THE RESEARCH AS A LOCOMOTIVE OF CAPACITY BUILDING AT IAMU MEMBER INSTITUTIONS

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Abstract. This paper has been composed by materials of January 2008 – June 2009 IMO meetings, that may have an impact on IAMU members activities ,development and capacity building. The Leximancer software was used to make the general analysis of these materials.

1. INTRODUCTION

Today "knowledge sharing", being based on Research, is becoming a key issue in collaboration of Higher Education with Shipping Industry, which needs knowledge from Universities but Universities also need practical knowledge from Industry. University's maritime education is not only fundamental for raising safety, security and protection of environment. It also has a significant impact by creating cadres of informed and thinking young people in support the general economic development of Industry. Intellectual links of Universities with Industry also are very important for Capacity Building in Educational Research activities of MET Institutions itself. Such kind of collaboration needs the creation of global area of mutual interests and mutual capacity building. It may be considered as a very significant trend in the XXI Century both for Universities and the globalizing Shipping Industry. But it is not enough to establish capacity, it must also work. One of the ways for IAMU to start the work in this area of mutual interests is its NGO activities in International Maritime Organization, which should be based on regular researches.

The paper addresses some, by author's vision, important concepts that should be built and researched within the IAMU's NGO work at IMO and can positively impact the capacity building of IAMU in general and its members in particular. Formal conceptual approach is proposed to tune the professional network of researches that can be used for long term activities in maritime research, education, training and assessment in collaboration with Shipping Industry.

2. FORMAL CONCEPTUAL ANALYSIS OF IMO BODIES ACTIVITY DURING CAPTIONED PERIOD

2.1. Concepts and their importance

What is concept? Concepts in Leximancer are collections of words that generally travel together throughout the text (Leximancer Manual Version 2.2, 2005). This paragraph addresses the principle formal research of captioned IMO texsts[1]. The most frequently current concept appears in the set of texts, the most important it is. So, the most important concept in the captioned set of texts[1] is *ships* and the least important is *near miss*, see Table1 and Annex.

[1]The following related documents were processed to make formal and informal analysis of topics by January 2008-June 2009 IMO materials that may be useful for IAMU research activity: FSI16/18, FP53/WP.5, FP53/WP.5, BLG12/17, TC58/13, MEPC58/23, LEG94/12, FAL35/WP.6, COMSAR13/14, MSC85/26/Add.2, MSC85/26/Add.1, MSC85/26, MSC 84/24/Add.2, MSC84/24/Corr.1, MSC 84/24, MSC 84/24/Add.1, MSC 84/24/Add.2, MSC 84/24/Add.3, STW40/INF.3, STW40/WP.1, STW40/WP.2, STW40/WP.2/Add.1, STW40/WP.2/Add.3, STW40/WP.2/Add.2, STW40/WP.3, STW40/WP.3/Add.3, STW40/WP.3/Add.1, STW40/WP.3/Add.2, STW40/WP.4, STW40/WP.5, STW40/WP.6, STW40/WP.6/Add.1, DSC 13/20, MEPC58/23/Add.1, SLF51/17, NAV54/25, SLF51/WP.5, DE 51/28, MSC 86/26.

Table 1

Concepts and their formal importance (for abbreviations, see Appendix)

Concept	Relative Count	Concept	Relative Count	Concept	Relative Count	Concept	Relative Count
ships	100 %	Msc	22.6 %	Lrit	7 %	Fp	4.8 %
cargo	**87.2 %**	**knowledge**	**20.8 %**	**SA**	**6.5 %**	**Fsi**	**4.6 %**
safety	48.9 %	engineer	20.5 %	education	6.3 %	Stw	4.5 %
equipment	41.1 %	fire	18.4 %	Nox	6.2 %	**Fsa**	4.5 %
training	38.1 %	navigational	17.7 %	Ais	6.2 %	leadership	4.5 %
regulation	37.1 %	casualty	16.3 %	Slf	6 %	De	4.4 %
assessment	36.2 %	manning	15.1 %	fatigue	5.7 %	Dsc	3.7%
resolution	33.4 %	master	14.7 %	Blg	5.4 %	Human_Element	2.1 %
competent	27.1 %	position	14.5 %	research	5.3 %	Fal	2.1 %
hazards	26.1 %	security	12.2 %	Nav	5.3 %	Leg	1.5 %
environment	25.5 %	Mepc	10.9 %	Comsar	5.1 %	Lng	1.3 %
oow	24.2 %	**e-navigation**	10.6 %	skill	5 %	Tc	1.1 %
oil	23.4 %	situation	9.8 %	Imdg_Code	5 %	**Near miss**	0.1 %

2.2. MSC 84/85 activities being shared with other IMO bodies

Taking into account, that MSC is one of the main IMO committees and referring also to outputs from Table1, we have analyzed if the captioned concepts shared by other IMO bodies, using the conditional probability approach. Using the list of concepts, it was identified, that MSC 84/85 shared its activities with the following Committees and Sub-committees (Fig. 1). MEPC activity was the most close to MSC area of work and there was no shared activity with the Legal Committee at all.

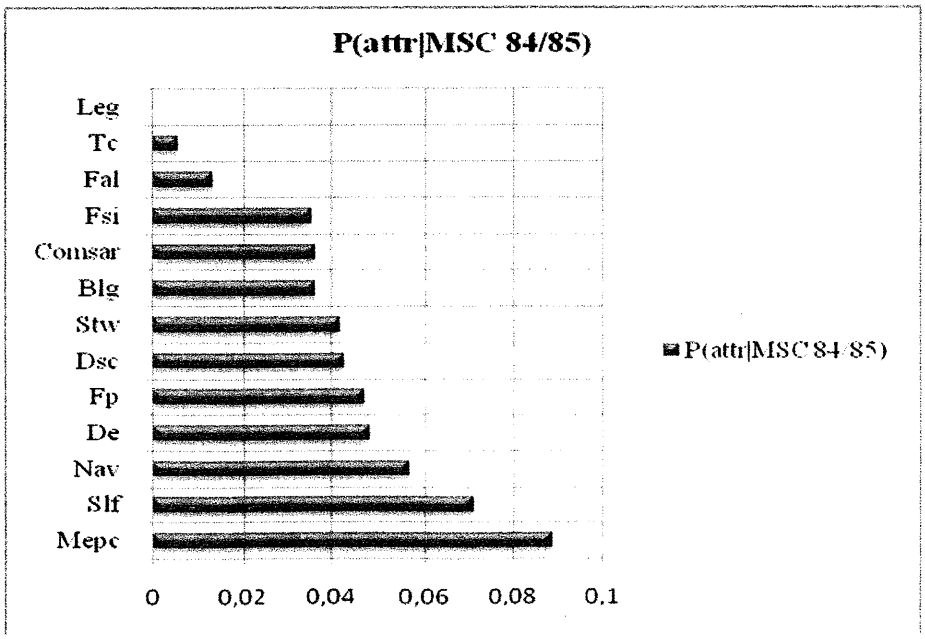

Fig. 1. MSC 84/85 activities being shared with other IMO bodies during January 2008 – June 2009

To process papers we used LEXIMANCER software for formal identification of 52 the most important (frequent) concepts and to understand their contextual similarity, which can help to identify the probable gaps from the view point of MET and research positions.

2.3. Contextual similarity

The more closer together the concepts appear on conceptual map, the more contextual similarity they have, (Fig. 2).

Location of concepts on Fig. 2 reveals, that in spite of STW Sub-Committee is involved in comprehensive review of STCW 78 Convention and Code, *Human Element* concept has a very poor contextual similarity with such concepts as *assessment, knowledge, education, OOW, training, manning, FSA, near miss, fatigue, e-navigation, situation awareness* etc. But could we state that *education, training* or *situation awareness* are not the components of *Human Element* or *e-navigation* or *FSA's* risk control options/ measures? It is an evident that all these very significant for safety concepts are correlated with coefficient close to 1 and should be considered and developed together. Education and training should be the base and origin of all this analyses related safety. It is MET institution's research business and optimum way to build their own capacity and cooperation with industry.

Using the above list of concepts, let's select the most important issues, in the research of which the IAMU members can be involved.

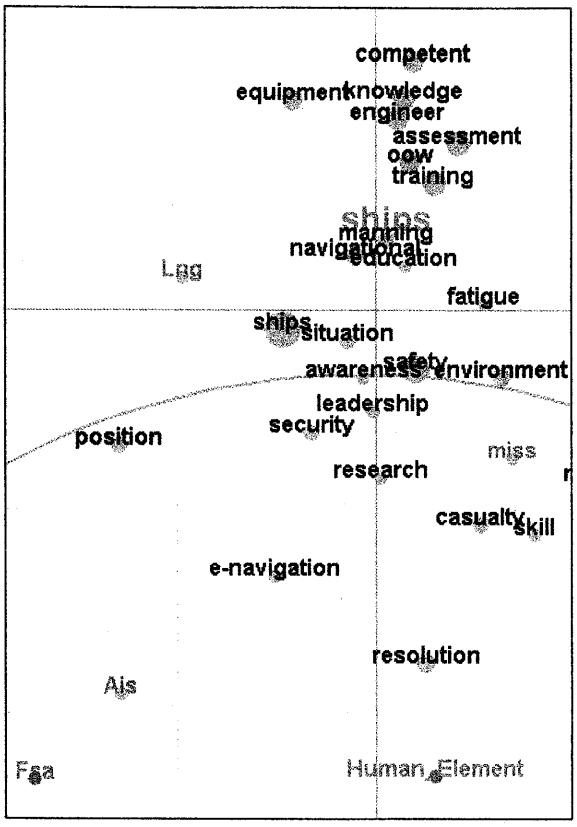

Fig. 2. Contextual similarity

3. LOGICAL NETWORK OF CONCEPTS FOR PRELIMINARY RESEARCH IN WHICH IAMU CAN BE INTERESTED AND INVOLVED

3.1. Situation Awareness (SA, relative count is 6.5 %)

Whatever we considered on negative contribution of Human Element into safety at sea (80 – 90 % of accidents), the "results from maritime operations literature survey revealed that 71 % of human errors were Situation Awareness related problems", (Grech, 2002).

A general definition of SA (by Endsley), that has been found the more close to marine navigation describes SA as "the safety driven perception of the elements in the environment within a volume of time and space (navigational area), the comprehension of their meanings (dangers, marks, ships, lighthouses…) and the projection of their status in the near future (developing of navigational situation). In other words SA involves the real-time processing of event-based information coming from an evolving situation in an attempt to understand what is happening" (Matheus et al., 2003).

The following quote is important: "Today's (navigational) systems are capable of producing a huge amount of data. The problem with today's (navigational) systems is not a lack of information, but finding what is needed when it is needed. Unfortunately, **in the face of this torrent of data, many operators**

(OOW) may be even less informed than ever before. This is because there is a huge gap between the tons of data being produced and disseminated and people's ability to find the bits that are needed and process them together with the other bits to arrive at the actual information that is required for their decisions..." (Endsley, 2000).

Traditionally the following so called "seed words" can be used for clarification of SA levels (Moore, 2007):

- Level 1SA = (perception, detection, recognition, identification);
- Level 2 SA = (comprehension, combine, interpret, store, retain, information);
- Level 3 SA = (project, projection ,dynamics, anticipate, future, events).

We need to take into account, that Situation Awareness is in STW intention to be included into 2010 pack of STCW amendments and it is worth to be done.

The literature review has identified several dimensions of SA that are specifically related to surveillance. However, no one dimension adequately addresses the knowledge of Seafarer (deck officer), who has to perform surveillance activities. At the same time, it does not seem likely that a combination of these dimensions would capture the construct that is of interest here. Therefore, focus on components of SA has not yet been particularly fruitful in shipping industry and MET institutions activity (Loginovsky et al., 2006). There is no doubt, that such concepts as teaching, learning, training and assessment should be adjusted for Situation Awareness.

The next paragraph is very much consistent with the Situation Awareness principles.

3.2. E-navigation (relative count is 10.6 %)

Definition: E-navigation is the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment, (IALA's e-NAV Committee).

In principle, it is new ideology of IT-based navigation and communication, which smoothly but confidently supplants the traditional and classic navigational techniques, creating new IT oriented vision on education and training of seafarers. In spite of electronic navigational equipment applies on board of vessels long ago, one can say that nowadays is transitional period from classic navigation to e-navigation (from paper charts to electronic ones). It is obvious, that the transition state is hardly good for safety but good for research, as uncertainty gives a lot of tasks to be solved in favor of raising the safety.

E-navigation is intended to meet present and future user needs through harmonization of marine navigation systems and supporting shore services. Research indicates that around 60 % of collisions and groundings are caused by direct human error. If e-navigation without proper education and training of seafarers could assist in improving this aspect, both by well-designed onboard systems and closer cooperation with vessel traffic management (VTM) instruments and systems.

However, although e-navigation may be able to improve the situations described above, there is also a need to recognize at a new stage the classic role of the practice of good seamanship, the provision of suitable training and the use of procedures.

IAMU can find itself before the vast and challenging field of research, triggered by IMO. To build, research and then understand the new ideology, to find its proper implementation and identify possible gaps in training at first we need to build and research the statistical concept of e-navigation, the results of which should be professionally interpreted into a logical concept and only then go ahead.

Why do we need at first to build the statistical (conditional probability) concept automatically extracted from publications? The main reasons can be as follows:

- There is a huge amount of publications in this and adjacent fields of knowledge, hence it is impossible to read all of them and process them manually;
- There is also the urgent need to identify the strong connectivity and very weak links between the components of a concept, including Human Element, Situation Awareness...etc.

The following "seed concepts" can be used to build the general and core concept of *e-navigation*: *additional value of e-navigation, information, integration, safety ,formal safety assessment, security, risk*[2]*,situation awareness*[2] *human element, decision making*[2]*, education, training, navigational near misses ,fatigue, mental workload...ECDIS, IBS/INS...,GMDSS, AIS...LRIT...GNSS.*

When the statistic and professional e-navigation concepts are built and understood, one can go ahead in carrying out further research projects in the field and develop teaching, learning, training and assessment technique based on situation awareness ideas.

3.3. Investigation into near misses (relative count is 0.1 %)

Near-miss: A sequence of events and/or conditions that could have resulted in a loss, or in an outcome with more severe consequences than actually occurred. This loss was prevented only by a fortuitous break in the chain of events and/or conditions. The potential loss could result from human injury, environmental damage, or negative business impact (e.g., repair or replacement costs, scheduling delays, contract violations, loss of reputation), (MSC 84/15/4).

The aprioristic data on accidents (history) at sea which is traditionally used by FSA to identify risk of accidents have some serious shortcomings due to not representative samples of such non sufficient and time – extended data. It is resulted in low efficiency of the analysis of root-causes of accidents, poor prediction of situations and therefore it affects on improving of safety as all the accidents has already occurred.

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Quoting paper (6) and adapting to shipping industry, it can be said, that "today, relatively few problem areas are identified through accident investigation", however Safety Management System based on ISM Code provisions is the main instrument of doing it. "One reason for this is that most causes do not reach the "accident" stage, because someone, usually the" master and crew, "saves the ship". Waterborn "emergencies that are safely recovered belong in this category; they are events that could have been accidents. In reality, they should be considered as accidents, accidents that did not result in injury or damage. And it is here that a fallacy becomes apparent: these "accidents" will not be analyzed for accident potential because there was no injury or damage. They are ignored in much the same way as the polluted water."

"The seriousness of this shortcoming was identified by H. W. Heinrich, a noted pioneer in the scientific approach to accident prevention, when he observed that ". . . for every mishap resulting in an injury [or damage] there are many other similar accidents that cause no injuries [or damage] whatever." He reached the conclusion that, in a group of similar mishaps, 300 will produce no injury whatever, 29 will result in minor injury, and one will result in major injury. He emphasizes that the importance of an individual mishap lies in its potential for creating injury and not in the fact that it actually does or does not. Therefore, any analysis as to cause and remedial action is limited and misleading if based on one major

[2] The terms *"situational awareness", "risk assessment" and "decision making"* will be included in new version of STCW Convention

accident out of a total of 330 similar accidents, all of which are capable of causing injuries or damage. In other words, those who limit their study to isolated, spectacular cases, major aircraft accidents, are looking only at the tip of an ominous iceberg..."

"Accidents do not occur frequently enough to establish trends, particularly at lower echelons of command. Unless a trend is established, commanders may be forced to treat the effect rather than the cause of accidents."

So, it is call of times to include ISM Code ideology principally based on Heinrich's Law (near misses collection, analysis and implementation for risk assessment) into FSA techniques as a long term research. Education and training aspects should be also included into such a research and linked with the navigational near miss analysis based on AIS /VTS information (it is also the adjacent field to e-navigation).

3.4. Formal Safety Assessment (relative count is 4.5 %)

What is FSA?

FSA is a rational and systematic process for assessing the risks relating to maritime safety and the protection of the marine environment and for evaluating the costs and benefits of IMO's options for reducing these risks. The use of FSA is consistent with, and should provide support to, the IMO decision-making process. It provides a basis for making decisions in accordance with resolutions A.500(XII) "Objectives of the Organization in the 1980's", A.777(18) "Work Methods and Organization of Work in Committees and their Subsidiary Bodies" and A.900(21). Objectives of the Organization in the 2000s (MSC/Circ.1023 MEPC/Circ.392, 5 April 2002).

Reverting to conceptual map (Fig. 2), one can repeat, that such very important for safety at sea concepts as *FSA, Human Element* and *education, training, competence*...are very poor contextually, and that means also professionally, linked.

Rising trends of marine accidents both in terms of numbers and costs are mainly associated with collisions and groundings. There are numerous examples of collisions and groundings that might have been avoided had there been suitable input to the navigation decision-making process. So, the decision – making process based on research, selection and implementation of appropriate Risk Control Options/Measures should be analyzed from the viewpoint of competence and experience of seafarers.

It's also obvious that such components of Human Element as academic background, level of competency, skill ...etc. can be included into FSA procedure for risk assessment and identification of appropriate RCO/RCM, which can help to answer the question "What level of education the Industry needs from seafarer?

"In many parts of the world recognition of competence is a necessary professional requirement for employment, career development and, unfortunately, liability insurance. As interest in the Human Element grows, not least in response to the awareness raised by Alert!, there will be a need for recognition of competence in the skills related to the science and practice related to addressing Human Element issues in the marine context... What is required in terms of professional recognition is a scheme that recognizes a range of academic backgrounds and gives due regard to experience and achievement", (Alert, Issue No. 12 July 2006).

FSA is a very important and useful tool for making decisions which is continuously improving by IMO. Situation Awareness is also goal-driven techniques used for Decision Making, but it is much closer to Human Element nature. The combination of two techniques can give useful results for improving safety, security and protection of environment.

Some more words about FSA: it is very academic and ambitious area of research and can be extended to a lot of fields related to safety at sea. Being consistent with the above paragraphs the following new seed concepts can be taken taking into consideration as "seed Risk Control Options/Measures" for further steps of research : *quality of seafarers, education and training, fatigue, seagoing experience ..., manning, potential risk (based on near misses), hazards as a function of MET level, decision making..., e-navigation...*

CONCLUSION

Based on considerations above the following may be concluded:

(a) In spite of Information Technologies are widely applied in MET and Shipping Industry, one can be considered, that both Industry and MET are in transitional period of applying them, which can be characterized by the raising risk of accidents. To improve the situation the vast spectrum of breakthrough researches should be carried out, including coherent and in-depth investigation into such cross correlated concepts as: *Situation Awareness, E- Navigation, Near Misses and Formal Safety Assessment*;

(b) At first, formal conditional probability network should be built and researched, which helps to identify all the tight and weak links between the components of the above concepts, which further can be professionally interpreted;

(c) The following key concepts (not words) for building the core Research Domain are cross correlated and should be treated jointly: *situation awareness (perception, comprehension, projection, shared situation awareness), human element,* ***education, training, assessment, skill,*** *manuals* and *guidelines, information, mental workload, fatigue, manning, safety, security, protection of environment, formal safety assessment, decision making, performance of actions, ...e-navigation, information technology, communication...accident investigation...* etc, as the independent research of them is supposed here to be not efficient.

References:

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[2] Grech M.R., et al. Human error in maritime operations: analyses of accident reports using the Leximancer tool, Key Centre of Human Factors and Applied Cognitive Psychology, University of Queensland, Brisbane, Qld, 2002.

[3] Moore D., Principles of Situation Awareness, Applied to Corporate Decision Support Systems, BusinessAvionivs Monday, April 23, 2007.

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[5] Matheus C., Kokar M. Baclawski and K., Phase I Final Report: A Formal Framework for Situation Awareness. AFRL Funding Number: F30602-02-C-0039, January 2003.

[6] http://www.airpower.maxwell.af.mil/airchronicles/aureview/1973/jul-aug/nichols.html.

Annex I

List of Abbreviations

AIS	Automatic Identification System
BLG	Bulk Liquids and Gases
COMSAR	Sub-committee on Radiocommunication Search and Rescue (IMO)
COMSAR	Radio-communications and Search and Rescue
DE	Ship Design and Equipment
DSC	Carriage of Dangerous Goods, Solid Cargoes and Containers
ECDIS	Electronic Chart Display and Information system
FC	Facilitation Committee
FP	Fire Protection
FSI	Flag State Implementation
IACS	International Association of Classification Societies
IALA	International Association of Lighthouse Authorities
IBS	Integrated Bridge System
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISO	International Standardization Organization
LC	Legal Committee
MEPC	Maritime Environment Protection Committee
MSC	Maritime Safety Committee
NAV	Safety of Navigation
SLF	Stability and Load Lines and Fishing Vessels Safety
SOLAS	International Convention for Safety of life at sea
STW	Standards of Training and Watchkeeping
TCC	Technical Cooperation Committee
VTS	Vessel Traffic Services