Multi-Layered Design and Game-Based Learning as a Pedagogical Concept

How to develop proper behavior in ARPA simulator training

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***Abstract* — To become a professional master mariner one has to develop many different skills and have an understanding of how to act in different situations on the bridge. Within the master mariner program at Chalmers University of Technology, Sweden, simulation technologies are used to evolve pertinent skills within the educational program. A challenge with using a full scale simulator from the outset of the program is to get the students to develop both professional competencies and internalize tacit knowledge in the navigation of a ship when the interface of the simulator itself is quite demanding. By using an adaptive Multi-Layered Design approach in combination with game based learning, this paper proposes how to guide the student through a more summative learning process. The main idea is to grant limited access to what the students can do with some functions, and gradually turn on more functionality in order to develop certain experienced behaviors to get them to understand the logical approach behind selections and to make them think through why and when they should do things.**

Keywords - Simulator training; game-based learning; Multi-Layered Design; radar.

I. Introduction

There is a trend of high technical fidelity in maritime simulators. Simulators provide a rich, realistic interface with a large amount of functions and possibilities where the user can explore and experience many different scenarios. However, high-functionality interfaces are often very challenging for a user to learn [1][2]. The high amount of functions require not only a skilled interface user, but also high skills within the scope of the application if the training is to be useful and not only seen as an advanced game. The user has to be relatively experienced in the naval context in order to draw educated conclusions and solve tasks in a realistic way [3]. When a simulator is used in an educational setting, the aim is usually to teach less oriented students something about a real setting or to practice a complex activity before they perform under real conditions. Students, beginners and novices are supposed to use the simulator in this way to become more experienced [4][5]. However, the user has to possess real life experience in order to be able to fully understand the simulator and make realistic choices, but at the same time the simulator should provide exactly that – a virtual surrogate for real live experience. It would be preferable if the tacit knowledge the experienced person possess within the specific domain, could somehow be transferred to the novice.

Our underlying assumption in this study is that the knowledge of an experienced professional can be captured and taught to new students through simulator-supported learning. The goal is to convey the process of decision making and the rules for why a specific decision is made. Furthermore, the novice user should understand the underlying logic in why certain behaviors are preferable in a specific situation. The outcome is to strengthen the ability to make educated and constructive decisions and value, order and select specific important data in a large dataset. By encouraging certain behaviours in the simulator, we believe that it could be possible to transfer the knowledge of a professional maritme officer to a novice student by practicing in a guided environment. If the interface is adapted to support guided learning and certain forced behaviors, the novice could practice how an experienced mariner officer would act and understand why problems should be solved in a specific way. To achieve this, the underlying learning processes as well as the profession at hand must be understood.

The focus of this study is the interface design and game based learning as a support for teaching of professional behaviors in a maritime simulator. We suggest an adaptive simulator design where a stepwise learning approach is used, a so called Multi-Layered Design [1][6]. The functions are divided into so-called layers and adapted to the learning scenario. The choices are limited at first and then they gets less and less restricted over time. The first layer will be rather restricted from a domain point of view and train certain behaviors that should be included in the novice's basic understanding. The next layer will give slightly more freedom and the last layer should have full functionality. The complexity of the data and the technical fidelity in the simulator is not simplified. The Multi-Layered approach is then combined with gaming-based learning strategies to encourage and create enthusiasm. By using a gaming philosophy, specific behaviors can be positively encouraged through rewards. This to encourage and/or force the learner to use certain behaviors in the simulator.

The remainder of this paper is organized as follows: sections II and III will introduce the current status of today's maritime education while section IV introduce the theoretical concepts further. A layered concept design is suggested and the resulting solution is discussed from a pedagogical viewpoint in section V. All design ideas are based on observations of students' behavior in the current maritime simulator at the master mariner program at Chalmers Technical University. Section VI discusses the results and presents our conclusions.

II. BACKGROUND

To become a master mariner both theoretical studies and extensive practical training are required. The practical training is initiated with simple examples on paper where different scenarios are walked through. The next step is to practice in different high fidelity simulators. When approved in the simulator the students are finally accepted to test their knowledge and ability on a real ship. To exemplify this learning process we use teaching of the Automatic Radar Plotting Aid (ARPA) in the following two sub-sections.

A. *STCW MANILA 2010*

STCW or the minimum Standard for Training and Certification for Watch-keeping officers describe radar navigation on management levels and is the guide for what students should know about navigation. With the start of STCW 1978, the convention has been amended several times; and the latest is STCW 2010 MANILA (used from 1 April 2012) [7]-[11]. The convention is explained in more detail in the STCW CODE, which describe competence and minimum standard of knowledge, understanding and proficiency for certification:

Competence, knowledge, understanding and proficiency

- The student should be able to show ability to use methods for demonstrating competence

Criteria for evaluating competence

- The student should use radar and ARPA to maintain safety of navigation.
- The student should show knowledge of the fundamentals of radar and ARPA.
- The student should show ability to handle the radar- and ARPA simulator plus in-service experience.
- The student should be able to interpret and analyze information obtained from radar and ARPA, taking into account the limitations of the equipment and prevailing circumstances and conditions.

The International Maritime Organization (IMO) gives out model courses with a detailed teaching syllabus to cover overall learning objectives within the convention. In this paper we focus on model course 1.07 and 1.08, [10][11] with the specific learning objectives:

Course 1.07

- 7.1 Set up and maintain an ARPA display
- 7.2 Obtain target information

Course 1.08

- 2.2 Carry out radar plotting

B. *Classical approach to learning*

The classical approach to learning Radar and ARPA, during the master mariner education is to start with simple scenarios and increase theire complexity during the course. The students are introduced to a two ship scenario using a "relative" motion setup to learn how to determine risk of collision. Figure 1 show this simple scenario with only two ships on a radar screen.

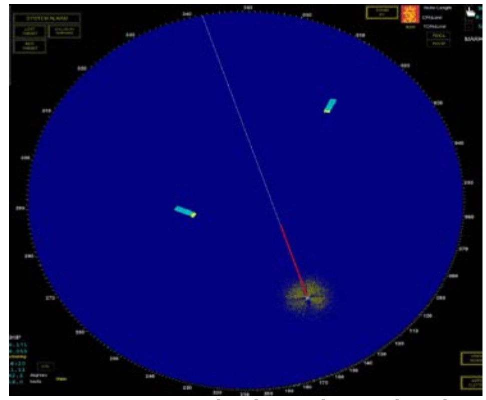

Figure 1. Scenario with only two ships on the radar

In the second scenario, there are three to four ships visible on the screen and introduces more ARPA functions that show navigational data for all the ships. In the third scenario, the complexity increases to more than seven ships and potential situations of collisions are introduced. This demands a good overall understanding of the traffic situation. Between the second and third scenario, students often switch setup from relative motion to "true" motion which can be easier to understand in more complex situations.

The left part of Figure 2 shows a part of the radar plot where six ships has been selected for tracking of position and course. More information for each ship is visualized when a ship is selected. In the right part of Figure 2 the data for two of the selected ships is visualized. Information such as speed, course, time to closest point of approach (TCPA) are shown.

Figure 2. Radar plot showing current position and surrounding ships. Six ships are plotted (numbered and with lines) and details on 015 and 003 (the two circled ships) are illustrated to the right.

With the information visualized in Figure 2 the martime officer can keep track of surrounding ships.

III. STUDY

In order to understand the learning process and how the students use the current maritime simulator to achieve proficiency, a number of activitities have been undertaken. Several groups of master mariner students have been monitored on how they use the simulator, how they develop skills over time and what type of mistakes they make. The observations have been made over four years of teaching and assessment of the course based an ARPA model course 1.07 (Operational level) and model course 1.08 (Management level) [10][11]. The participants are second year master mariner students at Chalmers University of Technology. The analysis in this paper is also made from assessment protocols from this course between the years 2010 and 2013. In the protocols, skills are given a score according to the student's performance on a 0-2 scale. Also interviews with the instructor of the course, who have more than 10 years of experience from teaching ARPA, was conducted. This was to confirm the assessment scores and get more information on identified challenges. The assessment protocols and the interview, as well as the authors own observations during these four years of teaching, lead to the same conclusions.

One of the more frequent behaviours among students are the approach of selecting all targets and using long vectors. It can be observed that in the high technical fidelity scenarios with seven or more ships the students tend to continue to select or mark all ships as the amount of ships increase in the scenarios. Figure 3 illustrates a photo taken during an assessment showing classical mistakes despite around 22 hours of practice in the simulator.

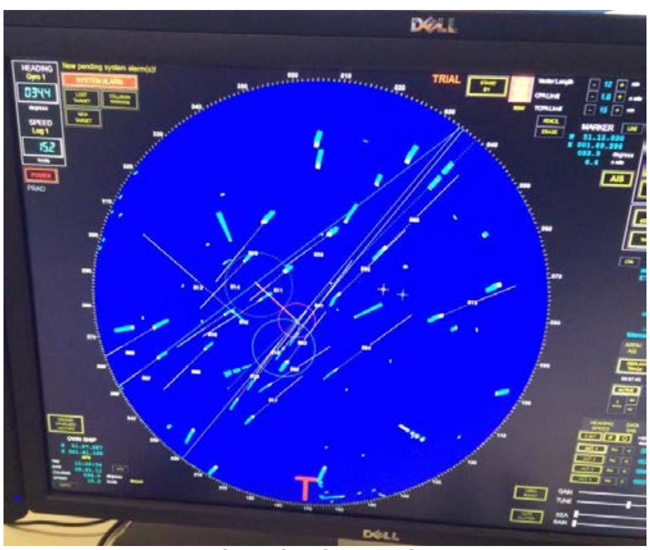

Figure 3. A photo taken during student assessment.

The students learn in the simple scenarios that all ships *can* be marked, but they do not understand the implications upon situation awareness in a more complex view, as a more cluttered radar picture is more difficult to understand (see Figure 3). It is still possible to follow all ships but that will require full attention on the radar screen, which is not a positive outcome in a real world case. On a real ship bridge, the officer of watch needs to keep control of a number of monitors and displays. Hence, the students tend to get information overload resulting in a suboptimal, bottlenecked behavior in the simulator. Best practice is to plot a maximum of 8 to 10 targets that might be of interest from an anti-collision perspective. From a teaching perspective, this creates challenges that relates to required competence in the STCW CODE for how to use plotting techniques and relative and true motion concepts, as well as setting up and maintaining multiple displays.

The different set-ups for combinations of relative and true motion vecrors poses another problem. In one interview the instructor states that "*Many students have difficulties in understanding the difference between relative and true motion, relative and true vectors, and relative and true trails*". There is up to eight different set-up combinations and all of them are appropriate for specific conditions or purposes. Relative motion shows if there is a risk of collision in an easy and quick way. True motion show real movement of vessels and are used to avoid grounding. True vectors give a hint of the direction of a vessel, and the direction is deciding which is the "stand on" vessel according to international regulations for preventing collisions at sea. Students normally do one set-up and maintain the same in all situations.

The instructor continues to discuss that "*ARPA settings and particular plotting of targets are almost impossible to teach*". This is due to the characteristics of the embedded tacit knowledge as there is never a perfect or expected setting for given conditions. The correct behavior is to switch between different settings and the officer of the watch needs to "*know*" when and why the specific setting is the right choice in that moment. Such knowledge takes time and practice to build up and it is seen amongst experienced deck officers. With better understanding and knowledge, the student would be able to change set-up according to the changing scenario. They should also be able to switch between which ship to select and track.

IV. THEORETICAL BACKGROUND TO DESIGN CONSEPT

Miller [4] was one of the first to start discussing the importance of fidelity in simulators and he made a distinction between physical fidelity and psychological fidelity. Physical fidelity is a technical aspect while psychological fidelity is how well the functional skills in the simulation relates to practice in the real world. The past years of increased computing power have largely increased the possibilities of the physical fidelity in simulations [5]. However, the ability to transfer skills from the simulator to the real world is a key element in the quality of the learning. Hence, functional fidelity is more important than technical fidelity, but a mix between good physical and psychological fidelity is needed.

The technical fidelity or the graphical user interface of a simulator is created to support a large number of complex scenarios and different types of users with different types of skills. This often powers a so-called all-in-one interface, where all various functions are visible at once [12][13][14], and so is also the case with the current maritime simulator. In a learning situation, this could lead to confusion but also mistakes when solving specific task.

To try to guide the learning of functions we suggest a Multi-Layered Design [1][6] combined with positive behavioral encouragement from game-based learning [15] [16]. A good behavior is then praised through rewards in the simulator leading to a practice of a "correct" behavior in different situations. The idea is to transmit knowledge of how to behave in certain situations through gaming, encouragement and limitations. Creating an, for the student adaptive interface, but for the instructor an adaptable interface (possible to alter). The following sub-sections will present these concepts further.

A. *Game-based learning*

It is possible to use gaming strategies in educational settings in several ways, but it is important to differ between Game-based learning and gamification [15][16]. Gamification means the use of game characteristics to achieve something else. An example is the usage of collecting points in a commercial advertisement campaign. Game-based learning means the use of games for educational purposes.

Rules define how a player interacts in a game and is more important than the educational theme [16]. One example is chess, if one, by mistake, touches a piece and it is moved out of position, both players restore the state of the game. If a player touches a piece and then regrets the start of the move, the player must move that piece. The difference between the two situations is explicitly agreed on and understood by chess players. The formal rules say that a touched piece must be moved and still we see this extra non-written rule.

Linderoth [15] argues two ways to use rules in games for learning. The first way is used for drill training. Instead of learning mathematics from a traditional book, an example is given as a space ship game (Matteraketen/The Math Rocket) [17]. The players need to shoot down meteorites to survive but the ammunition is only refilled by solving mathematical equations. The rule then states that a player needs to learn how to solve mathematical problems to refill ammunition. Observations have shown that players might cheat and bring a friend who is good at mathematics to solve the questions.

The second way to use rules is where the rules are representing the learning itself. An example is given in [16] a simple game for understanding environmental sustainability (Harvest about sustainability). In the game, fifty fish are in the ocean and five teams will fish for ten days. Every day the teams write down on a piece of a paper how many fish they will land that day. The instructor chooses randomly to hand out fishes to each team. If there are not enough fish that day in the ocean compared to what a team wished for, no fish are handed out. Every day the amount of fish in the ocean is doubled with up to maximum 50 fish. Normally all teams choose too much on the first and the second day for the ocean to be repopulated in a sustainable way. Rules are directed towards a discussion on the population level of fish for sustainable fishing. The players learn directly from the rules of the game.

A problem with a game-based learning approach is if the player end-up in bad state of a so-called gamer mode. A gamer mode is a state when a learner uses different options from given rules in a game and carry over this behaviour into the real world. This can be problematic when the learner tries to win instead of adhering to intended learning outcome. Frank [18] describes this behavior in a model illustrated in Figure 4. The left part of the figure is the scope of the game and to the right is reality. The overlapping part between these two areas is the intended learning zone that is aimed for when using the game as a learning platform in a simulator. When in gamer mode, the player tend to focus on things in the game that are only beneficial to the game and not to the real world scenario.

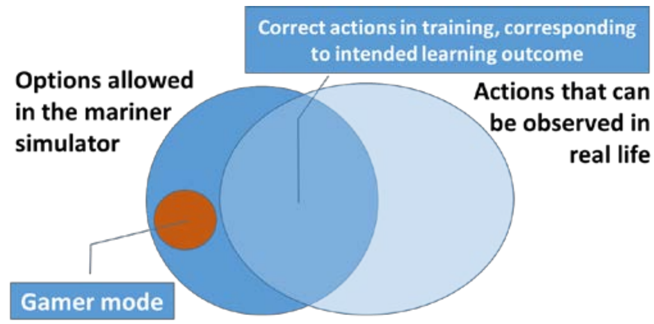

Figure 4. A model of learning outcome when a player focus on the wrong part of the game [18].

Frank [18] documents two contributing factors leading to a gamer mode. The first factor is when the game does not fully match the real world functions, corresponding to only partial functional fidelity. This invites the learner to leave the professional mode and uses the rules from the game to win. The second factor is the game-design itself. Playing for victory points does something to the learner. In a study, Frank [18] showed how the health indicator are lower at the end of the game when playing for points compared to when not playing for points. The learner enters into a mode where fulfilling game goals becomes more important than the intended learning outcome of managing military troops. Educational simulation consists of three elements according to Aldrich [3]; games, pedagogic, and simulation. Simulation enable experimentation, practice and transfer of practice to real world knowledge. The game element might not by itself contribute to intended learning outcomes but can be used to enhance learning experience. The game element contributes to engagement, enjoyment and can be a way to assess or direct the learners focus on a particular *thing*. The pedagogical element includes the meta-game with background, scenario and intended learning outcome for specific knowledge. Scaffolding is central in the learning process according to Aldrich [3] and Säljö [19].

B. *Multi-Layered Design*

Multi-Layered Design as a concept was first introduced by Shneiderman et al in 1998 [1] and further investigated in a number of studies [6][20]-[24]. In Multi-Layered Design, the graphical user interface is divided into layers and has a sequence in which the layers are ordered [6]. The sequence should provide a meaning to the interface structure and could be based on domain knowledge, frequency of use, or the user's task capability. It should be noted that although an application might have layers and a component like structure, it does not necessarily have a meaningful order and will not provide a proper layered design.

A layer is a set of specified functions constituting a part of an application. The layer could hold one or several functions, like program instructions, wizards, forms, data, graphical decorations and representations, or text information. Each layer always has a specific purpose, which for example could be to train a specific type of tasks (for example selecting ships on a radar plot) [1][6]. How the layer is composed depends on the intended purpose, the number of available functions, intended sequence and the level of complexity of the application at hand.

It is possible to choose if the layered design should affect only how the functions are divided or if the graphical presentation of the interface objects should change between the layers as well. For example, if a function should be visible in all layers but not available in lower layers. How to present information could also be varied between the layers.

The concept of layered design is not new, similar ideas have been used within games, learning environments, and access systems for a long time but then with different names, like levels, tiers, parts or paths. There are many types of structures and many varieties of applications using a design similar to the layered design.

C. *Adaptive and adaptable interface*

When creating layered structures, the design of the interface can follow two types of interactive approaches, either adaptable or adaptive. In an adaptable interface the users have control over the layer contents while the adapting interface is intelligent and change the contents based on external rules or algorithms [2]. Each of those include different techniques for how to actually design the graphical interface. The adaptive concept, for example, includes techniques like intelligent interfaces, self adapting menus and task based adaptation. The adaptable concept encompasses customization and user aware choices. An application can be both adaptable and adaptive for different types of users, depending on their access rights in the system.

V. RESULTS - WANTED LEARNING APPROACH

Based on the observations and the experiences from assessments and interviews, a concept for simulator learning is created. A wanted learning approach for the student is to understand the foundation of why decisions are made and what might be the consequences of a bad decision. The simulator should encourage a correct behavior and train the student in behaving like an experienced master mariner. However, this requires tacit knowledge to be transferred from the experienced mariner to the student via the simulator. A correct learning behavior, in the more advanced scenario with a large amount of ships, would be to understand how to sort the traffic information on the radar screen and select a "correct" number of ships to track. The decision should be made based on the risk of collision. Ships in close proximity to the student's own ship might require a course alteration or other activity to reduce the risk of collision. The amount of ships in more complex scenarios and reality are typically, somewhere between 15-25 ships (or more) in moderately busy European and Asian waters, depending on the scale used in the radar system (see real world example in Figure 5).

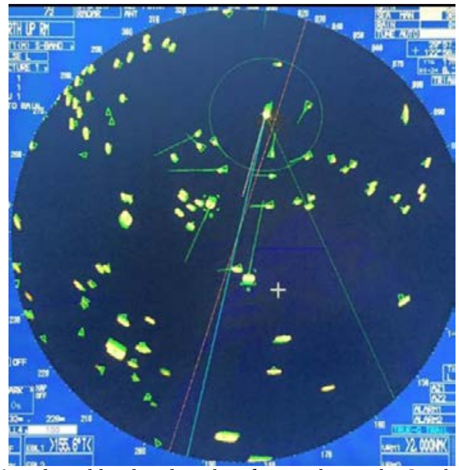

Figure 5. A real world radar plot taken from a ship in the South China sea.

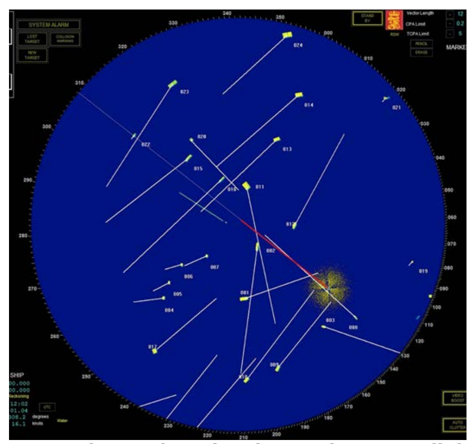

Figure 6. More than 20 ships plotted on a radar screen, all ships are selected for detailed information, creating an information bloat.

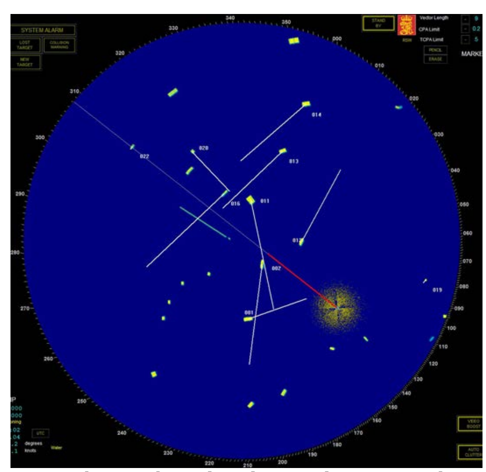

Figure 7. More than 20 ships plotted on a radar screen, only six targets selected for detailed information.

Normally, students should actively switch between a radius of 12 miles (up to 25 ships) and 6 miles (10-15 ships) on the screen. It is not possible to follow all 25 ships with full data coverage turned on, as seen in Figure 3 earlier and in Figure 6 below. Such a behavior will result in information overload. This indicates that an educated selection of ships has to take place. Figure 7 visualizes the same radar plot as in Figure 6 but with only six ships selected. It is now possible to get a quick overview of the situation and only information needed is visualized in detail and highlighted. Understanding this type of educated selection is what the students should strive for in the scenarios. To try to bridge the transfer of knowledge for how to make educated selections a concept based on Multi-Layered Design combined with game-based learning is suggested.

A. Learning approach with a layered and guided design

A simulator with a layered design implemented creates possibilities for a new set of training scenarios. The teaching can focus on radar plotting and how to safely navigate the ship. The training scenario, keeping in mind that training is scaffolding the knowledge, has a specific purpose and an intended learning outcome. The technical rules built into the scenario can be used to limit functions in the simulation to only allow usage of best practice combinations.

From the instructor's point of view, the layered design is adaptable and possible to customize for each intended learning scenario, while from the student's point of view the interface is adapting to how they behave in the simulator. The focused sequence is based on behavior in different situations and each layer targets to train a specific behavior. The fidelity will not change - only the rules for how to use the functions. As a first suggestion a design with three layers is chosen. The number of three layers is based on intended behavior tested during assessment.

Layer 1 - The first layer should hold only the most basic functions needed to be able to navigate but with full fidelity. The complexity of the radar plot should be realistic and the functions guide or force the students behavior. The interface should not allow the student to make unprofessional selections. If the student tries to make a selection or use a function that represents an unprofessional choice the simulator should give hints to why this is undisirable. From a graphical point of view this means that the functions should be grouped and ordered in a meaningful pedagogical manner. Functions not available in this layer should not be visible at all, since that could cause confusion. The rules for this layer should add a limit of ten targets to select. This may force the learner to prioritize early and to build experience about what type of targets that are of interest. The second learning effect should be to cancel the selection of targets that are not of interest anymore in order to be able to select and view new targets.

Layer 2 - The second layer should have less constraints for how the functions can be used. Game-based learning is used to encourage the student to make correct choices. If the student shows correct behavior and good strategies when solving problems, the simulator should be rewarding. A reward could be, for example, hints for the next upcoming risk that will help the student to make the next choice by an early warning. Another such reward could be to acknowledge correct selections and praise the student for good behavior as a feedback on earlier choices.

Like in the game "matteraketen" (math rocket) [17] the student has to safely navigate a moving vessel over an ocean, the learner needs to solve how other vessels move. This is done with the use of relative- and true-motion techniques. The second layer should help the student to practice how to switch between these modes and understand when and why to switch.

Layer 3 - The third and final layer should be very similar to what the simulator looks like today. Full fidelity, full functionality and the students have to make decisions based on previous training. The student should by now know from earlier layers how to behave. The game-based learning could still be used to give positive feedback or to improve on details and skills that are more advanced.

An example of how to map training scenarios to the layers can be seen in TABLE I. Three different steps for training are suggested, matching the layered layout.

TABLE I. PROPOSED NEW TRAINING

Scenario	# ships	Ship on collision	Layers	Game feature
1-2	10-15	1	Relative motion. 6 ships to plot True-motion available only for 1 minute	Points for correct ships plotted
3-4	20	2	8 ships to plot. Relative motion gives a hint	Hidden information
5-6	20	4	Full functionality	

The first two scenarios introduce the simulator and how to perform basic plotting. The focus is on which ship to select for more information and to follow its course. The idea is to identify the ships with potential risk of collision within the surrounding noise. Relative motion is available and true motion is available for short time spans to train the student in switching in-between those two modes. Note that the number of visible ships on the screen is rather large. The functional fidelity of the simulator has not been simplified, the scenario should mimic a real world case.

In the third and fourth scenario (used in the second layer), the number of visible objects on the radar plot is higher and more activity is required to avoid collision. Also more functions are available and can more decisions can be made. When showing correct behavior, the student is rewarded with hints that will help solve the task at hand.

The two last scenarios are played out with full fidelity, complexity and functionality. The student should now be able to handle the full simulator and based on previous training be able to demonstrate correct behaviors. This layer can also be used for exams where the student shows their skills during assessment. The interface will guide the learner through correct behaviors and give information during the time to why this was good behavior. In debriefing after the

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simulator session it is possible for the instructor and the student to reflect and discuss their experiences and why this is or should be the best practice. The suggested design should take the student away from gamer mode and with help of limitations encourage correct behavior. Our suggestion is to use the technical rules as layers to hinder behavior not corresponding to actions amongst professionals.

VI. Discussion and Conclusion

It can be concluded that maritime simulator training can adopt knowledge from other domains and it is argued that some challenges in ARPA training can be partly solved with elements from Multi-Layered Design and game based learning theory. The use of technical rules can steer towards intended learning outcomes.

The first challenge is how to provide knowledge for the setup of the ARPA display in a professional manner. As shown there is different mental loads when interpreting displays with all targets plotted or only a few targets. From a professional mariner's perspective two or three different settings might be workable in those scenarios while the rest are inadequate.

The rules of the layered structure are very important when creating the layers in the suggested design. In a classic Multi-Layered Design the functions are unavailable and the division of layers are based on the number of functions per layer divided by knowledge level or how often a function is used. In the current case all functions are available. Instead the layers are based on how a function is allowed to be used. The layers are divided based on the rules of the learning scenario. Rules in the simulation should steer the learning process according to the intended learning outcome so an improved overall learning amongst learners can be accomplished. By forcing the learner to adapt to the rules of how to use different functions in each layer a proper professional behavior is practiced. A disadvantage of a game based design could be that the learner tries to optimize the behavior in the simulator to solve the problem using added game features like hidden information just to win without actually understanding the learning scenario or the intended learning outcome. An active instructor is a way to get qualitative learning and avoid this risk for gamer mode behavior in the simulation according to Frank [18].

References

[1] Shneiderman, B. Designing the User Interface-Strategies for Effective Human-Computer Interaction. 3rd ed. 1998, Longman, Essex, United Kingdom: Addison Wesley.

[2] Dix, A. Finlay, J. Abowe, G.D. and Beale, R. Human-Computer Interaction. 3:d ed. 2004, Harlow, United Kingdom: Pearson & Prentice Hall.

[3] Aldrich, C. Learning by Doing, Section The Three Essential Elements to Successful Educational Experiences: Simulations, Games and Pedagogy.Page 79-96. Publisher Pfeiffer year 2005 San Francisco

[4] Miller. R.B. Psychological considerations in the design of training equipment. ; 1953. Report No.: WADC-TR-54-563.

[5] Glavin R&MNJ. Low- to high-fidelity simulation – a continuum of medical education? MEDICAL EDUCATION. 2003; 37: p. 22-28.

[6] Christiernin, L.G. “Layered Design Concepts, Case Studies and Processes – Theories and Implementations” Doctoral thesis, Department of Computer Science and Engineering, Chalmers University of Technology, Gothenburg University, Göteborg, Sweden, 2007.

[7] International Maritime Organization. IMO. [Online].; 2015. Available from: http://www.imo.org/MediaCentre/PressBriefings/Pages/02-WMD-launch.aspx#.VUsfDc4wyfQ [cited 2015 05 02].

[8] International Maritime Organization. STCW 1978. [Online].. Available from: http://www.imo.org/OurWork/HumanElement/TrainingCertification/Pages/STCW-Convention.aspx [cited 2015 04 25].

[9] International Maritime Organization. STCW 1978. [Online].. Available from: http://www.imo.org/OurWork/HumanElement/TrainingCertification/Pages/STCW-Convention.aspx [cited 2015 04 25].

[10] International Maritime Organisation. Radar navigation, radar plotting and use of ARPA. 2010th ed. London: IMO; 1999.

[11] International Maritime Organization. Radar, ARPA, bridge teamwork, search and rescue. 2010th ed. London: IMO; 1999.

[12] McGrenere, J. Baecker, R.M. and Booth. K.S. An Evaluation of a Multiple Interface Design Solution for Bloated Software. in The Conference on Human Factors in Computing Systems (CHI2002). 2002. Minneapolis, Minnesota, USA.

[13] Mozeico, H. A Human/Computer Interface to Accommodate User Learning Stages. Communications of the ACM, Computing Practice, 1982. 25(2): p. 100-104.

[14] Kaufman, L. and Weed. B. Too Much of a Good Thing?: Identifying and Resolving Bloat in the User Interface. in The Conference on Human Factors in Computing Systems (CHI'98). 1998. Los Angeles, USA.

[15] Linderoth J. Why gamers don´t learn more, a ecological approach to games as learning environment. Journal of gaming & Virtual Worlds. 2012;: p. 45-62.

[16] Linderoth J. Det regelstyrda lärandet. In R.Säljö ALA&. Lärare i den uppkopplade skolan. Malmö: Gleerups; 2014. p. 173-195.

[17] Matteraketen. 1994. Levande böcker (1994). Matteraketen [PC-spel]. Levande böcker: Stockholm.

[18] Frank A. Gamer mode. PhD Thesis. Stockholm: KTH Royal Institute of Technology, School of computer science and communication, Dept. of Media Technology and interaction design; 2014. Report No.: ISSN 1653-5723.

[19] Säljö, R. (2000). Lärande i Praktiken (Learning in Practice), Studentlitteratur, Lund, Sverige.

[20] Shneiderman, B. Promoting Universal Usability with Multi-Layer Interface Design. in Conference on Universal Usability. 2003. Vancover, British Columbia, Canada.

[21] Christiernin, L.G., "Guiding the designer: A Radar Diagram Process for Applications with Multiple Layers," Interacting with Computers, vol. 22(2), pp: 107-122, March, 2010.

[22] Christiernin, L.G. and Martin, A “A multi-layered aesthetical web-portal interface for governmental integration issues”. In Proc. of the International Conference on Advanced Visual Interfaces (AVI 2010), pp: 341-344, Rome, Italy, Maj, 2010.

[23] Christiernin, L.G. Bäckman, R. Gidmark, M. and Persson, A. "iLayer: MLD in an Operating System Interface" In Proceedings of International Working Conference on Advanced Visual Interfaces (AVI2006), pp: 87-90, Venezia, Italy, May, 2006.

[24] Andersson, M. Heldal, R. and Christiernin, L.G. “Applying Multi-Layered Design Aspects in a Role-Based Application – An Industrial Case Study”, In Proceedings of the International Conference in Human Computer Interaction, pp: 87-90, Phoenix, USA, November, 2005.