Gaming the Interrelation between Rail Infrastructure and Station Area Development: Part 2 – Insights from the serious game 'SprintCity'

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Abstract—**The authors analyze the complex interplay between rail infrastructure development and railway station area development in the Netherlands through the method of gaming-simulation, or serious gaming. The serious game SprintCity was developed in order to better understand and manage the dynamic interrelations between rail infrastructure and urban development of the Delta Metropolis in the Netherlands. So far, the game has been played in nine independent game sessions, with a total of around 70 stakeholders as players. The authors describe the design of the game in some detail and present the preliminary insights and results. Data before, during and after the game sessions are gathered through in-game participant questionnaires, data logging, observations and transcripts of end-of-game (debriefing) discussions between participants and the facilitator. The main conclusion is that the current prototype version of the game is supported by the stakeholder-players, significantly enhances the development and use of the underlying infrastructure-space model and generates questions for further scientific and policy research.**

I. Introduction

In a related publication (author information removed for review purposes) we analyzed the interrelation between infrastructure networks and urban growth [1]. On the basis of this analysis we presented a model of the interrelation between rail infrastructure and station areas in the Delta Metropolis of the Netherlands (or Randstad). This model forms the core of the serious game 'SprintCity' – an initiative of the Delta Metropolis Association in partnership with TU Delft and the Next Generation Infrastructures (NGI) foundation [2]. The name of the SprintCity game is inspired by the conceptual city of train station environments that are linked by frequent short-distance train services, known as 'Sprinters'. In this paper (Part 2) we present the serious game SprintCity, the validity and the preliminary results in more detail. We show the ways in which SprintCity and the evaluation and research instruments can be further developed to generate knowledge questions for research and policy. The most important, though preliminary, conclusion is that for the SprintCity game to be played with real players, the players have to become part of the model: in this way they help to validate and improve the model, but they also learn to understand the model, and on this basis generate new questions for research and policy.

The structure of the paper is as follows. Firstly we examine the question of what serious gaming is, and whether gaming is a suitable method for research, policy and learning about the interrelation between rail infrastructure networks and the spatial development of station areas. We then present the questions and aims of the SprintCity game and describe how the game is played. Finally, we present the research and evaluation method, and give a summary of the results and insights of the prototype of the serious game.

II. Gaming Multi-Actor Systems

Gaming-simulation is a well-accepted and widespread method among planners, including urban and infrastructure. Urban simulation gaming or planning games emerged in the late 1950s as one of the early civilian applications of gaming simulation. Since then, there have been numerous experiments worldwide showing a great variety of game types and concepts: urban board games, role-playing games, computer-based simulation games and, more recently digital games (e.g. SimCity), serious games and virtual worlds [3] [4] [5].

In short, simulation games can be defined as experimental and experiential rule-based interactive environments, where players learn by taking actions and experiencing their effects through feedback mechanisms that are deliberately built into and around the game. Gaming is based on the assumption that the individual and social learning that emerges within the game can be transferred to the world outside the game. This transfer is largely negotiated and not immediate, thereby making a simulation game low in external risks and giving the players a sense of safety, which is a prerequisite for experimentation [6]. Although the notion of serious gaming had already been launched in the late 1960s [7], it nowadays emphasizes the use of concepts and technology derived from entertainment computer games for non-entertainment purposes such as research, policymaking and decision-making, learning, training and education. Much of the attention in the worldwide serious gaming movement is concentrated on 3D graphics, virtual game worlds and game engines, but in our view serious gaming is a combination of using analogue and digital game concepts and techniques. In an earlier review publication, the first author has argued that

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the relevance of gaming-simulation and serious gaming for purposes such as urban and infrastructure planning lies in the fact that gaming is the most suitable method to simulate complex multi-actor systems (author information removed for review purposes). Bekebrede [8] has recently argued that infrastructures are complex multi-actor systems, and demonstrated that gaming is an effective means of policy-oriented learning about system complexity. In short, complex multi-actor policymaking for infrastructures needs methodologies and tools that are able to support both the 'technical-physical complexity' and the 'social-political complexity' of policy making [6]. Gaming is a unique form of decision-relevant or policy-relevant modeling because real people become an intrinsic part – as actors or stakeholders – of the model or computer model. Through playing, stakeholders learn about and reflect on the system, but also about their position and role in the system. This is largely done by making use of game principles such as experimentation, feedback and trial and error, which are also essential ingredients for active learning. These learning processes can be enhanced by making use of game mechanics such as safety, engagement (fun), visualization and creativity. But gaming can also be used for research purposes. The uniqueness of the method lies in the fact that gaming can combine and integrate 'quantitative' (hard) research data (e.g. quasi- experimental research, computer simulation, etc.) with qualitative (soft or interpretative) research data (e.g. case study research, group interviews and questionnaires, etc). In other words, gaming can constitute multiple bridges between modelers, policymakers and stakeholders, between academic research and policy analysis, between (analytical-scientific) research and action or intervention research, etc.

III. Research questions

The development and application of the SprintCity model and game will be scientifically investigated with reference to three central questions:

1. What is the validity of generic models concerning the interaction between mobility and spatial development when applied to the rail infrastructure and station areas in the Randstad?
2. What can we learn about the integrated, long-term development of rail infrastructure and station areas when stakeholders interact with these models in a serious game?
3. Is serious gaming an effective investigative and teaching method for validating and improving these models, generating policy-relevant knowledge and transferring this to policymakers?

Research question 1 is a methodological question concerning the modeling of the interaction between infrastructure and space [1] Research question 2 is the main content-based and policy-relevant question of the investigation, which will be answered in the course of the project. Research question 3, which is central to this paper, is a methodological question that is relevant for the professional field of gaming and policy analysis.

IV. SprintCity as a serious game

The serious game SprintCity was initiated in 2009 by the Delta Metropolis Association and developed in a joint project with the Serious Gaming Centre of Delft University of Technology (TU Delft) and the Next Generation Infrastructures (NGI) foundation. The prototype of the game was limited to the Leiden-Schiphol rail corridor in the Delta Metropolis, but was developed in such a way that it can gradually be expanded to include the entire Delta Metropolis and beyond. The game is intended for professionals from government agencies and stakeholders. SprintCity can be best characterized as a computer-based, multi-player (6-12 players), strategic planning game. A game version 1.0 with an improved and extended simulation model and more features is currently under construction and will be released around autumn 2010.

A. Aim of the game

Through improved attunement and cooperation between various station areas, a better development of the entire corridor in the long term is achieved. The players experience the dynamic connection (feedback) between:

1. The six station areas;
2. The various components of the program;
3. Rail infrastructure and spatial development. In this way attention is shifted from the densification of one particular station area to the significance of the station within the corridor.

B. Game play

In the current, limited version of the game six roles are represented, corresponding to the six cities on the Leiden-Schiphol rail corridor in the Delta Metropolis of the Netherlands. Each role or city is played by at least one player or by a team of players. The game leader divides up the teams before the game begins. The aim for the players in the game is to draw up a Master Plan (2010-2030) for the spatial development of urban station areas on a rail corridor, and to implement it in such a way that it complies with the 'values' (ambitions) established by the players themselves at the beginning of the game, such as public transport use, etc. The spatial outcomes of the game are assessed against these values. The better these are in accordance with each other, the higher the player's score. After a brief orientation and preparation round, the players take a number of decisions on the profile or character of the station area that they wish to develop and the spatial living, working and leisure program that they wish to achieve for their station area. In five rounds of play, each representing 4 years, the players enter their

decisions (choices) into the computer model, after which the effects for the station area and the total corridor are calculated for each round: the number of houses, inhabitants and employees, floor areas used, number of passengers at the station, etc. The results or effects of the individual and collective decisions are presented on the players' user interfaces, with an indication of whether, and to what extent, the profile of the stations is changed. After each round of the game a brief group discussion is held concerning choices, motivation, cause-effect relationships and results. The experiences in the game and the results form the basis for the subsequent discussion of the game: 1. What happened in the game? 2. Why, and what are the mechanisms behind this? 3. Does this also happen in reality? 4. How can events be managed to achieve better results in reality? Figure 1 gives and impression of the players' user interfaces. Picture 1 gives an impression of game play.

Fig. 1: Impression of the SprintCity user interface


Picture 1: Impression of the SprintCity game play

V. EVALUATION APPROACH

A. Method

For the learning experience of the players, for research purposes and for the transferability of insights, it is important that the progress of the game, the experiences within the game, the decisions and their effects, the discussions and insights are recorded. In SprintCity we make use of the complementary research and evaluation methods shown below:

1. Initial questionnaire: backgrounds of the participants (age, gender, experience with gaming, etc.), their involvement with and influence on the subject, the impression that the participants have of the real policy processes, etc.
2. Questionnaire during the game: concerning the game play and the progress of the policy process in the game.
3. Observations during the game: concerning the way in which the game is played, how the players organize themselves, what content-based and policy measures are taken, how the players interact with one another, what problems they identify and what strategies they follow, etc.
4. Group discussions at the end of the game: on the experiences in the game, the lessons for the situation in reality and the relevant knowledge-based questions, on the improvement and continued development of the game, etc.
5. Logging of data in the computer/calculation model: on the choices and decisions of the players, the various maps showing the development of the station areas, the results and effects of the players' decisions on a large number of indicators such as the increase/decrease in the number of passengers, etc.
6. Questionnaire after the game: on the impression that the players have of the quality of the game, the manner in which they have played the game, the use of the computers, the insights and relevance to policy, etc.

B. Data gathering and response

The prototype of SprintCity was played nine times in the period September 2009 - August 2010 with a total of around 70 stakeholders from a variety of organizations (see acknowledgements below). All of the sessions until now had the character of an introduction, and were not yet intended as policy interventions. After playing the game a total of 45 players filled in a brief questionnaire, made up of questions on the quality of the game and their learning experiences. Eight respondents who took part in a session in July 2010 filled in a more extensive questionnaire before, during and after the gaming session. Reports were made on eight sessions on the basis of observations and closing discussions, and the computer data from these sessions was stored. In the course of this paper we give a preliminary impression of the evaluation and results of SprintCity on the basis of questionnaires and observations.

C. Limitations

The extent, depth and reliability of the results and insights are as yet limited. The current version of the game is a playable prototype in which a number of aspects and interrelations are still lacking. The number of sessions and respondents is small, particularly for extensive measurement (1 session; n = 8). The accompanying evaluation and research instruments are in intensive development in parallel to the

development of the game. At the end of this paper we describe the way in which future versions of SprintCity can generate more and better research data and policy insights.

VI. Preliminary results

A. Validation of the game and game play

1) Who are the player-stakeholders?

The participants in the SprintCity sessions are professionals, the majority of them men, with little computer game experience. A considerable number of them have taken part in game simulations or serious games before. Figure 1 shows that the average experience in terms of content, involvement in the real planning process and influence is fairly limited (1 session; n =8). To increase the effect of the game on policy and learning, it is also desirable to play the improved versions of SprintCity with more influential key-stakeholders and experts, in order to raise the game above the level of 'professional edutainment'. For subsequent research into gaming, it might be interesting to analyze the potential correlation between background variables, game experience and learning. These analyses fall outside of the scope of this paper, and in view of the still small dataset we are leaving them out of consideration.

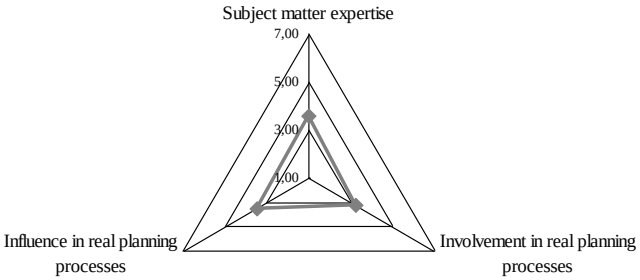

Fig. 2: Involvement and expertise of the participants (1= Min; 7 = Max)

2) How do the players experience the quality of the game?

Figure 2 and the accompanying tables 1 – 3 give an overview of the quality of the SprintCity prototype. This shows that the game is evaluated as moderately positive but that, as expected, there is still a great deal of room for the game to be improved and strengthened. In particular, the instructions and explanations prior to the game could be improved, and it seems to be not always quite clear what the aim of the game is. The computer can generally be operated easily, without many malfunctions, but the structure of the user interfaces and the sense of time could be improved.

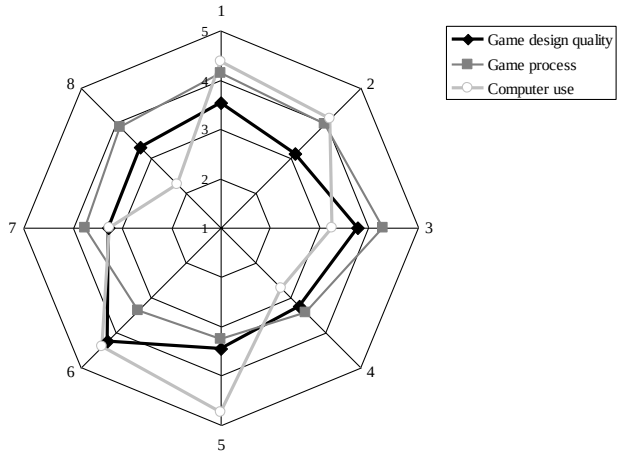

Fig. 3: Profile of the serious game SprintCity

TABLE 1: SERIES 1 - GAME DESIGN QUALITY

	Question (strongly disagree 1 - 5 strongly agree)	N	Mean	Std.
1.	The objective of the simulation game was clear.	45	3.53	.73
2.	The instructions and explanations at the start of the simulation game were clear.	45	3.13	.89
3.	The game materials were understandable and clearly written.	37	3.78	.95
4.	The rules of the game were clear and straightforward.	37	3.24	.76
5.	The tasks in the simulation game were understandable and clearly described.	37	3.46	.77
6.	All necessary materials and documents for the simulation game were available.	37	4.27	.80
7.	Given the aims of the simulation game, the simulation was sufficiently detailed.	45	3.27	.94
8.	Given the aims of the simulation game, the simulation was sufficiently realistic.	43	3.33	.94

TABLE 2: SERIES 2 - GAME PROCESS

	Question (strongly disagree 1 - 5 strongly agree)	N	Mean	Std.
1.	The simulation game was well led by the instructor(s).	45	4.13	.66
2.	Good feedback was provided during and immediately after the game.	45	3.96	.67
3.	Good efforts were made in the game by fellow players and opponents.	43	4.30	.51
4.	The discussions between the players were good.	44	3.43	.87
5.	As a team, we did enough internal reflection and adjustment.	08	3.25	1.04
6.	As a team we worked together well in the game.	08	3.38	.74
7.	Taking part in this game was an educational experience.	08	3.75	.89
8.	The simulation game was built up in an interesting and motivating way.	43	3.88	.70

TABLE 3: SERIES 3 - COMPUTER USE

	Question (strongly disagree 1 - 5 strongly agree)	N	Mean	Std.
1.	The computers in the game were easy to operate.	08	4.38	.52
2.	I enjoyed using the computers in the game.	08	4.13	.99
3.	The user screens (interfaces) in the game adequately reflected the changes in the process.	08	3.25	.89
4.	I had a clear sense of time in the game.	08	2.75	1.04
5.	During the game there were few or no computer malfunctions.	08	4.75	.46
6.	When there were computer malfunctions, these were quickly and satisfactorily remedied.	05	4.40	.89
7.	The tasks and assignments in the simulation game were too easy.	08	3.25	.71

8.	The tasks and assignments in the simulation game were too difficult.	08	2.25	.46

3) How do the players experience the game play?

Figure 4 gives an overall profile of the game play on eight scales (1-7). This shows that on average the players find the game 'relaxing' and 'engaging'; but also rather 'abstract', 'fictitious' and 'technical'.

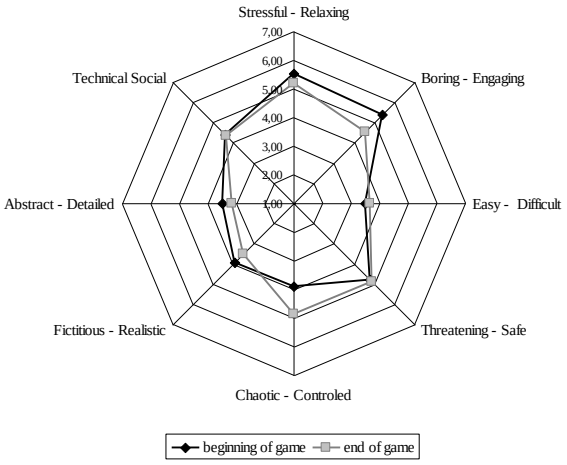

Fig. 4: Game play

B. Policy-oriented learning

1) How do the players evaluate the policy process in reality and in the game?

Figure 5 gives an overall profile on 8 scales (1-7) on which the participants evaluate the real policy process and the policy process in the game. The policy process in reality and in the game appear to be largely congruent, and as yet there are no significant observable improvements during the game, but it is striking that the participants find the real policy process significantly more 'viscous', 'conservative' and 'conflictuous' than the game.

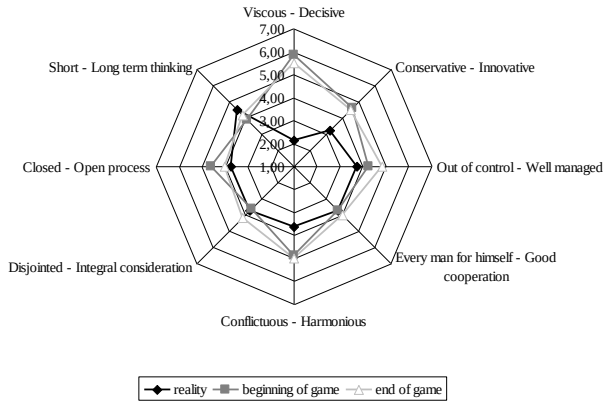

Figure 5: Policy process in reality and in the game

2) What do the participants learn from the game?

Figure 5 and Table 5 give a profile of the policy insights that the players – in their own estimation – acquire in the game. On these scales (1-5) the players are moderately positive, but there is room for a strengthening of the effects of the game. In particular, the game still scores weakly on the aspect 'insight into how the decisions of various actors influence each other' (2.88). The game offers relatively good insights into the 'long term developments' (3.75) and 'the interrelation between infrastructure and space' (3.63).

According to the players, the game confirms the importance of having greater insight into the attunement between hub developments. However, the game has been mainly constructed from a spatial development perspective, and still provides too little insight into the infrastructural issues around stations. Because of this, the interrelation between spatial development and the infrastructural network is still not fully brought out. The players experience the game as useful, because it generates the insight that working together with other parties can help in achieving personal and common goals. The players recommend that the game be played with teams from various disciplines within the same session, for example Dutch Railways, developers and managers, and that sufficient time is taken for explaining all the participants' vision and aims, and for reflection.

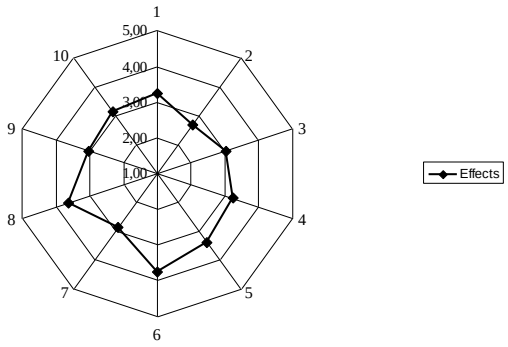

TABLE 5: POLICY RELEVANCE

	Question (strongly disagree 1 - 5 strongly agree)	N	Mean	Std.
1.	The game provides insight into spatial and infrastructural issues around stations.	43	3.23	1.07
2.	The use of this serious game is valuable for policymaking and decision-making.	08	3.25	.89
3.	The game provides more insight into how decisions on different levels of scale influence each other.	08	3.38	.92
4.	The game provides more insight into long-term developments.	08	3.75	.46
5.	The game provides more insight into how different decisions by various actors influence each other.	08	2.88	.84
6.	The game provides more insight into how spatial developments in the infrastructure network are interrelated.	08	3.63	.74
7.	The game provides more insight into various solution directions and alternatives.	08	3.00	.76
8.	The game provides more understanding of the interests and perspectives of other stakeholders.	08	3.13	.84

As the game progresses, more insight arises among the participants into the working of the game, so that they are able to improve the attunement of their strategies. Furthermore, the players find that the structure of the game does not yet in itself

invite consideration of higher managerial levels of scale or rail corridors. The educational value of the game is found in the consequences of the spatial developments for the 'network value of the station', but this educational aspect must be made even clearer in the game.

C. *Knowledge and research questions*

The knowledge that arises from playing the prototype of the serious game SprintCity with professionals from government agencies and other stakeholders provides real-life input for further research. This generates a fertile 'feedback loop' of knowledge. Some important knowledge questions that have been generated in the game until now are:

1. Increased frequency: To what extent is the frequency only influenced by the additional passengers from the spatial development? How can the optimization of pre-transport and post-transport contribute to attracting new passengers? When can an increased frequency of public transport compete with mobility on the roads?
2. Train occupancy: Can the division of the program over the various stations counteract asymmetry in the direction of travel of the passengers in a corridor?
3. Investment models: Is a link between infrastructural developments and real estate possible?

The following topics were generated for research and further development of the game on the basis of the experiences with the game until now.

1. Insight into the possible capacity of the station surroundings using the method of SpaceMate.
2. Insight into the interrelation between spatial program and infrastructure development.
3. Insight into the effects of improved interrelation between the various station surroundings on the scale of the Randstad.
4. Insight into the roles of the various parties: both private and public and on various levels of scale.

The game will be scaled up in the next phase. The Leiden-Dordrecht and Schiphol-Amsterdam-Lelystad corridors will be added to the Leiden-Schiphol corridor. In this way the game will grow by 23 and 11 stations respectively, bringing the total to 40. In version 2.0 the entire Randstad should be represented, and a representation of around a hundred stations in the game will be possible. More emphasis will also be placed on debate, discussion, consultation and negotiation during and after the gaming session. The research and evaluation tools in the game will be extended and validated.

VII. CONCLUSIONS

The knowledge that arises from playing SprintCity with stakeholders provides real-life input for further research and the continued development of the model and the game. In this way a fertile 'feedback loop' of knowledge is generated. Some important but preliminary conclusions (hypotheses) are:

1. By playing the game the stakeholders become familiar with the underlying (formal) model (in this case the complex relations of cause and effect).
2. By playing the game the stakeholders gain more insight into the interrelation between the technical-physical aspects (in this case the feedback in the model) and the politico-social aspects (the strategic behavior of the actors) on the various system and scale levels of the Delta Metropolis.
3. By playing the game the stakeholders learn what their individual and collective roles and behaviors in that system are.
4. By experimenting in the game the stakeholders learn to develop and validate alternative strategies and potential management and action options.
5. Playing the game generates 'objective' information on the complex behavior of the system and the actors, established in the simulation model of the game.
6. Playing the game generates 'intersubjective' information on the complex behavior of the system and the role of the actors within it: the perceptions and opinions of the actors arising from discussions, observations and questionnaires, etc.
7. By giving feedback on the model and the game, the stakeholders contribute to the improvement and expansion of the model and the game.
8. By giving feedback on the model and the game, the researchers learn how SprintCity, and gaming in general, can be better used for policy-relevant learning and policy research.

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