SKILLSEA

THE TOOLBOX GUIDE

Curriculum	
Learning Objectives	The report on future skills concludes that the maritime professionals (both seagoing and shore-based) need an in-depth understanding of the sophisticated systems onboard. The course aims to provide maritime professionals with the knowledge and skills required to use information infrastructure on board modern ships. The maritime professional will be able to assess available data and be able to act upon this data. The learning objectives focus on knowledge and skills related to: a) structure, components, and essential maintenance of the shipboard network, b) operation and use of different onboard sensors connected to the shipboard network, c) nature and quality of shipboard generated data.
Target group	This course targets any maritime professional at the STCW *operational* level (or currently undergoing training to achieve this level), e.g. a junior officer or cadet interested in upgrading or improving his/her digital knowledge and skills.
Entry requirements	Participants' minimum competence requirements to successfully follow this educational package is a national equivalent of EQF level 4 - 5.
Duration	The suggested duration of this course is 21 hours spread over a four-week period. The student should expect 21 hours of study, e.g. self-study by e-learning, directed study in a classroom and/or blended learning environment. Provision should be made as appropriate for on board learners.

Assessment	Diagnostic assessment will be used in advance, and quizzes will be used to scaffold learning (formative assessment) throughout, with a final quiz at the end (summative assessment). An example of a diagnostic test is provided in Appendix 2.
Course Outline	The course consists of 21 lessons listed below. These lessons will enable the student to achieve the learning outcomes described. Each lesson relates to the intended learning outcomes, as shown in the lesson plan (Appendix 1) **Lesson / Topic table and note below**

Lesson	Topic
1.*	Diagnostic assessment and overview of the aims of the course and the assessment strategy
2.*	Network Topologies
3.*	Evolutions in ship operations
4.*	Network components
5.*	Shipboard control and Monitoring Networks
6.*	Parameters to be monitored
7.*	Shipboard sensors
8. + 9.	Monitoring status of the shipboard network
10.+ 11	Interference and troubleshooting
12.*+ 13*	Shore-side data monitoring and effective communication
14.*- 20.*	Case Studies and Scenarios
21.	VLE Quiz

*These lessons are included in appendix 2 and 3 as examples

Learning Outcome	**Learning Outcomes:** *Knowledge* 1. Describe the structure of the shipboard network [hardware] 2. Identify the main network components onboard the ship 3. Recognise the error messages generated by the shipboard network and error states. *Skills* 4. Interpret the interdependent nature of shipboard generated data 5. Distinguish between types of sensor 6. Act appropriately in response to 'fault identified' 7. Establish effective communication between shore-based personnel and ship officers *Responsibilities and autonomy* 8. Assess the quality of shipboard generated data 9. Reflect on the limits of their digital competence and communicate their advanced needs
Teaching methods	This course requires high participant activity; therefore, audio-visual presentations could be used. For example, the student might be presented with informational or instructional content, such as: • Video – a compilation of clips with narration • Narrated PowerPoint The student will complete VLE quizzes, e.g. via Moodle as formative assessment throughout, ideally one per section (1-3). A case scenario is being used, which can be carried out as an onboard exercise or simulation exercise. For teaching methods suggested use, refer to the individual lessons; see lesson plan Appendix 1 and lesson examples Appendix 3. If this is being delivered on board a ship, consideration should be given to how officers delivering the EP will be supported in having the relevant detailed knowledge to develop the resources and support the students.

Teaching material	In part 3, the student will work on a case scenario focusing on familiarisation with the ship's data structure. This case can also be carried out as a simulator exercise. An example of a case scenario is provided in appendix 3.
Assessment	The final assessment is a VLE quiz (e.g. Moodle); the duration of this quiz is 60 minutes.
Evaluation	
Course Review	The students will complete a survey at the end of the course. Lecturers will review the survey outcomes and provide their reflections, with possible actions for developers/deliverers to consider.

Appendix 1 – Table of constructive alignment

№	Lesson topic	Learning outcome (Numerated as per toolbox guide)	Teaching method(s)	Assessment method
1	Diagnostic assessment	1		Test
2	Network Topologies	1	The method will be primarily lecture-based, providing the groundwork for a more active-learning approach later in the module.	VLE Quiz – Two questions per lesson (summative) One question (formative)
3	Evolutions in ship operations	2	This lesson will be delivered in the form of e-Learning, PowerPoint presentations and video compilation of clips with narration. A formative quiz is used to get an insight into the understanding of the lesson concepts.	VLE Quiz – Two questions per lesson (summative) One question (formative)
4	Network components	2	As this learning outcome is about recognition of components and familiarisation with their role in a shipboard network, the information will be delivered in the form of a presentation.	VLE Quiz – Two questions per lesson (summative) One question (formative)
5	Shipboard control and Monitoring Networks	2	This lesson is primarily action-based with lecturer support.	VLE Quiz – Two questions per lesson (summative) One question (formative)

6	Parameters to be monitored	3	This lesson will be delivered in the form of e-Learning, PowerPoint presentations, and video compilation of clips with narration. A formative quiz is used to get an insight into the understanding of the lesson concepts.	VLE Quiz – Two questions per lesson (summative) One question (formative)
7	Shipboard sensors	3	This lesson will be delivered in the form of e-Learning, PowerPoint presentations and video compilation of clips with narration.	VLE Quiz – Two questions per lesson (summative) One question (formative)
8	Monitoring status of the shipboard network	5	Teaching techniques: Student-Centred Approach to Learning, discussion - debates Teaching methods to support learning: - Flipped classroom –allow students to go beyond their normal boundaries and explore the lesson before the teacher describe them in classroom - ICT based teaching method – open educational resources Mind maps – use of self-learning tools	VLE Quiz – Two questions per lesson (summative) One question (formative)
9	Monitoring status of shipboard network	5	Teaching techniques: Student-Centred Approach to Learning, discussion - debates Teaching methods to support learning: - Flipped classroom –allow students to go beyond their normal boundaries and explore the lesson before the teacher describe them in classroom - ICT based teaching method – open educational resources Mind maps – use of self-learning tools	VLE Quiz – Two questions per lesson (summative) One question (formative)

10	Interference and trouble shooting	3	Teaching techniques: Student-Centred Approach to Learning, discussion - debates Teaching methods to support learning: - Flipped classroom –allow students to go beyond their normal boundaries and explore the lesson before teacher describe them in classroom - ICT based teaching method – open educational resources Mind maps – use of self-learning tools	VLE Quiz – Two questions per lesson (summative) One question (formative)
11	Interference and trouble shooting	3	Practical activity with PCB	VLE Quiz – Two questions per lesson (summative) One question (formative)
12	Shore-side data monitoring and effective communication	6	This lesson will be delivered in the form of e-Learning, PowerPoint presentations, and video compilation of clips with narration. A formative quiz is used to get an insight into the understanding of the lesson concepts.	VLE Quiz – Two questions per lesson (summative) One question (formative)
13	Shore-side data monitoring and effective communication	6	This lesson will be delivered in the form of e-Learning, PowerPoint presentations, and video compilation of clips with narration. If in a classroom setting, this could complement a simulator exercise with (either deck or engine room). The teacher should consider developing a scenario transcript for role-play session involving ship to shore communication. This scenario transcript can also be used for self-study in an e-learning context.	VLE Quiz – Two questions per lesson (summative) One question (formative)

| 14 - 20 | Case scenario | 4 | To be determined by training provider based on scenario approach used, for example: case studies, historical studies or case scenarios. | To be determined by training provider based on scenario approach used. |
| 21 | VLE Quiz | 8 | 1 hour | VLE self-assessment quiz covering topic-based questions from lessons 1-13 |

Appendix 2 – Example Diagnostic Assessment[1]

Guidance notes:

- The target group for this course are assumed to be at the following level:
    - The minimum competence requirements for participating students in this educational package is a national equivalent of EQF level 4 - 5.
    - DigComp 2.1 – FOUNDATION LEVEL *At basic level and with guidance -> At basic level and with autonomy and appropriate guidance where needed.*

- Teachers delivering the course can use this as an example diagnostic tool as the basis for a VLE quiz, or in-class exercise, e.g. discussion, to identify the existing competency level of the learners.

The diagnostic assessment questions proposed below could be further amended and adjusted to learners' profiles and their expected skills and level. The instrument below offers a range of questions, from basic abilities to work with information and data to slightly more advanced and relevant to the shipboard environment. Instructors are encouraged to adapt proposed questions and choose those that are more relevant for their learners.

It is critical that the outcomes of this diagnostic assessment are analysed, and learners are further supported to develop their skills gradually to meet the learning outcomes of this educational package.

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[1]**Guidance notes:**

The target group for this course are assumed to be at the following level:

DigComp 2.1 – FOUNDATION LEVEL *At basic level and with guidance -> At basic level and with autonomy and appropriate guidance where needed.*
D5_Contents_assessment_tool.pdf (dcds-project.eu)

	0 to 3 months	3 to 6 months	6 to 12 months	>= 12 months
How many months of seagoing experience do you have?				
How many months of simulator experience do you have?				

Competence Area	Sub-competence	Statements	1 = I have no skills at all	2 = my skills are very poor	3 = I have some skills, but not sufficient to operate on my own	4 = I have sufficient skills to operate on my own
1. Information and data literacy	1.1. browsing, searching and filtering data	My ability to use a search engine (Google, Bing, Yahoo) to find the information I need.				
		My ability to download and save files from the internet.				
		My ability to respond to information needs and do searches to obtain data / information.				
	1.2. Evaluating data, information and digital content	My ability to evaluate whether data, information, or content that I find online are reliable or not.				
		My ability to recognise error messages and when digital technologies are in a state of error, e.g. assess the status of the operating radar, satellite, and computer systems of a vessel.				

	1.3. Managing data, information and digital content	My ability to create, open, copy, move, delete files and folders on a) external/portable storage devices (hard disk, USB memory stick, memory card, CD), b) cloud storage services.				
		My ability to understand the interdependence of onboard communication systems (input/output).				
		My ability to identify appropriate means to respond to an error or a fault.				
		My ability to control, monitor, and adjust equipment, e.g. [Deck] telecommunication, navigation, radio transmission or broadcasting equipment. [Engine] onboard radio transmission, fuel consumption, or shaft rotation.				

Competence Area	Sub-competence	Statements	1 = I have no skills at all	2 = my skills are very poor	3 = I have some skills, but not sufficient to operate on my own	4 = I have sufficient skills to operate on my own
2. Interacting through digital technologies	2.1. Interacting through digital technologies	My ability to send and receive e-mails (send, reply, forward) and to manage them.				
		My ability to monitor maritime activities, materials, and surroundings [Deck] monitor speed, current position, direction, and weather conditions while carrying out watch duties. [Engine] monitor engine room alarms, generators, air compressors, fuel pumps, and speed.				
		My ability to adapt various digital technologies for the most appropriate interaction, e.g. using ICT software and hardware to collaborate and communicate with others.				
	2.2. Sharing through digital technologies	My ability to share folders on the cloud.				
		My ability to operate onboard marine communication systems; communicate with other ships or with the onshore control centre, e.g. to send urgent messages concerning safety; transmit or receive alerts.				
		My ability to perform routine interactions with digital technologies, e.g. use e-mail software and services, use personal organisation software.				
	2.3. Engaging in citizenship through digital technologies	My ability to fill an online form (also using a dropdown list, check box, radio button, calendar, and other functions).				

	2.4. Collaborating through digital technologies	Review information from equipment, events, or the environment; identify and assess problems and communicate with more senior officers				
		My ability to operate and maintain maritime communication devices; conduct periodic inspections of communication equipment.				
	2.5. Netiquette	My ability to apply the basics of e-mail etiquette (e.g. use of BCC, forwarding etc.).				
	2.6. Managing digital identity	My ability to create an online account and related professional profile and log in and out of it safely (including changing and protecting passwords to prevent identity theft), e.g. log in and out and share files in the company's cloud and online network.				

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			1 = I have no skills at all	2 = my skills are very poor	3 = I have some skills, but not sufficient to operate on my own	4 = I have sufficient skills to operate on my own
3. Problem solving	3.1. Solving technical problems	I can identify simple technical problems when operating devices and using digital environments				
		My ability to use common problem-solving support tools available in my device and applications (e.g. configuration guide, help function, set-up commands, etc.)				
	3.2. Identifying needs and technological responses	My ability to address fundamental problems with the most common digital tools (computer, printer, scanner, tablet).				
		My ability to address fundamental problems with the most common digital navigational aids (GPS, AIS, ECDIS) or digital engine tools (fuel consumption system, temperature, alarms)				
		My ability to distinguish between different sensors onboard, identify any fault in them and act appropriately.				
	3.3. Creatively using digital technologies	My ability to operate and maintain maritime communication devices; conduct periodic inspections of communication equipment.				
	3.4. Identifying competence gaps	My ability to recognise where my digital competencies need to be improved or updated when I need assistance.				

Appendix 3 – Exemplar Lessons

Lesson 1 – Diagnostic Assessment

Please find lesson 1 in appendix 2

Lesson 2 – Network Topologies

1.0 Introduction

The purpose of this lesson is to introduce students to ships' systems as networked computers that need to be able to talk to each other.

2.0 Learning Outcomes

LO 1 - Describe the structure of the shipboard network [hardware]

The student should be able to describe the structure of the shipboard network

3.0 Teaching Methods

As this learning outcome is about familiarisation with the concepts of networking, this will be primarily lecture-based, providing the groundwork for a more active-learning approach later in the module.

Module Content

In this lesson, the students will cover basic concepts of networking:

- What shipboard systems are networked together?
- How shipboard systems communicate with each other
- Basics of wired and wireless networking
- Introduction to when to avoid networking shipboard systems together

Lesson plan

Student activity: identify, based on existing knowledge, what sort of computer systems are installed onboard a typical ship. If students don't go beyond typical IT applications, e.g. 'Bridge Computer', 'Engine Room Computer, they could be prompted to think about 'devices' such as GPS units or Engine Control units. (5 mins)

Presentation on network topologies, e.g. radial networks used for some serial networks (where sensors connect to each other and then back to the controller) and star networks, as common in IT systems where computers connect through switches. (15 mins)

Student activity: identify the advantages and disadvantages of each wireless and wired networks. (5 mins)

Presentation on wireless and wired networks, with relevant shipboard examples of their application (15 mins)

Student activity: why might we *not* want two devices networked to each other (5 mins)

Presentation on redundancies in IT systems, and isolation of critical systems from the internet or from being accessible to unauthorised users. Could include hypothetical examples, e.g. what if someone hacked into engine controls and set full-ahead or emergency-shutdown. (10 mins)

4.0 Teaching Materials

PowerPoints

Websites

5.0 Socrative Questioning

- Where are computers used onboard ships?
- Why might we want them to share information?
- How do we connect the computers to the environment onboard ships?
- Why might we not want devices to be able to share information?

6.0 Self-Assessment quiz for topic:

- Identify examples of networked systems onboard a ship and explain the reasons they would be networked.
- Describe limitations and risks associated with networked systems.
  Explain the difference between a radial network topology and star network topology and describe the relative merits of each.
- Explain the relative merits of wired vs wireless networking.

Lesson 3 - Evolutions in ship operations

1.0 Introduction

Major technology changes are arising in the shipping sector that affects requirements for ship operations. These changes have allowed ship owners to be more economically efficient, by installing automated systems that control and monitor the ship's operation.

Modern and well-operated ships contain computers, laptops, scanners, and printers that are becoming the crew's everyday working tools. In addition to this, there is an increasing level of automation onboard – driven by economic factors, the design of the onboard environment/human factors - resulting in a significant evolution of ship operations.

This module aims to understand better the changes happening in operating ships prior to further lessons to explore the shipboard network further.

2.0 Learning Outcomes

LO 1 - Describe the structure of the shipboard network [hardware]

The student should be able to describe the structure of the shipboard network [hardware]

3.0 Teaching Methods

This lesson will be delivered in the form of e-Learning; PowerPoint presentations, and video compilation of clips with narration.

A formative quiz is used to check adoption of the lesson concepts.

Module Content

In this module, the student will explore the changes occurring to the shipping industry and their motives in an operational context.

Subject covered in this module are:

- Economic drivers for ship owners to become more efficient (automatic control and monitoring system for ships).
- Technologies to change the shipboard networks in recent decades, particularly the hardware
- Impact of the technological developments on ship operations
- The interrelation of shipboard sensors and managerial decisions made outside the ship

Lesson plan

A suggested plan is listed below:

Presentation 1 on Economic drivers for ship owners to become more efficient (automatic control and monitoring system for ships)

Presentation 2 Changing technologies in shipboard network in recent decades motivated by safety, particularly the hardware

Presentation 3 Impact of the technological developments and scope for greater levels of automation on ship operations

Formative quiz questions:

- o   Economic drivers
- o   Safety-related drivers [Human Factors]
- o   Technological drivers

4.0 Teaching Materials

PowerPoints

Presentation 1 - Economic drivers

Presentation 2 – Safety related drivers [Human factors]

Presentation 3 - Key technological developments and their impact on ship operations

Websites

https://safety4sea.com/wp-content/uploads/2018/10/IACS-Network-Architecture-2019_09.pdf

https://www.trelleborg.com/marine-and-infrastructure/-/media/Marine-Systems/Resources/Whitepapers-and-Barometer-Reports/Downloads/TMS_SmartPort_InsightBee_Report.pdf?rev=30d0a67e180a42b6be418d66362dce3e

https://www.inmarsat.com/content/dam/inmarsat/corporate/documents/maritime/insights/Inmarsat_ICT_Best_Practice_Guide_2019.pdf

https://significance.nl/wp-content/uploads/2019/03/2016-BZO-Evolution-of-the-EU-and-international-shipping-drivers-challenges-and-scenarios.pdf

https://ec.europa.eu/transport/sites/transport/files/modes/maritime/studies/doc/2015-june-study-sss-final.pdf

https://northsearegion.eu/northsee/s-hipping/drivers-and-enablers-for-future-shipping-activities/

https://www.shmgroup.com/blog/evolution-technology-shipping/

https://unctad.org/system/files/official-document/rmt2018_en.pdf (Chapter 5)

https://www.lr.org/en/insights/global-marine-trends-2030/global-marine-technology-trends-2030/

5.0 Socrative Questioning

These questions are provided as an appetiser for the students regarding this lesson to trigger a classroom dialogue based on questioning and answering to encourage critical thinking, highlighting new ideas. The answers should not be given to the students, but they should be encouraged to find themselves. The question can be used both for preparation for the lesson and reflection afterwards.

- Lecturer's role is to transpose the lesson content into unambiguous questions and think of suitable follow-up questions. He/she should react to incorrect student answers by going back to the starting point to let the students find the answer themselves (self-discovery method) or paraphrasing the question or asking simpler sub-questions (scaffolding).

- If in a classroom setting:
    o The student's role is to join the dialogue initiated by the lecturer actively. Their answers could be based on previous knowledge or pre-class preparation.
  E-learning software, such as Panopto, can be used to include prompts and to require a response from the learner before the slides progress.

- ***Can the evolution in the shipboard network eliminate the human role onboard vessels?***
- ***Do you think that technology has made shipping safer and more efficient?***

6.0 Self-Assessment quiz for topic:

- List the drivers of the evolution of ship operations.
- What are the key technological developments occurred in ship operations?
- How the evolution of ship operations impacted safety onboard?

Lesson 4 – Network Components

1.0 Introduction

The core purpose of this lesson is to familiarise students with the core components of a network and to help them visualise how these different components interact to contribute to the architecture set out in Lesson 2

2.0 Learning Outcomes

LO 2 - Identify the main network components onboard the ship

The student should be able to identify the main network components onboard the ship

3.0 Teaching Methods

As this learning outcome is about recognition of components and familiarisation with their role in a shipboard network, the information will be delivered in the form of a presentation.

Module Content

In this lesson, students will learn about the logical arrangement of devices in a network, including:

- Addressing and address allocation
- Routers, Switches and Access Points
- NAT, DMZs and Firewalls/Gateways
- Cables and connectors

Lesson plan

Presentation on how devices can communicate via a private network. Familiarise with MAC addresses, IP addresses and DHCP servers (to cover the use of wired networks - using switches, as well as Wi-Fi using WAPs) (15 mins)

Presentation on why devices might want to talk outside the network and why unlimited connections outside the network would be a bad idea from a security perspective. (Introduce routers and firewalls as a gateway between private/public networks) (10 mins)

Presentation on the use of NAT, Port Forwarding and DMZs as ways to allow outside communication into a private network. (Look at the risks posed to/by OT systems being mixed with IT systems and risks of those being exposed to the internet) (15 mins)

Presentation and image recognition task. Students are familiarised with different types of cables and connectors (e.g. Cat6, RJ45, Serial, RS232, patch panels etc.). Students are then tested on their recognition of those components, as well as components they have encountered earlier, such as WAPs, Switches, Routers etc. (20 mins)

4.0 Teaching Materials

PowerPoints

Websites

5.0 Socrative Questioning.

- How are devices logically arranged on a network?
- What key hardware devices are used for networking?
- What sort of cables and connectors are used for networking?
- How are devices addressed on a network?

6.0 Self-Assessment quiz for topic:

- Sketch a network topology, showing how devices can communicate locally and with the internet, but only one computer is available for external connections. Label all core components.
- Describe the risks posed by exposing OT devices to IT systems and IT/OT systems to the internet.
- What type of connector is this:
  - **RJ45**
  - RS232
  - BNC
  - RJ11
- What protocol is used to automatically assign addresses to network devices?
  - **DHCP**
  - DNS
  - NAT
  - RJ45

- What device would be used for connecting two networks?
  - **Router**
  - Switch
  - DHCP Server
  - Wireless Access Point

Lesson 5 – Shipboard Control and Monitoring Networks

1.0 Introduction

In a previous lesson, students were introduced to the concept that shipboard networking covers both IT and Operational Technology (OT) applications. This lesson builds on this concept to familiarise students with shipboard OT systems that are networked.

2.0 Learning Outcomes

LO 3 - Recognise the error messages generated by the shipboard network and 'error state'.

The student should be able to identify the main network components onboard the ship

3.0 Teaching Methods

This lesson will be primarily action-based with lecturer support.

Module Content

In this lesson, students will learn about the interrelation of operational technologies:

- Integrated Bridge Systems
- Engine room control and monitoring systems

Lesson plan

Depending on the level of the students, there may need to be enhanced familiarisation with the equipment utilised and more emphasis placed on familiarity with what data these systems exchange. The lecturer should use the knowledge of their students to decide how much guidance/structure is needed. If this session is primarily lecture led, the student activity will serve more as a formative assessment of the knowledge delivered.

Further differentiation: This could be tailored further if this was discipline-specific, e.g. deck students spend more time on bridge systems, engineers spend more time on engineering systems.

Presentation on bridge systems such as GPS, Radar, Echosounder, Speed Log, ECDIS, Steering Systems, Autopilot, Gyrocompass. Level of detail should be in line with notes on differentiation above and could be skipped if students are already familiar.

Student activity: students identify what sorts of bridge equipment they already know of and what sort of data that equipment may generate and may require. (Cumulative 30 mins for presentation and activity)

Presentation on engineering sensor/control systems such as engine monitoring and control. Level of detail should be in line with notes on differentiation above and could be skipped if students are already familiar.

Student activity: Students identify what sorts of engineering systems are networked together and what sort of data that equipment may generate and may require. (Cumulative 30 mins for presentation and activity)

4.0 Teaching Materials

PowerPoints

Websites

5.0 Socrative Questioning

- How do networking principles apply in the context of OT?

6.0 Self-Assessment quiz for topic:

- Identify the core components of an integrated bridge system and identify the benefits of these systems being networked together.
- Identify the core components of a monitoring and control system for an engineering system and identify the benefits of these systems being networked together.

Lesson 6 – Parameters to be monitored

1.0 Introduction

Automation of the shipboard network is an important issue in the improvement of the efficiency aboard a ship. It includes the safety and protection of the vessel and training and education of the personnel, and their adjustment to the new conditions. The staff manning a particular unit or system is a significant factor.

The core purpose of this lesson is to familiarise students with the main parameters that should be monitored within a shipboard network and to help them identify network generated error messages. The lesson that follows (Lesson 7) is focused on how to respond to, and to act accordingly, for either navigation components or engine control room related parameters.

2.0 Learning Outcomes

LO 3 - Recognise the error messages generated by the shipboard network and 'error state'.

The student should be able to recognise the error messages generated by the shipboard network.

3.0 Teaching Methods

This lesson will be delivered in the form of e-Learning, PowerPoint presentations, and video compilation of clips with narration.

A formative quiz is used to check understanding of the lesson concepts.

Module Content

Students have achieved the learning outcome when they are able to demonstrate an understanding of the shipboard monitoring and control process and the different parameters related to it, and the ability to identify error messages. A subsequent lesson will address how to respond to and perform actions or make decisions based on the data.

The module covers the following subjects:
- Parameters that need to be controlled or monitored:
  - Temperature
  - Pressure
  - Level
  - Viscosity

- o Flow control
- o Position of vessel
- o Speed
- o Torque control
- o Voltage
- o Current
- o Machinery status (on/off), Equipment status (open/ closed).

- Identifying dysfunction in the system such as error messages and false alarms

Lesson plan

Presentation 1 on the different parameters that should be on continuous and regular monitoring and control, with an explanation of their importance on efficient and safe ship operations.

Presentation 2 on the overall shipboard monitoring and control systems.

Presentation 3 on the shipboard systems that may generate network-related error messages with examples.

Formative quiz questions.

4.0 Teaching Materials

PowerPoints

Presentation 1 – Monitoring of onboard parameters

Presentation 2 - Shipboard monitoring and control systems

Presentation 3 - Presentation on common network-related error messages

Websites

https://www.trelleborg.com/marine-and-infrastructure/-/media/Marine-Systems/Resources/Whitepapers-and-Barometer-Reports/Downloads/TMS_SmartPort_InsightBee_Report.pdf?rev=30d0a67e180a42b6be418d66362dce3e

https://rules.dnvgl.com/docs/pdf/DNVGL/RU-SHIP/2015-10/DNVGL-RU-SHIP-Pt4Ch9.pdf

https://ec.europa.eu/clima/sites/clima/files/transport/shipping/docs/02_guidance_monitoring_reporting_parameters_en.pdf

http://www.mar.ist.utl.pt/mventura/Projecto-Navios-I/IMO-Conventions%20(copies)/SOLAS.pdf

https://www.zenitel.com/file/1674/download

5.0 Socrative Questioning

These questions are provided as an appetiser for the students regarding this lesson to trigger a classroom dialogue based on questioning and answering to encourage critical thinking, highlighting new ideas. The answers should not be given to the students, but they should be encouraged to find themselves. The question can be used both for preparation for the lesson and reflection afterwards.

- Lecturer's role is to transpose the lesson content into unambiguous questions and think of suitable follow-up questions. He/she should react to incorrect student answers by going back to the starting point to let the students find the answer themselves (self-discovery method), or by paraphrasing the question or asking simpler sub-questions (scaffolding).
- If in a classroom setting:
  o The students' role is to actively join the dialogue initiated by the lecturer. Their answers could be based on previous knowledge or pre-class preparation.
- E-learning software, such as Panopto, can be used to include prompts, and to require a response from the learner before the slides progress.

- ***Can you think of any other parameters that should be monitored to ensure safe and efficient ship operations?***
- ***In case of incorrect interpretation of an error message, what effect would that have?***

6.0 Self-Assessment quiz for topic:

- List the key factors that should be monitored and controlled onboard a ship.
- Identify the main components of the shipboard monitoring and control systems.
- How to act in case of a dysfunction in the system?

Lesson 7 – Shipboard sensors

1.0 Introduction

The core purpose of this lesson is to introduce students to the remote structural and machinery health monitoring of marine structures, such as analogues and digital sensors that can ensure their reliability.

2.0 Learning Outcomes.

LO 3 - Recognise the error messages generated by the shipboard network, and 'error state'.

The student should be able to understand the operation principles of different sensors or transducers for industrial and environmental use.

3.0 Teaching Methods

This learning outcome is about familiarisation with the types of sensors and transducers (Temperature, Pressure, Level, Viscosity, Flow control, Position of vessel, Speed, Torque control, Voltage, Current), analogue and digital.

Presentation for each sensor and transducer the way and the type of output information they give the remote structural and machinery health monitoring of marine structures.

Module Content

The student should be able to understand the operation principles of different sensors or transducers for industrial and environmental use.

They will be able to characterise them in terms of metrological criteria and evaluate their performance.

Additionally, the students will be provided with the knowledge they need to choose the appropriate sensor for measurement, process control and environmental monitoring applications and apply it in the correct way.

Finally, at the end of the module, they will be able to describe the structure of the shipboard network sensors and transducer for machinery health monitoring of marine structures.

Also, they should be able to identify the main network components onboard the ship.

The student should be able to recognise the error messages generated by each type of sensors or transducers on the shipboard network.

Lesson plan

Student activity: To identify, based on existing knowledge, installed sensors onboard a typical ship, in Engine Room and on the Deck.

Students could be prompted to recognise different instrumentation, sensors and their role.

Course contents

Instruments and Their Representation (theory 20 minutes)

Introduction, Typical Applications of Instrument Systems, Classification of Instruments, Standards and Calibration.

Examples of sensor applications on board ships for engine room or deck with discussion (10 minutes).

Self-Assessment Quiz (5 minutes)

Static and Dynamic characteristics of Instruments (theory 15 minutes)

Introduction, Accuracy, Precision, Resolution, Threshold, Sensitivity

Examples of sensor applications on board ships for engine room or deck with discussion (15 minutes).

Self-Assessment Quiz (5 minutes)

Sensors (theory 20 minutes)

The measurement process. Fundamental sensor applications: measurement and process control.

Examples of sensor applications onboard ships for engine room or deck with discussion (10 minutes)

Self-Assessment Quiz (5 minutes)

Metrological characterisation of sensors (theory 10 minutes)

Model of a sensor. Characterisation of a sensor. Parameters for static and dynamic behaviour characterisation of a sensor. Operating conditions.

Examples of sensor applications onboard ships for engine room or deck with discussion (10 minutes)

Self-Assessment Quiz (5 minutes)

Passive sensors: a principle of operation (theory 20 minutes)

Resistive sensors. Capacitive sensors. Inductive sensors. Magnetic sensors: The Hall effect. Magneto-resistors.

Examples of sensor applications onboard ships for engine room or deck with discussion (10 minutes)

Self-Assessment Quiz (5 minutes)

Active sensors: a principle of operation (theory 20 minutes)

Peltier, Thomson, Seebeck effects. Piezoelectric sensors. Pyroelectric sensors.

Examples of sensor applications onboard ships for engine room or deck with discussion (10 minutes)

Self-Assessment Quiz (5 minutes)

Sensors and transducers for mechanical quantities (theory 20 minutes)

Encoder, resolver, synchro. Inductive proximity sensors. Strain gage. Linear voltage differential transformer. Ultrasound position transducers.

Examples of sensor applications onboard ships for engine room or deck with discussion (10 minutes)

Self-Assessment Quiz (5 minutes)

Pressure and Flow Measurement (theory 15 minutes)

Introduction: Moderate Pressure Measurement, High-Pressure Transducer, Low-Pressure Measurement, Differential pressure, magnetic, ultrasound, vortex shedding and Coriolis effect volume or mass flowmeters.

Examples of sensor applications onboard ships for engine room or deck with discussion (15 minutes)

Self-Assessment Quiz (5 minutes)

Temperature Measurement (theory 15 minutes)

Introduction, Measurement of Temperature, Non-Electrical Methods – Solid Rod, Thermometer, Bimetallic Thermometer, Liquid-in-Glass thermometer, Electrical Methods – Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, (Thermistors).

Examples of sensor applications onboard ships for engine room or deck with discussion (15 minutes)

Self-Assessment Quiz (5 minutes)

Integration of sensors and electronic instrumentation (theory 20 minutes)

Equivalent circuit of a transducer. Noise and amplification of electrical signals. Signal conditioning. Smart sensors. Industrial data acquisition devices.

Examples of sensor applications onboard ships for engine room or deck with discussion (10 minutes)

Self-Assessment Quiz (5 minutes)

Optical sensors (theory 15 minutes)

Interferometric and intensimetric optical sensors. Operation principle: Michelson, Sagnac, Mach-Zehnder, Fabry-Pérot. Optical sources (led and laser). Photodetectors. Fibre optic. Fibre optic sensors.

Examples of sensor applications onboard ships for engine room or deck with discussion (15 minutes)

Self-Assessment Quiz (5 minutes)

4.0 Teaching Materials

PowerPoints

Lecturer's presentation

Websites

https://instrumentationtools.com/sensors-and-transducers-objective-questions/

Movies links

https://www.youtube.com/watch?v=w3Hfj2kMrGo

Temperature Sensors Explained – 10 minutes

https://www.youtube.com/watch?v=T6ykoEgWR8Y

Thermocouple vs Thermistor - Difference between Thermocouple and Thermistor

https://www.youtube.com/watch?v=v7NUi88Lxi8

How Thermocouples Work - basic working principle + RTD - 8 minutes

https://www.youtube.com/watch?v=12yINJakfZA

Tech Tip: RTD vs Thermocouple: Temperature Sensors – 2 minutes

https://www.youtube.com/watch?v=PZ-Eizpb5tY

RTD PT100 (Resistance Temperature Detector) Tutorial – 48 minutes

https://www.youtube.com/watch?v=iru8tRwS7Yc

What is a Pressure Sensor – 8 minutes

https://www.youtube.com/watch?v=XkMEto_x22A

Differential Pressure Transmitter Explained – 8 minutes

https://www.youtube.com/watch?v=EMotg3BQjlI

What is a Level Sensor – 9 minutes

5.0 Socrative Questioning

Tips for Using Socratic Questioning:

- ✓ Plan significant questions that provide meaning and direction to the dialogue
- ✓ Use wait time: Allow at least thirty seconds for students to respond
- ✓ Follow up on students' responses
- ✓ Ask probing questions
- ✓ Periodically summarise in writing key points that have been discussed
- ✓ Draw as many students as possible into the discussion
- ✓ Let students discover knowledge on their own through the probing questions the teacher poses

Socratic Question Type	Example
Clarification questions	What do you mean by analogue sensors? Could you also use digital sensors for the same purpose? What do you think is the main issue for measuring? Could you give us an example of a temperature transducer?
Questions about an initial question or issue	Why is this question important? Is this question easy or difficult to answer? Why do you think that?
Assumption questions	Why would someone make this assumption? What is _____ assuming here? What could we assume instead? You seem to be assuming _____.
Reason and evidence questions	What would be an example? Why do you think this is true? What other information do we need? Could you explain your reason to us?
Origin or source questions	Is this your idea, or did you hear if from someplace else? Have you always felt this way? Has your opinion been influenced by something or someone?
Implication and consequence questions	What effect would that have? Could that really happen or probably happen? What is an alternative? What are you implying by that? If that happened, what else would happen as a result? Why?

6.0 Self-Assessment quiz for topic:

- Identify the core components for each type of sensors and transducers.
- Identify examples of sensors and transducers onboard ship for the engine room, or in other place put on a ship.
- Explain the different type of signal output form between analogues versus digital type.
- Describe their limitations.
- Describe their errors in male functions.

1.0 Introduction

To a large extent, the effective operation of a modern vessel is determined by the quality of the relationships between shore-side personnel and seagoing staff. Effective communication is important for all facets of navigation but is essential to efficient shipping operations.

This lesson's core purpose is to familiarise students with ship to shore communication, with a focus on the need to monitor onboard data and the terminology used in typical ship to shore exchanges between crew and shore-based technical staff in this context.

2.0 Learning Outcomes

LO 6 - Act appropriately in response to 'fault identified'.

The student should be able to respond appropriately to 'fault identified'.

3.0 Teaching Methods

This lesson will be delivered in the form of e-Learning PowerPoint presentations, and video compilation of clips with narration.

A formative quiz is used to check understanding of the lesson concepts.

If in a classroom setting, this could be complemented by a simulator exercise with (either deck or engine room), and the teacher should consider developing a scenario transcript for role-play session involving ship to shore communication.

This scenario transcript can also be used for self-study in an e-learning context.

Module Content

In this module, students have achieved the learning outcome when they are able to demonstrate an understanding of how shipboard data is monitored by shore-side personnel and the need to communicate information effectively using prescribed terminology.

They should also reflect on the limitations of their ability to communicate effectively in this context and overcome such issues.

The module covers the following elements:

- Shore-side personnel who may request data from the ship
- Communication between the ship and the shore and typical terminology used in fault identification

Ship Performance Monitoring terminology.

1. Ship Operator - Operations management; Energy-saving operation, safe operation, schedule management. Fleet planning – Fleet allocation; Service planning; Chartering.

2. Ship Owner 1. Technical Management – Safe Operation; Condition monitoring and maintenance; Environmental regulation and compliance; Hull and propeller cleaning; Retrofit and modification. New building – Design optimisation.

Lesson plan

Presentation 1 - Why shore-side personnel may request data from the ship.

Presentation 2 - Big Data and the Maritime Industry Today; Examples from chartering and ship operations management.

Transcript of scenario: A role play session/transcript for self-study about the ship to shore communication, which will be in the form of either a narrated PowerPoint presentation, video clips, and a scenario transcript, and/or a simulator exercise for either deck or engine students using the scenario transcript.

The scenario transcript will be designed to put the students in a ship to shore communication situation and be able to identify and respond to the 'fault identified'.

Formative quiz questions.

4.0 Teaching Materials

PowerPoints

Presentation 1 - Typical KPIs associated with onboard data.

Presentation 2 - Why shore-side personnel may request data from the ship.

Transcript of scenario - Communication between the ship and the shore and typical terminology used in fault identification.

Websites

https://www.trelleborg.com/marine-and-infrastructure/-/media/Marine-Systems/Resources/Whitepapers-and-Barometer-Reports/Downloads/TMS_SmartPort_InsightBee_Report.pdf?rev=30d0a67e180a42b6be418d66362dce3e

https://www.hellenicshippingnews.com/case-studies-and-ship-performance-monitoring/

https://ww2.eagle.org/content/dam/eagle/publications/brochures/Vessel%20Performance.pdf

5.0 Socrative Questioning

These questions are provided as an appetiser for the students regarding this lesson to trigger a classroom dialogue based on questioning and answering to encourage critical thinking, highlighting new ideas. The answers should not be given to the students, but they should be encouraged to find themselves. The question can be used both for preparation for the lesson and reflection afterwards.

- Lecturer's role is to transpose the lesson content into unambiguous questions and think of suitable follow-up questions. He/she should react to incorrect student answers by going back to the starting point to let the students find the answer themselves (self-discovery method), or by paraphrasing the question or asking simpler sub-questions (scaffolding).
- If in a classroom setting:
  o The student's role is to join the dialogue initiated by the lecturer actively. Their answers could be based on previous knowledge or pre-class preparation.
- E-learning software, such as Panopto, can be used to include prompts and to require a response from the learner before the slides will progress.

- ***Can you think of what application big data may have in the maritime industry?***
- ***Should access to this data be limited to those on board, those ashore, third parties and external agencies?***

6.0 Self-Assessment quiz for topic:

- Why may shore-side personnel request data from the ship?
- What are the key performance indicators associated with onboard data?

Lesson 13 - Shore-side data monitoring and effective communication

1.0 Introduction

To a large extent, the effective operation of a modern vessel is determined by the quality of the relationships between shore-side personnel and seagoing staff. Effective communication is important for all facets of navigation but is essential to efficient shipping operations.

This lesson's core purpose is to familiarise students with ship to shore communication, with a focus on the need to monitor onboard data and the terminology used in typical ship to shore exchanges between the crew and shore-based technical staff in this context.

2.0 Learning Outcomes

LO 6 - Act appropriately in response to 'fault identified'.

The student should be able to respond appropriately to 'fault identified'.

3.0 Teaching Methods

This lesson will be delivered in the form of e-Learning, PowerPoint presentations, and video compilation of clips with narration.

If in a classroom setting, this could be complemented by a simulator exercise (either deck or engine room). The teacher should consider developing a scenario transcript for role-play session involving ship to shore communication.

This scenario transcript can also be used for self-study in an e-learning context.

Module Content

In this module, students have achieved the learning outcome when they are able to demonstrate an understanding of how shipboard data is monitored by shore-side personnel and what shore-side personnel will use the data for.

The module covers the following elements:

- Shore-side personnel who may request data from the ship
- What is the ship data used for?

Lesson plan

At an academy/training institution, it would be of great value to invite a performance manager from a local owner to elaborate on what they use the data for.

If this is not feasible, this could be a video record of a similar person.

Alternative:

PowerPoint: 1

- o   Typical systems used ashore for performance monitoring.
- o   Examples where this has gained value for the owners.

PowerPoint: 2

- o   Challenges getting the data ashore
- o   Connectivity, bandwidth, 3/4/5G, Wi-Fi, Starlink
- o   The importance of sorting data from a huge cloud to concrete figures that can be easily transferred via low bandwidth

4.0 Teaching Materials

PowerPoints

Websites

http://www.satflare.com/track.asp?q=starlinkAll#TOP

5.0 Socrative Questioning

6.0 Self-Assessment quiz for topic:

- -   Shore-side personnel may request data from the ship:
    - o   why are they important to them (shore-side personnel)?
    - o   why are the data important to the seagoing personnel?

Lessons 14 – 20: Case Studies and Practical examples

1.0 Introduction

The training facility may wish to develop case studies or practical exercises that support the development of the candidates' knowledge and skills in this subject.

2.0 Learning Outcomes.

LO 7 - Assess the quality of shipboard generated data

The students obtain basic knowledge of their own vessels data infrastructure and setup towards the shore organisation.

The students must act when they observe a fault, and become aware of their limitations, with regards to correcting an error.

3.0 Teaching Methods

If the training is being completed onboard a vessel or at a facility with access to simulators, this may include the collection of evidence based on the use of equipment and/or working through case scenarios.

If the training is being completed in a virtual or classroom-based environment, it may include case studies, historical studies, and other methods of exploring the topics that do not rely on access to shipboard equipment.

4.0 Module Content

4.1 Lesson plan

To be developed and reviewed as required by the chosen method of delivery and assessment.

4.2 Teaching Materials

Three examples have been provided to support the development of this part of the programme, a case study task, a case scenario-based exercise and an historical study task.

4.2.1 Case Study: Risk Assessment

Create a risk assessment and action plan by answering the following questions. Base your answers on the case study, information you have reviewed within the Digital Skills 1 course and other relevant sources (e.g. legislation). Ensure that your answers are precise, accurate and supported by evidence from your sources. This task should take approximately two hours.

1. What were the main causes of the incident?
2. What steps had been taken to prevent/address each cause at the time of the incident?
3. What else could have been done to prevent/address each cause at the time?
4. Have any actions been taken since the incident that have reduced the risk of it happening again?
5. Is there anything more that can be done to reduce the risk of it happening again?
6. Are there any technology-based options which might reduce the risk of it happening again?

Example case studies:

https://www.gov.uk/maib-reports/grounding-of-general-cargo-vessel-kaami

Grounding of general cargo vessel Kaami

https://mtip.gov.mt/en/msiu/Documents/MV%20Guroni_Final%20Safety%20Investigation%20Report.pdf

Safety Investigation Report: MV Guroni

https://www.atsb.gov.au/publications/investigation_reports/2017/mair/335-mo-2017-009/

Grounding of ABFC Roebuck Bay on Henry Reef, Queensland, on 30 September 2017

https://www.ntsb.gov/investigations/AccidentReports/Reports/MAR2103.pdf

Capsizing of Roll-on/Roll-off Vehicle Carrier Golden Ray St. Simons Sound, Brunswick River, near Brunswick, Georgia September 8, 2019

4.2.2 Case scenario

Case: Data systems onboard your vessel XX

During your watch, it is reported that there has been a loss of data from the anemometer and torque meter.

Over the last month, it has been observed that the fuel oil (FO) flowmeter for the main engine (M.E.) is drifting and not showing the correct consumption

- Describe which onboard systems are affected by the loss of data, as well as the incorrect data.
- Describe which systems ashore could be affected by this incident

Shortly after locating the above errors, you receive an e-mail from the Performance Department stating that your vessel performance has changed for the better over the last month.

- What could be the reason if you have maintained the same route and had the same average amount of cargo and weather?
- How would you respond to the Performance Department?

Shortly after your E-mail, you get the response to change and replace the sensors.

- Is it possible to correct the error/replace sensors yourself, or whom should you contact, if that is not possible?
- Elaborate your answer

4.2.3 Historical Study: Shipboard Equipment

This task should take approximately one hour.

1. Select a ship type or specific vessel currently working at sea.

2. Select any piece of electronic equipment used in the engine room of your chosen ship.

- Identify what was used in its place five years ago and how it was used.
- Identify what was used in its place twenty years ago and how it was used.
- Identify what was used in its place one hundred years ago and how it was used.
- Suggest what may be used in its place five years from now and how it might be used.
- Suggest what may be used in its place twenty years from now how it might be used.

3. Select any piece of electronic equipment used for navigation on your chosen ship.

- Identify what was used in its place five years ago and how it was used.
- Identify what was used in its place twenty years ago and how it was used.
- Identify what was used in its place one hundred years ago and how it was used.
- Suggest what may be used in its place five years from now and how it might be used.
- Suggest what may be used in its place twenty years from now how it might be used.

4. Select any piece of electronic equipment used in cargo operations on your chosen ship.

- Identify what was used in its place five years ago and how it was used.
- Identify what was used in its place twenty years ago and how it was used.
- Identify what was used in its place one hundred years ago and how it was used.
- Suggest what may be used in its place five years from now and how it might be used.
- Suggest what may be used in its place twenty years from now how it might be used.