

Usability criteria for simulators applied in the maritime engineering education

Stefan Kluj

Gdynia Maritime University
Gdynia, Poland

ABSTRACT: The paper presents the author's experiences in the development and use of ship engine room simulators in the field of maritime engineering education. Most users would expect a simulator to present the highest possible fidelity in the modelling of a real system. However, this trend generates increased simulator complexity and thus substantially increases its costs. The paper presents two very practical usability criteria: appropriate simulator class and the integration of checklists. In particular, the paper provides the example of a fuel separator operation, and compares how this operation can be trained utilising full mission (F Class), PC-based (P Class) or part task (B Class) simulators.

INTRODUCTION

Ship engine room simulators are used widely in the maritime academies and training centres as very effective and valuable teaching tools in maritime engineering education. Their specification and application have been partially defined in the STCW 95 convention, which has been signed by all of the member countries of the International Maritime Organization.

Several researchers have determined that user feedback can be effectively utilised to serve as usability criteria [6]. This should follow task performance in a timely fashion so that trainees may see the connection between their performance and the guiding criteria. Feedback should also be precise so as to let trainees interpret it easily. In addition, feedback should be thorough so that trainees may understand all of the relevant aspects of their performance, and so that corrective comments can be understood within the context of the full training situation.

Many of the very expensive simulators are not used properly (or not used at all) because of their limited usability. Importantly, usability criteria may differ from customer to customer and are dependent on many factors, including:

- The educational and training programme;
- The entry level of trainees;
- The instructor staff qualifications;
- The number of hours used for a simulator training [2].

Three important aspects of the ship engine room simulator usability are presented in this paper.

APPROPRIATE SIMULATOR CLASS

It is unlikely that one simulator (even one that is very sophisticated and realistic) will be able to fulfil all the above-mentioned expectations. Higher user requirements provoke a growing complexity of engine room simulators, resulting in their higher costs and longer development time. On the other hand, rapid changes in engine room equipment and in control techniques require a great deal of flexibility in simulator architecture.

At first glance, a most sophisticated and most expensive full mission simulator should provide the best quality of training and the best training results. However, the example presented below shows that this rule does not have to be always true. The fuel separator operation can be trained using full mission (F Class), PC-based (P Class) or part task (B Class) simulators; these are compared below.

Figure 1 shows how the fuel separator is modelled in the F Class engine room simulator. It should be emphasised that the separator modelling is very sophisticated and enables not only automated but also manual operation. However, the controls are rather small and the number of animated elements is somewhat limited. For example, it is rather difficult to observe the separator's rpm, primarily because the animated gauge has to be very small due to the lack of free space on the screen.

It is easy to understand what role the separator plays in the whole engine room, and what kind of external conditions (steam, electrical power and sanitary water) have to be provided in order to start the separator. On the other hand, it is not so easy for the student to learn how the separator has to be operated in the manual mode.

Manual operation of the separator can be also mastered in the P Class simulator, as shown in Figure 2. In this case, the user can see not only the external connections of the fuel oil separator, but also the fact when the separator model can be operated in a very typical manner.

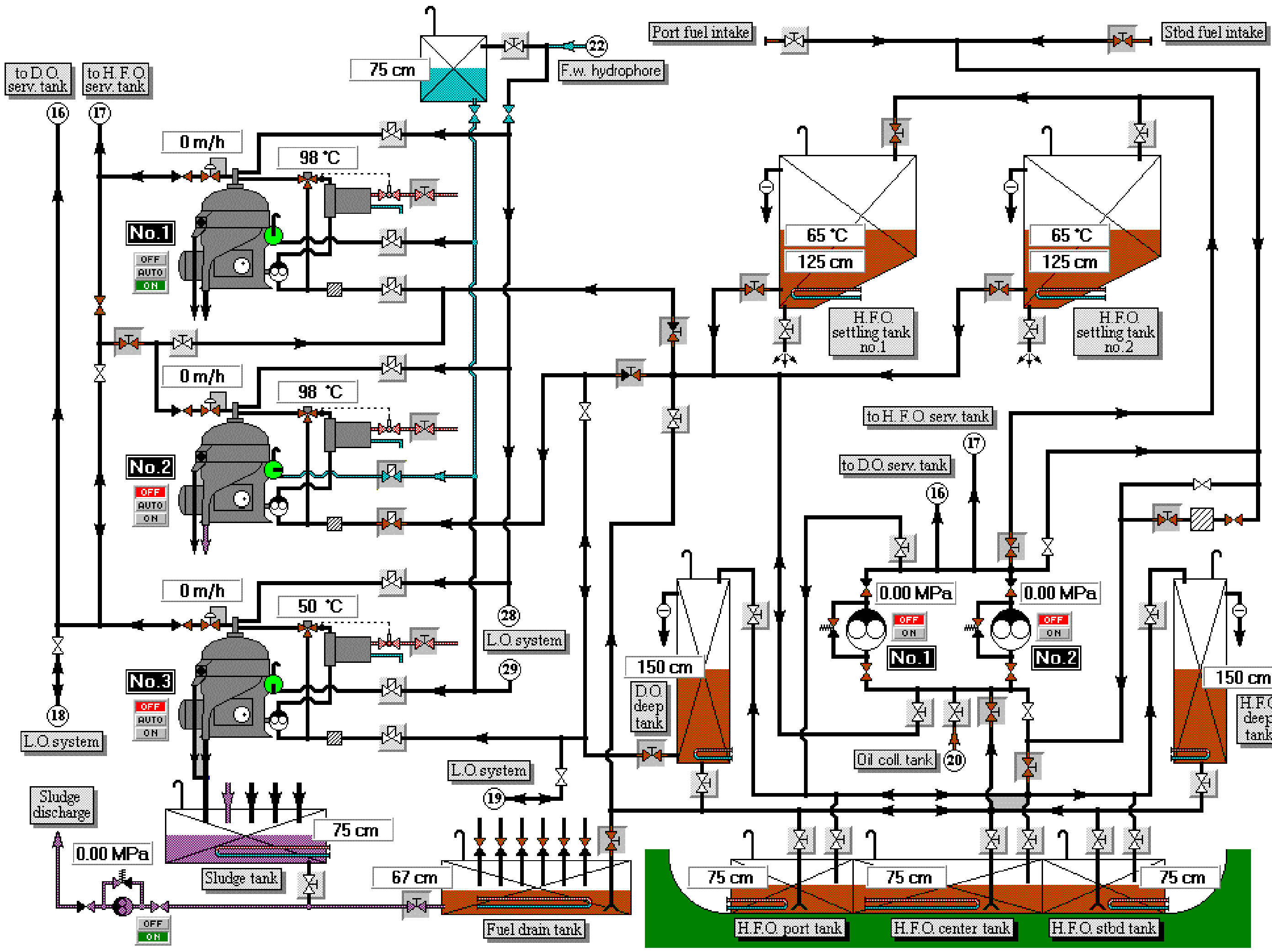

Figure 1: Screenshot example of an F Class simulator.

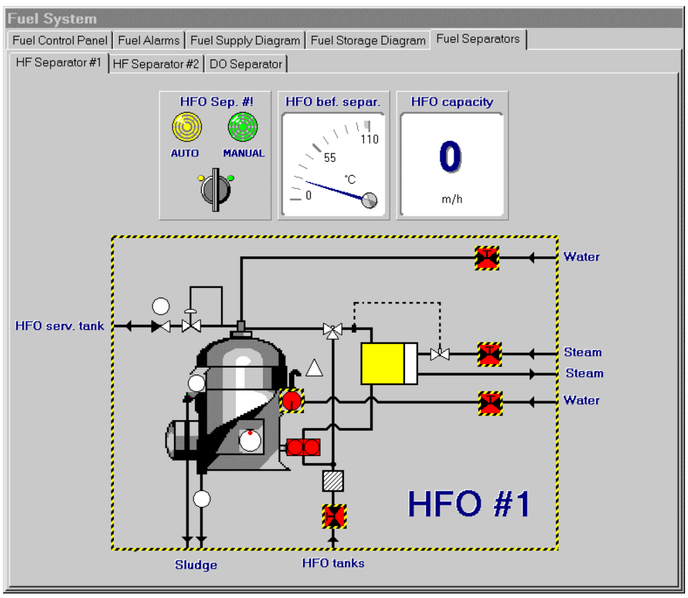

Figure 2: P Class simulator example.

However, the most detailed modelling and presentation of the fuel oil separator can be found in the B Class simulator. Figure 3 shows that the first important difference – especially when compared to P Class simulator – is the animated internal view of the separator and the detailed modelling of all valves and automation controls. These are all quite typical for this specific separator model. A trainee can learn not only how to operate the separator in the manual mode, but he can also learn how the automated control settings influence the way that the separator works (see Figure 3).

The application of different simulator types that are designed with a specific education task in mind can provide a better and more effective solution than when trying to build more and more complex simulators that can fulfil virtually any educational task.

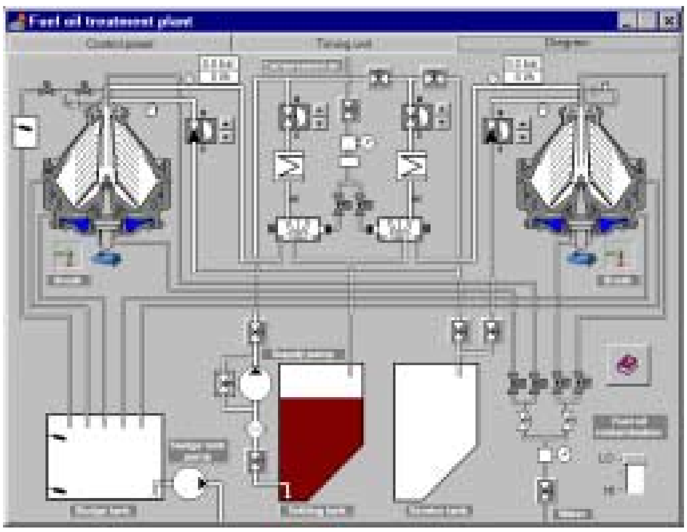

Figure 3: B Class simulator example.

INTEGRATED CHECKLISTS

The concept of checklists is well known with regard to fields of aviation and space technologies. Checklists have been developed and introduced in these areas with the following aims in mind:

- They should standardise operational procedures and training, particularly for very complicated machines (such as aircraft and space vehicles).
- They should ensure the avoidance of faults that are due to improper operating procedures.

Apart from aviation and space technology, checklists have also been successfully introduced into many other areas where the correct process of operation is very important. The main purpose of introducing checklists is to teach the user the proper engine room operating procedures.

The checklist concept has been implemented in such a way that the whole engine room operation has been divided into many smaller, typical tasks and a specific checklist covers each of them [3][4].

Each checklist is based on the following key principles:

- The checklist begins with a certain engine room set-up that is considered typical for that checklist. This, so-called entry set-up, is loaded automatically every time the user opens the checklist.
- A properly completed checklist should lead to another specific engine room set-up, which is a target of this procedure.
- Clear instructions concerning what to do and how to do it is given at each single step of the checklist. Thus, a user who follows the list precisely, covering all of the instructions given, must be able to obtain the target set-up at any time when the checklist is used. Blinking control lamps and gauges are displayed alongside the text information in order to simplify a search for specific controls.
- The checklists have been linked in such a way so that, in almost every case, the target set-up of one checklist is an entry set-up for the next one. This means that learning all of the checklists facilitates learning the whole engine room operation at a rather basic level.

The user can select a specific task to learn (a main engine start for example) and he/she will be guided step-by-step until the task is successfully completed. At the beginning of the so-called scenario, the appropriate engine room set-up has to be loaded or the previous scenarios have to be completed. Later, a set of precise instructions are shown one by one, and only the completion of the present instruction enables progress to the next set of instructions.

Besides the text information, the appropriate control (ie switch, push-button or lever) will blink until it is set in the correct position (examples are provided in Figures 4 and 5). Realising the necessary conditions can also include a period of waiting until the specific parameters have been reached. It is easy to understand that every scenario is based on a hidden checklist, but from the student's point of view, it provides a friendly instruction offered by a very patient expert.

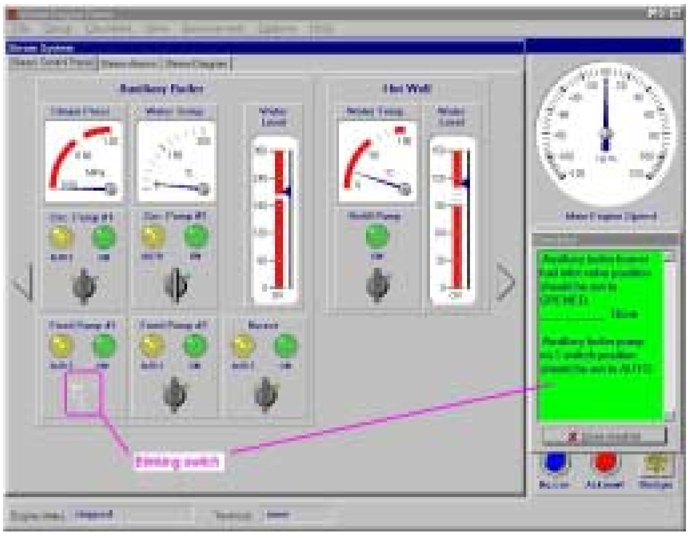

Figure 4: An example of the checklist instruction (blinking virtual switch).

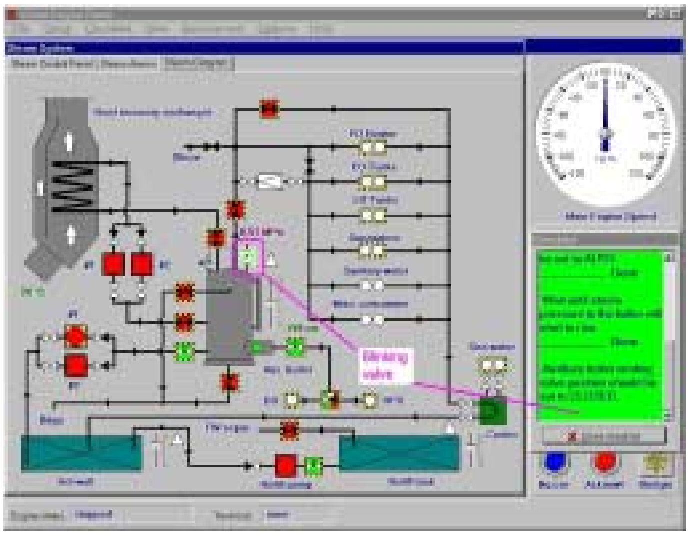

Figure 5: An example of the checklist instruction (blinking valve symbol).

CONCLUSION

The usability criteria presented in this paper are not based on the software usability theory. They have rather been based on the author's experiences in the development and use of ship engine room simulators.

The theory applicable, regarding the usability of simulators, can be found in the standard ISO 9241-11, for example. This *Guidance on Usability* provides recommendations for the identification of the product context of use, (including hardware, software, service), the required measures of usability, as well as how the usability of a product can be specified and evaluated as part of a quality system [1]. Indeed, there needs to be a clear match achieved between the learning objectives and the simulator type [5].

Many simulator users believe that the only simulator usability criterion that should be considered is the actual level of *reality* of the simulation. The author is convinced that the simulator used for maritime engineering education should offer much more than the fidelity in order for it to be a usable and effective teaching tool.

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