

E-Learning Training Tool for Automated Transport Systems

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Abstract. Automated vehicles are rapidly invading our everyday mobility reality. Systems of lower automation levels are already installed in many private cars' models - some also at more advanced levels - while automated shuttles are in operation in several cities across Europe and beyond. Moreover, automation is also becoming a reality in several rail and maritime operations, along with drones' applications. In this context, a crucial parameter for the success of such applications is the acceptance of users, either as passengers, drivers or operators of these vehicles, or as stakeholders in a decision-making position for the deployment of such vehicles. To achieve this, training is essential in order to make users accustomed to the new functionalities and operation modes, while making them aware of the benefits and gains resulting from the introduction of such technologies. Drive2theFuture Horizon 2020 project aims to prepare "drivers", travelers and vehicle operators of the future to accept and use connected, cooperative and automated transport modes and the industry of these technologies to understand and meet their needs and wants. Among its other activities, an e-learning tool has been developed, including courses for all transport modes and for different user groups, with the aim to train the future users of automated mobility means. The tool is structured in a way that the user or the trainer can choose the desired course or group of courses and form a training session customized to their needs and purposes. Different means of visualization are offered, including texts, pictures, real life and simulator videos, etc. Moreover, quiz feature is included, to assess the user's acquired knowledge after completing each course. The tool has been used and assessed in six pilot sites across Europe (Italy, Austria, Belgium, Germany and Denmark) addressing road, rail, maritime and air mobility. The contents of the training courses include Human Machine Interface (HMI), general knowledge on transport automation, conspicuity issues, in-vehicle and remote operation, safety and security issues and many more; moreover, they address not only private vehicle users but also operators of bus, train, vessel as well as drones. In this paper the development of the Drive2theFuture e-learning tool will be presented.

Keywords. E-learning, automation, CCAM, training, HMI, transport

1. Introduction

In the era of radical technological evolution in the transport sector and in view of the upcoming invasion of autonomous vehicles in all modes of transport mobility, one parameter that is of significance – yet sometimes overlooked – is how ready are the final

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users to accept, use and adopt this new reality. Following this concept, Drive2theFuture H2020 research project is aiming to prepare “drivers”, travelers and vehicle operators of the future to accept and use connected, cooperative and automated transport modes and the industry of these technologies to understand and meet their needs and wants [1]. Among its other activities, the project is also focusing on users’ and stakeholders’ training on automated transport systems. This includes both developing relevant training tools and testing them in project pilots. In this paper we are focusing on the design and development of the Drive2theFuture e-learning training tool, with the aim to raise users’ awareness and acceptance regarding automated transport, taking into account the training needs of each user group, while following a modular approach, with dedicated content for each transport mode (road, rail, maritime and air).

To do this, a stepwise approach has been followed, starting with identifying the user groups, then specifying their training needs and analyzing existing training programs. Following, contents were prepared along with graphics and storyboards and the outcome was integrated in an online platform. In the framework of Drive2theFuture project, a series of training tools emerged (such as PowerPoint slides, videos, e-learning, virtual reality and quizzes) of which, in this paper, the development of the e-learning tool is presented, which has been used in selective Drive2theFuture pilot sites.

2. Developing the Drive2theFuture E-learning Tool for Automated Transport Systems Users

2.1. E-learning Tool Development

The initial step for defining training programs and the corresponding tools was the identification and specification of the users’ clusters. This was performed early in the project; the main groups identified were: Vehicle user; (Remote) operator; Road user; Industry and Legislation/licensing bodies, while each of these groups was broken down to detailed subgroups [2]. Moreover, identification and thorough analysis of AV operators and users’ training needs has been performed for all modes and automation levels, considering more than 20 literature sources and relevant projects, thus resulting to a comprehensive compendium of training needs per user group and transport mode [3]. In addition, extensive literature review and analysis of already existing training programs was realized, through which relevant material was identified and adapted for the needs of the project. Finally, interviews were carried out with the Drive2theFuture 12 pilot sites’ leaders, ensuring their needs and requirements are considered in the final outputs.

2.1.1. Content

Following the above approach, training content has been collected, adapted, created and organized in the form of training programs, addressing specific topics for each transportation mode and user group, according to the identified training needs. These training programs start with introductory courses for each mode, mainly focusing on key definitions, legislation and the state of the art with links and references to past and present research initiatives. The main objective of these introductory courses is to provide a general overview of automated systems in each transport mode to a wider audience in a simplified and understandable way. Further to these, training courses focusing on

specific aspects and topics – for example HMI – are also included. The main aim of these specific trainings is to provide deeper knowledge into specialized topics for expert audience. The Drive2theFuture training tools were used to complement and illustrate the developed training programs. Moreover, these were adapted to the needs of the project piloting activities, ensuring to match and serve their training requirements.

Table 1. Training programs per transport mode [4]

Transport mode	Training title
Road	Introduction to Connected and Automated Driving
Road	Autonomous Vehicles Challenge: Balancing Ethics and Innovation
Road	Introduction to Connected and Automated Freight Vehicles
Road	Introduction to Autonomous Public Transport
Road	Safely docking a bus to allow passengers to board at a bus stop
Road	Driving a highly automated car of the future
Road	Introduction to C-ITS
Road	Evolution of Traffic Management towards CCAM
Road	Training pedestrians to interact with automated vehicles on the road
Road	Riding in a future autonomous shuttle
Rail	Introduction to Rail Automation
Rail	Train drivers and signalers as remote operators
Rail	Train traffic safety and safety management for train dispatchers/signalers
Maritime	Introduction to autonomous vehicles in the maritime sector
Maritime	Maritime autonomous operators
Air	Introduction to drone operations
Air	Operating a drone via an HMI concept
Air	Online risk assessment for drone operations

These programs have been the basis for the content of the e-learning tool. The development of the e-learning tool followed a series of storyboards. Upon deciding the topics and the specifics of the information to be included in the tool, essential storyboards were created, i.e. sequences of narration and directions for visualization of the provided information. MS PowerPoint was the application that has been chosen for the storyboards creation, as it provided most useful tools for the draft designs of the courses and the involved researchers were more familiar with, in comparison to other more complex software options.

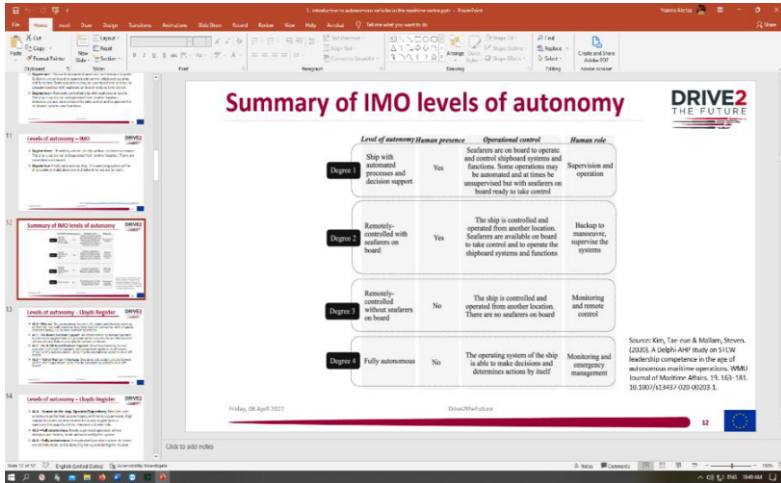


Figure 1. Screenshot of storyboards creation.

After carefully examining the objectives of each module, efforts were made to keep the sub-sessions brief, even if that meant further dividing some proposed presentation screens. This resulted in the development of e-learning courses per each transport mode

2.1.2. Preparation of Graphics in Various Editing Applications

The rough sketches, written instructions, schemas and all visual aids contained in the storyboards were being interpreted to high resolution graphics through various specialized graphic applications. In particular: Photoshop was used for editing and enhancing images and pixel-oriented elements; Illustrator for creating object-oriented ones, namely vector graphics (providing the advantage of having no restriction in exporting regardless of the screen resolution); Premiere and Audition for video and audio editing respectively.

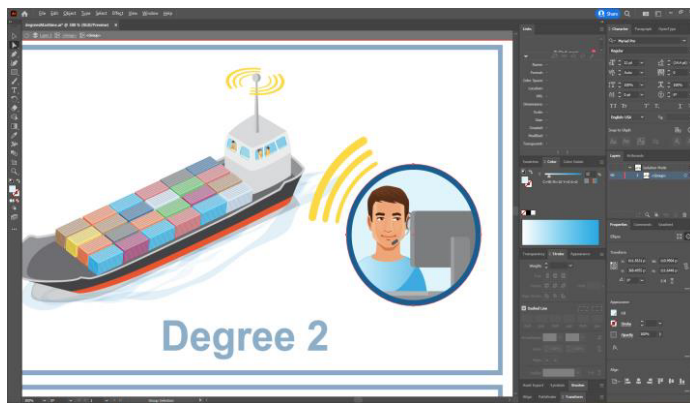


Figure 2. Snapshot of Illustrator vector graphics development.

2.1.3. Courses Creation

The graphic and multimedia elements have been imported in the Adobe Captivate application. Instances of the graphics were deployed on a timeline that defines their time of arrival on the screen, their animation, if any, and their duration. Interactivity is a great asset while delivering an educational product, so various elements that empower it were placed wherever possible: roll-over actions that present extra information, buttons guiding to analytic graphics, next chapters, interactive quizzes, etc.

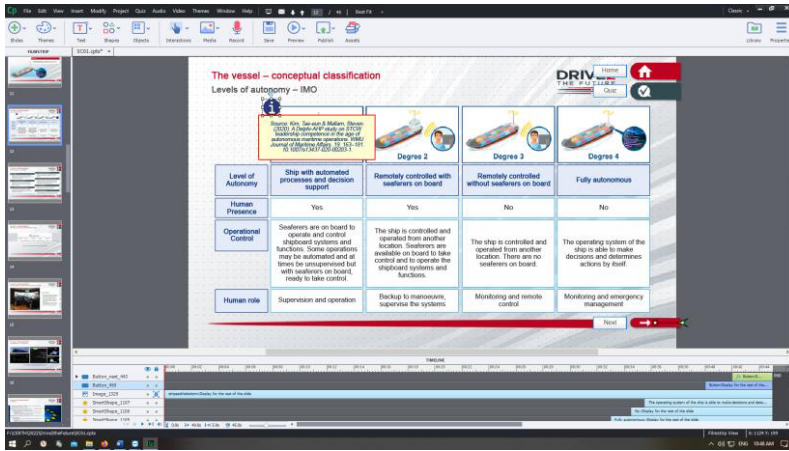


Figure 3. Snapshot of courses development in Adobe Captivate.

2.1.4. Final Outlook

For each e-learning session, a Shareable Content Object Reference Model (SCORM) file was generated by Captivate in the form of a compressed ZIP folder. SCORM [5] is a set of technical standards for e-learning products that provides the communication method and data models that allow e-learning content and LMSs to work together. LMS stands for “Learning Management System”, a software application or web-based technology used to plan, implement and assess a specific learning process.

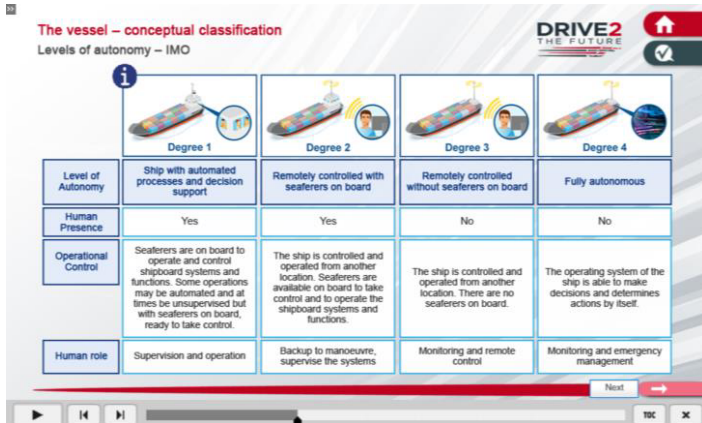


Figure 4. Example of course layout in Drive2theFuture e-learning tool.

2.2. Online Platform Integration

The Drive2theFuture e-learning tool is hosted in an e-learning platform with a Moodle architecture set up behind it. Moodle [6] is a free and open-source learning management system (LMS) written in PHP (PHP: Hypertext Preprocessor) and distributed under the GNU General Public License. It is designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments. With customizable management features, Moodle is used to create private websites with online courses to achieve learning goals, while allowing for extending and tailoring learning environments using community-sourced plugins. Moodle has been selected between different LMSs for several reasons, as it has a high ranking among LMSs, it is developed on technologies the development team is familiar with (e.g., PHP and REST services), as well as because the development team is highly specialized on it, having more than a decade experience in developing e-learning courses with Moodle.

Following the needs of the Drive2theFuture e-learning tool, necessary configuration has taken place within Moodle. First, the project identity (logo) has been integrated in all available views. Also, SCORM format has been selected for the easiest uploading of content, as the courses have been developed in this format.

A login page has been created to facilitate the user identification and personalized experience (Fig. 5).

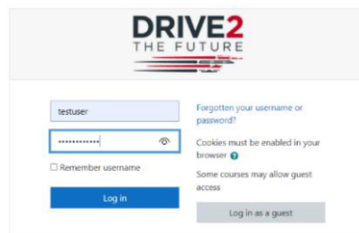


Figure 5. Login page.

The main page of the tool includes the Drive2theFuture courses grouped per transport mode, while in the dashboard view each user can see all information on the available courses and his/her personal activity (Fig. 6).

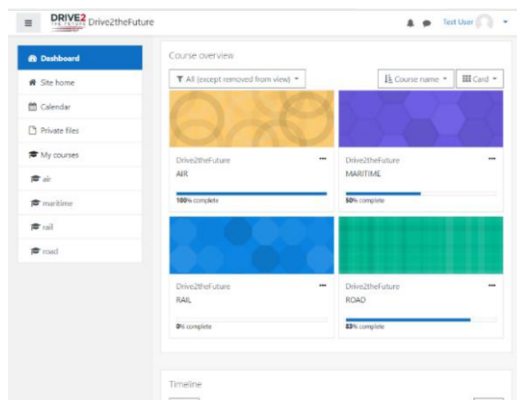


Figure 6. Drive2theFuture eLearning platform dashboard view.

A guide is also available, providing the user with detailed instructions on how to use the tool, navigating step by step through its different contents and functionalities (Fig. 7).

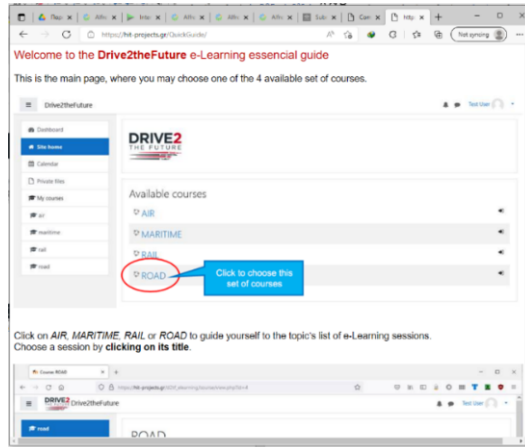


Figure 7. Drive2theFuture eLearning platform guide.

Upon selecting the desired mode, the page displays the courses addressing different topics on this mode (Fig. 8). In addition to the list of courses, in each mode's page there is also an evaluation questionnaire, for the users to express their opinion and comments upon experiencing the tool.

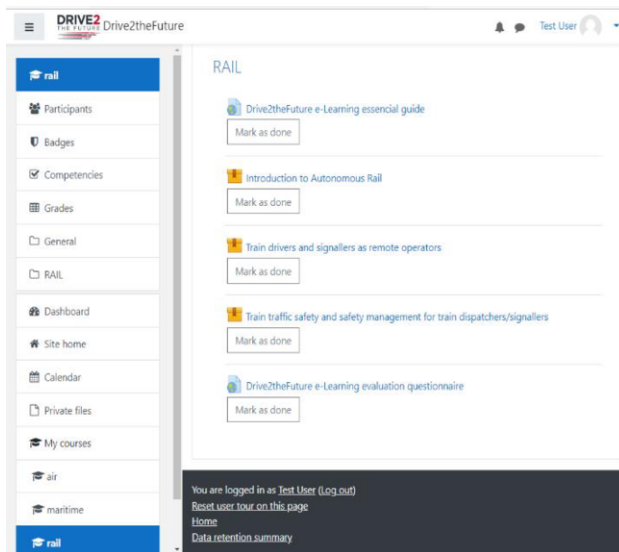


Figure 8. Drive2theFuture e-learning tool – Rail courses.

At the end of each course, a short quiz is displayed, for the participants to validate the knowledge they gained through the course, in a “lessons learned” concept.

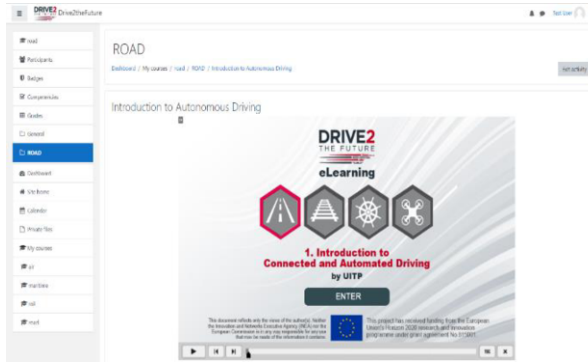


Figure 9. Drive2theFuture e-learning tool content example – Road 1: Introduction to connected and automated driving.

Overall, through the platform settings, the number and grade of attempts is monitored, as well as the final grade of each course.

2.3. Evaluation in Pilot Sites

Upon completing the development of the online tool and testing its features and interactive options, this was provided to selected Drive2theFuture sites, representing all transport modes and different types of users (passengers, operators, etc.), to perform evaluation with users. During the dedicated sessions, the users were invited to use the tool upon receiving some guidelines from the pilot site leaders and provide some feedback on their experience, through a short questionnaire.

The preliminary analysis of the results shows that the training activities achieved increased awareness and understanding of the system, while providing useful feedback for further development and improvement of training programs to different user groups. In terms of quality, most of the participants provided a high rating score, expressing their satisfaction especially regarding its clarity and conciseness. Regarding suggestions for improvement, many among the participants were in favor of multilingual support to allow broader application with users in their own language. Moreover, it was suggested to enrich and/or adapt the contents to what regards issues which will enhance users' trust and willingness to use towards automated transport systems.

Overall, the efficacy of the learning tool can be correlated through the positive rating obtained about the new knowledge acquired through the different courses, and quizzes performed by participants. Interestingly, even participants with prior experience on automated systems, expressed that the courses helped them enrich their knowledge and encouraged them to further explore the systems' possibilities.

3. Conclusion

Automated vehicles are becoming a reality in mobility for all modes of transportation. The technology is rapidly progressing towards achieving higher levels of automation and soon these vehicles will be an everyday reality in the transportation systems worldwide. On the other hand, for the smooth and effective deployment of such vehicles, it is of utmost importance that their intended users are accustomed with and aware of their use, modalities, risks and benefits, in order to accept, adopt and use automated vehicles in a

safe and effective manner. In this framework, together with testing and awareness activities, training of users is essential for providing the users the necessary knowledge (generic and more exquisite, depending on the user group) on the concepts, the purpose and the functionalities of automated vehicles.

Recognizing this need, Drive2theFuture has developed a series of training programs and tools, deriving through extensive literature review for recognizing the training needs, defining the contents, and considering relevant existing tools and initiatives. These programs and tools have been developed separately for each transport mode and addressing different user groups training needs, as defined within the course of the project, while they are validated in the project pilot sites.

Among these, the e-learning tool is an online platform containing a series of courses, with texts, videos and quizzes, which can be used individually or in a classroom format. The tool is structured in a modular way, providing a set of courses per transport mode for all four transport modes (road, rail, maritime and aviation), while differentiating specific courses for different user groups. The great advantage of the tool is that it is very flexible in its use, allowing the user to select and combine the courses of interest, without having to go through all the available material. Also, its visualization and presentation are pleasant, modern and user friendly, making the contents understandable by all, regardless of the level of knowledge on the topics. Moreover, the quizzes, available at the end of each course, allow to check if the main “lessons learned” are conceived in a fun way, while it is possible to be repeated as many times as desirable. The tool’s evaluation through selected Drive2theFuture pilots, showed a positive feedback by the users, who found it a useful and easy to use tool, providing them with essential information on the systems and/or enriching their already existing knowledge. Suggestions of improvement were also provided, to be taken into account by the developers.

Summarizing from all the above, the Drive2theFuture training tool is a usable and flexible tool, useful and applicable for training people of different user groups, regardless of age, gender, professional background and previous knowledge on the addressed AV topics for all transportation modes, in a user-friendly and pleasant manner. Improvements are foreseen, following the validation and evaluation process performed in the project pilots, while – in its final form - it is aimed as an exploitable product upon the project finalization.

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References

- [1] Drive2theFuture, "Drive2theFuture," 2019. [Online]. Available: www.drive2thefuture.eu. [Accessed April 2022].

- [2] Markvica, K., Rosekranz, P., Loukea, M., Gaitanidou, E., Bekiaris, E., Giro, C., Orfanou, F., Vlahogianni, E., Yannis, G., Fassina, F. and Lenz, O. "D1.1: User clusters, opinion, research hypotheses and use cases towards future AV acceptance," Drive2theFuture, 2020.
- [3] Anund, A., Sjors Dahlman, A., Alertas, I. Loukea, M., Agiasophiti, Z., Giro C. and Tozzi, M. "D4.1: Novel training tools and scenarios," Drive2theFuture, 2021.
- [4] Giro, C., Zotos, T. Billiet, M., Alertas, I., Loukea, M., Gaitanidou, E., Bakalos, N., Orfanou, F. and Agiasophiti, Z. "D4.2: AV training programmes," Drive2theFuture, 2021.
- [5] Rustici software, "SCORM," Rustici software, [Online]. Available: www.scorm.com. [Accessed April 2022].
- [6] Moodle, "Moodle," [Online]. Available: www.moodle.org. [Accessed April 2022].