Class of experience: a high level approach to support content experts for the authoring of 3D environments

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ABSTRACT
In spite of the evolution of computer graphics in recent years, the production of 3D environments still reflects an old situation: 3D modelers are often deputed to the whole construction of the 3D interactive worlds, even if in many cases the focus of 3D worlds is not simply on geometry and demands the specific contribution of experts belonging to different areas. This doesn’t permit a full exploitation of the new 3D interactive media potentialities. We propose a new approach to the production of 3D interactive environments, based on the concept of class of experience and on the re-definition of the role of authors.

The aim of this approach is to give content experts a chance to be an active part of the 3D world creation process and to stimulate the reuse of 3D building work.

The approach is described in the frame of applications for cultural heritage, and is exemplified with VRML multimedia presentations built by one of the authors for the exhibitions of Palazzo Grassi in Venice, Italy. They demonstrate that this approach enables content experts to produce significant 3D experiences collaborating with a pool of computer scientists, but without knowing the peculiarities of the implementation language and low level implementation details.

Keywords: 3D worlds, authoring, class of experience, cultural heritage

INTRODUCTION
The computer graphics domain has deeply evolved in recent years. In the past, the main research topics were rendering algorithms to simulate reality and issues related to low-level representation of the scene, aiming to find the best way to describe the 3D scene according to the maximization of the hardware potentialities [2].

Today, low-level modeling and rendering are solved problems: advances in hardware allow users to explore 3D scenes in real time; this has radically changed the approach to 3D graphics, enlarging the issues related to 3D representation; in particular this new situation has led computer human interface specialists to study the issues related to interaction in 3D scenes [3].

In spite of this evolution the production of 3D environments often reflects an old model: 3D modelers are often still deputed to the whole construction of the 3D interactive worlds, while in many cases 3D worlds demand the specific contribution of specific content experts belonging to different areas. Unfortunately in many cases these experts are relegated to the role of external consultants, a situation that does not permit to exploit the new 3D interactive media.
The current 3D scene production model

Figure 1 outlines the current life cycle for the production of interactive worlds, highlighting the roles of the subjects involved. We base our discussion on desktop 3D interaction in VRML-based virtual worlds. The choice of VRML derives from the open standard and interoperability requisites of this language and from the availability of a number of tools and run-time engines which allows developers to test rapidly all the phases of the development process.

- The vendor implements a 3D browser for general use, according to VRML specification; since VRML leaves a number of features open, the vendor implements also a number of interface artifacts to perform basic actions such as moving, rotating, flying and so on.
- The author/world builder has a key role in the whole process: he/she manipulates the 3D geometry and defines the interactive behaviors, following the VRML specification and the technical specifications given by the vendors that have implemented the 3D browsers.
- The final user interacts in the 3D world using the artifacts implemented by the vendor and by the author/world builder.

Even if this method has permitted the production of complex interactive 3D worlds, several drawbacks prevent a full exploitation of this new media.

- The author/world builder is directly responsible for designing the interaction model; the content expert, not evidenced in Figure 1, gives his/her contribution filtered through the technical sensibility of the 3D modeler, without having a direct control of the process of content organization.
- Elements assembling is not modular, since the world builder uses a number of specialized tools that requires a deep technical knowledge to manipulate the 3D primitives and the interaction. Often the building process requires iterations among these tools; in general it is not possible to give different contributions to the building process using interfaces tailored to the

![Figure 1. The life cycle for authoring 3D worlds](image-url)
skills of the content experts.

- Besides, the absence of modularity originates 3D worlds which are not easily reusable by other authors because of the complex low level relations between the various components of the interactive environment.

- For what concerns VMRL, we may notice that this language offers only low-level constructs for representing interaction [1]. Even to build a simple scene, a number of low level constructs must be used together in an organized way. Available VRML tools for the development of interactive worlds are characterized by a one-to-one representation of low-level interaction objects. These visual representations are a valid help to understand the relations between the VRML components of the interactive scene. However, people who don’t have a deep knowledge of the low level mechanisms of VRML can’t use them.

What we need is wrapping the low level notions of VRML nodes, allowing authors to use a language directly related to their area of interest. This prevents the proposal of any universal language for this task. We feel that it would be more appropriate to suggest a new methodology for helping content experts to author 3D worlds.

A DIFFERENT PERSPECTIVE: DEFINING CLASSES OF EXPERIENCE

We use the term interactive 3D experience to define the result of the authoring process. This concept emphasizes that the key point of a 3D simulation often it is not only the represented geometry, but the whole simulation. This is similar to what happens in the real world, where the geometry of buildings and places is in many circumstances only the scene where humans live different experiences, like participating to a political debate, buying flowers at the weekly market, meeting friends and so on.

The organization of experiences in classes is the main focus of our approach: we believe that standardization offers significant advantages over ad-hoc definition of specialized experiences. More specifically, with the concept of class of experience we denote a typology of interactive experience general enough that can be used as a template. For example, we may define the class Visiting a museum to be subsequently specialized by authors with particular guided tours, different architectures for the museum building, different artworks to be shown, still having the same basic interaction mechanisms, e.g. same walk modalities, artwork description perspectives, tour management options, and so on.

The purpose of defining these classes is to give a high level metaphor that can be easily understood by the authors and by the final users. The tools for authors and final users built according to this approach are based on this concept, as next section will show in more detail. Besides, the concept of class of experience favor modularity and code re-use.

From the final user's point of view, the concept of class of experience helps to smooth the learning curve of 3D worlds: users are presented the same interactive objects for performing the same typology of behaviors in different instances of the same class.

A revised life cycle of 3D interaction design

The starting point of our proposal is a more appropriate definition of subjects involved in the 3D interactive scene production, evidencing the necessity to integrate a wider number of skills; this
definition includes a substantial re-formulation of the concept of author, considered as an intermediate category between the final user and the world builder, who speaks the technical language of his/her domain, but who is not necessarily skilled in the fine-grained language of interaction.

Figure 2 shows a revised life cycle of the 3D interaction design. The life cycle starts with the discussion of the contents of the 3D world and ends with the final user interaction.

- **Conceptual design.** This phase is characterized by the identification of the content and of the interaction requests, in order to build a conceptual scheme for the author and the final user interfaces. A new subject, the meta-author, interprets the main role of this phase; this subject must have a deep knowledge of the contents domain and didactic skills too. The meta-author interacts with the interface designer (the technical counterpart in this phase) to take advantage of the current interaction technology.

The conceptual phase has, as a result, the production of user interfaces (UI) schemes for defining classes of interactive experiences, for example the class *Guided tours in a museum*. UI schemes are produced both for the final users and for the authors, who instantiate the classes of experience.

- **Tool implementation.** The interface designer, who has a deep knowledge of low-level interaction mechanisms, builds the author and the final user interfaces on the basis of the UI schemes produced by the meta-author. The results of this phase are available as tools for the authors who want to build interactive experiences belonging to the specific implemented class.

- **Content development.** Authors are the main protagonists of the third phase; they choose

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**Figure 2. The new life cycle for authoring 3D worlds**

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among the available classes of interactive experiences and instantiate the one that fits their particular needs. They take advantage of the skills of a number of complementary subjects to build the interactive experience.

- **Final user interaction.** The final user interacts with the contents of the 3D world composed by the author, through the interface implemented by the interface designer.

## AN EXAMPLE OF CLASS OF EXPERIENCE: GUIDED TOURS FOR CULTURAL HERITAGE

To clarify the concepts expressed in the previous section we describe here a particular class of experience, *Guided tours for cultural heritage applications*, commenting the tasks performed by the various actors along the whole process. This class has been defined after some interactive experiences designed by one of the authors [6] for Palazzo Grassi, a cultural institution in Venice, Italy, that in recent years has hosted several important exhibitions accompanied by virtual tours in 3D worlds related to the exhibitions’ themes.

### Conceptual design

The meta-author discussed with the interaction designer the current state of art of technology, In this reciprocal information exchange the interaction designer received information about the kind of content and education techniques of the meta-author. Reciprocally, the meta-author received a complete information about the interactive features offered by VRML language that best fit his/her needs for the development of guided tours.

In order to have a wider contribution for the definition of the interface schemes, we chose to write a first formulation of the interaction problem. This description was then given to a number of testers, splitting in this case the responsibility and the point of view of the meta-author for the definition of this crucial passage. The meta-author was then given the task to unify in an unique proposal all the different points of view.

The interaction problem related to the class *Guided tours for cultural heritage applications* was formulated in the following terms:

*Your task is to prepare a guided tour in a virtual exhibition of some kind for students. You have to illustrate the architectonic features of the environment and the features of the other objects that will be shown at the exhibition.*

*The user will start the tour from a given location and advance step by step to a sequence of ordered key locations to visit; he/she can go on and turn back to the previous location, and can reach the beginning and the end of the tour directly, e.g. by clicking over start and end buttons. The user can also move without constrains using four directions of navigation (onward, backward, right, left).*

*Entering specific locations can automatically activate sounds, spoken comments, animation sequences and information pages. Clicking over selected objects belonging to the scene, the user can play sounds and animations or display information pages.*
The testers were given a certain amount of time to perform the task; they were asked to list in a written form the verbal sentences they would have used to describe the actions related to the guided tour, as if they should describe their point of view to a computer science technician (the interaction designer) for implementation.


Besides, some visual schemes on paper were drawn by the meta-author to have a first rough visualization of the interfaces for the final user and for the author.

**Tool implementation**

The written sentences and the paper schemes were then used by the interaction designer for the implementation. These basic materials were analyzed in order to establish consistency between

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**Figure 3 – A screen shot from the author interface**
the features of the interfaces for the user and for the author. Then the interface designer imple-
mented the user interface and the author interface.

Figure 3 illustrates the author interface. For clarity it is not presented like a blank template, as
produced by the interface designer, but it is filled with the contents belonging to a particular in-
stance of experience, the Einstein Tower guided tour that replicates one of the experiences de-
sign for Palazzo Grassi in Venice during the exhibition on German Expressionism [8].

The screen of the author interface is divided into three main parts. The upper left side is reserved
to the visualization of the 3D model characterizing the 3D experience. The author can navigate
the model using the four directional buttons. All the other navigation possibilities (fly, scroll
head, tilt, etc.) given by general purpose VRML browsers were inhibited because they appeared
not useful for this class of experience; in addition they proved to be confusing in the final user
interface for the novice users.

The lower left side visualizes the two typologies of interaction available for the author: the or-
ganization of the path as a sequence of views and the activation of objects (active objects) belong-
ing to the scene. For what concerns the composition of the tour, the author can store the current
3D view as an element belonging to the tour and subsequently re-arrange the chosen views. For
what concerns the active objects, the author can select any object belonging to the 3D scene just
clicking over the 3D window.

The right side visualizes the properties of the elements listed on the left lower side. For what con-
cerns the views, the author may associate sounds, animations or textual information to each of
them from a library created on the basis of the suggestions provided before by the meta-author.
This additional information will be automatically activated in the final user environment each
time the related view is selected. For what concerns the active objects the author may associate
sounds, animations and texts to any object belonging to this category; this information will be
automatically activated in the final user environment each time the user selects the object.

Content development
The author interface resulting from the implementation phase was at this point filled with content
to create the Einstein Tower guided tour: the 3D model of the building, texts and iconography
were used as raw materials to simulate the application of the new methodology.

The simplified interaction mechanisms provided by the author interface were proficiently used by
the authors, who found implemented here the interaction modalities described in the first phase
(conceptual phase) by the meta-author in the form of verbal action and visual schemes on paper.

The prototype demonstrated to be suitable to produce experiences similar to those ones produced
before with the old methodology. This is an important result: in particular the key point is that
using the interface resulting from the proposed methodology a new class of authors (as previously
defined) was enabled to produce significant 3D experiences collaborating with a pool of com-
puter science experts and other collaborators, but without knowing the peculiarities of VRML
language and low level implementation details.

Final user interaction
The production of experiences similar to those obtained in previous implementations for the ex-
hibitions of Palazzo Grassi which did not use this approach produced, not surprisingly, similar
user feedback. We registered additional benefits in terms of simplification of navigation and
augmented the usability for the concurrent use of visual and audio information and hypertext.
It is important to notice why the availability of these tools should take additional benefits even for final users: the definition of classes of experiences and the definition of a unified interface for each class gives users a standardized way to interact in order to perform similar tasks, not only in terms of look and feel but, mainly, in terms of actions to be performed and expected behaviors.

**A FURTHER STEP: MULTI-AUTHORED WORLDS AND REUSABILITY**

The testing phase described above gave us a confirmation of the advantages of our approach, therefore we performed an additional step towards *reusability*. If this approach allows re-using the templates produced by meta-authors for different experiences, it would be interesting to use the same 3D models to implement different experiences on the same geometric base.

The main reason for this extension is that the production of 3D models for interactive worlds is a time consuming activity that in a significant number of cases could be re-used for different purposes, similarly to what happens for real places; a public square can be used for a variety of events, ranging from musical happenings, flower markets, political conferences and so on.

The orientation of our approach towards authors helps extensibility towards this new typology of worlds, which we may call *multi-authored*. In fact, if we examine the structure of the worlds built by following our approach, we can consider them as composed by two main components:

- the *base world*, composed by the 3D static part of the simulation and by the dynamic parts that are not subjected to the author’s control, and

- the *experience layer*, composed by the work of the author.

Experience layers are built using the available classes in the repository; different experiences are then superimposed as layers to the basic structure of the 3D world.

It is therefore possible to derive experience layers for different worlds from the same class. The simple modularization offered by our approach gives the chance to shift smoothly towards *multi-authoring*: the higher-level component (i.e., the experience) can be changed without affecting the functionalities of the base world. The experience layer may be then modeled from the same class or even from different classes of experiences.

**The experience switches**

To successfully re-use the base world for different experiences, we need one more condition: the introduction of a class of new artifacts in the 3D scene that we call *experience switches*, to allow the final user to switch between experiences.

Figure 4 represents the structure of worlds according to this view: each base world has one or more experience layers superimposed and available in different times. Shifts between different experiences are performed by the final user interaction with the *experience switches*.

**A multi-authored world: The Newton Cenotaph**

We do not elaborate further on this issue in this paper: the reader is referred to [7] for a deeper discussion on multi-authored worlds. We present here only a summary of another experience built for the *Cosmos* exhibition at Palazzo Grassi, which charted the most important itineraries and the most significant stages in man’s effort to discover, represent and evoke space, nature, landscapes, the sky, the universe. In this occasion we built for the official exhibition Web site a virtual world based on the *Newton Cenotaph*, an ideal building conceived, but never built because of technical difficulties, by Louis Etienne Boullée in 1715 as a homage to this great scientist.
We felt that the simulation of a tour through this building would have been an exciting opportunity for the visitor of the site. We modeled the Cenotaph on the basis of the few paper drawings available and used it as the scene for an exhibition composed by a selection of objects belonging to the real exhibition. Part of the exhibition materials are placed in front of the Cenotaph and on the various squares of the building. Figure 5a shows a screen shot from the guided tour.

Palazzo Grassi organized, in the context of the exhibition, a poetry appointment characterized by the reading of verses related to the theme of the exhibition. This event took place on a small church near Palazzo Grassi and was transmitted over the web using streaming technologies. We felt that in this case the strength of verse reading could have been empowered by the integration in a scenario, the Cenotaph itself, characterized by the same fascination and sense of mystery that pervaded the verses. So we built an experimental 3D world where the Newton Cenotaph had the role of a significant architectonic counterpart of the themes expressed by poetry.

The final user interface in this case permitted the user to wander through the significant places of the Cenotaph that were adorned with the live streamed images and sounds coming from the real event place.

Figure 5b shows a screen shot from this live experience, built on the same base world shown in Figure 5a. The panels used before for the works of art and the nude walls of the Cenotaph are here adorned with live video. The video stream is transmitted in different places of the building; this feature allows users to wander through space without loosing video and audio contact with the live experience, that they can appreciate from different points of the building.

![Figure 4. Multi-authored worlds](image-url)
The implementations of the Newton Cenotaph were very useful to test the advantages of the approach based on components and the feasibility to implement the scene switching mechanism, giving us a confirmation of the usefulness of our multi-authored extension.

In the recent history of interactive media too much emphasis has often been made on the technological side, even assigning to computer science technicians the role of experts in domains not belonging to their experience. Our position is that a new range of subjects must be more involved in 3D environments, taking advantage of the 3D media without being constrained by low level technological issues.

Our approach has proved to be effective in solving a number of problems related to the development of 3D worlds and to the maximization of the development effort. In other words, our approach takes full advantage of interactive technology but, most of all, of the active participation of content experts. We can define our approach as content-centered.

Our proposal can be compared with another approach, characterized by a similar attention toward the user: the user centered approach [5]. This approach was born as an alternative to an older (but still widely used) development practice which assumes that the understanding of the user needs is implicit in the design of products. Unfortunately this conviction is misleading: applying this philosophy, only technology guides the development of projects and this often generates products that are not easy to use, unsatisfied customers, difficulties on technical support and training and so on.

A special section of the IBM web site [4] is dedicated to the benefits related to the application of the user centered approach; the following excerpt, taken from their site, is very useful to understand the key features of user centered design:

**CONCLUSION**

In the recent history of interactive media too much emphasis has often been made on the technological side, even assigning to computer science technicians the role of experts in domains not belonging to their experience. Our position is that a new range of subjects must be more involved in 3D environments, taking advantage of the 3D media without being constrained by low level technological issues.

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A special section of the IBM web site [4] is dedicated to the benefits related to the application of the user centered approach; the following excerpt, taken from their site, is very useful to understand the key features of user centered design:
User centered design is a method for designing ease of use into the total user experience with products ... It calls for a multidisciplinary team to design everything the user sees and touches and to gather user input and feedback during each stage of the development process ... User centered design focus heavily on understanding users and gathering input and feedback from them throughout the development cycle.

In other words the user centered approach involves users in all the phases of the development process in order to obtain a better result. Our approach recognizes the benefits of the user centered approach and goes a step beyond; users are non only consulted through the development process, they are also encouraged to actively participate in the process of creating the product.

We have seen in the previous paragraphs that this approach is particularly interesting for software projects that have the following features:

- different categories of users are involved in the development cycle of the project;
- the software product is not simply a tool to perform a certain task, but a product that requires and incorporates the knowledge of a domain different from computer science;

Guided tours for education, that have characterized a part of our test implementations, and, more generally, computer supported education share the features outlined above.

We can say that our approach doesn’t want to substitute, but rather to integrate the positive results of the user centered methodology with a more active role for users in order to improve the quality of content. That is the reason why user feedback has not been widely outlined in the explanation we made above; for this part we take advantage of the methods already available for the user centered methodology.

An improvement to the modularity and to the standardization of the high level approach we have proposed in this paper will come from the exploration of the potentialities of the upcoming X3D standard [9]. The features of XML [10] seem to be significant to refine our approach, in particular for the transformation capabilities offered by the associate XSL technology [11], in order to manage and assemble blocks of code describing geometric objects and behaviors.

REFERENCES


