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DIGITAL MODELING OF FREE FORMS SRUCTURES AT EXPERIMENTAL DESIGN

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The use of 3D animation tools at experimental design is new, easy to use and creative method of generating free-form structures. This paper presents a transdisciplinary or hybrid approach through the creation of multimedia educational materials. The multimedia consist of short animated forms supported by concise textual explanations with aim to give the students of engineering and art the basis of geometrical education.

1. Experimental design

The experimental design deals with the creation and generation of free-form using 3D animation tools. At the multimedia DVD are integrated contributions of the experimental design representing research and experimentation of free form.

1.1. Free form

Free-form surfaces (free forms) can be classified according to the value of their total or Gaussian curvature. Their further classification is possible by way of their generation. The most appropriate method of determining the geometric surface, in a constructive sense, is to consider them as parts or path (track) of lines and curves. Methods of generating a geometric surface are:

1. Dilative translation: expansion, contraction; 2. Translation: translation profile curve along another curve; 3. Rotation: rotation of the plane or space curve around the axis; 4. Movement made by another straight line or curves the directrix: ruled surface; 5. NURBS surfaces (Non Uniform Rational B-Spline).

NURBS surfaces and techniques provide ways for determination of any imaginable surface. Freeform NURBS surfaces require complex geometric structures of objects, starting from the line, curves and planes, their mutual interactive procedures to determine and create new forms in an iterative manner. Complex network mapping NURBS surfaces are composed of parts with control points and polygons. The term element means lines, surfaces or solid, the element of finite dimensions. A basic function of NURBS in most cases is not of interpolation character. There are two kinds of concepts network: the control network and the physical network. The control points define the control network and the control network is interpolated by control points. The control network consists of multi - linear elements in two dimensions that are bilinear quadrilateral elements, and the three dimensions as three - linear hexahedron. Control network does not correspond to real

geometry but control it. Control network looks like a typical network of finite multi - linear elements. Control elements could be translated to much simpler forms such as triangles or tetrahedral. The physical network is decomposed - disaggregated actual geometry. There are two terms of physical network elements, such as: patch and knot range. Patch involves macro-element that is made of an arbitrary number of finite elements. For most academic tests one patch is sufficient to represent the matter to any curve, surface or solid. In the case when the surface is complex character meaning that it contains of surfaces of different origin (cylindrical, spherical, conical, etc.) should be introduced more than one patch. Each patch has two teams, one in nature, and one in physical space. In the two-dimensional topology, the patch rectangle in the natural domain representation is the three-dimensional cuboid. Patch may be decomposed into intervals that are defined by spacing between nodes. These defining elements of the domain are the basic functions of smoothness. Nodes could be understood as micro elements because they are the smallest elements isogeometry dealt with. Also they have a team in natural and physical space.

The key to understanding NURBS is an index (parameter) space that uniquely identifies each node; it also discriminates amongst those nodes that have a multiplicity greater than one. All points are control and some of them are interpolation, these are just the ones that belong to the surface. For interpolation points weighting factor is equal to one. NURBS (Non-Uniform Rational B-Splines) are a standard in describing and modeling curves and surfaces in CAD (Computer Aided Design). The computer analyses of geometric NURBS are used for isogeometrical analysis. From the computer - geometrical's point of view NURBS provide precise represent effectively the data geometric forms, with the ability to control a simple form of interactive manipulation of control points, weights, knots and degree of curvature. Using NURBS modeling system used an internal representation for a wide range of curves, surface and bodies

1.2. Free-form dome structures

Good example of using free form structures are on domes. Images shown variations of free-form dome structures formed from various basic geometric shapes. From free-form dome structures formed by triangles, free-form dome structures formed by hexagons to variants of triangulated 3D mesh.

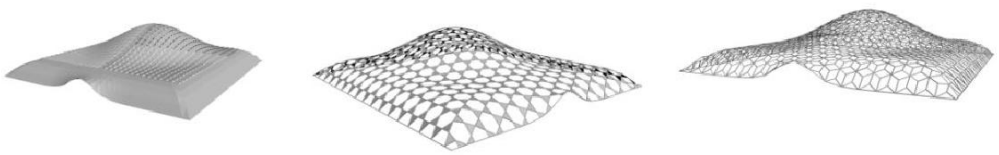

Fig1. Variations of free-form dome structures

2. Multimedia

Regarding the method of generating free-form using 3D animation tools Softimage provide more detailed explanations on published multimedia related to the experimental design. Animation was chosen as the new method because it allows the observation of shape changes in time. So far it was working in the context of a model with a fixed shape while here form changes, develops, and tests. Through these changes the experimenting with a new degrees of freedom. In 3D applications deformers can serve for modeling or animation in the sense that it is required to follow changes - deformations in time.

2.1. Animation

During the animation process a large number of points is taken to follow the topology which facilitates a larger number of forms. With a larger number of points and denser network configuration change that is more organic - freer and the result is softer. NURBS geometry is one of the softer. The basic geometric bodies are chosen in order to move from simple shapes to better display the differences in the results. Lattice deformer enables prism around the object, the prism has a small number of points. In order to facilitate deformations points are grouped into clusters and the choice is free; it is possible to make cluster from one point but this is often done in groups. Clusters are used for animation. Basic geometric transformations that are used here are Scaling, Rotation, and Translation (SRT). We distinguish between rigid (hard) and soft (organic) surface. The process of making multimedia is rigging; it's the process of the control for animation. There is possibility to choose several forms simultaneously. A number of variations of shape could be obtained because it is possible to animate the geometry the object itself except animation deformers. It is also possible to work simultaneously on the object and animation deformers. Tools that are used are tools for character animation allows the digital sculpting. It is possible to selected one form for further deformation and animation. Multimedia applications show that the animation tool can easily affect the topology. The network can be selected form a triangular or quadrilateral, but furthermore can be changed one into the other.

3. Multimedia DVD.

On multimedia DVD in the framework of experimental design (free form) are multimedia described in this paper: Lattice deformer (Lattice), Duplicate along a curve, and profile and two guides (Birail tool). On Figure 2, 3 and 4 showed the front page of multimedia.

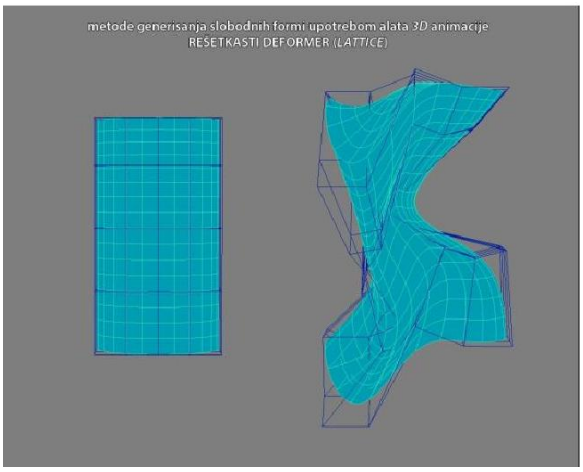

Fig 2. Frontpage: Lattice

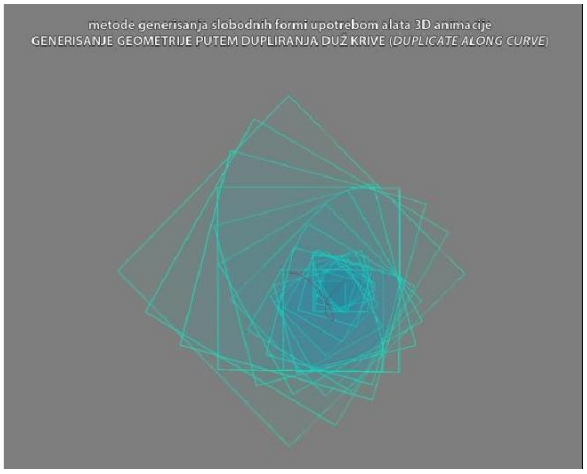

Fig 3. Frontpage: Duplicate along a curve

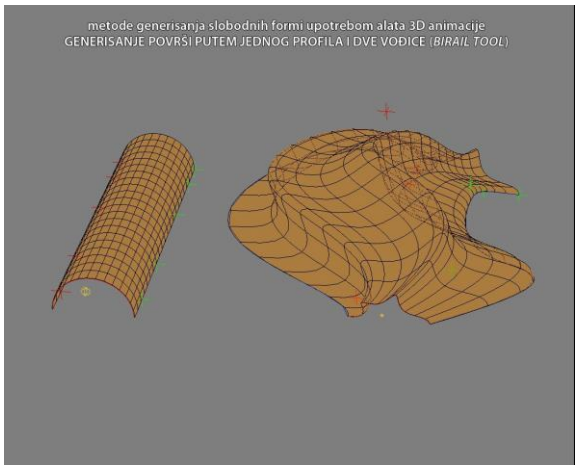

Fig 4. Frontpage of multimedia: Birail tool

Conclusion. Multimedia DVD is the digital learning tool done for the students of engineering and artistic orientation, to greatly facilitate and accelerate the process of geometrical education. The DVD is composed with short animations which could be used for exercises, further experiments and explorations in any software that is available to students. The accent is to stimulate students for further research at free-form construction process. The importance of dynamic geometry education is to make the opportunity for almost unlimited variations in forms. The special advantage of this method is the possibility to create the physical models of chosen form.

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ЦИФРОВОЕ МОДЕЛИРОВАНИЕ КОНСТРУКЦИИ СО СВОБОДНОЙ ФОРМОЙ ПРИ ЭКСПЕРИМЕНТАЛЬНОМ ПРОЕКТИРОВАНИИ

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Способ 3D анимации при экспериментальном проектировании есть новый, простой в использовании и творческий способ создания конструкций свободной формы. Эта статья представляет собой трансдисциплинарный или гибридный подход путем создания мультимедийных учебных материалов. Мультимедийный материал состоит из коротких анимационных форм и сопровождаются краткими текстовыми пояснениями с целью дать студентам инженерных и архитектурных специальностей основы геометрического формообразования.

ЦИФРОВЕ МОДЕЛЮВАННЯ СПОРУДИ З ВІЛЬНОЮ ФОРМОЮ ПРИ ЕКСПЕРИМЕНТАЛЬНОМУ ПРОЕКТУВАННІ

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Спосіб 3D анімації при експериментальному проектуванні є новий, простий у використанні і творчий спосіб створення споруд вільної форми. Ця стаття являє собою трансдисциплінарних або гібридний підхід шляхом створення мультимедійних освітніх матеріалів. Мультимедійний матеріал складається з коротких анімаційних форм і супроводжуються короткими текстовими поясненнями з метою дати студентам інженерних та архітектурних спеціальностей основи геометричного формоутворення.