metric-British Units)
- Loading by Weight, Percentage (%), Ullage or Level
- Warning for Sloshing Effect in Tanks or Holds
- Bridge Visibility (if applicable)
- Optimum Capacity Utilization of Cargo Holds
- Viewing Details of Dead Weight items [Bounds, Volume (Trimmed, Untrimmed, Bale), V.C.G., L.C.G., Max. Tank Top Strength, Max.
- Air Draught Calculation from Radar Mast / Propeller Immersion
- Vessel List Calculation

Checks:

- Plimsol & Port Draft Restrictions
- Propeller Immersion
- Bridge Visibility
- Local Strength Diagrams
- Air Draft from Hatches or Manifolds
- Air Draft from Radar Mast
- Automatic check on Sloshing danger
- Minimum Forward Draft for Slamming
- SOLAS Chapter XII Reg. 14

Provides instantly technical information, such as:

- Capacities (grain, bale)
- Trimmed & Untrimmed Volumes
- Max. Homogeneous Load
- Grain Heeling Moments
- Tank Top Areas
- Tank Top/Deck Strength

Cargo Tank Ullage(headspace)/Level Data

Covers all Ship Operation Manuals:

- Trim and Stability
- Grain Loading
- Loading Manual
- Loading & Unloading Sequence
- Water Ballast Exchange Manuals

Software options with screen

- When we start the program, we proceed with ship selection.

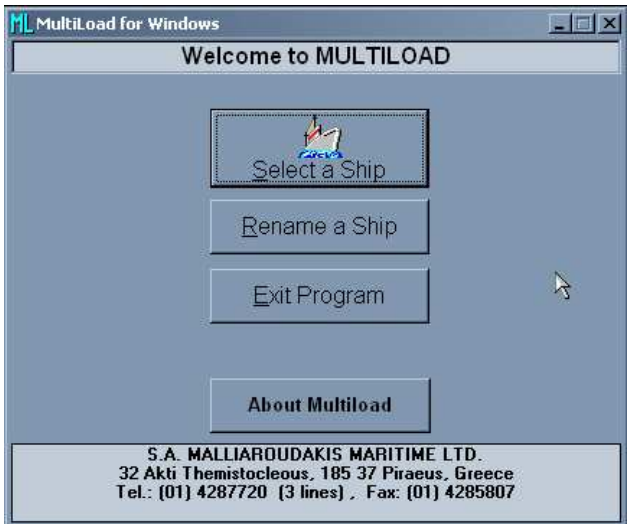

Figure2

- In this screen we select the type/types of Cargoes to be loaded during a specific loading condition. We may choose more than one cargo type if necessary or we can recall a previously saved condition.

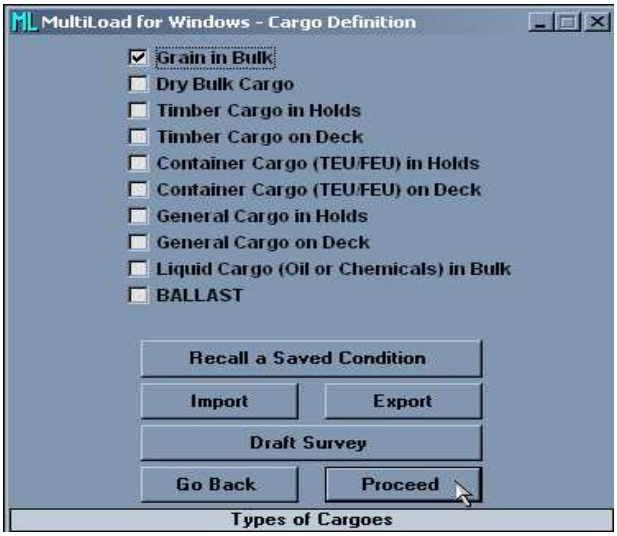

Figure 3

- In this screen for each cargo type we specify, the storage factor units and the storage factor value

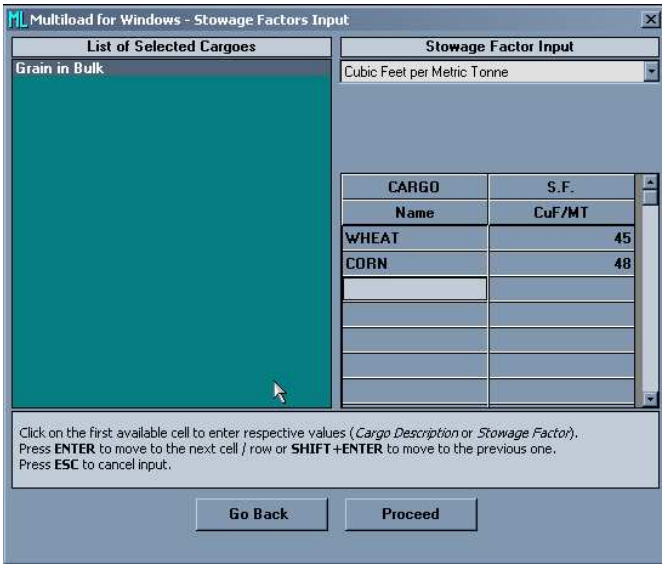

Figure 4

- Once we have set these options, the weight input & results form for our vessels, screen appears.

Figure 5

- The First Step for any loading pre-calculation is to set the correct Sea water density. Ocean Sea water density is 1,025 MT/m3 which is Multiload's default. Tropical fresh or Panama is 0,966 MT/m3.

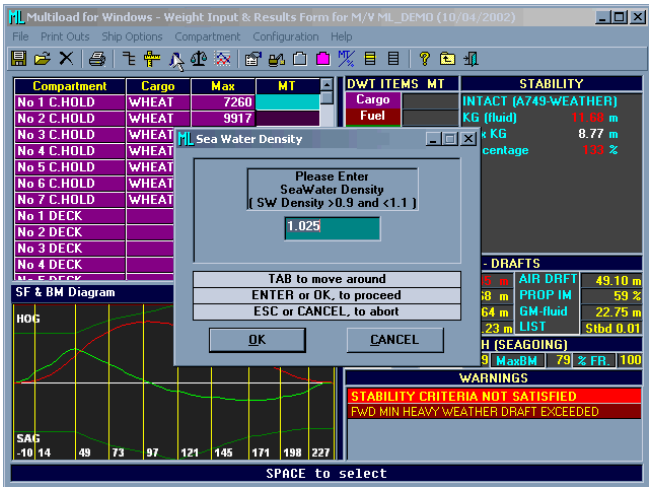

Figure 6

- In this screen we select the loading condition. The usual case for ships is to have one seagoing and one port strength condition.

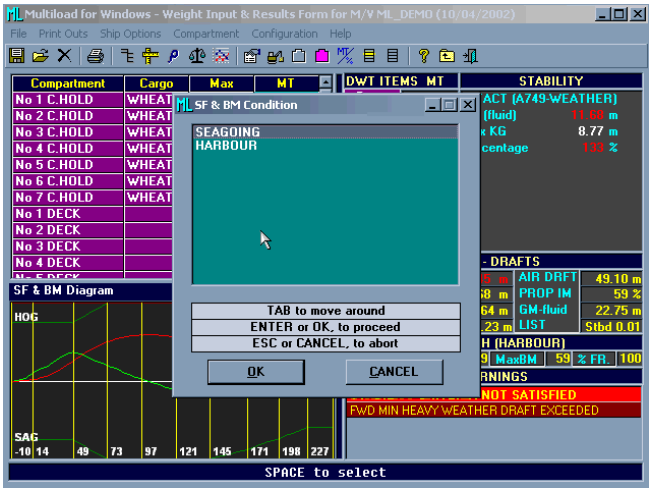

Figure 7

- After sea water density, strength condition we must also specify the Plismol Load Line Mark and/or any Port Draft Restriction.

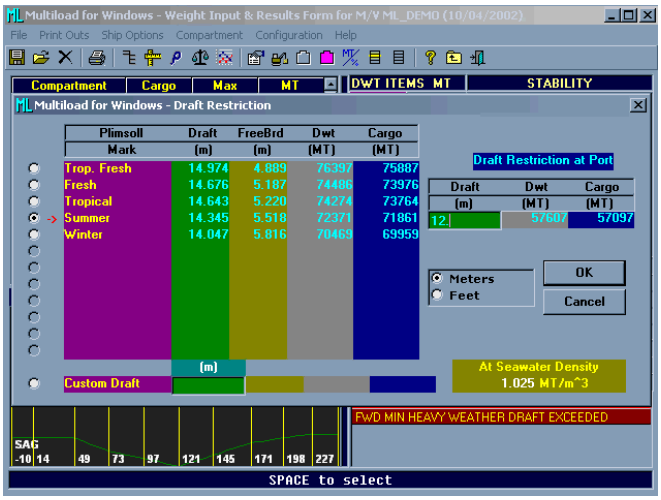

Figure 8

- In this screen the Shear Force and Bending Moment Diagrams, appears. These diagrams are automatically updated for every weight change and shows:
    - Strength condition (Port or seagoing)
    - Maximum allowable SF & BM Envelopes
    - Ship frames & actual values for each curve
    - Main ship bulkheads

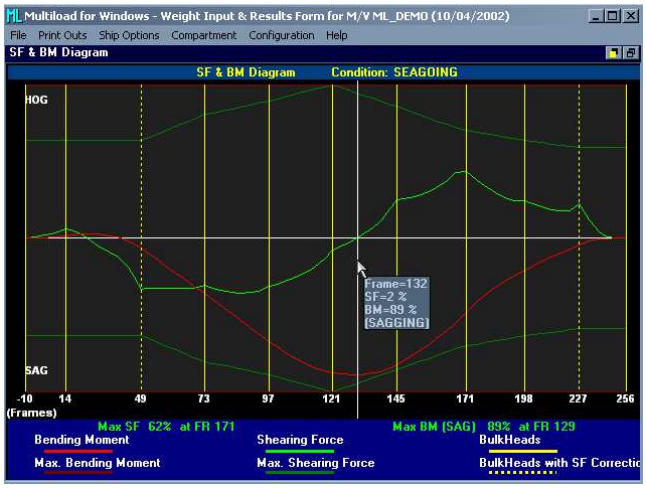

Figure 9

- In this screen we get a graphical representation of a ship with all Deadweight. Items shown on profile and plan views. In the plan view of the vessel, partially loaded components are partially painted in left-to-right direction. A blue line denotes the ship current water line.

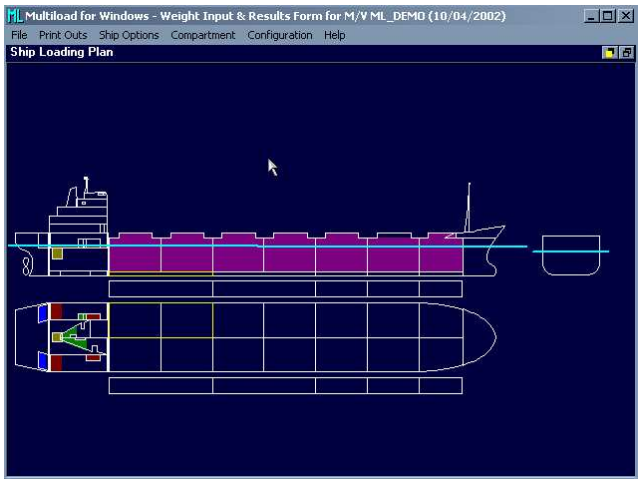

Figure 10

- The checks & messages & warnings window in the weight input-results screen serves the most important role during ship loading pre-calculation in helping us to end up with:
    - no warnings signals
    - minimum shear force and bending moments values
    - adequate stability (60% - 90%) without on the other hand, very high values of GM resulting in a very nervous rolling that in heavy seas increases torsional stresses on hull

Figure 11

IV. TRAINING IN SHIP LOADING/UNLOADING SOFTWARE

A. Education in Vivo

Greece, as a traditional maritime country, has established an education system that guarantees the high level of professional training of Greek seafarers so that they can fully meet the ever-increasing demands imposed by international maritime activity, technological development and of course, by the institutional framework governing itat a national, EU and international level. In order to meet the requirements of the Greek fleet in both quality and quantity, it has created a Maritime Education System that meets its needs and the requirements of international law.

The training of Merchant Marine Officers takes place at the Merchant Navy Academies (AEN), operating in various cities in Greece. The studies at AEN. Include 6 semesters of theoretical training and 2 semesters of maritime training and offer state-of-the-art and specialized knowledge of a high quality level with the Sandwich Courses system whereby the training alternates between school and ship.

The studies at AEN. include attendance of theoretical lessons, practical training in corresponding workshops and simulator training [11].

Commercial marine school

The Greek Marine Education, Training & Certification System consists of:

- Ten (10) Merchant Nautical Academies for Master Officers and Engineers,
- Three (3) Merchant Navy Training Centres for Masters Officers, Engineers and Radio Spellers,
- Two (2) School of Fire and Fire Protection.
- The Public School of Merchant Marine Training.

Courses related to the loading and unloading of ship cargo at the Merchant Marine Academy are in the fifth and sixth semesters, "Cargo transport" in which, in addition to the theoretical knowledge acquired by students in handling all cargo types, stowage and insurance, the effect of the load on the stability of the ship and ensuring successful communication during loading and unloading, shipboard demonstration and computer modelling and stability loading programs are also performed.

B. Distance education

SLIM-VRT− offers a potential solution to the maritime industry's training needs through the use of interactive multimedia and virtual reality technology. Ultimately it aims to provide integrated maritime self-learning on board and ashore.Distance learning through the SLIM-VRT training platform places emphasis on ship security and environmental protection across the range of ship operations (loading, unloading, balancing, fuelling, navigation in bad weather, navigation on ice, etc.). They introduce participants to the basic principles of shipbuilding, the different types of ships, the various types of cargo and the procedures of safe loading, stowage and stability.

Training CDs − Almost every loadicator software has a training cd with it. It has full support and free training for masters and chief officers, before they
join the vessel. Most of the times the analytical Manual for familiarization and training purposes is incorporated electronically in the software. Apart from the manual it has Computer Based Training Availability, with simulation scenarios. That training software is very useful for the officers because every ship loading instrument has many differences from the others.

V. DESIGN AND CONDUCT OF RESEARCH

The present essay deals with the presentation of loadicators software that is necessary for every vessel. By now, besides the description of one of the ship loading / unloading software, the necessity of this kind of programs was studied, as well as the training of the officers in this software.

At this point, a small survey of the above issues will be carried out through questionnaires which will be shared electronically with Navy officers. They will be consulted on the following two questions:

1. How satisfied are the *Merchant Marine* officers with the use of these kinds of software?
2. Did they have the appropriate training on these kinds of software?

The questionnaire is listed at the end of the essay. The results of the survey will be presented below and then analyzed in order to compare them with the theory.

1st question: Sex

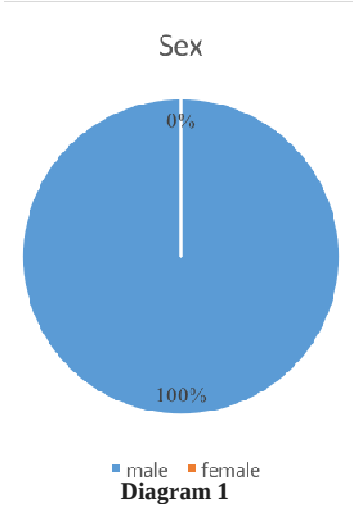

Diagram 1

2nd question: Age

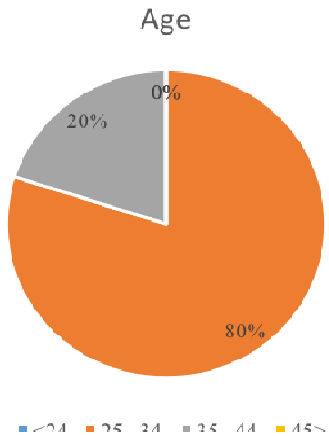

Diagram 2

3rd question: Rank

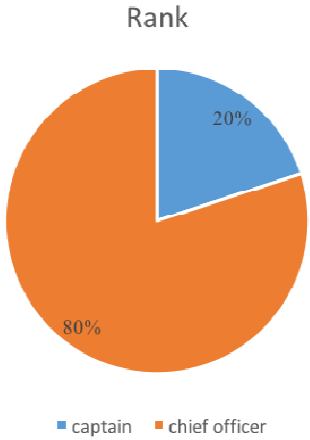

Diagram 3

4th question: Type of Vessel you have worked

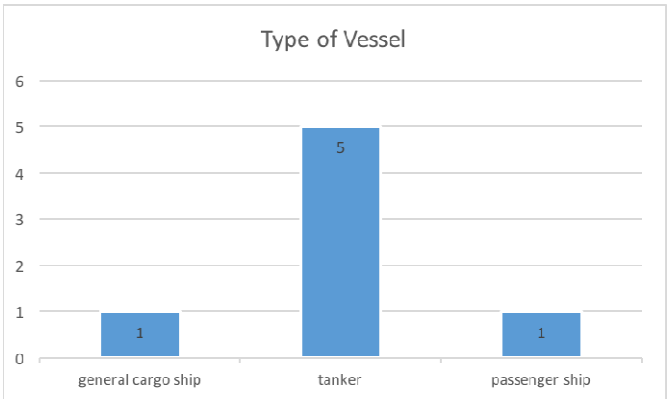

Diagram 4

5th question: Loadicator software you have used

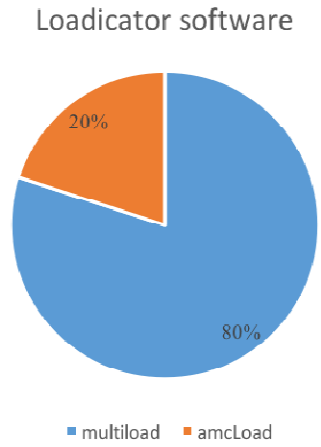

Diagram 5

6th question: How useful do you think is the Loadicator software?

All participants answered that they find the loadicator software very useful for their work.

7th question: Did you find any problem with the loadicator software you use?

One of the participant answered that he found deviation plunge 0,5%. The others answered that they did not find any problems.

8th question: Is there any option that you want to have the Loadicator program you use?

The answers the participants gave was more accurate calculation in deviation plunge, more useful manual and more options for the weather.

9th question: How many options of the loadicator software do they use? Likert scale (1=none,5=all)

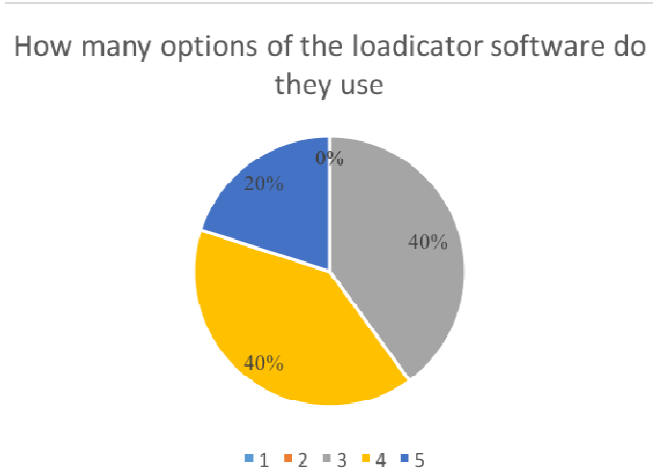

Diagram 6

10th question: How have you trained on Loadicator software?

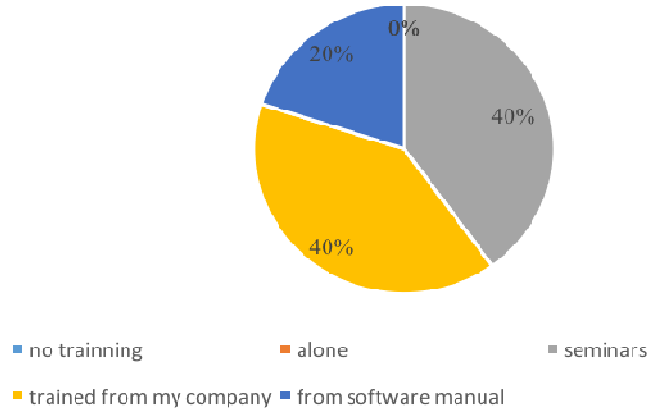

Diagram 7

11th question: How well do you believe that you know the loadicator software? Likert scale (1=not well, 5=excellent)

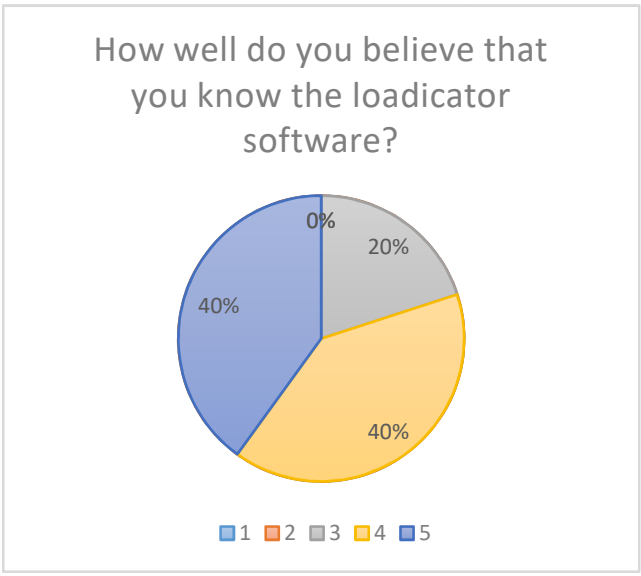

Diagram 8

VI. CONCLUSIONS

The above survey was conducted on a sample of 5 merchant navy officers. All of them were men from 25 to 45 years old and 4 of them were chief officers and one captain. All respondents appear to have worked on general cargo vessels while one of them uses to work on a tanker and another on a passenger ship. Most of them (80%) have used Multiload loadicator software that was expected, for two reasons:

1. Because all of them work in Greek interests' ships that are expected to show their preference in Greek software, such as Multiload.
2. Because Multiload is software that mainly supports general cargo vessels.

All respondents replied that this kind of software is very useful in their work. As mentioned above, such programs are necessary and mandatory by law to be installed in vessels.

Questions which refer to whether they have found a problem with the software or if there is something they want to add to the software options, most of them answer that they want the software to be more accurate with loading calculations and to have a more up-to-date user manual.

The need for a more informative user manual or online help is also apparent from the following replies, in which they replied that they do not know all the software choices well, nor do they feel they have been trained adequately. Although they seem to have been trained in the marine school, none of them gave that answer to the question of "how they have been trained in using the software". Instead, most respondents said they were trained by themselves or by the software manual.

As it emerges the ship loading/unloading software is vital for the ship but, while it is installed on any merchant ship, its users are not sufficiently trained. This raises the issue of obligatory training of certified officers in this and, more generally, for all the software used on board ships.

In conclusion, all the problems that may arise in using and training software on a ship can be solved by creating a job for an IT engineer on each ship. A solution quite radical but also very useful.

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