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Using Games Technology for Concept & Design Validation
of Local Health Care System in Cameroon
Featured Paper   by Joseph Kossmann & Mario Kossmann

Using Games Technology for the Concept and Design Validation of a Local Health Care System in Cameroon[1]

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Abstract

All complex projects are potentially full of challenges; yet charitable, i.e. not for profit, international development projects often have increased burdens in terms of the geographical distance between the various stakeholders of the project; cultural, national and legal boundaries including multiple languages; uncertainty regarding the available budget and resources throughout the project life cycle, including the availability of volunteers; as well as lack of the usual infrastructure in terms of electricity, roads or telecommunications if the project is at least partially carried out in developing countries. This paper looks at the use of Games Technology (GT), including modelling and simulation methods and tools, in order to enhance and shorten technical project activities such as concept development and validation, design development and validation, as well as awareness and fundraising activities that are needed to secure the necessary project funding. Using the example of the 'Mahola' project, which is concerned with the development of a local health care system in a deprived area of Cameroon, it is shown how GT was effectively and efficiently used to support the concept and design phases of the project.

Introduction

All complex projects are potentially full of challenges. However, there are arguably some typical challenges that are particularly characteristic of charitable (not for profit), international development projects. These challenges stem from multiple factors that influence the successful outcome of such projects. Some of the key factors are the geographical distance between the various stakeholders of the project; cultural, national and legal boundaries including multiple languages; uncertainty regarding the available budget and resources throughout the project life cycle; as well as lack of the usual infrastructure in terms of electricity, roads or telecommunications if the project is also carried out in developing countries.

As a result, communications may become more difficult and prone to misunderstandings; the project schedule and/or the actual scope of the project tend to be relatively volatile to accommodate for the changes in the available budget and especially resources, i.e. volunteers; and the effective handover of the project outcomes to the beneficiaries of these outcomes may be difficult. In short, such projects will frequently have to cope with the fact that everything takes longer and is more difficult; and the fact that the resources working on the project are usually volunteers and will only have limited time to work on the project.

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One way to tackle these challenges within the usual constraints of such projects is to optimize the project activities so that only those activities that are really necessary to achieve the successful completion of the project will be carried out by the project team members, while cutting out any waste in terms of non-value added work. In other words, this can be achieved by carefully simplifying all project activities and the related documentation to the necessary minimum, while continuously monitoring the associated risks.

This paper looks at the use of Games Technology (GT), in particular state-of-the-art modelling and simulation methods and tools, in order to enhance and shorten technical project activities such as concept development and validation, design development and validation, as well as awareness and fundraising activities that are needed to secure the necessary project funding.

Games Technology, also known as game studies or ludology, primarily focuses on the technical processes of creating engaging multimedia entertainment, from anything as small as smartphone apps to anything as large as massive computer experiences. It is a relatively young field in its current state, only getting actual academic attention at the turn of the millennium, but one publication really pushed the study of games into the forefront of academia and that was 'Rules of Play: Game Design Fundamentals' written by Katie Salen and Eric Zimmerman (2004) [1]. This book outlines not which specific tools to use to make the next greatest hit, but rather discusses the socio-political and human statements games and their creators have, as well as how they affect them and their players, solidifying the validity of the study as a whole. As can be gleamed from what has been mentioned, games technology has ties to several other disciplines and studies, such as sociology and psychology.

In the present day the teaching of games technology is often accompanied by a myriad of tools, most of them software. 3DS-Max [2], for example, is a commercial 3D graphics programme developed by Autodesk Inc. and is designed for making models of objects, individuals and anything else, as well as animating them. It has been used in video games and movies, as well as for conceptualisation in general. An alternative tool for this purpose is 'blender' [3] by the Blender Foundation. Unlike 3DS-Max, blender is an open source tool that can be used free of charge, it is less complex and therefore very popular amongst amateurs.

Once a model is made, be it a building or a car, it can imported into any number of game physics engines, such as the Unity engine [4], created by Unity Technologies, in order to be placed into a scene, where it can be interacted with by the player, or it can be the player itself, or it may just populate the in-game world that was created. Other tools exist in the market, each having their pros and cons of course.

GT seems to be particularly suited to such charity projects as described above, because the associated tools allow relatively (compared to professional 3D design tools) quick and flexible modelling and simulation of anticipated physical outcomes of the project, so that even complex technical details can be visualised and communicated to stakeholders and experts for advice, or other feedback. This is argued to enhance both the quality of the project outcomes and the sense of ownership by those who are involved. Furthermore, this considerably contributes to reducing the time and costs needed for the development and validation of both the concept and design of

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these outcomes. In addition to that, the created models and visualisations can be re-used to effectively and efficiently support the awareness and fundraising activities of the project.

The paper will look at the main objectives of using GT for an example charitable, international development project, namely the 'Mahola' (Aid) project [5, 6], which is still on-going at the time of writing this paper and is concerned with the development of a local health care system in a deprived area of Cameroon. Then we will explore in detail how GT has been used to support the concept and design phases of the project, focusing on the relevant method and tool aspects.

Objectives of using Games Technology for the Mahola project

In light of the above, the main objectives of using GT for the Mahola project were related to (1) saving time and cost; while (2) improving the quality of the resulting technical outcomes of the project; and (3) being able to visualise in a sophisticated manner these technical project outcomes very early in the project so that potential supporters could be shown what the project is about and how it anticipates to solve the identified local problems and needs.

Figure 1 provides a simplified view on the Project Management, Awareness & Fundraising, and Systems Engineering activities of the Mahola project, over time from the start of exploration to the project closure and beyond. The project management activities here include the usual planning, budgeting, risk and opportunity management, monitoring and control, information management etc.; whereas the awareness & fundraising activities include the planning and management of events, talks, fairs, concerts, publications and the internet presence of the project.

The Systems Engineering activities are displayed in more detail and in phases that are roughly aligned with the INCOSE Systems Engineering Handbook [7] and the ISO 15288 [8]:

- Concept phase;
- Design phase;
- Implementation & Integration phase;
- Transition & Validation phase.

The 'Concept' phase here corresponds to the following technical processes [7, 8]: Business or mission analysis process, stakeholder needs and requirements definition process, system requirements definition process, and architecture definition process. The 'Design' phase corresponds to the design definition process and the system analysis process. The 'Implementation & Integration' phase represents the implementation process, the integration process and the verification process. This verification process is understood here to be split into two parts, one as part of the design definition process (verifying that all design requirements have been met) and one as part of the integration process (verifying that the actual physical outcomes of the project meet the specified system requirements). And finally, the 'Transition and Validation' phase corresponds to the transition process and the validation process; the latter being about validating that the developed system, when put in its intended context, satisfies the real needs of its users and other stakeholders.

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GT has especially been used to support the Concept and Design phases (in terms of both development and validation of the concept and the design respectively); as well as the awareness & fundraising activities of the project by re-using the created digital models and simulations in order to better visualise to interested people what the project is about and what it aims to achieve.
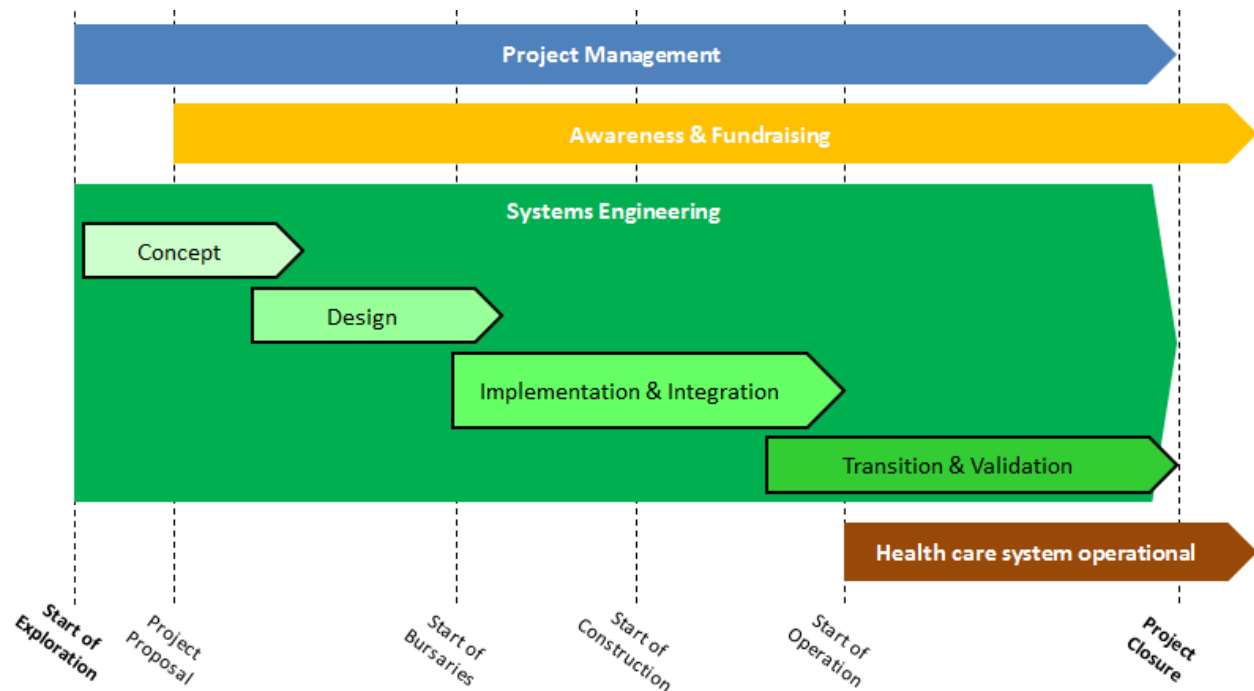

Figure 1: Project Management, Awareness & Fundraising and
Systems Engineering activities of the Mahola Project

At the time of writing this paper, the Mahola project moved towards the end of the design phase, hence the focus on the contributions of GT to the Concept and Design phases, rather than on contributions to later stages of the project. However, it is anticipated that the use of GT will continue to greatly enhance the project during these subsequent stages, as well as for Awareness & Fundraising purposes. The following sections will provide more details on how the use of GT has supported the technical project activities of both the concept and design phases of the 'Mahola' project.

Supporting the Concept Phase

Based on the established project needs some early conceptual design decisions had to be made regarding the elements of the local health care system, which in turn had an influence on the structure and content of the initial system requirements, including the requirements for the modular building of the health centre. A number of iterations followed during which both the system requirements and the conceptual design evolved in parallel until a stable state was reached that could be analysed in detail and presented to the project stakeholders and relevant

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domain experts (from different fields, such as construction and medical) for discussion and validation.

All of these activities could be greatly enhanced by the 'quick and dirty' modelling of the conceptual ideas, enabled by the use of GT tooling, even increasingly so towards the validation of the system requirements and the conceptual design at the end of the concept phase of the project. The communication of the technical consequences of these system requirements – in terms of the conceptual design representing part of the solution to the requirements – was greatly facilitated because it made it easier for the relevant stakeholders and domain experts to visualise and thereby comprehend the proposed ideas, which enabled them to give the necessary feedback.

Figure 2 displays one screenshot from the blender tool's graphical user interface (left hand side [2]) that depicts the simplified model of a multi-purpose room of the modular building of the health centre; and one screenshot from the unity tool's graphical user interface (right hand side [3]) that provides a view of the site where the modular building will be built. Details regarding the immediate environment of the building site include different types of local vegetation such as trees, bushes and grass. The picture also shows that the place for the foundations of the health centre has been prepared by removing the excess earth that will later be replaced by a reinforced concrete slab.
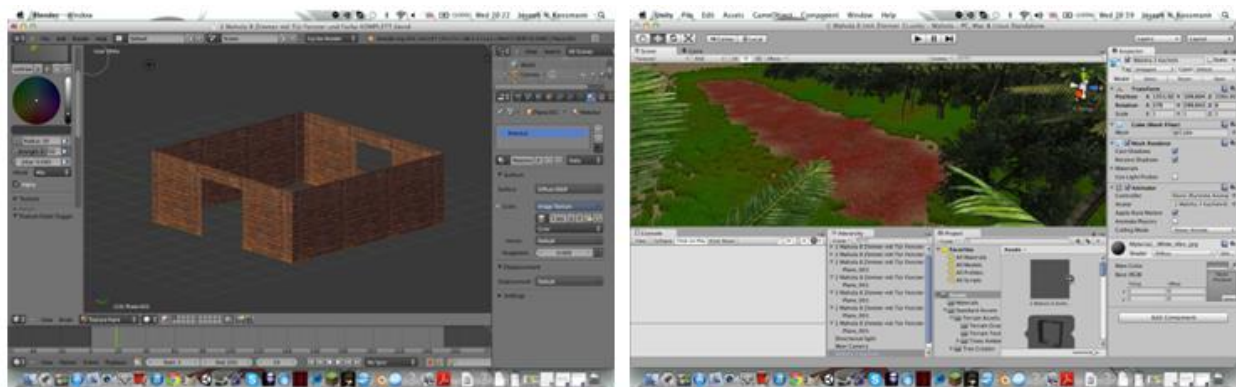

Figure 2: Modelling in blender (left) [2] and unity (right) [3]

Figure 3 provides three screenshots of the integrated rendered conceptual model of the health centre including solar panels, people and the immediate environment (above); the ambulance parked in the patient off-loading area of the health centre (bottom left); and the prepared ground of the site showing the place for the modular building's concrete foundations and a hole for one of the two cess pools of the health centre. The screenshots for Figure 3 were taken from unity [3].

These early models of aspects of the anticipated health centre could be discussed with members of the local population, to give them an early impression of the concepts developed, and receive their feedback. This for example helped to identify the most appropriate size of the health centre and secure a suitable location. Also, they were discussed with members of the medical profession such as General Practitioners and Nurses in order to have first feedback regarding the layout of

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the health centre. For example the locations of the wet room, the patient off-loading area, the reception with triage area and the emergency treatment room could be determined this way.

Figure 3: Elements of the health centre with ambulance (modelled in blender) integrated into the local environment (modelled in unity) (Screenshots from unity [3])

Supporting the Design Phase

Based on the validated system requirements and the conceptual design of the local health care system including the health centre, the detailed design had to be created that will enable the procurement of needed equipment, materials, components and supplies, as well as the step-by-step assembly of the health centre. This detailed design would have traditionally been produced by means of 2-dimensional technical drawings, which take a relatively long time to create and they do not visualise detailed components in a flexible and 3-dimensionally movable fashion.

Using a suitable GT modelling tool, it was possible to model all major components efficiently in sufficient detail to allow the creation of detailed building instructions, identify and describe necessary implementation and integration steps, record associated assumptions and conduct design verification activities against the validated system requirements. Finally, the detailed design could be presented to the different project stakeholders and relevant domain experts for discussion and validation. All the above activities were greatly enhanced by the still efficient but now much more detailed modelling of the design. The created 3-dimensional models allowed

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visualisation of the design in a way that tremendously enhanced its analysis, verification and validation.

Figure 4 shows the overall layout of the health centre with the modular building, the combined utility housing and the waste and recycling housing; as well as details of the related water distribution network, cess pools, pathways and the rooms of the modular building. The rooms of the modular building from left to rights are the reception and triage room, the medical treatment room, three patient rooms for up to 6 patients each, one staff room, and one wet room with four showers and four rainwater fed toilets. Each room of the modular building has one sink with running drinking water. 'Black' sewage water from the toilets is led to one maintainable cess pool; 'grey' sewage water from the sinks and showers is led to another cess pool. Figure 4 was created by using the standard MS Office software PowerPoint [9].
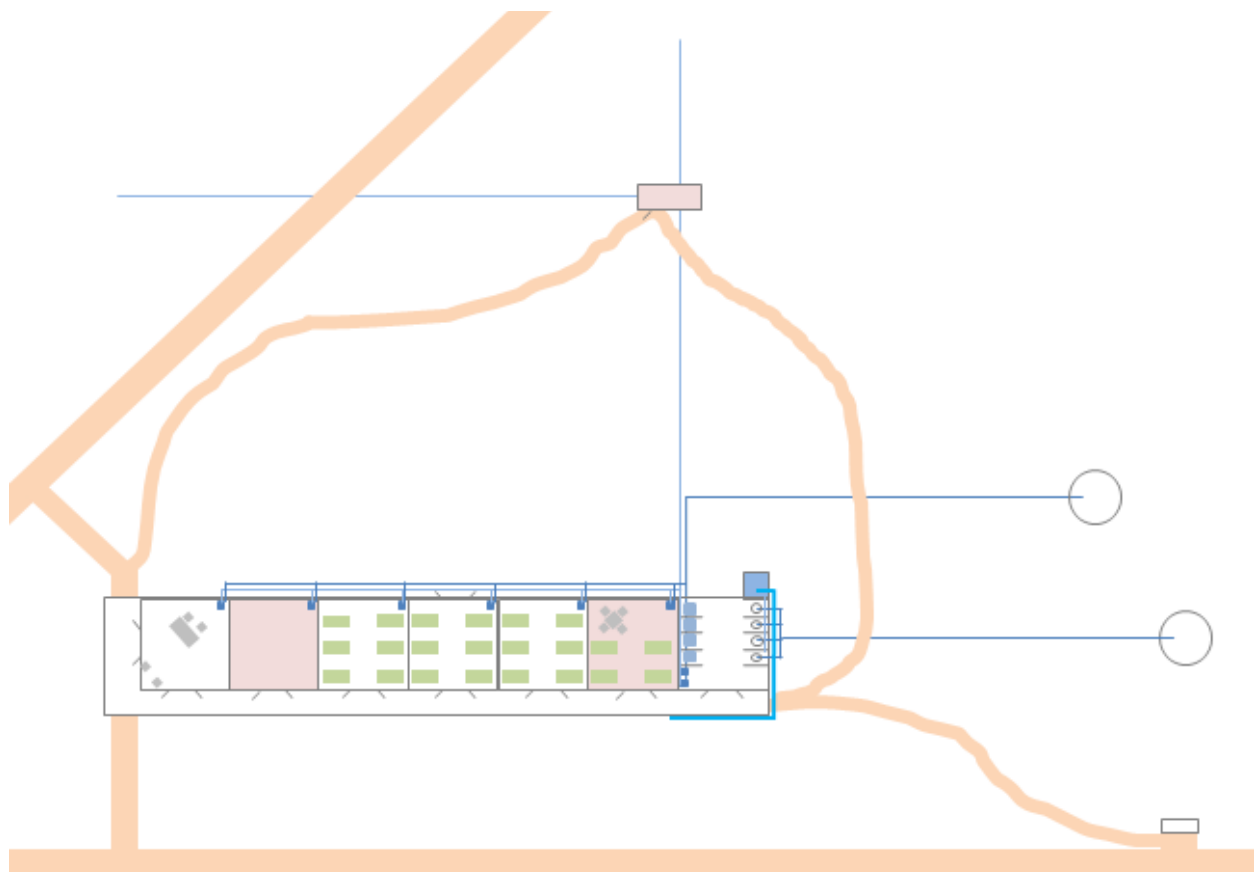

Figure 4: Overall layout of the health centre (screenshot from [9])

The layout shown in Figure 4 was discussed with members of the local population and the land that had already been made available for the health centre could hence be inspected and measured in more detail to ensure the compatibility of the design with the conditions of the actual plot of land.

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Also, the feasibility of flexible extensions of the health centre as recommended by the World Health Organization in case of an outbreak of viral haemorrhagic fevers such as Ebola could be reviewed and confirmed with relevant medical experts. These extensions include the use of prepared sets of materials and kits to create divided areas that would allow the separation of infected patients from staff (high and low risk areas). Furthermore, the specific requirements in terms of space and drinking water for a nominal number of patients could be identified.

Figure 5 shows the detailed models of one of the maintainable cess pools with sewage pipe, wooden lid and brick structure including climbing steps using additional bricks (left upper and right lower screenshots); as well as two intermediate stages of producing the concrete slab for the foundations of the modular building, showing the preparation of reinforcing rods and metal mesh prior to the pouring of the cement mix (right upper screenshot) and the same during the subsequent pouring of the cement mix (left lower screenshot). The screenshots depicted in Figure 5 were created using the GT modelling tool 3DS-MAX [4].
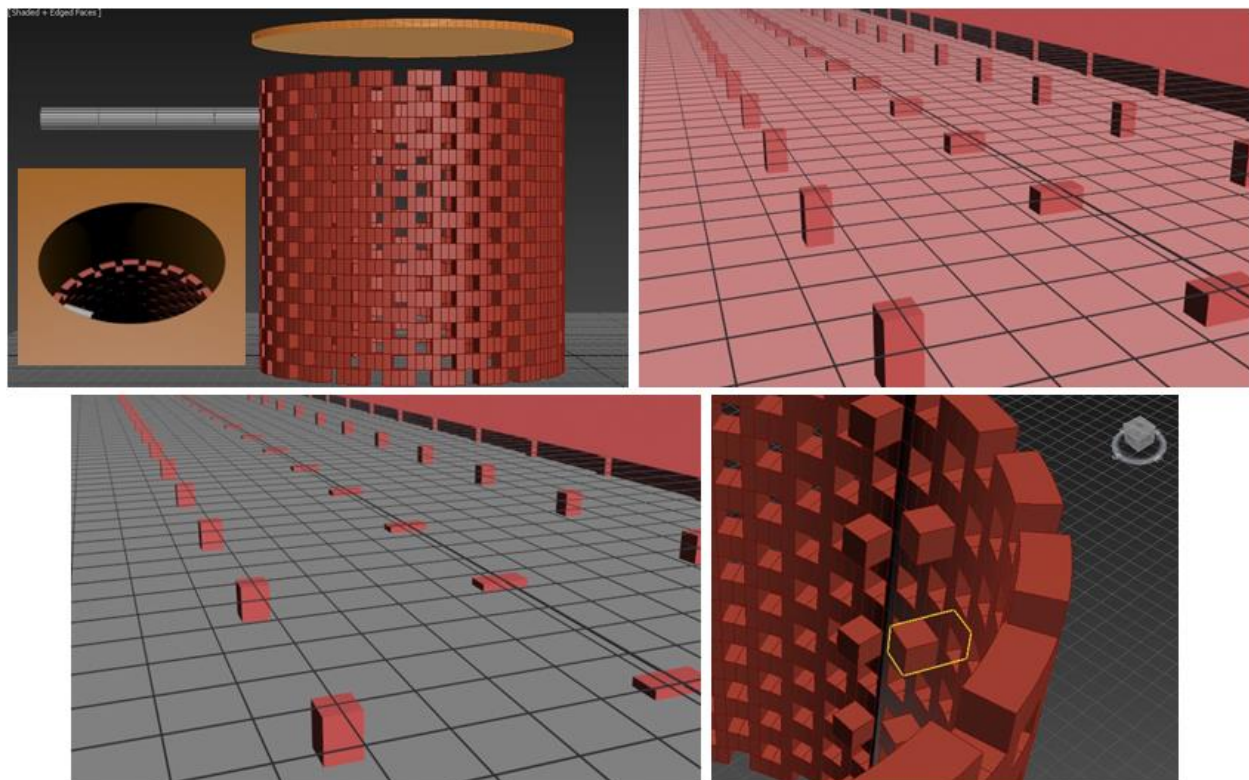
Figure 5: Detailed models of the foundations and cess pools of the health centre
(Screenshots from 3DS-MAX [4])

Although the 3DS-Max tool is a commercial tool – and hence not an obvious choice for a low budget charity project – it was used in the context of the Mahola Project along with the open source blender tool, in order to evaluate and compare both tools.

Design models of the building and the cess pools that were produced using the 3DS-Max tool were discussed with relevant experts from the construction industry in order to validate the design and in some cases discuss alternative solutions. For example, the use of locally produced

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bricks within the structure of the cess pools as climbing support to enable the maintenance of the cess pools (see Figure 5, right lower screenshot) was adopted instead of metal bars, thereby keeping costs and environmental impacts low.

Conclusion

All complex projects are potentially full of challenges. However, there are arguably some typical challenges that are particularly characteristic of charitable (not for profit) international development projects such as the geographical distance between the various stakeholders of the project; cultural, national and legal boundaries including multiple languages; uncertainty regarding the available budget and resources throughout the project life cycle (including very importantly the availability of volunteers); as well as lack of the usual infrastructure in terms of electricity, roads or telecommunications if the project is also carried out in developing countries.

One way to tackle these challenges within the usual constraints of such projects is to optimize the project activities so that only those activities that are really necessary to achieve the successful completion of the project will be carried out by the project team members, while cutting out any waste in terms of non-value added work. This can be achieved by carefully simplifying all project activities and the related documentation to the necessary minimum, while continuously monitoring the associated risks.

This paper looked at the use of Games Technology (GT), in particular state-of-the-art GT modelling and simulation methods and tools, in order to enhance and shorten technical project activities such as concept development and validation, design development and validation, as well as awareness and fundraising activities that are needed to secure the necessary project funding. Using the example of a charitable, international development project, i.e. the 'Mahola' (Aid) project [5, 6], which is concerned with the development of a local health care system in a deprived area of Cameroon, it was shown how GT was used to support the concept and design phases of the project.

GT was found to be particularly suitable to this charity project, because compared to professional 3D design tools the GT tools allowed relatively quick and flexible modelling and simulation of anticipated physical outcomes of the project, so that complex technical details could be visualised and communicated to stakeholders and experts for their feedback. This enhanced both the quality of the project outcomes and the sense of ownership by those who were involved. Furthermore, this considerably contributed to reducing the time and costs needed for the development and validation of both the concept and design of these outcomes. In addition to that, the created models and visualisations could be re-used to effectively and efficiently support the awareness and fundraising activities of the project.

Further research will be helpful in the area of simulation of the actual use of the health care system during the operational phase, using available online computer games or simulation tools. This is anticipated to help optimisation of the system design, deployment and operation; as well as enhancement of on-going awareness and fundraising activities in support of the project and beyond, after the project has been completed, i.e. throughout the life cycle of the health care system.

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Joseph Kossmann is pursuing his academic studies of Games Technology at the University of the West of England, as part of the faculty of 'Creative Technologies'. Having lived in France, Germany and the UK, his academic interests lie amongst other topics in the application of Games Technology aspects to Project Management and Systems Engineering; in particular to the stages of requirements elicitation as well as early concept and design development and validation. He has gained experience in software programming, in particular in C, C++ and Python; as well as digital modelling and simulation with different commercial tools such as blender, 3DS-MAX and Unity. Since 2013, Joseph has been responsible for the Modelling & Simulation Support of the 'Mahola' (Aid) project, which is concerned with the development of a local health care system in a deprived area of Cameroon.

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Dr. Mario Kossmann (ESEP) is an experienced Systems Engineer and Capability Integrator for Airbus, having previously worked for Blohm & Voss as Program Manager, Systems Engineer, Technical Manager and Consultant in Services Marketing. He has served as a naval officer with the German and French navies, and was awarded an MEng in Aerospace Technology from the University of the Federal Armed Forces in Munich (Germany), an MBA from the University of Warwick (UK) and a Ph.D. in Requirements Engineering from the University of the West of England. He is the author of the books *Delivering Excellent Service Quality in Aviation* (Ashgate 2006) and *Requirements Management – How to ensure that you achieve what you need from your projects* (Gower 2013), as well as numerous research publications in the fields of Systems Engineering, Software Engineering and Project Management. Mario is also a certified Project Manager and Expert Systems Engineering Professional. Mario has been involved in the 'Mahola' project as Project Leader and Systems Engineer from the start of the project in December 2012.