



E.02.37-M012-AeroGame-Final Management Report

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Abstract

The final management report of the AeroGame project provides a publishable summary of the results. In addition it lists all deliverables, eligible costs, deviations, bills and lessons learned.

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Publishable Summary

Introduction

The Single European Sky ATM Research program (SESAR) aims to modernize the current (fragmented) European ATM system. To achieve this ambitious goal, several solutions need to be deployed that will have a large impact on the current way of handling air traffic in Europe. Although many changes may present themselves as obvious improvements for the ATM system, stakeholders are often hesitant because they may have difficulty to quantify the costs and benefits of these changes for their own operation and for the ATM system as a whole. Changes that may seem insignificant for one stakeholder can have major implications for another. In addition, stakeholders can attempt to create a last-mover advantage by waiting with their investments until all others have proceeded with investing. Limited knowledge about the position of other stakeholders towards the change may encourage such behaviour even further which could even lead to deadlocks in the change process.

The AeroGame project investigated how *serious games* can support change in ATM. Compared to pure (fast-time) simulation models, serious games allow for human interaction. Human interaction is important to include when the effects of human behaviour are difficult to model and yet have strong impact on outcomes. This is especially the case for multi-stakeholder innovation and change processes such as the modernisation of ATM systems. Compared to real-time (human-in-the-loop) simulation, serious games do not provide a 1-to-1 translation of reality; they rather focus on processes and interaction. A serious game, when well designed, can provide an engaging, experimentation and learning environment, which allows players to grasp the essence of complex socio-technical systems. By trying out different strategies and 'seeing' the effects of their actions, stakeholders can get a better understanding of how a system works and how it is affected by their actions and those of others.

Approach and methodology

An initial workshop was organised to get input from stakeholders on the challenges around change processes in ATM. Based on this workshop, the AeroGame serious game has been developed to support ATM change processes. AeroGame is a hybrid game, combining a board game with an electronic score board. The use case that was chosen is that of the transition from the current ATS to a system that supports 4D Trajectory based operations.

4 players participate in a single game session. Each player represents its own organization and can choose one out of six roles (ANSP, airport, low fare airline, legacy airline, government or military). To ensure realism of the gameplay, players should behave as representatives of their respective organizations. To further emphasize this, players are frequently asked to motivate their actions in the game. The goal of the game is to jointly build an air traffic system capable of supporting 4D trajectory based operations.

At the start of the game, each player (i.e. stakeholder) chooses the two Key Performance Indicators (KPIs) that he/she would like to see increased most; the player needs to motivate this choice. Every round, the players receive income. This income can be invested in technologies that enable/support 4D trajectory based operations. An underlying interaction model translates player investments into a change of KPI values. The technologies that can be invested in are formed by the SESAR solutions; the interaction model is based on (SESAR) cost-benefit analyses. Players quickly learn that although individual investments lead to increased values of the KPIs, they will never reach their goals if they do not cooperate. Joint investments lead to synergy advantages and to larger increases of KPIs. As each player has an own interests, constant discussions, coordination and negotiations about the investments are necessary.

To ensure a steady stream of investments, at each round the target KPI values are increased. If a target is not met, players receive less income in the next round. To win the game, a player has to constantly balance between convincing others to invest in the right technologies (that increase its goal KPIs) while at the same time spending some resources to support the goals of *other* players.

If the KPI targets at the end of the game are not met, every player loses. If they *are* met, the game is won by the player that has the most resources left at the end of the game.

Evaluation

As there is no standardized methodology to assess the effectiveness of serious games, a methodology has been developed within the project. The game's effectiveness has been evaluated from different perspectives. The first perspective was game engagement, which is the ability to motivate and to draw people into the game. The second was game-based learning for the stakeholder involved in the game, which is what they learn from playing the game. The third perspective was related to what the *project* wanted to learn from the game (the meta-goals of AeroGame). Combined, these results provided information about the effectiveness of the game.

The AeroGame evaluation plan consisted of pre- and post-game questionnaires and plenary discussions after playing the game to measure what stakeholders learned. To measure the effect on direct game results, observations, logging of events, and questionnaires were used. A dedicated observer was used to collect the indirect game results. The collected information was used to answer the main research question on the value of serious games to support change processes in ATM.

The game has been evaluated during a full day workshop in January. In three parallel game sessions, 12 stakeholders evaluated the game. Each game was assisted by a game master, a facilitator and an observer.

Key results

A lot of information can be extracted from the behaviour of players during game play and the answers provided in the questionnaires. However, the amount of data (collected by the three game sessions) is not always sufficient to draw definitive conclusions. In addition, care should be taken to translate behaviour in the game into behaviour in the real world.

Even considering the limited size of the workshop, the results provided strong indications that AeroGame raises awareness about the topic with the players. The introduction, game elements and discussions during and after the game provide information to players about the topic at hand. It was clear from the results that the knowledge about 4DT increased during the game session. In contrast to a (regular) workshop, a serious game forces a player to reason about the topic, weighing the pros and cons and confronting him with the results of his actions. This increased, among others, the awareness that the introduction of 4DT is a collaborative effort. These elements contribute to the awareness process.

The attitude towards 4DT clearly became more positive after playing AeroGame. This attributes to the change process because if the attitude towards the change is more positive, stakeholders are expected to be more willing to cooperate. Although the number of players was relatively low, the results showed interesting differences between the investment strategies of individuals which is useful information, for example when building a roadmap to introduce the change.

It can be concluded that AeroGame provided several indications that serious games can contribute to ATM change processes. A serious game brings stakeholders around the table (at different levels in the organisation), and helps with a better understanding of the topic and the attitude of other stakeholders towards this topic, it creates a buy-in by engaging players and contributes to the creation of a roadmap. Care should be taken when translating game results to real world conclusions. Both observations and reactions from players indicate that such translation is possible but more empirical data is necessary to draw definitive conclusions.

The strength of the combination of paper-based and hybrid games is that they support in-depth communication and sense-making processes between stakeholders with diverse views and interests.

Future steps

The results of the AeroGame project provide promising clues that serious games can play a significant role in ATM change processes. Although AeroGame focussed on one single topic (transition towards 4DT) the game *framework* can be easily adopted for other subjects as well. The results achieved by playing the game fall into two categories: first, awareness with the players and second, conclusions about the change process itself. To increase awareness with the players, the scalability is a limitation. At most 8 players are usually involved in playing a board game. If one wants to reach more stakeholders one either needs to organize more game sessions or turn to computer games (and consequently, miss out on the direct interaction and communication elements of a board

game). For the sole purpose of creating awareness, it is interesting to investigate the use of digital games to reach a broader audience.

For conclusions about the change process itself, future games could go one step further by not only playing the game and measuring its immediate effects, but also building a roadmap for change and observing to what extent playing the game helps in facilitating the creation of such roadmap.

Conclusions

The AeroGame project provides first – not conclusive – empirical support that serious games are able to contribute to an ATM change process. AeroGame raises awareness by the players and contributes to a climate in which players are more susceptible for other stakeholders' opinions. In addition, support was found that serious games help to create a more collaborative climate among stakeholders in the introduction of new technologies. Together with the observation of player choices, behaviour and interaction, this provides interesting new information that can be used in (the definition and implementation of) ATM change processes.

1 Introduction

1.1 Purpose of the document

The purpose of this document is to:

- Summarise the technical results and conclusions of the project (Publishable Summary);
- Provide a complete overview of all deliverables;
- Provide a complete overview of all dissemination activities (past and in progress). Where appropriate, provide feedback from presentations. Describe exploitation plans.
- Provide a complete overview of the billing status, eligible costs, planned and actual effort (incl. an explanation of the discrepancies).
- Analyse the lessons learnt at project level.

1.2 Intended readership

The final project report provides a high level overview of the results of the AeroGame project. Everyone interested in the results of the project can use this document as a starting point.

1.3 Inputs from other projects

The input for the AeroGame project rests on two pillars: knowledge about ATM and SESAR and knowledge about serious games. The first is mainly contributed by NLR. NLR's ATM and SESAR knowledge is the result of the execution of tens of projects over the last decades at the ATM and Airports department. NLR was and is involved in many SESAR projects fulfilling several different roles ranging from management through execution of real-time simulations to contributions to expert panels.

T-XChange (collaboration between Thales and Twente University) has been founded to target the growing serious gaming market and throughout the years has gained extensive experience with serious games and the science attached to it (selection of right toolbox for a specific purpose, matching expectations and results, validation etc.).

1.4 Glossary of terms

Not applicable

2 Technical Project Deliverables

Number	Title	Short Description	Approval status
D0.1	Project plan	Project plan	Approved
D1.1	Applications report	Identification of ATM applications for serious games	Approved
D3.1	Evaluation Methodology	Definition of Evaluation Methodology (T3.1)	Approved
D2.1	Serious game design report	Design document for one or more serious games	Approved
D3.2	Validation report	Report of the game validations	Submitted
D4.1	Implementation manual	Manual with project teams experience of how to implement a game in ATM	Submitted
D4.2	Final project report	Conclusion and identification of serious gaming applications in ATM	Submitted
D5.4	Dissemination results	Overview of the dissemination activities	Submitted

Table 1 - List of Project Deliverables

3 Dissemination Activities

The following is a summary of the dissemination activities. Full details can be found in D5.4: dissemination results.

- Accepted conference papers:
 - ATOS 2015
 - ISPIM 2015
- Flyers
 - One early in the project explaining the project goals;
 - One at the end of the project explaining the results.
- Demonstrations and presentations
 - SID 2013: poster session
 - SID 2014: poster and test-playing sessions
 - World ATM congress 2015
 - Presentation of AeroGame at the AT-One stand.
 - Thales JPAL conference
- User group activities
 - User group workshop to collect input for project.
 - AeroGame final workshop.
 - Questionnaire to collect input.
- Mailing list
 - With people that expressed interest in the project.
- Website
 - With project explanation and results.
- Movie
 - Short movie explaining goals of AeroGame
- SESAR newsletter
 - Article in the February 2015 issue.

3.1 Exploitation plans

NLR

NLR is involved in many change processes in ATM either as researcher, consultant, project leader etc. The results of AeroGame extend the range of tools that NLR is able to provide to support such change processes.

T-XChange (Thales and UT)

University of Twente: the results of this study will be used in the ongoing research into game mechanics to support multi-player/ stakeholder collaboration in innovation and change processes.

Thales: the results of this study will be used as input for the development of digital multi-player game-based awareness and training games.



4 Total Eligible Costs

As not all invoices have been sent, the italic figures are estimates.

Date	Deliverables on Bill	Contribution for Effort	Contribution for Other Costs (specify)	Status
<i>Date of invoice</i>	<i>List of deliverable numbers</i>	<i>Requested contribution for effort</i>	<i>Requested contribution for travel, licences, logistics etc.</i>	<i>Billed or paid</i>
23-07-2014	D0.1, D5.2, D0.3, D1.1 (D5.1 was combined with D0.1)	€93772.13 (incl. VAT)	€4565.62 (ex VAT)	Paid
17-12-2014	D1.1, D0.4, D0.5, D0.6, D3.1, D2.1	€288162.36 (incl. VAT)	€3325.32 (ex VAT)	Paid
May 2015	D0.7, D5.3, D0.8, D3.2	€130658	??	To be billed
After closing all dissemination activities (est. September 2015)	D4.1, D4.2, D5.4, D0.9	€109029	??	To be billed
GRAND TOTAL				

Table 2 Overview of Billing – As final figures are not yet know, italic figures are estimates.

Company	Planned man-days	Actual man-days	Total Cost	Total Contribution	Reason for Deviation
NLR (coordinator)	322.5	322.5	384780	288585	
Thales	225	225	193660	96830	
University of Twente	265	265	178080	178080	
GRAND TOTAL	812.5	812.5	756520	563495	

Table 3 Overview of Effort and Costs per project participant

5 Project Lessons Learnt

What worked well?
The AeroGame framework is flexible in the sense that it can be applied to various change processes in ATM with little effort.
Applicability of serious games is broad. This gives a lot of possibilities for exploring the potential of serious games. Proper preparation remains important though.
Enthusiasm of stakeholders when confronted with serious games is high. This makes it easier to "recruit" players.
Although a simplification of reality, the players were able to link the processes and decisions in the game to their real-life counterparts. This makes the results of the game more reliable.
Serious games can be tailor made, from a nice intermezzo during a meeting to a multi-day game with a specific purpose.
What should be improved?
Although liked by most, actually convincing people that serious games are a serious tool is challenging.
Proper, standardized validation methods to validate the effectiveness of serious games do not exist.
Expectations of the effect of serious games should not be too high; they can contribute to change processes but they are certainly not the whole solution.
For a proper validation of the effectiveness of the game (statistically relevant), more play sessions are necessary than the three in AeroGame.
For the sole purpose of creating awareness with a serious game, a board game with four players, a game master, a facilitator and an observer is not an efficient method to reach a broader audience.
To more widely disseminate the game (framework), its saleability should be improved.
To ensure the quality of game-play and its results, it is important that the proper players join the game. These should be experts on a management level.

Table 4 - Project Lessons Learnt

6 References

- [1] A. Majj, D. Nieuwenhuisen, R. Aalmoes, E. Faber, Serious games to advance change in ATM, ATOS 2015, to appear
- [2] E. Faber, R. Aalmoes, T. de Groot, R. Hryniewicz, D. Nieuwenhuisen, Serious gaming for change in Air Traffic Management, The XXVI ISPIM Conference 2015, Budapest, to appear