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Importing a 3D Model from an Industrial Design

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In the media industry, sharing and transferring a 3D model to other programs for different stages of design is widely used. The final year project was carried out based on a case study in which a 3D model was imported from an industrial design to Autodesk 3ds Max.

The thesis focuses on defining the workflow for importing a third-party 3D model to the 3ds Max program. In general, importing a 3D model made by one program to another one always presents many challenges. The purposes of this study were to introduce: a) how three different file formats, i.e. 3DS, STEP, and IGES, can be imported to the 3ds Max program; b) what the existing problems are; and c) what the possible solution is.

Firstly, the thesis presents some background information by going through the 3D modelling workflow, and different stages of 3D modelling are discussed. Secondly, file formats that are compatible with 3ds Max are described. Finally, the case study demonstrates different problems, which rose during the transfer of 3D models between different industrial design programs, and possible solutions for each problem. The outcomes of the study are two-fold a) for a successful conversion, the STEP format is preferable; b) alongside with the preferable format, the study suggests a list of tips users need to keep in mind during the converting process.

In summary, the thesis deals with the workflow of converting the 3D model from the CAD software into the 3ds Max program and making the model ready for later designing processes. The thesis specifically discusses common challenges that rose during the process and presents potential solutions for each problem.

Keywords	Importing, exporting, modelling, texture, render, Xref objects, Xref scenes

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List of Abbreviations

3D	Three-dimensional
3DS MAX	3D Studio Max
CAD/CAM	Computer-Aided Design / Computer-Aided Manufacturing
CATIA	Computer-Aided Three-Dimensional Interactive Application
IGES	The Initial Graphics Exchange Specification
STEP	Standard for the Exchange of Product model data
3DS	Graphics (Autodesk Three-dimensional Studio)
UAS	University of Applied Sciences

1 Introduction

The three-dimensional (3D) technology, producing realistic 3D objects and characters, has become more important to the media industry over the past twenty years and it has always introduced new functions and practices in the industry. In this thesis, the author will deal with the theories and practical issues on the 3D modelling process, specifically the sharing and transferring of a 3D model from one piece of design software to another.

This study was carried out based on a case study of a collaboration project between Helsinki Metropolia University of Applied Sciences (UAS) and a Finnish ship-design company called Deltamarin. Deltamarin designs different kinds of ships and they also specialize in offshore engineering. In this project, the company co-operated with Metropolia UAS in making a short commercial video for their new ship design. The problem of the project was that the 3D model of the ship, which was designed in the CAD software, did not come with texture and animation required for an impressive commercial video. Hence, in order to make a realistic model for short animation, first of all, the original design had to be transferred to the premises of Metropolia UAS and refined by Autodesk 3ds Max, a common tool used in the media and entertainment industry that Metropolia has licenses for. Eventually, importing the 3D model made by the CAD software to Autodesk 3ds Max became the first and the most important part of the project.

A model, which is imported into other programs for more design stages, always contains errors and problems. The model in this case was exported from CATIA and could not be used directly in 3ds Max. To make the model ready to be used, different tools were essentially used for different types of processes. In the later part of the thesis, I will define the workflow of converting a 3D model from an industrial design to 3ds Max, as well as the necessary post-process for producing a usable model.

To be able to transfer the most accurate and detailed 3D model, many file formats were tested and eventually three file formats that are compatible with 3ds Max were exported and evaluated. My final observation is that only one format, the STEP format, works.

Alongside with the preferable format (STEP), the thesis also includes a list of tips that users need to keep in mind during the converting process of a 3D model.

The thesis is structured as follows. Firstly, the thesis introduces a general 3D modelling workflow. All the processes needed to implement a 3D model are described. Next, the file formats that were used to import a 3D model are explained. Finally, the demonstration of how to import a 3D model made by the CAD software to 3ds Max is presented together with possible challenges that might occur during the process. The section is concluded with some potential solutions tackling the challenges.

As a disclaimer, because of the confidentiality of the project, only a small portion of the full model (including pictures) was used in the project described in this thesis. Despite its imperfections, enough information, explanations and analysis will be presented in the thesis.

2 3D Modelling Workflow

In the world of computer design, 3D modelling is the process of developing graphics and images that appear to have three dimensions and the process of transforming a simple object into a refined and detailed object. Models may be created automatically or manually. From models to virtual objects, the process is complicated. In general, the approach completes by connecting the knowledge of 3D modelling, texturing and rendering. [1.]

3D models display a 3D object using a point collection in 3D space. The model generally involves connecting a set of points with various geometric entities such as triangles, lines and curved surfaces. [1.]

3D modelled virtual objects can be found in many fields, for example movies, games, designs and media. Depending on the purpose of the uses, 3D models can be created using different software. The models are easier to do with the programs designed expressly for that purpose. There are many various programs that are used all over the world such as CATIA, Autodesk, Blender, and Houdini. [1.]

Because of use requirements, 3D models sometimes need to be shared and transferred to different software for different stages of a design. An importing and an exporting method can help to transfer 3D models from one to others.

In order to make the model ready for use, the processes require many stages, as it is shown in figure 1.

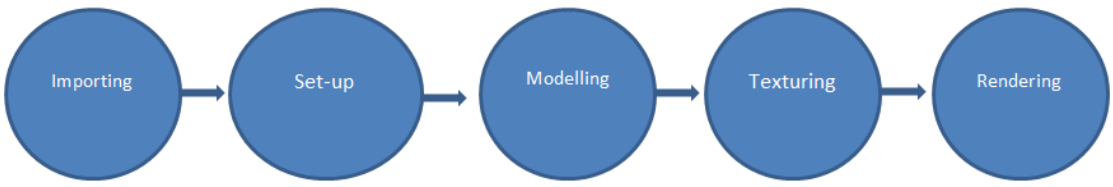

Figure 1: 3D model process stages.

The thesis covers all the processes that are shown in figure 1. This information is necessary to have a deeper understanding of the workflow of the 3D model to the very last stage.

3 Modelling and Texturing

According to Michele Bousquet, “Models are the main building blocks of scenes. When creating a model, it is important to model just enough detail to make a good rendering. It is easy to get bogged down in small details that take a long time to model and will not even be noticeable in the final rendering”. [2.] Users spend most of their time modelling, and then lightings, texturing and animations are applied on the model. In the early stage of the media industry, when computer graphics were new and not widely known, any model, texture and render were impressive. Nowadays, especially in the media industry clients expect a more decent quality for production. If the production does not look realism, it is useless. To achieve the goal of making the 3D model look realism, the best approach is to take time at the very first stage to gather all the reference materials such as photos, drawings, and textures. In order to save time, users should know beforehand what they are going to do and what outputs clients expect. Clear structure, useful instruction and vivid output pictures can let users achieve the goal without hesitating. [2.]

3.1 Modelling

Kelly Murdock said, “Modelling is the process of the pure creation. Whether it is sculpting, building with blocks, construction work, carving, and architecture or advanced injection modelling, many ways exits for creating objects. 3ds Max includes many different model types and even more ways to work with them”. [3.] This process is one of the most important parts in the modelling process in order to make models for virtual objects. In fact, users spend a lot of time modelling. It is possible to draw basic lines and create curved surfaces, making detailed and vivid models.

3D modelling is used to design 3D objects with specific programs to make virtual objects. The 3D objects are represented as a collection of points in 3D space. They are connected by various geometric entities such as triangles, lines and curved surfaces as it shows in figure 2.

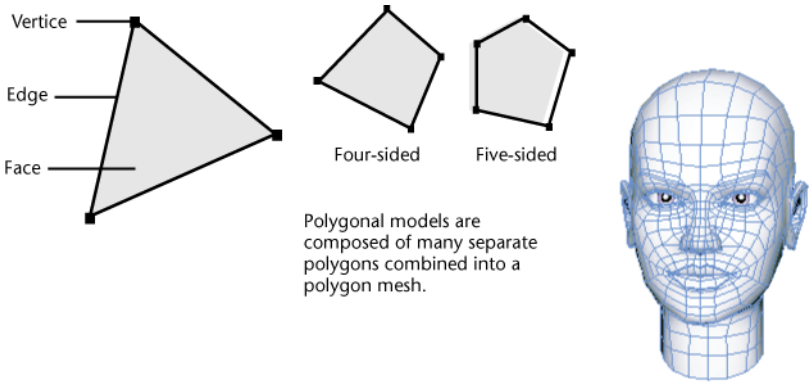

Figure 2: Polygonal Meshes. Copied from Autodesk Mudbox 2009 [4].

The point collection creates the edges, and then edges can form a plane in the gaps between the edges. These polygons assemble and build the object's surface; the combination of these polygons is called polygon mesh. The surface of the polygon area is called face, and each of these polygons has its own face. [1.]

To represent a model, there are four specific methods:

- Primitive modelling: This is the most basic and simplest modelling method. In general, it involves geometric basics use such as cylinders, cones, cubes and spheres. This method is popular and used in creating 3D models of technical applications.
- Polygonal modelling: This is a more advanced approach to 3D modelling. Line segments are connected through points in a 3D space to form a polygonal mesh and they are called vertices. Polygonal modelling becomes the most popular method in modelling since it is simple and easy to use. However, because of creating exact curved surfaces, this method is limited of use in some certain application.
- NURBS modelling: This is one of the best ways to create smooth, curved surfaces. This method allows users to bend the space of the curves. This method is most used across platforms.
- Splines and patches modelling: This method is a more advanced form of NURBS modelling. It becomes popular in the 3D modelling industry since it allows users to use curved lines to identify and design the visible surface.

[1.]

Out of the four above ways, the users can choose the right way to use depending on the models and their needs.

Sharing a 3D model with other software for different design stages, it is really important to pay attention to the model's format. Many 3D formats are mesh-based. Sometimes when importing a model as a mesh objects, it can cause problems. By collapsing an imported model to an editable mesh, it is possible to help to clean up the problems. [2.]

3.2 Texturing

Michele Bousquet has stated, "Good texture maps are the key to believability in renderings. Realistic textures can bring a crude model to life." [2.] Alongside with the modelling, texture takes the most of user's time in designing parts. A good model but texture that look awful can fully destroy a model.

According to Justin Slick, "A texture map is a two dimensional image file that can be applied to the surface of a 3D model to add colour, texture and other surface detail like glossiness, reflectivity or transparency". [5.] To make the model look realistic, texture map is one of the important methods that need to be applied.

Similar to modelling, texturing also has various methods to apply on the model. Texturing contains different methods with different tasks:

- Texture is defined as the process of details and graphics being added on the surface of an object polygon. This helps lengthen the period of existence of an object and make it look appealing and real. Having the accurate textures for rendering realistic 3D images is very important.
- A shader describes the material on an object in detail, including how the light is reflected, how it is absorbed, and translucency and bump maps. The 3D object can have its particular look when a texture gets connected to a shader.
- Specularity determines how a surface reflects light that is basically the texture's reflection of the light source. It is necessary to have the right specularity in defining what the 3D object's material is made from.
- UV mapping stretches out the 3D model into a 2D image so that it can be easier for a program to apply an image on the model.

[6.]

Apart from the methods of texturing, there are some other techniques to decorate the models as described below:

- Colour map: to add colour or texture on the surface of an object, this method is a simple method like applying a wood grain texture on a table surface.
- Specular map: This is to divide object into various parts to apply different separated texture. For example, texturing for a game character, multiple materials such as skin, clothing and a metal sword are added on the model. As a result, a specular map would need to convey the different levels of glossiness.
- Bump, displacement or normal map: this method is more complex compared to either of the two methods above.
    - A bump map: simulates bums and wrinkles on the surface of an object.
    - A displacement map: displaces the texture on the geometry of surfaces.
    - A normal map: adds details without using more polygons, and it simulates the impression of a detailed 3D surface by modifying the shade of the surface of an object.

[5.]

All these methods with different ways of using are the most popular in texturing. To make the process faster and easier, users need to get familiar with the methods so that they can choose an accurate technique to apply on the model.

4 Rendering

Rendering is the final step of 3D modelling. A model in a 3D scene is actually a mathematical representation of points and surfaces in three-dimensional spaces. Therefore, the term rendering refers to a number of calculations by a 3D software render engine. The engine translates the scene from a 3D model to a finalized image. During the process, the entire scene lighting and the textural and form information are calculated to determine the colour of each scene so that it translates into image. In general, rendering is similar to taking pictures of things, to translating all the virtual bits of 3D virtual objects into actual output images so that people can see the model in every single shadow and detail as videos or still images. All the reflections and the shadow details used in the texture are calculated for every pixel in the rendering process. Besides, the camera effects such as fog and depth of field are also taken into account during the rendering process. [7.]

4.1 Local Rendering

Rendering is an essential part because it represents all the work that has been done so far. The process is to render out the finished animated model to the last sequence frames. All the textures and mapping that are applied on the model, they will be displayed on the image in every small shadow of the pixel. [7.]

There are two ways of rendering the frame images, which are rendering on the computer that the model has been working and network rendering. If the model is small, it simply can render on one computer. In case the model is too big and heavy with too much polygons and textures, it is easier and faster to use network rendering.

Local rendering is rendering the model on a computer that has been used to model and texture. In 3ds Max, it is easy to find a render scene on the top menu bar as can be seen in figure 3. [8.]

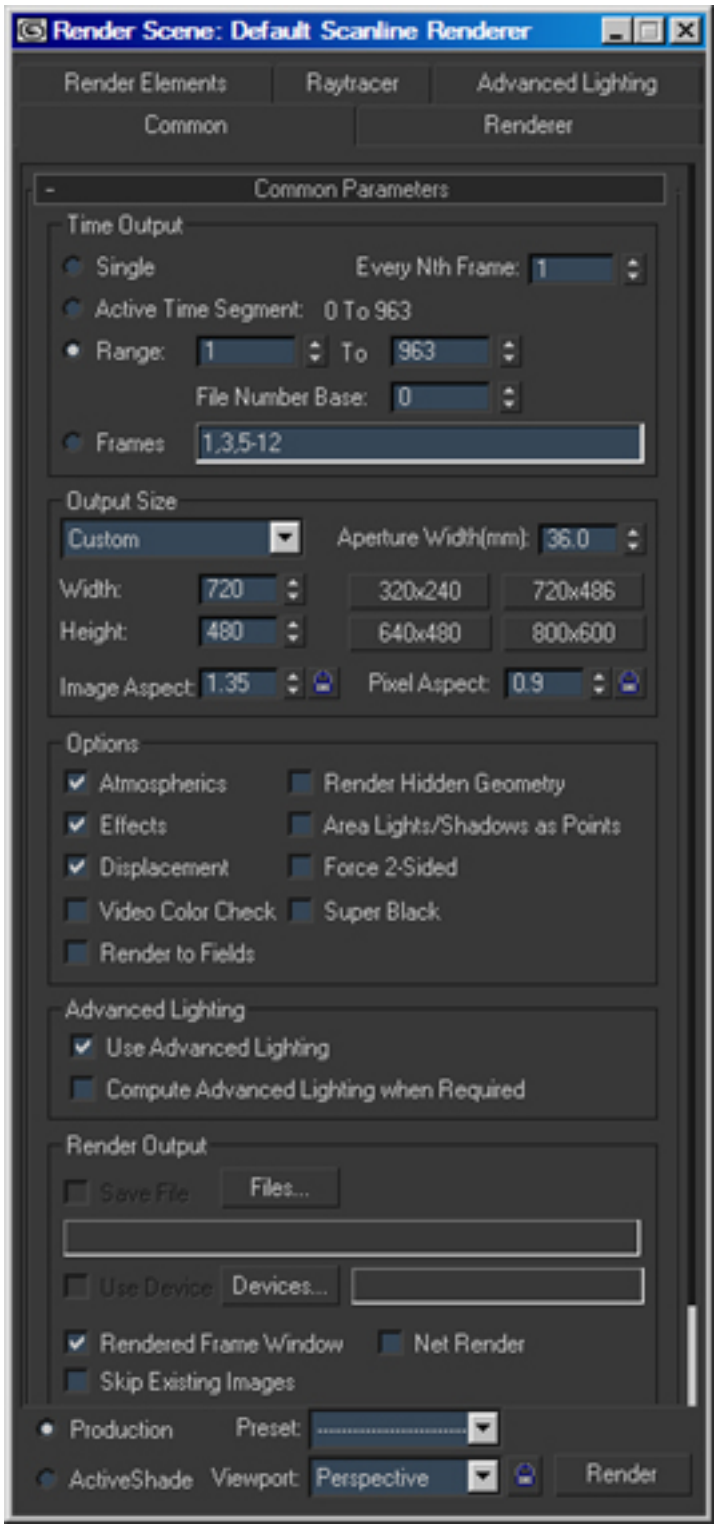

Figure 3: Render Scene Setting Dialog Box. Copied from Rendering Your Completed Animated Scene to a Sequence of Frames in 3DS Max. Screenshot [8].

On the render scene, render output represent sequences of frame such as tga, png or jpg. The advantage of rending to a sequence of frame is allowing users to decide the

amount frames of the output. Customizing the output size for multiple file formats can modify the highest image quality. [8.]

4.2 Network Rendering

Network rendering is sending the work over a network to multiple computers. In order to facilitate network rendering, Autodesk Backburner is installed with 3ds Max. There are few software tools that can support network rendering such as Lux Render, Render Pal V2 and Backburner. Autodesk Backburner is a free software application packaged with 3ds Max, Flame, Maya and other Autodesk products. The Backburner software is responsible for coordinating how job assignments are processed. [9.] It acts as the queue manager for background and managed network-processing tasks. It allows more than one computer to perform the tasks while maintaining the main Autodesk program available for use. In order to make the tasks more quickly and efficiently, Backburner breaks the job into many smaller parts. This feature works both on local networks and over the Internet as long as the same version of servers is installed. [9.]

In order to use the network rendering, the following condition must be applied:

- 3ds Max must be installed on all computers. It is not necessary to have a 3ds Max license on those computers if they are just for rendering.
- All network communications and protocols should be installed and operating correctly.
- Each computer must run a recent version of Windows such as Windows 7.
- All computers must be named as letters.
- Manager and Server should not be installed as services.

[9.]

As it is demonstrated in figure 4, the networks render setting dialog shows:

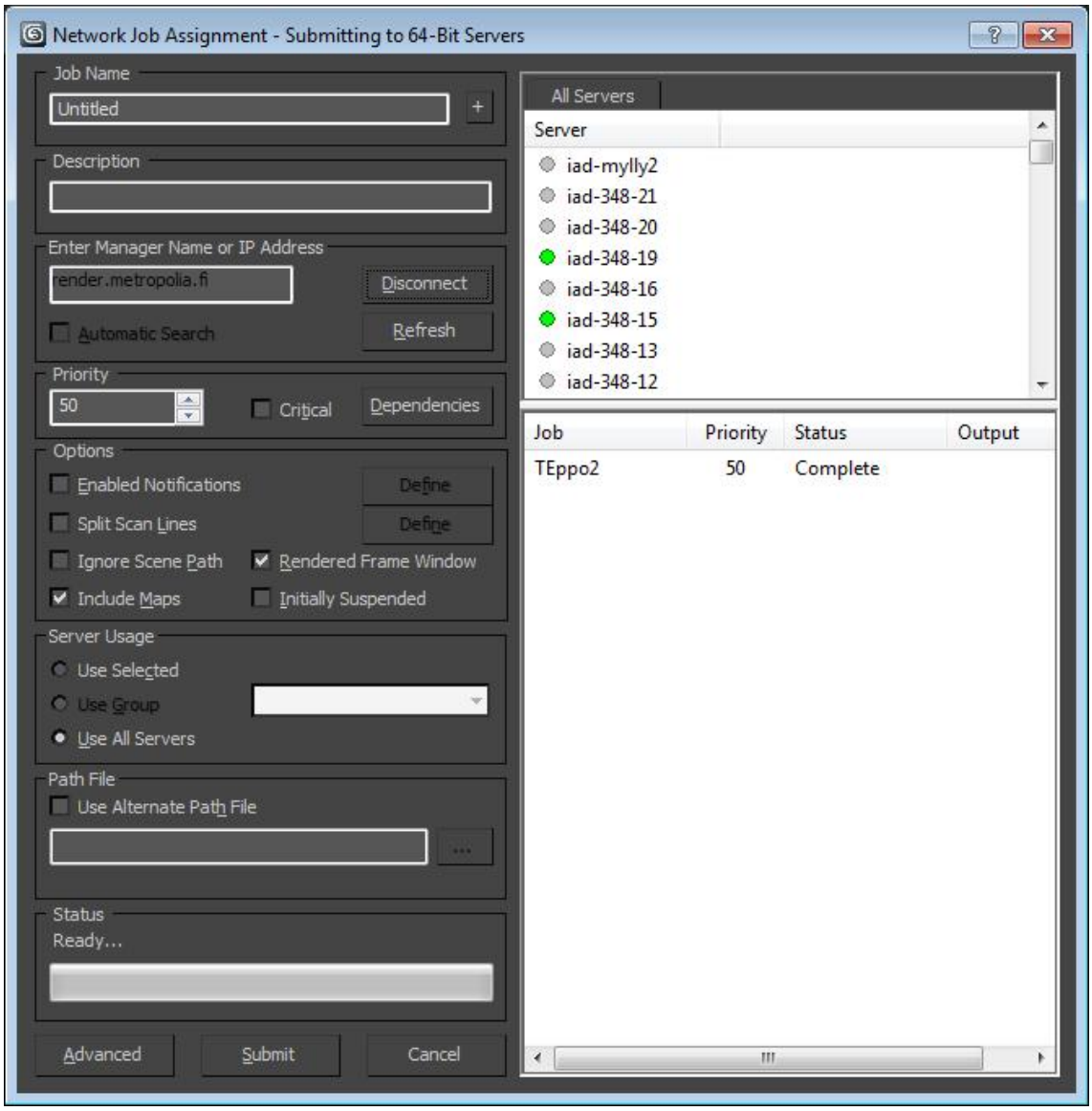

Figure 4: Network Render Setting Dialog Box. Copied from 3ds Max Network Rendering. Screenshot [10].

Backburner is the software used to render over network. It consists of three different components.

- Backburner Manager is the centre of the process.
- Backburner Server is mainly used to run on workstations, also known as slaves. The server runs on slaves when all machines are free to use. Slaves do the hard time taking calculations and then save all resulting images on the same output folder that is normally called “output Render”.

- Backburner Monitor is used for monitoring the render jobs and how the process is implemented, whether the process is successful or there are errors that need to be fixed.

As can be seen in figure 5, the monitor-setting dialog of Backburner software tool shows:

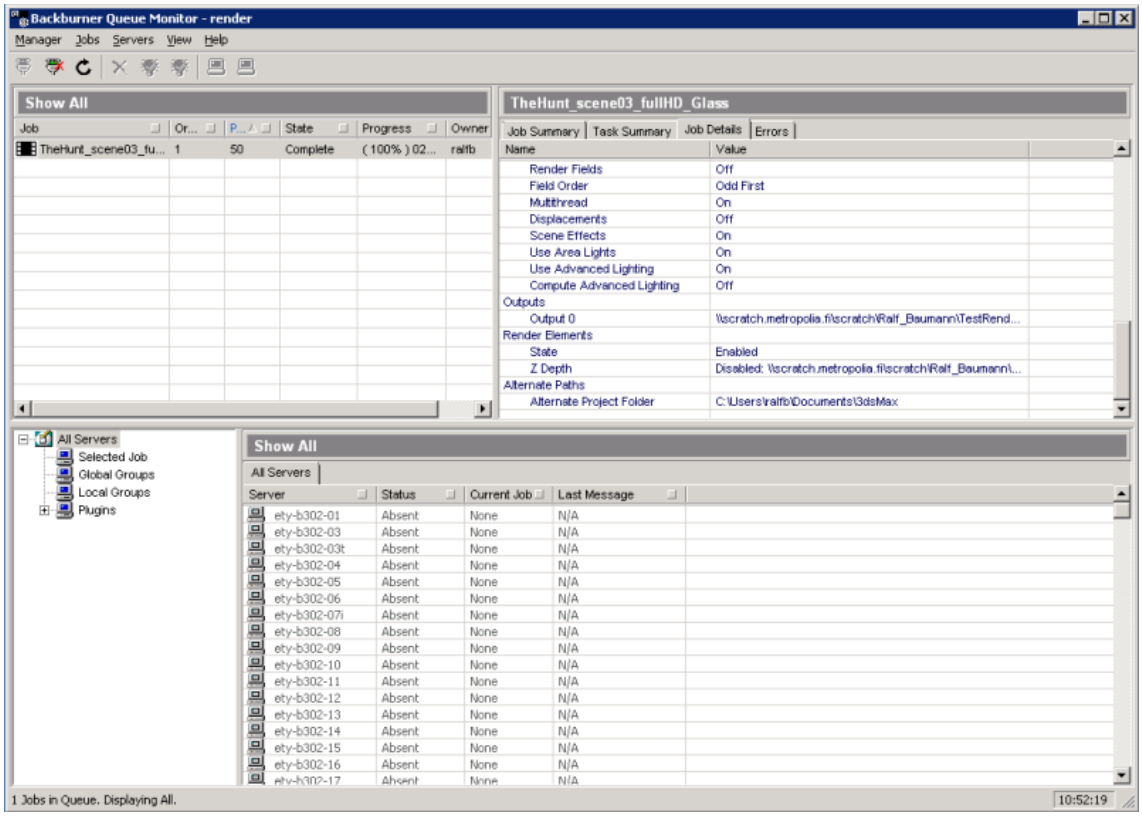

Figure 5: Backburner Monitor setting. Copied from 3ds Max Network Rendering. Screenshot [10].

In order to recheck the render system, “Monitor” should be opened and “connect to manager” should be selected to check the work that has been doing so far. Monitor lists all the current jobs, showing the names, owners, states and progress of the jobs. The bottom part shows a list of all the servers that are connected to the system, the list displays all the slaves that can be used and whether they are online or not.

- Job Summary: To show details of the job, mainly when it was submitted and finished.

- Task Summary: To show the processing details, for example whether it is done or under processing and how long it took to render.
- Job Details: To check if the set output path is correct.
- Errors: shows if there is anything wrong or error.

If there is an error that needs to be edited, the project name should be right clicked and “Edit setting” should be chosen. This function helps designers to edit certain things without sending the job all over again. [10.]

4.3 Common Rules

The rendering process takes time and space. After rendering the images can be transformed into video. In order to make the process easier, the output folder should be empty. All unnecessary images should be cleared up. [2.]

Additionally, the name of the job or folder should be short and simple. It is important to avoid extra-long names, non-alphanumeric or special characters. The best relevant choice is to use naming that combines letters a-z and numbers 0-9. [2.]

The output format has to use an image format such as tiff, png, jpg and tga. Due to experience in rendering, the tiff format is given the best resolution when converted to video. Therefore, it is recommended to use the tiff format as the final image format for output rendering. [2.]

In order to make the rendering successful, it is really important to save the location and set the output path so that the system knows where the images can be stored. [2.]

5 Importing

The actual dimensions are referred to as 2D and 3D in a computer workspace. 2D is flat and uses the horizontal and vertical (X and Y) dimensions. Since the image has only two dimensions, when turning the image into one side, it becomes a flat image. On the other way, 3D adds the depth (Z) dimension that allows rotation and visualization from multiple perspectives. This shows how different a photo and a sculpture are. [11.]

3D modelling is widely used in different industries like films, animation and gaming, interior designing and architecture. Besides these, it is used in the medical industry for interactive representations of anatomy. In constructing digital representations of mechanical models or parts, the large numbers of 3D software are utilized before they are actually manufactured. With the software used in such fields as CAD/CAM related software, not only the mechanical models are constructed but also assembled and functionality is observed. [12.]

Moreover, 3D modelling is utilized in the industrial design in which 3D products are modelled before being represented to the customers. 3D modelling is used in media and event industries for the stage or set design. [12.]

Different programs support different functionalities and different tools are used for different types of projects. Hence, the models are shared and transferred between different programs for different stages of the design.

The various 3D programs have been launched and used in the media industry. Hence, exchanging files between them is where the importing and exporting menu commands come in. These command options can be found in the file menu as it shows in figure 6.

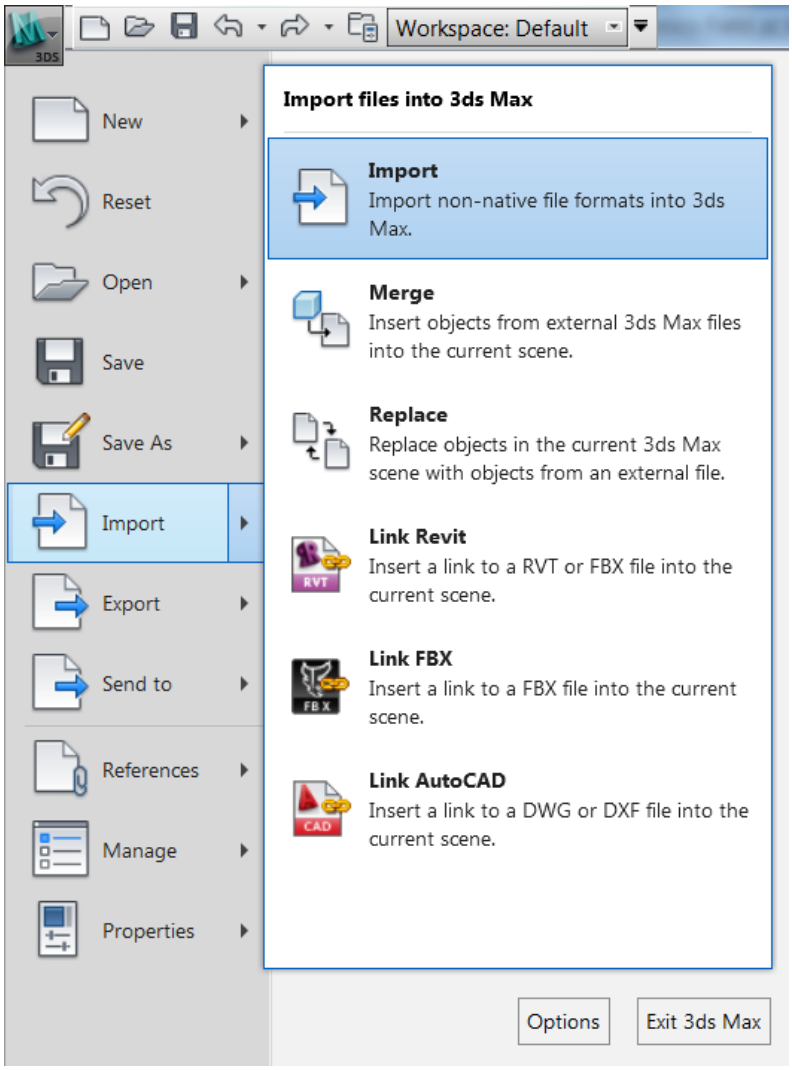

Figure 6: Import Command Menu. Screenshot [13].

The importing and exporting commands allow users to share 3D geometry with other 3D program. There are many 3D programs used in the world nowadays. Depending on the purpose the software is chosen to meet the requirement.

Autodesk 3ds Max is one of the programs widely used in the media and entertainment industry all over the world. It is also utilized in media education institutions such as, Metropolia US. It was also used in the project that this thesis describes.

There are several file formats that can be imported and exported into 3ds Max. All acceptable files are automatically displayed in the file dialog box when selecting the import option. [14.]

The available import formats include the following:

- Autodesk (FBX)
- 3D Studio Mesh, Project and Shapes (3DS, PRJ; SHP)
- Adobe Illustrator (AI)
- Collada (DAE)
- LandXML/DEM/DDF
- AutoCAD and Legacy AutoCAD (DWG, DXF)
- Flight Studio OpenFlight (FLT)
- Motion Analysis (HTR, TRC)
- Initial Graphics Exchange Standard (IGE, IGS, IGES)
- Autodesk Inventor (IPT, WIRE, IAM)
- Lightscape (LS, VW, LP)
- OBJ Material and Object (OBJ)
- ACIS SAT (SAT)
- Google SketchUp (SKP)
- StereoLitho (STL)
- VIZ Material XML Import (XML)
- STEP (STP, STEP)
- Rhino (3DM)

[14.]

Many available options can be imported into 3ds Max, but not all of them are mentioned in this thesis. In the thesis, only those formats were utilized to import a 3D model for the project of the case study are analyzed. STEP, IGES and 3DS are file formats used to export the model. Though those format files are exported from the same CAD file, two of them are not compatible.

In the case study, the model designed by the CAD software is utilized mostly in industries. The model cannot be used directly because it lacks textures and materials. In order for it to work in video commercials, it needs to be transferred to other software for more designs. Moreover, to give more options for using the model with fewer errors and the best result, the model is exported into three different formats IGES, STEP and 3DS.

How these formats work is explained in the next chapter.

5.1 IGES File

IGES (Initial Graphics Exchange Specification) was the first specification for CAD data exchange published in 1980 as a NBS (National Bureau of Standards) report in USA. [11.] IGES was originally created for exchanging the drafting data like 2D/3D wireframe models, text, dimensioning data, and a limited class of surfaces. Due to developing and requiring of users, IGES has been ongoing improvement and now it can support more capabilities such as entities, syntax, clarity and consistency.

The IGES specification describes the file format, language format, and the product definition data. In the product definition, geometric, topological, and non-geometric data are included. The geometric entities used to define the geometry are determined in the geometry part. The topology part describes the entities that identify the relationship between the geometric entities. There are three divisions such as annotation, definition, and organization in the non-geometric part. The annotation category contains dimensions, drafting notations and text. With the definition category, users can define specific properties of individuality or collections of entities. The organization category describes groupings of geometry, annotation, or property elements. An IGES file has six sections, which are Flag, Start, Global, Directory Entry, Parameter Data, and Terminate. A directory entry and parameter data entry are included in each entity instance. The directory entry has an index and attributes to describe the data. The parameter data defines the specific entity and is defined by fixed length records in accordance with the corresponding entity. The size of the IGES files and the processing time are practical problems. As IGES files are composed of fixed format records and in both the directory entry section and the parameter data section each entry has to have record, errors occurs in pre-and post-processor implementations. [16.]

5.2 STEP File

STEP (Standard for the Exchange of Product model data) is a new international standard (ISO 10303) for representing and exchanging product model information including an object-flavored data specification language called EXPRESS. STEP also describes implementation methods, for example, a physical transfer files, and offers different resources such as geometric and topological representation. STEP was developed in

1984 as a worldwide collaboration with the purpose of defining a standard to cover all aspects of a product during its lifetime. It is a collection of standards to represent and exchange product information. While the main parts of STEP are already international standards, many parts remain to be under development. The development is performed under the control of the International Standards Organization (ISO), Technical Committee 184 (TC184, Industrial Automation Systems) and Subcommittee 4 (SC4, Industrial Data and Global Manufacturing Programming Languages). STEP aims to offer system-independent mechanisms describe the product information in computer-aided systems throughout its lifetime. It separates the representation of product information from the implementation methods that are used for data exchange. A basis for archiving product information and a methodology for the conformance testing of implementations are provided by STEP. EXPRESS is used to specify the representation of product information. This facilitates development of implementation and enables consistency of representation. STEP does not only define the geometric sharpness of a product, but also includes topology, features, tolerance specifications, material properties, so that the goal of the design, manufacturing, testing, inspection and support of the product is completely defined. STEP covers the total product life cycle in terms of sharing, storage and exchange. It is said that STEP is the most important effort ever established in engineering and will take the position of current CAD exchange standards. [17.]

STEP is well known and widely used as an exchange data form. It is supported by many software tools such as ECAD or EDA (Altium Designer, Circuit Studio, Circuit Maker, Cadence, etc.), MCAD (IDA step and express Engine), Dassault Systemes (Catia, Solid Works and 3DVIA shape), PTC and Autodesk [16.]

5.3 3DS File

There is a series of information in a 3DS file and it is used to describe every detail of a 3d scene composed of one or more objects. A 3DS file also contains a series of blocks called chunks. The name of each object, the vertices coordinates, the mapping coordinates, the list of polygons, the face colors and the animation key frames are what is necessary to describe a scene. These chunks do not have a linear structure, thus some chunks depend on others and can only be read if their relative parent chunks are read first. There is no necessity to read all the chunks, so only the most important

ones are mentioned here. A description of the 3DS file format on the information contained in the 3dsinfo.txt file written by Jochen Wibelmy is shown [18.]. A chunk is composed of three fields:

-An identifier is a hexadecimal number two bytes in length that identifies the chunk.
-Length of the chunk is a 4-byte number that is the sum of the chunk length and all the lengths of every contained sub-chunk.
-Chunk data include all the data for the scene and the data has variable length, depending on the scene data information.
[18.]

6 Case Study

A case study was based on a project between Deltamarin and Metropolia UAS. In order to make a short commercial video for their new design, they made co-operation with Metropolia UAS.

A 3D model of a ship was designed by using a 3D software program. In order to make the video, the 3D model designed by Deltamarin had to transfer to the premises of Metropolia UAS so that it could be transformed into video. Prior to the project, Metropolia UAS and Deltamarin had been using two different programs. Detamarin used a CAD software for industrial design usage. In turn, Metropolia UAS used Autodesk 3ds Max for the media and entertainment industry involving for example films, animations and games. Hence, accurate formats had to be chosen for the 3D ship model so that it could be imported successfully into 3ds Max.

The model used for this case study was designed for industrial usage without texture and material related data. Moreover, in order to create the 3D ship model for the video, the model needed more tasks. The model needed some refinement to ensure making them realistic, being able to create a short animation, and rendering to take pictures of all things and then translating all the virtual bits of 3D model into actual output images that transform to real videos in high quality.

Importing the model to other software for more design stages always contains errors and problems. The model in this case was exported from CATIA and could not be used directly. The model needed to implement the basic workflow of 3D modelling which was illustrated in figure 1. To make the model ready to use, different tools were essentially used for different types of process.

To be able to transfer the most accurate and detailed 3D model, many files are chosen. Though many file formats support importing into 3ds Max, in this case only three file formats are compatible and could be exported. Three file formats were tested and used to import the model, but only one file was compatible to use.

6.1 IGES File

Firstly, the IGES file was chosen to import the model from the CATIA software to 3ds Max. However, when selecting the IGES file to be imported to 3ds max, the program could not read the file. The error message is shown below in figure 7:

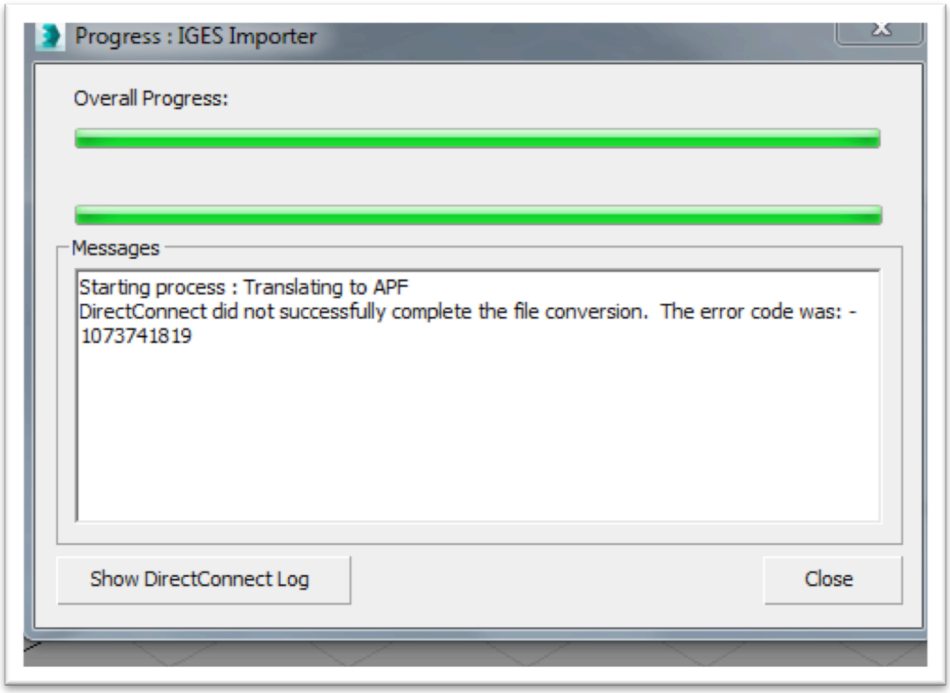

Figure 7: Message show when importing IGES file to 3ds max by Metropolia students. Screen-shot.

Normally, the IGES file is supported by 3ds Max, and it can be imported successfully as it shows in import menu options. However, it does not work as expected this time. In this case, the error occurs when exporting a 3D model from the original CATIA software. The model can miss some data and information when being exported from CATIA software. It makes the model unreadable. Therefore, the model has to be exported to different format files so that Autodesk 3ds Max enables reading and using.

6.2 STEP File

Because of the error, the IGES file cannot be used. Hence, the model is exported into STEP format. Luckily, it was successfully imported to 3ds Max, and the message showed in figure 8 below appeared:

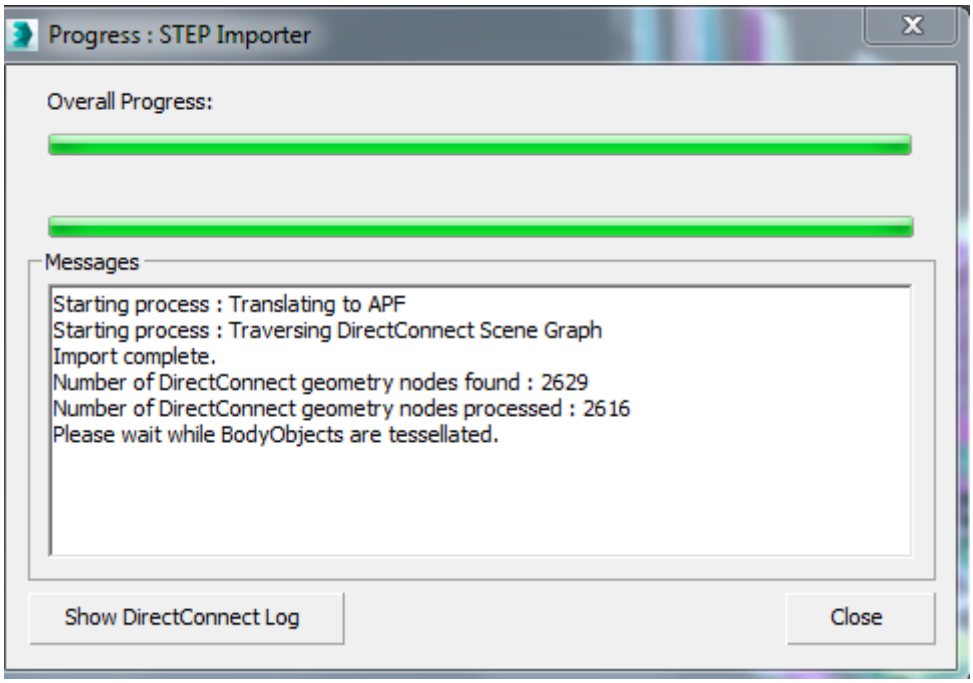

Figure 8: Importing message from the STEP file. Screenshot.

The model was effectively imported. However, some problems needed to be solved such as that the entire object names were missing and many helpers were invented. [19.]

As it shows in figure 9 and figure 10, many helpers were found and all objects names were missing in the case study.

Figure 9: Helpers were invented automatically when being imported the STEP file. Screenshot.

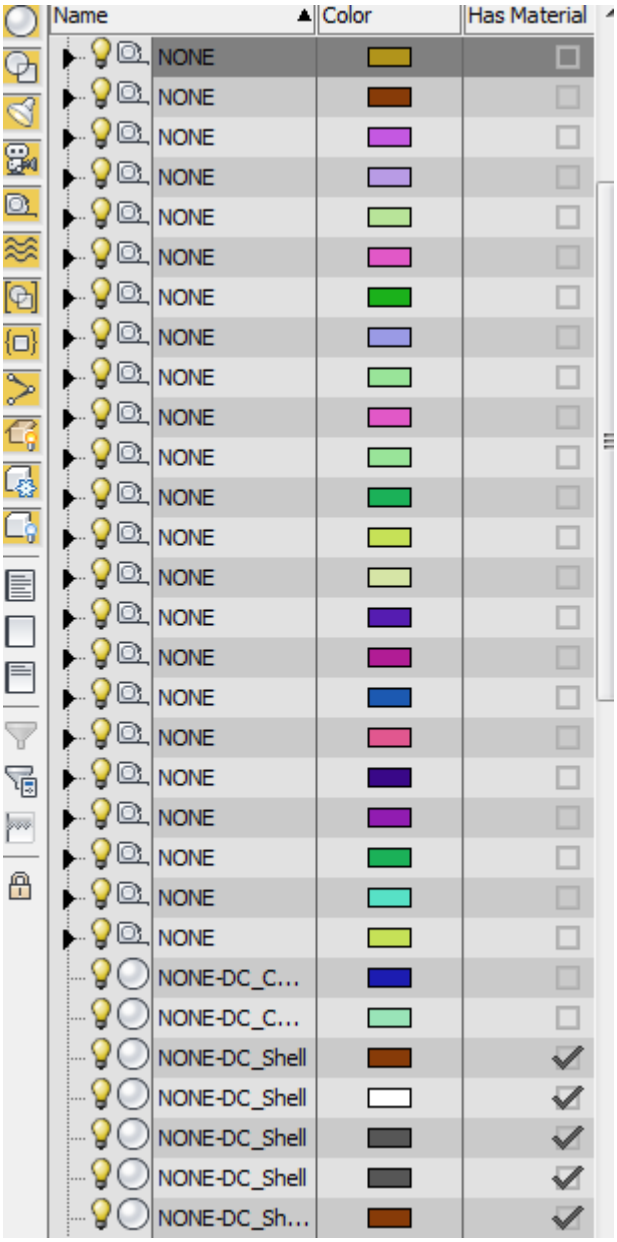

Figure 10: Missing object names. Screenshot.

A common error when importing the STEP files to 3ds Max is that all the object names are lost and many helpers are created. This leads users to be confused when dealing with the model. The object names must be renamed correctly in order to work easily with the model. The helpers somehow are difficult to find, because they exist as tiny dots on the scene. However, they do not affect the model or object much, as users can delete or hide them.

As can be seen in figure 11, a way to fix the helper is showed.

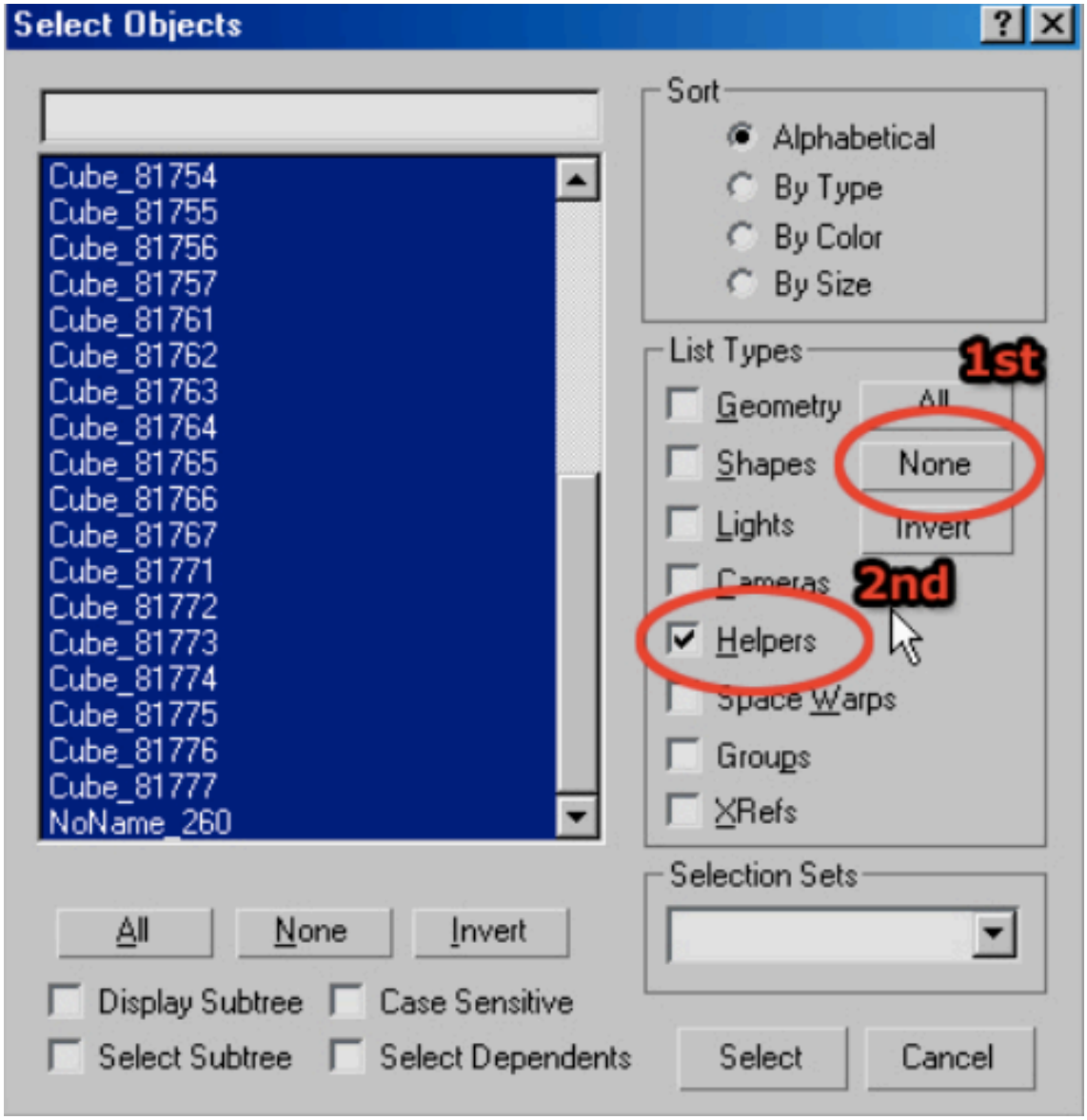

Figure 11: Select Object Dialog Box. Screenshot [20].

In order to hide or delete the helpers, it is necessary to open the Select By Name Dialog from the top of the user interface. In the list types, the “None” button should be clicked and the helpers should be turned on as figure 11 shows. Subsequently, all the helpers should be selected by clicking the “All” button under the list, and then all the helpers from the imported model are selected. They can be grouped for hiding or simply deleting. [20.]

After dealing with the helpers, the model implements the stages described in figure 1.

6.3 3DS File

Since the STEP file caused too many errors, the model was exported into the 3DS format to get a better result. As was suggested in theory section, 3DS is a product of 3ds max. Thus, any 3DS file is supposed to be imported easily into the 3ds Max software. However, this did not work, when the 3DS file was selected to be imported into 3ds Max. The error message that was shown can be seen in figure 12:

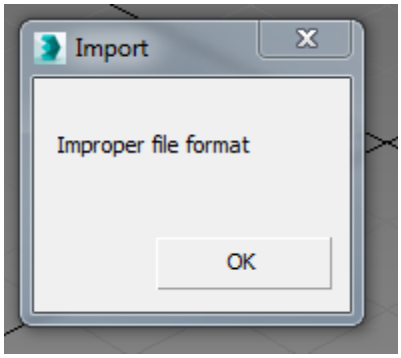

Figure 12: 3DS file importing message. Screenshot.

The problem above is reminded of once again that it is really important to pay attention when exporting 3D model files. Users should be discreet when exporting the 3D models, and the files should be set up so that no names are lost and no files are missing. If something is missed when being exported, errors occur and the third party programs are unable to read the file. In fact, materials and mapping in each 3d model programs are different. In order to avoid the error, the model should be prepared properly before being exported. Nevertheless, if the designers were not known beforehand whether or not the model is exported, they could design the model that met target software requirements. The error can be reduced in the setting of the file. Selecting all the materials and mapping related to the model is necessary for the file when importing.

At the beginning, people who worked for this project hope that there is no problem when sharing and transferring 3D model from industrial CATIA usage to 3ds Max. As many options are available to import files from the CATIA software to Autodesk 3ds Max, the model can be designed for media usage which is the most important purpose for this project. However, after testing how different formats are imported to 3ds Max, the files could not be read well in 3ds Max. Therefore, there was no choice but using the model exported from the STEP file. Though only one file can be read so far even

with some enclosed problems, it is used to solve the problems. This brings some challenges but that is good to learn how to over the difficulties.

7 Set-up

7.1 Name and Scale

Before working on the model, there are a few things designers should pay attention to. The first is to create folders for the project. All the files and related folders should stay in the same common folder so that it can be easily defined. No file and folder is missing when implementing. [2.]

Folders should be created as follows:

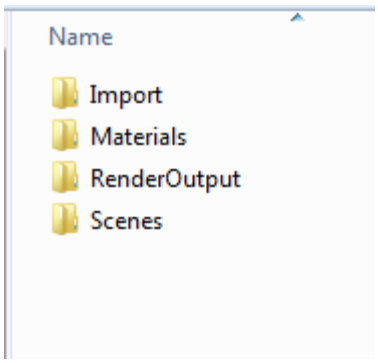

Figure 13: Folder files. Screenshot.

The name of the file must simple and easy to remember. The program and computer can be shut down at any time. When working on the product, every single change should be saved; in case the computer is corrupted, the file would not lose information. It is very smart to make a backup of the file for the safekeeping, to make sure that designers do not need to work again and again from the very starting point. Without proper processes and pre-thought workflows, refining an existing 3D model in another software can become an intriguing task. Many changes can be made and many files are saved. Therefore, a simple name can easily tell which one is the latest one or which one is the one the designer is looking for. [2.]

Secondly, the very first thing users need to do after importing is applying the appropriate scale so that the product will be at the correct scale. In fact, materials from a particular inventor are not imported with the correct scaling and orientation. Sharing and transferring 3D modelling appears different from mapping differences between other

programs as a mesh or body object. Therefore, they produce different results when being imported. [21.] It is really significant, if the users do not want all the changes to be in the incorrect scale. An incorrect scale can lead the product into trouble such as unrealistic model, rendering taking a really long time to implement and the file being corrupted. Moreover, with scenes in 3ds Max, if the model has too small or too large units, it often behaves in a very odd way in viewport. This primarily affects the value scale of lights, shadows and cameras. It is really important to use the rescale world unit utility at the beginning. To perform the accurate scale on the model, this is a good thing when dealing with the next stages.

Thirdly, it is important to change the number of levels with the customization setting, and it can help to increase the number of undo and redo actions. It is really helpful when making mistakes, as the designer can easily be back to the very last change to redo it one again.

Finally, before start working with the model, one of the simplest and most important things users should do to help keep the models and scenes being organized are to give objects of the models meaningful names. [2.] In fact, there are numerous objects created during the process. Organizing and naming objects correctly, helps users to know which one they want to deal with. However, Rename Object Tool can be used to rename object names when necessary.

7.2 Xref Scenes and Xref Objects

Autodesk supports Xref Objects and Xref Scenes allows users to divide the model into separate files. Xref scenes can make large files much easier to work with, as well as dividing the file into small parts. It also can allow many users in a team to animate, model and texture a model at the same time. This function allows members in a team to work on different sections of a project without interrupting one another or altering each other's work. [3.]

External references objects and scenes break the model into separate Max files made available for reference during a Max session. There are two types of references, reference objects and reference scenes with different purposes of use. [3.]

Since the model in this case study is too large, it is not easy to work and takes too much time for the model to run and sometimes causes the file to be corrupted. Therefore, Xref Scenes is used to divide the model into many small files to make it easy to model and texture.

To help people have clear ideas about how these functions work, the explanations are described as below.

7.2.1 Xref Scenes

An external referenced scene displays in the current Max session. The scene is linked to a parent object and it can be updated automatically once changes are made and saved to the source file but users cannot edit the scene or change anything on the master scene. [3.]

Xref scene allows users to divide the model into small files to make larger files much easier to deal with. An external reference scene displays the entire contents of an external Max file in the current scene. In order to prevent accidental changes, the objects within the external file are frozen, and they can be visible but cannot be selected.
Any changes from the original file can also be updated and changed in the target file once the changes are made and saved to the file. [22.]

Kelly Murdock pointed out that “Xref Scenes makes it easy for creative team to collaborate on a project without having to wait for another group member to finish his or her respective production task”. [3.] Each user can deal with one of the files. A modeller can create the character, and an animator can animate the character without making changes to the setting of the character. If the setting file is changed, the changes will be reflected in the animator’s scene. When it is done, the files can merge together as it shows in figure 14. [22.]

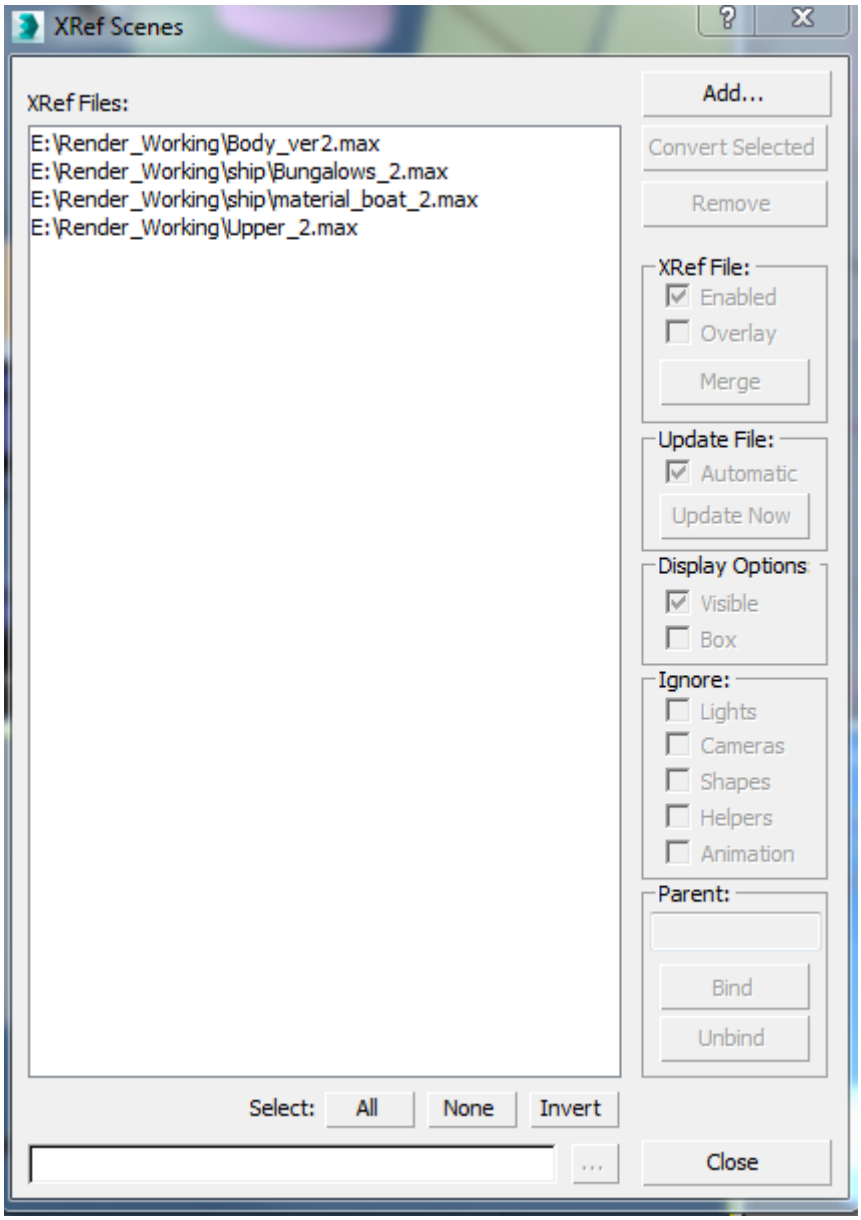

Figure 14: Xref Scenes Dialog Box. Screenshot.

The figure shows several options for controlling the appearance of the scene objects. Users can choose whether the scene can be updated automatically or not, and to which object the scene is bound. This dialog box is modeless and the options can be changed anytime as users wish. To change the options of the file, the Xref scene dialog box has to be selected and any option that is needed should be kept. [22.]

There are several options to select from in the dialog box:

- The Convert Selected button can allow users to convert any selected objects in the current scene to Xref objects by saving them as a separate file. When this button is selected, the new dialog will be opened and it allows naming and saving the file as a new file. In case, no file is selected, then this option is disabled.
- Updating an external scene is used to set the scene automatically updated. By choosing this option box, the scene is updated anytime any changes are made and saved to the source file.
- External scene appearance: this option lets users to decide how a scene is displayed in the viewports. Users can choose whether or not to display the external scene invisible or visible. The option allows external scenes invisible from the viewports. Despite this the scene is still included in the rendered output. In order to remove it clearly from the rendered output, the Enable option should be deselected.
- Positioning an external scene: This option is implemented by binding the scene to an object in the current scene. Autodesk allows users to change the selection any time because the Xref scene dialog box is modeless.
- Specifying an Xref as an overlay: This option makes the Xref scene visible to the current scene but not to any other scene that including the overlay. This allows users to hide Xref content from more than one level.
  [22.]

Besides the freezing the objects, Xref scenes allow functionalities such as Snap, AutoGrid, Clone and Align to position local objects in context, as well as to pick up objects as the target location for the clones. In order to move, rotate or scale objects in reference scene, users can bind them to a local object. [22.]

Transforming the object in the reference scene was bound to transform all the objects in the reference scene. When all changes from external referenced files are saved, an update of Xref scene will inherit the changes. [22.]

Another way to use an Xref scene is to create a scene with light or cameras. Light and cameras can be positioned at regular intervals around the scene. An Xref scene dialog box lets users to disable lights, cameras and helpers from the source file. Lights, cameras and helpers can be created again and repositioned.

In order to reposition the Xref scene as needed, users can create dummy object from the Helpers options, after having dummy object, in the Xref scene dialog box, and after selecting the Bind button and then the dummy object. Now this enables repositioning the Xref scene.

One hint needs to be remembered in this process, which is to make sure the scale of the model is correct. This helps to reduce the errors and causing problems.

Application on Case Study

The model was exported from a CATIA file and when importing it to 3ds Max, the file seems too big to deal with. If the file is too large, it not only causes problems for users working on the model but also lowering the speed of rendering.

As can be seen in figure 15, the summary information of the file shows the content of the file.

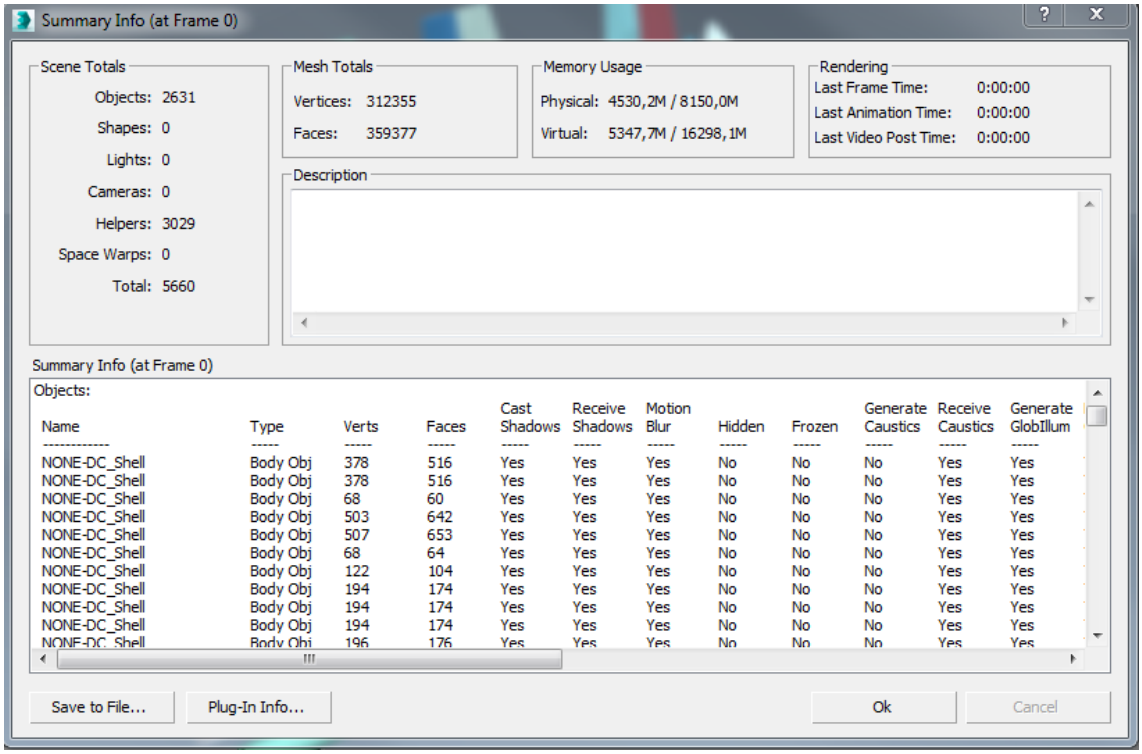

Figure 15: Summary Information Dialog Box. Screenshot.

Summary information displays statistics about the current scene, which was imported from CATIA. The information was sorted by category and included the names of ob-

jects, assigned material name, type of material, object vertex and so on. On the left corner, the scene total group lists the number of objects in the current scene by type. The number of vertex and faces are also listed under the Mesh total. [22.]

As a result, the file was divided into small parts by using Xref scene. The file was smaller as it shows in figure 16.

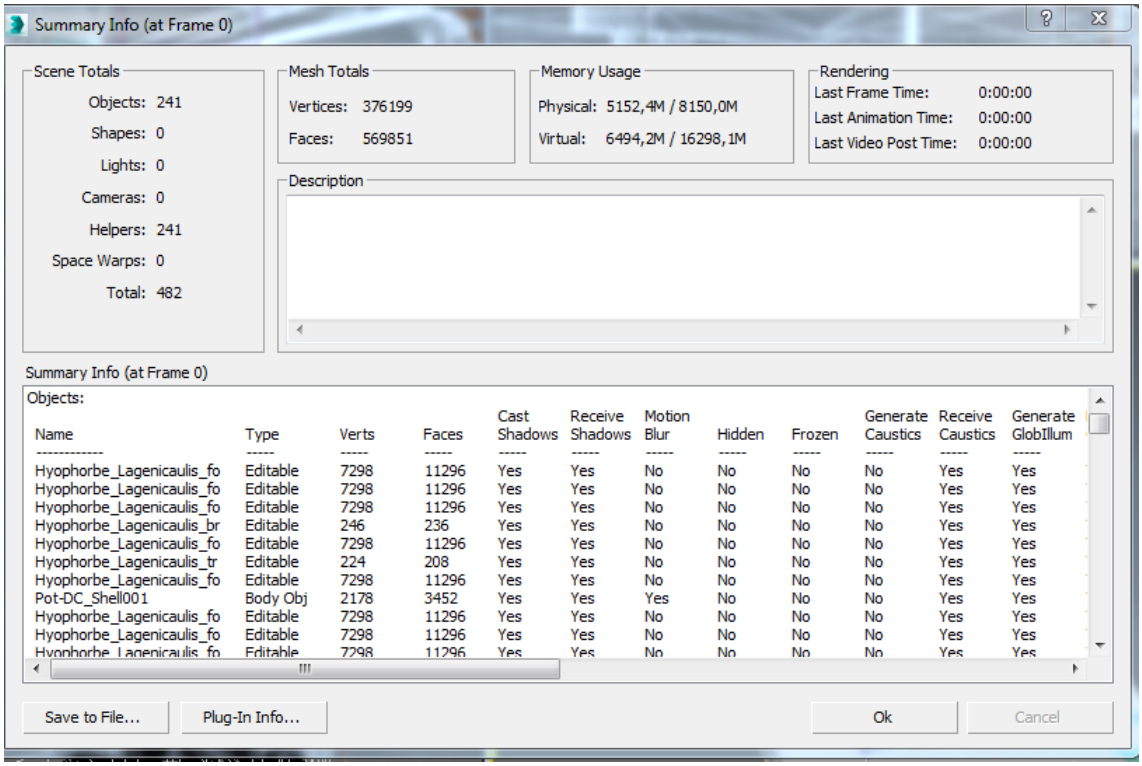

Figure 16: One separate file from the current scene by using the Xref scene. Screenshot.

The file showed in figure 16 is one of four files, which is separated from the main current scene by Xref Scene. It makes the file easy to work with the model. Moreover, the study case is a group work project. Using the Xref scene lets members in a team working on the model without interfering with each other's work. [3.]

7.2.2 Xref Objects

External referenced objects appear in the master (current) scene but are actually from external 3ds Max files. Therefore, the objects from a source file are protected from modifications the user makes to the Xref objects. Any change made from the source object can also be updated in the current file when the source scene is reloaded. [23.]

According to Kelly Murdock, “Xref objects are slightly different from Xref scenes. Xref objects appear in a scene and can be transformed and animated but the original object’s structure and Modifier Stack cannot be changed”. [3.] This function is not similar to the Xref scene since the object in the scene is not freezing but it can move and animate.

As can be seen in figure 17, Xref object dialog box shows:

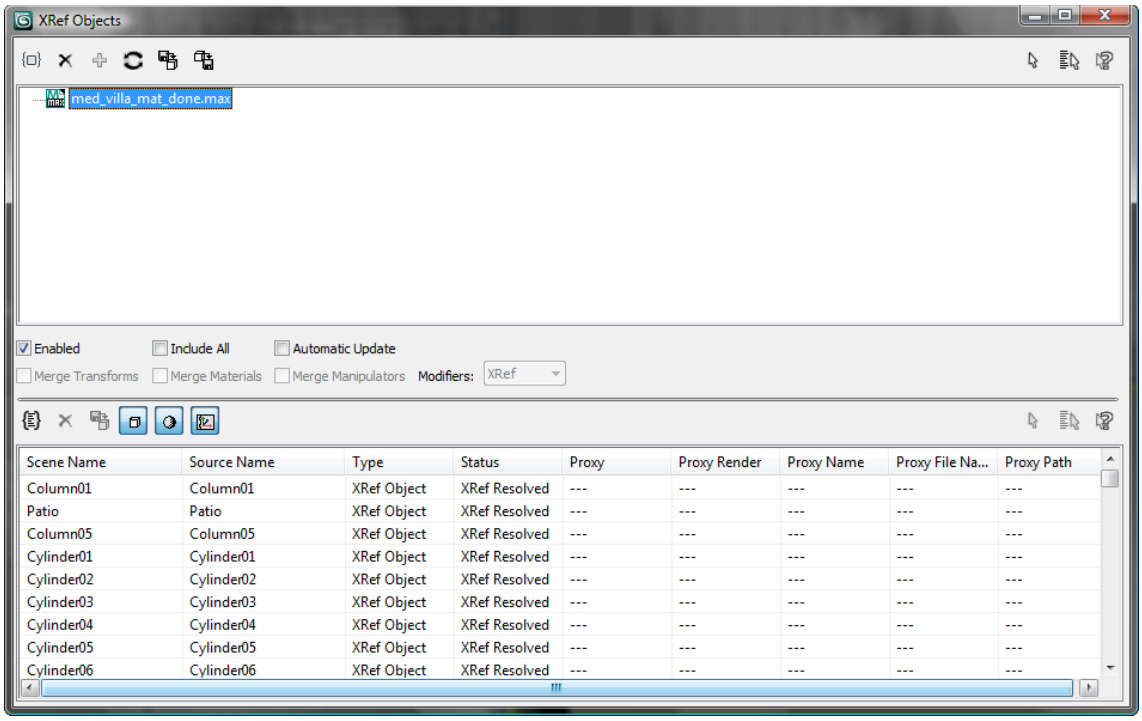

Figure 17: Xref Object dialog box (3ds max Help). Screenshot [24].

The dialog box of Xref objects is divided into two sections. The top section displays the external referenced source files and lower section displays the objects, materials or controllers selected from the source file. It helps users to understand and work easily. [23.]

Xref object’s function allows users to edit and animate the objects in the scene. It depends on the Xref object setting so that users may or may not be able to edit the object’s entities such as transforms, materials, manipulators or modifiers.

The function is really useful and efficient in teamwork projects. However, there is no need to use this function for the case study. Only the Xref scene is utilized for dividing the model into separate files to make it easier to work with.

8 Problems and Solutions

When exporting and importing models to other programs, users are ready to face the fact that there will be many problems and errors in the model. The common problems users always meet are polygon breaking, overlapping, duplicate. Therefore, the problems are explained and analyzed in this thesis.

8.1 Polygon Breaking

As mentioned above, the software supports various fields based on the main use of the model to choose the correct software. However, sometimes for some reasons, users need to share the model with and transfer them to other software that might not support that model. That is the reason why errors have occurred. For example, the pipe is created in the CATIA file, when it is imported to 3ds Max. 3ds Max cannot read the elbow of the pipe. Thus, the program automatically performs the elbow into many small polygons. The pipe somehow was broken in many parts that could not be used for modelling and texturing.

As it is demonstrated in figure 18, breaking polygons was taken from the case study.

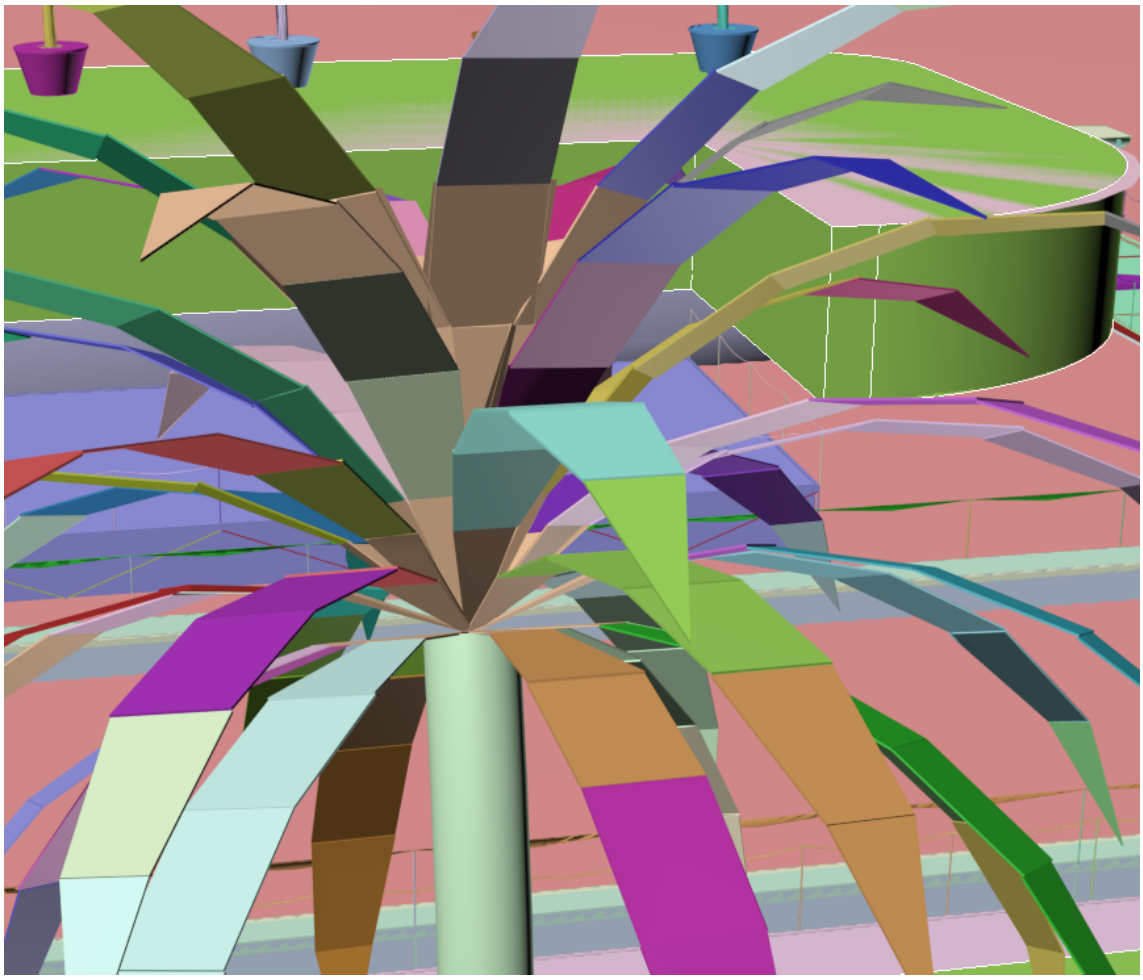

Figure 18: Polygon breaking example.

The figure shows the error of the coconut tree. The leaves in this situation were broken into many polygons that are not easy to fix.

In fact, when sharing and transferring 3D files to other programs, the breaking of polygons is a common problem that users meet. Normally, when facing this problem, users usually choose to delete an object to create a new similar object. If the model has only a few broken polygons, it can be fixed by using editable poly tools.

8.2 Overlapping

Overlapping is also one of the most common errors met when sharing the 3D files. This error happens when the third party cannot read the texture that has been applied on the model from the previous software. The third party will automatically modify that tex-

ture by the plane; this will cause the model present many layers on top of each other as can be seen in figure 19.

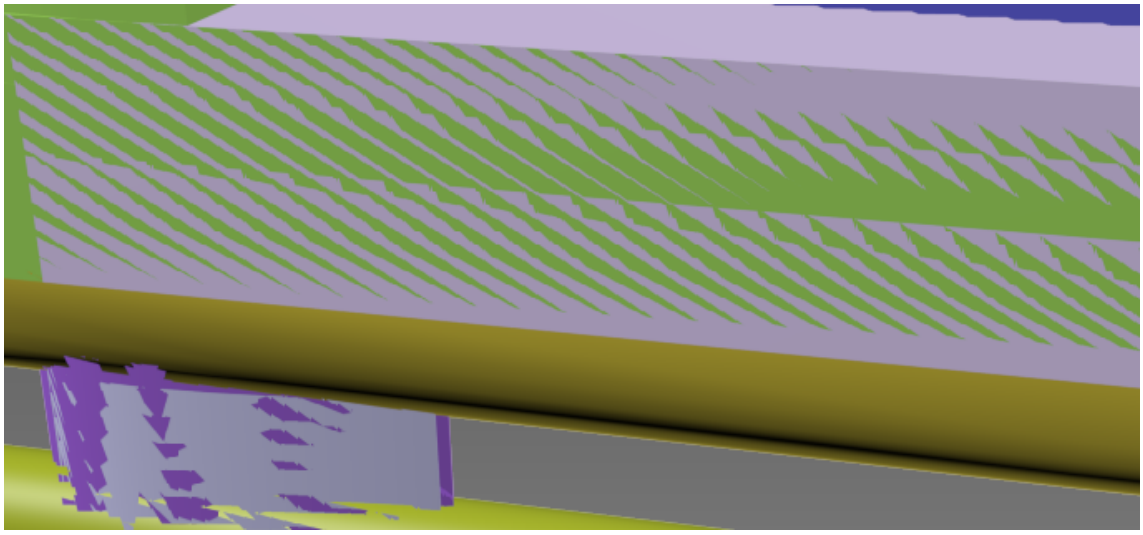

Figure 19: Overlapping polygon.

If only a few polygons have overlapping problems, it is easy to remove and delete them manually. However, if there are thousands of them, users obviously do not want to spend time removing every single layer one by one. There is a way around for each case. In 3ds Max, there are three common overlapping cases, overlapping face, over lapping UVs, and overlapping vertices.

- Overlapping UVs can be fixed by using Unwrap UVW tool to edit the overlapping. In Edit UVWs, tools and render UV template should be selected, and then “show” overlapping should be turned on. The overlapping will be showed in red and it is easy to fix by relaxing the overlapping area. [25.]
- Overlapping Faces: the problem can be fixed by following these instructions.

    1. Select the model and make sure that the object is ungrouped
    2. Go to “Customize”, then “Units setup”, and select “Generic units” so that the unit matches the checkmate script.
    3. Go to “Xview” tool and select “overlapping Faces”.
    4. When the model is selected, click on “Click here to configure” at the bottom of the scene.
    5. Change the “Tolerance”: to 0.0001

6. Overlapping Faces appear in green now. On the Modifier List, select Poly in the Editable Poly tool.
7. It is possible to fix the overlapping faces by moving it out slightly by moving the X-coordinate or selecting “Absolute Mode Transform Type-In”, entering the X-coordinate where it should be moved from original location.

- Overlapping Vertices is similar to overlapping faces to fix overlapping vertices. Therefore, the instructions from step 1 to 5 are as same as above. Overlapping is showed in green but in case it did not show up, select “Click here to Update” at the bottom. In order to remove the overlapping vertices, select “Vertex” in Editable Poly and on the setting button next to the “Weld” button, set the “Weld Threshold” to what is needed. In most cases, this works well. However, if it does not work, then it means that there is no need to remove the overlapping Faces. Therefore, there is another way to fix overlapping vertices [27.]
    1. Select the overlapping Vertices Object, right click and select “Convert to Faces”
    2. Select “Alt” and then “click” to deselect all the faces that have been highlighted in red
    3. Click Delete to delete the unneeded overlapping faces.
    4. Now repeat the steps that have been done before with “Vertex” and “Weld”

    [27.]

8.3 Duplicates

Duplicates are more complex than either of the two problems above. Duplicates happen when objects or polygons are cloned on top of each other or objects with the same names.

There are three ways to fix the problems.

- Select all faces, with Multiple Objects Tools selected, the tool will find and select faces that are duplicated

- Using Customize User Interface Tool by selecting Customize and then Customize User Interface, toolbars tab, category and Collins Script should be selected. To run this option, the duplicated will be found.
- Run script: Autodesk supports using script for making modelling easier. There is a code of script that can be used to remove duplicates. These codes are displayed on the script bar, which is found on the left corner of the scene of the 3ds Max software program.
  [28.]

9 Discussion

As mentioned in the beginning, the main goal of this study was to create a short video of a 3D model. To create the video, the model needed to have some short animation. Moreover, the model was created in the CATIA software and designed for industrial usage, but lacking texture and animation. As a result, the model had to be imported to software that could model, texture and make some short animation. In this case study, 3ds Max that is compatible with modelling and transforming the model into the video was used to implement the project.

From models to virtual objects, the process was complicated. Progress was achieved by combining the knowledge of 3D modeling, texturing and rendering. Different models were accomplished in different operations. In order to make the models look more appealing and real, many stages needed to be implemented. Some suggestions of modelling and texturing methods were applied for the model. Modelling and texturing was one of the most important parts in the process as good modelling and texturing can bring a crude model to life. However, to make the model ready to be used in the media industry, users need to put more effort and work into testing and rendering as well. Rendering is a process to transform the model into high quality image pixels with all reflections and shadow details. Rendering output represents the sequence of frames. To ensure the model looks realistic and that it meets the requirements as closely as possible, rendering the frame was checked, which helped to figure out what needs to be improved. Overall, this process made the work proceed.

The process was modified many times. For each rendering time, something needed to be improved. Therefore, instead of rendering the whole sequence of frames, it was better to render only the frame the users wants to check. Because the model was too large, network rendering was utilized to make the render process quickly and efficiently.

To render out the finished animation to a sequence of frames such as tgd, png and jpg, the highest quality images was retained for the frames to multiple file formats, and it was imported into a video-editing program such as Adobe Premiere. A sequence of one frame could be modified with an audio track and video setting to produce the high quality video image.

Since the project of the case study needed to be done in a short time of five weeks, it was really essential to use some 3D models from another application so that the models could be merged and imported to the project. Models created in another session of 3ds Max allowed users to merge files together. However, the models used after merging or importing were also necessary to reset the scale operation and texturing. There were many free 3D models for downloading which could be found via the Internet such as Turbosquid, 3DModelFree, and Archive3D. In order to use the free model from the Internet, the licence of using had to be checked carefully. Otherwise there would be trouble. The models downloaded from the Internet were just small portions of the project. Adding more objects to the project helped to save time and make the model look realistic.

10 Conclusion

3D modelling is becoming more popular in different media and non-media industries such as films, animations, games and architectures. The developments in the field of computer design have tremendous impacts on the modelling technology. Various programs are used to produce 3D models and different tools provide different functions. Sometimes a model needs to be transferred between different software for different designing functions. Thus, sharing and transferring a 3D model has become an essential process in the media industry.

The case study described in this thesis demonstrates that in order to minimize the number of errors and to improve the readability of the converted model, a 3D model should be properly prepared before being imported to other software in order to make it readable. In fact, when importing the 3D model from one program to another, problems always occur. Hence, the thesis presents some potential solutions for each problem.

Overall, the project was really time consuming and challenging because of many problems accompanying with the file format. The result of the project was not as good as expected. If the project were carried out again, the result would have changed and improved.

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