



# **New MET system based on essential training concept**

M. Endo<sup>1</sup>, H. Kobayashi<sup>2</sup>, Y. Arai<sup>3</sup>, S. Murata<sup>4</sup>, T. Takemoto<sup>4</sup>,  
S. Toya<sup>4</sup>, H. Mizuno<sup>5</sup>, S. Senda<sup>5</sup> & M. Endo<sup>6</sup>

<sup>1</sup>*Toyama National College of Maritime Technology, Japan*

<sup>2</sup>*Tokyo University of Mercantile Marine, Japan*

<sup>3</sup>*Marine Technical College, Japan*

<sup>4</sup>*Institute for Sea Training, Ministry of Transport, Japan*

<sup>5</sup>*Mitsui O.S.K. Lines, Japan*

<sup>6</sup>*Ishikawajima-Harima Heavy Industries Co.,Ltd., Japan*

## **Abstract**

In MET(Maritime Education and Training) fields, there is no standard system using ship handling simulator currently. The authors developed and proposed the new MET system based on essential training concepts which are composed of the elemental technique development of the ship handling technique and the systematic reconfiguration of it as a systematic training system. These concepts were already reported at some international conference, such as IMLA, INSLC MARSIM and etc.. The training effectiveness of this system by comparison of the learning characteristic of learning process of ship handling techniques between the simulator training and onboard training were also confirmed and reported. In this paper, the proposed training and assessment methods are mainly described through the discussion of ship handling technique and the results of experiments using simulator.

## **1 Introduction**

The high training efficiency can not be expected without any use of systematic training method generally. So, the authors developed the training system based on the systematic maritime techniques according to the following process.



No.	Task	Required Skill		
		2/O	C/O	Master
1	To plan the navigation schedule considering own ship, sea and weather condition.	Yes	Yes	Yes
2	To estimate ETA at important point for the navigation.	Yes	Yes	Yes
:	:	:	:	:
8	Actions abided by law when meeting with two or more vessels.	Yes	Yes	Yes
:	:	:	:	:
17	To fix the position by more than one method.	Yes	Yes	Yes
18	To carry out the parallel indexing.	Yes	Yes	Yes
:	:	:	:	:
23	To use the standard maritime communication phrases properly.	Yes	Yes	Yes
24	To communicate with VTS using VHF and gather needed information	No	Yes	Yes
:	:	:	:	:
43	To understand the ability of crew and conduct the bridge team as a leader.	No	No	Yes
:	:	:	:	:

Fig. 1 : The sample result of the questionnaire survey

- 1) Analyzing the task onboard and extracting the objective skill to be trained
- 2) Systematizing maritime techniques
- 3) Developing the guideline corresponded to the objective skill
- 4) Developing the assessment based on the objective skill
- 5) Developing the training scenarios based on the objective skill

The 10 scenarios are developed for 3 licensed level. All the techniques for the ship handling can be obtained by the training using proposed scenarios. The training effectiveness of this system were also confirmed.

## 2 Task Analysis on Jobs Onboard

In order to clarify the objective techniques to be trained, authors had analyzed essential jobs onboard by means of questionnaire surveys for 100 and more master and mates. A sample result of the questionnaire survey is shown in Fig.1. In the meantime, the standard ability of each license rank in STCW regulation is clarified. As a result of these discussions, essential jobs for each ship's operator's rank were clarified as objective techniques.

## 3 Guideline for Techniques

On the other side, It have been clarified that the ship handling technique can be developed into 9 elemental techniques based on continuous study about maneuvering technique. The main content of nine types of elemental techniques is shown below.

- 1) Watchkeeping : The technique to identify and recognize the moving targets and the fixed targets and to gather information of direction, distance and speed and to estimate the future situation of the targets.
- 2) Positioning : The technique to find the position of ship by selecting and recognizing proper obstacles using eyes, radar and etc.



E/Technique	Guidelines to Maneuver	Rank
Maneuvering	<ul style="list-style-type: none"> <li>Turning rate for altering course less than 5deg/min except in case of avoiding dangerous situation.</li> <li>Deviation from charted course line less than 0.3mile.</li> <li>To control ship based on understanding maneuvering ability and circumstances.</li> </ul>	Master C/O 2/O
	<ul style="list-style-type: none"> <li>To reduce ship's speed as planned (see an example of speed-reducing plan).</li> <li>Ship speed at pilot station less than 6k'ts and to keep ship's posture.</li> <li>To anchor inside 1/2L circle centering around planned anchorage.</li> </ul>	2/O
Management	<ul style="list-style-type: none"> <li>To understand the navigational plan and shared duties before the training start.</li> <li>To keep communication with other bridge members, ships and VTS etc.</li> <li>To confirm whether the ship's course and rudder angle is in order.</li> </ul>	Master C/O 2/O
	<ul style="list-style-type: none"> <li>To put each crew in charge of the task from viewpoint of each ability.</li> <li>To reply to the reports suitably and direct each crew to show their ability.</li> </ul>	2/O

Fig.2 The Sample Description of Maneuvering and Management

- 3) Maneuvering : The technique to control course, speed and ships position using steering and main engine control etc.
- 4) Instrument Manipulating  
The technique to properly utilize instruments for watchkeeping, positioning, ship handling and etc.
- 5) Communication : The technique to exchange information among the bridge and inside and/or outside of the ship.
- 6) Rule of Road :The technique to run according to the Regulations for Preventing Collision at Sea.
- 7) Planning : The technique to gather information concerning the navigational environment conditions and to make an operational plan and a navigational plan.
- 8) Emergency : The technique to cope with malfunction of a main engine and a steering system etc. and a rescue activity properly.
- 9) Management : The technique to make good use of members ability and raise the bridge team's performance.

The concept that the ship handling ability is made up of compound elemental techniques is expressed in the formula (1).

$$f(a, b) = g_1(a) + g_2(b) + g_3(a, b) \quad (1)$$

Where f: total ability

a: elemental technique 1

$g_1$ : ability for elemental technique a

b: elemental technique 2

$g_2$ : ability for elemental technique b

$g_3$ : ability for added technique in case of both a and b are compound

In this formula, a and b are elemental techniques, f is ability for total technique to attain both techniques a and b simultaneously,  $g_1$  is ability for elemental technique a and  $g_2$  is ability for elemental technique b.  $g_3$  is ability for

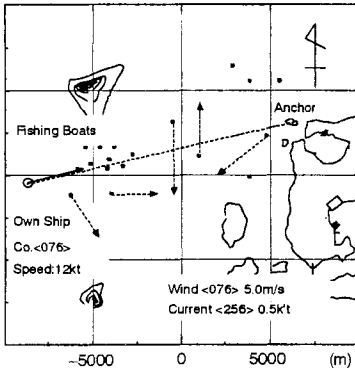


Fig.3 : Training scenario for chief mate

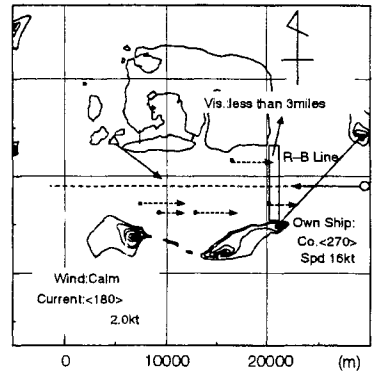


Fig.4 : Training scenario for second mate

added technique when the task **a** and **b** are compounded. Generally speaking, respective **g1** and **g2** alone is not sufficient for a ship maneuvering technique for certain cases. In such cases when the technique **a** and **b** are performed simultaneously, a new ability is required which should be added to **g1** and **g2**. This kind of ability is defined as **g3**, a compound term. Based on above concept, it is possible to regard the total technique consisting of more than three elemental techniques as a combination of an independent elemental technique and compound elemental techniques. And the ship maneuvering technique as a whole can be generalized by using formula (1).

To clarify required techniques on the requested task, it is necessary to develop the guideline of the required elemental techniques and skills. In which, what the mariners are to accomplish and how to execute the requested task adequately, is indicated. The sample description of the standard maneuvering manual is shown in Fig.2.

#### 4 Simulator Training Scenarios

As a result of above-mentioned researches, the authors have developed 10 kinds of simulator training scenarios for the MET.

The training scenarios are developed for three ship's license rank respectively. The training scenario for a chief mate intending to be promoted to a master, consists of 2 kinds of scenarios. The time of each training scenario is about 60 minutes. Scenario10 is a typical scenario of ship maneuvering technique in port. Scenario10 is shown in Fig.3.

The scenario for second mate intending to be promoted to a chief mate consists of 4 kinds of scenarios. Each training time is about 40 minutes. These are the typical scenarios of ship handling techniques at restricted water and etc.. Scenario7 for second mate is shown in Fig.4. The scenario for a cadet also consists of 4 kinds of scenarios and each training time is about 30 minutes.

Table 1: The List of Scenario on the Simulator Training

License Grade	Scenario	Techniques for Training (Elemental Techniques and Compound Techniques)	Contents
Class 3	1	Positioning, Maneuvering, Positioning/Maneuvering	(1) Proceeding Planned Route
	2	Positioning, Planning	(1) Confirmation of Deviation (2) Planning and Practice Altering Course
	3	Watchkeeping, Rule of Road, Maneuvering, Communication, Watchkeeping/Maneuvering	(1) Acknowledge two ship relations (2) Maneuvering based on the Rule
	4	Watchkeeping, Maneuvering, Communication, Positioning, Planning Rule of Road Watchkeeping/Maneuvering	(1) Acknowledgement of Two Ship Relations (2) Maneuvering based on Rule (3) Confirmation of Deviation while Avoiding Vessels (4) Planning and Practice back to Original Course
Class 2	5	Maneuvering, Communication, Rule of Road, Communication/Maneuvering, Rule of Road/Communication	(1) Avoiding Vessels under the Restricted Conditions (2) Proceeding Planned Route under the Restricted Conditions
	6	Communication, Watchkeeping, Maneuvering Watchkeeping/Communication Maneuvering/Watchkeeping	(1) Avoiding Vessels under the Restricted Conditions (2) Proceeding Planned Route under the Restricted Conditions
	7	Watchkeeping, Instrumentation, Maneuvering, Rule of Road, Management Watchkeeping/Instrumentation, Maneuvering/Watchkeeping	(1) Avoiding Vessels under the Restricted Visibility (2) Proceeding Planned Route under the Restricted Visibility
	8	Communication, Watchkeeping, Maneuvering, Watchkeeping/Communication, Maneuvering/Watchkeeping	(1) Avoiding Vessels in Night Time (2) Proceeding Planned Route in Night Time
Class 1	9	Watchkeeping, Rule of Road, Maneuvering, Watchkeeping/Rule of Road, Rule of Road/Maneuvering, Maneuvering/ Watchkeeping, Watchkeeping/Rule of Road/Maneuvering, Positioning/Planning, Maneuvering/Planning, Management	(1) Planning Navigation with Decelerating (2) Navigation in Congestion Waters under the Restricted Conditions with wind and current disturbance (3) Approaching to Pilot Station
	10	Planning, Positioning, Maneuvering, Positioning/Planning, Planning/Maneuvering, Positioning/Maneuvering Positioning/Planning/Maneuvering Management	(1) Planning Anchoring Maneuver (2) Amending and Practice the Plan corresponding to Circumstances (3) Anchoring at Designated Area under the Restricted Conditions with wind and current disturbance

These scenarios are typical ones of fundamental techniques under collision avoidance and etc.

All the techniques needed for ship handling are contained in these 10 scenarios. The List of Scenario on the Simulator Training is shown in Table 1. The training techniques and contents of each scenario are indicated.

## 5 Assessment on Skills

Assessment on the skills is important and necessary to educate and train the techniques. It isn't only for the MET but also for general education and training fields. Authors have developed the quantitative assessment method and its criterion.

The items of assessment include the contents of handling and ship's motion, understanding of present and future situation that are obtained through the hearing by assessors. These assessing items are listed corresponding to the flow of training scenarios. It's possible to make assessment of training easy and to keep the real time assessment.



Scoring methods of assessing items are discussed in order to realize the rational and effective training. As the each assessment may not depends on the personality of assessor, standard maneuvering manuals are developed above-mentioned and assessment are executed based on them. The characteristics of this assessment system are as follows ;

- The items are concrete and corresponding to the elemental techniques.
- The assessment is objectively and quantitatively.
- The assessment meets the progress of training scenario.

## **6 Briefing**

Briefing is one of important factors in training, briefing in simulator training are divided into 3 steps.

### **6.1 Basic briefing**

This briefing is held at the initial period of simulator training. The contents of briefing are constructed by the following items.

- The explanation of the objects of training.
- The lecture for the maneuvering characteristics of own ship in simulator training.
- The explanation of navigating environment such as geographiic and traffic rule.
- The lecture based on handling manual.
- The explanation of ship handling simulator.

### **6.2 Pre-briefing**

Pre-briefing is held at the just before the training in simulator in short time within 5 to 10 minutes. Therefore, the contents are mainly reconfirmation of the objects of training and the explanation of navigating environment.

### **6.3 Post briefing**

The post briefing is one of imporatant factors that decide the effectiveness of the training. Most time of post-briefing are made based on the assessment. Therefore the contents of post-briefing are discussed in the following chapter.

## **7 Discussion**

In this chapter, showing the example of typical result of the simulator training

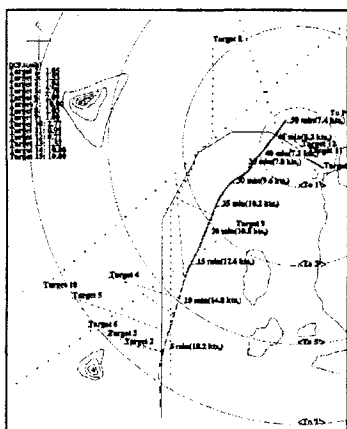


Fig. 5 : The result of 1st training (Scenario 9)

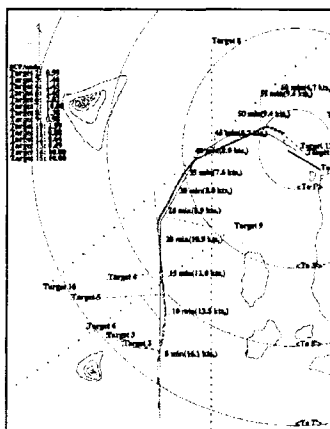


Fig. 6 : The result of 5th training (Scenario 9)

based on proposed MET system, we confirm the effectiveness on proposed MET System by using scenario 9.

In this scenario, wind is NE 15m/s, current is 1.5 k't in direction to North, plural ships exist. The objects of this training is to bring up the competency as follows.

- 1) To make plans timely considering the safety and efficiency based on guideline.
- 2) To avoid collision considering the safety and efficiency based on guideline.
- 3) To maneuver safely for picking up pilot considering guideline, 1 and 2 mentioned above.
- 4) To manage members including myself and communicate with members, target ship and VTS etc..

One of tasks in this scenario is to arrive at pilot station according to information from VTS. Fig.5 and 6 show the trajectories in each training. The pilot station is located on the center of circles. The circles indicate remaining distance to pilot station every 2 miles. The solid line indicates planned line to pilot station. The shapes of ship indicate trajectory in training every 5 minutes. Black dots indicate trajectory of other ships every 5 minutes. Table 2 shows assessment sheet that is indicated as results of 1<sup>st</sup> and 5<sup>th</sup> training. In 1<sup>st</sup> training, ship's operator recognized the movement and relations based on traffic rule for plural ships in early stage. Therefore, the handling for avoiding target ship was appropriate for guideline. However, he could not confirm performance of member in bridge and he could not communicate with all members and target ships completely. Accordingly, he could not recognize the situation timely and his planning lacked the consideration on effect of wind and current and on margin of handling error after avoiding collision. Consequently, Fig.5 indicates



Table2: An Example of Assessment Sheet (Scenario 9)

No.	Task	Elemental Technique	Contents of Assessment	Points			Score		
				1	0	-1	1st	5th	
1	Recognizing for avoiding collision	Watchkeeping	On recognition of the movement for plural ships (the distance when trainee recognized)	Ship 8	dist>5'	5-3'	3>dist	1	1
				Ship 9	dist>5'	5-3'	3>dist	1	1
				Ship 10	dist>5'	5-3'	3>dist	1	1
				Ship 11	dist>5'	5-3'	3>dist	1	1
				Ship 12	dist>5'	5-3'	3>dist	1	1
			Ship 13	dist>5'	5-3'	3>dist	1	1	
							100%	100%	
2		Rule of Road	On recognition of relations for plural ship based on the traffic rule (interview and replay)	Ship 8	attained	-	missed	1	1
				Ship 9	attained	-	missed	1	1
				Ship 10	attained	-	missed	1	1
				Ship 11	attained	-	missed	1	1
				Ship 12	attained	-	missed	1	1
			Ship 13	attained	-	missed	1	1	
							100%	100%	
3		Watchkeeping/Rule of road	On recognition target ships based on the traffic rule (interview)	attained	-	missed	1	1	
							100%	100%	
4	Maneuvering for avoiding plural ships	Maneuvering (1)	On maneuvering for avoiding plural ships based on the guide line (DCPA)	Ship 8	dcpa>1'	1'-0.5'	0.5>dcpa	1	1
				Ship 9	dcpa>1'	1'-0.5'	0.5>dcpa	1	0
				Ship 10	dcpa>1'	1'-0.5'	0.5>dcpa	1	1
5		Rule of road/Maneuvering	On maneuvering for avoiding target ship based on the traffic rule (interview and replay)	attained	-	missed	1	1	
							100%	100%	
6		Maneuvering/Watchkeeping	On decision of the timing for avoiding target ship (distance when trainee practiced)	attained	3-1'	1>dist	1	1	
				attained	lacked	missed	1	1	
			On decision of maneuvering for avoiding target ship timely (interview and replay)						
							100%	100%	
7	Planning for heading to pilot station and accomplishment	Positioning/Planning	On planning of the course for heading to pilot station considering wind and current	attained	lacked	missed	0	1	
				attained	lacked	missed	0	1	
			On planning of the maneuver for heading to pilot station considering wind and current (interview and chart)				0%	100%	
8		Maneuvering/Planning	On planning of the maneuver for heading to pilot station considering a margin of error and accomplishment for reported ETA and designated ship's speed at pilot station	diff<5m	5-10m	diff>10m	-1	0	
				ETA below 6kt at P.S	ETA 6-7kt at P.S	ETA over 7kt at P.S	0	1	
							0%	50%	
9		Watchkeeping/Rule of road/Maneuvering	On correction on the plan, maneuvering and procedure for heading to pilot station timely (interview and replay)	attained	lacked	missed	0	1	
							0%	100%	
10	Maneuvering for catching pilot and entering port	Maneuvering (2)	On maneuvering for catching pilot at pilot station (interview and trajectory)	attained	lacked	missed	-1	1	
				attained	lacked	missed	-1	1	
			On maneuvering for entering port at pilot station (interview and trajectory)						
							0%	100%	
11	Management in Training	Management	On explanation of the plans and each task to all members	attained	lacked	missed	1	1	
				attained	lacked	missed	1	1	
				attained	lacked	missed	-1	1	
				attained	lacked	missed	0	1	
				attained	lacked	missed	0	1	
			On confirmation of member's performance						
			On communication with all members						
			On communication with target ship and VTS (interview and video)						
							20%	80%	
							20%	100%	
Total							54%	93%	

that ship in 40 ~ 50 minutes was not headed for designated pilot station. Moreover, the difference from ETA reported to VTS was over 15 minutes and ship's speed at pilot station was over 6 k't. The results of assessment are indicated in Table.2 shown in end of this paper. In 1st training on Table.2, scores of Positioning/Planning, Maneuvering/Planning and Watchkeeping/Rule of Road/Maneuvering are assessed as 0%, scores of Maneuvering and Management are assessed as 20% and score of Total is assessed as 54%.

At post briefing after 1<sup>st</sup> training, ship' operator was pointed out that the plan must be considered on the wind and current and a margin of error and the management must be practiced to confirm member's performance and



communicate with member and target ship timely.

In 5<sup>th</sup> training, comparing with 1<sup>st</sup> training, ship operator communicated with members about the circumstances frequently and confirmed member's performance timely. Therefore, he could recognize the circumstances timely and maneuver for avoiding target ship by utilizing VHF. Moreover, timely information and maneuvering gave him time to make plans considering wind, current and a margin of error. Accordingly, Fig.6 indicates that ship's deviation from planned line is small and ship in 55 ~ 60 minutes was headed for pilot station appropriately. However, the difference from ETA was 8 minutes. This result was caused by his planning which lacked consideration on margin of error. These results are indicated in Table.2. In 5<sup>th</sup> training in Table.2, score of Maneuvering/Planning is assessed as 50%, score of Maneuvering is assessed as 80%, score of Management is assessed as 100% and score of Total is assessed as 93%.

Considering the achievement from 1<sup>st</sup> to 5<sup>th</sup> in simulator training in scenario 9, the competency on techniques of Management, Positioning/Planning, Watchkeeping/Rule of road/Maneuvering and Maneuvering were improved highly. In every post briefing, instructor pointed out the contents of required techniques repeatedly. As the contents were acceptable for ship's operator, these techniques indicated high scores with fluctuations gradually. Maneuvering/Planning indicated low improvement. At post briefing, this technique was pointed out by same method. Therefore, it is clarified that many training times are required to learn this technique. The rest of technique indicated high improvement, and Total competency was achieved from 54% to 93%. Moreover, the trajectory indicates good agreement with guideline in 5<sup>th</sup> training. Other trainees also showed same tendency. Therefore, it can be said that proposed MET system is effective.

## 8 Conclusion

Authors have developed the MET system based on the systematized maritime techniques, as a result of above-mentioned research. The characteristics of the developed system are as follows ;

- By utilizing the proposed guideline, the systematic knowledge conformable to the actual situation can be educated.
- By utilizing the proposed assessment system, the achieved degree of ability conformable to the techniques to be trained can be clarified respectively. As a result, insufficient ability can be trained intensively and training period will be shortened.
- By utilizing the proposed training scenarios, the effective training curriculum can be constructed corresponding to the required techniques.
- Because of all the techniques needed for ship handling are contained and assessed in this system, it can be said that the simulator training based on



the systematized maritime techniques is obviously effective to train objective techniques.

## Reference

- [1] Hiroaki Kobayashi, et al (1997), Developing of Ship-handling Techniques into the Elemental Techniques and Proposal of Education/Training Methods Utilizing Ship-handling Simulator, *Proceeding of IMLA* , St. John's Canada
- [2] Japan Maritime Ship Handling Simulator Conference, *Japan Institute of Navigation* (1997,2000), proceedings of Marine Simulator Seminar Tokyo, 1997,2000
- [3] Hiroaki Kobayashi, et al (1997), Proposal for Educational and Training Curricula Using a Ship Maneuvering Simulator, *The Journal of Japan Institute of Navigation* Vol. 96 (March), pp.127-137.
- [4] Hiroaki Kobayashi, et al (1998), Assessment Methods of MET using Ship Handling Simulator (1998), *Proceedings of IMLA* , St. Malo France
- [5] Hiroaki Kobayashi (1998), Training and Assessment Utilizing Ship Handling Simulator, *Proceedings of International Navigation Simulator Lecturer's Conference INSLC 10*, UK.
- [6] Hiroaki Kobayashi and Shin Murata (1999), The Training and Assessment Utilizing Ship Handling Simulator, *The Journal of Japan Institute of Navigation* Vol. 100 (March): pp.161-168.
- [7] Hiroaki Kobayashi, et al (2000), New Standards of MET using Ship Handling Simulator, *Proceedings of MARSIM 2000*, Orlando, Florida, USA, pp.159-171.