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Design of 3D Virtual Classroom in Second Life for Metal Cutting Technology Course

Andjelija Mitrovic [1], Maja Radovic [2*]
[1] Technical College Cacak, Čacak, Serbia
[2] University of Kragujevac, Faculty of Technical Sciences, Čačak, Serbia
[*] maja.radovic@ftn.kg.ac.rs

Abstract: *The paper describes possibility of using 3D virtual classroom in Metal cutting technology at the Technical College Cacak. The classroom is designed with aim to overcome common problems at laboratory classes, such as lack of time to work with real 3D models. Virtual worlds such as Second Life enable upgrading the reality and development of 3D models within virtual classroom. The 3D classroom will be used to allow students to access the high quality 3D models of cutting tools in virtual world at any time.*

Keywords: *3D virtual classroom; 3D models; cutting tools; Second Life*

1. INTRODUCTION

The Metal cutting technology course provides elementary knowledge in the field of metal cutting. Through laboratory classes students gain practical knowledge that are necessary to successfully accomplish the course. Laboratory classes for machining cutting at the Technical College Cacak are performed in a mechanical laboratory, with a large number of different types of tools that are used in cutting processing. Over the years, the problem has been notice, that students don't have enough time to interact with presented cutting tools. The interaction is based on brief visual presentation, without further detailed study of the complex tool geometry.

On the other hand, use of virtual environments for distance learning and training shows significant growth in the recent years. The 3D worlds offer the ability to create complex, highly interactive simulations using in-world modeling and scripting tools [1]. Educators rapidly adapt these new technologies to their courses, since these tools solve several difficulties frequently associated with practical classes in engineering laboratories [2].

Second Life virtual world [3] is one of the most promising environments for teaching and learning. It enables large groups of students to interact with each other as well as within a three dimensional environment [4]. The Engineering Education Island that is dedicated to teaching engineering related subjects is introduced in [1]. Practical use of its additional functionality is also discussed. Preparation and implementation of Computer graphics course is described in [4]. Authors in detailed explained lesson implementation and evaluation in Sloodle environment, which presents integration of Second Life and Moodle platform. Design of learning environments, called MecaTeam 3D, for mechanical engineering is described in [6]. It should help students improve their machining skills. However, to the best of our knowledge there are no descriptive case studies published on the use of Second Life in the fields of metal cutting technology education.

The main contribution of our current work is design and implementation of additional laboratory class in Second Life. Its main purpose will be to further introduce students with complex geometry of different metal cutting tools, and also to give them opportunity to learn at their own pace and time.

The rest of the paper is organized as follows: in section 2 (Uploading complex models to Second Life) we explain in detail how to upload complex models of metal cutting tools; in section 3 (Design of 3D classroom) we give overview of the main classroom elements and their purpose; in section 4 (Concept of one laboratory class in 3D classroom) we give explanation how first meeting in virtual laboratory will look like; and finally the section 5 provides the summary and future work.

2. UPLOADING COMPLEX MODELS TO SECOND LIFE

Second Life has user friendly and free 3D modeling tools that allow users to create basic 3D shapes called primitives. Those models can be resized, deformed or scaled and linked together to form, in some extent, complex 3D models. However, Second Life has limited capabilities for modeling objects with complex geometry. [7]. Due to this limitation, cutting tools that are very

complex consisting of large number of surfaces cannot be directly created or uploaded to Second Life.

The issue can be partly resolved, in two ways. Teachers can first develop models in some of the software packages for 3D modeling, such as SolidWorks, CATIA, etc. These tools achieve the highest degree of model fidelity. However, if teachers are not skilled in working with these software packages, they can join GrabCAD community, which is a place where engineers and designers from around the world share their CAD models [8]. GrabCAD library offers variety of complex models created in some of the CAD packages. Regardless of chosen method, it is only possible to upload models to Second Life if they consist of primitive shapes.

Blender application [9] turns out to be the best solution for resolving this issue. It is a professional free and open-source 3D computer graphics software product used for animated films, visual effects, art, 3D applications, etc. 3D modeling is one of the Blender's most important features.

In order to import model into Blender, it needs to be in some of the following file formats: .stl, .3ds, .obj, etc, that are used as file formats for conversation between different 3D modeling software. To reduce number of triangles and vertices of the model, we used Blender's Decimate Modifier option [10]. It allows reducing with minimal shape changes (Fig. 1).

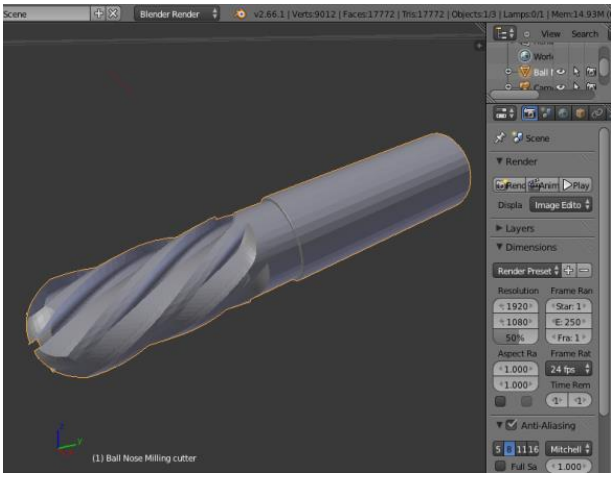

Figure 1. *Model ball noise milling cutter in Blender program*

Define After preparation in Blender, process of uploading edited cutting tool model to Second Life requires several steps and adjustment of some important options (Fig. 2). In order to select Model with *.dae extension teacher needs to go to Build menu that contains Upload option. Model's preview, with option for name and level of details, is presented in Upload dialog box. Card Level of Detail shows how many triangles and vertices does model have when it is in High, Medium, Low or Lowest level. Depending on the selected level, preview of the model is changing. Edges or textures of the model can be seen with Display option.

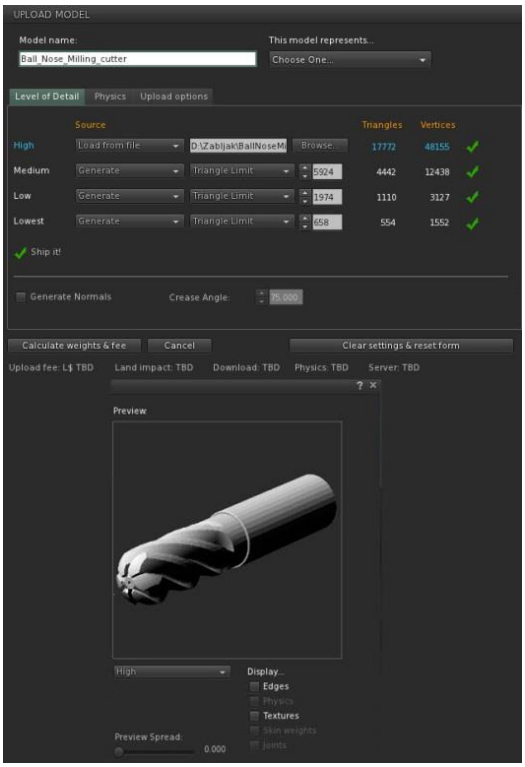

Figure 2. *Uploading ball noise milling cutter model to Second Life*

Besides cutting tools, the machine laboratory in Technical College Cacak contains different machines for metal cutting. 3D virtual classroom will also have 3D model of such machines. Fig. 3 shows milling machine in SolidWorks and Fig. 4 shows milling machine in Second Life.

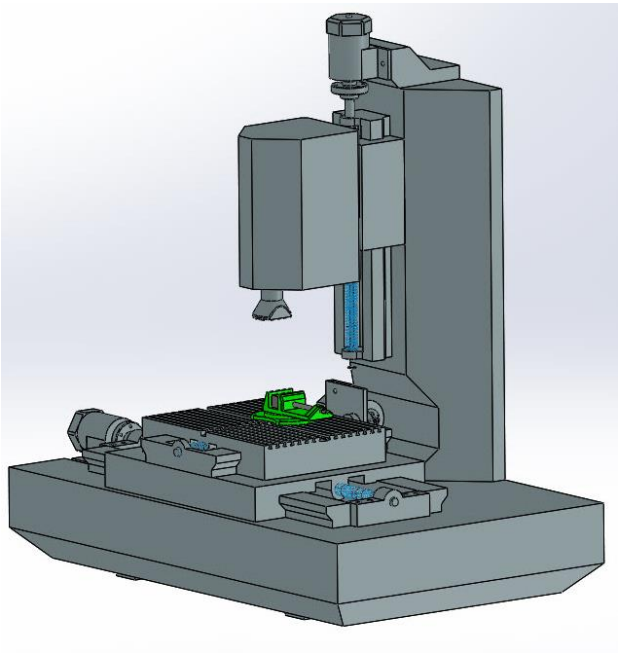

Figure 3. Milling machine in SolidWorks

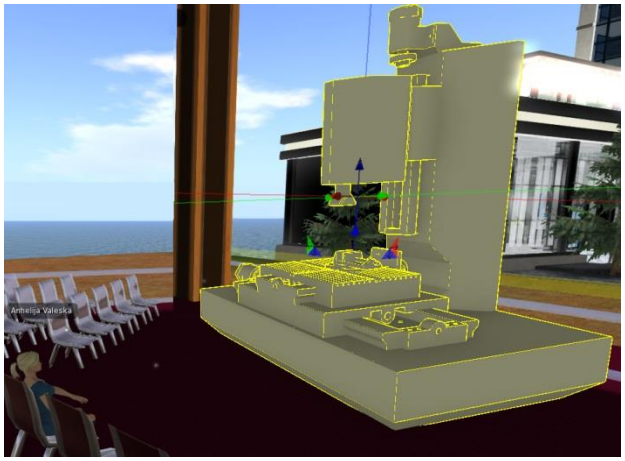

Figure 4. Milling machine in Second Life

Uploaded model can be further modified in Second Life. Beside simple modification, such as changing size or color of model, Second Life offers complex modification such as adding interactivity to model through different programming scripts. The Linden Scripting Language (LSL) which is official Second Life programming language is used to add functionalities to cutting tool models. Fig. 5 presents LSL script that is used to give models' ability to rotate. When users approach, model will rotate, thus allowing users to observe it from different angles.

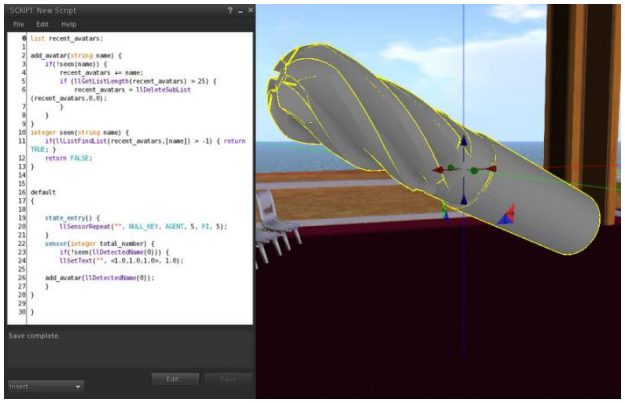

Figure 5. LSL script for rotation

3. DESIGN OF 3D CLASSROOM STRUCTURE

3D laboratory classroom is set within Second Life, and its organizational structure is based on users' activities that are grouped at particular 3D classroom floors. There are five floors and each one contains particular activities.

Registration Area is set at the first floor (Fig. 6). It has two main purposes. At the beginning it serves as gathering area before class starts. At the end of class visitors are expected to answer questions with the Choice tool.

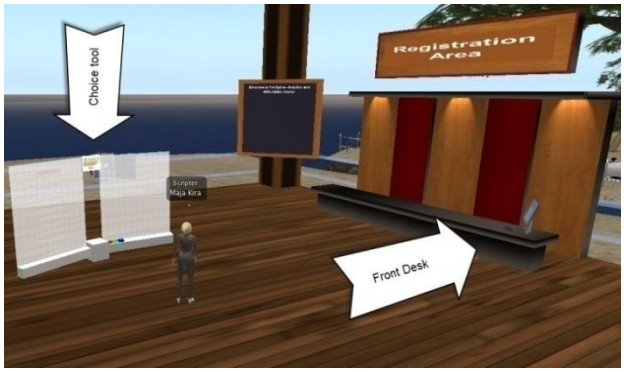

Figure 6. First floor of 3D classroom

The Choice tool (Fig. 7) can be used as a polling device to collect visual display students' preferences. In our class, we predicted that users go through all five levels of 3D classroom, and then to return to the First level and give their answers to Choice tool in what extent they are satisfied with 3D classroom. We set Choice question "How do you like this type of laboratory class?", and add following options: "I like it, and I would like to have more classes like this", "I like it, but I prefer traditional mechanical laboratory" and "I don't like it". These options then are listed as different colored bars on which users could click. The 3D choice bars will immediately grow once students submit their choice. This tool will give us general overview of students' satisfaction with the presented 3D classroom. For more detailed analysis, we are preparing evaluation, which will be more complex and presented to students in near future.

Figure 7. Choice tool at the first floor

Second floor is set as Presentation Area (Fig. 8). At this floor we placed different milling cutting tool models, such as ball noise milling cutter, end mill, face milling cutter, etc. When student approaches the model it begins to rotate, thus allowing student to observe it from all sides.

Above each model is placed presentation about that particular tool. We used Presenter slideshow

tool to set up presentations. Beside slide image, presentation can be video or a website.

Models that are placed on the second floor are used only for presentation purpose. Teacher can also share models from his inventory with students.

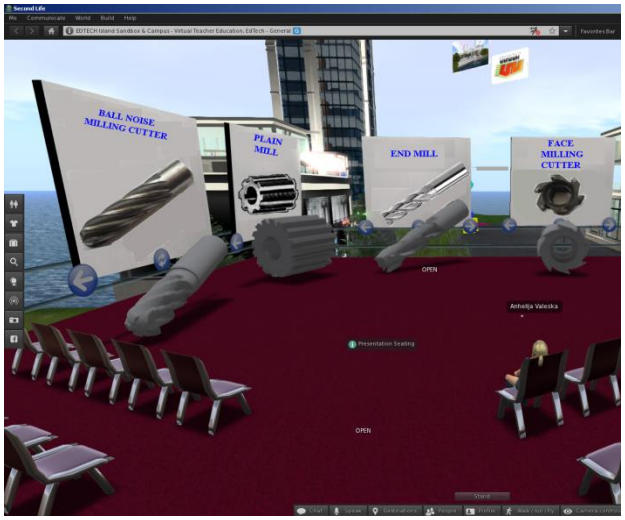

Figure 8. Second floor with cutting tools *models and presentations*

Meeting Area is set on the third floor of 3D classroom (Fig. 9). Here, teacher and students can discuss about cutting tools that they saw in Presentation Area. Also this area can be used for different sessions about some important issues, problems, etc. For the purpose of our class we placed in the center Milling machine surrounded by chairs.

Figure 9. *Third floor of 3D classroom*

At the fourth floor (Fig. 10) students will test their practical knowledge through solving particular assignments. Here, students will have different assignments to accomplish. For example, they will have to choose particular model that teacher assigned to them.

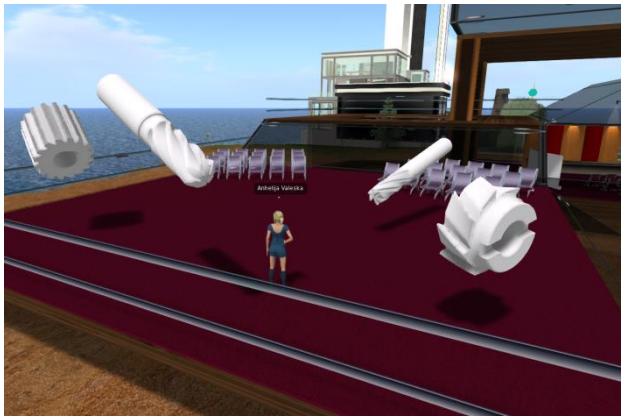

Figure 10. *The fourth floor of 3D classroom*

At the fifth floor students will test their knowledge about particular tools through quizzes (Fig. 11). Quiz chair is used for providing multiple-choice questions. In order to take quiz student has to place its avatar on quiz chair. When answer shows student can choose some of proposed options. If the student answers correctly, the quiz chair will rise half a meter, and if the student answers incorrectly, the quiz chair will descend.

Figure 11. *The fifth floor with Quiz chair and Scoreboard*

Beside quiz chair we placed Scoreboard tool, which displays points that user gained in quiz chair in order of highest to lowest. This will encourage users' competitive spirit.

Following section presents concept how one laboratory class in 3D classroom will look like.

4. EXAMPLE OF ONE LABORATORY CLASS IN 3D CLASSROOM

At the mechanical laboratory at the Technical College Cacak students first see real milling tools, such as ball noise milling cutter, end mill, face milling cutter, etc. After the class, teacher arranges meeting in the 3D virtual classroom. Meeting is arranged in the particular time so that all students can participate. Prior to the meeting they need to have their avatars created. Each avatar presents in the Second Life. At the scheduled time, teacher meets students in the Registration Area, and explains them how 3D

classroom works. At the Presentation Area on the second floor teacher introduces students with every 3D model of milling tool that are presented in front of them, and that they already saw in the mechanical laboratory. They can start presentations that contain important theoretical information, such as what types of milling tools exist, different geometry of each tool, etc. Also, students learn how to observe tools from different positions. After detailed observation of presented tools, teacher guides students to the Meeting Area at the third floor. There they have comprehensive discussion about tool they have seen. Through teacher's guidance students make comparison between real models and virtual ones. In that way they improve their theoretical knowledge.

At the fourth floor where the practical assignments are placed teacher explains what kind of assignment students can take, but they do not do them at that meeting. They are left for the student to solve them in their own time and pace.

Unlike practical assessment, at the fifth floor students do quiz to see what theoretical knowledge they gained at that particular meeting.

At the end of the class in the virtual classroom, teacher leads students to the Registration Area where they fill questionnaire about that particular class. This feedback will help teacher to decide about further meetings.

It should be noted that this is how virtual class will look like each time a new topic is processed. After the first meeting students can come to 3D virtual classroom whenever they choose, and learn at their own pace.

5. CONCLUSION

Although students participating Metal cutting technology course at Technical College Cacak have laboratory classes in the mechanical laboratory, they have not enough time to interact with presented tools. On the other hand 3D virtual worlds offer ability to create complex, highly interactive 3D models that will provide students the opportunity to practice at their own time.

In this paper we have presented the following results:

- Referred to some related work of Second Life application regarding training with 3D models
- Explained in detail implementation of complex 3D models to Second Life
- Applied Linden Scripting Language to enhance models' interactivity thus allowing students to better understand 3D models
- Described 3D virtual classroom
- Gave concept of one laboratory class in 3D virtual classroom

The importance of proposed approach is reflected in providing student with opportunity to work with complex 3D models that are often not available in real world practice. Future work will be related to conducting laboratory class in 3D virtual classroom and its evaluation.

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