Extending the Reference Method for Game Production: A Situational Approach

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Abstract— In this research, we describe the development of a situational game production method. In earlier research, the Reference Method for Game Production was proposed, which gives a complete overview of all possible activities and deliverables in a game production process. However, this method is a generic method that is not suitable for every game development project. The need exists for a method that can be tuned to different situations. In respect to this research, a situation corresponds to a game genre or another type of factor that influences the development steps. We conduct case studies at nine Dutch game companies, in order to a) validate the activities and deliverables in the existing reference method, and b) analyze the companies’ existing methods in order to identify new situational routes which can be used to extend to the reference method. We use method-engineering principles and a meta-modeling technique to document, compare and analyze the nine methods. Based on the analysis, we propose four new routes, where each route represents a specific production case. The four routes are: serious games, online games, prototype and localization. Finally, we integrate the new routes with the existing method by developing a route map.

Serious games, game production, reference method, route map, genres, method engineering.

I. INTRODUCTION

Computer games are today a vibrant part of the advanced world countries’ economies. According to van Eck [9], the digital game industry in the US is at 10 billion $ per year, while serious games produce an income of 20 million $. These numbers are expected to grow, since in the next years more U.S. companies will adopt serious games as part of their training efforts [17]. Also in Europe, serious games is a emerging field. For example, in the Netherlands, the Game Institute for Training and Entertainment (GATE) was awarded with a 10 million euro grant1.

Serious games can be used for many purposes and in different industries, e.g. for educational institutes, in the healthcare sector, in the military and more (cf. [24]). When developing educational games, the focus is on matching the game content to the intended reason for creating the game; the game should actually achieve a goal further than entertainment [9] [25]. A clear distinction between serious games and educational games does not exist. The same applies to management games and real-world simulations. The boundaries are blurry and as some respondents indicated, a game includes elements of all genres in different proportions.

Although many different game genres exist, such as serious games, online games and simulations, most game production literature present methods that treat all game genres alike, cf. [5] [8] [15]. However, different game genres need different game production methods.

This research will attempt to provide more insight in the game production process. In order to do so, the Reference Method for Game Production, developed by Van de Weerd, Weerd & Brinkkemper [22] will be validated and extended. The current reference method offers a generic route for all game genres. However, since different game types need different game production processes, we extend the method with different routes that can serve as guidelines to the production of different types of games.

In earlier research, we proposed a game categorization based on similarities of genres, rather than focusing on the differences between them [1]. The aim of developing a game categorization was to specify genres, and other factors such as technology and player profiles that might influence the production process and indicate a different game production route then the standard one. In this research, we will use the game categorization for identifying new routes in our current reference method.

In the next section, we describe our research approach. Then, in section III, we present the results of our research. Section IV describes the discussion, and finally, in Section V, we describe our conclusions and future research.

II. RESEARCH APPROACH

In this research we want to answer the following question:

How can a situational game production method, that describes the game development production process for all types of games, be constructed and validated?

Since the goal of our research is the construction of a method, we use the design science approach. This approach seeks to extend the boundaries of human and organizational
capabilities by creating new and innovative artifacts, which can be constructs, models, methods or instantiations [11]. The research steps of the design cycle are illustrated in Figure 1. In the remainder of this section, we will explain each step of the design cycle.

![Figure 1. Design Cycle Steps [19]](image)

A. Awareness

The design cycle begins with realizing a problem, which in this case is the need to conduct research on game production methods in order to improve the Game Production Reference Method.

B. Suggestion

This step comprises the suggestion of an assembly based situational method engineering approach. We follow the following steps: a) carry out case studies to document the different production method at the game companies; b) analyze the production methods and find similarities; c) select similar method fragments and assemble them in new method by using route map configuration to obtain situational methods.

This research answers questions of how and why. Hence, it does not require control of behavioral events and also focuses on contemporary practices of game companies. Therefore, as Yin [24], argues, a case study is the most appropriate research method to use. According to Yin, every case study follows a series of logical steps to achieve its goal. The logical model he proposes includes the following five elements: a study’s questions, its propositions, the unit of analysis, linking the data to the propositions, and the criteria for drawing conclusions from the data. The study proposition is the scope of the research. In this study, the scope is the development of game production methods for specific game genres. The unit of analysis is the game production method of each company that will be included in the case studies. Finally, the data from the interviews are linked to the game genres in order to draw conclusions. For example, if companies that develop casual games follow the same pattern, then the conclusion can be made that this pattern can be an extra route included in the reference method.

C. Development

In the development step, the existing Reference Method for Game Production will be extended. This is done by conducting case studies, analyzing the results, and assembling the new routes. The challenge is to develop a situational method, that is, a method tuned to the situation at hand [10]. In respect to this study, the situations at hand correspond to different game genres or other factors that influence the game production process. The method is tuned to each production case by adding the relevant route to it.

1) Case studies

Two sources of evidence are used to collect data. Interviews were the main source of data and after each interview the company respondent was asked to provide company documentation. For the purposes of the interview an open-ended questionnaire that has three parts is constructed. The first part includes contextual questions, the second tests the game categorization and the last part aims at validating and extending the existing method by collecting data concerning the production method of each company.

A total of nine case studies were conducted. All the companies that participated are based in the Netherlands and some of them are internationally oriented. Out of the nine companies that participated six develop educational games. Out of these six companies three develop real world simulations, two define their games as management and construction games and two develop serious games.

2) Method engineering approach

We use a method engineering approach [6] [13] for the analysis and comparison of the existing method and for the assembly of the new situational methods. Method engineering is the discipline that designs, constructs and adapts methods, tools and techniques for the development of information systems [6]. During the case studies, we select similar method fragments that exist in multiple methods and assemble them in order to build a situation-specific method. These situation-specific extensions will be added to the existing Reference Method for Game Production in the form of extra routes.

Our method engineering approach is supported by the meta-modeling technique, in which Process Deliverable Diagrams (PDDs) are being developed [20]. PDDs simplify the storage and comparison of methods and therefore are an ideal solution to synthesize the case study evidence. The left-hand side of the PDDs describes the activities executed, which means the steps taken in order to complete an action, while the right-hand side of the PDDs describes the deliverables of the activities. Dotted arrows are used to indicate which deliverables are created or adjusted in the corresponding activities. In Figure 2, the typical structure of a PDD is
illustrated. Figure 4 shows a real example of a PDD that was developed during this research.

![Process-deliverable diagram](Figure 2)

Figure 2. Process-deliverable diagram

Some unique adjustments to the standard UML notation [14] in both the activity diagram side and class diagram side have been made. The first adjustment is the use of unordered activities, which do not have a predefined order. In Figure 1, Activity 2 is illustrated as containing three sub activities. Sub activity 4 is sequential and Sub activity 5 and Sub activity 6 are unordered. The other adjustment is the use of standard, open and closed activities and deliverables. A standard activity or deliverable has no further sub activities or deliverables. On the other hand, both open and closed activities and deliverables can be decomposed in other activities and deliverables. The ‘open’ construct is used when all sub activities or deliverables are expanded and elaborated on. The ‘closed’ construct is used when its contents are not known or not relevant in the specific context. More information on this meta-modeling technique can be found in van de Weerd and Brinkkemper [20].

After the data collection and meta-modeling, the new method is assembled. The most appropriate method fragments from each case study are combined to represent a specific situation. For each situation a route is constructed. After a company selects a route, the route should remain static; this means that the production steps cannot change [21].

D. Evaluation

We validated the existing Reference Method for Game Production during the interviews. The respondents evaluated the activities and concepts of the method, they compared them to their own method, and they provided suggestions for further improvement.

We would like to address the issue of validity and reliability. Table I presents the actions taken during this research in order to address the issues of validity and reliability. During the data collection phase a chain of evidence was followed as presented in Figure 1. Moreover, an attempt was made to collect different sources of evidence.

<table>
<thead>
<tr>
<th>Validity</th>
<th>Action taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use multiple sources of evidence</td>
<td>Interviews and company documentation were the two sources of evidence.</td>
</tr>
<tr>
<td>Establish chain of evidence</td>
<td>There is a logical sequence from the research question to data collection and analysis and to the conclusions.</td>
</tr>
<tr>
<td>Apply cross-case synthesis</td>
<td>Tables that compare activities and deliverables are created.</td>
</tr>
<tr>
<td>Use replication logic</td>
<td>If companies who develop similar games follow the same pattern then a route will be defined.</td>
</tr>
<tr>
<td>Use case study protocol</td>
<td>A protocol was used.</td>
</tr>
</tbody>
</table>

In order to analyze the evidence collected, cross-case synthesis is performed [24]. Cross-case synthesis is a technique used to analyze data collected from multiple case studies. Tables that include the results of the case studies are created and compared in order to identify cross-case patterns. The data from each case study are captured in the form of PDDs and where used to create tables that compare activities and concepts (section III).

E. Conclusion

Finally, the conclusions are presented. During the process, we gained operation and goal knowledge [19], which leads to suggestion for further research. We describe the conclusions and further research in section V.

III. RESULTS

In this section, we provide an overview of the results of our research. First, we describe the four routes that are added to the Reference Method for Game Production. Then, we elaborate on one of the routes, namely the serious games route. Finally, we describe the knowledge infrastructure which is used to make the reference method accessible for anyone interested in game production.

A. The Reference Method for Game Production

Even in the small sample of the nine companies, common method fragments exist; identical processes and deliverables that support the assembly of specific routes based on these similarities. This section provides arguments and describes the selection of method fragments and the creation of the different routes.

One of the results of this research was the game categorization that served as a tool to group companies based on the games they developed and also helped in the identification of other factors such as the target audience and how these factors influence the production of a game. And
indeed the grouping of companies that target the serious market initiated the development of the serious games route.

We created two routes that correspond directly with the found game genres in our categorization [1]. These are the **serious games route** and the **online games route**. Furthermore, we identified a route for companies that follow an agile development method using **prototypes** and a route for companies that focus on the **localization** of games. In Figure 3, a high-level overview is depicted of the reference method, containing the four extra routes.

1) **Serious games route**

First of all, common concepts were identified in the methods of the five companies that develop serious games. As expected, the Concept Phase includes a number of new concepts and activities that are not included in the existing method. The new main activity that is added to the method is marked in blue. The sun activities are not expanded, but will be elaborated on in section III-C. The reason underlying the inclusion of this main activity is that the game concept should be defined in this phase and has to satisfy the customer needs and the educational or training character of the game. Therefore this phase consumes a great amount of time for these companies.

2) **Online games route**

The companies that develop online games focus on the Post-Production Phase since they have to update the game code and provide after sales support to the players. Common activities and deliverables were identified between the five companies that participated in the case studies that develop online games and therefore the online games route was added to the Reference Method for Game Production. The main activities for the online game route are illustrated in red.

Apart from the game genres, we found that other factors are also influencing the production process. Such factors are e.g. time, budget, and customer requirements. Companies need to continuously update game elements depending on customer needs; moreover technology advancements and the unstable economies force businesses to adopt an iterative development method. Therefore, we added two extra routes which are not based on game genres, but on other factors.

3) **Prototype route**

The third route is the prototype route, which describes an agile method where game features are developed in steps. Depending on project needs a company can develop an extensive prototype that contains the essence of a game (then the main activity ‘Build Prototype’ is added in the Production Phase) or a short prototype to be used for brainstorming with the client (in this case, the Define Game Concept activity is slightly adapted). The extra prototype activities are marked in yellow.

Figure 3. High level method overview
4) Localization route

Finally, we identified the localization route. Production differences exist between companies who localize their games and companies who don’t and thus the localization route is created to represent this production case. The main distinction is that companies who localize their games perform quality assurance tests after localization while other companies test and debug their games during the Production Phase. The localization activities are marked in green.

B. The serious games production route

In the next few paragraphs, the common activities and deliverables of the companies that develop serious games are described and depicted in Figure 4. It is important to note that the method comparison is primarily based on the common deliverables because deliverables were easier than activities to compare. The reason underlying this fact is that many activities deliver more than one concept and some new deliverables result from activities that already exist in the standard route of the method.

Figure 4. Serious Games routemap in the Concept Phase
Since this route only deviates from the standard route in the Concept phase, we only show this phase. On the left side of the diagram we can observe the activities of this phase and on the right side the deliverable(s) of each activity.

The serious games route is added to the Concept Phase of the method because, as can be expected, in the Concept Phase a number of new concepts and activities that are not included in the existing method are identified. The reason underlying this fact is that the game concept should be defined in this phase and has to satisfy the customer needs and the educational or training character of the game. Therefore this phase consumes a great amount of time for these companies.

The production of serious games, according to the case study informants, has a consulting character since specific learning objectives should be included in the game. Members of the project team should understand the client requests, and then specify the game goal, game mechanics, game context and game ideas in order to discuss and evaluate them with the client during the next activity. In Figure 4 we can observe the first three activities of the serious route and the above mentioned deliverables.

Two crucial activities that consume time during serious game production are the development of the knowledge model and the consulting of experts. The knowledge model represents the knowledge objectives and fragments that have to be included in the game. Moreover, experts are consulted when developing the GAME CONCEPT and the GAME CONTEXT of a serious game. On the right side of Figure 4 we can see how the knowledge model and the experts influence the game concept development.

Two of the participating companies create a detailed planning of the game at this stage. Moreover GAME CONTEXT and GLOBAL PLANNING are common deliverables of the participating companies. Finally USBILITY TESTS are performed but at a later stage. When the client approves the concept, both parties agree on the TIMEFRAME and the BUDGET and then the CONTRACT is signed. Table II and Table III present the concepts and activities introduced by the companies that develop serious games; next to them we can see in how many methods they were present.

### TABLE III. ACTIVITIES OF SERIOUS ROUTE

<table>
<thead>
<tr>
<th>New Activities</th>
<th>Identified in: Number of Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create Global Planning</td>
<td>2</td>
</tr>
<tr>
<td>Have Brainstorm Session</td>
<td>1</td>
</tr>
<tr>
<td>Sign Contract</td>
<td>2</td>
</tr>
<tr>
<td>Create Game Synopsis</td>
<td>1</td>
</tr>
<tr>
<td>Consult Domain Experts</td>
<td>2</td>
</tr>
</tbody>
</table>

C. Public knowledge infrastructure

Currently, a website that contains the results of this study is being developed\(^2\). This website includes the four phases of the method and the four routes identified. Companies will be able to access the website and inspect the phases of the method, the deliverables and the activities. Each deliverable of the method such as GAME CONTENT, for example, will be described in detail and provided with a template, example and best practices. This makes it possible for companies to actually follow a formal method, inspect the completeness of their method and improve their process.

IV. DISCUSSION

The final phase of the design cycle is the presentation of the conclusions and further actions that need to be done. The conclusions of a research might indicate one or more new problems to be solved [18]. During the evaluation of the results many ideas for further improvement came to surface.

The number of companies that participated in the research is small compared to the genres of the categorization. This is a limitation of the research since there was not a significant number of companies that develop a specific game type. On the other hand, this same fact has a positive influence since many production methods were collected. Future research could focus on game production methods for specific genres, such as console, serious etc. This way the method will be applicable to more production cases and the routes will be richer and will reflect more development methods.

The respondents were asked to provide feedback regarding the correctness of the modeling of their methods before proceeding to the evaluation and conclusion phase of the research cycle. Three participants responded to this request and therefore the feedback results were not as expected. Nevertheless the three companies that replied didn’t identify major problems in the diagrams since during the interview the analysis of each method was extensive.

Documentation of company methods is confidential and most respondents were not willing to share it. Nevertheless two of them provided company documents with the description of their methods. This is a fact that influences the results, since such documents could provide us with more deliverables and activities, and also increase the validity of the results.

\(^2\) [http://people.cs.uu.nl/weerd/gameproduction/](http://people.cs.uu.nl/weerd/gameproduction/)
V. CONCLUSION AND FUTURE RESEARCH

In this paper, we presented the development of a situational Reference Method for Game Production. We validated the existing reference method, and extended it with four situational routes for serious games, online games, prototypes and localization. Finally, we developed a website that opens the Reference Method for Game Production to a broad audience.

In the future, the Reference Method for Game Production can be improved in several ways. Firstly, we need more case studies to validate and the method. Also, these case studies can be used to add more routes to the method, for example a Console route. Finally, the website should be filled with templates and best practices, in order to become a useful knowledge infrastructure.

REFERENCES