



Collaborative Learning & Serious Game Development

Customer
European Commission

NLR-TP-2013-580 - March 2014



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EXECUTIVE SUMMARY

Collaborative Learning & Serious Game Development



Problem area

Airport management and management of airport based companies are continuously required to deal with various, often complicated, changes. These organizations need well-trained change managers to facilitate the implementation of these changes. The main objective of the MAnaging System Change in Aviation (MASCA)¹ project is, therefore, to develop a dedicated Change Management System that will facilitate the transfer of an effective change management capability for the aviation industry. MASCA's Learning, Training and Mentoring framework provides an environment in which future change managers are educated and trained. One of the main tools within this framework is the Serious Game Skyboard.

Report no.
NLR-TP-2013-580

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Report classification
UNCLASSIFIED

Date
March 2014

Knowledge area(s)
Training, Missiesimulatie en Operator Performance

Descriptor(s)
Change management
Learning
Training
Serious Games

¹ For more details about the MASCA project and the Change Management Systems that MASCA develops the reader is referred to <http://www.masca-project.eu/>

Description of work

The key focus of the Learning, Training and Mentoring framework is on the establishment of a collaborative learning framework and an integrated learning package that supports continuous performance improvement and learning (competency and capability at all levels) and ensures that this overall learning is fully aligned to the strategic blueprint of the organization. The Learning, Training and Mentoring Framework enabled the development of a Serious Game called Skyboard. The creation of Skyboard was based upon a training needs analysis and an iterative development and implementation approach at a large airfield. The goals of Skyboard are to train important for change managers: communication, collaboration and plan and executing the plan.

Results and conclusions

The effectiveness of Skyboard has been analyzed empirically. Skyboard was effective in enhancing communication, collaboration and executing the plan. Players from different organizations effectively worked together in the game.

Applicability

Many applications for Skyboard have been identified among which the use of the game in trainings provided by Eurocontrol at airports dealing with the introduction of Airport Collaborative Decision Making. Change managers do not only work at airports and the competencies required from change managers do not vary much between domains. Therefore, the game could be transformed to other domains and be used to train the same competencies, but in other environments.



Collaborative Learning & Serious Game Development

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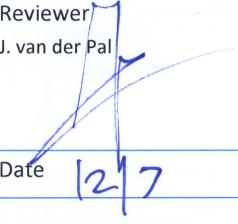
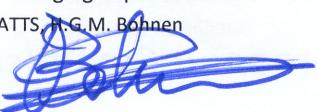
March 2014

This report is based on a presentation held at the SESAR Innovation Days Conference, Stockholm, December 17-19, 2013.

The contents of this report may be cited on condition that full credit is given to NLR and the authors.

Customer	European Commission
Contract number	266423
Owner	European Commission
Division NLR	Air Transport
Distribution	Unlimited
Classification of title	Unclassified
Date	March 2014

Approved by:

Author A. Maij 	Reviewer J. van der Pal 	Managing department ATTS, H.G.M. Bohnen 
Date 16-1-14	Date 12-7	Date 12-3-'14

Abstract

This paper presents the overall Learning, Training and Mentoring Framework as developed as part of the MASCA project. The key focus of the framework is on the establishment of a collaborative learning framework and an integrated learning package that focuses on supporting continuous performance improvement and learning (competency and capability at all levels) and ensuring that this overall learning is fully aligned to the strategic blueprint of the organization. One of the key outputs of the Learning, Training and Mentoring Framework was the development of a Serious Game called Skyboard. The development of Skyboard was based upon a training needs analysis and an iterative development and implementation approach at a large airfield. The research found that Skyboard was an effective means of enhancing communication, collaboration and decision making across intra-organizational agencies which had to collaborate in order to implement a cross-agency change initiative. This paper includes an overview of the supporting learning theory that has emerged from the MASCA project.





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Abbreviations

Acronym	Description
EASA	European Aviation Safety Agency
ICAO	International Civil Aviation Organization
LTM	Learning, Training and Mentoring framework
MASCA	MAnaging System Change in Aviation
NLR	National Aerospace Laboratory NLR
TNA	Training Needs Analysis

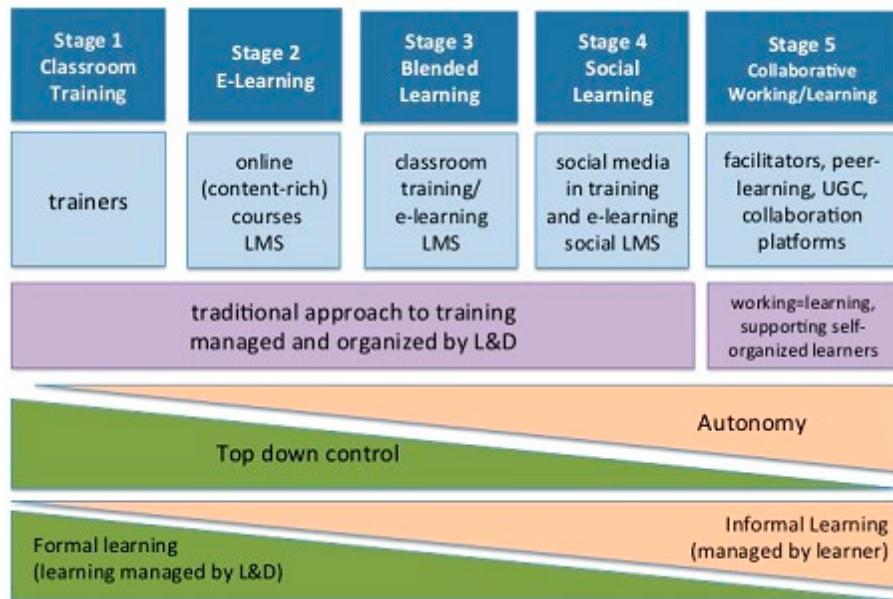
1 Introduction

The concept of 'learning' has been related to formal education but is also used more and more frequently in the context of work. Interest in workplace learning has expanded since the beginning of the 1990s, and currently the research in this area is both wide-ranging and interdisciplinary. The rapid development of information and communications technology, the growing production of knowledge in the economy, increasing internationalization and globalization as well as changes in occupational structures all have contributed to a challenging and continuously changing working environment that requires personnel to be flexible and to quickly adapt to be able to operate in this environment. This work environment has made it necessary to find effective means of training that guarantee the preservation of high proficiency levels in employees. The contents and organisation of work have challenged not only educational institutions but also work organisations to develop new ways of ensuring that the level of competency and capability of the workforce meets these challenges [1]. Continuous and collaborative learning has become important both for individuals operating in the learning society and for organizations competing in international markets.

However many organizations are still focusing on the traditional approach to training. Figure 1 outlines five stages of work-place learning from stage 1 'traditional classroom training' right through to stage five more 'collaborative based training'. The emerging evidence suggests that while many organizations are highlighting that they are not getting the value from stages 2-3, this is still where the majority of training activities are focused. Hart [2] found in her research that only 14% believe that the traditional approach to company training is an essential way for them to learn in the workplace.

For example in the Aviation sector, Human Factors training was mandated from a number of regulatory bodies (e.g., ICAO, EASA) which resulted in huge volume of Human Factors training offered to staff of Airlines, Aviation Maintenance Organisations, Airport Operators, Airport Handling Companies and Air Traffic Services. But 10 years on – does this approach to training (again primarily falling between stages 1-3 as identified in Figure 1) actually result in improved performance and enhanced capability in the workplace? Research from previous EU funded projects [3,4,5] highlighted that during the Human Factors training programmes, frustrations were often expressed by staff that they were trying their best to apply the new learning but the system did not support them. Training was criticised by staff as being 'idealistic' and 'removed from the realities of the system'.

5 Stages of Workplace Learning (2010)



© Jane Hart, 2010 (Orange/green elements added by Jay Cross)

Figure 1 Five Stages of Work-Place Learning

Collaboration is broadly defined as an interaction among two or more individuals and can encompass a variety of behaviours including communication, information sharing, co-operation, co-ordination, problem solving and negotiation in order to create an overall common and compatible operational picture. One of the most important elements of learning which is absent from traditional approaches to training and learning is the process of social interaction in order to establish an understanding of this common and compatible process and the content of knowledge, competency and capability to achieve the overall strategic plan for change.

The overall MASCA work program has a primary focus on the transfer of change management capability into the organizations that are responsible for and involved in change. In order to effectively support the change initiatives a core component of the MASCA Change Management System is a framework for Learning, Training and Mentoring (LTM).

As one of the key aspects of the framework focused on the establishment of a learning community the active use of social media (e.g., on-line discussion groups) and on-line collaborative learning tools (e.g., webinars) was utilized as part of this overall learning framework. The development of a Serious Game was one of the innovative outputs of the project and the following section provides an overview of the development process, implementation and evaluation of the SKYBOARD Serious Game and how it supported the implementation of change in one organization.

2 Serious Games as an Effective Means to Meet Learning Needs

“Serious Games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement.” [6]. They are games that aim to teach the players competencies that are important and relevant for their professional development. Serious Games are often used in parallel with other learning tools and environments, such as lectures, e-learning forums, and simulators.

The advantage of using serious games over other learning tools is that serious games enhance students’ motivation [7]. In fact the games elicit them to play, and therefore learn, over and over again [7]. A serious game is considered well-developed when the correct balance between entertainment and education is found [8]. Therefore, the development of a serious game is a flexible process with many iterations and interactions between developers and potential users to ensure the correct balance and continuous and on-going learning.

3 Methodology

The development process of serious games is iterative in nature and visualised in Figure 2.

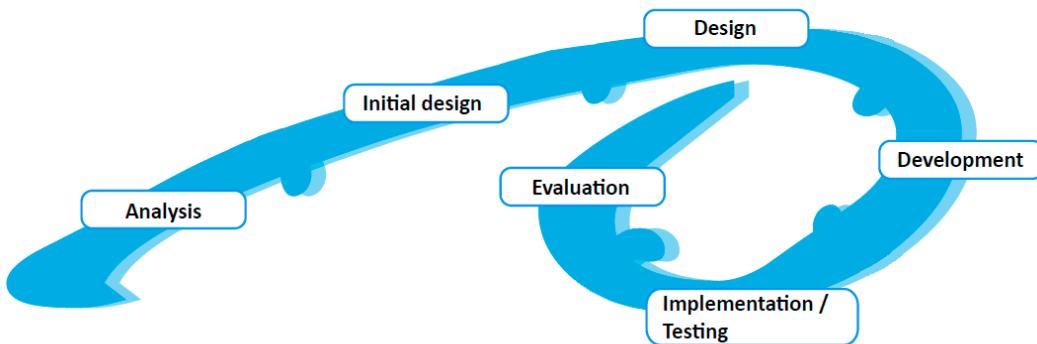


Figure 2 Development process of MASCA game

The development process starts with gathering information necessary for the initial design. Most of this information results from a training needs analysis (TNA), such as demographics of the target population, the available training time and the competencies that need to be trained. The rest of the required information comes from the user requirements analysis. This information answers questions regarding four entities: the domain in which the game takes place, the game principles, the simulation model and the didactical principles. The target audience of Skyboard consists of people working at airports in middle or higher management. These are the decision makers for their company with regard to dealing with events in their daily operations, such as lost passengers, de-icing and closed runways.

Based upon the TNA a competency profile was developed, with the key competencies including creating a common understanding of the mutual benefits of implementing A-CDM, communication, joint decision making and information sharing [9]. The competency profile forms the basis for the learning elements of the game. These are for example awareness of the benefits of A-CDM and training of the competencies communication, collaboration and planning and execute the plan. The game dynamics form the framework and the basis for the ‘fun’ elements of the game. They comprise the way how players interact with the game. Examples of game mechanics are the pawns that are used in a game of Monopoly and how they move over the board (rolling a dice and stepping from field to field in a clockwise direction). Learning elements from the competency profile and ‘fun’ elements from the game dynamics are necessary to create an effective serious game.

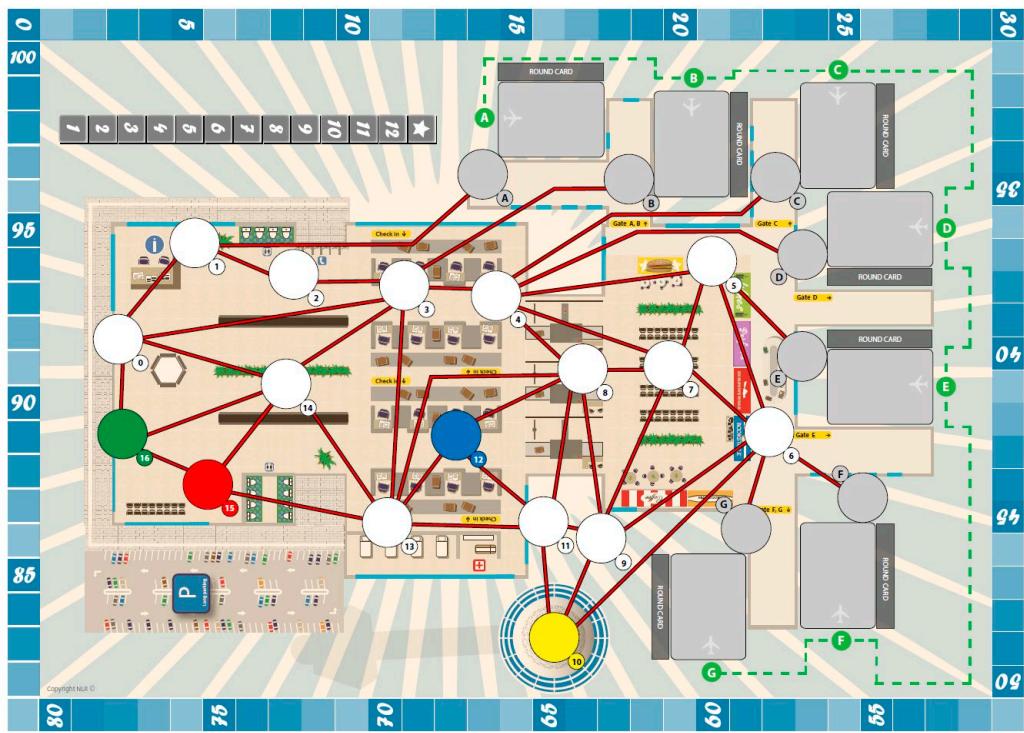


Figure 3 The Skyboard Game

Competencies and game dynamics are selected and deselected in this phase of game development to create the best fit between the two. Some game mechanics cover multiple competencies and some none. Care needs to be taken to ensure that players will be rewarded for demonstrating the behaviour that matches with the competency profile and ‘punishes’ non-compliant behaviour.

After this important analysis and initial design phases, the iterative phase starts. Part of this phase is aimed at balancing and test-playing the game with prototypes. Balancing is necessary to ensure that each player has an equal chance of winning. In serious game design it also entails ensuring that appropriate use of the to-be-trained competencies is more rewarding. An automated procedure based upon a computer model of the game was developed for parts of the balancing work. This procedure was alternated with test playing with real players to compare computer models with the creative and erratic behaviour of real human players.

4 Playing Skyboard

Skyboard is a board game that is played by 4 persons. Each represents a stakeholder in the A-CDM process: ATC, Airline, Ground Handling and Airport Operations.

The players aim to get all aircraft to depart on time. However, during the game several bottlenecks occur at random, such as missing passengers, snow on the runways, etc. These bottlenecks make it difficult to adhere to the schedule and forces players to decide which aircraft should be services first or maybe be cancelled.

The game can be played in two different modes. In the A-CDM mode players are rewarded and elicited to collaborate and play as they would in an airport where all stakeholders are fully operating according to the A-CDM principles. In the non-A-CDM mode players are encouraged to work as they normally do without a strong necessity to collaborate or work according to A-CDM principles. Based upon the scores that players will accomplish when playing the game and based upon the feedback that players will receive from the trainer the difference between A-CDM and non-A-CDM will become unmistakably clear to all players.

The game board (see figure 3) can be seen as a shared representation of the situation between the players. The board presents a bird's eye view over the airport. All aircraft standing at the gate, all bottlenecks that need to be solved and the status of every player can be seen. All players are able to see for themselves what the situation at the airport is, where help is needed, where deviations from the planning are taking place. They can decide for themselves whether they should take action and support the other stakeholders or not based upon this knowledge.

The game can be played without an instructor present. However, a well-trained instructor will enhance training effectiveness. The instructor's task is to observe players during the game to identify behavioural markers that are related to the selected competencies. Upon identifying one of these behaviours, the instructor interrupts the game and discusses the behaviour with the players. This way, the players are given the chance to practice the correct behaviours during the same game in a safe learning environment.

5 Evaluations from Development Workshops

The test sessions during the first development cycles took place within the development team, with gaming and training experts at the Dutch National Aerospace Laboratory – NLR and with training experts at Trinity College Dublin. Three more elaborate test sessions /workshops were held at the airport with representatives of the target group.

Each of the large sessions was preceded by a presentation of the role of the game in the process of introduction of A-CDM and test play to familiarise the players with the new game. Instructors were present during the test sessions, but their primary role was to guide players through the game rules and to gather information on improvements. Therefore, feedback on the competencies was not provided by the instructors during gameplay.

Before and after playing the game, players were asked to fill out a questionnaire aimed at identifying their attitudes towards CDM and serious games in general and towards Skyboard specifically. The following paragraphs present these test sessions and the results they have generated.

First Test Session

The first of these sessions was intended to test the concept of Serious Games and to generate ideas for further development. An early prototype of the game was played and commented on by airport staff. This session focused on game dynamics and on how representatives of the target group considered serious games.

The trainees were very enthusiastic about using a Serious Game to aid the introduction of A-CDM. They were positive about physically meeting other representatives of airport stakeholders, instead of only talking on the phone or emailing. However, the game dynamics were not good enough yet. The game did invite trainees to discuss A-CDM related issues with other trainees, but it did not immediately invite to cooperate. Therefore, the game development after this session focused on developing game dynamics that force trainees to cooperate. A game dynamic that changed after this session was, for example, the introduction of barriers that make it harder for players to achieve their goals.

Second Test Session

The second session was conducted with representatives of the game's target group, change managers. The goals of this session were to verify how the trainees appreciated the improvements that were made to the game and to explore what the trainees learned by playing the game.

This session started with exploring the attitudes of participants towards the introduction of A-CDM. Even though the expectation was that some participants would still be a little unsure of the implementation of A-CDM at the airport all participants indicated that they were looking forward to it. Their expectations for CDM were that it contributes to a better coordination and better predictability of arrival and departure times.

The second research question pertained to the belief of participants that Serious Games can effectively contribute to learning. Trainees were asked to rate several learning environments on their suitability for training skills. After playing the game, the trainees were more convinced of the effectiveness of serious games compared to their initial attitude towards serious games before playing the game (the belief that serious games can be used for training skills and attitudes increased significantly after playing the game, $p < 0.05$).

Thirdly, trainees were asked which learning goals they thought the game would achieve. Most of them indicated that the main learning goal is in the area of collaboration.

A final research question was to find out how much players enjoyed playing Skyboard. This is an important question, because students (as stated above) who enjoy a learning experience are more motivated to perform their best and will therefore learn more from their experience. The participants indicated that they enjoyed playing the game. Figure 4 shows the attitudes of players regarding Skyboard. Players were satisfied with most aspects of the game, but somewhat less positive on learning how to play the complex game.

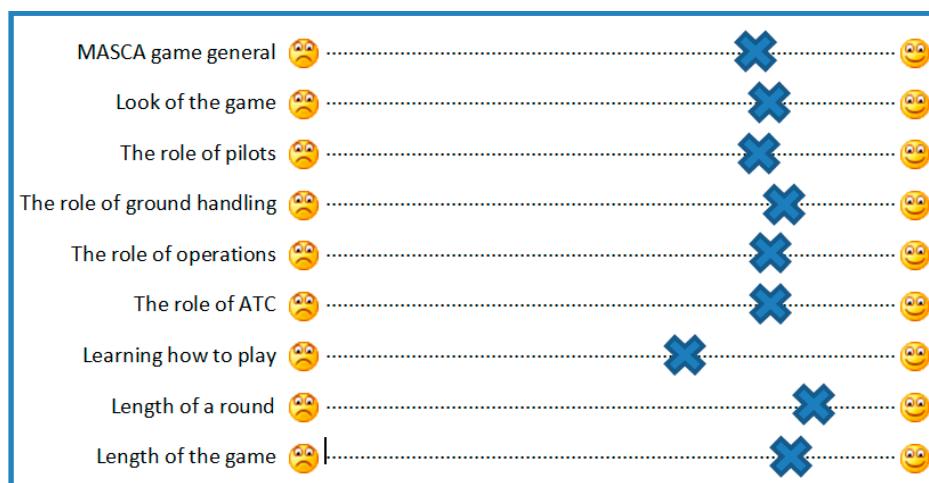


Figure 4 Target Group Attitudes towards Skyboard

Third Test Session

The third session was performed with the same target group as the second session and it mostly studied the same questions, but it was performed with other stakeholders from the airport. An additional goal of this session was to study if the game required further improvements or if it was ready for finalisation and validation.

The results are mostly comparable to the second test session. All participants looked forward to having A-CDM introduced at their airport. They expect better predictability and more accurate information on arrival and departure times. The participants' beliefs towards the effectiveness did not change after playing Skyboard, but were quite positive (7 positive against 1 negative) beforehand. The learning goals that they expected were a better understanding of A-CDM and were in the area of cooperation.

An important finding from this session was that there were no significant differences in the appreciation of Skyboard when compared with the second test session ($F = .192$; $p = .977$). Thus, the participants in the final test session were comparably satisfied with the game, indicating that further improvements on game dynamics were no longer necessary and the game is ready for validation.

Final validation

A final validation test has recently been undertaken to identify whether players learn the competencies the game aims for and whether they enjoy playing the game. The results of this validation will be published elsewhere.

6 Conclusions

Studies have shown that Serious Games do play a role in fostering the development and improvement of various competencies, like communication, collaboration or negotiation and to enhance overall collaborative learning [10, 11]. The key benefits of introducing the Serious Game to support the implementation of A-CDM in this case included the opportunity for the key stakeholders to spend significant time with each other, getting to know each other in a fairly relaxed and ‘fun’ environment and getting a better understanding of each other’s roles and the challenges they were facing with the implementation of A-CDM. A second benefit of the game was that it raised more awareness and initiated a more in-depth discussion of the implementation of A-CDM and what it meant for each of the stakeholders. The next phase of the overall approach within the airport is to embed the Serious Game into a specific training program for the key operational staff. Collaborative learning is an approach based on the idea that learning is largely a social behaviour involving groups of learners working together as a team to find a solution and work together in implementing that solution.

It is becoming apparent that we are at the beginning of a fundamental shift in the way that both learning and working is happening in organisations. Therefore the establishment of a collaborative learning process and integrated learning package needs to focus on supporting continuous performance improvement and learning (competency and capability at all levels) and to ensure this overall learning is fully aligned to the overall strategic blueprint of the organization.



Acknowledgements

The above mentioned research has received funding from the European Commission's Seventh Framework Programme FP7/2007-2013 under grant agreement 266423 "MASCA".

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