FIRST – Fire strategies for unmanned island ferries

Appendix 2 – Human factors

JJOHANNESSON APS

Content

1 Introduction

This appendix focuses partly on the one crew member and partly on the passengers onboard a ferry designed for (semi-) autonomous operation.
The human factor topics addressed, concern the following:

- Which personality and performance profiles are the most relevant when recruiting personnel (i.e. the captain) for a semi-autonomous ferry? Obviously, the officer must be able to respond appropriately in critical situations, provide (everyday) service to passengers, etc.
- How to train or educate any given captain based on his or her individual profile including all its strengths and shortcomings in relation to the special task of being the one and only crew member on a passenger ferry?
- Which attitudes and beliefs exist among passengers in relation to the (future) use of a semi-automated ferry? What are their possible worries linked to a semi- or fully autonomous ferry – would use it or not, etc.
- How to establish the best possible basis for self-reliant mustering and evacuation onboard semi- or fully autonomous ferries, using design, procedures and insights into passenger behaviour?

The appendix makes use of both theories, evidence-based research and in-depth hands-on experience with behavioural psychology, assessment and training with maritime officers. It also includes a minor field study among passengers at the current Esbjerg-Fanø crossing, performed July 2018.

2 Personality and Selection

Think of two doctors, same age and gender. Both have gone through the same education, holds the same position at the same department at a hospital. They even wear the same (white) uniform and are supposed to take care of the same assignments while they work. Yet, when you consult them, they are probably two very different doctors. One of them might be diligently looking into the anamnesis, while the other tend to ask only a few questions, trusting experience instead. One of them might be gentle when examining you, the other quite the opposite. And so on. Many factors are likely to contribute to this difference in job behavior, but one intuitively obvious factor is their difference in personality. Actually, this intuition can find support in extensive research into how personality affects the way we do our jobs, even how a given personality performs in safety critical jobs (Beus et al. 2015, Andel 2015, Hogan et al 2010). Even though it is debated to what extend our personality influence our job behavior, say, compared to the influence of an organization's overall safety climate (Toppazzini et al. 2017), there seem to be no doubt among researchers that personality is a factor to seriously consider when working with safety critical jobs and the manning hereof.

In the following we will elaborate on the concept and taxonomy of personality traits and present a useful way to illustrate which personality features blends well with safety critical jobs. We will also outline which type of additional information about a given (maritime) job candidate's mental abilities to consider when deciding which profile to look for when manning a one-man operated vessel. We argue, that a Psychological Safety Profile comprised of both an assessment of a candidate's **personality** and **mental abilities** is very useful in supporting a manning process.

2.1 Personality traits

When we know other people well, we can often say "this is typical of him/her", because we recognize the person's actions, opinions and preferences in various situations. Thus, we tend to recognize enduring characteristics in the person's behavior, generally acknowledged by psychological theory (and research) as **traits,** which basically can be thought of as common language descriptors. In the field of psychological research many attempts have been made on identifying which traits are the most meaningful and it is widely accepted that the Five-Factor model used in the work by Costa & McCrae (1992), provides a comprehensive vocabulary of traits and a useful method to determine the "portion" of the five overall factors (traits) a given person holds in his/her personality. For example: One of the traits is called Conscientiousness, and a person having a large portion of this trait is more likely to be described as one demonstrating self-discipline and "always prepared" rather than "messy". The full list of factors concerns the person's

- level of conscientiousness
- level of openness to experience (eg. intellectual curiosity),
- level of extraversion (outgoing vs reserved),
- level of agreeableness (friendly/cooperative vs suspicious/antagonistic) and finally
- level of neuroticism (sensitive/nervous vs secure/confident).

Each of the five overall factors or traits are sub-divided into several facets, which we will not go through here.

The method used to determine person's level of the traits and facets is widely known as a personality test (or personality assessment), which often includes self-reporting: A questionnaire invites the person to choose between a (very large) number of true/false items or statements, concerning many different aspects of that persons likes/dislikes, behaviors, etc. Statistical techniques are then used to produce a description of the personality in question, i.e. what the most probable behavior is to expect from him or her in various situations, including the interactions with other people. Most commercial personality tests aim to predict the performance of the assessed person in a job situation, but the tests available vary in quality and validity. However, the Hogan Assessment System (Hogan & Hogan, 2007, 2009, 2010) provides extensive documentation on their research, test validation and practical implications, making Hogan tools (tests) relevant to unfold in the present context.

2.2 The Hogan Safety Report

Taking seriously that personality has an influence on job behavior, Hogan (2010) has developed personality-based scales to predict safety-related behaviors, aiming to "help organisations identify job applicants who are likely to engage in safe…behaviors" (p. 2). Clearly, the work has a commercial goal most likely aimed at HR departments, however the documented research supporting the scales (and the Hogan Safety Report) is satisfactory for the present context.

As many other providers of personality assessment tools, the Hogan System offers a personality test, The Hogan Personality Inventory (HPI), based on the Five Factor Model, with minor variations in vocabulary of the scales and facets included. The HPI has accumulated quite a bit of data over recent years, due to a large number of persons assessed with it (Hogan 2007) and research into the correlations between HPI scales and the number of accidents that the assessed people were involved in, showed that people (e.g. in a sample of field technicians, N=393, p. 15) with high scores in certain combinations of HPI scales/facets, had fewer accidents than people with lower scores in these scale/facet combinations.

This research led to the development of a safety competencies model, identifying competencies that defines safety behaviors across industries and jobs. These competencies include (Hogan 2007, p. 16):

1. following standard operating procedures
2. handling stress
3. maintaining emotional control
4. focusing attention over time
5. avoiding unnecessary risks over time and
6. engaging in training and development opportunities

Please note, that the 6 bullets do not represent 6 personality traits directly, but rather 6 forms of behavior that a person is more or less likely to engage in based on his or her personality. Thus, the model provides statistically based clues as to how likely a person might engage in unsafe – or safe – behavior within the identified categories (1-6). To determine this probability for a given person, the person simply just needs to fill in the Hogan Personality Inventory. If requested that resulting profile can have a "Safety Report" generated too, based on the identified statistical link between the scores on the personality test and the proneness of being involved in incidents or accidents.
To illustrate the practical implications, we will provide a couple of real-life examples.

First, have a look at the following table showing the (personality based) safety competencies and its descriptions (from Hogan 2010, p. 16):

Table 1: Safety Competencies

Competency	**Description**
Compliant	A person's tendency to follow rules. Poor performers ignore authority and company rules. Exceptional performers willingly follow rules and guidelines
Strong	A person's ability to handle stress with confidence. Poor performers tend to panic under pressure and make mistakes. Exceptional performers are steady under pressure
Emotionally stable	A person's ability to handle pressure without emotional outbursts. Poor performers easily lose their tempers and then make mistakes. Exceptional performers control their tempers
Vigilant	A person's ability to stay focused when performing monotonous tasks. Poor performers are easily distracted and then make mistakes. Exceptional performers stay focused on the task at hand
Cautious	A person's tendency to avoid risk. Poor performers tend to take unnecessary risks. Exceptional performers evaluate their options before making risky decisions
Trainable	A person's tendency to respond favorably to training. Poor performers overestimate their competence and are hard to train. Exceptional performers listen to advice and like to learn

2.2.1 The case of Person A

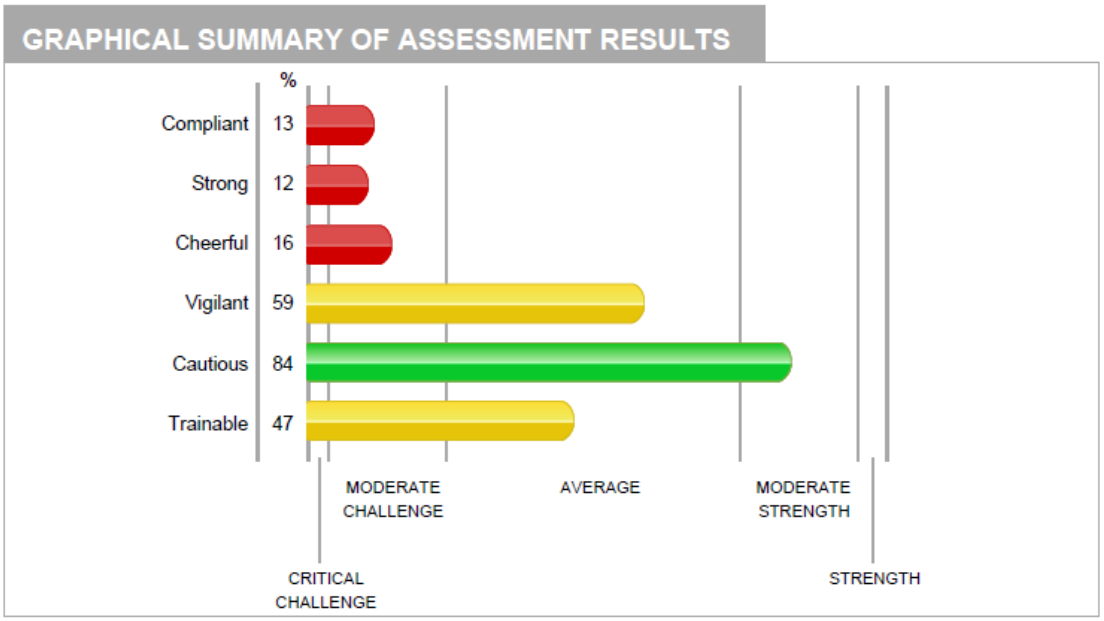

Figure 1: Safety report on Person A

Figure 1 shows a graphical summary of a Person A's assessment result, thus showing that person's likelihood of being involved in an incident or accident in comparison with the pool of other people tested this way (Hogan 2010). The six competencies are listed to the left, and the scores are in terms of percentiles: For example, a score of 84% means that a person's score is above 84% of people assessed. The color of the related bar indicates whether the predicted level of each of the 6 safety related competencies are below average (red), aligned with the average (yellow) or above average (green).

Based on Person A's personality, he or she has a "red score" in the compliant scale. This does not mean that Person A will definitely have an accident due to non-compliant behavior. However, the red score implies that Person A due to the personality has a higher risk than the average person holding a safety critical job of being involved in an accident due to non-compliant behavior. Likewise, the green color shown in the case of Person A (high level of cautiousness) does not mean, that this person will never be involved in accident due to risky (non-cautious) behavior. Instead, the green color means, that Person A has a lower risk than the average person holding a safety critical job of being involved in accident due to risky behavior. Thus, the colors indicate probabilities, not causalities.

Finally, the graphical summary in the Hogan Safety Report states whether the given level of competency can be labelled as either a "critical challenge", "moderate challenge", "moderate strength" or a "strength" to the personality in question.

In the case of Person A, the red **Compliant** score indicates that this person will probably tend to bend a rule now and then, maybe finding it somewhat annoying to work strictly according to checklists, rules and regulations and maybe demonstrating some criticism of authorities ("rule-makers") from time to time. Compared to the average person holding a safety critical job, that is.
The red score on the **Strong** scale indicates a higher probability for this person to become "high jacked" by emotions during pressure, making it hard for the person to think straight in that situation. Since Person A's score on **Emotionally stable** (labelled cheerful in the graphical summary) is also red, it signifies a higher-than-average tendency to give in to the emotions resulting in e.g. outbursts or other stress signals clearly visible for people around Person A. Roughly speaking, the Strong scale concerns what goes on inside (ranging from calm thinking to unstructured panic) and the Emotionally Stable scale concerns the ability to control the display of emotions to others (ranging from full control to uncontrollable outbursts).

Person A's score on the **Vigilant** scale is in the average area, which means that this person seems just as capable of performing monotonous task without becoming distracted as the average person. It often comes as a surprise to socially very outgoing personalities, that their score on this scale often turns out red. However, the tendency to become easily distracted is positively correlated with outgoingness (as opposed to more introvert behavior) (Beus et al 2015, Hogan 2010, Toppazzini et al 2017). In practice, this means that the extrovert person is more likely to become distracted away from the task at hand, due to social urges or activities around him or her (the urge to eavesdrop on conversations nearby, crack a joke with the crew, check Facebook maybe? etc.)

The green score on the **Cautious** scale signifies a moderate strength in the related safety behavior for Person A. It is probably so, to a higher degree than the average person, A will evaluate the options at hand before taking action in whatever the safety critical job her or she is executing. Less cautious people tend to demonstrate more impulsive and spontaneous decision making, in which case they would have a red score on the cautious scale.

The last scale score (**Trainable**) is in the average range, thus implying that Person A probably responds quite well to settings of training and education. Persons with low scores tend to have less interest in listening to advice, maybe even demonstrating arrogance (i.e. overestimating their own level of competence), sticking to the way they have always done things. The level of trainability is clearly of great importance to safe workplace behavior, which often needs adjustment due to (accident-) experiences from other companies, domains or simply colleagues.
Obviously, another person than A will have a different safety profile, as illustrated below.

2.2.2 The cases of Person B and C

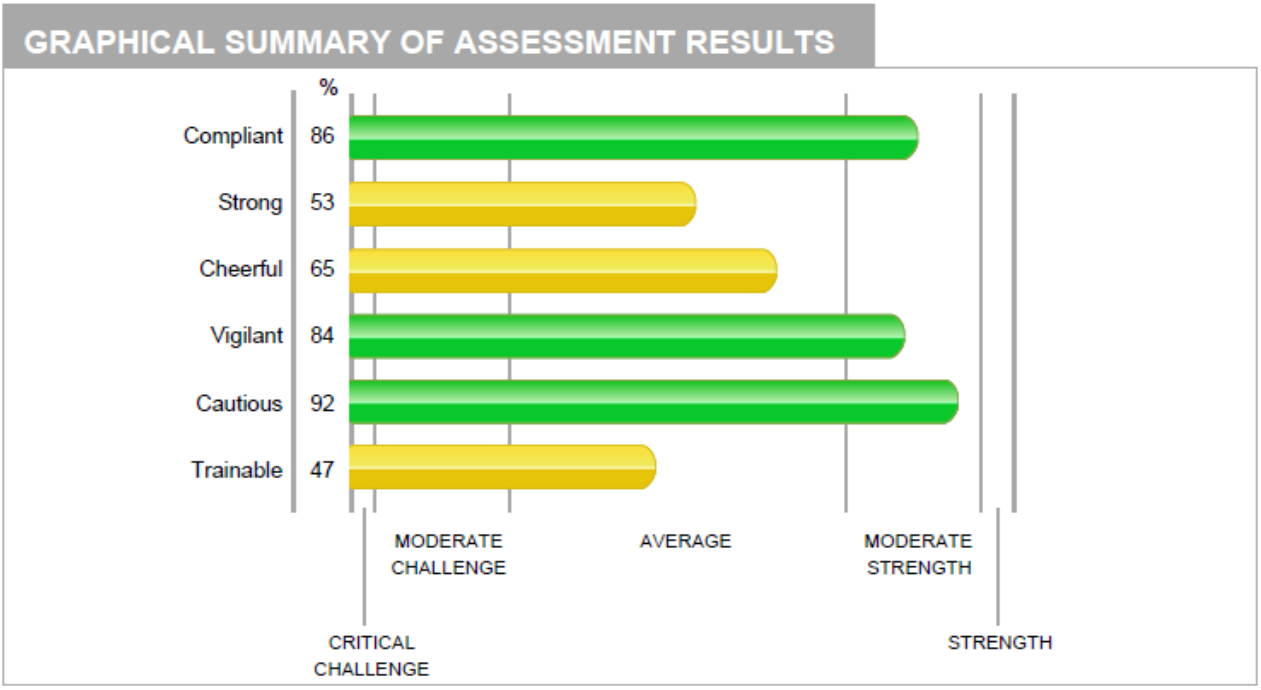

Figure 2: Safety report on Person B

Clearly this profile looks "safer" than Person A's. However, caution must be taken when evaluating real people this way. As mentioned earlier, the safety profile is based on statistics and no causalities between personality and accidents exists as such. Person B is not guaranteed to avoid being involved in incidents and accidents, even though the probability hereof is a little lower than holds true for the average person holding a safety critical job.

For person C, the opposite is true. The personality behind this red profile is quite likely to have several critical challenges in order to behave as safe as the average person. However, even though the behavioral tendencies in the person is statistically less safe than the average person's, it is by no means impossible for Person C to act safely. It all depends on the level of self-awareness and insight into his or her own tendencies (Brøsted 2015, 2016). A person might very well have a tendency of becoming distracted but could also very well initiate compensatory actions or procedures to avoid problems: Keeping distracting devices away during important time slots at work, for instance. Or asking other people to leave the control room if a "head down mode" is needed, etc. Of course, to do this, one must know one-self and a test like the Hogan Safety Profile could be useful in the right training context (Brøsted 2016). The safety profiles are based on a person's specific personality traits and facets, which are stable over time and therefore not easily changed. However, knowing how to compensate or take precautions is the key to stay or become safe, depending on the individual profile.

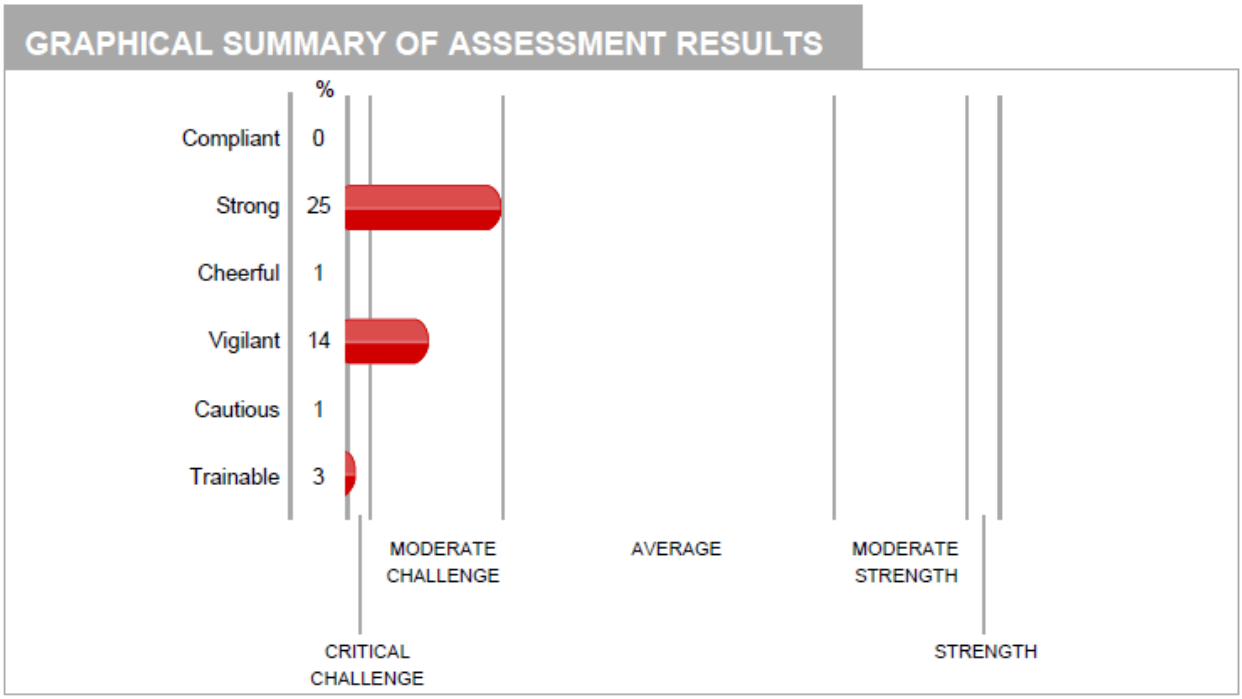

Figure 3: Safety report on Person C

2.3 Derailers of work behavior: Fight, flight or freeze

Still based on personality tests, Hogan Systems offer yet another angle from which possible (predicted) work behavior can be assessed. This should be seen as a useful supplement to the Safety Report above.

Using the same data collection techniques (evidence-based questionnaires) as with assessing personality traits and the statistically related levels of safety competencies, research has shown (Hogan 2009) that it is possible to identify behavioral tendencies that are likely to emerge when a person is either stressed, bored or fatigued. The term "derailers" refers to something that could cause a train to bump off its rails, clearly as a metaphor for something obstructing good job performance. Derailers fall into three overall categories that any given personality might possess: Flight, fight or freeze.

Flight pattern

Having this derailer pattern will probably not make the person physically 'run away' from very stressful situations. Instead, the flight concerns **turning away from people**, either identifiable as lowering the level of communication, postponing deadlines set by others, being very skeptical towards others, irritated with others, etc. Especially regarding communication, this can be dangerous in safety-critical situations, e.g. if the team or people around a maritime officer is kept unaware of a dangerous situation at hand or the team simply does not know that the officer needs help. Situational awareness can suffer severely from this.

Fight pattern
Likewise, this pattern will probably not make the person in question fight other people physically, but could cause him or her to argue exaggeratedly, make much social drama and give the surroundings an impression of being overly confident and even arrogant ("I basically know better than others"). Obviously, this can severely diminish situational awareness as the e.g. team around an officer with a fight pattern might avoid him or her altogether, not providing the information the officer needs (simply out of fear of giving 'bad news') or not questioning officer decisions in case they have alternatives to the safety-critical situation at hand. Alternatively, the officer's fight behavior might even distract or stress the team around thus preventing the appropriate level of situational awareness.

Freeze pattern
Freezing in this context does not mean 'doing nothing'. Instead, this derailer pattern could cause the person to engage in wrong or unimportant priorities when having a very stressful situation at hand. Being overly diligent could bring an officer into a focus on details while ignoring the big picture, not trusting the subordinates and preferring to do detail-oriented things as a soloist. In addition, the officer might be stubborn and inflexible towards subordinates about how work gets done. With respect to the person's (officer's) orientation towards (other) authorities, the freeze pattern could make the officer too eager to please and therefore reluctant to act independently. Hence, he or she might not offer strong opinions in a safety critical situation, and the freeze-prone officer would probably seek approval from authorities before acting. The officer simply waits for other authorities to make the difficult decisions.

2.4 Another factor to consider: Mental abilities

Another part of the considerations recommendable when recruiting personnel for a safety critical job is known as mental abilities or skills, which is still something innately connected to the person, although not directly linked to the concept of personality. Quite obviously mental abilities are associated with the classical concept of IQ and numerous cognitive tests are available for measuring this in a person. A well-established and widely accepted example is the Bochum Matrices Test (or BOMAT, Rüdiger et al, 2001) which aims to measure general intelligence.

However, in the context of a maritime working environment (or a safety critical one in general), a selection of specific cognitive abilities is relevant due to the requirements of the safety critical working conditions. IQ as a single measure can be said to reveal the person's ability to think logically and deduct rules. However, a maritime officer's ability to mentally rotate shapes and figures, transform 2D images/maps to the 3D world, having good hand-eye coordination, etc. is obviously relevant for his or her ability to navigate and act safely on a ship's bridge as well as the ability maintaining a proper visual attention level during repetitive work (e.g. outlook, monitoring instruments). Where the BOMAT test is an example of IQ measuring, the d2-R is one testing the level of a person's visual attention (Hogrefe Verlag, 2016).

At the Department of Applied Psychology, FORCE Technology a computer-based test battery, APRO+ has been found useful in the evaluation of maritime officer's mental ability. APRO+ is composed of a number of sub-tests that collectively provide an insight to abilities mentioned above. Since all sub-test are timed, the person being tested must balance the time consumption with correctness in answers (which can be either right or wrong). Compared to a norm-group of sea officers, the resulting measure of **correctness-priority** shows whether the person places correctness over speed or vice versa. In a safety critical environment the preferred strategy is to put correctness over speed. The correctness-priority taken together with the individual results from the sub-tests, also uncovers the person's (probable) need for training, when required to adapt new technologies, learn new skills and implementing new procedures.

2.5 Is there an optimal profile for Sønderho II?

As shown, both personality and mental abilities influence (safe) work behavior and an obvious question emerges: What is the optimal profile for an officer expected to be the only official on board a one-manned ferry?

A simple question to formulate, but complicated to provide an answer for. Even though the pages above concentrate on tests, we are not arguing that the answer is simply testing. When considering candidates the person's track records and impressions from job interviews are highly important. However, the research mentioned, and the test tools explained provide additional information to consider, when trying to identify the best possible candidate for the job.

Suppose recruiters have a somewhat equal impression of two candidates based on track records and interviews. But one is person C, and the other Person B presented in the Graphical summaries from the Hogan Safety test. The testing is in favor of person B, no doubt, due to the distribution of green/yellow scores compared to person C's all red scores.

A real scenario of recruitment would of course be more complex. Therefore a proper way to describe the optimal profile for the maritime officer needed on the one-manned ferry is the following.

- Personalities with scores on the Hogan Safety report in the yellow/green areas. However, a few red scores should not be a criterion for exclusion. The person might be well aware of his or her possible shortcomings and might also be very good at compensating for them.
- If the candidate reveals one of the mentioned derailer patterns (flight, fight or freeze), the fight pattern seems to be the least problematic. The fight pattern indicates readiness to act, which might not be the case with a freeze pattern. The flight pattern could mean communication – say, with passengers in a critical situation – is slow or even absent.
- The mental abilities should preferably be as high as possible; however the most likely applicant has an average level of mental abilities which can easily suffice. In any case, it is relevant to look at scores (aka probable abilities) within the different sub-tests managed, checking for extreme (low) scores, which indicates cognitive or perceptual shortcomings. Also, it is recommendable that a candidate's correctness-priority is in favor of correctness over working speed, due to the safety critical nature of the job.

3 The training concept for the master role

3.1 Individually oriented, intensive training based on the master's personal safety profile

It is widely recognized that the master (and the entire crew) on a ferry should be training in so called "non-technical skills". This training is founded in insights from aviation safety and human factors research dating back to the 1970-es and adapted by maritime industry in the 1990-es. This type of training has been provided under many different names such as Bridge Resource Management (BRM), Crew Resource Management (CRM), Bridge Team Management (BTM) and Human Factors Training. The focus of the training has been – and still is – the psychological aspects of safe and efficient work on board ships including – but not limited to – psychological capabilities and limitations, decision making, communication, teamwork and leadership style. The format of the training is usually a combination of theory and practical exercises using ship simulators as the scene for role plays illustrating important points from the theory part. There is a tradition that this type of training has a focus on the soft skills related to the interaction between people (hence communication, teamwork and leadership style) rather than the internal psychological processes in the individual. The reason for this is twofold: (1) that the behaviour – as it is expressed in communication and collaboration – is easier to observe in simulator exercises by the training instructor, and thereby easier to give feedback and so called "debriefing" on and (2) that the utilization of good communication, teamwork and leadership style is considered an effective safety measure used to compensate for the individual limitations. In other words: Participants are taught to get support from their team in difficult situations, and that the team skills and assertiveness is important for that to work. The internal psychological processes are often included in the theoretical parts of the training only, often including the context of subjects such as sleep, fatigue, stress and other so called "performance shaping factors" (PSF's). The internal psychological processes and the performance shaping factors are regarded as something to compensate for using team skills and synergy within the team.

Based on the above it does not make sense to apply traditional conservative BRM, CRM, BTM or Human Factors training to a situation where the master is the only person onboard the ferry. The single hand control of the ferry is a special situation, moving away from the traditional focus on communication, teamwork, assertiveness and leadership skills towards focus on the internal psychological processes of the master. The master should be prepared and trained in his or her own reactions independently of a group context, which is non-existing (on board) in the single hand situation.

Further, there can be different approached to the human factors training of the master on board a ferry. One approach can be "one size fits all". This is a very common approach in maritime training, when it is provided in the format of courses. The idea is, that the structure and content of the course (syllabus) should be fixed, but that the learning approach e.g. the balance between theory and practice could be accommodate to the learning style of the individual. This is done by simply utilizing different learning techniques, presenting them as a mixture to the participant, thereby trying to satisfy different individual learning styles by inviting the participant to buy in on the learning techniques they benefit the most from.

Another approach can be to focus the content (syllabus) of the training to the specific needs of the participant e.g. the master. This approach will require a thorough investigation of the specific individual needs before planning the content of the training. Personal safety profiles provide a picture of the master's strong points – as well as his/her less strong points – in relation to the daily work on board the ship. A job that might involve periods of heavy (mental) workload, important and complex decisions and prioritisation in relation to safety, regularity and compliance with rules and procedures. A special type of training can be planned based on these safety profiles. The safety profile can be seen as the "diagnosis", the training as the "treatment". Focus in this "diagnosis-treatment" regime is the psychology of the individual master. Through the entire process – from the first test to completion of the training – the master should therefore be supervised by experienced psychologists with considerable and practical knowledge of the work on board a ship. Throughout the training, focus will be on the master's personal safety profile. The training – based on that profile – include concrete techniques and strategies the participant can use to compensate for his/her own challenges and issues as well as to handle friction and barriers in cooperation and management. Please notice that it is suggested that personal safety profiles are also used when selecting the right person (and personality) for the job as master on board a one-manned ferry. Personal safety profiles should be used to optimize both the selection and the training for the special job as master on a one-manned ferry. And if safety profiles are used for selection, they are already available for the planning and orchestration of the subsequent training.

3.1.1 A specific course

Below is an example of training based on the outlined approach above and on a personal psychological safety profile for the individual master (or other relevant positions e.g. land-based control room operators):

Objectives of the course

At the end of the course, the master must be able to:

1. Identify relevant issues in relation to psychological profiles
2. Identify relevant psychological patterns of behaviour in him-/herself and others
3. Choose relevant techniques and strategies and apply them with the desired effect in the actual situations

in relation to situations in the daily operations.

The master must also have gained a basic knowledge of:

1. The correlation between personal profile, behaviour and safety
2. Causes of varying performance and behaviour in each person over time
3. Causes of different persons' differences in performance

Method

The method of the training is based on three steps:

1. The master's experience with own personal psychological challenges through specially designed simulator exercises and role plays.
2. The master reflects on issues and patterns of behaviour together with the psychologist and discuss relevant techniques and coping strategies.

3. The master tries the discussed techniques and coping strategies in practical simulator exercises, and in the debriefing, the participants, together with the psychologist, reflect on the application and effect of the techniques and strategies.

Program and content (example)
Day 1 (½ day = afternoon):

- Introduction to training concept
- Theory on intra- and interpersonal variations
- Theory on the correlation between personal profile, behaviour and safety
- Introduction to simulator

Day 2 (morning exercise #1 and reflection, afternoon techniques, strategies and exercise #2):

- Theme "emotional control" (example – this must be adjusted to fit the personal safety profiles of participants)
- Handling of emotions, workload, stress
- Relates to the results of the personal safety profile: the so called "HPI Adjustment and HDS Fight/Flight/Freeze"

Day 3 (morning exercise #1 and reflection, afternoon techniques, strategies and exercise #2):

- Theme "passenger interaction" (example – this must be adjusted to fit the personal safety profiles of participants)
- Passenger reactions in emergency, communication and crisis management style
- Relates to the results of the personal safety profile: the so called "HPI Ambition, Sociability, Interpersonal Sensitivity"

Day 4 (morning exercise #1 and reflection, afternoon techniques, strategies and exercise #2):

- Theme "task approach and work style" (example – this must be adjusted to fit the personal safety profiles of participants)
- Prioritisation, balance, work style, supervision, feedback and learning
- Relates to the results of the personal safety profile: the so called "APRO+ and HPI Prudence, Inquisitive, Learning Approach"

To summarise: The training of the master in non-technical skills (BRM, CRM, BTM, Human Factors) on board one-manned ferries – as well as other relevant personnel e.g. land-based control room operators – should be based on a special concept where

a) focus is on internal psychological processes rather than communication and teamwork skills and
b) the training is designed for the individual based on the individual's own personal safety profile rather than "one size fits all".

An example of a specific course based on this training philosophy has been given in the text above as an illustration of how the this can be conducted in practice. The example has as prerequisite that the master has been through psychological assessment and that a personal safety profile has been generated as part of the selection process as described in the above chapter "Personality and Selection".

4 Esbjerg-Fanø crossing: Field study among passengers

For two days, July 4th and 5th 2018, Department of Applied Psychology at FORCE Technology performed a field study among passengers onboard the current ferry crossing, Esbjerg-Fanø in Denmark. The purpose was two-fold:

A) Collecting information about the perception of safety and attitudes towards safety among the passengers using semi-structured interviews.

B) Collecting data concerning the visual attention towards safety signs and safety information among the passengers. Data collection was via eye-tracking recordings.

Obviously, the field study was done during a narrow time span compared to a full season of crossings, limiting the validity of the generalizations put forward in the following. However, the field study did provide some notable clues as to how some passengers might react e.g. in emergencies and from observing the visual attention among a small sample of passengers, it became relevant to us to suggest a way of informing the passengers about safety, outlined below under heading 4.3 Pre-ride.

4.1 The outcome of the interviews

The ferry crossing Esbjerg-Fanø lasts only approximately 10 minutes. Since there is a lot of human activity before and after the crossing (people embarking and disembarking, bringing bikes, cars, etc), we chose to perform interviews with passengers while the crossing took place. While passengers were sitting in the designated areas, we kindly approached them with the request of participating in our research into the "perception of safety onboard" and the "attitudes towards safety information". With only 10 minutes at our disposal with each passenger, the team was set up with 4 interviewers (3 psychologists and an intern) in order to reach a fair number of interviewees during the two days. Going back and forth with the crossing, we managed to interview 30 people, using a guideline for the interview show in appendix 2-A ("Guideline for interviews – passenger profile and competencies, perception of and attitudes towards safety"). The guideline consists of 20 questions, divided into 5 thematic areas. However, the idea of a semi-structured interview is not to diligently go through all questions available, instead the guideline provides a framework for the interview leaving room for flexibility and level of details in the question-answer process. Based on the unfolding specific conversation, the interviewer might skip a question, rephrase it or ask a slightly different question than the (next) one listed in the guideline. Please note that the results of the interviews reflect the passenger's self-reported view on their own imagined behavior in relation to safety and emergencies. This might be different from their actual behavior in case of a real-life emergency. Obtaining data on real-life emergency behavior at the Esbjerg-Fanø crossing, has not been possible for obvious reasons.

As shown in appendix A, the thematic areas of the guideline focused the interviews around

1. How often they use the Esbjerg-Fanø crossing, and with what purpose (work, leisure)
2. To which degree do they – according to themselves – pay attention to the safety information onboard
3. Do they feel safe onboard and/or do they worry about safety?

4. In case it was an option to use an unmanned ferry on this crossing, would they use it? Would some things worry them?
5. How would they – according to themselves – react to occurring fire/smoke onboard an unmanned ferry?

Due to the qualitative and semi-structured nature of the interview design, it does not make much sense to provide the reader with a lot of numbers and percentages aiming to illustrate how many passengers answered this or that way, i.e. quantitative results. Instead, we will provide an overview of recurring tendencies spotted among the interviewee's responses across the thematic areas listed above.

For a start, though, some numbers:

- The average age among the passengers interviewed during the two days was approx. 50 years, some down to 18 years, others at age 65+.
- A little more than half of the passengers were commuters, and therefore using the crossing daily.
- Very few of all the people we talked to, indicated to use the crossing less than one day per week.
- 3/4 of the interviewee's stated that they used the bike as transportation to and from the ferry. But please note, that most people using their car, stays in the car during the crossing, thus not entering the designated passenger area. Our resulting interviews is therefore bias towards those passengers using a bike or arriving at foot. Passengers driving their car onboard is not a relevant user group on Sønderho II
- We learned that during the height of the summer season, the crossing is packed with wind surfer enthusiasts and large numbers of tourist, mainly from Germany.

4.2 Paying attention?

When asked about whether they as passengers notice the safety signs onboard, very few people responded with a "no" and most people replied something like: "I have used this crossing so many times, so … I know it is there, but I do not dig into the details" and "I can see the sign LIFEWESTS from here. I guess, that's the most important one". A significant part of the passengers was travelling with someone else and explained their own "low level of attention to safety information" as the result of full engagement in conversations.

When asked about whether they notice the safety equipment, the response pattern is the same. Very few answers "no" and most people have a vague notion of "it must be here, but I don't look for it". Equipment like lifeboats was to a large extend known to be located on top of the small ferry. In one single case, talking about fire safety, the interviewee responded that he had not seen a single piece of safety equipment onboard. He was sitting right next to a fire extinguisher.

Even though this last anecdotal case is obviously not representative of the passenger's general level of awareness of the safety equipment onboard the Esbjerg-Fanø crossing, we were left with the impression that the safety signs and safety equipment is very much in the background of attention. Around 15% of the interviewee's noticed this themselves but stated that if they were using a (much larger) ferry elsewhere, they "would pay more attention to safety".

All passengers stated that they felt very safe onboard and that they "basically do not worry" about their own safety on "this short crossing". However, when urged to think of the worst thing imaginable on the crossing, they mostly mention fire, but also chemical leaks from the (infrequent) dangerous goods transportations or a collision with another ship resulting in sinking.

To summarise: Passengers appear mostly unaware and maybe even uninterested in safety issues and this should be kept in mind when designing attempts to control passenger behavior in case of emergencies, e.g. PA announcements, signs and directions from the master. Thus, procedures must not rely on safety competencies among passengers alone, since these might not be adequate.

4.3 What if the ferry was autonomous?

We asked people to imagine a future scenario where this crossing was offered via an unmanned (or autonomous) ferry: Would they use it? Would any worries be introduced in that situation?

All people responded that they would indeed use such a ferry crossing with no significant safety concerns. In retrospect, we might have seen a slightly different response pattern, if we had presented a hypothetical opportunity of choosing between a manned and an unmanned ferry for the crossing. Fanø is isolated without a ferry crossing, thus forcing people to use the only ferry available. Some passengers did in fact put it this way: "Well, I would have to take the unmanned ferry – wouldn't I!".

Albeit, we were left with the impression, that the overall attitude towards an unmanned ferry is the same as with the current ferry: No significant resistance towards using such a ferry based on safety concerns, but mainly "because the crossing time is so short and the shallow water here".

But what if a fire occurs on an unmanned ferry? There would be no officials around to take appropriate action or tell passengers what to do. Then what?

Among the passengers interviewed the responses to this scenario were along these lines

- "I would expect the equipment to perform automatic fire extinguishing"
- "I would expect announcements in the loudspeakers"
- "There would have to be some sort of call-button, - a way to contact people on land"
- "I would call 1-1-2" (equivalent to 9-1-1)
- "I would find a life west and probably jump overboard"
- "Depending on severity, I would either seek a lifeboat or jump overboard"

The interviewee's demonstrated the same type of answers to an imagined scenario where smoke occurred (and not visible fire). We asked this because the smell of smoke leaves more room for interpretation of the situation among passengers.

It gives rise to some concern that a significant number of passengers consider jumping overboard in case of a fire (or smoke) occurring. This 'imagined reaction' might be quite different in a real-life situation, especially during the winter season or during night time. But in any case, jumping overboard should be the absolute last option, since people in the water immediately adds danger to an already dangerous situation. The passengers we talked to (considering jumping overboard) were very confident that they could swim ashore.

We do not share this confidence and would definitely recommend different precautions to prevent the situations of man over board on top of a fire. One mitigation is to deliver safety information specifically addressing this identified tendency among a significant number of passengers, urging people not to jump overboard, even though it is tempting for some.

Another recommendable mitigation to provide passengers with a safe escape in the form of a life raft even though the life raft is not strictly necessary from an evacuation perspective (the ferry being "its own life raft").

As shown, we also clearly identified an expectation among passengers on a (future) unmanned vessel: Some sort of direct communication line with people on land. Further away from coast lines than the Esbjerg-Fanø crossing, cell phones might not be able to connect to a network, thus making a more stable line of communication needed. Also, if the unmanned ferry is equipped with a call-button feature, it would be expected to be able to directly get in touch with professionals familiar with the specific ferry and all of its features, including the safety equipment. Calling 9-1-1 (or 1-1-2) might not reach professionals with an appropriate level of detailed knowledge about the ferry in need. At least not immediately.

4.4 In case of MOB or other passengers creating problems – then what?

We also investigated which actions the field study's respondents imagining themselves performing, in case there was a man overboard (MOB) situation on an unmanned ferry crossing. The main categories of the reflections among passengers was:

- "I would find a lifesaver and throw it to the person in the water"
- "If no one else jumps in the water, I would do it – with a lifesaver, I guess"
- "Push some sort of 'emergency break', throw a lifesaver and call people on land, maybe 9-1-1"

As was the case earlier, passengers clearly expect some sort of emergency feature installed that one could push in order to alarm people on land. In this case the imagined button installed would be able to stop the ferry (and alarm people on land simultaneously).

Also, the idea of jumping in the water should not be ignored: It seems that many passengers consider this to be a good option, even though it is not recommendable since it adds danger to an already dangerous situation.

The recommendable mitigation is to provide alternative measures in form of a Man Over Board alarm button. Activation hereof should include a logging of the ferry's position.

Even though we did not ask the interviewees specifically, we noticed that only 2 or 3 passengers spontaneously mentioned, that in case of any emergency (not just the MOB situation) they would make sure to help other people in need of assistance. Our data does not establish proof of any unwillingness among passengers to help each other, however our finding leads us to suspect that passengers implicitly expect officials/crew members to take care of people in need of assistance (injured, children, elderly, disabled, etc). Since (semi-) automated ferries have no (or only one) official crew member present, we recommend mitigating this issue as part of the ferry's general safety information or via P.A. announcements like: "in the unlikely event of an emergency, please make sure to help children, elderly, disabled and injured fellow passengers in need of assistance".

Finally, we asked passengers to reflect on their own imagined actions, in case other passengers create trouble on an unmanned ferry crossing. The scenarios could include other passengers fighting, vandalizing equipment or even sabotage. Then what?

Not surprisingly, our respondents would make use of some sort of call-button (maybe use 9-1-1), however the possibility of intervening divided the imagined responses somewhat.

- Most male passengers would not intervene, if the troublemakers are big and strong looking men, but would do so if it concerns young people and if one of the persons involved seems to be victimized.
- Most women would prefer to step aside and call for help, possibly with the help of other passengers

4.5 Eye-tracking data points to pre-ride safety instructions

The second overall purpose with the field study at Esbjerg-Fanø ferry crossing was to collect data concerning the visual attention towards safety signs and safety information among the passengers. In recent years the technology for collecting such data has improved, making it relevant to use in a case like this. The eye tracking data was collected using Tobii Pro Glasses 2 which is a lightweight wearable technology. It consists of two units: a head unit (the glasses) connected via a HDMI cable to a belt clip recorder unit. The head unit has a scene camera recording the wearer's front view (including audio) and the frame has infrared illuminators and sensors installed thereby using the eye tracking technique *Corneal reflection* (dark pupil). The belt clip unit holds a SD card for recording data, operates on rechargeable batteries and is Wi-Fi controlled through PC-based software.

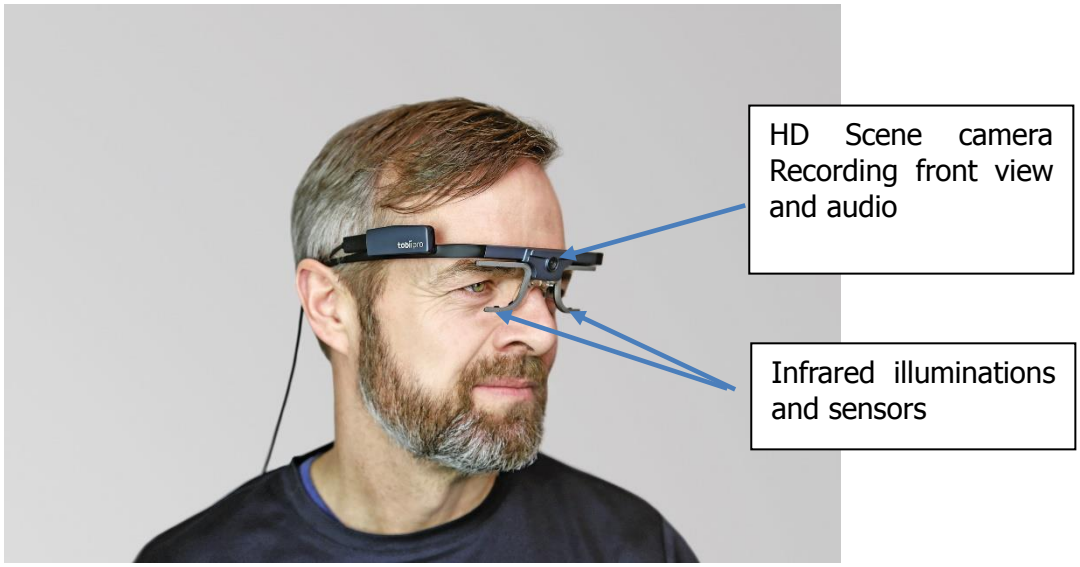

Photo 1: FORCE Technology, 2018.

This setup makes it very easy for the person wearing the eye trackers to freely move around on the ship and due to the non-invasive design, most users easily forget they are even wearing them. Based on the recording from the scene camera and the associated eye tracking data, the software produces a video showing what was in the wearer's field of view during the recording (a 1st person perspective replay), **including** a graphical overlay: A yellow dot indicating where in the field of view the person was looking at any given time (eg. shown in Photo 2). The software can be set to illustrate fixations by either increasing size of the yellow dot or color change hereof. A fixation is defined as a period (100 ms or more) in which the person's eyes are locked toward a specific object (or location) in the field of view (Blanke, M., Koester T., Brøsted, J.E. et al, 2018).

We managed to record eye tracking videos with a small sample of passengers (4) using the ferry crossing. These passengers were recruited from the waiting area where most waiting passengers spent the time prior to embarkment. We instructed the volunteers to behave as natural and unaffected by the glasses as possible while using the ferry and to us, I did indeed seem like they did so. One of our eye-tracker wearers even went straight to a chair onboard the ferry, leaned against the wall and fell asleep, thus not providing much eye-tracking data from his closed eyes. The other obtained recordings gave us some insight into what passengers are most likely to look at while embarking as pedestrians (sometimes bringing a bike or a stroller).

For obvious reason we cannot show a recording in this report, but a couple of illustrative still images from such a recording are shown below. As mentioned earlier, the yellow dot reveals where in the visual field the person is looking.

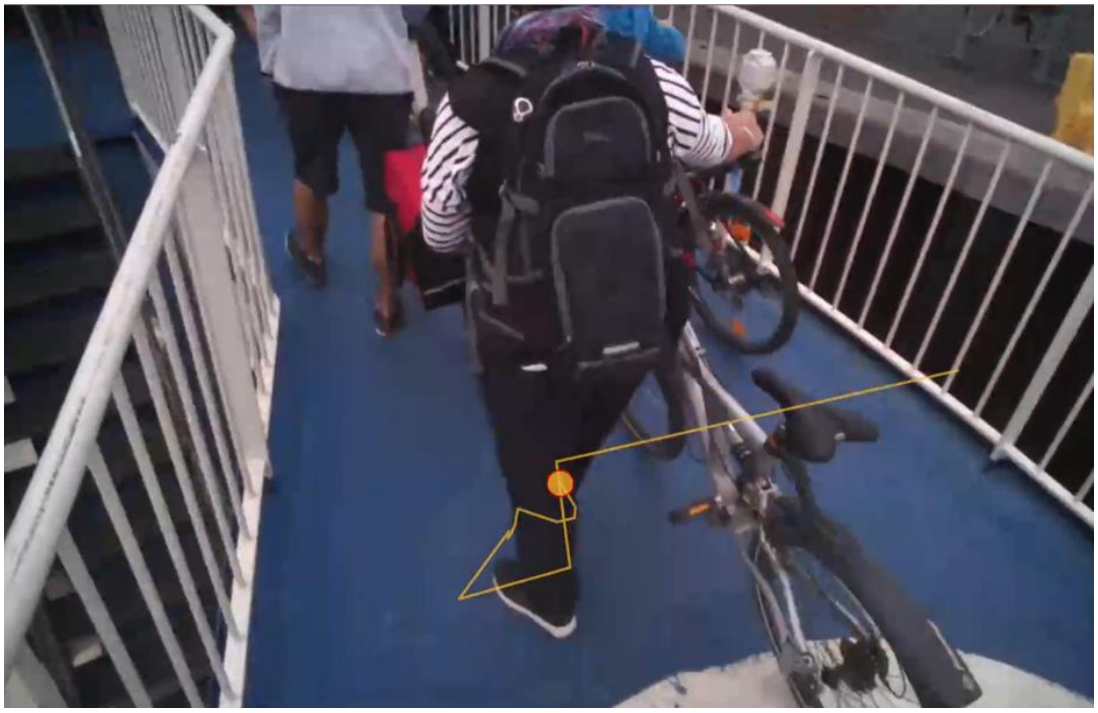

Photo 2: Passenger A wearing eye-trackers, bringing his own bike. There are many things to watch while embarking. Other passengers, e.g.

Photo 3: Passenger A. Making sure not to collide with other passengers.

Photo 4: Passenger A. Not looking at (safety) signs but observing other people instead.

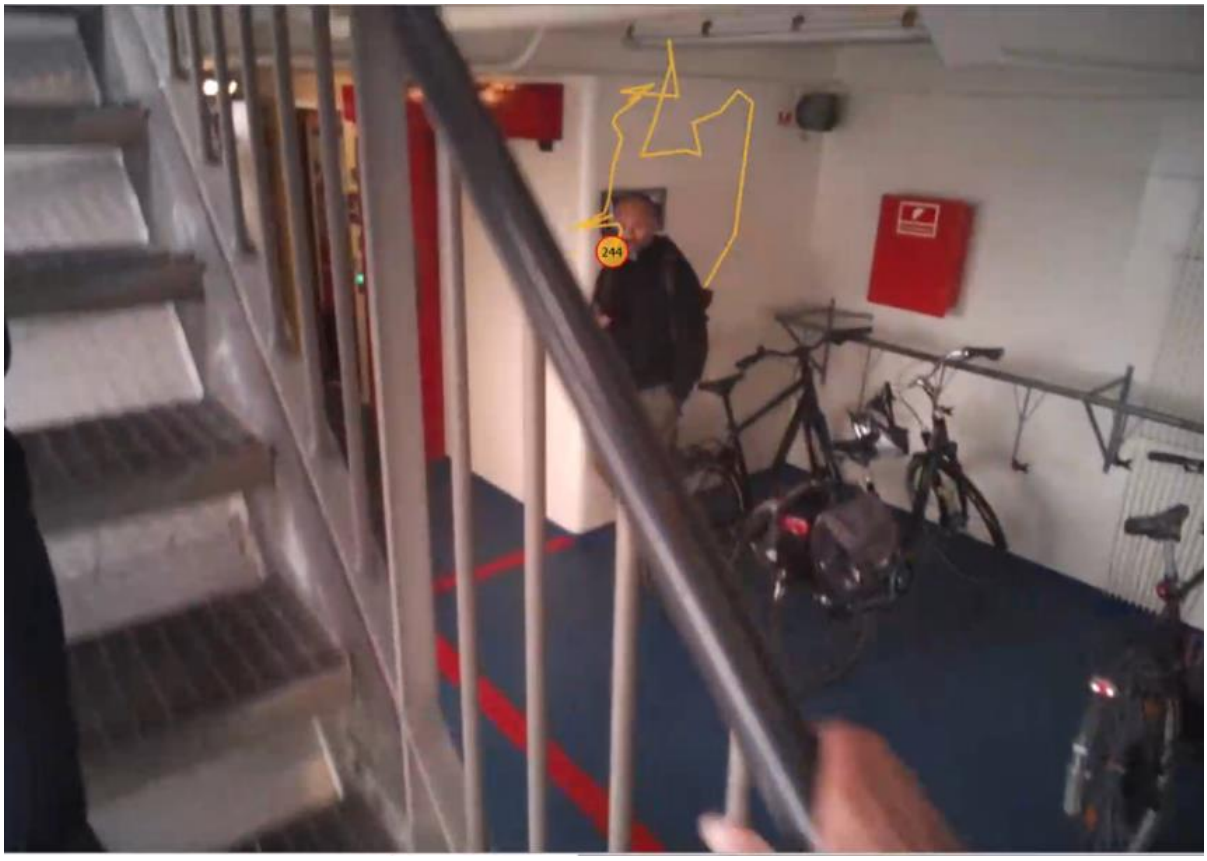

Photo 5: Passenger A. Not looking at (safety) signs or equipment but observing other people.

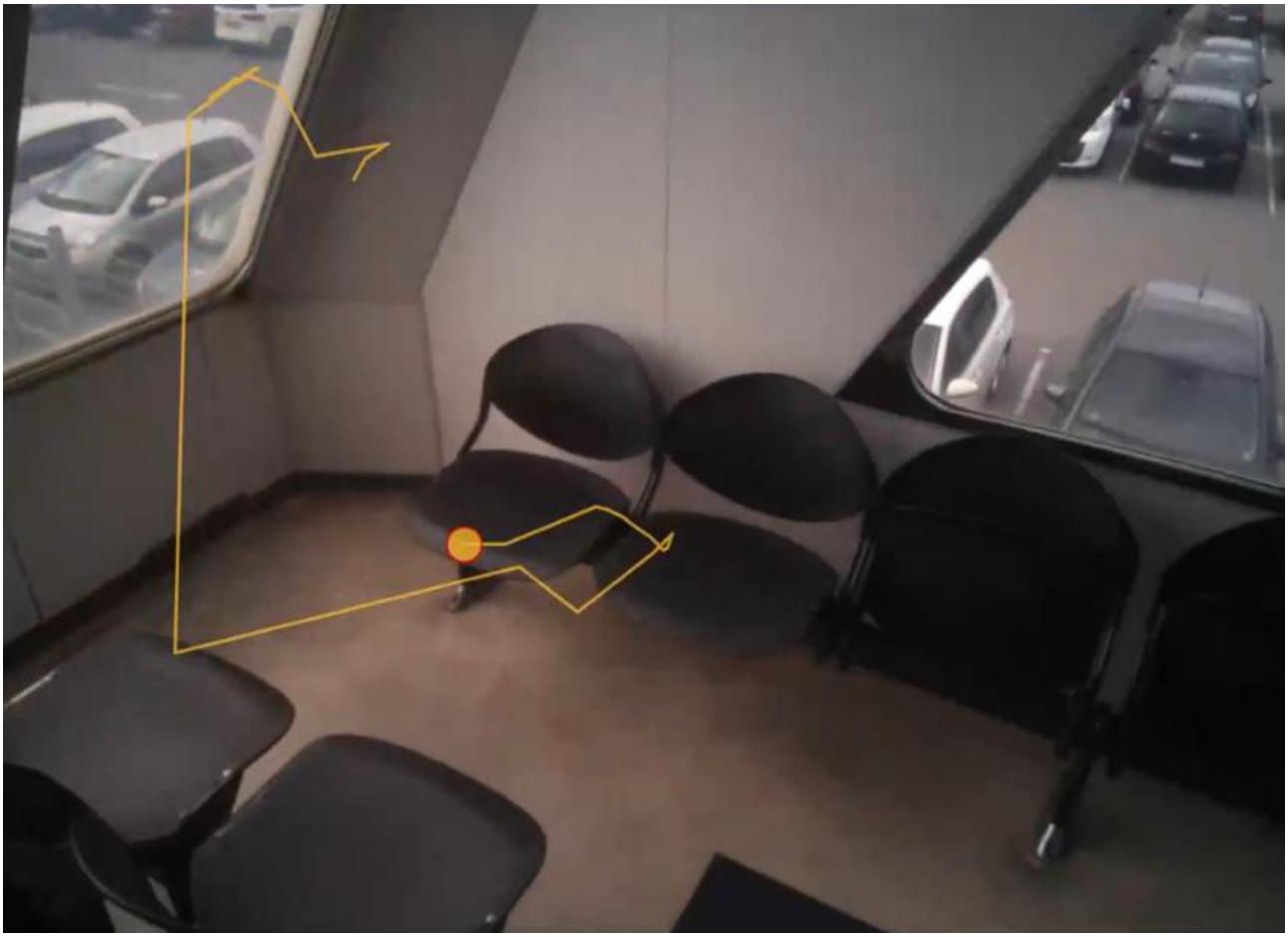

Photo 6: Passenger A. Finding the right spot to spent time while crossing with the ferry.

The still images show an example of what our interviewees likewise revealed to us: Passengers do not pay much, if any, attention to safety signs or safety equipment. In the case of passenger A, he was bringing his own bike and was therefore occupied with avoiding collision with other passengers, finding a spot to park his bike, looking at other people, etc. Everything but the signs.

The visual attention of passengers using Esbjerg-Fanø investigated via eye tracking is a very small sample, indeed, however the findings seem to be quite the same as in the Passenger A-case.

If the tendency not to look at safety signs and equipment holds true for most passengers (and we have no reason to believe otherwise), it leads us to recommend an additional strategy to signs onboard following the task of providing safety information to passengers onboard. And by additional we wish to stress, that signs on board is by no means superfluous, since they might become very relevant in case of critical situations at sea. But as a supplement to the information given onboard, a communication strategy in the pre-ride areas surrounding the Esbjerg-Fanø crossing seems appropriate. In these waiting areas, people spend several minutes not really doing anything else but waiting for the next ferry to arrive. Once the embarkment begins, many other activities (as shown in the still images above) preoccupies the passengers, forcing safety signs into the background of people's attention. If safety information was provided to people while they are waiting in the designated areas (indoors and outdoors at the harbour), the chance of successful communication is higher.

4.6 Pre-ride

The concept pre-ride is well known in theme parks and it was originally introduced as a concept by Disney theme parks in United States and Europe. The idea is that guests in a theme park (or amusement park) are prepared for an activity (e.g. roller coaster) when standing in line and waiting for their turn. The preparation has two purposes:

1. That the perceived waiting time is shorter because the guest feels herself or himself entertained or maintained occupied with something while waiting.
2. The experience (and quality of experience) in the activity is enhanced through anticipation and expectations building up before entering the activity.

The two purposes are fulfilled by introducing e.g.

- video entertainment relevant for the activity and building up expectation through storytelling for guests standing in the waiting line
- designing the waiting area in a way that the activity can be seen when waiting and/or
- designing the entry and exit to the activity in a way that guests waiting for the activity will see and experience the excitement of other guests leaving the activity.

If we apply the concept pre-ride to airplane travel, we see some similarities. However, the focus of pre-ride in commercial aviation is not shorter perceived waiting time or the build-up of excitement. The aviation pre-ride is planned for efficiency, security and safety. The different activities, the way they are conducted in the airport and inside the airplane prepare passengers for optimal safety behaviour in case of an emergency. This is illustrated in the table below.

Phase of travel	Practical "front stage" purpose	Safety "back stage" purpose
Arrival at airport – passengers are directed to different arrival facilities e.g. parking lots and from there to different buildings	Logistics	The passenger is primed reading signs and following directions for wayfinding
Check-in – passengers should follow a check-in procedure, be on time, wait in line for check-in or baggage drop, answer security questions at check-in etc.	Logistics and efficient operation	The passenger is primed following instructions and procedures, rules and regulations and being punctual. Timing is important, and actions should be performed in the right order and before deadline. Instructions for check-in can be in writing on travel documents, on signs and verbally given from personnel.
Security procedure – waiting in line for security check, follow procedures for actions during security check e.g. how to have bags and personal items scanned	Security	The passenger is primed following instructions and procedures and rules and regulations. Everybody must do certain actions to pass. Timing is important, and actions should be performed in the right order. Instructions for security procedure can be a combination of signs, videos and verbal instructions from personnel.
Boarding – pre-boarding check, boarding procedure at gate	Logistics and efficient operation	The passenger is primed following instructions and procedures and rules and regulations. Passengers can be divided into groups (boarding zones), and conformity to the group is exercised and maintained. Groups wait when told to and board when told to. Timing is important, and actions should be performed in the right order. Instructions are given through PA-systems, video monitors and directly from personnel.
On board airplane – safety instructions, meals	Safety, logistics and efficient operation	The passenger is primed following instructions and procedures and rules and regulations (e.g. wear seat belt, turn off phone). Again, timing is important, and actions should be performed in the right order and at the right time (e.g. meals are handed out at specific time, light is dimmed for night flight). Instructions can be given through PA-system, directly from cabin personnel or from signs (e.g. seat belt sign) or in-flight safety leaflet.

Table 2: Preparing passengers

To summarize, the flight pre-ride experience prepares passengers to follow instructions and directions given by personnel, PA-announcements, signs and video monitors etc., to be conform with the group in their behaviour and to time actions according to instructions. All of these are relevant in case of an emergency, emergency landing or evacuation.

With this knowledge in mind about the pre-ride concept, including the exemplary implementation hereof in commercial aviation, we can now look at the Esbjerg-Fanø crossing pre-ride experience.

The terminal areas in Esbjerg and Fanø are arranged according to the table below:

Terminal in Esbjerg	Terminal building with ticket office for passengers without car and staging area for cars. Outdoor partly sheltered waiting area for passengers with gate to boarding ramp. Passengers can walk/drive in without any procedures or pre-checks right until ferry departure. Some posters with passenger announcements and safety information are found in the area but not at very prominent positions. There is a lot of other information on posters as well, such as advertising, time tables and general passenger information.
Terminal in Fanø	No terminal building but a shed for waiting passengers. Staging area for cars. Marquee with information about departure times. Passengers can walk/drive in without any procedures or pre-checks right until ferry departure. Some posters with passenger announcements and safety information are found in the area but not at very prominent positions. There is a lot of other information on posters as well, such as advertising, time tables and general passenger information.

Table 3: The current terminal areas at Esbjerg-Fanø

It is clear from the design of the terminals at the Esbjerg-Fanø ferry crossing (as they are now), that passengers are not prepared for receiving instructions, for conformity and timing of actions before going on board the ferry. This is not unusual. For example: Car passengers waiting in the staging area at Molslinjen in Sjællands Odde have a clear view to a big video screen marquee before driving on board, which could have been used for pre-ride safety experience/information. However, this big screen is not used for pre-ride safety information but for advertising. The safety information (call out and video) at Molslinjen is given when passengers are already on board the ferry and mentally occupied finding a seat or buying a meal from the cafeteria.

This means for the current Esbjerg-Fanø ferry crossing that:

- Passengers are not trained or prepared with safety relevant skills before going on board.
- Passengers are not reminded about safety as part of the pre-ride, and safety awareness is therefore low. This fits well with the understanding from our passenger interviews where passengers express little concern about safety issues.
- Passengers are expected to read signs and information when on board the ferry at a time where they – according to our on-board observations – are mentally occupied with for example finding a space for their bike or a seat in the lounge.

We would therefore recommend a redesign of the passenger terminals and boarding area from a pre-ride philosophy as illustrated in the example below:

Phase of travel	Recommendation
Arrival at terminal	Upon arrival at the terminal, passengers should be primed with "safety thinking" through signs and directions. For example: The use of different path ways through the terminal area for passengers with prepaid tickets and passengers who need to buy tickets.
Waiting	While waiting at the terminal (area), passengers should be primed with "safety thinking" through information and announcements, e.g. PA-messages like "never leave your belongings unattended", and "in the unlikely event of an emergency, please make sure to help children, elderly, disabled and injured fellow passengers in need of assistance". Waiting time could also be used to give relevant safety information to the passengers e.g. by video (looping) or PA-announcements (repeating) explaining what to do in case of an emergency on board, how to deal with it and how to alarm the master or land station. Further, the waiting area can be arranged with a pre-boarding area, which opens e.g. 5 minutes before departure. This has no real practical purpose, but it will exercise passengers' timing of actions and conformity (acting as a group rather than individuals).
Boarding	Passengers should be primed with "safety thinking" during boarding. A boarding sequence could be applied like in commercial flights: First disabled and travellers with small children, then passengers with bikes and last all other passengers. A boarding sequence like this might even improve the efficiency of boarding, but the most important point is that passengers are prepared for conformity and timing of actions. Passengers can also be primed with "safety thinking" during boarding by placing safety equipment such as fire extinguishers and lifebuoys close to the boarding ramp, where they are clearly visible for passengers boarding.
On board	Safety information as required by regulation should be maintained, but we have pointed out the need for additional information on for example man over board (MOB) alarm button or emergency phone.

Table 4: Pre-ride recommendations

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6 Appendix 2-A Interview guide

Guideline for interviews.
Passenger profile and competencies, perception of and attitude towards safety

Ferry crossing, Esbjerg - Fanø , etc **Time of fare** **Gender and age of interviewee**	
Use of fare, including frequency hereof	
1. How often do you use the Esbjerg-Fanø ferry crossing?	
2. Why do you use this ferry crossing? (commuter, tourist, own a summer cottage on Fanø, etc)	
3. How do you use the crossing? (by car or bike, as a pedestrian)	
4. How often do you use **other** ferry crossings?	
Perception of safety / feeling safe on board?	
5. Do you have responsibility for anyone travelling with you? (children, family members)	
6. Do you notice safety signs onboard?	
7. Do you notice safety equipment onboard? (Manual fire alarm activation, fire extinguisher, etc.)	
8. To which degree do you take interest in safety onboard? Including feeling safe. (please elaborate)	
9. To which degree do you worry about safety and feeling safe onboard? (please elaborate)	
10. Do you feel safe and secure onboard? (compared to other places like ferries, planes)	
11. To you, which event onboard would be the worst imaginable? (accident, unpleasant experience…)	

Other means of transportation	
12. How often do you fly?	
13. When flying, do you notice safety procedures and instructions? (if relevant)	
Autonomous ferries. Attitudes and concerns	
14. Would you use the ferry if it was unmanned (without crew)?	
15. What would be your possible concerns/worries in that case?	
16. Would you take special precautions if you were to use an unmanned ferry?	
Scenarios onboard unmanned ferries	
17. What would you do if a fire occurred (flames) on an unmanned ferry?	
18. What would you do if you detected smoke on an unmanned ferry?	
19. What would you do if a passenger fell overboard on an unmanned ferry?	
20. What would you do in case of uproar, fights between passengers or vandalism/sabotage occurred onboard an unmanned ferry?	