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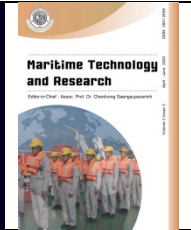
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Review Article

Digital training solutions in the maritime context: Options and costs

Volker Bertram[*] **and Tracy Plowman**

DNV GL, Hamburg, Germany

Article information	Abstract
	This paper surveys techniques for distance learning, discussing the characteristics, suitability, and cost aspects of various digital technology options. While the techniques and the employed software are generic, the discussion concerns the maritime context, with focus on technical and regulatory content and a scattered trainee base, as is typical for a classification society.

1. Introduction

1.1 Digital transformation (also in training)

Digitalization (a.k.a. Digital Transformation and Digitization) is a magic word in our times. While there is no clear definition of what exactly "Digitalization" is, the general idea is widely understood and shared. It concerns the next wave of automation, not just increasing efficiency, but also offering new and better services - in theory at least. And all companies seem to want to be part of it.

While we might think first of Industry 4.0 or autonomous ships, digital transformation affects virtually all functions of a company. Digitalization is central to our strategy and, consequently, we have embarked on a digital journey in training for several years now. Digital training solutions are on an exponential rise, and not just in our company. The term "digital training solutions" encompasses a much wider choice of training techniques than just self-paced e-learning, as we shall elaborate on in this paper.

In principle, digital solutions make us an offer we cannot refuse: flexibility. You can have training:

• When you want: Traditional classroom training requires a critical mass of participants to happen, e.g., 6 paying participants to break-even with the cost of a trainer and, possibly, venue and catering costs. In a highly fragmented industry, where the work force is scattered globally, classroom courses are often not conducted because of insufficient registrations for a given date and location. The problem is aggravated for a classification society, where certain tasks in surveying

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[*]*Corresponding author: DNV GL, Hamburg, Germany*
E-mail address: volker.bertram@dnvgl.com

and auditing may only be performed if formal training and re-training is proven. If you need a surveyor with a certain training element for a customer in your port next week, and you do not have one on site, you either need to train him quickly (not an option with classroom training) or fly in a qualified surveyor from some other station (involving extra cost and unproductive travel time).

- Where you want: For classification societies, you may have 150 - 200 stations around the world, some with only a handful of employees, and they all need training. Traditionally, we tried clustering trainings regionally, but travel was unavoidable for many employees. The challenge is similar for all classification societies. Digital solutions now allow training anywhere, as long as you have a computer and internet access (for most solutions). If there is no internet access with sufficient speed and affordable cost, as is typical on ships at sea, digital solutions can be adapted, e.g., to allow, downloads in port and offline training at sea.

- What you want: Digital solutions are generally faster than classroom training. Traditional elements in classroom training, such as a round of introduction of all participants for social bonding, no longer apply. The main advantage is that the trainee can skip parts at will, e.g., because he knows the material already, or because it is not relevant to his work. The trainee can also self-pace the progress, advancing faster if he is fast in reading and processing the offered material. Classroom training, by necessity, must compromise between the interests, abilities, and learning targets of a group of participants. In contrast, digital training comes with the option to tailor competence schemes to individuals.

We all use digital solutions in our individual quests for knowledge, both at work and at home. Where we used to grab an encyclopaedia, an atlas, or a manual, we now Google, use Wikipedia, or find a "how to" video on YouTube. But in work-related training, digital solutions (especially 'next click' e-learning courses, where poorly designed course resemble digital page turning) have acquired a bad reputation in the work force:

- "Most people hate e-learning. Or perhaps more accurately, they hate e-learning at work," Burrough (2016).

- E-learning software supplier Articulate surveyed more than 500 people, finding that "38 % say they get bored with [e-learning] courses", https://articulate.com/what-people-love-and-hate-about-elearning.

- Thalheimer (2017) confirms that "[…] elearning has had a reputation for being boring and ineffective at the same time it is wildly hyped by vendors and elearning evangelists".

But, as vendors and e-learning evangelists are quick to point out, this bad reputation is because the training solutions were inappropriate, and mistakes were made. In order to get digital training solutions right, we should first understand the reasons for the widespread disenchantment better.

1.2 False expectations result in (collective) disappointment

In general, the maritime industry does not place a high value on training. If companies spend money on training, it is more often for compliance with international regulations or contractually imposed quality standards, such as within IACS, http://www.iacs.org.uk, for classification societies. Placing a relatively low focus on training is not particular to the maritime world; it is typical for mature industries.

As a result, most of the work force in maritime companies, including top and middle management, has little focus on training, and even less expertise. Here lies a root cause for many short-comings in the current training "eco-system" in the maritime industry. Lack of knowledge (about training, and about digital training in particular) leads to false expectations; false expectations invariably lead to disappointment.

Different stakeholders have different (unrealistic) expectations:

- Management: Digital training is part of the overall drive towards a lean organization that has trimmed away all unnecessary fat, in this instance, cutting costs for inappropriately imposed training. However, the savings don't materialize (quickly). Self-paced, flexible, mobile learning already existed before the Internet - we had books. But few managers contemplated having their experts writing books for training in maritime topics. They were familiar with books and, thus, were able to instinctively estimate effort involved and savings expected. For digital training solutions, this instinct is missing. See **Appendix A** for a payback analysis of a digital training solution.

- Training providers / Training departments: Digital training is exciting, if you are concerned primarily with training and not with financial issues. Here we have new training tools, and the demos from vendors are impressive. There is a new-found optimism, a spirit of a new beginning, where we will leave the drab, underfunded old world of classroom training in dull engineering/regulatory topics behind us, and enter a new world of exciting training options, with videos, Virtual Reality, and gaming to make training memorable and fun. But then, there is no funding to match the expectations. This kind of disappointment is common in technology hype: "The idea is that we get excited with all the buzz and potential of the technology that our implementation of these technologies also follows the Hype Cycle. Many companies start by attempting to boil the ocean and not by focusing on something smaller and attainable," Denis Morais in http://blogs.ssi-corporate.com/waveform/2018/technology/compit-2018.

- Customers / Trainees: Most trainees are not half as excited about e-learning as the managers or the training departments. Do you remember a really good class from school or university? Most people will. But we struggle to separate the course and the trainer, and mostly remember the trainer (who invariably was very charismatic). For digital training solutions, people have fewer examples, and are generally less enthusiastic. If they remember a good example, it will be invariably be professionally produced material for a mass market. BBC's documentary "The Blue Planet" was nice, we enjoyed it ourselves and learnt a lot. (Production cost estimates range between 8 and 21.5 million Euro) One cruise company asked us for some professional training involving gamification, in high-end Virtual Reality, for a new range of cruise ships. We pointed out that production costs for high-end video games after 2010 were in the range of 40 - 200 million USD, https://en.wikipedia.org/wiki/List_of_most_expensive_video_games_to_develop.

In our private lives, we are part of the mass markets (learning English, getting a great documentary to watch, playing the happy ship master, etc.) In our professional lives, we are niche markets, where training is mostly developed on low budgets.

In addition, training has not just been about learning something. It always had a social component, getting out of your office and spending time with like-minded people, networking over a coffee. Forgetting or underestimating that function would be a mistake.

We may now understand better why each stakeholder involved in training is a bit unhappy with the reality of digital training in maritime topics. We may not be able to change the size or fragmentation of our industry, but we can at least mitigate the gaps between expectations and offered training solutions. The way forward starts with a guiding principle that is simple to state, simple to understand, and difficult to follow: "Disappointment is best avoided by having a realistic understanding of what is feasible and reconcile budget limitations with customer (trainee) needs." In the following, we will survey various digital training techniques with their pros and cons, giving a snapshot of our experiences.

2. Key technologies for digital learning solutions

The multitude of options for digital training can be decomposed into 4 major approaches:
- E-notes and e-books
- Online training
- E-Learning
- Social media

The borders between these approaches sometimes become fuzzy. Web-based teaching may be recorded and downloaded for offline teaching (on-board ships without cheap and fast internet access); online tests may be transferred to downloadable pdfs and uploaded again, etc. The structure is meant to help in getting a clearer picture, not to start a philosophical argument.

2.1 E-notes, e-books and wikis

While not glamorous, pdf files are often a great and cost-effective option:

• Short instructions: "Sometimes it makes more sense to deliver new training content in the form of a job aid. Don't stretch out a small amount of content in order to create an hour elearning course," Ferriman (2013). If you have little to say, put it on one page.

• Reference knowledge as add-on: A cardinal sin in training is 'slidumentation', Duarte (2008), the mixing of slides with documentation ("We will use the PowerPoint handout as documentation; therefore, all the tables and text needs to be on it."). Much of our traditional training material contains reference knowledge. Nobody can seriously expect trainees to retain this knowledge after brief exposure: Catalogues of welding defects, **Figure 1**, pages of regulations applicable if A exceeds this threshold, and B that. All the trainee should learn is where to find that documentation, and how to work with it. Transferring classroom training to digital solutions, we often include links to pdf files or websites, where the reference knowledge is found, and focus on the learning goals "I know this resource exists", "I know where to find it" and "I know how to work with it". Referenced websites should not be short-lived; few things frustrate trainees more than clicking on hyperlinks and getting error messages. Websites under your own control, and rather stable links (Wikipedia, IMO regulations, ISO standards, etc.), work well, though.

• "Lecture notes": Traditional self-studies were based on books. In some cases, having an e-book or lecture notes in the form of pdfs for self-study with an online quiz may work much better than an e-learning. The lecture notes can be updated frequently and cost effectively, much faster and cheaper than programming an e-learning, and the quiz may be kept online constantly (e.g., with random variations from a pool of quiz questions). In our experience, we converted an older e-learning, which was text-heavy with many technical drawings, into a pdf-attachment of lecture notes (96 pages) and a lean e-learning, consisting essentially of a page for the download of the e-notes and a quiz to ensure that trainees had studied the material. Pdf files may also be used for interspersed tasks or case studies. For example, after an e-learning has presented material for 20 min, you may attach a pdf with a cross-word puzzle reflecting the presented material, **Figure 2**. Time for a coffee and a pen and let's crack that crossword. Such media breaks work well, and generally receive positive feedback from trainees.
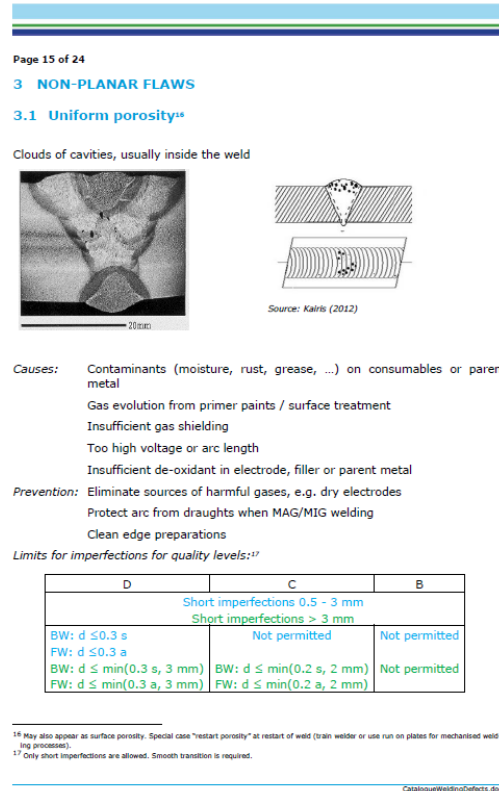
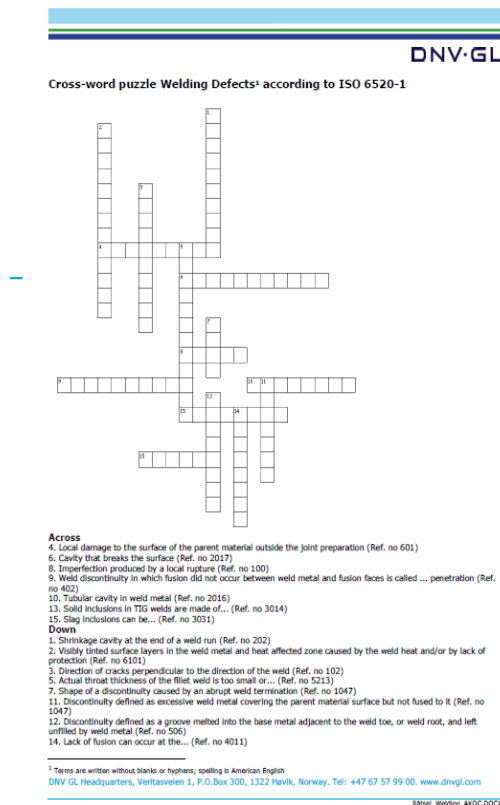**Figure 1** Typical reference knowledge in pdf.

Figure 2 Crossword puzzle as media break.

Pdf files come with some inherent advantages:

- They can be downloaded and printed. We get a lot of reading done during our commutes to and from work, and we often prefer reading a paper version, where we can work with a pen or a highlighter, and where the strain of reading seems less after hours spent in front of computer screens.

- They are standard software from a major supplier, in an open format based on ISO 32000. As such, it can be expected that, in decades to come, we will still be able to open and read pdf files, with free and easily available software.

- The standard reader for pdf software comes with a search function, which is particularly useful in large documents.

Many of our colleagues have asked for pdf lecture notes for future reference after having taken an e-learning and passed the test. It is a more convenient and more accessible form for quick reference than e-learning platforms.

For quick reference, we have become so accustomed to Wikipedia that it is hard to find an old-fashioned printed encyclopaedia in our households. For corporate training, wikis have been suggested for training and competence building, including within our company (a wiki is a website on which users collaboratively modify content and structure directly from the web browser). However, wikis need a critical mass of competent contributors to be built up and maintained, and they need governance to ensure that uploaded material is acceptable (following company guidelines, not biased, etc.). In practice, this makes wikis problematic for small and medium enterprises, i.e., the maritime industry. We have never used them in our work.

2.2 Webinars and other forms of live online training

Short "conference-style" presentations of 20 - 30 min have often been converted into online webinars. As with classroom/conference presentations, there are good ones and bad ones. Bad ones follow the format, "you look at PowerPoint slides while the expert drones on". Participants often zone out, doing other things like checking their emails, passively absorbing the audio and tuning back into the webinar every once in a while. The good ones are relatively brief, focused on a single, tangible topic with a clear take-home message, and have strong user interaction. Key lessons learnt in our experience are, Bertram and Plowman (2017):

- Subject matter experts (SMEs) are much more willing to take the time for a webinar than for the development and wide-scale delivery of classroom training or e-learning. Webinars are often enthusiastically embraced, as they are quick to develop, allowing rapid response to new developments in technology or regulations.

- SMEs are generally neither communication nor webinar technology experts. Raw material (PowerPoint) needs reworking for a webinar, and delivery is similar to being on the radio; SMEs need technical support, and possibly some coaching on how to speak during a webinar.

- Webinars should be designed for a maximum of 20 - 30 min presentation time. Beyond that, audience attention cannot be maintained, and the message is lost. Webinars may be combined with prior or follow-up emailing of pdf files with more detailed information.

- PowerPoint slides used for webinars should have even less text than for the classroom version and rely much more on visual language to convey the message, **Figure 3**.

- After 5 - 10 min speaking time, an interactive element ("poll" in the jargon of webinar designers, **Figure 4**) should stimulate the audience to refocus on the topic. Otherwise, the temptation to multi-task (i.e., read incoming emails, etc.) becomes overwhelming for most people.

- While recordings of webinars can be offered after the broadcast, in our experience, virtually nobody downloads these recordings. Consequently, webinars for a global audience need to be offered "live" several times, in order to cover different time zones.

Technically, there are many platforms that support webinars; we have experience with Citrix and Adobe Connect. The functionalities are similar; it is not the platform, but the content and design, that decides on the impact of the webinar. Typical functionalities that we use frequently are:

- Webinars always come with live audio. That makes them easy to prepare and generally livelier than e-learning, but introduces the challenge of accent; listening to a voice from another nationality requires more concentration than listening to someone from your own language. In the first few minutes, our brain tunes into to a different accent; native English speakers are often the hardest to understand for non-native speakers. Keywords should then appear on the screen to help the listeners. Also, simple vocabulary helps; in engineering, most engineering terms are considered to be simple by an engineering audience.

- Presentations can be broadcast with or without webcam videos of the speaker. Having an inserted window with a speaker makes a webinar more personal but runs the risk of participants getting distracted from the content slides.

- Webinars allow "polls" (the functionality comes under different terms in different software), where participants typically click a box and automatic statistics can be shared of the feedback.

- There is a chat function for instant messages, typically used to collect questions which may be addressed immediately, but which are mostly collected and screened at the end. Then, selective questions may be answered live, and the rest via individual or collective emails, or on a website with FAQs (frequently answered questions).

- Webinars can be recorded to a video file, typically in mp4 format.

- Webinars track user behaviour and allow exportation of the statistics, e.g., in Excel. Information gathered includes: registration information (name, email address, company, etc.), time of joining webinar, time of leaving webinar, attention rate (percentage of time when window with webinar was active; you check your email and the system knows about it and reports it), questions asked, and what was answered in polls. Both for training and marketing purposes, such statistics are very interesting.

Webinars have become a standard tool for many companies. The problem is that we all get flooded with emails touting upcoming webinars. As a simple self-defence, webinar invitations often land in the spam folder. In order to avoid this fate, it is best to use a specific invitation from a known colleague/manager and find a title for the webinar that raises curiosity or motivation to join.
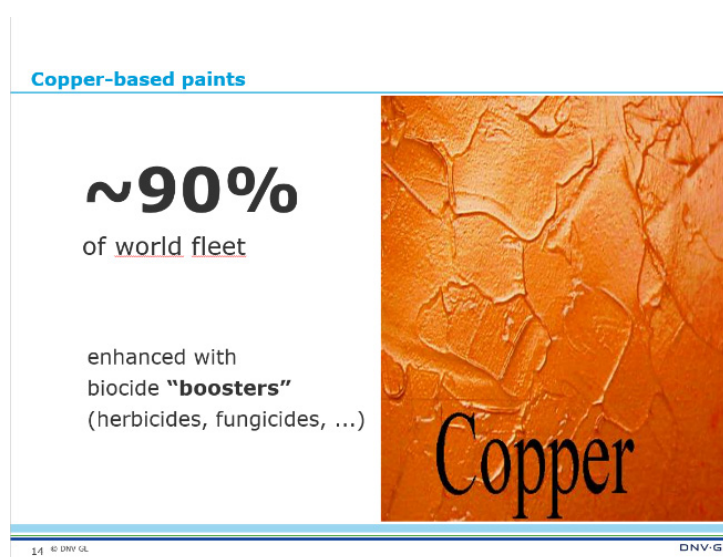
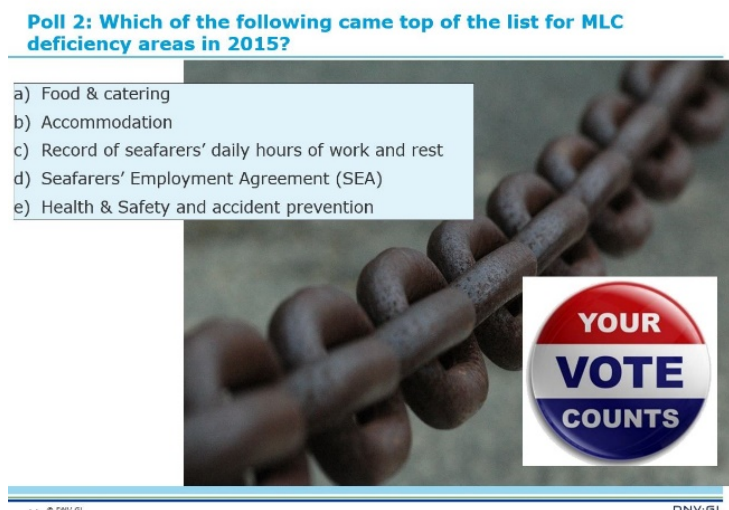

Figure 3 Typical webinar slide.

Figure 4 "Polls" stimulate audience to think.

For small-group knowledge and higher interactivity, video conferences (e.g., based on Skype), with the option of mutually sharing screens, may be used, **Figure 5**. This approach allows rapid, virtually ad-hoc, knowledge transfer sessions. It may be considered as a flanking measure, e.g., in software implementation schemes for super-user groups, one-to-one coaching, etc.

More recently, "virtual classrooms" have been suggested as a variation or evolution of the webinar idea. Virtual classrooms are webinars with extended functionality, where participants can interact more with each other (and not just with the trainer, as in webinars), e.g., in chats and audio and video conferencing between (subgroups of) the participants. In principle, this allows small-group work as a direct digital counterpart to classical classroom training. The participants may appear as in real life (as in a video-conference) or slip into the role of an avatar, as in, e.g., AULA, an immersive 3d learning environment, http://www.vcomm.ch/en/home, **Figure 6**. Problems are similar to those of larger video-conferences: participants may (mentally) wander off, different people try to speak at the same time, making communicating difficult, or increased risk of technical / IT (competence) problems. Slipping into the role of an avatar is fun initially but distracts from the learning goal. With proper design of the training material, it seems to be possible to use standard webinar software instead of virtual classroom software to implement online training. The added value of current virtual classroom technology does not seem to justify the added effort (software licenses, training of technical support).
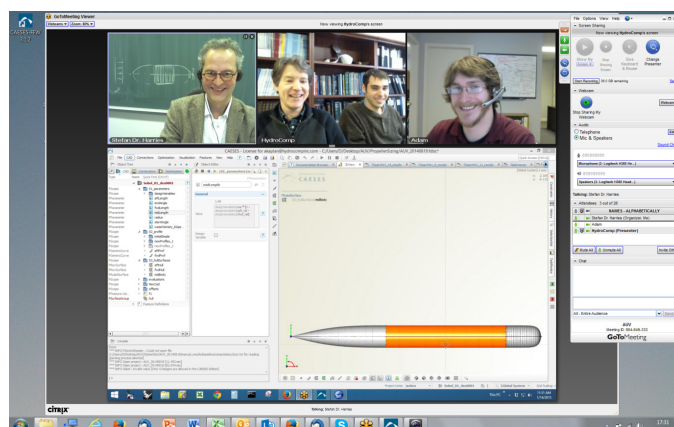

Figure 5 Videoconference for small-group knowledge transfer, Harries et al. (2015).

Figure 6 Avatar-based virtual classroom AULA, www.vcomm.ch.

2.3 E-learning

These days, most people think of self-paced, click-through e-learning when they hear terms like "computer-based training", "digital training solutions", or "digital transformation of classroom training". Alas, it is just one of our tools, albeit a powerful and useful one if properly used. We distinguish them, depending on the duration of the training:

- **Web courses / e-learnings** have durations of anything between 20 min and several days (then typically subdivided into modules, which are in turn subdivided into chapters; each chapter typically has a duration of 10 - 20 min). Due to their longer duration, web courses generally employ a wider range of techniques to avoid fatigue.

- **Nano-learnings** are short web courses, with typical durations of 5 - 10 min. They are often employed for quick once-off instructions, e.g., when a new software is rolled out inside the company, or a short safety instruction is needed, and a one-page pdf instruction is ruled out, e.g., because some short video clip is needed.

Both web courses and nano-learnings use techniques akin to PowerPoint presentations - text (sometimes animated), images, embedded videos. In addition, e-learning allows information on demand (e.g., mouse-over pop-up explanations, magnification of images, links to websites or pdf documents) which allow decluttering of slides and faster progress for those who do not need that information detail at that time. You can also include "go to" buttons to jump to a chapter of choice. In principle, all good advice for designing PowerPoint presentations for classroom training also applies to designing e-learnings.

A time and cost effective way to get authorization for e-learnings is having an SME prepare a good training in PowerPoint, with explanatory text in the PowerPoint Notes pane. This way, the SME can work with a tool he is already familiar with, and usually has at least half the material in already. Then, the PowerPoint can be converted to the e-learning tool (in our case Storyline Articulate), either using text-to-speech narratives or reading text without an extra time burden for the SME.

While e-learnings should be strongly visual, there is usually text information that needs to be transmitted. Various options exist:

- Full texts: All text information is given as full text (as in a pdf). This is the easiest and cheapest way to produce; trainees do not need audio, i.e., they can also use the training in crowded areas (commuting, open-plan offices, etc.) without headphones. However, then, the eyes have to do all the work. For short trainings, like nano-learnings, this is a good option.

- Keywords on slides + audio narrative: This is often used for e-learning. Subtitles help in a multi-national context (accent challenge), but also distract from other visual information, with the risk of information overload for trainees. For spoken narratives, there are various options:

- Text-to-speech: Some e-learning programming software, like Storyline Articulate, have the option to generate voice narrative by converting a typed text automatically, with the choice between US and British English and female and male speakers. Subtitles can be automatically generated. This is fast and cost effective, and the e-learning is easy to maintain with future updates as the "speaker" stays with the software. The disadvantage is that the automated voice sounds tinny and doesn't have the speech rhythm that a human speaker would use, e.g., to stress something or pause for dramatic effect. It is understandable, but irritates some trainees, who then switch off the sound and just use the subtitles (leading to earlier fatigue, as the eyes then have to do all the work).

- Professional speaker audio: Professional native speakers may be hired for the narrative. This is an expensive and disruptive option, as external services need to be sourced, a studio production needs to be arranged, and the resulting audio files need to be embedded in the e-learning. Internal and external costs, taken together, are budgeted for 4,000 - 6,000 Euros for adding professional speaker audio to 1 h of e-learning. Production of subtitles is an additional labour that roughly doubles the costs. If the e-learning needs to be changed, the same speaker needs to be found, or the whole e-learning needs to get recorded again to avoid obvious patchwork.

- Subject matter expert audio: Using in-house experts adds a personal touch, and gives credit to the experts who have most often represented the company's expertise in classroom training. It is their expertise that the trainees are ultimately willing to pay for. The downside is that the labour costs for SMEs are even higher than for professional speakers. Even if free audio recording software (e.g., Audacity, https://www.audacityteam.org) is used, this still needs to be installed, training in handling it given, and several takes often required to get the audio right. Another issue is that subject matter experts are not selected or trained for particularly clear pronunciation. Rather, it is recommended to embed small videos of the SME speaking. As for professional speaker audio, subsequent maintenance of the audio tapes and considerable extra costs for subtitles should be kept in mind.

Videos are frequently used in e-learning, varying from small add-ons to complete lecture recordings. Basic options are:

• Recorded lectures: This option gives high focus on the SME, making the perception much closer to classroom training. Blue-screen or green-screen recordings, https://en.wikipedia.org/wiki/Chroma_key, of the speaker may be overlaid with slides (PowerPoint) while the trainer synchronizes narrative with slide advance himself, **Figure 7**. While blue or green screens are quite cheap, you need a quiet room with proper lighting, a good camera on a tripod, good microphones, etc., for the recording. The set-up or studio rent needs to be considered as a cost factor. Alternatively, at significantly lower cost, the expert may be recorded by a webcam clicking through the slides and running his natural narrative. Video conferencing software, such as Skype, have functions to record speakers while using a PowerPoint presentation. Maintenance/update costs are high, as the same speaker needs to record a whole section of slides between break points (which are typically 10 - 15 min apart). Typically, 2 - 3 takes are necessary to get a useful recording.

• Technical videos: For special, usually promotional, purposes, video production is typically outsourced. Prices always depend on content and length but is in the order of magnitude of 1,000 - 3,000 € per minute of video, Bertram and Plowman (2017). For most training purposes, the production of such videos is prohibitively expensive but, for both classroom and e-learning, existing videos may be re-used, embedded in part or through a hyperlink. Embedding videos of external sources (such as YouTube) is illegal, unless consent is given by the copyright owner.

• Animation videos: Rather dry (technical or regulatory) material may be made more entertaining by using animated, cartoon-type videos. We use Vyond (ex-GoAnimate), www.vyond.com, **Figure 8**. One may get tired of the style of such cartoons, but this style of video is much easier to produce, maintain, and update than videos with real persons which, in addition, may no longer be available when updates are required. Costs depend on many factors but, as a rule of thumb, 1 min of such animated videos costs 200 - 400 € to produce. This includes the time to

develop a script similar to a movie script, but excludes costs for specification creep, where the customer changes/adds specifications after seeing the first prototype.

Overall, producing new videos adds significant costs. It should, thus, be considered in each case whether a video is "nice to have", "important", or "essential" in the context of the learning goals. On the other hand, it is recommended to re-use existing videos (in full or in part) wherever this supports the learning goals: pay once (for the development), use many times. For video formats, wmv and mp4 seem to give the least technical problems. Often, it is advisable to split longer videos into shorter chunks to embed them in training. Beyond 30 s, the mind wanders.

Figure 7 Trainer filmed with blue-screen technology giving narrative to PowerPoint presentation.

Figure 8 Still from e-learning video merging cartoon-like animations with tailored image elements.

A key risk with self-paced learning is that the trainee does not study, whether it is an old-fashioned book or a programmed e-learning. Often, the trainees are "motivated" by a test at the end, required to get the formal qualification. It may not follow a feel-good modern view on pedagogy,

but it has been proven to work, and our industry is used to it. For such an assessment, there are various options:

- Ungraded quizzes: The softest option: Have a quiz (usually programmed in the e-learning software) with tasks, most often multiple-choice questions, and give immediate feedback to the trainee, whether the answer was correct or incorrect, possibly giving additional explanations on the correct answer. This type of quiz is intended to give just a voluntary assessment to the trainee of how much or little has been learnt. The SME has to furnish a list of questions, possible answers, and correct answers. The programming is straightforward.

- Graded quizzes: As above, but this time there is an overall grade at the end, most often without additional details. The trainee gets the final score and is informed whether this was enough to pass. The assessment result is entered automatically in the learning platform, and possibly an e-certificate (e.g., pdf file with name, course and success) is issued and emailed or offered for download. This is our standard option for courses. However, if the certificate is important (e.g., a university degree, a formal license, etc.), this approach is not suitable, as it is difficult to ensure the identity of the person taking the test.

- Classroom quizzes after e-learning: In cases where the identity of a candidate has to be checked and assurance that no external help was received given, we have not found an alternative to classroom testing under supervision. The knowledge acquisition may be based on digital solutions, but the knowledge assessment in the classroom makes the approach "blended learning".

- Human evaluations of free text: In some cases, the assessment may be in the form of a free text (essay). We use this option in our joined post-graduate diploma courses with World Maritime University, https://www.wmu.se/distance-learning. This approach comes with significant time required from a subject matter expert.

In our work experience, we have used Lectora, www.trivantis.com, and Storyline Articulate, articulate.com, as e-learning software. The 2 are not compatible, and do not support a neutral interface to export-import e-learnings from one to the other. If need be, a virtually completely new programming is required to convert an older Lectora training to the more modern Storyline Articulate. Storyline Articulate, however, can import PowerPoint files with text boxes, images, and videos as separately manageable items. However, much manual post-processing is needed, and no export to PowerPoint is possible. In practice, PowerPoint is a practicable in-between platform for development and discussion with an SME, resulting in a good blueprint for the e-learning programmer.

In general, e-learnings require high effort. The costs are similar, whether the e-learning is programmed in India or in Germany, as added man-time for specification and quality control eats up the advantage of the lower hourly rates in India. The required high effort (mainly man-time; software licenses are almost negligible compared to labour costs) may be justified if there is a "return on investment", typically savings in terms of man-time of your own staff or customers willing to pay for the added value. E-learnings should then be targeted at large number of users and avoid frequent updates (as a rule of thumb, an e-learning should be used 3 - 5 years before an update is necessary). See **Appendix A** for an example of a pay-back calculation. Because of the long-term perspective used with e-learning, the programming should be based on the standard software of major suppliers to ensure continued support.

2.4 Simulations including Augmented or Virtual Reality

Simulations mimic the real world in computer models. In the context of training, simulations denote any application where the user changes some interactive control and sees the outcome. Often, gamification of training is connected to simulations in digital solutions. There are various maritime applications in simulation-based training:

- Engineering simulations: Computer simulations with suitable graphics can help trainees to learn and retain qualitative relations, e.g., between ship form parameters and stability, **Figure 9**. The underlying simulation model should be as simple as possible for quick response time and as complex as required to give realistic behaviour. Simple simulations may manipulate only one parameter; more complex multi-parameter simulation models offer more flexibility and achieve different learning objectives with one simulation model.

Bronsart and Müsebeck (2007) give an example where the effect of heel angle or ship breadth may be studied to understand the effect of design on ship stability and the behaviour of capsizing separately. Chaves and Gaspar (2016) present a 3d ship simulator intended for training ship designers as an example of a multi-parameter simulation, **Figure 9**. While we use simulation extensively for its engineering services, we do not use it in our training. At least in part, this can be explained by our portfolio of training topics that do not lend themselves easily to physical simulations.
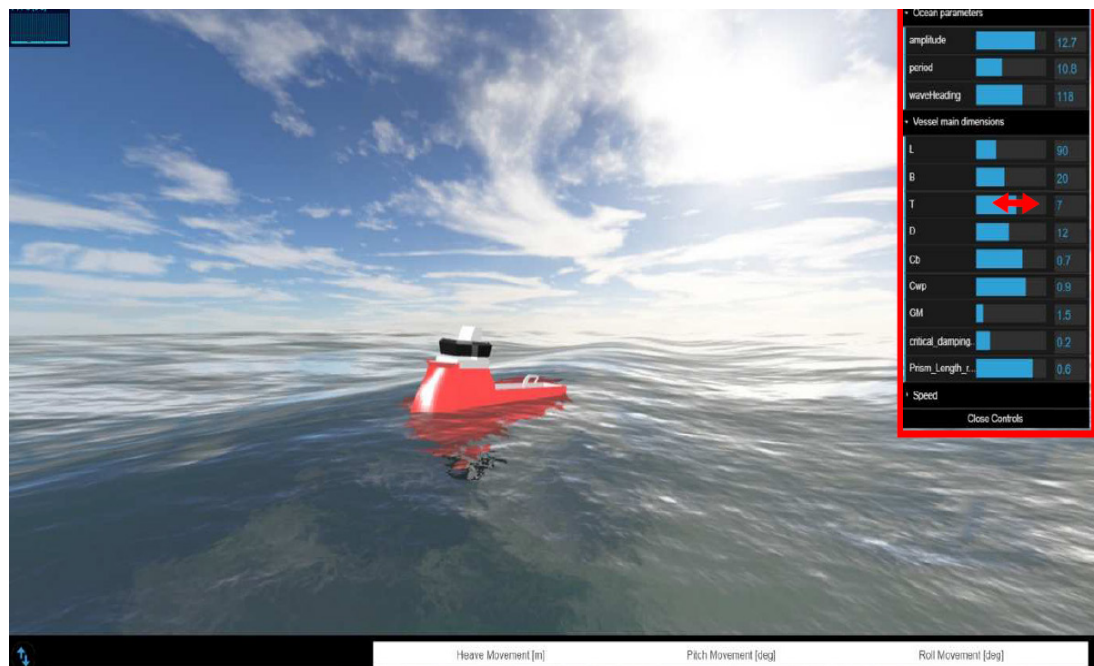

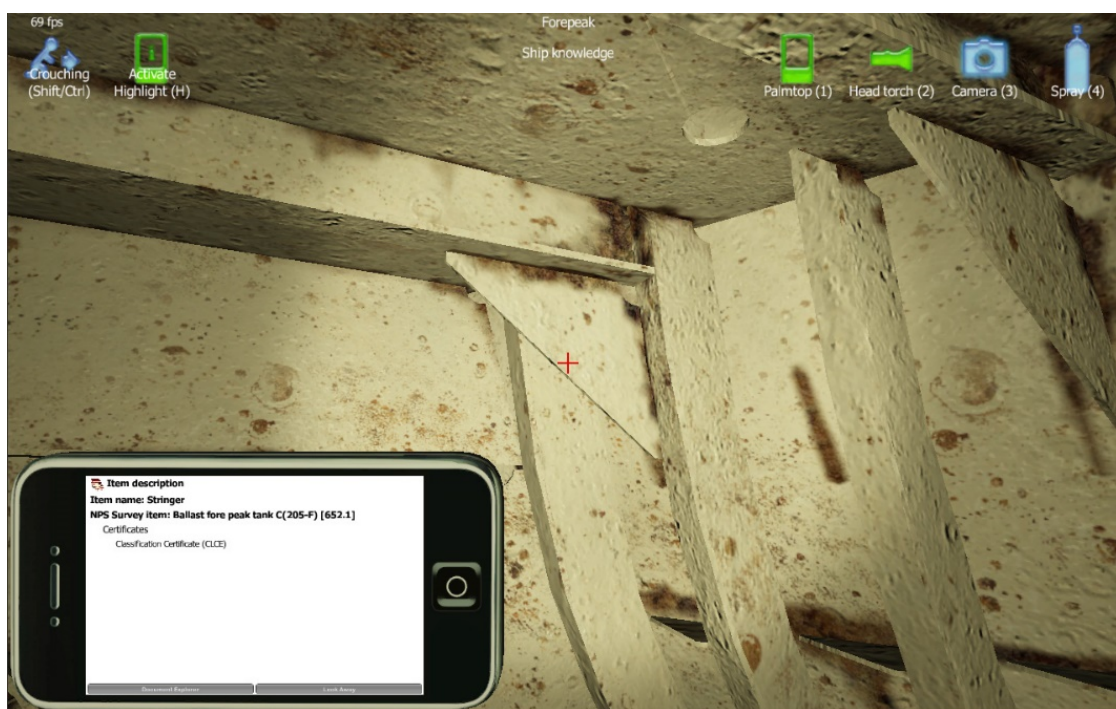**Figure 9** Sophisticated simulation model for ship design, Chaves and Gaspar (2016).

Figure 10 VR training tool with survey simulation, Bertram and Plowman (2018).

- Virtual Reality (VR): VR for us means a computer-generated 3d space to navigate through, with control devices allowing manipulation, operation, and possibly control of items in this 3d space. Bertram and Plowman (2018) reviewed VR maritime training applications, concluding that the high costs for VR based training limit applications severely. Even if we do not expect a high-end video game, think in budgets of several 100,000 € to create a complex ship training scenario, **Figure 10**. Besides the cost issue, there are other aspects to consider with VR-based training:

  - Symptoms akin to motion sickness may occur, especially if using head-mounted displays, https://en.wikipedia.org/wiki/Virtual_reality_sickness.
  - Loss of trainee group coherence due to varying IT savviness. Much is intuitive for video gamers but have nothing for digital immigrants aged 50+.

Both issues can be overcome by using projected (2d) images and a guided tour by a trainer. VR-based training does not seem suitable for self-paced learning without support.

- Augmented Reality (AR): AR combines real world with overlaid computer-generated images. A typical application is a nautical simulator which combines a real bridge with a simulated outside world. The approach is ideal with scenario-based learning, where a given task in a scenario has to be solved, e.g., handling a rudder failure without causing an accident.

Simulation-based training is generally well received by trainees and effective, but comes with high costs. Realistically, the only option is to re-use existing models.

Simulations are best integrated in blended learning concepts where theoretical basics are covered in classroom and/or e-learning. Our experience confirms Sitzmann (2011): "Trainees receiving instruction via a simulation game had higher levels of […] knowledge […] and retention […] than trainees in the comparison group. […] Learning from simulation games was maximized when trainees actively rather than passively learned work-related competencies during game play, trainees could choose to play as many times as desired, and simulation games were embedded in an instructional program rather than serving as stand-alone instruction."

2.5 Social media

As a response to an invitation to a webinar, we received the following reply: "I shall not register to the webinar, whatever the topic, for the simple reason that I do not see the point… no networking, no coffee, no time out of the office." This echoes a widely shared feeling: people miss the exchange of experience, the maritime gossip, the networking. Can social media step in and help? In our company, we employ 2 technologies (besides video conferences, which were covered above) to "reach out and stay in touch" within groups of people interested in a certain theme:

• Yammer, www.yammer.com: This is a social networking service used for private communication within organizations. For training purposes, it is thus limited to internal training. There are mixed feelings about using a platform like Yammer as an add-on in digital training solutions:

- Does it serve a specific purpose? "Want people to hate eLearning? Try including social media tools that have no purpose," Rosenberg (2018). How purposeful the social media you may employ for your training depends. As a posting platform for occasional nuggets of information ("I was recently at a conference on our theme and the proceedings can be found here") or specific questions ("Has anybody any experience with…?"), it works well in small and coherent groups.

- Does it work for your trainee pool? You may want to ask members of the training target group what they think about including social media, making sure that you get one from the age group 25 - 35, one from 40 - 50, and one from 55 - 65. Do not include training elements that will alienate a sizable part of your trainee pool.

- The more Yammer groups you subscribe to, the more messages pop up. Soon people react in mental self-defence and no longer open any of them.

In some cases, only time will tell whether a social media channel like Yammer works for its intended training purpose or not.

• Email as follow-up: Email may work as an electronic hotline in some fields where there is a designated person or department in charge of the topic. Often, specific questions come when you have to solve a specific problem. If it so specific that it is of little interest to the rest of the trainees, individual emails work much better than a broader discussion via Yammer.

3. Conclusions

Digital training solutions are more than the (in)famous e-learning. Here are a few key characteristics to remember:

• It is flexible: The big advantage is the flexibility to train where you want, when you feel like it, and pick what you learn at that time. In essence, it allows individually tailored training.

• It is not cheap: There is a wide misconception that digital automatically means cheap. It requires cooperation between (digital) training experts and SMEs, and it takes longer than writing a book or an article. The estimate of Defelice (2017) of 40 - 70 h work for 1 h of simple, passive e-learning should be kept in mind. Double this if adding higher-end elements with more interactivity, videos, etc.

• It is neither better nor worse than classroom training: "[E-]Learning often produces better results than classroom instruction, often produces worse, often similar results. […] It's the learning methods that matter, […] NOT whether [it] is elearning or classroom instruction. […]," Thalheimer (2017). Poor classroom training does not turn into good training by programming it into a software tool. But, sometimes, poor classroom training turns into good digital training, because the conversion prompts some long-overdue thinking about what can be achieved and shall be achieved by the training, and the old training material is better structured, and with key learning tasks stressed and reference knowledge relegated to attachments or deleted.

We have no doubt that the next decade will see digital training solutions on the rise. But we will see classroom training (possibly improved by adapting some of the brain-friendly training techniques that came with the new wave of digital training), a lot of blended learning, and fully

digital solutions together, as they address different training needs, and each have their own justification.

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Appendix A: How much do we save by going from classroom to digital training?

How much does e-learning cost? The correct answer is the time-honoured "that depends". However, it is not cheap:

- "Industry research suggests that a basic, but professionally produced, hour of eLearning requires about 185 h" https://community.articulate.com/discussions/building-better-courses/cost-of-developing-1-hour-of-elearning.

- Defelice (2017) updates an older estimate [of 90 - 240 h] for the development of 1 h of e-learning of Kapp and Defelice (2009), giving 42 - 71 h for passive or limited-interactivity e-learning, and 130 - 143 h for complex digital training techniques. The reduction in required time may be explained by more user-friendly development tools and an evolving, more experienced, e-learning developer workforce.

- Bertram and Plowman (2017) give costs for converting 40 slides of PowerPoint into e-learning that translate roughly into 50 - 100 h. The number of slides may roughly equate 1 h of e-learning.

For our payback calculation, we assumed:

- 60 h for the development of 1 h training (realistic for plain-vanilla basic e-learning).

- 2 days = 10 h classroom training (the rest is lost because participants are late, the round of introductions of who is who, safety instructions, etc.).

- 10 participants in a classroom training, 4 local, the others flown in from the region.

- The travel time is 2 half-days, i.e., 1 day.

- 3 nights in a hotel, flight, local transport, meals, etc., are grouped together and expressed in hours at a typical company rate: 5h.

- Self-paced e-learning saves time: No breaks, and skipping familiar material or material not deemed useful for one's work. Instead of a day's (7.8 h), training, it then takes 2/3, or the face-to-face time, i.e., 4 h.

In this case, 40 - 45 trainees accumulated (or 4 - 5 conductions at 8 - 10 participants) are needed to break-even. Frequent updates before this number is reached would destroy any business case for e-learning.

On the other hand, opportunity costs incurred because an employee is not trained in time are not considered here and would shift the break-even point to lower numbers of trainees.