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EDA: New System for Improving Navigation Standards (Totem Plus)

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ABSTRACT: EDA is a tool for auditing vessel's performance that helps installing strict safety navigation standards on ships. The practice of investigating every near-miss event is common in aviation, but unheard of in the maritime industry. At the same time, major accidents attributed to human errors are increasing, including collisions and groundings that cost lives, pollute the seas and lose property.
The idea of EDA, short for E-navigation Data Audit, is simple: analyze the navigational data from VDR and/or ECDIS, find the events that should not have happened ("near misses"), and instruct your ships that it is not the standard you want on your vessels. EDA allows remote auditing on how the bridge team is performing and how the ship is handled, as required by ISM but seldom done. A pilot project for the EDA was carried out during 6 months. The first data showed 18 events of close proximity ("Near-collision"); 4 of them showed severe violation of the International Regulations for Preventing Collisions at Sea (*COLREG, 1972*). As expected, after sending the EDA first report to the ship, NO such events were found in the next 5 months of the pilot project.

1 THE PROBLEM

Marine catastrophes happen all the time. EMSA (European Maritime Safety Agency) reported that in 2014 there were 331 cases of Groundings or Stranding, 378 cases of Contacts and 293 cases of Collisions. More than 250 persons lost their lives and 2000 were injured in those incidents, apart from the financial loss and pollution 1. The numbers worldwide are definitely higher as EMSA reports only on incidents reported by EU member states. Most important, 67% of the reported incidents were related to Human Erroneous Actions.

The reasons why so many incidents happen because of Human Erroneous Actions is attributed by many to deteriorating standards of mariners and the tendency to employ cheap crews. Complaints about deteriorating level of seafarers are very common, and can be heard of at any marine conference or gathering. Possibly it is true, but we do not see that only so-called "cheap crews" are having more than the average number of accidents. Others take a somewhat different approach and blame the "advanced technology as well as the of-quoted human element [2]. "and consequently see the solution (or part of it) by providing the mariners with standardized modes of operation – the so called S-MODE (in other words, the claim is "mariners are not so smart, give them simple systems") .Several high profile incidents, for example the groundings of the Costa Concordia and the Rena, or the collision of the Baltic Ace, do not agree with both assumptions (two of the three were manned by well-trained European officers). We believe that the reason of those accidents can be attributed to cockiness and over-confidence of the bridge team, and even more so to lack of proper supervision, auditing and feedback. No real action is taken to check the current navigation performance onboard in order to assimilate navigation safety standards. It should be emphasized that the numbers of accidents above are those of real and reported accidents, while at sea there are many more "Close call" incidents. Those incidents are not reported, not analyzed and never learned from. A system of feedback to the navigators is badly needed, one that will make every "close call" incident known, accountable and learned from.

2 NEAR MISSES

In the aviation industry, near misses are taken very seriously and administrations investigate such events in depth. It is possibly easier for the aviation industry because most of the air traffic is supervised by traffic control centers. Ships, on the other hand, still enjoy the freedom of the seas and near misses are not recorded or investigated (most of them). This fact is indeed a violation of the ISM code, which requires auditing of ship performance and recordings of near misses. Class NK Safety Management System, for example, requires 3 "*Reporting of Hazardous Occurrence (Near miss) and Measures to address them - Are hazardous occurrences (Near miss) reported to the company ? Are these reports investigated and analyzed by the company? Have these matters, together with preventive measures, been brought to the attention of other ships concerned?* ".Unfortunately, in most cases this requirement is not followed, and ends with paper shuffling for the sake of bureaucracy, possibly because up to now there was no adequate tool to find such events. We cannot expect the mariners to report it voluntarily, as it is against human nature for one to incriminate himself, and even honest mariners that experienced a near miss may not always admit that it was indeed a near miss. The definition of what is indeed a "near miss" may vary according to several technical parameters such as ship's type, maneuverability, geographic location etc., but also by the standards of the investigator. One cable distance from a ship overtaken may look safe to one mariner, but not prudent to another. We have different expectations (and tolerance) from an experienced pilot entering a busy harbor than from a junior officer in open waters. Some companies have standards of safe distance and safe clearance below the keel, but those are many times overlooked. We will see below how this obstacle can be dealt with.

3 DATA SOURCE

Modern bridge systems are equipped with various recording capabilities, such as a dedicated Voyage Data Recorder (VDR) which should record all navigational data for 30 days 4, and also with other systems recording their data internally such as ECDIS (and possibly other systems). Analysis of recorded history for near misses is possible today and, as will be shown further, is already available by EDA.

4 EDA (E-NAVIGATION DATA AUDIT) – INTRODUCTION

EDA is a software program designed to analyze historical data recorded by ECDIS and VDR, to find events of "near miss" as defined by the user, and to allow analysis of navigational data. The program is currently working on Totem ECDIS and Totem VDR, and analysis can be done by Totem Plus as a service to owners or directly by the owners. The aim of EDA is not to find and punish culprits, but to promulgate the company desire to keep safe navigation standards. Consequently, the "near misses" should be brought to management attention in order to assist in establishing a dialog with the ships resulting in superior navigation safety standards across the fleet. It should be noted, however, that the so called "near misses" found are analyzed based on data recorded by ECDIS and/or VDR alone, and the navigators or masters may explain the situation by giving more information such as visibility or sea state or special circumstances that may shed different light on the actions taken onboard and further enhance the safety dialog.

5 USING THE PROGRAM AND EVENT DEFINITION

The program is friendly and its use is intuitive. The user can define the criteria that he wants to find by using recorded information such as speed, depth, distance from other ships etc.(distance can be calculated from either AIS or ARPA)."Near collision", for example, can be defined as an event where another ship passed at a distance smaller than 0.4 miles, while steaming at speed greater than 15 knots and at a depth greater than 30 meters (see picture 1). Speed and Depth values are chosen as above to limit the findings to open sea and to filter out entry to ports etc. Other events (such as near grounding) can be similarly declared. Once the criteria for the search are defined the program will search all available data files to find a possible match. The criteria can also be given a title and be saved for future use.

Figure 1. Search for Near Collision

In the example in figure 1, showing a search for "Near Collision", two events matching the requested search parameters (as defined above) were detected. Replay of the exact data showed that one event is justified, while the other event from the two showed clearly that the ship was violating the International Regulations for Preventing Collisions at Sea.

6 PILOT PROJECT

EDA was used on a large and fast car carrier, as a pilot project from March 2016.The duration of the pilot was 6 months and the results were so impressive that the owners decided to use EDA across the fleet on all 60 car carriers. During the first month of the case study (March 2016) ,18 incidents of close proximity were discovered as shown in Figure 2. Analysis of these events showed 4 events where the vessel clearly violated the *COLREG, 1972*:

1 Not giving way to a Fishing vessel crossing from Starboard, forcing the other vessel to alter course and speed. Close proximity detected was 0.36 miles.
2 Mixed action (first turn to starboard then turn to port) resulting in close proximity (0.36 miles) to an ARPA target.
3 Mixed action on an ARPA target resulting in close proximity (0.23 miles). Target had to change course - possibly to avoid the vessel under investigation from passing close on the target's stern.
4 Not giving way while overtaking in a separation zone, forcing the other vessel to increase speed to 19 knots in order to pass clear. Minimum distance recorded was 0.08 miles.

Figure 2. Full list of close proximity during March 2016

It should be noted that the incidents found were analyzed based on data recorded by ECDIS and VDR, without any input from the navigators or master or any concrete information on visibility or sea state that may shed different light on the actions taken onboard.

7 THE EDA EFFECT

The results of the analysis were sent to owners which in turn promulgated them back to the ship. The effect was striking. During the next 5 months (April to August 2016), the data analyzed showed NO BREACH of the Collision Regulations (COLREG, 1972). It shows clearly that the level of navigation performance onboard can be raised with relatively little effort ,using the "Big Brother Watching" ability of EDA. The results convinced the owners to use the EDA across the fleet. EDA is currently implemented on two large fleets of tankers and car carriers.

8 OTHER EVENTS & ANALYSIS

EDA can look for all kinds of events, not only close proximity. A similar search for "Near Grounding" is given in Fig.3, showing a ship sailing in 15 Knots (yellow line) over very shallow waters of less than 2 meters below the keel (magenta line) – something to be frowned at. The effect of "squatting" due to shallow water can be seen clearly by the speed reduction due to that squat. It should be noted that 2 meters clearance below the keel is measured at the depth sounder sensor and no allowance for trim is taken, hence the clearance can be much smaller.

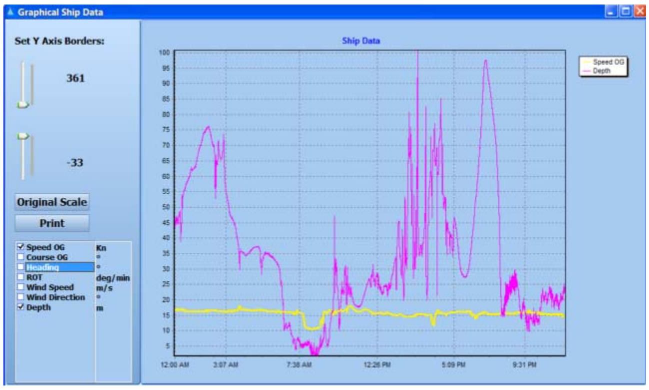


Figure 3. Ship sailing in 15 Knots (yellow line) over very shallow waters.

EDA has also the capability to analyze the data from navigation sensors, to show each parameter graphically and to compute the Standard Deviation (SD) for any selected period. Comparison of SD on similar vessels (or on same vessel in different conditions) can be illuminating, for example the response of the auto pilot and the difference between heading and COG. In Figure 4 we see the comparison between Heading and COG for several days, and in figure 5 we see the calculated SD for this period for several key parameters.

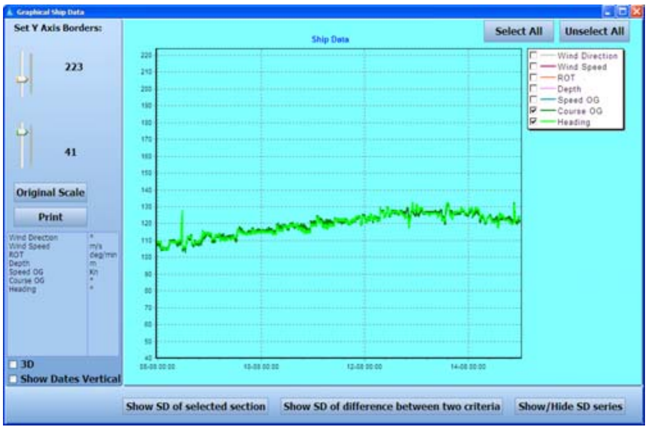
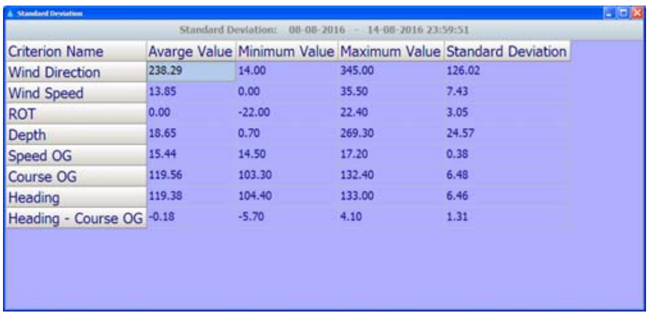


Figure 4. comparison between Heading and COG over 6 days.



Standard Deviation: 08-08-2016 - 14-08-2016 23:59:51

Criterion Name	Avarge Value	Minimum Value	Maximum Value	Standard Deviation
Wind Direction	238.29	14.00	345.00	126.02
Wind Speed	13.85	0.00	35.50	7.43
ROT	0.00	-22.00	22.40	3.05
Depth	18.65	0.70	269.30	24.57
Speed OG	15.44	14.50	17.20	0.38
Course OG	119.56	103.30	132.40	6.48
Heading	119.38	104.40	133.00	6.46
Heading - Course OG	-0.18	-5.70	4.10	1.31

Figure 5. Standard Deviation of key parameters.

The Efficiency Analysis above is separate from the Near Miss analysis and should be viewed differently. It will take more time to learn how this Efficiency Analysis is indeed important and how it can help to understand the navigation equipment performance. We expect that more reports on more ships will give us the answer to that or to the direction in which the analysis should pursue and may require further research. It is not the main goal of EDA and, until shown otherwise, can be taken as an added value feature to the main task of finding Near Misses.

9 SUMMARY

EDA is a new concept in the marine industry, and in relatively short time has demonstrated its potential to assimilate safe navigational standards onboard ships analyzed. The ability of owners and/or management to send back to the ship a list of Near Misses and possible unsafe conduct and ask for a proper feedback, is a very powerful tool that serves as a detriment to reckless actions by navigators. EDA showed its value in detecting unsafe close encounters involving violation of *COLREG, 1972* as well as events of unsafe sailing over shallow waters. EDA should be considered as an integral part of the continuous training onboard ships, and can be used by owners wishing to fulfill the ISM requirements for proper audit. It is up to the maritime community and IMO to make systems like EDA part of the required safety audits.

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