

Albert, Al & Bart and the special relativity theory

Francesco La Regina, Giuseppe Laria, Giovanni Posella,
Elena La Regina, Daniela Fiorelli

OGM Animation Studios – via Frugiuele 39, 87100 Cosenza, Italy
E-mail: laregina@ieee.org

Abstract – This paper expounds the development of a 3D multimedia product intended to explain elements of physics. It could be an innovative approach to m-learning, using cartoons' language to stimulate the youngest students' attention. The aim is the exploration of cartoons as an alternative way of lesson [1]. The short film has one leading character and three supporting characters. It was totally developed in Computer Graphics (CGI) using four virtual sets and nine lighting schemata. Albert, a nice scientist with flowing hair, explains the special relativity theory. He shows Bart, his bouncing assistant, that travels close to the speed of light and the effects of velocity.

Keywords – M-Learning, Edutainment, CGI, Cartoons, Physics, Relativity

1. INTRODUCTION

1905, a young German physicist sends the review “*Annalen der Physik*” an article about “*The electrodynamics of bodies in motion*”. It states that the speed of light is an independent-from-system constant and that the Galilean relativity principle is valid inside the uniform speed systems.

This physicist was Albert Einstein.

His Special Relativity Theory is rather difficult to understand especially because it disagrees with common experiences. And probably because of lack in scientific knowledge communication strategy [2].

2. PROJECT DEVELOPMENT

In order to involve the audience, every digital visual redevelopment needs an accurate representation of each showed object. Accuracy allows audience to forget watching a representation and to start playing with it. In fact, when we play, we learn better because our attention level is higher and when we finish playing we would start again [3].

The CGI sets of this cartoons had been designed and developed as real cinematographic sets. Then every visible object had been modelled and inserted inside the sets.

The project development phases are: subject and script, storyboard, dubbing, modelling, animation, rendering, postproduction, editing, authoring and distribution.

2.1. Development phases

Writing screenplay starts from subject, that is the tale we are going to tell. Of course, it's necessary to write the script always thinking about

the kind of audience. This phase took a long time because of writing and physicists' proofreading.

Fig. 1 shows some storyboard images: characters have been much detailed since this phase.



Fig. 1. storyboard excerpt

Developing cartoons, animators need to hear characters' voices in order to give them a personality and to develop a precise lip-sync. Thus, we recorded dubbing voices before starting 3D development.

It's possible to model real objects starting from geometrical primitives. In modelling sets it is necessary to represent inorganic objects. These are, usually, shaped as simple geometrical bodies, without a lot of details or complex details. When necessary, some details could be added as shading.

Instead, modelling character is a very complex phase. Sometimes it's necessary to model organic objects and these are shaped as complex curves. It could be very effective in this phase the use of

subdivision surface algorithms (for instance the Catmull-Clark algorithm) that convert plane surfaces in curved surfaces without sharp corners.

This project needed four three-dimensional sets: the Albert's office, an exterior location, the interior of a spaceship, a sky-dome. Fig. 2 shows the characters: Albert, Bart (the bouncing ball), Al (the twin brother), God.

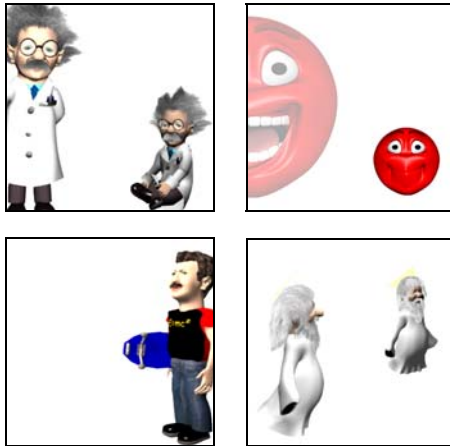


Fig. 2. Characters

In order to model interior sets we used geometrical primitives with a low subdivision level. Using these sets as cinematographic sets we took care of every single detail, because characters' personalities are underlined by sets. Fig. 3 shows some sequences inside the modelling and animation environment.



Fig. 3. modelling and animation environment

During the texturing phase, coverings are added to 3D models' surfaces. This phase is important because surfaces and textures are the part of models visible by audience. So, a lot of work is pointed to defining surfaces and their peculiarity.

For instance, a wood surface could be gathered and this peculiarity could be represented by two

textures. The former used to give surfaces wood colours (primary texture) and the latter to give surfaces wood gathering (bump-map).

Exterior locations had been developed using a plane surface with a displacement-map. This moves surface points in order to fit fluctuations of colours.

Studying lighting is also important to define as surfaces react to light.

Fig. 4 shows a set detail with plane primary textures (blackboard and poster) and a bump-map (wall scratches).

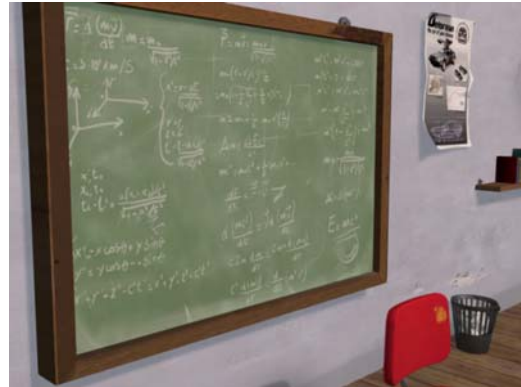


Fig. 4. Set detail

Remembering the didactic goal of the project, we decided to add a lot of details to sets. This in order to avoid distracting audience. Few objects could be examined, but a lot of objects are just looked at.

The rendering phase took a lot of computing time. We used several computers connected to have a parallel computing of every still. In order to save time, we simulated *radiosity* algorithm using several appropriately positioned virtual lights. Then we used the saved time to develop the best simulation of Albert's hair, as shown in Fig. 5.



Fig. 5. Hair simulation

We used nine lighting schemata to simulate different atmospheres.

Interior locations need a lot of point lights to simulate artificial lighting and create soft shadows.

Exterior locations need distant lights to simulate sun light and to create clear outlined shapes.

Some additional lights had been added in order to increase colour contrast and remove some black shade areas.

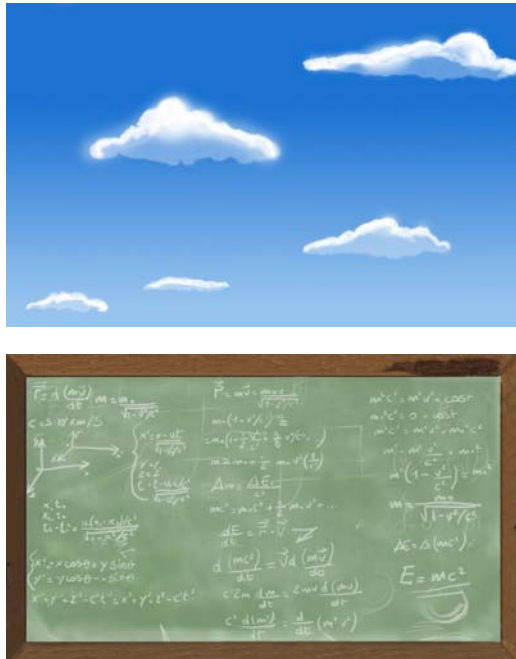


Fig. 6. Examples of textures

To keep the audience attention we used almost exclusively primary colours; as shown in Fig. 6.

Colours were also used to emphasize differences between interior and exterior locations. Interiors are white and grey; exteriors are yellow.

In fact, this difference isn't only a cinematographic needing, but it had been used as semantic dichotomy. Interior locations mean theory, exterior locations mean practice.

It's a metaphor of scientific method.



Fig. 7. Lighting simulation and virtual set

Short film script could be schematized in: explanation, experiment, confirmation, that are: theory formalization, experiment conceiving and

development, data verification and corollaries conceiving.

Some cinematographic tricks were used to link sequences. As shown in Fig. 7, a tracking shot moves the camera outside from Albert's office revealing that the office is a set.

2.2. Cinematographic style

Short Film and 3D Animation are two cinematographic genres with some peculiarities. These details are *de facto* untold rules and were fixed because of limits of first CGI software. For instance, it's usual insert several references to great old movies or self-references to other animations.

On the wall behind Albert there are a desktop, a blackboard and a poster. On the desktop there is the lamp leading character in Pixar's first short film "Luxo Jr". On the blackboard there is the $E=mc^2$ formula proof. On the poster there is a project of Delorean, the "Back to the future" time machine.

A leading character is a caricature of Albert Einstein. Its twin brother, Al, is younger because travelled a lot of time almost at the speed of light. This is an obvious reference to Einstein's twins paradox.

Albert's characterization is composed of several elements. Several facial expressions are generated by several morphing levels. Cartoons style had been guaranteed by a low-def shading and a shrill voice. Hair is a fundamental part of the character, so we worked a lot to make it flowing.

Al's characterization started from some pictures of young Einstein. Bart is a simple red bouncing ball, useful to show Albert's experiment.

2.3. Distribution

The short film had been authored in a DVD containing it in 4 languages: Italian, English, Spanish and French. At the same time a poster (shown in Fig. 8), cards, a press package and dedicated web-pages have been developed [4].

Albert, Al & Bart and the special relativity theory was broadcasted at:

- TVuno – Argentina
- Corticontrò channel – Italy

was screened at:

- Arcacorti Film Festival, Rende – Italy
- Napoli COMICON, Naples – Italy
- Whip.zip, Rome – Italy
- ANIMAGO Awards, Stuttgart – Germany
- Inventa un Film, Lenola – Italy
- ilCORTO.it Festa di Roma, Rome – Italy
- Mendicino Corto, Mendicino – Italy
- CyBorg Film Festival, Anghiari – Italy
- Un ciak a..., Roggiano Gravina – Italy
- Riviera dei Cerdi FF, Cetraro – Italy
- Short Video Exhibition, S. Fili – Italy
- Jonio in corto, Ali Terme – Italy

- Indyvision, Corsico – Italy
- Cuneo Film Festival, Cuneo – Italy

participated in:

- Prix Ars Electronica, Linz – Austria
- Visionaria, Siena – Italy
- Net Independent FF, Rome – Italy
- Discovery on Film, Rovereto – Italy

received nominees for:

- Best actor at Arcacorti Film Festival
- Best educational short at Animago Awards
- Best Italian cartoon at Inventiva un Film
- Internet audience's award and Best animation at ilCORTO.it Festa di Roma
- Best animation at CyBorg Film Festival
- Audience's choice award at Jonio in corto
- Best short at Indyvision

and had been awarded as:

- Best educational short at Mendicino Corto
- Special mention at Un ciak a...
- Best debut film at Riviera dei Cedri FF



Fig. 8. The Poster

3. DIDACTIC AIM AND CONCLUSION

The topic of our character explanation is the special relativity theory. The target audience are the youngest people (from 10 to 13 years old) that normally don't love physics.

Our Albert, in a simplified scientific language explain: *"If we are travelling close to the speed of light, some weird things happen. When we are standing still watching something running in front of us really really fast, we are able to see two particular effects.*

First of all we can see that item shortened as if it had been pressed. But the strangest effect is that the clock hands run slower then our clock hands.

It's not a visual effect, those things really happen!

If, instead of staying still, we would ride this item, we would be pressed and our clock would run slower. It is happening to us, even if we don't realize it! [5]

Every day we travel in some way, but no one is able to see these phenomena because nobody can reach such a speed. Just think that a Ferrari, the world fastest car, can reach 350 Km/h at the most, while light travels at 1 billion Km/h."

After this explanation, young audience could watch an experiment that proofs the theory and shows the scientific method.

ACKNOWLEDGEMENT

The authors wish to acknowledge advisors prof. M. Muzzupappa and dr. F. Bruno of REVR Lab at University of Calabria for their support in developing this 3D short film.

REFERENCES

- [1] A. Calvani, *I nuovi media nella scuola. Perché, come e quando avvalersene*, Carocci, Rome Italy, 1999.
- [2] A. Einstein, *Come io vedo il mondo; La Teoria della Relatività*, ed. Newton Compton, Rome Italy, 1974.
- [3] D.H. Jonassen, *Learning with Technology: a Constructivist Perspective*, Prentice Hall, Old Tapan NJ USA, 1998.
- [4] <http://www.ogm3d.com/albert/>
- [5] A. Einstein, *Relatività: Esposizione divulgativa*, Boringhieri, Turin Italy, 1960.