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ACCESSIBILITY, REUSABILITY AND INTEROPERABILITY IN THE EUROPEAN SERIOUS GAME COMMUNITY

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Abstract: *Reuse and repurposing are two of the most basic software concepts. They are powerful practices that can deliver significant improvements in software productivity and quality, as well as substantially lower software development and maintenance costs. Unfortunately, few serious gaming research entities have been able to capitalize on the tremendous benefits that reuse and repurposing offer. The rapid growth of the serious game research community in the EU has set the stage for a large diversity in serious gaming scientific research in terms of the application domains (military, health, business, engineering), scientific disciplines (psychology, computer science, social science), and development solutions. It is often argued that the large growth has created a problematically fragmented serious gaming community. The fragmentation makes it difficult to maximize contributions and successes, avoid overlap, enable resource reuse, as well as harmonized development efforts through interoperability. Questions remain regarding the demographics and outcomes of this polymorphous research community. By answering these questions, fragmentation can be reduced and synergy can emerge. Moreover, by knowing the status quo, the serious gaming research community's development can be analysed over time. The EU has tried to reduce the fragmentation in the serious gaming community by funding the Game and Learning Alliance (GALA) Network of Excellence. The GALA tasks included the establishment of a Technical Committee on Interoperability and Semantics, and of the European Academy of Serious Games (SG Academy), a web-based social networking website that enables EU serious gaming researchers, students, teachers and professionals to collaboratively build and share knowledge of serious gaming. In this paper, the authors build upon the expertise of this community to answer the following questions: What is the reusability and interoperability potential of existing serious games (SG)? Are information, software components, and SGs easily accessible? How many SGs have been developed through European funding? How many of these SGs are available online? How many are open source? How many require a user account? For what languages are these games available? What are the most common topics games are developed for? This research aims to enable the adoption of accessibility, reusability and interoperability principles within the SG community, as well as to support the development of the next generation of serious game researchers and developers.*

Keywords: *serious games, research community, research fragmentation, reuse, interoperability*

I.   INTRODUCTION

The need to enable accessibility and sustainable SG development and implementation [1], corroborated with the significant growth of the serious games (SG) community calls for new levels of resourcefulness that would address specific needs, would decrease fragmentation and would enable advanced opportunities by fostering transparency, dissemination, collaboration, reusability and interoperability. To achieve these goals, there are considerable challenges to overcome, both at a technical and a community level.

On one hand, SG development represents a complex process that involves many factors with a high optimization potential. Reusability and interoperability are two such factors that can have a positive impact upon development, if applied properly [2]. The Digital Agenda for Europe (COM(2010) 245) also emphasises the issues of fragmented digital markets and the lack of interoperability [3]. Educational technology standards (Sharable Content Object Reference Model - SCORM, Tin Can API), as well as reusability and interoperability solutions have tried to provide optimization patterns, but failed to reach their full potential, mainly because they have addressed particular issues and not an integrated perspective [4], [5], [6].

On the other hand, the fragmentation residing within the SG community has increased over the years. Funding opportunities at the European Union level have facilitated the development of a significant number of projects that targeted games with an educational purpose. Coupled with national programs and private initiatives, the spectrum of SG research and development has expanded notably over recent decades, paving the road for new initiatives, but also for information overload and inefficiency.

There has been some progress in tracking EU initiatives and projects - CORDIS, the Community Research and Development Information Service [7]; Eve Platform, the electronic platform for the dissemination and exploitation of results of projects supported by programmes managed by the European Commission in the fields of Education, Training, Culture, Youth and Citizenship [8] -; however, these do not permit an in-depth analysis of the experiments, extended accessibility to project outcomes and implementation of reusability and interoperability solutions. Therefore, the value of valid resources is employed only in part because dissemination efforts usually fail to reach extensive horizons, and are rarely exported and reused outside the project consortiums. Current databases developed at European level serve mostly for information purposes, but they do not provide consistent insights of the entirety of a project, as the centralized project profiles are usually incomplete and offer only basic information. The fragmentation and the overlaps in the SG community partly derive from the fact that there are no mechanisms, recommendations or specifications that facilitate cross-project collaborations in terms of reusability and interoperability. The negative effects of these facts translate into higher costs, inefficiency and overlaps.

This research has emerged from the necessity to understand if and how reusability and interoperability are applied in practice within the SG community; how can SG researchers and developers access timely, accurate information on SG projects, enabling them to enhance their performance and collaborative efforts, as well as their ability to implement reusability and interoperability solutions? The authors aimed to provide answers to questions such as: *What is the reusability and interoperability potential of existing serious games (SG)? Are information, software components, and SGs easily accessible? How many SGs have been developed through European funding? How many of these SGs are available online? How many are open source? How many require a user account? For what languages are these games available? What are the most common topics games are developed for?*

To address these research questions, the authors have created an index of SG projects funded at European level, with the purpose of identifying specific SG project information and resources that would provide validated answers to the above research questions and would enable the extraction of solid recommendations for the SG community in terms of reusability and interoperability. This research is a joint action initiated by the Technical Committee on Interoperability and Semantics (TC2.5) and the European Academy of Serious Games (SG Academy), part of the EU funded Game and Learning Alliance (GALA) Network of Excellence that supports the adoption of standards and interoperability principles within the current and potential future SG community.

II.   CHAPTER II

When addressing SG reusability and interoperability, it is important to consider not only the challenges related to technical factors, but also the role of the SG community. The domains targeted by the serious games community and the interconnections that are built are increasingly diverse, which make outcomes harder to manage and exploit [9]. The European Union provides funding for a broad range of projects through a preset of programs. The lists of beneficiaries of EU funding has grown extensively, making it difficult for specialized communities to access timely, relevant information and knowledge.

2.1   Reusability and interoperability at technical level

The success of SG development relies on the effective utilization of resources [10], [11]. In this context, reusability and interoperability emerge as critical factors. As consumers of cutting-edge gaming technologies and platforms, SGs are ideally placed to benefit from the convergence of these technologies leading to increased interoperability. The emergence of authoring tools enables access to game development for people without advanced ICT skills. One major issue that occurs is the lack of reusable SG components and of interoperability [2].

Software reuse is considered to be contingent on the following general provisions [11]:

- A measure of independence between the processes of asset development and asset use;
- A systematic process that governs the production, storage, a retrieval of reusable assets;
- A cognizance of the form of the reusable asset; and
- The retrieved assets should be used as part of a development process.

The benefits of software reuse can be summarized into three categories [12], [13]:

- Increased productivity: by reusing existing SG assets, the development of the game requires less manpower.
- Increased quality: when a component is developed for reuse, one can rationalize large investments in its quality, on the premise that these investments will be amortized over its multiple uses; and when a reusable component is used by a larger community, it gets debugged more thoroughly.
- Optimization of the development schedule: the reuse of SG assets saves not only manpower, but also reduces the development schedule in terms of months. This translates into shorter time to market, which may in turn mean a bigger market share.

Each SG addresses different requirements and is implemented in various environments; therefore interoperability solutions have to be customized and tailored to specific needs. The development process needs to be adapted for each specific situation that a SG implies. Each SG is different: different budget, schedule, scope, and risk profile. Each development team is different: different sets of skills, capabilities, and experience. Every organization is different: a different value chain operating in a different market.

These situations require different interoperability solutions that range from technical to non-technical profiles. Moreover, they highlight the fact that a "one size fits all" development methodology does not work. But where exactly does interoperability steps in? How can interoperability solutions be applied efficiently?

To obtain sustainable results, it is important to identify and analyse the interoperability opportunities that occur during the development process of a SG. By modelling the workflow of a SG development lifecycle as a value stream and then creating an interoperability tracking and visualization system, interoperability opportunities can be identified, analysed, customised and implemented. Such a system has to rely on an extensive mapping of interoperable SG assets that present best practices, and details the strengths and weaknesses of each case scenario. In order to optimize SG interoperability solutions, it is necessary to have access to timely information and resources.

2.2   Swimming in the Digital Sea

The Web is a powerful tool. Researchers can now search, sort, and filter SG projects to find the resources they need. As advances in information technology and communication supply us with information at an ever accelerating rate, our ability to manage this information becomes more and more stretched [14].

In today's information-driven economy, the ability to efficiently find, critically analyze, and intelligently use reliable information and resources is vital for efficiency, profit and advancement of research and development. However, the massive exposition to this critical valuable resource called information leads to information overload and its detrimental effects.

The development of the Internet quickened the pace at which information could be transmitted and received, and the advent of Web 2.0 went even further. As an example, a simple Google search for "serious games" results in over 462,000,000 hits. The searcher is then left to sift through all the results to find the desired information. While some forms of information and communication technologies provide solutions for information overload, for example through the use of search engines and gatekeepers, enhanced solutions need to be sought and applied.

The general openness of the Web's communication poses a problem for all information seekers, who face the task of looking for valuable facts in a vast sea of information. To add to the problem, much of the information that constantly surrounds today's information seeker comes from limited or unreliable sources [15].

The information on web sites and in databases is fragmented and, at times, contradictory. The mix of messages is difficult to sort through and is dependent on which site one visits and when [16].

While some may contend that there is no such thing as too much information per se, what does exist without question is an inability to manage the flow of information so that people can easily find what they are looking for and not feel overwhelmed. Information overload affects productivity, reduces our capacity to absorb and learn, as well as our capacity to innovate [17].

The usefulness and efficiency of the Web landscape depend on the ability of communities to efficiently distillate information and facilitate access to valuable resources. The role of communities in managing information has become central. People have come together in alliances that have improved education, human rights, business ethics, and many other areas of public and private life. Community organizing, building the power of a group to change the world, is both an art and a science. Bringing groups of people into effective community organization takes skills and attention to many details and dynamics at the same time. It takes understanding of how groups work, why people join them, how to structure them, how to set goals, and rules, how to develop values and how to move people to action. Community groups can provide the intelligence needed to solve problems. A community that focuses the resources and the energies and intelligence of many people who are close to the problem has the chance to actually solve problems [18].

2.3   Serious Game Projects: the case of reusability and interoperability

Under these premises, the authors have analysed the activity and the outcomes of the SG community, in order to identify opportunities for reusability and interoperability. Several online sources have been used to collect the data: online databases (CORDIS; EVE); project websites; reports issued by funding authorities; internet searches; and compendium.

Although there are several databases available online, there is no unified perspective of the SG research and development funded at European and national level. The information available is usually incomplete and does not support extensive analyses. The information provided in the online profiles of the funded projects is insufficient. To fill in the missing information the authors have conducted in depth searches by accessing project websites, and other documents that contained details on the projects that have been funded in the SG area through different programmes. There is no accurate evidence of the SGs that can be accessed online, or on the open source games. Therefore, researchers and developers find it hard to identify games that address topics that are of interest for them, and open resources are not always accessible to developers.

To evaluate the reusability and interoperability potential of SGs, the researchers have carried out a preliminary research to identify projects that targeted games. 1605 projects have been identified

using CORDIS, and 100 projects have been identified using the Eve platform. Out of these, 50 projects have been evaluated until now. The analysis has included the following project data: project title; start and end year; project website; total cost in EUR; funder; source(s) of information; project objectives; project outcomes; and project consortium. Special attention has been given to project outcomes. Researchers aimed to identify if the project outcomes have included (digital, non-digital) SGs or other resources with reusability or interoperability potential, and in what languages these games are available. This paper focuses on project outcomes with reusability potential.

35 out of 50 projects have developed at least one serious game. Out of the 35 SGs, 32 games were digital and 3 non-digital. 11 SG projects have developed other resources with reusability and interoperability potential, such as software components, model, design patterns, frameworks, etc., while 4 SG projects out of 50 had outcomes that do not relate directly to reusability and interoperability. Only one game out of 50 was open source, 11 were freeware, and 5 were under development.

The main topics that these SGs have targeted were languages; culture; history; geography; health; manufacturing; security; training; entrepreneurship; etc. 12 of the games where available in English, while only 6 of the games were available in more than 3 languages. Other languages that have been identified were: Bulgarian, Dutch, Estonian, French, Finnish, German, Greek, Hungarian, Latvian, Irish, Italian, Polish, Portuguese, Russian, Spanish, Slovenian, and Turkish.
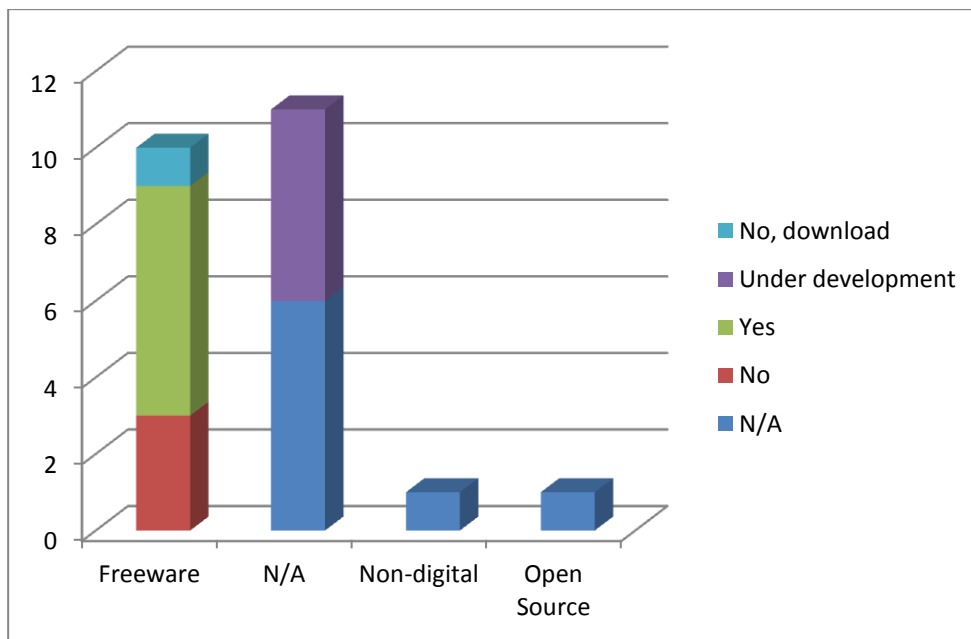

Figure 1. Number of SG by license type and availability

Out of the 10 freeware SGs, 6 games require online registration, 3 are accessible online without registration, and one is downloadable. In addition, we have identified only one SG that is open source. As shown in Figure 1, information on game license and availability are scares. Details on the SGs were not accessible on the SG project profiles registered in the online databases that have been used for this study. The authors had to conduct extensive researches to identify further information on the SG projects they were evaluating and their related SGs.

III.   Conclusions

This initiative aims not only to support bridging the gap between research and industry in the serious games field, but also between research and research, by enabling joint efforts, avoiding overlaps, and promoting sustainable advancement of the domain, based on accessibility, reusability and interoperability solutions.

Results have shown that in order to scale up accessibility, reusability and interoperability in the SG community at international level, there is an urgent need to increase the awareness, understanding and availability of these solutions among key potential users in academia and businesses and policy makers, who are either looking to apply them to their own production systems, through their supply chains, or as screens to determine their engagement.

Further questions to be addresses are: Which scientific research institutions within the EU are involved in serious gaming research? What long-term (min. 1-year) publicly/privately funded research projects have been carried out over the period 2002-2012 among these research institutions? What scientific publications (authored/edited books and journal articles) have been published as a result of these research projects?

Efforts will continue in the future in order to provide a unified vision of reusability and interoperability opportunities in the SG community. The authors aim to facilitate the development of general recommendations and specifications that will be fundamental in SG development and implementation within national and EU projects, with the purpose of enabling gains in productivity, costs, time and quality.

Acknowledgements

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