Practical Implementation of e-navigation
- focus on MSP

2014. 5.28

Prof. Yung Ho YU, KOREA

Head of AITASC (Advanced IT & Ship Convergence Center)
Chairman of IEC TC 80K, TTA PG 607, e-Navigation Strategy Forum
Korea Maritime University
yungyu@hhu.ac.kr
Contents

- SIP overview of IMO e-navigation
- Why need to measure the effectiveness of MSP
- Seven Pillars of e-Navigation As a MSP Framework
- Case study to find out what and how to measure the effectiveness of MSP
- Results of evaluation experiment
After performing the gap analysis, following solutions were identified:

- S1: Improved, harmonized and user-friendly bridge design
- S2: Means for standardized and automated reporting
- S3: Improved reliability, resilience and integrity of bridge equipment and navigation information
- S4: Integration and presentation of available information in graphical displays received via communication equipment
- S5: Information management
- S6: Improved access to relevant information for Search and Rescue
- S7: Improved reliability, resilience and integrity of bridge equipment and navigation information for shore-based users
- S8: Improved and harmonized shore-based systems and services
- S9: Improved communication of VTS service portfolio (not limited to VTS stations)
As a part of the FSA, following RCOs were identified to provide effective risk reduction in a cost–effective manner

- **RCO 1**: Integration of navigation information and equipment including improved software quality assurance
- **RCO 2**: Bridge alert management
- **RCO 3**: Standardized mode(s) for navigation equipment
- **RCO 4**: Automated and standardized ship–shore reporting
- **RCO 5**: Improved reliability and resilience of onboard PNT systems
- **RCO 6**: Improved shore–based services
- **RCO 7**: Bridge and workstation layout standardization
SIP overview of IMO e-navigation

Considering previous Solutions to solve the Gap and RCOs in a cost-effective manner, following MSPs were identified:

- MSP 1 VTS Information Service (IS);
- MSP 2 VTS Navigation Assistance Service (NAS);
- MSP 3 VTS Traffic Organization Service (TOS);
- MSP 4 Local Port Service (LPS);
- MSP 5 Maritime Safety Information (MSI) service;
- MSP 6 pilotage service;
- MSP 7 tugs service;
- MSP 8 vessel shore reporting;
- MSP 9 Telemedical Maritime Assistance Service (TMAS);
- MSP 10 Maritime Assistance Service (MAS);
- MSP 11 nautical chart service;
- MSP 12 nautical publications service;
- MSP 13 ice navigation service;
- MSP 14 Meteorological information service;
- MSP 15 real-time hydrographic and environmental information services;
- MSP 16 Search and Rescue (SAR) Service.
Also MSPs should consider operation in following areas, which are agreed in NAV 59:

- port areas and approaches;
- coastal waters and confined or restricted areas;
- open sea and ocean areas;
- areas with offshore and/or infrastructure developments;
- polar areas; and
- other remote areas.
Why need to measure effectiveness of MSP (1/2)

- “With the implementation of the e-Navigation strategy, there will most likely be different sets of service provided and different levels of these services, operational, technical (and commercial) in adjacent areas throughout the same voyage of a vessel from berth to berth.” in Report of e-Navigation CG(NAV 56/8), 23 April 2010
  - Consideration not to become indiscreetly
  - Maintaining interoperability of MSP
  - Maintaining interoperability between MSP and ship network
  - Consideration effectiveness and usability of MSP
  - Preventing confusion caused by similar MSPs
To avoid these, need to

- Standardize the MSP framework and Architecture
- Consider to be networkable with ship standard network
- Be managed and registered by one organization
- Set up criterion to evaluate effectiveness and usability
Seven Pillars of e-Navigation As a MSP Framework

Check and Measure
- General Items
  ✓ Easy to Understand
  ✓ Language selectable
  ✓ Display effectively
  ✓ Comply with
    - IMO PS
    - IEC IS
    - MSP Architecture
    - MSP Framework
- Specific Items
  ✓ Effectiveness and usability → measure
    What and How

Operational MSP

MSP CMDS

Technical MSP

Ship Standards Network

Ship Equipment
- SE
- ECDIS
- INS

AIS
VDE:

CO
M

COM

SI
Local Admin.
PSC
VTS
A&H

Objective of MSP
Study Example what and how to measure

- Provided Information: Route planning information of other ship adjacent own ship in crowded traffic
- Hypothesis: Provided information might help for safe navigation
- How to provide MSP: Display route planning of other ship on own ship ECDIS
- Experiment:
  - Using FMSS (Full Mission Simulation System)
  - Place: Entrance route of Busan and Osaka Port with equivalent traffic environment
  - Mariner: 2 captains and 2 3rd mates
  - Method: Compare when MSP is provided and not
  - Vessel: Container ship with 51,309 Displacement tonnage
  - Engine Power and Max speed: 25,270 kW, 22.5 knots
  - Environment: Wind 280°, 10 knot, Current 100°, 0.5 knot for Busan
    Wind 053°, 10 knot, Current 233°, 0.5 knot for Osaka
**Characteristic of ship used in Simulation**

<table>
<thead>
<tr>
<th>PILOT CARD</th>
<th>Date</th>
<th>29.12.2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship name</td>
<td>Container ship 11 (Dis.22458t) bl. TRANSAS 2.31.3.0</td>
<td></td>
</tr>
<tr>
<td>IMO Number</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Load Condition</td>
<td>Ballast</td>
<td></td>
</tr>
<tr>
<td>Displacement</td>
<td>22458 tones</td>
<td>Draft forward</td>
</tr>
<tr>
<td>Deadweight</td>
<td>35000 tonnes</td>
<td>Draft forward extreme</td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td>Draft after</td>
</tr>
<tr>
<td>Air draft</td>
<td>49.25 m / 162 ft 0 in</td>
<td>Draft after extreme</td>
</tr>
<tr>
<td>Date</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ship's Particulars**

<table>
<thead>
<tr>
<th>Length overall</th>
<th>222.17 m</th>
<th>Type of bow</th>
<th>Bulbous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breadth</td>
<td>30 m</td>
<td>Type of stern</td>
<td>Transom</td>
</tr>
<tr>
<td>Anchor Chain(Port)</td>
<td>24 shackles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchor Chain(Starboard)</td>
<td>13 shackles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchor Chain(Stern)</td>
<td>N/A shackles</td>
<td>(1 shackle =27.5 m / 15 fathoms)</td>
<td></td>
</tr>
</tbody>
</table>
## Characteristic of ship used in Simulation

### Steering characteristics

<table>
<thead>
<tr>
<th>Steering device(s) (type/No.)</th>
<th>Semisuspended / 1</th>
<th>Number of bow thrusters</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum angle</td>
<td>35</td>
<td>Power</td>
<td>1750 kW</td>
</tr>
<tr>
<td>Rudder angle for neutral effect</td>
<td>0.13 degrees</td>
<td>Number of stern thrusters</td>
<td>N/A</td>
</tr>
<tr>
<td>Hard over to over(2 pumps)</td>
<td>17 seconds</td>
<td>Power</td>
<td>N/A</td>
</tr>
<tr>
<td>Flanking Rudder(s)</td>
<td>0</td>
<td>Auxiliary Steering Device(s)</td>
<td></td>
</tr>
</tbody>
</table>

### Stopping

<table>
<thead>
<tr>
<th>Description</th>
<th>Full Time</th>
<th>Head reach</th>
<th>Ordered Engine: 100%, Ordered rudder: 35 degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAH to FAS</td>
<td>303.6 s</td>
<td>8.99 cbls</td>
<td>Advance</td>
</tr>
<tr>
<td>HAH to HAS</td>
<td>213.8 s</td>
<td>4.46 cbls</td>
<td>Transfer</td>
</tr>
<tr>
<td>SAH to SAS</td>
<td>214.9 s</td>
<td>3.26 cbls</td>
<td>Tactical diameter</td>
</tr>
</tbody>
</table>

### Turning circle

<table>
<thead>
<tr>
<th>Type of Main Engine</th>
<th>Slow speed diesel</th>
<th>Number of propellers</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Main Engine(s)</td>
<td>1</td>
<td>Propeller rotation</td>
<td>Right</td>
</tr>
<tr>
<td>Maximum power per shaft</td>
<td>1 x 25270 kW</td>
<td>Propeller type</td>
<td>FPP</td>
</tr>
<tr>
<td>Astern power</td>
<td>70 % ahead</td>
<td>Min. RPM</td>
<td>27.99</td>
</tr>
<tr>
<td>Time limit astern</td>
<td>N/A</td>
<td>Emergency FAH to FAS</td>
<td>203.9 seconds</td>
</tr>
</tbody>
</table>

### Main Engine(s)

### Engine Telegraph Table

<table>
<thead>
<tr>
<th>Engine order</th>
<th>Speed, knots</th>
<th>Engine power, kW</th>
<th>RPM</th>
<th>Pitch ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Sea Ahead</td>
<td>23</td>
<td>20000</td>
<td>100</td>
<td>1.14</td>
</tr>
<tr>
<td>Full Ahead</td>
<td>16.1</td>
<td>6955</td>
<td>70</td>
<td>1.14</td>
</tr>
<tr>
<td>Half Ahead</td>
<td>11.5</td>
<td>2593</td>
<td>50</td>
<td>1.14</td>
</tr>
<tr>
<td>Slow Ahead</td>
<td>9.2</td>
<td>1359</td>
<td>40</td>
<td>1.14</td>
</tr>
<tr>
<td>Dead Slow Ahead</td>
<td>6.4</td>
<td>496</td>
<td>28</td>
<td>1.14</td>
</tr>
</tbody>
</table>
Sample Ports used in Simulation

- Position A
- Position B
- Busan
- Osaka

Define reference position
Overlapped wake of Simulation for Busan Port
Overlapped wake of Simulation for Osaka Port
Criterion and Evaluation

Criterions

- Controllability and control allowance: Ability to be able to control and how much controllable allowance against limitation and constraint of rudder and engine each.
- Distance from reference position: Closest distance between ship and reference position. If each distance from each reference position is similar, then navigation can be evaluated smoothly.
- Navigational threat for Mariner: Anxiety for accident or uneasiness of navigation which is felt by mariner subjectively. It is graded from −3 to +3. +3 is easiest and −3 worst.
### Controllability and Control Allowance Analysis

**Port of BUSAN**

<table>
<thead>
<tr>
<th></th>
<th>Rudder Angle</th>
<th>Engine RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average (degree)</td>
<td>Allowance(%)</td>
</tr>
<tr>
<td>Captain A</td>
<td>4.8689</td>
<td>86.09</td>
</tr>
<tr>
<td>Captain B</td>
<td>4.2131</td>
<td>87.96</td>
</tr>
<tr>
<td>3rd Mate C</td>
<td>8.2951</td>
<td>76.30</td>
</tr>
<tr>
<td>3rd Mate D</td>
<td>5.0492</td>
<td>85.57</td>
</tr>
</tbody>
</table>

**Port of OSAKA**

<table>
<thead>
<tr>
<th></th>
<th>Rudder Angle</th>
<th>Engine RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average (degree)</td>
<td>Allowance(%)</td>
</tr>
<tr>
<td>Captain A</td>
<td>7.0984</td>
<td>79.72</td>
</tr>
<tr>
<td>Captain B</td>
<td>6.3559</td>
<td>81.84</td>
</tr>
<tr>
<td>3rd Mate C</td>
<td>6.2143</td>
<td>82.24</td>
</tr>
<tr>
<td>3rd Mate D</td>
<td>11.6393</td>
<td>66.74</td>
</tr>
</tbody>
</table>
## Distance from Reference Position Analysis

<table>
<thead>
<tr>
<th></th>
<th>Port of PUSAN</th>
<th>Port of OSAKA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distance from A (m)</td>
<td>Distance from B (m)</td>
</tr>
<tr>
<td>Captain A</td>
<td>Can’t measure</td>
<td>Can’t measure</td>
</tr>
<tr>
<td>Captain B</td>
<td>158</td>
<td>117</td>
</tr>
<tr>
<td>3rd Mate C</td>
<td>Can’t measure</td>
<td>Can’t measure</td>
</tr>
<tr>
<td>3rd Mate D</td>
<td>119</td>
<td>110</td>
</tr>
</tbody>
</table>

MSP Provided
Navigational Threat Analysis

<table>
<thead>
<tr>
<th>Classified</th>
<th>Mariner A</th>
<th>Mariner B</th>
<th>Mariner C</th>
<th>Mariner D</th>
<th>Mariner A</th>
<th>Mariner B</th>
<th>Mariner C</th>
<th>Mariner D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BUSAN</td>
<td>OSAKA</td>
<td>OSAKA</td>
<td>BUSAN</td>
<td>OSAKA</td>
<td>BUSAN</td>
<td>BUSAN</td>
<td>OSAKA</td>
</tr>
<tr>
<td>Maneuvering Threat</td>
<td>-3</td>
<td>-1</td>
<td>-3</td>
<td>-3</td>
<td>-1</td>
<td>-1</td>
<td>-3</td>
<td>-2</td>
</tr>
<tr>
<td>Average</td>
<td>-2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological burden</td>
<td>-3</td>
<td>-1</td>
<td>-3</td>
<td>-3</td>
<td>+2</td>
<td>+1</td>
<td>-2</td>
<td>-3</td>
</tr>
<tr>
<td>Average</td>
<td>-2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.5</td>
</tr>
</tbody>
</table>

MSP Provided
Evaluation Experiment Results

- Controllability and Access Distance from reference position Analysis
  - No difference by provided MSP
  - Depend upon mariner’s maneuvering style
  - Caused by unfamiliarity with using information and MSP
  - In urgent situation, embarrassed without allowance to use information and think
  - Tend to operate rudder and engine under anxiety

- Navigational Threat Analysis
  - Maneuvering threat and psychological burden is reduced remarkably by providing MSP
Evaluation Experiment Results

Results

- Need to find more reasonable measuring elements to evaluate safety of navigation
- for experienced mariner depend on Radar in comparison with unskilled mariner
- Need education and training to use information provided
- Effectiveness of MSP might be far from expectation in real case
THE OCEAN IS PAST, PRESENT AND FUTURE, ALWAYS BLUE OCEAN

Thank you for Listening.