



Comments on Maritime Cybernetic – What is Maritime Cybernetics ?

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(Citation)

神戸大学大学院海事科学研究科紀要, 06:55-63

(Issue Date)

2009-07

(Resource Type)

departmental bulletin paper

(Version)

Version of Record

(JaLCD0I)

<https://doi.org/10.24546/81001465>

(URL)

<https://hdl.handle.net/20.500.14094/81001465>



Comments on Maritime Cybernetics

- What is Maritime Cybernetics? -

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(Received April 10, 2009)

Abstract

The concept of Maritime Cybernetics was born at Kobe University of Mercantile Marine in Japan and quickly involved all faculty members. Because the field of cybernetics is changing rapidly, faculty must keep up with the changes and adapt their teaching methods accordingly. In the *Review of Kobe University of Mercantile Marine*, discussion of the challenges of integrating Maritime Cybernetics into everyday instruction has occurred; however, not much has been done beyond discussion. One important aspect of the mission of maritime universities and colleges is to keep abreast of, and to utilize where appropriate, new technology. That said, the new technology must be studied carefully to determine if its interface with humans (cybernetics) is conducive to maritime content and instructional methodology.

The authors are opening a dialogue about Maritime Cybernetics in this paper as one result of a collaborative research project begun in 2008 between Maine Maritime Academy in the USA and Kobe University in Japan.

1. INTRODUCTION

In Japan, education for a merchant navigator is controlled by two universities (old Kobe University of Mercantile Marine [KUMM] and old Tokyo University of Mercantile Marine [TUMM]) and five national maritime technology colleges (Yuge, Oshima, Hiroshima, Toba, Toyama), rather than by a navy or coast guard. Originally, KUMM and TUMM developed the idea of *Syousen-gaku*: 商船学, or “maritime science” in Japan. Now, instruction in maritime science is entrusted to Kobe University, Graduate School/Faculty of Maritime Sciences which supports the mission of the former KUMM.

What is “Maritime Cybernetics” in relation to maritime training or “*syousen-gaku* 商船学” in Japanese? We have only five papers in our review [1]-[5]. One paper on Maritime Cybernetics showed a Navigator Performance Pattern Model (NPP, Figure 1). The NPP model is similar to the human performance model in psychology; however, the NPP model is a pioneer model when applied to a ship navigator’s performance and navigational instruments in the mariner’s world. The model consists of “感覚 /biological sensor or instrumental sensor”, “解析処理 /analysis”, “認識・判断 /recognition and judgment”, and “アクチュエータ /action or actuator” which taken together constitute “責任 /responsibility”. We agree that in the NPP model, although the given “与件 δ /condition” is the same, the sense of the “データ /data” differs. The navigational information (“航海情報” in Fig.1) depends on individual “感性 (or 悟性 /gosei) /kansei” (most easily defined as a mariner’s mixture of common sense and skill), which can be quite different from person-to-person. The “行動方針 /plan” and “実行行動 /action” (Fig.1) also differ among individuals depending on each one’s *kansei*. Given the above terms, it is possible to adapt the human performance NPP model in psychology to the investigation of a navigator’s common

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sense/*kansei*.

In this paper, we have set the NPP model in the Navigational information concept [6]; we consider Maritime Cybernetics from four aspects; *Kansei*, Maritime English, U.S. Maritime Education, and U.S. Training Ship Education at this time.

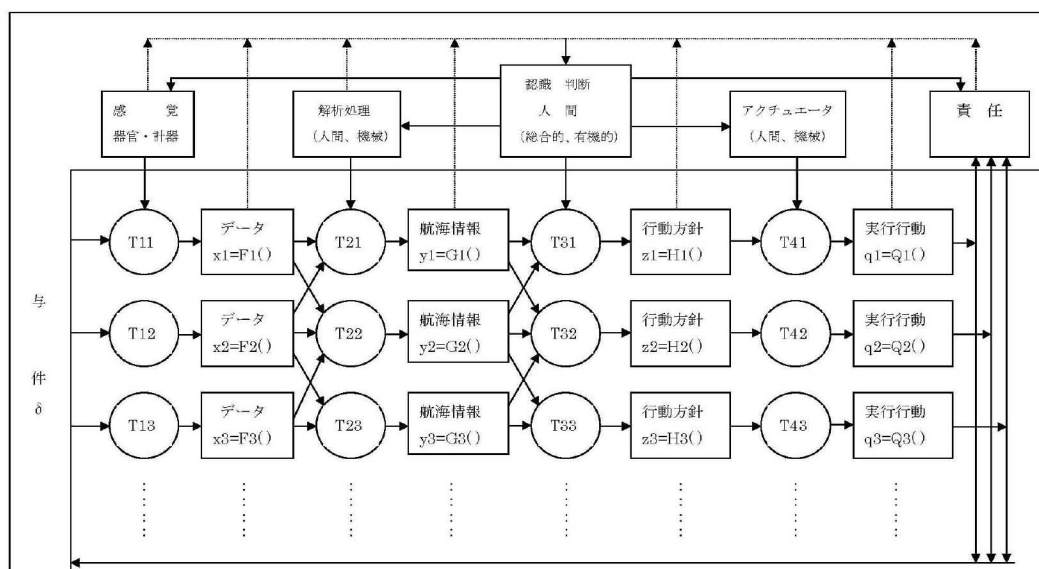


Fig. 1 The Navigator's Performance Pattern Model [3]

2. *Kansei* and NPP Model in Navigational Information Concept

Associate Professor Koji Murai, Maritime Sciences

Kansei information is divided into four kinds - 'symbol', 'parameter', 'pattern', and 'image'. We can express the symbol in an adjectival word like 'warm'. We can express the parameter by a vector in the coordinate data made by adjectival words using factor analysis. Pattern is difficult to describe in the same way that it is difficult to describe the feel of fabric or the tonal quality of an instrument. Image is difficult to exteriorize just as a mental picture or inspiration [7], [8].

Research on *kansei* attempts to identify a person's common sense while performing a certain activity. Psychological and physiological methods are used to determine the kinds of *kansei* information processing. The psychological method measures the relationship between an impulse (e.g., light, sound, heat, music, and picture) to the human and the response to it. Emotion is evaluated by Semantic Differential: SD assessment. The physiological method measures the heart rate, respiration, skin temperature, blood pressure, etc. of the subject of an investigation. The idea of *kansei* is not the same as human error as revealed in human performance models. We recognize that *kansei* for ship handling includes skill, and our definition of *kansei* considers it a cognitive process of a high order.

Research to identify human factors in transport systems has been challenging. A ship is different from other systems because the navigator is in a fixed operational seat and members of the Bridge Resource Management (BRM) team move freely on the bridge in order to keep a sharp lookout of 360 degrees around the ship. The

maritime traffic system is most difficult to navigate because of the large number and kinds of ships which are often in close proximity to the navigator's ship such as oil tankers, LNG/LPG ships, car carriers, container ships, tall ships, ferry boats, battle ships, motor boats, fishing boats, and so on. In addition, the infrastructure for maritime traffic management is not sufficient on the sea and traffic managers never have full control of small vessels. We think the navigator's individual sense is more dependent on the BRM and traffic managers when trying to guide his ship in a complex, high traffic sea area. Of course, common sense is in each navigator so we propose the navigator's *kansei* is based on a navigation information concept.

Research into *kansei* in artists and musicians has been popular in Japan; however, the research has not yet been attempted among navigators. The concept of *kansei* among navigators is shown in Figure 2 as the navigator-centered navigational information model (TPK model) on three dimensions of space consisting of: 'Time (T):x-axis,' 'Position (P): y-axis' and 'Kansei (K): z-axis' (Fig.1) [9]. This model shows the importance of individual aptitude. The proposed TPK model may make clear the navigator's *kansei* in maritime science, and human system research on maritime science is fixed as part of it. Moreover, the NPP model is fixed at the origin of the TPK model.

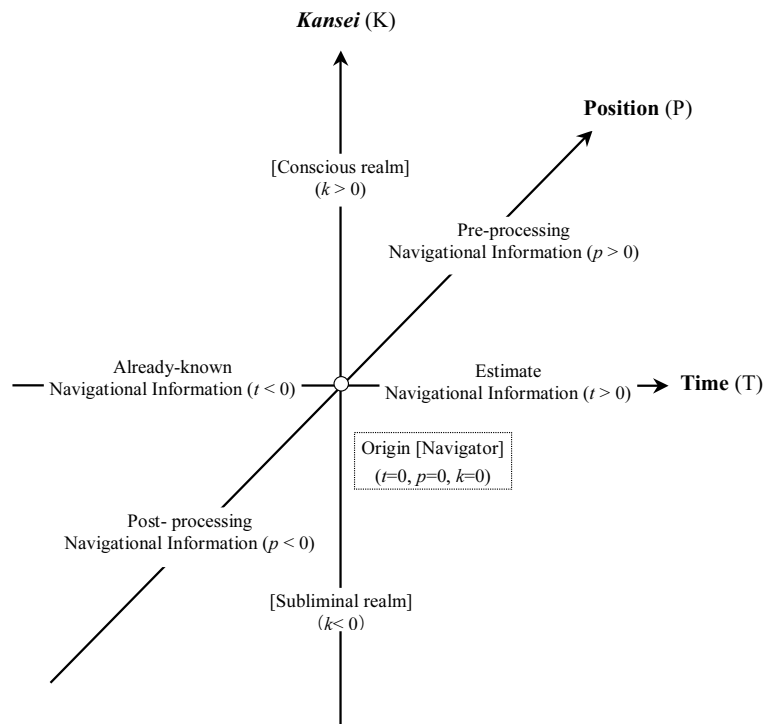


Fig. 2 The TPK model based on navigational information concept

We need some evaluation indices of *kansei* and skill for ship handling in practical training which must be able to rate human *kansei* and skills; however, we do not require 100 percent perfection from them. Professionals (instructors) always join in the training, so the indices should help show them the evaluation of necessary *kansei* and skills. *Kansei* refers loosely to human common sense which is an individual ability, not equal to the measurable training received in a year. Therefore, our research considers the new concept of a navigator's *kansei* based on the navigational information using physiological indices [10], [11] in an attempt to see the relationships between a navigator's common sense skills and his/her physiological reactions. Ultimately, we propose that our research will aid instructors train their student navigators more thoroughly.

3. Maritime Cybernetics – Perspective of a Maritime English Professor

Professor Laurie Stone, Arts and Sciences

In order for a young mariner to be successful in the present world of international shipping, he or she needs to meet the International Maritime Organization's (IMO) basic standards for maritime English found in the IMO *Standard Marine Communication Phrases* (2001). The purpose of mastering the relatively straight-forward phrases is simply to improve safety at sea when sets of mariners are using different languages. The difficulty with maritime English is that human lives and expensive ships depend quite literally on the mariner's ability to speak it accurately and clearly. Unfortunately, many non-native speakers, as well as native speakers, of English do not speak clearly. Non-native speakers may have thick accents which interfere with the ability of other mariners to understand them, especially in times of crisis. Native speakers may elide their words or use slang which can also cause interference. The use of ship-to-shore and ship-to-ship communication devices adds a complicating layer to understanding since these devices can have low level clarity or do not filter out background noise well.

A challenge for teachers of maritime English is to assist all navigation students in the world's maritime academies to speak English with clear enunciation and obvious meaning. To achieve this goal, various methods and machines have been used over the years including tape recorders, live native speakers, teacher exchanges, and now highly sophisticated interactive computer programs (Takagi & Stone 2004) (Takagi & Uchida 2006). Despite the latest teaching efforts and sophisticated technology, many mariners remain weak in their required English skills. Some reasons for the residual weakness are a lack of speaking confidence and a lack of speaking opportunities on a regular basis.

Speaking confidence obviously comes from constant, real-life practice. Many language learners have a natural lack of confidence when they first confront the target language. They go through stages of trepidation and then excitement when they realize they have mastered a few words, phrases, and sentences. However, the confidence level often plummets when the learner meets a native speaker and realizes he/she can understand very little. Native speakers speak faster than instructors and employ more unfamiliar vocabulary, often filled with slang and neologisms. Some students panic in this situation and lose their confidence. Once this stage is reached, the student will do the bare minimum required to get by but will not be prepared for real scenarios at sea requiring a quick switch to English for the safety of one's ship and shipmates as well as for other ships and mariners in the area.

Additionally, not every mariner has a passionate desire to learn maritime English though he/she might have passion for the maritime industry. Instructors can drill and test students repeatedly only to find that many simply retain only enough to pass the tests. Once at sea, the students who are weak in maritime English are a danger to themselves and others in this international industry.

Cybernetics (in this case, computers and simulators) can be tremendous teaching tools for maritime English instructors. Not only can non-native speaking students use interactive computer language programs and sit in classrooms with live instructors, but they can also be required to use their newly acquired maritime English whenever they are working on the marine simulator. A new student could be asked to use a few words from the SMCP list. As the student progresses through his 4 years of instruction at his maritime college, he could be required to use more and more phrases until by the 4th year, he can use maritime English easily and clearly

whenever he is working on the simulator. Asking the student to use the language in a training scenario will bring the language alive for him and he will quickly come to see the value of mastering the language.

Native speakers of English could also benefit from this requirement. Of course, the SMCP are fairly easy for them to master, but native speakers could be required by their instructors to speak clearly and without slang at all times when on the bridge simulator. They could be audio-taped at the time and could later listen to themselves so that they could work on their enunciation, pace, and use of the SMCP.

The concept of cybernetics and the teaching of maritime English is a new area of investigation for researchers and instructors but is one that holds much promise for all speakers of maritime English. Low-confidence students could build their confidence by interfacing with computer programs and trying a few phrases at a time when working on the bridge simulator. Native speakers could spend more time practicing their enunciation and slang reduction. They could easily use computer programs that allow them to speak into a microphone and then replay what they've said. The possibilities are endless and need now only to be incorporated into more training scenarios.

4. Maritime Cybernetics – Perspective of a U.S. Maritime Professor

Captain Daniel S. Parrott, Marine Transportation Operations

Generations of deck officers have successfully embarked upon careers without the benefit of bridge simulator training. Yet there is reason to believe that simulator training offers advantages over earlier methods of career preparation. Simulator training cannot impart all the skills required of a competent watchkeeper. It will not, for instance, necessarily make a poor navigator into a good one. However, simulator training can highlight human performance in ways that other types of training do not, particularly with regard to stress. A superb navigator in a relatively static situation may discover he or she has poor skills when it comes to a dynamic traffic situation involving frequent radio calls. Conversely, an average navigator may be exceptionally well suited to piecing together a complex traffic situation and making timely decisions. The ideal mariner combines both, but when dealing with human beings we are invariably faced with a spectrum of abilities.

One area where we see improved performance through bridge simulator training is the manner by which passage planning appears to reduce stress on the officer in charge. Students who have not been instructed in passage planning, and do not apply the techniques, frequently do poorly in simulator exercises. They cannot keep up with developments; they quickly become overwhelmed, and may ultimately lose control of the situation. As cadets gain exposure to passage planning techniques, and incorporate them into their preparations, they are able to develop a more accurate mental model of the simulated world around them. Situational awareness rises, and students often appear calmer and more able to handle the unexpected. Importantly, cadets are often well aware of this transformation in themselves and thereby adopt the concept of passage planning as part of their personal route to success.

Admittedly, a mariner with extensive experience may be able to perform successfully with very little situation-specific preparation. But cadets who do not have the benefit of long experience quickly learn that passage

planning is one of the best ways they can compensate for their lack of experience and lower their stress levels. All of this can easily be practiced by the young navigators through bridge simulation.

5. Maritime Cybernetics – Perspective of a U.S. Training Ship Master

Captain Larry Wade, Master, T.S. STATE OF MAINE

Training students to become officers on the merchant vessels of the future is the goal we strive to achieve as operators of training vessels. How we enhance the awareness of these future officers to the environment around them is where we can make the biggest difference in their education at sea.

To do this we have to provide the most technologically advanced platforms available, and train the students to operate each piece of equipment individually as well as a component in the entire system. This training is necessary and valid for both the Deck Officers and Engineering Officers, especially as the new ships are becoming more and more totally integrated.

How does it all work? What are the key points? These questions fit into what has been termed “Situational Awareness”, a term that is a key to the safe and efficient operation of merchant vessels giving early warning to system failures. The resulting timely warning will insure sufficient time for adequate intervention to prevent disaster.

Traditionally Maritime Educators have been very good at teaching equipment operations. As new equipment has been introduced in the Industry and as new governmental regulations have been instituted, training has evolved to integrate these new pieces of equipment into the curriculum. With the introduction of the internationally-mandated STCW, competency assessments were standardized. However, it is obvious that individual assessments do not really address how an individual views and comprehends the bigger system picture. Although to date that system concept has not been thoroughly assessed, recent research in maritime cybernetics is adding to the instructor’s understanding of how an individual processes and responds to complex navigational situations.

Almost all ship systems are tied into each other today and they also communicate over a network and with a language that has been established through standards that insure that regardless of manufacturer crew are still able to communicate. This has greatly enhanced the safety of the vessel and does make it considerably easier to view the overall picture of the health of the ship’s system. What is vital to this is the officer’s ability to inherently evaluate the accuracy of the information that the equipment is providing. Is the equipment information correct based on the traditional good seamanship or engineering practices? Is there a trend developing which will lead to a problem? These are important questions. Simulator training and evaluation of physiological indices can certainly increase a young navigator’s ability and common sense(*kansei*) when he/she attempts to answer the technical questions posed above.

Needless to say, simulator training is only the beginning of a mariner’s sense of *kansei*. A licensed mariner with years of experience will have a heightened awareness of images and patterns not necessarily measured by

equipment. For example, an experienced navigator might face this scenario: A ship is on a voyage traveling North on a dark cloudy night. As dawn approaches the port side horizon brightens more than the starboard side horizon. A lifetime of training (observing) should inherently cause the officer of the watch to immediately check his/her gyro compass, magnetic compass, and GPS heading all of which are obviously keeping the vessel on that Northbound heading which in fact it is not. More than likely the course error is somewhere in the > 90 degree range. There is a massive equipment imbalance that is detected by the officer's "situational awareness". It is an ingrained sixth sense (*kansei*) that alerted the officer, based on a lifetime of watching or feeling the sunrise in the East.

The same could be said for the engineering spaces: A simple change in sound, tone or vibration may alert an engineer of impending equipment failure long before the instrumentation detects the failure and sounds the alarm.

So, the question on training ships is "How do we teach 'Situational Awareness'". It starts from the instant a student reports aboard a vessel. As he/she came up the gangway, was there a current? Is there a tide and what is it doing? Was it cloudy or cloudless? Was it windy? Was it cold? Was the gangway safely attached to the vessel? Was the ship flat or nearly so? Did it have a list? Were the lights all on? Any and all of these questions can be answered by ANY crewmember coming aboard. They are aware of the environment around them and to the vessel they are boarding. A big part of 'Situational Awareness' on a vessel is how a navigator "feels, sees and hears" the vessel as he/she walks aboard. This is valid for both deck and engineering students.

Another major factor in preparing the students for their future roles is teaching them the "traditional" skills of engineering and seamanship which will prepare them for recognizing what is right and not right on this unique moving work platform. In the last twenty years, simulators have become invaluable components used to train the 'whole person' in attempts to develop the navigator's "situational awareness" (*kansei*) before boarding the training vessel.

As educators strive to pass on what we have accumulated through lifetimes at sea, the importance of continually asking students about what they see, hear, and feel about the platform they are on and what the equipment they are operating is telling them will prepare them for excellence in their future job performance, ultimately keeping themselves, their shipmates, their vessel and its cargo safe.

6. Education of the "Whole" Navigator – Perspective of a U.S. Commandant of Midshipmen

Capt. P. Jeff Loustaunau, Vice President of Maine Maritime Academy and Commandant of Midshipmen

Those of us involved in the education and training of students to become officers in the merchant marine appreciate that it is not a simple task, and in fact, it is a very challenging task. Upon their arrival at Maine Maritime Academy, all of the students in the unlimited license program are made to memorize a saying from one of the United States' greatest maritime officers, John Paul Jones. When answering the question of what qualifications are required to be an officer, he stated "It is by no means enough that an officer be a capable mariner. S/He must be that, of course, but also a great deal more."

So what else is there to being a maritime officer?

Plenty!

Most would agree that an officer must be a leader, a strong manager of people, a good business manager; with the qualities of honesty, integrity, strong character, good judgment, strong work ethic, all coupled with strong technical skills. Ensuring all officers possess these becomes a monumental task, especially when added to the bottom line that they need to be capable mariners as well. It basically equates to the need to educate and train the “whole” person. A marine simulator can be used as one component for developing the “whole” person. Knowledge of precise and clear English, detailed passage planning, and how to reduce stress levels when operating a ship can all be learned while training on a simulator before the student navigator goes to sea.

While at their college or university, all aspects of their academic endeavors, professional activities, and residential life experiences contribute to their “whole” person education. All teaching and education techniques are required to achieve this. As we all know, we are no longer in the days of sail. The demands on the mariner’s skill are ever-increasing in an ever-increasing number of areas including more advanced technologies in engineering, navigation, communications, and controls. There are more demands in the areas of ship’s business, labor management, admiralty law, and most recently - security.

We therefore must take advantage of the best techniques and technologies available to provide students with these skills. Maritime cybernetics appears to be one of the answers as it utilizes the latest technologies in the training and educating of students on the latest in maritime technologies.

7. THE EPILOGUE

Professor Yuji Hayashi, Capt., Maritime Sciences

We argued about Maritime Cybernetics as one result of a collaborative research project between Maine Maritime Academy in the USA and Kobe University in Japan. At first, we set the Navigator Performance Pattern Model [NPP model] in the Navigational information concept; we consider Maritime Cybernetics from four aspects; *Kansei*, Maritime English, U.S. Maritime Education and U.S. Training Ship Education. At the second, we proposed the navigator-centered navigational information model [TPK model] might make clear the navigator’s *Kansei* in maritime science, and human system research on maritime science is fixed as part of it. Moreover, the NPP model was fixed at the origin of the TPK model. After that, we discussed about various topics, which were the perspective of a maritime English professor, a U.S. maritime professor, a U.S. training ship master and a U.S. commandant of midshipmen.

Acknowledgments

These considerations derive from the collaborative research between Maine Maritime Academy in the USA and Kobe University in Japan. This research, was steered by Professor Laurie Stone at Maine Maritime Academy, and conducted from 9th November, 2008 to 26th March, 2009 with the support of Ministry of Education, Culture, Sports, Science and Technology of Japan, Project of Advanced Education and Research 2008.

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