The Tomas Bata Regional Hospital Grounds – The Design and Implementation of a 3D Visualization

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Abstract. This paper briefly describes a visualization method of the Tomas Bata Regional Hospital grounds in Zlín. This hospital was founded in 1927 and has grown rapidly to the present day. We also collected all available historical materials of the Tomas Bata Regional Hospital and its surrounding area. We mainly focused on building plans, cadastral maps and historical photos. All the information we collected was chronologically sorted and on this basis, we created a 3D visualization of the urban development of these hospital grounds. To begin with, we created the grounds terrain model based on the Daftlogic database [14]. All buildings and accessories were separately modeled (we used the standard polygonal representation) and textured by the UV mapping technique. After that, we created the more complex 3D scenes from the individual models in these years: 1927, 1930, 1935, 1940, 1950, 1960, 1980, 1990, 2000, 2005 and 2013. The visualization output is performed by rendered images and animations in these years. We used the Blender software suite for this visualization.

Keywords: Computer Graphics, 3D Visualization, Modeling, Texturing, Animation.

1 Introduction

Data visualization is a hot topic. A simple definition of data visualization says: It's the study of how to represent data by using a visual or artistic approach rather than the traditional reporting method [1]. Represented data are most often displayed through texts, images, diagrams or animations to communicate a message.

Visualization today has ever-expanding applications in science, education, engineering (e.g., product visualization), interactive multimedia, medicine, etc. Typical example of a visualization application is the field of computer graphics. The invention of computer graphics may be the most important development in visualization since the invention of central perspective in the Renaissance period. The development of animation also helped the advance of visualization. [17]

With the development and performance of computer technology, the possibilities and limits of computer graphics are still increasing. The consequences of this are 3D

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visualizations, which are used more frequently, image outputs get better quality [5] and the number of configurable parameters is rising [6]. As mentioned above, these visualizations are used in many scientific and other areas of human interest [2] [4].

One of the fields is visualizations of history. Based on historical documents, drawings, plans, maps and photographs, it is possible to create 3D models of objects that exist no more - things, products, buildings or extinct animals. If we assign suitable materials and the corresponding textures to these models, we can get a very credible appearance of these historic objects. From these individual objects, we can create very large and complex scenes that can be very beneficial tool for all people interested in history.

This paper describes a 3D visualization method of the Tomas Bata Regional Hospital grounds in Zlín in history and at present.

1.1 The History of the Tomas Bata Regional Hospital in Zlín

The first written record of Zlín dates back to 1322, when it was a center of an independent feudal estate. Zlín became a town in 1397. Until the late 19th century, the town did not differ much from other settlements in the surrounding area, with the population not exceeding 3,000. In 1894, Tomáš Baťa founded a shoe factory in Zlín. The town has grown rapidly since that time. Baťa's factory supplied the Austro-Hungarian army in World War I as the region was part of the Austro-Hungarian Empire. Due to the remarkable economic growth of the company and the increasing prosperity of its workers, Baťa himself was elected Mayor of Zlín in 1923. Baťa designed the town as he saw fit until his death in 1932, at which time the population of Zlín was approximately 35,000.

Fig. 1. The entrance building of the Tomas Bata Regional Hospital in 1927

Due to the population growth, it was also necessary to build a hospital. The history of the Tomas Bata Regional Hospital in Zlín dates back to May 1926, when the project was proposed. The hospital was situated approximately 3 km east of the city center on an almost square plot of land between the Dřevnice River and the forest. This forest was felled some years later and houses were built in its place, so the hospital was directly connected to the entire city.

The first hospital buildings were built in 1927 – i.e. the entrance building (Fig. 1) and two pavilions. By 1938, 16 hospital pavilions had been built, including the original buildings. Each pavilion was designed with the standardized appearance and typical architecture for most buildings in Zlín at this time – the combination of red bricks and a light gray concrete. The structure of the pavilions was also unified. Slight differences were only given by the specific needs of individual departments [8].

New development plans were created for the further expansion of the hospital grounds in 1946. Based on these plans, over the following years, new five pavilions were constructed. For the ensuing almost 30 years, the hospital grounds were without major changes. Only some reconstructions, adaptations and changes of pavilions were carried out over the years.

The next significant development of the hospital grounds was implemented after 1973, when the Surgery Building, Pathology-anatomical Department, District Health Station, Internal Departments and Utility Energy Block were developed in step-by-step phases. The new Ophthalmology pavilion was built in 1984 and the Hospice was built in 1989 [7].

The Tomas Bata Regional Hospital grounds encompasses nearly 60 buildings numerically designated for orientation purposes at present. These buildings have different medical and/or technical functions. Our main objective was to create complex 3D visualizations of the construction phases of the Tomas Bata Regional Hospital grounds in 1927, 1930, 1935, 1940, 1950, 1960, 1980, 1990, 2000, 2005 and 2013. The choice of these years was based on the available documentation, and these were the years that brought the greatest changes in the construction phases of the entire hospital complex.

2 Resources and Software

The first phases we needed to do were to collect all available historical materials of the hospital and select suitable programs for visualization creation.

2.1 Acquiring Resources

The overall progress of this work was initiated by the collation of available historic materials and information about the Tomas Bata Regional Hospital. The main resources were the State District Archive in Zlín – Klečůvka [11], the Moravian Land Archive in Brno and the Tomas Bata Regional Hospital Archive. We mainly focused our attention on building plans, cadastral maps and historical photos.

In the archives in Zlín – Klečůvka and Brno, we mainly found historical photos of this hospital from the foundation to the end of the nineteen-forties. Most resources and information were obtained in the Tomas Bata Regional Hospital Archive, where we found most of the construction plans of the individual buildings. We also held discussions with the hospital staff about the whole hospital grounds and its development over time.

The two books published for the 75th and 80th anniversaries of the Tomas Bata Regional Hospital [7], [8], were the next two important resources. These books contain information about the construction of buildings in the grounds as well as period photographs that were not stored in the archives. A website called Old Zlín [12] was the last important source in the creation of this work. The information on this webpage helped to verify some information which was obtained from the other references.

Based on the materials we obtained, we created a table that contains all of the acquired data on the construction sites, renovations and demolitions of individual buildings. This table was divided into several parts. In the first worksheet, we created a complete list of buildings, from their construction to the present or their possible demolition. For greater clarity, we created additional document pages that contain all construction events in the area in five-year intervals.

From this table, we created a bar graph that shows the number of newly constructed buildings over five-year intervals. This graph is shown in Figure 2.

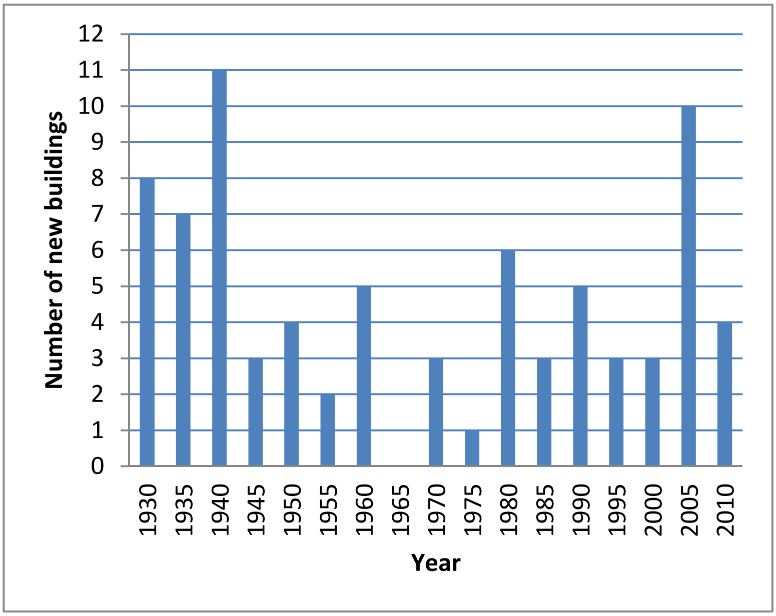

Fig. 2. Number of new buildings in five-year intervals

2.2 Used Programs

We preferred "free to use" software. For 3D modeling, texturing and rendering, we therefore used the Blender software suite [13]. Textures were drawn in GIMP [15]. And Microdem [18] was the last software that we used.

Blender is fully integrated creation suite, offering a broad range of essential tools for the creation of 3D content, including modeling, uv mapping, texturing, rigging, skinning, animation, particle and other simulation, scripting, rendering, compositing, post-production, and game creation [3] [9]. Blender is cross platform, based on the OpenGL technology and it is available under GNU GPL license.

GIMP is an acronym for GNU Image Manipulation Program. It is a freely distributed program under the GNU General Public license. It is mainly a digital image editor and a drawing tool. It allows one to retouch photos by fixing problems affecting the whole image or parts of the image, adjust colors in our photos to bring back the natural look, image compositing or image authoring [10].

Microdem is a freeware microcomputer mapping program designed for displaying and merging digital elevation models, satellite imagery, scanned maps, vector map data or GIS databases [18]. We used this software to convert a landscape elevation map data into a bitmap image (i.e. a heightmap).

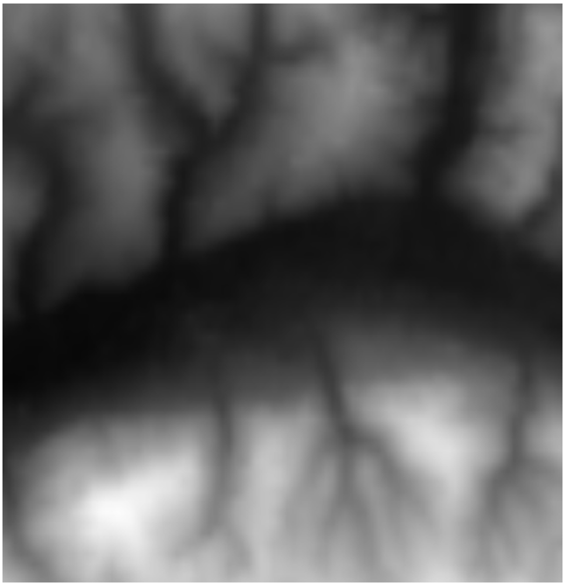

Fig. 3. The heightmap of the Zlín's Region

3 A Landscape Model of Zlín

We used data files which contained text information about the earth elevations to create the landscape model of Zlín (including its hospital grounds) and its vicinity.

We used the Digital Elevation Model data (i.e. DEM) which was provided by the NASA Shuttle Radar Topographic Mission (SRTM) in 2007. The data for over 80% of the globe is stored on [2] and can be freely downloaded for noncommercial use.

So we downloaded the data of Zlín's region, and then we opened it with the Microdem freeware program, which we described above. This software is able to convert the obtained data into a bitmap image. Microdem can clip and convert these images to grayscale (e.g. into a heightmap). We applied that to the Zlín's region. Specifically, we created a heightmap area of 25 km2 (a square with side lengths of 5 km, centered on the center of Zlín – Figure 3).

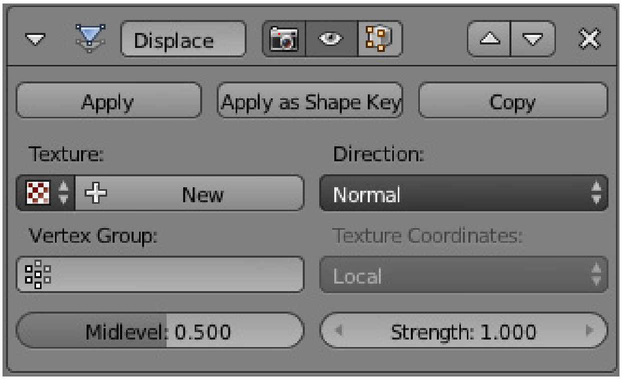

Fig. 4. Settings for the Displace modifier in the Bender environment

We saved this heightmap in PNG format (it is very important to use lossless compression). In Blender, we inserted a square (the Plane object) in the new scene and we divided it several times with the Subdivide tool to get a grid with a density of several thousand vertices. Then, we used the Displace modifier, to which we assigned a texture (for the obtained heightmap). The Displace modifier deforms an object based on the texture and setting parameters (Fig. 4). We got the model of the Zlín's landscape using this method. Although this model is not entirely accurate, but given the scale, the whole scene and the quality of the factory area model buildings, it is sufficient.

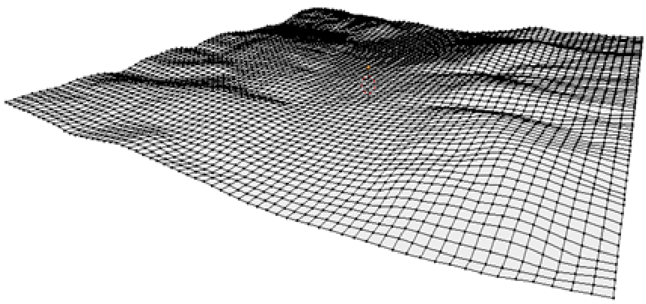

Fig. 5. The final mesh model of the Zlín conglomerate's landscape

This way, we created the landscape model. Its precision is sufficient to the surrounding area of the hospital grounds (within a few meters). But we wanted to obtain higher accuracy for the hospital grounds themselves. We also selected the part of the landscape model where the hospital grounds are, and used the Knife tool to multiply the cuts made to this object in the next step in order to get a lot of new vertices. In the following step, these vertices were placed in suitable positions (i.e. on most roads and paths between hospital pavilions) so as to create the most accurate possible 3D terrain model. The space coordinates (altitude) were measured by a GPS navigation device (Fig. 6).

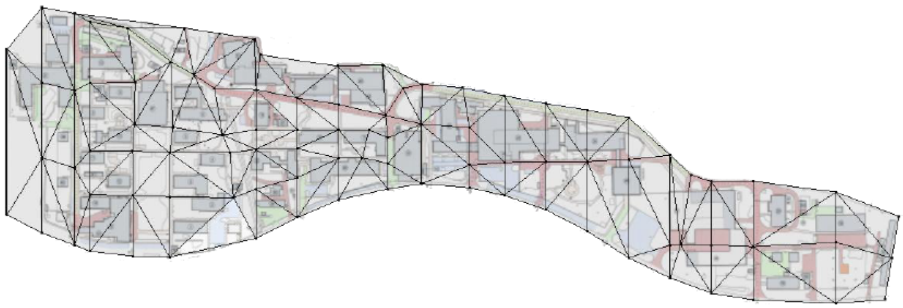

Fig. 6. The hospital ground plan with the inserted ordered vertices of the 3D terrain model

4 Modeling Buildings and Accessories

The modeling of the buildings was always performed according to the same scenario in the Blender program. Before the modeling phase, we put the appropriate construction plans of the selected building on the background screen in Blender. After that, in the window with the floor construction plan, we put the Plane object and then we modified its profile (i.e. the size and shape) according to the floor construction plan of the building. We mainly used two tools to shape this object. The Extrude tool allows us to alter the selected face in a specifically chosen direction and the Subdivide tool which breaks down the selected face into even greater number of smaller parts [9].

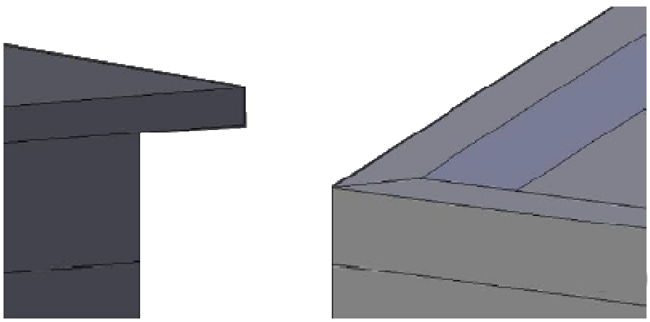

Fig. 7. A flat roof with an overhang (Left) and a flat roof with a raised edge (Right)

When the floor shape was finished, we extruded this profile to a height corresponding to the construction documents. Extrusion was performed for each floor until we reached the total height of the building.

The next step was the necessity to model the building roof. The buildings in the hospital complex have three different types of roofs – a pitched roof, a flat roof with an overhang and a flat roof with a raised edge (Figure 7). The pitched roof was created by dividing the top face into two parts, and the newly created edge was subsequently moved to the required height. The flat roof with an overhang was created by one more extrusion and the newly formed faces were pulled in the normal direction. The flat roof with a raised edge was created by the Inset Faces tool, which creates new smaller faces at the edges of the selected area. After that, these new sub-faces were subsequently extruded in the vertical direction.

To make the windows and doors embedded in the buildings, we used the Subdivide tool again on the relevant faces. After this, we deleted these new sub-faces to model holes. Additionally, we extruded the border edges of these holes to the depth of embedment of windows and doors.

Accessories (e.g. windows, doors, chimneys, railings, etc.) were modeled as separate objects by using the tools described above. All sub-models of each building were subsequently linked to the main building model to unify manipulations with the whole building after completing the model. Overall, we created around 200 models of buildings in this way.

An example of one modelled hospital building is shown in Figure 8. In this picture we can see the 13th pavilion model from 1929 in the Blender environment.

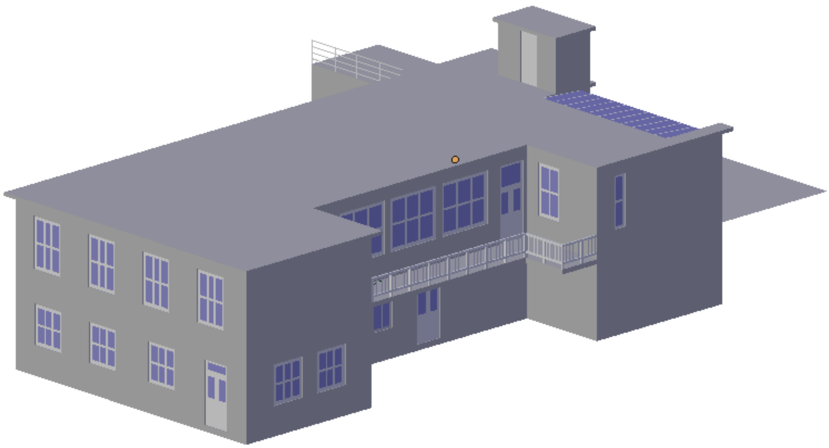

Fig. 8. The 13th pavilion model from 1929 in the Blender environment

We also separately created all models of buildings of the hospital grounds of each period in this way. In addition, we created several simple models of trees and shrubs, which allowed us to make the 3D hospital area model more complex. These models were created by the deformation of the Sphere (treetops) and Cylinder (trunks) objects, which can be simply added into scene in the Blender environment.

5 Texturing

We used the UV mapping technique for texturing objects. This process starts by the decomposition of each object into 2D sub-surfaces (a UV map). At the beginning of the decomposition process, it is necessary to mark the edges, which should be ripped from another one. In Blender, this process is performed by the Mark Seam command. After that, it is possible to finish decomposing by using the Unwrap tool. The UV map created in this way is saved into the .png raster graphic format (it is also possible to save it into another raster graphic format, but we need to use a lossless compression algorithm). We used the resolutions 512 x 512 or 1024 x 1024 pixels for the UV maps.

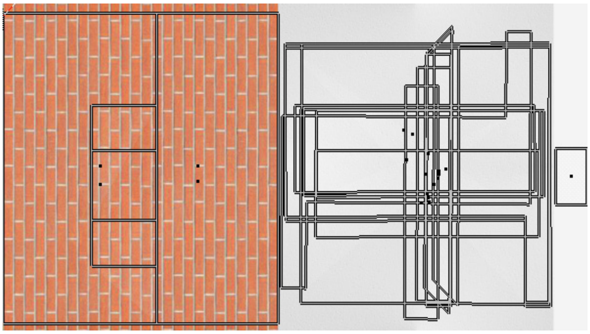

Fig. 9. The UV texture of the Baby box building

All textures were drawn in the GIMP software environment. We also opened all created UV maps in GIMP. In these pictures, the location of each part of the 3D object is visible. With this information, we can fill each individual sub-surface as necessary. Most of these textures were drawn by hand, and in some cases, we used pre-created textures from the CGTextures website [16] – these textures were edited and modified in order to use them on our models. For texture creation and editing purposes, we used standard GIMP drawing, coloring and transforming tools [10]. Once this process was finished, we saved all of the created textures back into same files (it is also possible to use the jpg graphic format with lossy compression) and opened and mapped these on the appropriate 3D models in the Blender environment. An example of the drawn texture is shown in Figure 9.

Once the textures were drawn, they were saved in .jpg format. In this case, we can already use the graphic format with a lossy compression algorithm to save computer memory and the .jpg format is ideal for that. The next step was to re-load these created textures in Blender and to correctly map them into 3D objects. This process is performed by correcting the set parameters in the Texture Mapping panel (Fig. 10).

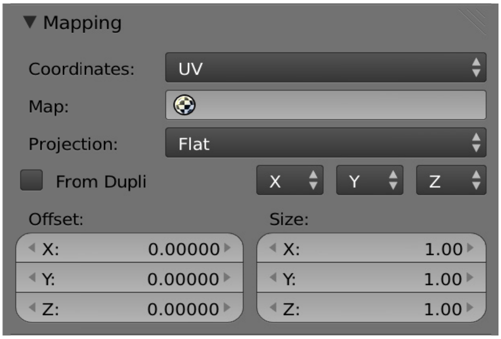

Fig. 10. The user environment for the UV mapping settings in Blender

We also created and textured all 3D sub-models of each period in this way. As mentioned above, we created a completed model of each building of the hospital grounds in 1927, 1930, 1935, 1940, 1950, 1960, 1980, 1990, 2000, 2005 and 2013.

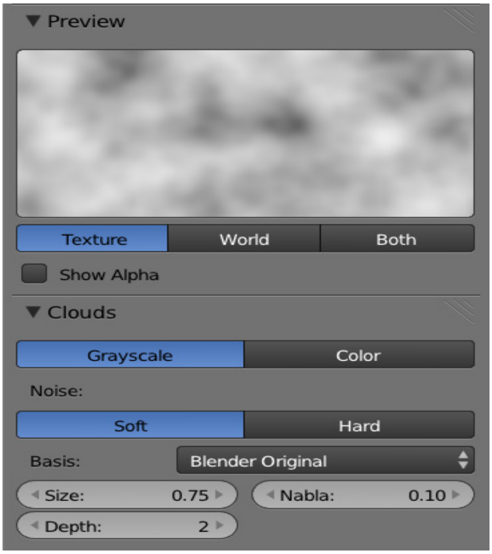

Fig. 11. Setting parameters for the procedural Clouds texture in Blender

6 Rendering and Animation

After the completion of the modeling phase of separate buildings, we imported each of them into a single complex 3D scene with the landscape model. In addition, we set other suitable parameters like the surroundings and lighting. The surrounding area setting parameters are performed by the World window in Blender. It is possible to set simple colors for horizon and zenith and to blend them or to use the internal (procedural) or external texture (any bitmap file). We used the Clouds procedural texture, which looks close to reality in our scene (Fig. 11).

Lighting of the scenes can be realized in several ways in Blender. It is possible to use light objects (called Lamps in Blender) for local lighting or global influences (i.e. Ambient Light, Ambient Occlusion and Environment Lighting and Indirect Lighting). We used the Environment Lighting technique combined with the Emit material settings of selected objects.

The last step before the rendering process was to select a suitable position for the camera. We wanted to create more rendered images from different positions. Due to this, we added more different camera objects and oriented them correctly in order to capture the most graphic images of the whole scene.

The Render command performs the rendering calculation process in the Blender environment. Additionally, we can set many of the accompanying parameters. The basic parameters are the choice of a rendering algorithm, image or animation resolution, type of output file format, antialiasing, motion blur, enable/disable ray-tracing and shadows. We made the decision to use Blender's internal renderer with an image resolution of 1280x720 pixels, 25 frames per second and the MPEG-2 output format to render animations. Figure 12 shows one rendered image of the hospital area from 1980.

Fig. 12. The rendered image of the hospital area from 1980

7 Conclusion

In this paper, we have presented a visualization method of the Tomas Bata Regional Hospital grounds. Based on the historical materials, we created more complex 3D scenes in the Blender software suite in these years: 1927, 1930, 1935, 1940, 1950, 1960, 1980, 1990, 2000, 2005 and 2013.

Our future goal is to expand and improve these models. This process includes creating more detailed pavement models and to add the modeling and texture of the road on the edge of the Dřevnice River (this river is in the surrounding area of the hospital) and more trees model types, etc.

Another improvement would be to create time animation, which visualizes the development of the hospital area over the years of its existence.

A further extension could be the rendering of the current hospital area model in high resolution. After that, this rendered output could be stored on the hospital www pages and converted into an interactive image which could show specific information about each building when the mouse cursor is placed on it.

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