



AGRIENT – Enhancing Youth Entrepreneurship Skills, Careers Guidance and Competences in Agriculture through a Game Based Virtual Reality Platform

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O2 State of the Art in 3D Virtual Worlds

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Enhancing Youth Entrepreneurship Skills, Careers Guidance and Competences in Agriculture through a Game Based Virtual Reality Platform

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Table of Contents

Introduction.....	5
Virtual Reality	5
Augmented reality	6
The concept of the Industry Revolution	7
The three stiles of learning	8
1. Formal Learning	9
2. Informal Learning	11
3. Non-formal Learning.....	14
Software for Virtual Worlds.....	18
Representative Software	18
Introduction.....	18
Unity 3D.....	20
Unreal Engine 4	20
World Of Warcraft	22
Minecraft	22
Entropia Universe	23
Neverwinter Nights	24
Kaneva	25
Second Life.....	26
Active Worlds	27
Open Wonderland	28
Open Cobalt.....	29
Comparison.....	29
OpenSimulator	30
Introduction.....	30
Architecture.....	31
Installation	31
1. ICT and Entrepreneurship.....	33
Machine Learning and Data Mining	33
Mobile Programming.....	33

Von Neumann Architecture.....	34
3D Printing	34
2. “The world of drones”	35
World of Lasers.....	36
3. “Robots world”	36
3D Graphics	37
Special Purpose Sculpted Prim Tools.....	39
Blender	39
Plopp.....	39
POV-Ray	39
Archipelis Designer	39
AC3D	40
3D Viewers and User Accounts.....	40
Avatars.....	41
Textures	43
Video textures	43
Lighting	45
Sound.....	46
Basic Interactivity	46
Non-Playable Characters	46
Head-up display, HUD.....	47
Integration with LMS	47
TalentLMS.....	48
References	48

Introduction

This introduction is based on “State of the art in Virtual 3D Worlds (for Training)” report developed by in the frame of VR4STEM project but the author had to update and expand certain sections to keep the information useful and up-to-date as of the time of writing this introduction – August 2019.

Virtual Reality

Virtual reality (VR) is a *digitally simulated environment* that can be used in order to create to amplify or manipulate our perception of physical surroundings [4].

Virtual reality has a variety of uses for training and education (i.e. technical, medical or military training), and can be widely applied to engineering and robotics, architectural or urban design, digital marketing, entertainment, healthcare and clinical therapies, archaeology as well as social science and psychology.

The computer simulation is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to better understand how the system works. By changing variables in the simulation this can lead to predictions about the behavior of the system and that seems to be one of the most important capability. Computer simulation can be used as a strong tool to virtually investigate the behavior of the system and to study simulated experiences that can be similar to or completely different from the real world.

In a society, where young people spend most of their time on social media or on their smartphones, books are starting to lose their focus and relevance. People use online resources as means of knowledge and communication and consequently new ways are needed in order to modernize and revitalize books. Unfortunately, older people are usually skeptical regarding the introduction of e-books, so we have to think at other alternatives needed for combining the advantages of both worlds: physical books and technological features.

A possible solution to the previously mentioned problems involves the inclusion of technology for augmenting books and reading in general. Probably the first project which had the intention of modernizing books was Enciclopedia Mecanica, which appeared in 1949 and is considered the precursor of the e-book. Created by a Spanish schoolteacher, it combined mechanical, electrical and air pressure components, adding functionalities such as illuminating the pages, zooming in, writing and drawing notes. Text fragments and graphics were placed on cylindrical devices so that the reader could move them easily and stop to whichever topic they liked. Many books could be read and integrated in the same device, thus solving the problem of students who had to carry around heavy books for each school subject [8].

We can appreciate that nowadays VR became one of the most spectacular and popular technologies because it can be defined as a technology which creates “complete, 3D virtual representations of the actual world or of objects within it” [1] [2]. Indeed, nowadays we can take virtual tours of museums or other cultural buildings, we can train skills in the virtual world, we can even treat psychological conditions or doctors can perform surgical procedures by using virtual means.

Augmented reality

Over the last years, augmented reality books have slowly started to gain ground. They consist of physical books where digital content has been added in order to increase interaction and immersion, while still keeping the advantages of paper documents [13].

The authenticity of the experience can be increased by a series of various additional devices, such as head mounted displays, gloves, vests etc. Another technology, this time related to both virtual and real worlds, is the augmented reality (AR). If we think about a scale connecting the real world and the virtual reality, the augmented reality would be situated somewhere in between, as it refers to the introduction of virtual elements or objects in a real environment [3].

The introduction of virtual data adds some new information to people which can be valuable, if processed and used at its full capacity [3]. Combining augmented reality with physical books can produce an interactive, modern component, which can help the revitalization process of reading. The idea is not new since more than 15 years ago Pierre Wellner from the University of Cambridge presented the concept of Digital Desk, a device which allows the tactile manipulation of electronic elements placed on top of physical documents. His main arguments for the usefulness of this invention involved the advantages brought by both electronic documents and paper ones, which should be combined through various ways. According to Wellner, the best solution is to add electronic properties to a physical desk, by using a projector and a camera connected to a computer. The camera is used in order to identify the user's movements with the help of gesture recognition techniques, thus seeing which parts of documents are touched by the user. Based on this identification process, the projector is used to display feedback or other digital components on the physical document placed on the desk. But, at the time, few hardware limitations brought a series of implementation issues, such as: low resolution standard cameras, the slow response time of processing images in real time, or slow system architectures.

Today, all these could be overcome by the evolution of technology.

Today virtual reality is used to describe a wide variety of applications commonly associated with immersive, highly visual, 3-D environments [4]. Most of the current VR environments are displayed via a computer screen or special stereoscopic displays and rely mainly on visual stimulus, however there are simulations include additional sensory information, such as sound and force feedback (tactile information).

In near future, remote communication environments will become available. They will provide users with virtual presence (telepresence and telexistence) and will use either standard input devices such as a keyboard and mouse, or multimodal devices like wired gloves and omnidirectional treadmills. The simulated realities.

Modern projects which use augmented reality are now running on more powerful hardware devices, overcoming the previous limitations. Such an example is represented by a project called WikiTUI, from 2008, which creates a system based on gesture recognition where users can utilize both physical books and digital content (images, videos, links or comments) in order to read their favorite material [5]. Similar technologies evolved even further, with the project FingerLink created by Fujitsu [6]. Their goal was to create a bridge between physical paper and digital technologies and to use a camera and a projector in order to identify the finger touches or swipes over any type of printed material. Its evolved technology manages to follow finger movements as high as 30 cm / second, thus easily capturing the natural reading movements. Another interesting example, but at a smaller scale, is "Novais Teixeira", a Portuguese biography of a famous cinema critic [7].

People still prefer physical paper, as they feel like they own that specific document, they like the tangible feeling of turning pages or they feel more comfortable than reading from a screen [14].

Augmented reality books assure the introduction of digital elements (tactile interactions with the user, 3D animations, sounds) when the printed document is viewed through special devices, such as smartphone or web cameras, smart glasses or head mounted displays [15]. A review related to the interest shown in research studies about AR books has been conducted at Anadolu University, from Turkey. By taking into consideration the biggest and most well-known scientific databases, they discovered only 46 studies published until 2016 related to augmented reality books, augmented desks or approaches used for paper augmentation. Their review shows that the concept of using a digital desk has lost popularity over the years and the focus is lately on the creation of AR books for children (so called “interactive 3D pop-up books”). Regarding the devices used, more accessible ones are preferred over the years, such as smartphones and laptop cameras [13].

The concept of the Industry Revolution

The industrial revolution reshapes life, work and the way to relate to each other, while people try to understand and benefit from technology changes. Connectivity and networking of people from all over the world by Internet and mobile devices, processing speed, access to knowledge, storage capabilities and the impact of disruptive and collaborative innovations in different fields such as: Internet of everything (Internet of Things, Internet of People, Internet of Services, Internet of Data) [9], Virtual Reality, 3D printing, material science, nanotechnology, self-driving cars, artificial intelligence, quantum computing, energy storage. Interdisciplinary approaches, “fusion of technologies across the physical, digital and biological worlds” [2].

Emerging business models make the circular economy in form of regeneration and preservation of natural environment necessary and new paradigms in our expression, entertainment influence our entire behavior.’ The new concept of the Industry Revolution 4.0 has as core elements the prioritization of the future challenges relative to prosperity and quality of life [11], resources consolidation, promotion of innovation transfer and networking, strengthening of the dynamism of innovation in industry, creation of favorable conditions for innovation and transparency and participation through an innovation policy.

According to [12], there are nine trends in the Education 4.0:

- (a) *classroom-free learning* - meaning learning at different places and at different times,
- (b) *flexibility* - students can modify their learning process with tools that are suitable for them,
they will learn with different devices, programs and techniques based on their own preference
(like blended learning, flipped classrooms and “Bring Your Own Device”),
- (c) *personalized learning* – the study tools are adapted to the capabilities of each student,
- (d) *mentoring* – students develop more and more independence in their learning process, so that professors as mentors become fundamental to student success and though the future of education seems remote, the teacher as a focal point in the information flow is vital to academic performance,
- (e) *practical application* - curricula will make room for skills that solely require human knowledge and face-to-face interaction and educational institutions will provide more

opportunities for students to obtain real-world skills that are representative to their jobs, offering students to fulfill internships, mentoring projects and collaboration projects,

(f) *project-based thinking, learning and working* - as careers are adapting to the future freelance economy, students have to learn how to apply their organizational, collaborative, and time management skills in shorter terms to a variety of situations,

(g) *ownership*- students will become more and more involved in forming their curricula, with critical input from students on the content and durability of their courses,

(h) *evaluation instead of examination* – Q&A are replaced by working in projects,

(i) *data interpretation* - the human interpretation of data using human reasoning to infer logic and trends from these data will become a fundamental new aspect of the curricula. Industry 4.0 requires adequate skills for the 21st century.

As about the *Stiles of Learning* some authors divide it into three categories, as presented in the next chapter.

The three stiles of learning

When you think of higher education, chances are that virtual reality is not something that immediately comes to mind. In recent years, online learning has changed the face of education by becoming a supplement to traditional methods, allowing people to learn at a distance, on their own time and at their own pace. It has become a powerful tool for educators to expand their reach while providing students with a way to get an education without having to step foot into a classroom.

Despite these advantages, online education has proven to be a double-edged sword. At some point in their learning, every student needs personal help that interactive workbooks and textbooks alone cannot provide. Relying solely on asynchronous communication with a faceless professor stifles the kind of momentum that a classroom setting promotes.

Classrooms and lectures allow students to engage with their professors, teaching assistants and with each other. Students have the ability to raise their hand to get clarification in the moment, when it is most useful, rather than having to send an email and await a reply. Students can be broken up into workgroups for projects; and potentially most important of all, students can turn to other students and ask them questions, make study-groups and form friendships and rivalries that provide emotional motivation for pushing themselves to learn more and succeed. The highest quality education must be social and interactive, and although online learning provides a degree of that via a website, the practicality of the real-world instant feedback and social dynamics are missing.

Virtual worlds promise to deliver the best aspects of both real-world classrooms and online distance learning into a single platform. With tools that provide avatars that represent the educators and the students, voice and video capabilities, PowerPoint and other collaborative whiteboard technologies and group and private messaging chat, educators are finding that the newest generation of virtual worlds can simplify the lecture and presentation process, allow students to ask/answers questions to their teacher or each other (without interrupting the lecture), socialize and learn in a very streamlined manner. All of this is done with the convenience and cost efficiency of distance learning.

The concept of virtual worlds is meant to have as a result an easier acceptance of Schome (a play on the words school and home) which is believed to be the optimal educational system for the 21st century.

There are two types of virtual worlds:

- **Entertainment-Based:** The launch of multiplayer 3-D games in the 1990s gave birth to new advancements in interactive virtual worlds. In this category of virtual worlds, users play games through their avatars. These virtual worlds are strongly influenced by fantasy, science fiction, and anime genres of literature and film. Entertainment-based virtual worlds represent the majority of virtual worlds in existence today.
- **Social Interaction-Based:** Focuses on user interaction, education and training through simulated worlds. These worlds offer a more open-ended experience such as exploring landscapes, playing adventurous sports, socializing with communities, taking part in political debates or experiments, attending educational sessions, training in a simulated environment and countless other virtual possibilities. Although younger than gaming worlds, these social virtual worlds are quickly gaining popularity, particularly in educational, political, commercial and military organizations.

Enabling students to meet other students who are learning the same material as they are allows students to exchange already accumulated knowledge and generally makes learning more fun. Virtual World environments have an enormous advantage when it comes to engaging with other students, even at a distance.

1. Formal Learning

The terms *formal* and *informal* learning have nothing to do with the formality of the learning, but rather with the direction of who controls the learning objectives and goals. In a **formal** learning environment, the training or learning department sets the goal and objectives, while **informal** learning means the learner sets the goal and objectives.

Formal learning, normally delivered by trained teachers in a systematic intentional way within a school, academy/college/institute or university, is one of three forms of learning as defined by the OECD, the others being informal learning, which typically takes place naturally as part of some other activity, and non-formal learning, which includes everything else, such as sports instruction provided by non-trained educators without a formal curriculum.

Formal learning theory is the formal study of inductive problems and their intrinsic solvability for both ideal and computable agents. Modal operator theory has very little to do with formal learning theory especially with respects to:

- The significance of method and methodological recommendations.

- The idea of weakening the convergence criterion in order to get more problems within the scope of reliable inquiry.

One example of formal learning in virtual environments is archeology. This was one of the subjects attempted in the “Pedagogy” dimension of the virtual learning environment of Scheme Park.



Fig.1 Scheme Park

The initial archeology activity involved an in-world discussion of museums, focused on learning about their function and thinking about their future. This was followed by sessions in which students gathered information about artifacts and created a museum display about them. These activities involved ‘teacher’ led discussions in Scheme Park, independent research by the students using information books and the Internet, and finally the creation of in-world museum displays.

While the students were in-world for the initial discussions about museums, and in that sense, they were immersed in the environment, they could equally well have carried on these discussions using synchronous chat tools. The independent research took place outside Scheme Park and thus was clearly not ‘immersive’. The creation of the displays was immersive in the sense that the students were in-world and were creating replicas of the artifacts, so they were in Scheme Park, and one could argue they were learning by doing. However, this activity did not inform thinking/understanding about the historical artifacts, so the learning that was taking place was about how to build in Scheme Park [20].

Another activity attempted in Scheme Park was chess. Different groups of students engaged in creating chess sets and/or playing games of chess. Creating chess sets involved knowledge about chess, which was reinforced through the process of crafting the pieces, a non-trivial task if you are trying to create ‘traditional’ style pieces. Playing the game involved learning by doing. One of the groups created a giant chess board and then played games of chess in teams, with more experienced players working with less experienced ones in deciding what moves to make.

Aside from the “Pedagogy” dimension, Scheme Park also experimented with a “Theoretical” dimension.

What this dimension highlights is that implicit in many aspects of activity in formal education is an individual view of the learner within which the focus of attention and assessment is on individuals working ‘on their own’. In contrast, the Scheme Park model sees knowledge as being distributed, rather than being ‘in the head of an individual’. Thus, the focus is on what individuals can do in collaboration with others. This was the goal of the “Theoretical” dimension.

From a socio-cultural perspective, learning is ‘a process of becoming competent and belonging, ie, becoming a particular type of person’ and that this makes knowledge and identity interdependent. Similarly, it is argued that identity is crucial to learning, in that ‘all learning in all semiotic domains requires identity work. It requires taking on a new identity and forming bridges from one's old identities to the new one’. It is argued that games which involve the use of avatars (virtual characters controlled by the user) provide fertile ground for engaging in identity work.

The use of avatars engages people in an explicit process of projecting themselves, which inevitably involves a degree of reflection and self-analysis. More than other interactive online settings, Metaverses like Second Life may induce a rather deep dissociation between the invisible acting ‘I’ in the background and the visible performing ‘me’ on the screen. In SL, this is happening particularly in the case when one chooses the default ‘observer’ mode where they can see their own avatar acting. This implies that they take a decentered, objectivized stance toward their avatar: not unlike the observing position they take to all others. By observing themselves, they can take a self-reflective, critical attitude toward their nonverbal performances and their effects on others.

Thus, avatars provide a vehicle to support reflection on practice—directly addressing the need to make tacit knowledge explicit and enabling learners to reflect critically on their experiences and understandings.

All the technologies that facilitate education can happen in a virtual classroom, including the ability to record lectures, so that students can come back and listen to it later, replay the parts that they need to hear again and not have to rely on extensive notes. Students can attend classes from anywhere that there is Internet, and the costs of transportation and housing can be vastly mitigated.

Virtual learning will open the doors for people to access the best kind of education by blending together the best of the real world, the best of the internet and online applications, and the best of the virtual world technology so that the most modern techniques are utilized to obtain that education.

2. Informal Learning

Informal learning can be defined as a *particular way of learning which arises from the activities and interests of individuals and groups*. After having identified and selected interests expressed by learners, informal-learning activities (discussion, talks or presentations, information, advice and guidance) are carried out in a flexible and informal way, in informal community locations. ^[4]

The speed at which technology evolves today is increasing more than ever before and technology keeps offering new tools in order to simplify our lives. At the same time, teaching strategies are out of step with the times and students are not being taught how to adapt their learning to fit today's complex work environment.

Although formal forms of instruction such as classroom lessons and *e-learning* will still be used for many years to come, it is becoming more and more important to pay attention to the more informal methodologies that students are using.

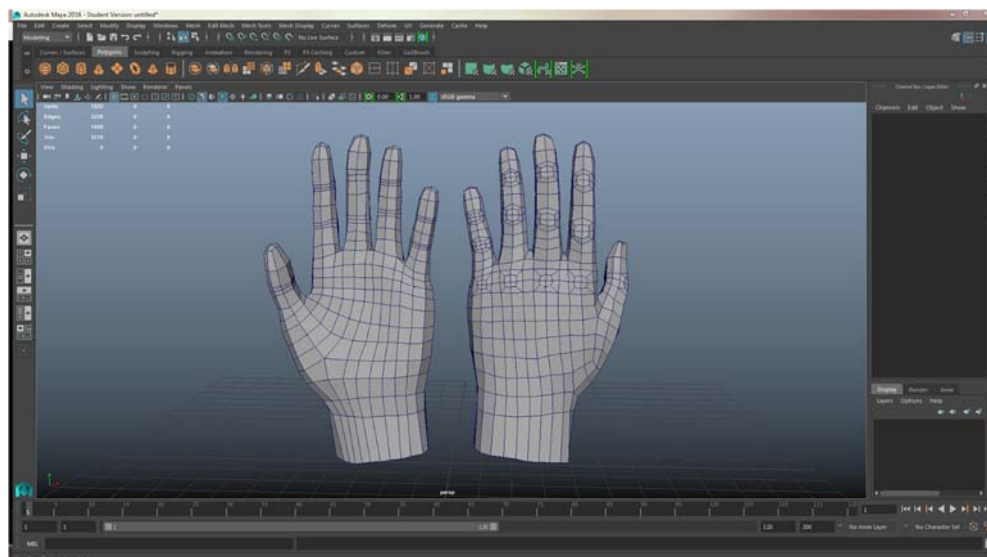
The reasons why **informal learning** is becoming so popular have to do with *immediacy* and *relevancy*. Informal methods of learning are often found in the work environment as they are seen as techniques that a learner can take advantage of right away and with immediate application to their job. Another reason consists in the fact that learners can drive their learning in a more meaningful and self-directed manner.

Joining an IT-intensive community such as Second Life immediately exposes one to a number of learning possibilities and, at the same time, to a number of learning needs:

- In terms of language, since the most interesting events in the community seem to take place in English.
- In terms of IT skills, since one must master the Internet and PC skills for meaningful involvement.
- In terms of social and communication skills (since the way in which people interact in Second Life definitely differs to the way they do so in the real world) and in terms of jargon, attitudes and behaviors.

Therefore, participating in such a community definitely has an indirect learning effect and raises a number of learning-related issues.

Active Worlds University is an organisation of volunteers who provide training and education for both novice and advanced users. The overall curriculum of AWU is divided into the four programme areas of graphic arts, 3D object modelling, advanced AW building, and AW technology.



A teacher chose to offer her class as a synchronous in-world learning environment in which all of the students met at the same time and location within the AWU once a week for approximately 2 hours. Her teaching style was discussion oriented, with much interaction with and between students. Because the chat tool relies solely on text, interaction was dependent upon typing speed and skills as well as bandwidth. However, the teacher's text always appeared boldfaced and was easily recognized and followed. During each class, typically, he presented a concept of 3D object modelling by way of the chat tool.

To illustrate each concept, she provided examples of how the concept was actualized by presenting a sample 3D object in the 3D environment. She provided further illustrations of how a technique or concept was constructed by supplying the underlying scripts of the object in the integrated web browser. This allowed learners the opportunity to follow the RWX script as well as see the resulting object in the 3D environment. For example, when she discussed the 3D coordinate system, she presented an axis in the 3D environment. Learners were able to move their avatars around the axis in order to understand how vertices on the axis define polygons.

Benefits of Formal and Informal Learning

We are all learning machines. We learn constantly and in so many ways. We learn by doing, by observing, by listening, by reading, and by teaching others. We also learn through **formal** and **informal** means. What's the difference between the two and what are the benefits of each? Let's see!

First, what is formal learning versus informal learning? These two terms refer to the dissemination or acquisition of knowledge in our organizations. Formal learning occurs through a controlled and structured approach on a broad-based institutional level. Examples include formal training programs and/or formal written procedures. Informal learning happens more spontaneously between groups of people. An example includes learning by sharing experiences with others in a chat room online or at a company picnic.

We learn in both ways at work so what does this information mean to us as trainers? Let me start by saying that all learning, no matter how it takes place, is valuable. Remember, knowledge is power right? In our training departments we spend a great deal of our time **designing** and **delivering** formal training programs for our employees. However, we can also create environments or situations where informal learning between employees occurs as well. Therefore, I am going to share my thoughts on some benefits of each type of learning so you can think of the best times to include both in your company.

Benefits of Formal Learning:

- Large numbers of employees will learn the same information and/or processes at the same time.
- If properly designed, the course content should be accurate and up to date.

- Employees learning through formal training programs come up to speed faster once they start their jobs.
- Properly designed formal training programs can include a variety of methods to appeal to all learning styles and conform to adult learning principles.

Benefits of Informal Learning:

- Creating informal learning situations can be less costly and more time efficient given all of the **social media** technologies and electronic devices we have today.
- Learning informally can be more personal and less intimidating for some people.
- Subject-matter experts may be more willing to share their knowledge with others this way.
- Since learning this way happens more naturally during the flow of someone's work day, employees may be less likely to resist learning new things.

3. Non-formal Learning

Non-formal learning is purposive but voluntary learning that takes place in a diverse range of environments and situations for which teaching/training and learning is not necessarily their sole or main activity. These environments and situations may be temporarily, and the activities or courses that take place may be staffed by professional learning facilitators or by volunteers. The activities and courses are planned but are seldomly structured by conventional rhythms or curriculum subjects. They usually address specific target groups, but rarely document or assess learning outcomes or achievements in conventionally visible ways.

From a didactic point of view, games are an interesting phenomenon. In general, games are very popular because they fulfill the needs for affection, attention and recognition, as well as the needs for prestige, strength, achievement, independence and freedom. Because of the high intrinsic motivation of the gamers to meet these needs, gaming becomes an end in itself with the single purpose of the playing activity.

Although learning processes are usually neither intended nor reflected by the gamers, a major part of cognitive, motoric and social development takes part within the context of games. The easiness of acquiring knowledge, skills or cognition while playing arouses interest in using this kind of learning for different intentions. In this case, games are designed or transformed in such a way that they pursue at least one further purpose other than the pure pleasure of the game. Games become more serious because they now take on functions which are perceived to be relevant beyond the borders of the game.

The player's motivating force, the pursuit of satisfaction, does not become less important but is in fact exploited in terms of the additional purpose because the motivated engagement in the game represents the prior condition for imparting transferable knowledge. On the other hand, it is this very exploitation which may adversely affect the motivation of the player because it is precisely the stepping out of "real" life which constitutes the game situation.

Each attempt to influence the gamer from outside the game causes a serious intervention into the game's world and runs the risk of reducing the gaming pleasure of the players. Nevertheless, gamers may accept non-game-related purposes under one of the following conditions: [2]

Ignorance – The gamer does not recognize the manipulation and appreciates just the game itself.

Tolerance – The gamer recognizes the manipulation but rates the satisfaction of the game higher than the possibility of being affected adversely.

Acceptance – The gamer recognizes the purposes of the game provider and endorses his intention in principle or trusts his reputation.

Agreement – The aims of the gamer correspond with the intention of the game provider.

Commitment – The game setting is integrated within an institutionalized context and, at least in part, is extrinsically motivated.

Characteristics of non-formal learning:

1. Relevance to the needs of disadvantaged groups
2. Concern with specific categories of person
3. A focus on clearly defined purpose
4. Flexibility in organisation and methods

Goals/objectives of non-formal learning:

1. Provides functional literacy and continuing education for adults and youths who have not had the advantage of formal education or who did not complete their primary education.
2. Provide functional and remedial education for the young people who did not complete their secondary education.
3. Provide education to different categories of graduates to improve the basic knowledge and skills.
4. Provide in-service, on-the-job, vocational and professional training to different categories of workers and professionals to improve their skills.
5. Give adult citizens of different parts of the country necessary aesthetic, cultural and civic education for public enlightenment.

Advantages of non-formal learning:

Non formal education is beneficial in a number of ways. There are activities that encourage young people to choose their own programme and projects that are important because they offer the youth the flexibility and freedom to explore their emerging interests. When the youth can choose the activities in which they can participate, they have opportunities to develop several skills like decision making skills.

Non formal learning has experiential learning activities that foster the development of skills and knowledge. This helps in building the confidence and abilities among the youth of today. It also helps in development of personal relationships not only among the youth but also among the adults. It helps in developing interpersonal skills among the young people as they learn to interact with peers outside the class and with adults in the community.

Disadvantages of non-formal learning:

There are drawbacks to non formal education which include that non formal learning is not based on curriculum but based on experience. There is low efficiency in non formal education.

In case of behavioral patterns like ignorance, tolerance and acceptance, the gamer's interest is focused on the game itself, while learning processes occur, at best, incidentally.

This Incidental Learning can sometimes be linked to Non-Formal Learning. It is neither goal-oriented nor reflected but arises simultaneously to another performed activity. This means that Incidental Learning is always situational and linked to a certain problem.

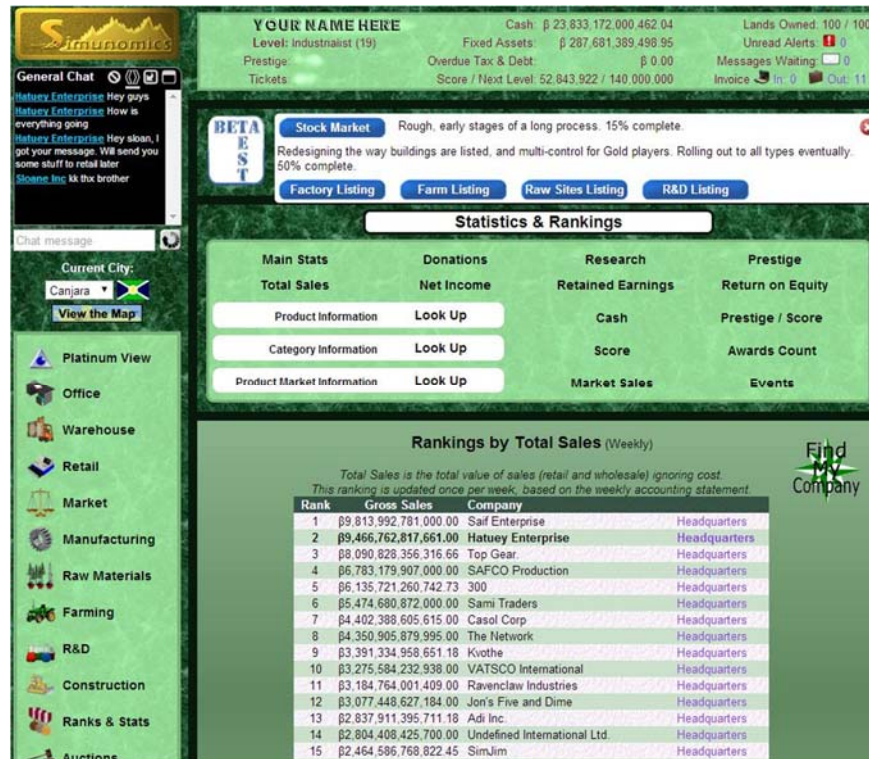
Formal Learning can be defined qualitatively through characteristics such as external structure, curricular learning targets and independence from specific problems. Informal Learning is marked by its own problem-oriented construction of learning targets and a self-determined learning rhythm.

The differentiation between Formal and Informal Learning is not always clear-cut due to the relative reference, but it is always focused on the learner, which makes the the approach discussed most



suitable for didactic considerations, especially in cases of Non-Formal-Learning. While games for Informal or Incidental Learning purposes can be easily integrated into Formal Learning contexts, they must be adapted to suit the substantial requirements of a leisure-oriented Learning environment.

The notion of Non-Formal Education has been a significant feature of policy debates around



Rankings by Total Sales (Weekly)

Total Sales is the total value of sales (retail and wholesale) ignoring cost. This ranking is updated once per week, based on the weekly accounting statement.

Rank	Gross Sales	Company	Headquarters
1	β 9,813,592,781,000.00	Self Enterprise	Headquarters
2	β 9,466,762,817,651.00	Hatuey Enterprise	Headquarters
3	β 8,090,828,356,316.66	Top Gear	Headquarters
4	β 6,783,179,907,000.00	SAFCO Production	Headquarters
5	β 6,135,721,260,742.73	300	Headquarters
6	β 5,474,680,872,000.00	Sami Traders	Headquarters
7	β 4,402,388,605,615.00	Casol Corp	Headquarters
8	β 4,350,905,879,995.00	The Network	Headquarters
9	β 3,391,334,958,651.18	Kvothe	Headquarters
10	β 3,275,584,232,938.00	VATSCO International	Headquarters
11	β 3,184,764,001,409.00	Ravenclaw Industries	Headquarters
12	β 3,077,448,627,184.00	Jon's Five and Dime	Headquarters
13	β 2,837,911,395,711.18	Adi Inc.	Headquarters
14	β 2,804,408,425,700.00	Undefined International Ltd.	Headquarters
15	β 2,464,586,768,822.45	SimJim	Headquarters

education in southern countries for three decades. It has drawn attention to the importance and potential of education, learning and training that takes place outside recognized educational institutions. There are questions about usefulness of the notion when looking at the process of education. It has also gone in and out of fashion. Given the **extent to which notions of lifelong learning and associated ideas have gained ground in recent years** it will be interesting to see how the language of policy debates will change over the next few years.

A good example for a non-formal learning game, could be Simunomics [21]. Simunomics is a business simulation game. Players can build their own business, setting their own products, prices, research, advertising, expansion, and partners in a real-time, multi-player environment.

In Simunomics players purchase land, construct buildings on that land, produce products, and sell those products either to other players or to the public (who are controlled by the game). There are over 100 products to choose from, so focus is advised.

There are currently 4 cities in the Simunomics world (and more can always be added). The currency of the land is βucks, which are used to purchase products, buildings, and services.

In Simunomics, **any value can change at any time**. The most obvious changes are growing or shrinking economies, or the public paying less when there is more competition for a product. But other things can change too, making processes or business lines more or less expensive. Therefore there is no "perfect answer" how to get ahead. A successful player will watch for changes and adapt their strategy to match. [5]

This game teaches players economics in a non-formal fashion, the players exhibiting a behavioral pattern of acceptance. It also develops the players' analytical and organisational skills.

A very important question is: *“Do virtual world classes replace campus-based classes or online course management systems?”*

Based on our previous comments and observations the answer is No. Campus-based classes offer rich interaction, expression, and other forms of communication and real-world experiences that are not possible given today's virtual world technology. For classes that center on formal papers and research reports, campus-based and online classes excel.

Even though slides and text-based information can be used in the virtual world, its strengths center on 3D visualization and sensory experiences that are harder to simulate in the campus-based and online classrooms. The use of virtual worlds expands on the campus-based and online classrooms, enhancing learning experiences.

Classes in virtual worlds offer opportunities for visualization, simulation, enhanced social networks, and shared learning experiences. Some people learn best by listening to the course content, others by seeing and visualizing the content in context, and the rest by using a hands-on approach to demonstrate course competencies. In virtual worlds, we can leverage a mix of content and activity to support all learners: auditory, visual, and kinesthetic. Virtual worlds support these different learning styles and give students opportunities to explore, discover, and express their understanding of the subject.

Naturally, the tool's capabilities do not guarantee a great learning experience. The success of a course depends on effective course design, delivery, and assessment. Course designers, instructors, and IT professionals are challenged to create stimulating content, deliver it reliably, and ensure a stable virtual world learning environment. Do the benefits outweigh the risks associated with venturing into a virtual world educational platform? This question does not have definite answer yet. However, over 400 universities and 4,500 educators participate on the Second Life Educators List (SLED) and this number keeps growing each year.

Software for Virtual Worlds

Representative Software

Introduction

A virtual world is an online community that takes the form of a computer-based simulated environment through which users can interact with one another and use and create objects. The term has become largely synonymous with interactive 3D virtual environments, where the users take the form of avatars visible to others. These avatars usually appear as textual, two-dimensional, or dimensional representations, although other forms are possible (auditory and touch sensations for example). In general, virtual worlds allow for multiple users.

The computer accesses a computer-simulated world and presents perceptual stimuli to the user, who in turn can manipulate elements of the modeled world and thus experience a degree of telepresence

As virtual world is a fairly vague and inclusive term, the above can generally be divided along a spectrum ranging from:

- massively multiplayer online role-playing games (MMORPGs), also called virtual game worlds, the user playing a specific character is a main feature of the game.
- massively multiplayer online real-life games (MMORLGs), also called virtual social worlds, where the user can edit and alter their avatar at will, allowing them to play a more dynamic role, or multiple roles.
- Systems that have been designed for a social application include: Second Life, Active Worlds, Twinity, Kaneva, Smallworlds, Onverse.

There are various approaches for developing 3D Worlds, each one with different advantages and disadvantages.

Developing an application from scratch using a programming language and graphics libraries used to be the only option in previous decades. This option requires a vast amount of time since you'll be creating a game engine specifically for the virtual world you want and requires high level of programming skills in order to achieve something of quality.

Game development platforms are highly sophisticated software kits that allow one to create 2D and 3D games/applications using a supplied game engine with little limitation in terms of customization. They offer toolkits that can help someone carry out specific tasks but in overall it takes a lot of time for someone to learn and use it and in order to create a 3D Virtual World with social interactions a lot of development. Two of the most important game development platforms right now are Unreal Engine 4 and Unity 3D, both offering excellent level of graphics and they are used by top game development companies, creating state of the art game experiences.

Existing MMO games are also an option in some cases, since they already offer social interactions between users. Some of them also offer capabilities to create content inside the game, but the customization options are limited and in most cases it is impossible to use scripts to design your own scenarios.

The easier option to quickly create a virtual world with social capabilities, is by using dedicated virtual world platforms. These platforms can already be online, offered as services where you connect and create your content (e.g Secondlife, Kately) or offered as software that you can install on your own machine as a server process, where client users will connect to. This option can definitely save a lot of time since most of the necessary Virtual World functionality is already implemented and one can focus on creating the content of the virtual world. Using scripts to create custom scenarios is usually a feature available in these platforms but customization options are limited compared to the game development platforms.

In the following section we present some of the most popular platforms, representing the different approaches described above.

Unity 3D

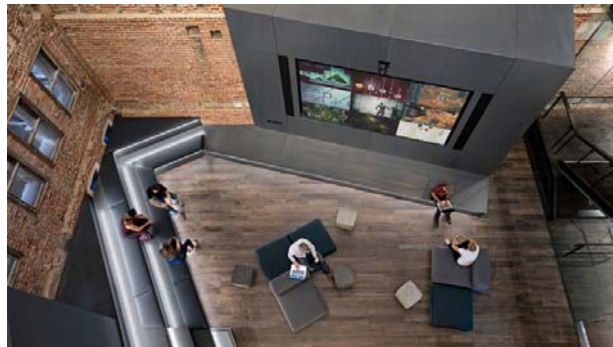
Unity is a cross-platform game engine developed by Unity Technologies and used to develop video games for PC, consoles, mobile devices and websites.



Unity is notable for its ability to target games to multiple platforms. Within a project, developers have control over delivery to mobile devices, web browsers, desktops, and consoles. It is a powerful 3D engine and a user friendly development environment, Easy enough for the beginner and powerful enough for the expert.

There is a Pro edition that comes with more features and tools, however, a free version allows you to build complete games, and even publish them to the desktop and the web without paying anything. Games published under the free edition will have a small Unity watermark. Unity has been used for many popular video games published recently and is being used by both big companies and individual "indie" game developers.

As a general purpose game engine Unity can be used for almost any kind of game, including of course Multiplayer Virtual Worlds. However, it requires a great amount of work to develop the required functionality of a virtual World and experience and skills with programming and working with 3D modelling, shading and other advanced concepts.



Unreal Engine 4

The Unreal Engine is another high end game engine developed by Epic Games, first introduced in the 1998 first-person shooter game Unreal. Although primarily developed for first-person shooters, it has been successfully used in a variety of other genres, including stealth, MMORPGs, and other RPGs. The code is written in C++, so the Unreal Engine features a high degree of portability and is a tool used by many game developers today. The current release is Unreal Engine 4, designed for Microsoft's DirectX 11 and 12 (for Microsoft Windows, Xbox One, Windows RT); OpenGL (for OS X, Linux, PlayStation 4, iOS, Android, Ouya[5] and Windows XP); Vulkan (for Android); Metal (for iOS) ;and JavaScript/WebGL (for HTML5 Web browsers).



As of March 2, 2015, Unreal Engine 4 is available to everyone for free. There is a very active marketplace with assets, many offered for free by Epic Games itself, where one can find, download

and use in his project. Unreal Engine 4 is a complete suite of game development tools made by game developers, for game developers and offers everything you need to create high quality games.



Figure 2.a Photorealistic scene created with Unreal Engine 4



Figure 2.b: photorealistic scene created with Unreal Engine 4

Similarly, with Unity 3D, the Unreal Engine can be used to create Virtual Worlds but requires a lot of effort and skills to use it. The quality of the graphics can be excellent, but it also means that there are very high requirements in hardware to use it for development (a very expensive GPU card), and the resulting game will also need a high-end computer to run.

World Of Warcraft

World of Warcraft is a Massively Multiplayer Online Roleplay (MMOR) game, where players take on the identity of characters in a narrative-rich plot, working together to overcome challenges. World of Warcraft was released in 2004 by Blizzard Entertainment and still remains the world's most-subscribed MMORPG and holds the Guinness World Record for the most popular MMORPG by subscribers.



World of Warcraft requires a subscription fee to be paid to allow continued play, with options to pay in one-month, three-month, or six-month blocks. WoW uses Lua, a scripting language that can be used to create custom Interface modules. Unfortunately, apart from this, there are almost no room for players to create custom content.



Figure 3: players cooperating to overcome challenges in WoW

There are occasions where WoW has been used in education, but it is definitely not an option if you want to create your own content. However, since it is collaborative game and players are usually forced to work together to overcome obstacles in the game, it could successfully help in language training, if a trainer oversees the students and creates scenarios for them to follow.

Minecraft

Minecraft, released in 2011, is a popular video game in which players can work together in a sandbox area to use various types of simple blocks to construct buildings in a 3-D world. While constructing creative and imaginative buildings, players can explore the land, gather resources or fight in combat. There are many occasions where Minecraft has been used as a tool for learning. Minecraft is currently being used in classrooms around the world to teach everything from STEM subjects to arts and poetry.



Unlike WoW and other MMORPs that focus on offering players a detailed, specific scenario and quests to follow in the game, Minecraft is an open world that promotes creativity, collaboration, and problem solving, with users actually forced to create their own content. In January 2016, Microsoft announced a new tool for education, called Minecraft: Education Edition or MinecraftEDU, planned to be released in 2016. The student's characters in MinecraftEDU will be able to retain characteristics. Students will also be able to download the game at home, without having to buy their own version of the game. Finally the last large difference is that students can take in-game photos. These photos will be stored in an online notebook with the students online notes.

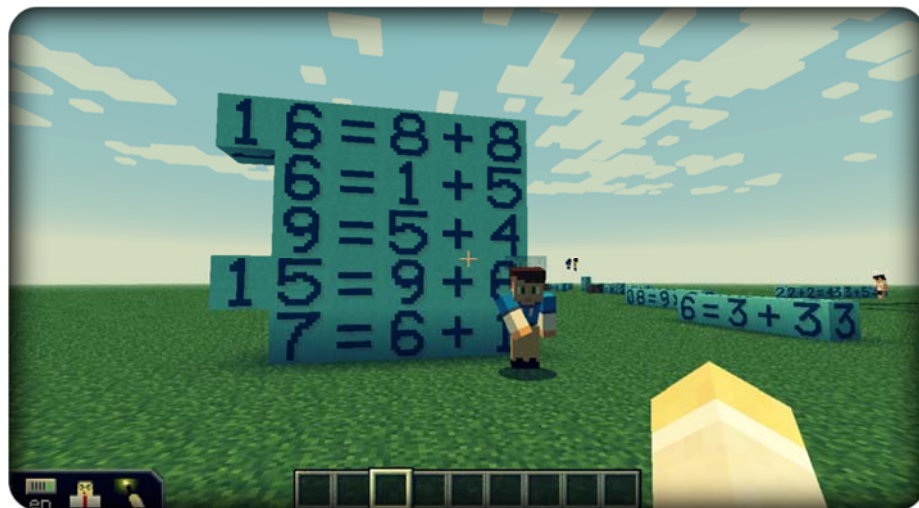


Figure 4: simple math exercises in Minecraft

Minecraft is a great tool for trainers to create collaborative assignments for the students, where they need to build something based on the specifications (e.g. something they were taught in classroom). The limitations are mostly the quality of the "blockish" graphics that do not allow detailed items and the limited options to use scripts and create your own scenarios.

Entropia Universe



Entropia Universe is a massively multiplayer online virtual universe designed by the Swedish software company MindArk. Nearly all in-game activities require expendable resources which must be purchased from vending machines (or other players) but there is no account fee or connection charge.



Figure 5: Entropia Universe 2019

Neverwinter Nights

Neverwinter Nights is a third-person role-playing video game developed by BioWare. Its sequel Neverwinter Nights 2 was developed by Obsidian Entertainment and published by Atari. The games are set in the fantasy world of the Forgotten Realms and the game mechanics are based on Dungeons & Dragons rules.

The game engine was designed around an Internet-based model for running a massively multiplayer online game (MMOG), which would allow end users to host game servers. More importantly the games are accompanied by powerful toolsets that allow users to create their own adventures, focusing on the scenarios and dialogues of the game. More specifically Neverwinter Nights included the so-called "Aurora toolset", a collection of tools allowing users to create their own digital adventure modules to be played either in single-player or in online multiplayer. The toolset enjoyed great popularity among the modding community, with over a thousand fan-made modules produced in it within half a year after the release. Similarly, Neverwinter Nights 2 included its own toolset called the Electron. Through the Electron toolset, Neverwinter Nights 2 gives you all the tools you need to build your own modules, campaigns, and adventures - create buildings, terrain, script encounters, write dialogues, create quests and items.

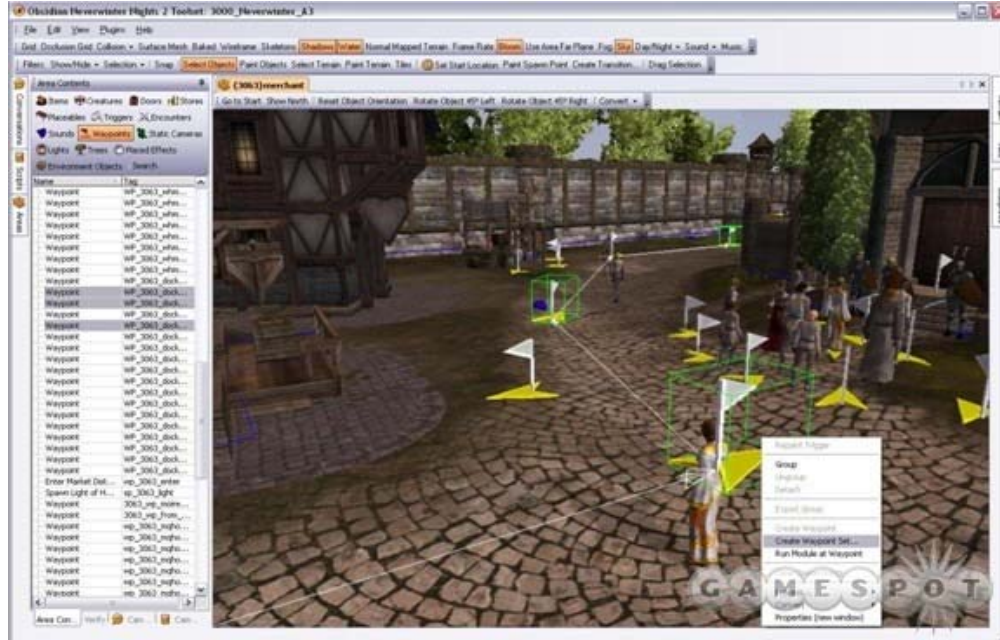


Figure 6: using the toolset to create your own adventure (source: [Gamespot](https://www.gamespot.com))

Kaneva

Kaneva, LLC is a privately owned Atlanta-based company founded in 2004 by Christopher Klaus and Greg Frame. Kaneva is a 3D Virtual World that supports 2D web browsing, social networking and shared media. Kaneva was originally founded to develop a massively multi-player online game (MMOG), but it was later decided to use the technology to develop a virtual world that combined video sharing, social networking and 3D environments. The Virtual World of Kaneva was released into beta in mid-2006.





Figure 7: Kaneva dance party

Second Life

Second Life (Linden Lab, 2003), is probably the most popular of the social worlds, with a large active user base and the most active educational community. Secondlife is open to users over 18 years of age and offers a detailed 3D environment and avatars, voice and text communication tools. It is also a social network, with users able to be members of groups and to create and share information and objects. Second Life allows building objects, that are completely owned by their creators, and there is a very active marketplace where one can buy or sell content (clothes, accessories, homes and diverse items including educational tools). Most of Second Life itself was created by its users and since there is not a specific objective, creating objects and areas is one of its main activities. SL also has a vibrant economy with an enormous market for clothes, accessories, homes and diverse items including educational tools.



The environment is completely customisable for the land owner of an area. Second Life is free to use for the purpose of creating an avatar and visiting the lands created by other users, but users have the option of paying a small monthly fee to get a parcel of land where they can build their own content. More serious building projects require the purchasing of an island and the payment of a monthly rental fee, in addition to the initial terra-forming and design and building costs.

Many top universities and educational organisations have presence in Second Life, and many trainers have been using it as a tool in classes of various subject areas.



Figure 8: Ohio University's Second Life campus

Although SL is proprietary software, Linden Lab has released the source code leading to the creation of many open-source tools and viewers by the user community. The most important of these open-source platforms is OpenSimulator that allows running your own server of a Virtual World, with almost identical functionality with Second Life but no limitation in terms of land. OpenSimulator has been growing on its own and currently offers its own great community of users and the educational community surrounding it is also growing quickly. OpenSimulator, is the software we decided to use for the Virtual World that will be created in this project, so we are going to present it in detail in the next section of this report.

Active Worlds

Active Worlds was launched in 1997 and works much in the same way as Second Life. Although it is free to use with the limited 'tourist' account, paying a small monthly fee allows one to become a 'citizen', offering them features such as having a unique name, unrestricted access to any world, the ability to customize their avatar and to build their own content, and access to social networking features such as voice chat, IM and file sharing (tools which are usually offered for free by default in most other social worlds). For users needing more control over their environment and more privacy, personal firewall-protected Universes are available for enterprises and educational projects. These are separate worlds from the main universe and are priced starting at \$2400. A separate set of worlds and a community for educational projects is also available named [Active Worlds University](#) and boasts over 80 participating organizations. Despite this, Active Worlds is often disregarded in favor of Second Life, especially with regards to educational projects.



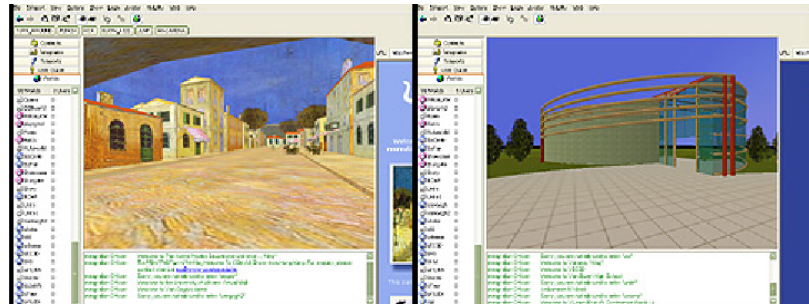


Figure i: Two examples from Active Worlds educational universe (left to right): Van Gogh world and VLearn online learning environment

Open Wonderland



Open Wonderland (previously Project Wonderland) is a Java open-source toolkit for creating collaborative 3D virtual worlds. It has recently become a community-supported open-source project. Users can communicate with audio, share live desktop applications and documents. Open Wonderland is completely extensible; developers and graphic artists can extend its functionality to create entirely new worlds and add new features to existing worlds.



Figure 10: Space vehicles exhibit in a Wonderland virtual museum (source: mfeldstein.com)

Open Cobalt

Open Cobalt is a free, open source software platform for constructing, accessing, and sharing virtual worlds both on local area networks or across the Internet, without any requirement for centralized servers. One of the main features that Open Cobalt offers, in comparison with other platforms is that it does not require the use of servers to create and share virtual worlds (since it is based on a peer-to-peer synchronization architecture/messaging protocol).



Figure 11: Open Cobalt Virtual Workspace

Comparison

	free	Open source	Graphics	text	voice	User community	Custom content	Type
SecondLife	no	no	Very Good	yes	yes	Very Active	Yes	Virtual World Platform
OpenSim	yes	yes	Very Good	yes	yes	Very Active	Yes	Virtual World Platform
Active Worlds	no	no	Good	yes	yes	Fairly Active	Yes	Virtual World Platform

Open Cobalt	yes	yes	Good	yes	yes	Not Active	Yes	Virtual World Platform
Open Wonderland	yes	yes	Very Good	yes	yes	Not Active	Yes	Virtual World Platform
World of Warcraft	no	no	Great	yes	yes	Very Active	No	MMO Game
Minecraft	no	no	Low	yes	yes	Very Active	Yes	MMO Game
Never Winter Nights 2	no	no	Very Good	yes	yes	Fairly Active	Yes	Multiplayer RPG

OpenSimulator

Introduction

OpenSimulator is an open source 3D application server that can be used to create a Virtual Environment, accessible through a variety of clients. It can simulate virtual environments similar to Second Life, supporting the core of its protocols and functionality.



OpenSimulator

OpenSimulator has a very active community of people and groups that contributing to its development and also the creation of open content. Many universities and other educational

institutes have integrated OpenSimulator as part of their courses and have successfully used it for innovative research on learning methodologies.

In the following chapters we will present and describe many of the features offered by OpenSimulator.

Architecture

OpenSimulator is a server application that runs on a machine (or multiple machines when used in grid mode) and serves client applications (3D Viewers) through HTTP messages and the Second Life protocols.

The OpenSimulator server can be used in two modes. In the standalone mode the whole simulation is run as a single process so it can only run in a single machine. This makes it much easier to configure but it is not possible to connect the hosted virtual world with other Virtual World online. In the alternative mode, called grid mode, various aspects of the simulation can be separated and run as different processes across different machines. This allows multiple Virtual Worlds running in different servers across the internet to share common users and assets data, giving users the ability to easily teleport from one to another while keeping their inventory items, thus forming a hypergrid of connected worlds. The hypergrid is effectively supporting the emergence of a Web of virtual worlds.

OpenSimulator is written in C# and is designed in a way that allows to be extended through modules. OpenSim uses a database to store almost all content of the 3D Worlds. It can be configured to use any of the popular database software (mysql, postgres e.t.c).

The software running on the server is just a command line program that communicates with the clients and sends the necessary information that will be displayed on the client's machine. Consequently, the server machine does not require a demanding 3D graphics card. Client machines on the other hand will need a machine with a good GPU since the rendering will take place in them. For the server running the simulation it is important to have a enough memory, particularly if many users (client computers) will connect at the same time.

Installation

To Run OpenSim you need:

For Windows: .NET Framework 3.5

For Linux : At least Mono 2.4.3

Additional software:

- **Freeswitch** server for Voice communication (optional)
- **Apache server with PHP** is required for some modules (e.g. offline messages or groups) to work but is not necessary to run the simulation
- **MySQL Server** or other databases can be configured to be used instead of the default, already embedded in OpenSim (MariaDB).

OpenSim does not need installation. Only Extraction of the archive file. There are a number of important configurations files with parameters (such as credentials for connecting to the SQL server etc) that can be configured by the administrator. To initialize and run the simulation, the administration runs the OpenSim executable and then has access to a console displaying logging messages with the communication with clients and allowing using a set of commands. The administration can use these commands to create users and regions, import terrain height maps or folders of items in inventories and many other administrative tasks.

A 3D virtual space is a 3D computer representation of a real or imaginary space for the field of a certain application. Anything that is visible in a real space can, theoretically, be represented in a virtual 3D space, for example buildings, persons, water, vegetation, etc. Sound and various physical dynamics and interactions can be simulated also.

With the increase of computing power and particularly of computer graphics, such virtual spaces are becoming more and more used, in applications ranging from various types of computer games to life-critical systems in industry, engineering, medicine, military or science [33], [34], [35].

A very promising field is the use of 3D virtual spaces in e-learning and edutainment (education + entertainment). This is due to the fact that the realistic and immersive representations that can be achieved capture the attention of the users of such systems and, at the same time, are able to deliver a lot of heterogeneous information, unlike any other methods used before [6]. Also, 3D virtual spaces can be a very modern mean of collaborative interaction between users

The international team involved in Agrient project, composed by specialists from University of Patras, Slovak University of Agriculture and University POLITEHNICA of Bucharest have experimented in a previous Erasmus project titled VR4STEM a 3D virtual space in e-learning which is a 3D virtual platform devoted to subjects from STEM (Science, Technology, Engineering and Math). The 3D World platform has been prepared as described in the proposal and offers the following courses: Entrepreneurship, Lasers, Computer Architecture, Drones, Gamification, Robots, Data Mining, 3D Printing, Mobile Programming.

The platform contains four main domains - island of knowledge:

ICT and Entrepreneurship, Modern Technologies and Entrepreneurship, The world of lasers, Robots world, The world of drones.

1. ICT and Entrepreneurship

The course is divided into the develop the following sub-topics:

Gamification:

- Where students can learn what Gamification is, the basic principles and application domains and find specific successful start-up and enterprises examples. The course contains also two practical examples of application of Gamification in different domains (Educations, Industry)



Fig.12. Gamification island VR4STEM

Machine Learning and Data Mining

- which describes the basic principles and domains of application and also find specific examples of successful start-up in the field.



Fig.13. Data Mining island VR4STEM

Mobile Programming

- describing the basic principles and application domains and find specific successful start-up and enterprises examples.

Von Neumann Architecture

- where students can learn about Von Neumann Architecture, about hardware components and how to assemble a computer by learning and recognizing its parts

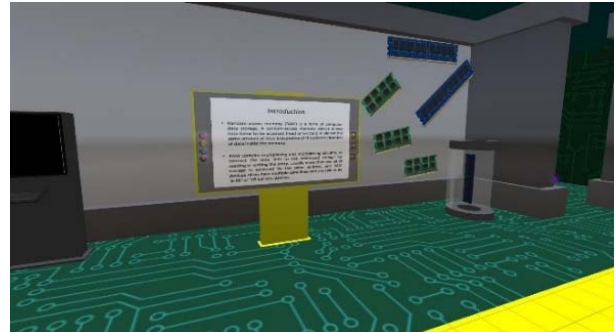


Fig.14. Von Neumann Architecture island VR4STEM

The 3D environment itself has a huge informational value by itself:

The user/the Avatars are able to see how describes a design architecture for an electronic **digital computer** with these components:

- A processing unit that contains an arithmetic logic unit and processor registers
- A control unit that contains an instruction register and program counter
- Memory that stores data and instructions
- External mass storage

The user gets a feeling of immersion inside a computer

There is the possibility to study in detail a 3D exhibit object by rotating it or even magnifying (zooming in). As a new type of application, it attracts users and serves as a support for the other integrated means of delivering information and collaboration.

3D Printing

- aiming to introduce the students with 3D printing and how it can be used in various domains with successful results. Thus, students will learn what 3D printing is, the basic principles and application domains and can find specific successful start-up and enterprises examples with two practical examples in Medicine and Automotive domains

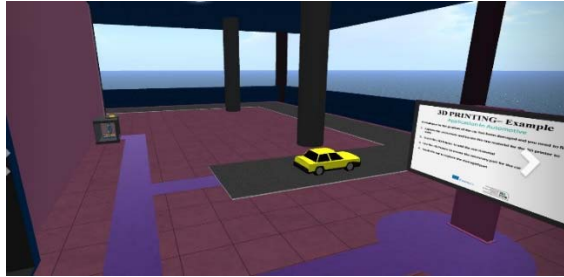


Fig.15. 3D Printing island VR4STEM

2. “The world of drones”

teaching what a drone is, its components, how it’s steered and how it can be used. The students have to engage in several practical applications where they will complete a series of scenarios in which they will develop essential skills that form the basis for future projects in agriculture, land reclamations, etc.



Fig.16. The drone’s island VR4STEM

World of Lasers

The course World of Laser aims is giving an introduction about lasers: when it was created, its inventors, the definition of laser and concepts of light spectrum as well as courses on how lasers work. In addition, the course presents many interesting laser applications in various areas such as data storage, laserdisc, communication, displays, scientific research, energy technologies, military and healthcare.



Fig.17. The laser's island VR4STEM

3. “Robots world”

teaching youth how to construct and to program a DC Sumo Competition robot and how to construct a robot for a follower up challenge. For the first competition the combatants try to force each other out of the ring. For the second, robot must follow a black line on a white background as quickly as possible. During this lesson, the student will gain basic knowledge of electronics, and of laws such as Ohm’s Law, Kirchhoff’s Laws, DC motors and how to design a circuit. They will also learn about robotics, how to build a robot, the mechanical parts of a robot and how they interact. To program these robots, they will acquire some programming skills, such as if, else constructs, while and for loops, the concept of a function etc. The lesson will touch on every aspect of creating a functional robot, from the hardware to the software. This information will be enough to start with building and to ultimately join competitions.



Fig.18.a The Robots's island VR4STEM

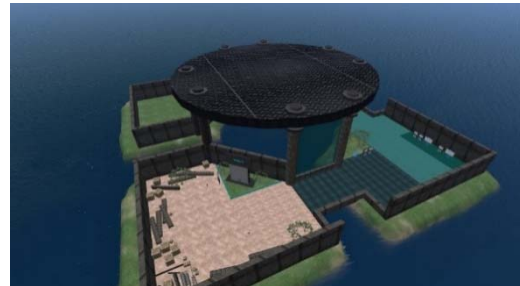


Fig.18.bThe Robots's island VR4STEM

3D Graphics

3D graphics were first created in the 1960s, when vector images were introduced. The vector approach allowed for the 3D graphics to be created, using the same techniques - mathematical formulas calculating the position of each pixel in the 3D image. Building and rendering high-quality 3D images is a very complex task for your computer. if you have high polygon counts and many objects in your scenes you need lots of RAM. But, of course you need also GPU, graphics processing unit (GPU) which is a specialized electronic circuit designed to rapidly manipulate and to accelerate the creation of images in a frame buffer intended for output to a display device.

The tools designed for creating 3D objects for games and animation are complex and have tons of features that allow you to build objects and manipulate them.

The tools for creating objects are made from planes, composed at their turn of vertices or points in 3D space. Objects can be moved, scaled and rotated. Vertices and planes can be pulled around, which allows the object you're working on to be sculpted. They can be combined or split which means to increase their complexity. Curves surfaces require a lot of vertices and are composed of small, flat surfaces.

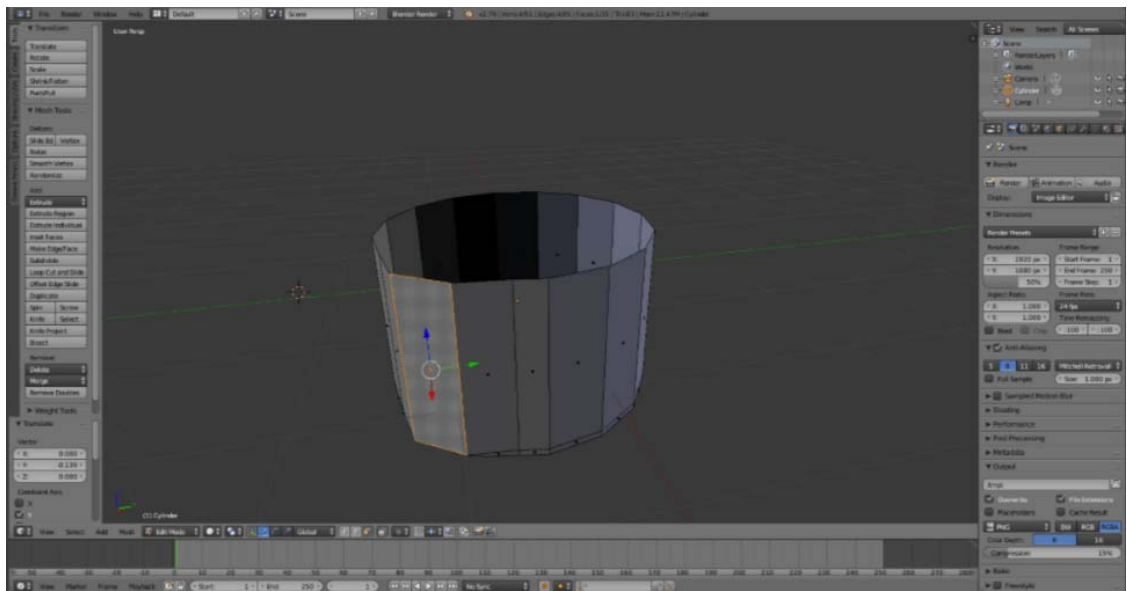


Fig.19a. 3D Graphics

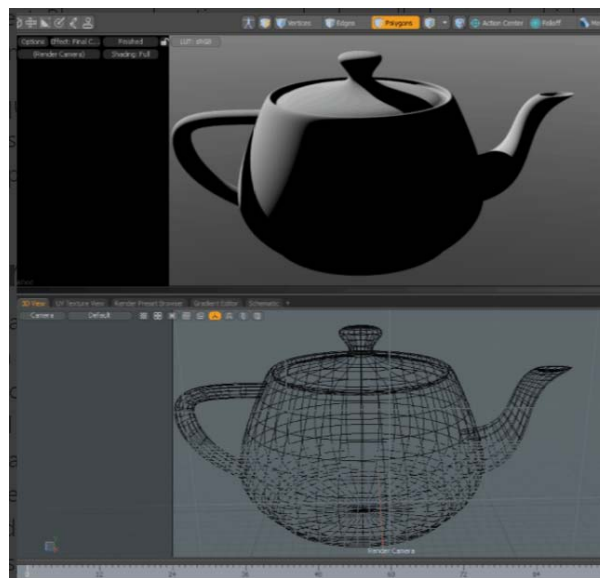


Fig.19b. 3D Graphics

Some 3D objects, such as 3D polygons, NURBS curves, meshes, 3D symbols, spheres, cones, hemispheres, and 3D loci, can display coordinates relative to the layer plane (X, Y, Z)—also called the user coordinate system—or the active working plane (X', Y', Z'), when a working plane is selected.

Given time, one can learn to create complex, detailed objects, by joining simple prims, but there is also the option to import 3D models designed in more advanced modelling software such as Blender, Modo, SketchUp e.t.c., through the widely used Collada format. There are many communities online that offer for free existing 3D models in collada format, that can be directly imported in OpenSim.

Special Purpose Sculpted Prim Tools

Blender

Blender is the current king of the open source modeling programs. With all the features of the expensive programs, an active development community and even some existing SL-based tools this is going to be the default choice for many people.

Plopp

Plopp is a cute 3D modeling tool designed for little kids. Imagine one of those new mylar balloons. You paint the one side with an image, and then paint the other side with an image representing the other side. Plopp then blows up the balloon and shades it. You can also import graphics from other tools (Photoshop, a scanned drawing, etc.), make a "cutout" with the eraser and inflate that.

POV-Ray

POV-Ray is a renderer - you have to do all your modeling in another application, or by describing in plain text the mathematical shapes which make up the model. Some other programs like AC3D (below) can also call on POV-Ray for texture baking.

Archipelis Designer

With Archipelis Designer you just draw an outline from a background image(s) to make it a 3D textured model. Or you can use a blank view and just draw the shapes you want from scratch. It's an intuitive approach to sketch the shapes out that can then be enhanced with textures and photographs and then exported to a set of sculpted prims.

AC3D

AC3D is an inexpensive polygon modeler with SubD support designed to be easy for novice users. The sculpt map plug-in will export any model that has a perfect uv space. Several pre-mapped starter shapes are included with the plug-in, including a cube that can be used as basis for complex objects by artists familiar with the popular box modeling method using sub-division surfaces.

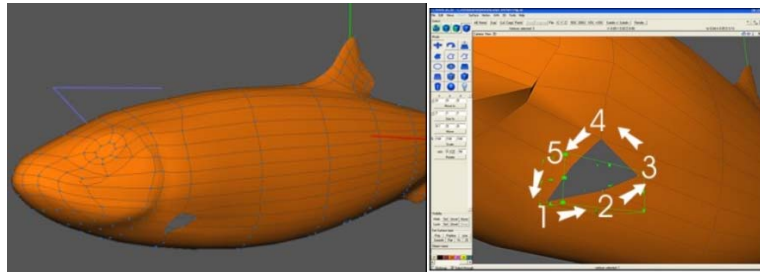


Fig.20 AC2D Polygon modeler

You must select vertices in counterclockwise order when creating an ordered surface.

3D Viewers and User Accounts

The Virtual World is accessible for visitors through a special type of software called a 3D Viewer. There are multiple alternative 3D Viewer options, such as Kokua, Firestorm, Imprudence and Singularity and although they have some differences in the user interface, they mostly share the same functionality. Users can change the viewing angle, select and watch one of the available animations. In order to gain access to the 3D world, usually done through a web site interface, users have to create a user account, to provide a name for their avatar and a password. There are different alternative user management interfaces such as Wifi, based on different technologies. If an interface is not used, then the server's administrator would have to manually create accounts for interested users that want to visit the 3D World.

To connect to a specific Virtual World running on a distant server, the user needs to know the server's address and port on which the simulation is running (similarly to the address of a web page) and provide the credentials for the user he had previously created as described above.

Avatars

Users entering the virtual world, control an Avatar character representing them. The avatar is a crucial aspect in order to achieve a high degree of immersion. Avatars can be customised to take the desired appearance, by modifying body parts (Shape, Skin, Hair and Eyes), clothes or using various items as attachments. SkillReal unique Virtual Humans technology lets you create amazing user experiences and automate communication with immediate impact on results and performance.



Fig.21: using sliders to adjust the shape of an avatar



Fig.22: using sliders to adjust the shape of an avatar

It is possible to create a custom 3d model and rig for the Avatar using 3D modelling software, instead of using the default shapes. For very detailed and realistic characters you can choose skin, hair and eyes color.

A set of Different clothe types sets are also available and can be adjusted using menu sliders, but, of course one can also create custom,

complex ones, using the attachment slots. Attachment are 3D objects (single prims or link sets). This can be "attached" firstly and then adjusted to specific slots of the character. Using the "flexible path" parameters of an object, it is possible to create attachments that behave in a very realistic manner, such as hair that flow when the character moves, or following the direction of the wind.

The animation of the character (e.g. walking or flying around) can also be overridden by adding custom animation files in the popular motion capture format "bvh". Many datasets of motion capture data in that format are already available online, that one can find and use directly or with minor adjustments. These may have been manually made or automatically through motion capture techniques, recording the animation of real people. It is not difficult to create a custom animation using software like QAvimator or Unity, that displays an Avatar and rig of an OpenSim character and allows setting the position of each part of the body for every time point in the timeline. Animations can be triggered inside the world manually by the user, by selecting and "playing" an animation file in his inventory, or as a result of an action (e.g. touching an object) or a script.

In Unity, when importing a rigged model in instead (an FBX model with a skeleton or bones and, optionally, animations), it will configure it automatically for a Generic avatar. When hitting the Configure button the actual scene and the Inspector will be temporarily replaced with the avatar, (as in the following screenshot), until the Done button is clicked and the editor returns to the previously loaded scene.

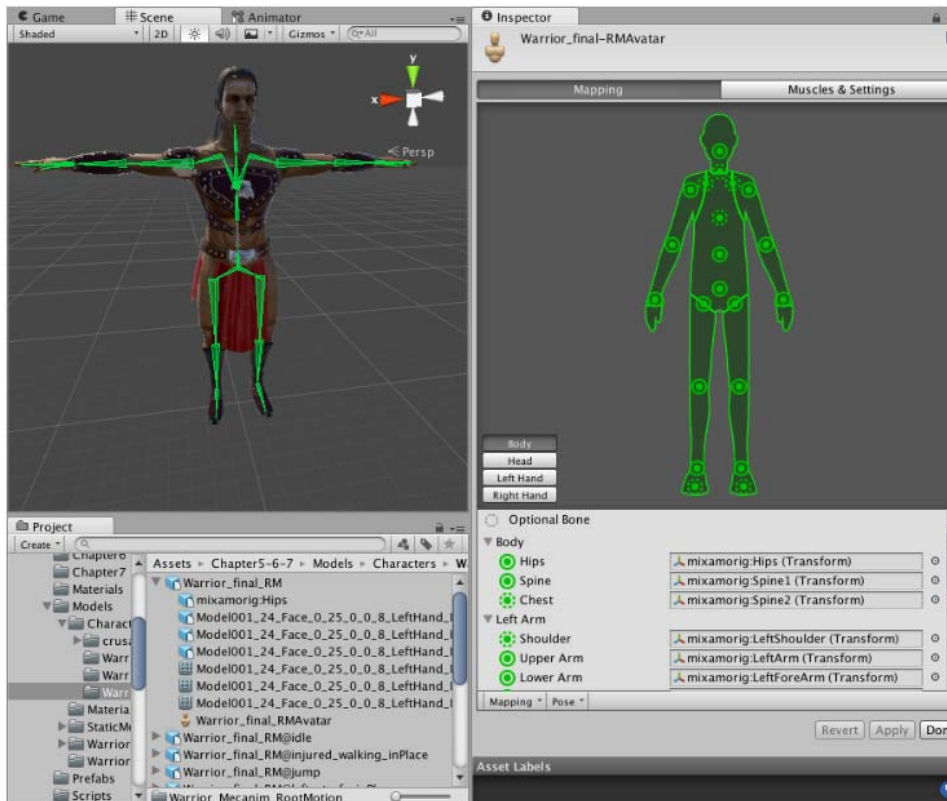


Fig. 23 Creating a custom animation in Unity

Controlling the character and the camera view is easy and usually through the same keys used in other Virtual Worlds or popular 3D Video Games. Avatars can walk, run, crawl and even fly around, unless the region's administrator has specifically restricted it.

Textures

Textures are 2D images mapped to the 3D surfaces, using different mapping methods.

Realistic representations require high resolution textures, which are usually extracted from optimized on-site photos. Creating quality textures for the 3D objects is crucial to achieve detailed, realistic worlds and for complex objects is a difficult and demanding task referred to as "UV mapping". However, when working on simpler, basic prims with limited planes it is much easier.

Video textures

Creating

It is also possible to map video content to 3D surfaces, usually rectangular planar surfaces, but not necessarily.

Such videos can have: small dimensions, providing various animation to the virtual space, or big dimensions – providing cinema-like presentations right inside the virtual space.

OpenSimulator also allows using a mask over the textures to easily modify the colour, add a glowing effect on it, or even setting a transparency value, giving it an opaque view.

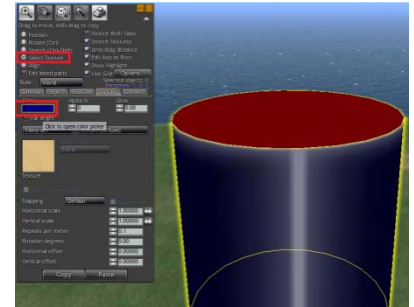


Fig. 24 3D texture

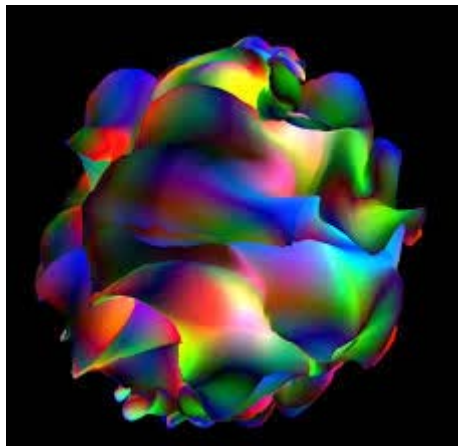


Fig.25: colouring textures

Technically speaking, SketchUp enables you to import images that are already on your hard drive. When you import images from your hard drive you can import the image as an image, a texture, or a matched photo.

It is possible to import the image as

- **a texture**, and to apply the image to an existing face. However, you also gain access to all the materials and Position Texture tools. These tools are introduced in adding Colors and Textures with Materials, but that article focuses on tiled images.

- a **matched photo**, and you activate SketchUp's Match Photo tool, which enables you to match a photo of an existing building to a model of that building or draw a building based on a photo. Match Photo enables you to apply images to buildings two faces at time, using the corner of a building or room to apply a 2D image onto a 3D model.

Image formats with transparency capabilities such as PNG, can be used to create simple 2D objects that appear as 3D from specific angles.

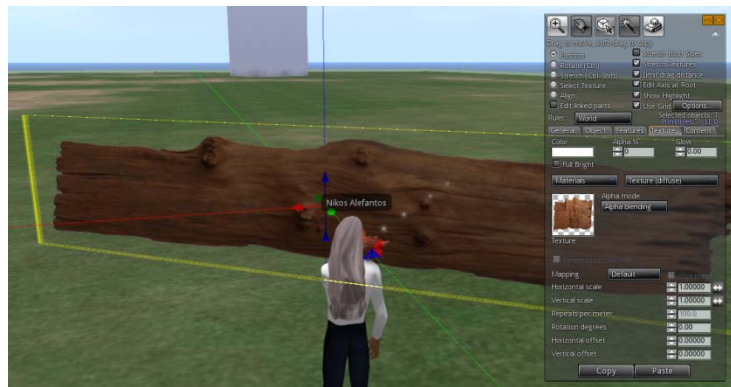


Fig.26: using an image with transparency to create a 2D tree trunk.

Finally a recent feature is **MOAP (Mobile Oriented Applications Platform)** is the software platform for **mobile phones**. This allows projecting a web site on the surface of a prim. This is a very important aspect for trainers, that allows them to project existing learning material (e.g text or presentations) inside the Virtual World, so they do not need to create 3D objects.



Fig.27a. Projecting a website inside the 3D World



Fig.27a. Projecting a website inside the 3D World

Lighting

Lights and shadows add realism to a 3D scene.

The system that builds lighting in UDK is called "lightmass". UDK, using lightmass, needs to handle at least two distinct types of lighting:

- Static (unchanging) lighting, which can be heavily optimized by baking the lights to textures called lightmaps or to vertex colors. Used to assemble the 3D space, these lights have fixed position, color and intensity; as their contribution to the scene is precalculated and mixed into the texturing, they won't require any CPU or GPU time at runtime.



Fig.28 Static light

- Dynamic (changing) lighting, which cannot be optimized nearly as much. UDK can use something called light environments to optimize dynamic lighting, but a lot more calculation must be done. Dynamic lighting has dynamic position, color and intensity and their contribution to the scene is calculated in real time. It is a common practice to use some variable (dynamic) light sources in the 3D scene to simulate some natural light variations, like sunlight or weather conditions, in order to make the scene more realistic.



Fig.29 Dynamic lighting using RGB lightmap

During gameplay, both static and dynamic lighting are combined.

Sound

Sound enhances the immersion in the 3D virtual space. It can be:

- background music and sounds
- voice records
- audio for the video textures
- various other sounds (example, step sound for animated characters)

Basic Interactivity

Avatars can interact with various objects in the 3D world by touching (clicking) them or other events that can trigger a behaviour that has been scripted in them. For example, clicking on a chair object may cause the avatar to sit on it.

Every avatar has an Inventory, which is a file directory that stores various types of files such as 3D objects/prims, sounds, animations, scripts, body parts, clothes etc.

However, as advanced as those technologies are, there are a few limitations



If we are thinking to HMD - head-mounted display, primary component of virtual reality headsets, which is a display device reflecting projected images and allowing a user to see through it, it is well known that a HMD has many uses, including in gaming, aviation, engineering, and medicine lift. But the HMDs give visual support for the simulation while motion tracking devices provide means for our body to interact with the virtual world. On one hand, most HMDs deal exclusively with visual perceptions and head movement while completely ignoring any other body movement. As a result, HMDs applications are usually static and display static, generic avatars, frustrating any kind of user interaction other than through vision and head movement. Therefore, users are limited on how they can interact with the system, depending on which device they use. A possible solution is to use the capabilities of both devices in an integrated hardware-software approach. Ideally, this system would be able to track body movements, record user images and present them inside the head mounted display, reacting to what the user is looking at and how the user is moving.

Non-Playable Characters

Using a specific set of scripts, it is possible to generate and control the behaviour of NPC Characters (avatars that are not controlled by a player. NPC behaviour in computer games is usually scripted and automatic, triggered by certain actions or dialogue with the player characters.

Some of the actions available to control these characters are:

- NPC character can be created at target position
- NPC walks, runs or flies to a target position.
- NPC says a message that appears on screen.
- NPC rotates to face towards a direction.
- NPC does some animation: attack, or dance, etc.
- NPC follows the user-avatar.

These actions can be used along with the scripts described earlier to program in detail the behaviour of the characters based on events triggered by real avatars or the environment.

NPC characters can act as simple static bots that just give specific information, or even responsive dialogue agents that ask questions and respond to the user answers (through dialogue menus or by writing messages in specific chat channels).

These "non-players", NPC are often distinguished from player characters by avatar appearance or other visual designation, and often serve as in-game support for new players.

Head-up display, HUD

A head-up display known as a HUD, also known as a HUD, is any transparent display that presents data without requiring users to look away from their usual viewpoints.

A typical HUD contains three primary components:

- a projector unit,
- a combiner, and
- a video generation computer



Objects can be attached on an avatar in specific slots used for HUDs. These objects will be stationary in a specific position on a user's screen, so they can be used to create custom interfaces for displaying specific messages or textures to a user and even use scripts to allow interactivity with the HUD. For example, users will wear a HUD item and a small window will appear on their screen with a score updated based on their progress.

Integration with LMS

A very important capability of OpenSimulator and the LSL scripting language are the commands allowing it to send and receive HTTP messages, communicating with other servers or applications as well as querying and manipulating a database. This makes it possible to have other applications such as custom web sites or even Content and Learning Management Systems fetch and display data from the virtual world or send and manipulate data inside the Virtual World.



Taking advantage of these capabilities, integrations with LMS environments have been developed, with most notable among them being SLOODLE, an integration of OpenSim/Secondlife with popular LMS platform Moodle offered as a free and open source project. SLOODLE provides a range of tools for supporting learning and teaching to the immersive virtual world; tools which are fully integrated with a tried and tested web-based learning management system used by hundreds of thousands of educators and students worldwide.

TalentLMS

TalentLMS is a super-easy, cloud LMS software covering all training needs which can build eLearning, presentations and videos or a wide range of online material with our social integrations in a very easy and fast manner.

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Course management



Content friendly

Build courses by re-using Presentations or Videos you already have or by consuming content from web-sources.



Scorm & xAPI

Support for the latest industry standard in content interoperability. [Read more >](#)



Assessments Engine

Support for multiple types of questions and a variety of test types. Extensive reporting on test results.



Surveys Engine

Collect and analyze survey responses.



Learning Paths

Restrict the way that courses can be completed or course content can be viewed.



Files repository

Organize, reuse and share files with selected users.

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