

Layered scenario mapping

Layered scenario mapping is a technique used to gain insight into the 'situation one designs for'. It is a systemic technique and emphasises presenting information in different layers going from an overview to very detailed information. The technique proposes a structured approach to collecting and presenting data and provides a template for sorting and presenting the data in a layered manner hierarchically, spatially, and temporally.

The layered scenario mapping process

Preparation

A) Identify the scenario to map out. The scenario should be representative and cover the most important aspects of the 'situation one designs for'. The selection can be informed by the objectives of the design project, and criteria for selecting the scenario can be based on frequency (how often something happens) and/or criticality/importance (related to the potential consequences if something goes wrong). Some insight on the situation one is designing for is required to select an appropriate scenario. Involvement of users and subject matter experts is encouraged. Identify the main steps and make draft of the outline.

B) Define type of data to be collected. This depends on both the needs of the design project and how the data will be presented (see Designing the scenario). The template provided on the next page can be used as a starting point. Adapt according to your needs.

C) Identify data sources. The users, subject matter experts, and the field site may be primary sources of information. Other sources may include user training

materials, user manuals, regulations and procedures, incident reports relevant to the scenario, and online materials shared by users.

D) Plan how data collection should be carried out and decide on methods and techniques to be used.

Observational studies, interviews with users and subject matter experts, and other techniques involving users are valuable approaches. The guide *Design-driven field research at sea*¹ may prove valuable if you plan to do field studies.

The template on the next page can be used as the basis of an observation form. Communication analysis tools such as *Comms Usage Diagrams*² can be used to identify who communicates with whom in the scenario and by which means, *link analysis*³ can be used to identify how actors physically move, and *Applied cognitive task analysis (ACTA)*⁴ can prove valuable in determining expertise needed and identifying critical points.

Consider what kinds of video/audio recordings to make and what images to take and the equipment needed to do so. Making a list can be useful.

E) Make practical arrangements. Agree with companies and users on field trips, interviews, etc. Note: This can be time consuming. Start early and set aside sufficient time for this activity.

Data collection

Collect data as planned. Note: You may need to carry out data collection activities several times as deficiencies are identified and new needs emerge during designing of the scenario.

Designing the scenario

Decide on the format and layout of a scenario map that supports the presentation of both overview information and detailed data. Designing the map goes beyond listing the data collected. It involves developing new knowledge by interpreting the collected data, collating the data, and designing the data. Use visual presentation whenever appropriate. Spatial and temporal data are particularly appropriate for visual presentation.

The map can be presented analogously or digitally. The template presented on the next page can be used for paper-based versions. Note: The template is suggested as a starting point, and the layout of the map should be adjusted to the needs of the specific design project.

Validation of scenario

Ensuring that the information included in the map is correct is important. Invite users and other subject matter experts to examine and validate the scenario.

¹ *Design-driven field research at sea*. The Oslo School of Architecture and Design

² See Stanton et. al (2005). *Human factors methods: a practical guide for engineering and design*. Aldershot: Ashgate.

³ See Stanton et. al (2005). *Human factors methods: a practical guide for engineering and design*. Aldershot: Ashgate. or Kirwan & Ainsworth (1992). *A Guide to task analysis*. London: Taylor & Francis.

⁴ Militello & Hutton (1998). Applied cognitive task analysis (ACTA): a practitioner's toolkit for understanding cognitive task demands. *Ergonomics*, 41(11), 1618–1641.

Layered scenario mapping template

Scenario: Rig operations PSV

Ship Type: Platform Supply Vessel | Year Built: 2011 | Deadweight: 4542 t | Flag: Norway | Gross Tonnage: 3750

Deck load 2285 t
Cargo deck area 850 m²

Dimensions: 86 m x 18 m

Tank load 7463 m³

Actors in the scenario:
Captain (1st officer), Second officer, Chief engineer, Able seaman 1, Able seaman 2, Craneoperator rig, CCR operator rig, Craneoperator onshore

MV Thor is on its way to the rig Beta to deliver 14 containers, brine, cement, and fresh water. It will also receive 12 back haulers and must, twelve hours earlier, she left the port in Tananger, Norway. While in port the officers planned operations when the deck cargo plan was made in the loading meeting. This was based on the cargo to be sent and received as well as on knowledge of the weather forecast and on the positioning of cranes on the rig.

The captain (1st officer, depending on the time of day) and the 2nd officer are on watch on the bridge, and the 2nd officer is manoeuvring from the front according to the passage plan that was developed while they were in port. When Thor is 1 hr from the rig, in accordance with the procedures, the captain contacts the rig's central control room (CCR) via VHF radio to inform that they expect to be by the rig in 1 hr. They also inform the engineers in the engine control room (ECR) on the ship, before they reach the 500 m safety zone; they complete the pre-arrival 500 m safety zone checklist. This includes assessing weather conditions, starting bow thrusters and testing all thrusters, testing the UHF radio channel that the crane operator on the rig uses and testing the emergency manoeuvring system. Before they enter the 500 m safety zone, they contact the rig's CCR again to ask for permission to enter the zone. They confirm the loading operations to be carried out, agree on which side of the rig to position the vessel and agree on which crane will be used. Today, the vessel should be positioned on the starboard side alongside the rig. As always, they mentally assess whether or not the suggested positioning is safe, given the weather conditions, and what their escape route would be if something would go wrong while they are by the rig.

Permission is granted, and the 2nd officer switches from auto pilot to manual mode and enters the safety zone at a safe speed. The captain contacts the crane operator in order to check that the UHF connection works and to get confirmation on the agreed-upon position. Approximately 100 m from the rig, the 2nd officer turns the vessel heavily towards port side in order to prepare for positioning the starboard side of the vessel alongside the rig. At this stage, the captain is at the aft of the bridge. The 2nd officer sets all thrusters to zero at the front and yells 'all in zero' to the captain, and the captain takes over control in the aft. Using the manual thruster levers, the captain continues to manoeuvre the ship towards the rig in manual mode for a short while until the ship is in parallel with the rig at a safe distance. He then switches to dynamic positioning (DP) mode, locks the heading and steers the ship closer using the DP joystick. He takes control of the power management system from the ECR. At the same time, he assesses the reference systems' quality and adds them to the DP system one by one. The captain locks away across ship and fine-tunes the position alongside before he locks surge as well. The vessel is now in full DP (auto position). He then fine-tunes the position by changing the heading 1-2° at a time and the position astern and starboard by 1 m at a time. MV Thor is in position on the leeward side of the rig. However, because the currents are a bit stronger than expected, the vessel is dragged out of position, and the DP off-position alarm sounds at several occasions. The captain assesses the situation as not critical and mutes the alarms. He takes a sip of coffee, assesses the situation, and signs the DP checklist.

At this stage, the 2nd officer is also at the aft, and after clarifying with the crane operator and the able seaman, the loading operations can start. They first deliver deck cargo before they receive backload. Last, they deliver and receive the bulk cargo. During the loading operations, both the captain and the 2nd officer ensure that the vessel position is kept by (1) looking at the DP screens and by (2) assessing the vessel's relative position to the rig by looking out of the window and comparing a point on the rig to the window pillars on the bridge. What they fear the most is losing their position and touching the rig. The loading operations take 3 hours and 45 minutes. When they are finished, the captain pulls out from the rig and contacts the onshore organiser, who tells them what they are supposed to do next.

0 min
20 min
30 min

Mode	AUTO PILOT	MANUAL OUTSIDE SAFETY ZONE										MANUAL INSIDE SAFETY ZONE				
What happens	1. Transit	2. Captain assesses weather by consulting weather forecast received by email, wind sensor and by looking outside. Discusses with 2nd officer.	3. Captain contacts CCR on rig to inform that they expect to reach rig in 1 hr.	4. Captain contacts engine control room (ECR) and inform that they expect to reach rig in 1 hr.	5. 2nd officer continues moving ship towards rig.	6. 2nd officer switches mode from Auto to Manual steering in the truster control system.	7. 2nd officer reduces speed, starts bow thruster and lowers and starts retractable thruster; tests all manoeuvring and steering gear systems, as well as emergency manoeuvring system. Ref. NWEA annex D, pt. 8 and 9.	8. Captain and 2nd officer agree on who shall navigate and who is responsible for communication. Captain documents in log book.	9. Captain checks which UHF channel is used by cranes on rig and switches to this channel. Ref. NWEA annex D, pt. 5.	10. Captain checks that UHF connection between deck and bridge works. Ref. NWEA annex D, pt. 5.	11. Captain consults radar and ECDIS to assess distance to rig.	12. Captain on MV Thor contacts rig's CCR to get permission to enter 500 m safety zone. Confirms that pre-arrival safety zone checklist is completed. Agree on which side of the rig they will position vessel.	13. Mental task. Captain assesses that suggested position is safe according to weather conditions. Plans escape route if something would go wrong while alongside rig.	14. Captain updates log book with checklist completed and time for entering 500 m safety zone.	15. Second officer reduces speed to safe speed which is assessed based on weather conditions, and manoeuvres MV Thor into Beta's 500 m safety zone. Ref. NWEA annex C.	16. 2nd officer starts to ship to port side.
Actors involved	• Captain • 2nd officer	• Captain • 2nd officer	• Captain • CCR operator • 2nd officer (listen in)	• Captain • Chief engineer (listen in)	• 2nd officer	• 2nd officer	• 2nd officer	• Captain • 2nd officer	• Captain	• Captain • Able seaman	• Captain	• Captain • CCR operator • 2nd officer (listen in)	• Captain	• Captain • 2nd officer	• 2nd officer	
Communication			• VHF • ECDIS	• Tel					• UHF			• UHF				
Position on the bridge																
Equipment used	• Autopilot • ECDIS • Radar	• Office PC • Wind sensor	• VHF • ECDIS	Telephone (internal)	• Autopilot • ECDIS • Radar	Thruster control system	• Thruster control system • Manual thruster levers	Log book	List (paper) showing all preset UHF channels used by ship	UHF	• Radar • ECDIS	• VHF • Installation data card, ref. NWEA annex H	• Log book • Pre-arrival safety zone checklist, ref. NWEA annex D	• Manual thruster levers in front • Radar	Manual levers in front	
Information needed	• Where is ship relative to other objects (shore, ships, reefs) • Other ships' heading and speed	Weather conditions: • Weather forecast • Wind conditions from wind sensor • Weather conditions outside	• Estimated time of arrival (ETA) • VHF-channel used by rig/area	Internal phone number to ECR	Distance to rig's 500 m safety zone (shown by circle around rig in ECDIS or circle around ship in the radar)	• Distance to rig's 500 m safety zone • Status mode (that the auto pilot is off)	• Thruster status and angle • Setpoint - feedback • Thruster wash	UHF channel used by crane	Information from installation data card, including: rig's heading and crane location.	Distance to rig's 500 m safety zone (shown by circle around rig in ECDIS or circle around ship in the radar)	• Weather conditions • Crane position • Hazards listed in installation data card • Ship's technical condition	• Distance to rig • Distance to other objects (ships) within 500 m safety zone	• Distance to rig • Pre-arrival safety zone checklist, ref. NWEA annex D	• Manual thruster levers in front • Radar	• Distance to rig • Distance to other objects (ships) within 500 m safety zone	
Functionality needed	• Change heading (if heading control) • Accept waypoints (if track control)	Access to weather forecast on office PC	• Change VHF channel (if needed) • Push-to-talk	Telephone functionality	• Change heading (if heading control) • Accept waypoints (if track control)	Change mode from Auto to Manual steering	• Start thrusters • Manual thruster control	Documentation	Change UHF channel	Push-to-talk	Push-to-talk	Thruster control/manoeuvring	Thruster control/manoeuvring	Thruster control/manoeuvring	Thruster control/manoeuvring	
Critical points			⚠ Ref. collision btw Big Orange and Biofosk 2/4-W		⚠ Ref. collisions between Big Orange and Biofosk 2/4-W, Far Symphony and West Venture and Ocean Carrier and the Ekofisk 2/4-P Bridge.		⚠ Be certain that machinery and thrusters work as they should, to be sure that they have enough force to get away from rig if needed.					⚠ It is important to be able to escape quickly if something would go wrong. Ref. ACTA-interviews with officers and incident reports.				

Excerpt from layered scenario mapping of a rig operation scenario of a PSV (Platform Supply Vessel). Overview information is provided to the left and detailed information in the timeline matrix to the right. See next page for descriptions of the individual elements.

Layered scenario mapping template

The template on the previous page suggests how information can be presented with overview information to the left and detailed information to the right. The overview gives the reader a frame of reference to use when making sense of the detailed information. The detailed view consists of a timeline matrix with step-by-step descriptions. The number of steps depends on the length of the scenario and the needed level of granularity. The following content elements are included:

1) Descriptive title

2) Visual presentation of ship's technical specifications. Presents what the users physically control and the technical systems to design for controlling.

3) Description of the scene and introduction to scenario. Lets the readers of the map know the setting of the scenario.

4) Presentation of actors involved in scenario. Lets the readers know who is involved. Colour coding of the actors can be useful.

5) Written scenario story. Presents the scenario from start to finish. Provides the readers with an initial frame of reference to use when interpreting the detailed information. Also useful in developing the outline of the timeline matrix.

6) Document info. States which data sources the map builds on. Includes version of the document and date. Adds to the trustworthiness of the map.

7) Timeline. Not necessarily linear in a mathematical sense (it must not have a fixed scale where one step represent a set time period).

8) Visual presentation of vessel position. The vessel is shown in relation to other objects, such as the port and the rig.

9) Mode. The mode of operation indicates what kinds of rules apply and the technical mode of the vessel.

10) What happens. Gives a short description of what happens at each step.

11) Actors involved. Presents the main actors involved at each step. Colour coding from item 4 is used.

12) Communication. Shows who communicates with whom and by what means for each step. Colour coding from item 4 is used.

13) Position. Visual presentation of the users' position at each step in a bird's-eye view (here, position on the ship's bridge). Colour coding from item 4 is used.

14) Equipment used. Shows what kind of equipment is used at each step.

15) Information needed. Describes information the users need to be able to carry out the actions at each step. Includes information from technical systems and the natural environment. Needed to judge what information to present when, where, and how.

16) Functionality needed. Describes the functions the users need to be able to carry out their tasks at each step. Needed when designing controllers and other interactive elements.

17) Critical points. If the step is particularly important to ensure safety, it is highlighted, and the critical factors are pinpointed. The critical points can, for example, be identified through ACTA or risk analysis.

18) Illustrative photos. Provide contextual information and can, for example, show the physical environment or the equipment used. Could also include pictures of the actors in the scenario.

Advantages to the technique

- Easy to understand and requires little training.
- Offers a framework for sorting and making sense of large amounts of data from a range of sources.
- The map can support collaborative work and be used to share insight among a design team.
- Different disciplines of a development team can use the map for different purposes.
- The map can be used to document work done on the project, such as field research.

Limitations of the technique

- Can be time-consuming and relies on substantial data collection.
- May lead to fixation on the current situation and requires conscious interpretation of what the scenario means for the design of future situations.

Things to consider

- The example used in this guide is a ship's bridge but can be adapted to other complex environments.
- To overcome the limitations of the technique, consider combining it with more open-ended and future-oriented techniques.
- Information with a lower level of detail gives a more open-ended map that invite interpretations useful at the start of the design process, while more detailed information may result in a less-open map useful later in the design process.