G.E.M.I.X.: Game Engine Movie Interaction eXperience

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ABSTRACT

The use of Computer Graphics in the production of movies and Visual Effects is a well-known and established practice in the today industry. Due to the articulated structure of a movie production pipeline, there is a continous need for advanced tools aimed at speeding-up and optimizing the work of each pipeline department. In particular, *previsualization* represents a crucial step of the pipeline, because it helps to visually evaluate the potentiality of a scene before the final production by using an approximated version of its features (models, animations, etc).

In this paper, we describe the design and implementation choices at the basis of G.E.M.I.X. (Game Engine Movie Interaction eXperience), a tool for the interactive production of previsualizations, implemented as an extension of the Unreal 4 game engine. In particular, we have focused our efforts in the analysis and implementation of the visual interface of G.E.M.I.X.. We have adopted a Human-Centered Design approach, collaborating with professionals in the visual effects production, and analyzing their specific needs and requirements, in order to allow a rapid adoption of the G.E.M.I.X. as the main previsualization tool in the production pipeline.

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation (e.g. HCI): User Interfaces

Author Keywords

Previsualization; Human-Centered Design; Game Engine; Movie Production Pipeline

INTRODUCTION

The current state of movie and visual effect production industry sees a massive use of Computer Graphics-based techniques. As a consequence, not only the research on Computer Graphics is particularly active in investigating and proposing novel algorithms and techniques to enhance the quality of the produced renderings and animations, but there is also a constant request for novel tools aimed at supporting an efficient and optimized production of the final contents.

In particular, the role of *previsualization* (also known as *previs* or *previz*) is becoming increasingly crucial in the preproduction stage. A previsualization in today industry is basically a "rough" version of the final, more complex, scene [4]. This preliminary version of the scene is usually used by the production team to analyze and tune its features. For example, a previs can be used to test the efficacy of a particular lighting setup, the placement of actors or objects in the scene, a camera setting and movement, etc. In any case, the final goal of previsualizations is to avoid as much as possible changes to the scenes content in production or post-production stages, thus speeding-up the overall work, and lowering the budget.

With the increasing complexity of today movies and special effects, there is a growing need for flexible tools for previsualization production, allowing the full interactive control of every feature, with the possibility to automatically adjust the overall preview to different levels of approximations. The *game engines* [5] currently used in the video game industry seem to satisfy these technical requirements and to provide most of the desired features for a previsualization tool.

However, a relevant problem is that these environments are not specifically designed for previs production; as a consequence, members of the production team have to face a tough learning curve in order to become proficient in the use of these tools. Therefore, this can reduce the control over the creative process, and, as a consequence, also the final effectiveness of the produced previsualization.

In this paper, we present G.E.M.I.X. (Game Engine Movie Interaction eXperience), a tool for the interactive production of previsualizations, implemented as an extension of the Unreal 4 game engine. G.E.M.I.X. has been designed adopting a Human-Centered Design approach, collaborating with professionals in the visual effects production, and analyzing their specific needs and requirements, in order to propose a previsualization tool characterized not only from a complete set of customization features, but also from an usability based on the users skills, needs and preferences.

The remainder of this paper is organized as follows: in the following sections we will present a brief overview of the state of the art related to the production of previsualizations, and

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then we will present the overall design process of G.E.M.I.X.. Finally, we will draw conclusions and discuss major future developments.

RELATED WORK

If compared to the situation in the production and post-production stages, where several well-established tools, techniques and technologies have been proposed in the last years, it is evident how there is a relevant lack of standardization in the previsualization production field. Indeed, often previsualizations are managed internally at the pre-production department, with ad-hoc approaches and tools.

In analogical productions, previs were usually based on sketches and illustrations, produced and used in relation to the overall storyboarding process. In more recent digital productions, different approaches are adopted. In some cases, previs are produced using standard 3D modeling and animation softwares and a set of preliminary predefined assets. However, this approach requires the presence of a skilled professional (a modeler or an animator), who usually is not involved fulltime at this level of the production pipeline. Some specific commercial softwares for previsualization have been proposed: in some cases, they allow to produce a more advanced version of 2D storyboards, based on animated sequences of digital drawings with audio and sound. Other tools allow the production of rough 3D scenes by selecting assets from a set of predefined models and textures, and setting up animations at different levels of sophistication. However, these tools often limit the possibilities in the customization of the previsualization features, and are characterized by interfaces comparable to other typical 3D animation softwares, thus not easily accessible to not-experts in 3D content production.

Some academic researches have been proposed to investigate different solutions and aspects related to the production of previsualizations. In some cases [13, 6], the goal was to propose some level of standardization in the process, to achieve an efficient interoperability between different production tools and among pre-production and production departments. Other works [12, 14] have investigated instead the potentiality of currently available high-level video game engines as tools for the efficient production of previsualizations. The influence of cinematography on video game production is not a novelty, from both thematic and technical point of view. A well-known example is the use of *cutscenes*, used to break gameplay in order to show not-interactive moments like e.g., conversations, effects of a player's action, etc. These short animations usually follows conventions taken from movie production, and were generated in the past using the same tools and techniques. In the last years, due to the continuous growth of the computational power of graphics cards, real-time rendering has seen a relevant enhancement, such to allow the use of the same rendering engine for both gameplay and cutscenes. As a consequence, current game engines like Unity and Unreal Engine provide specific tools to create and manage both interactive than offline animations.

G.E.M.I.X. DESIGN AND IMPLEMENTATION

While most of the works considering high-level game engines for the production of previsualization address mainly technical aspects, less efforts have been given to address the *usability* of these systems.

In this paper, we describe the design and implementation choices at the basis of G.E.M.I.X. (Game Engine Movie Interaction eXperience), a tool for the interactive production of previsualizations. G.E.M.I.X. has been designed not only considering how to adapt or to integrate the production tools available in the game engines from a low-level development point of view, but mainly focusing on a Human-Centered Design (HCD) approach [9, 18, 7] in the overall design of the whole production environment. To this aim, we have collaborated with *EDI - Effetti Digitali Italiani* [1], an Italian company with almost 20 years of experience in the production of visual effects for cinematography and commercials. EDI staff has expressed in the last years interest in the integration of technologies and techniques from different fields (video game, Virtual Reality) in the production pipeline. In particular, EDI has decided to radically change the current pre-production pipeline, by adopting a game-engine based previsualization as close as possible to the actual needs of the professionals involved in this process, and with a particular focus on a high level of usability. To this aim, in collaboration with EDI staff, we have structured the design process of G.E.M.I.X. following the HCD principles [7, 3, 2] as resumed in Figure 1.

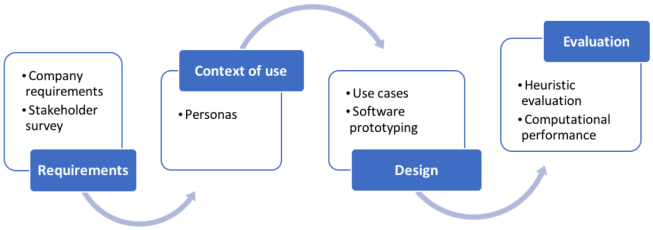


Figure 1. G.E.M.I.X. design process

G.E.M.I.X. requirements

The first stage of the design of G.E.M.I.X. has been the analysis of EDI requirements, and the understandings of the needs of the professionals involved in the pre-production stage. This process was based at first with meetings with EDI managers and staff, to discuss about the goals and requirements of the overall project. At the end of this briefings session, a detailed Project Charter document was produced. Then, several stakeholders have been asked to fill out a survey regarding the G.E.M.I.X. project. Using the survey, the goal was to collect separately the personal vision of different professionals involved with different roles in the project. The survey has been structured with a common section to be proposed to all the stakeholders, related to general comments and opinions on the overall G.E.M.I.X. project, followed by a section specifically prepared for different kinds of stakeholders. Professionals directly involved in the pre-visualization process were asked to discuss about the current setup in previs production, and about the decisions taken to choose the

[1] https://www.effettidigitali.it/en/

technology and tools to adopt, while professionals involved in production stage were asked to discuss about the interoperation between pre-production and production stages, and to express their opinion on the current previsualization setup used in EDI. Finally, managers were asked to fill out a dedicated section related to the strategies and goals for the future of the company.

Once collected all the surveys, a detailed list of the requirements and goals of EDI about the G.E.M.I.X. project has been defined. We resume the main points:

- Adoption of a game engine as the main environment for interactive previs production
- Achievement of a high visual realism still maintaining real-time interaction with the previs features
- High interoperation between differen production departments, through the possibility to import, visualize, and modify 3D assets of various standard formats, already available and used in the production stage
- Possibility to create, personalize and animate all the features of 3D human models
- Possibility to automatically create large outdoor environments, with full control over the morphology of the terrain and its features, and with illumination based on daytime
- Full control of the virtual camera settings and movements
- Possibility to export the previs as an animation
- The adoption of a high-usable and high-intuitive visual interface, in order to make the tool and its features easily understandable also to the stakeholders directly involved in previs production, usually not suited to 3D assets production softwares

G.E.M.I.X. context of use

On the basis of the analysis of the company requirements, and of the professionals involved in the design and production of previsualizations, we have decided to better define the final stakeholders of G.E.M.I.X. before the beginning of the actual design of the application. We have decided to adopt the *personas* approach [11], in order to identify a small set of potential target users of a previsualization tool.: the *film director*, the *director of Photography*, the *previs artist*, and the *scenographer*. In Table 1 we present a very synthetized resume of the main details of each persona.

G.E.M.I.X. design

After the conclusions of the activities described in the previous sections, we had all the necessary informations in order to begin with the design and development of a first prototype of G.E.M.I.X..

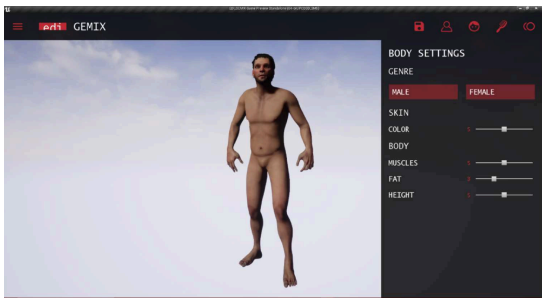
First of all, we have evaluated the currently available game engines, in order to select the most appropriate for the inclusion of the needed functionalities. We have decided to use Unreal Engine as the basis for the implementation of G.E.M.I.X., because of the very realistic level of rendering quality, and for the availability of an advanced multi-track editor (the *Sequencer Editor*) providing specific tools for the production and preview of cinematic sequences in real-time, which is one of the requirements indicated by EDI. Due to the strict constraints imposed by Unreal Engine related to the extension of its features, it was not possible to develop G.E.M.I.X. as a stand-alone application; rather, it has been implemented as an application to be run inside Unreal Engine. Regarding the production features required by EDI, the adopted approach was to develop only the tools not already provided by Unreal Engine, and to collect together those already present, but providing an alternative and intuitive visual interface designed specifically for the identified personas. At the end of the prototyping process, G.E.M.I.X. was composed by four main modules, each dedicated to specific functions, which will be described in the following subsections.

Model Viewer

The Model Viewer module is used to visualize one of the 3D models placed in the previs scene, and to modify its characteristics and material. Moreover, it allows to import a model created with an external 3D modelers, or from a database of available assets.

Character Creator

The Character Creator allows to create and customize a 3D model of a human character, to be animated and placed inside the previs scene. The editor (Figure 2(a)) allows to modify in an intuitive way several characteristics of the model, like e.g., height, hair color, or the amount of body muscles (Figures 2(b) and 2(c)). Moreover, it is possible to load previously modified models, and to apply further customizations.



(a)

(b) (c)

Figure 2. The Character Creator (Figure 2(a)) allows to customize a 3D model of a human character. Figures 2(b) and 2(c) show the results of different settings of the *Muscles* parameter

Persona	Role	Behaviour	To include in G.E.M.I.X.	To avoid in G.E.M.I.X.
Film Director	• To decide the content of each scene and of the whole movie	• Impatient • She wants her work to be recognized • She trusts her staff	• Choice among different scenes/locations • Predefined models of humans • Production of effective previsualizations	• To lose time with irrelevant details • Slowness in the production of the final result
Director of Photography	• To set up lights • To collaborate with the scenographer to design the scene • To set up the framing	• Perfectionist • She surrounds herself with people who support her artistic talent • She loves experimenting with framing	• Presets of customizable lights • Full control of camera movements and shooting parameters	• Not-customizable tools • Simulated lighting not close to reality
Previs artist	• To set up the scene for previsualization • To visually communicate the film director's ideas	• Very aware of production times • She exploits her artistic background to undestand the film director's needs • She is skilled with 3D production tools	• Easily accessible production tools • Possibility to customize the production process	• Limited flexibility of the software GUI • Differences from standard movie production pipeline
Scenographer	• To design a scene and its features on the basis of the film director's needs • To coordinate the other staff members responsible for the scene preparation	• She follows her own personal aesthetic taste • She has different artistic skills	• A database of different models • Freedom to place objects • Customization of object materials	• Limited customization of materials • Not-realistic preview of objects

Table 1. Main characteristics of the identified personas

Level Editor

The Level Editor is the more sophisticated module implemented for G.E.M.I.X.. It allows the automatic generation of an outdoor terrain to be used as the main environment for the previsualization. This module applies techniques from the *Procedural Content Generation (PCG)* [1] field in order to create a complex scenario controlled by a limited set of parameters, like e.g., dimension, roughness, etc. The adoption of a PCG-based approach allows several future extensions of the Level Editor: in fact, PCG is applied in different fields of Computer Graphics, like e.g., the automatic generation of buildings and cities [16, 17], or of game levels for platform games [15, 8]. Once generated, the morphology of the procedural terrain can be further modified by the generation of roads (Figures 3(a)), or the application of a *Sculpting tool* (Figure 3(b)). Moreover, models and characters generated with the Model Viewer and Character Creator modules can be loaded inside the environment.

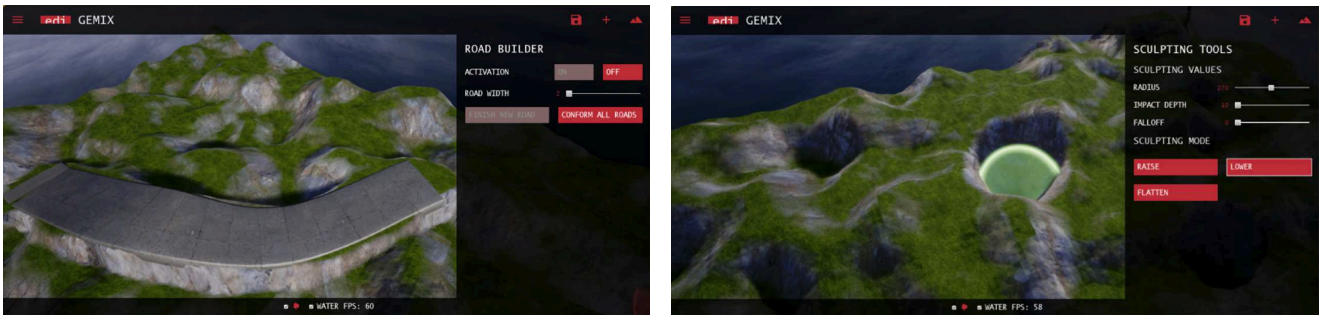
Cinematic Level

Once the previs scene and models have been created and tuned, the Cinematic Level gives to the user specific tools to set up the camera settings and movements, using parameters and techniques directly inspired by cinematography. The user can then "register" the previsualization, apply post-processing, and export it as a movie. The main idea at the basis of the Cinematic Level is to give to the user a feedback as close as possible to the real cinematography experience, from both the technical than visual point of view.

G.E.M.I.X. evaluation

We have then focused our attention on the evaluation and finalization of the visual interface, whose usability and easiness to use were two of the most important requirements indicated by EDI.

We have implemented a first wireframe version of the visual interface, and we have conducted a Nielsen's heuristic evalu-



(a) (b)

Figure 3. The Level Editor allows the procedural generation of a terrain as the main scene for the previsualization. It is possible to modify the scene by generating roads (Figure 3(a)), or sculpting the morphology of the terrain (Figure 3(b)).

ation [10] with usability experts. A total of 36 violations of the heuristics were detected, in particular in the Level Editor and Cinematic Level modules. Figure 4 shows a graph of the violations of the Nielsen's heuristics.

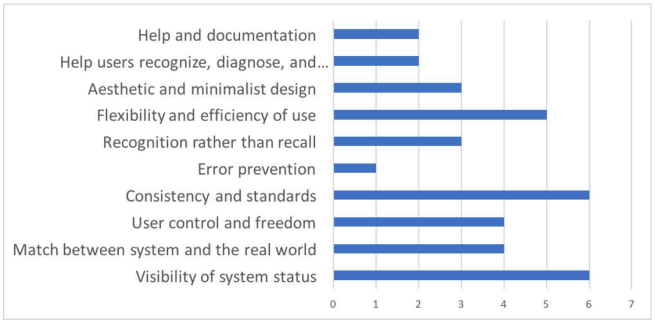


Figure 4. Violations of the Nielsen's heuristics of the first prototype of G.E.M.I.X. visual interface.

The evaluation has led to a clear identification of strengths and weaknesses of the visual interface of G.E.M.I.X.:

- Strenghts:
  - Good level of attractiveness
  - Coherent distribution of functionalities
  - Easiness of navigation
- Weaknesses:
  - No coherence in the layout of some sections
  - Difficult reachability of some sections
  - Sporadic problems with terminology
  - Lack of accelerators to speed up the interaction

We have proceeded to revise the visual interface, with particular attention to correct the issues in the two more problematic modules. We have performed a second heuristic evaluation, which had a positive result. The last step was to finalize the visual interface with a visual identity based on the EDI logo. Figures 2, 3 and 5 show the final visual interface of G.E.M.I.X.

EDI is currently using G.E.M.I.X. in some selected projects, and a further evaluation stage will be performed as soon as relevant data could be collected.

CONCLUSIONS AND FUTURE WORK

In this paper, we have presented the design and implementation details of a tool for the production of previsualizations based on Human-Centered Design approach. G.E.M.I.X. has been developed as an extension of a currently available game engine, in collaboration with an Italian company (*EDI - Effetti Digitali Italiani*) with almost 20 years of experience in the production of visual effects. The goal of the project was to achieve an innovative tool characterized not only from a high flexibility in the interactive generation of the previs scene with a high level of visual realism, but also on the accurate design of a usable and intuitive visual interface, in order to make it easily understandable to previs professionals with limited skills in 3D assets production.

The final version of G.E.M.I.X. is currently used in EDI, after an iterative process of validation of its visual interface. In the future, we plan a second evaluation stage, based on the opinion and comments from EDI professionals after the adoption of G.E.M.I.X. as main tool for previs production.

Future extensions of G.E.M.I.X. functionalities are possible, like e.g., the integration of procedural tool to generate other environments (cities, indoors environments), and the support for Virtual Reality visualization devices, due to the growing interest in the production of immersive movies.

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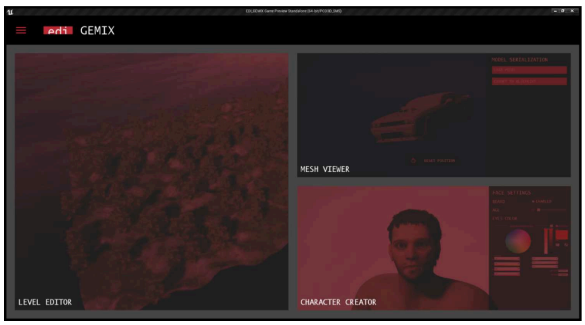

Figure 5. G.E.M.I.X. main menu

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