CREATING A THREE-DIMENSIONAL MODEL USING LASER SCANNING

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Abstract
3D laser scanning has progressed over the last half of the 20th century in an effort to accurately visualize the surface of various territories and objects. Over time, 3D laser scanning has become less complex and easily accessible, and it has become a popular technology for collecting data "as is". Technological advances in data quality, software processing, and ease of use are rapidly expanding the scope of 3D laser scanning. This article will cover the AVEVA E3D software used in 3D laser scanning.

Annoteation
3D лазерное сканирование прогрессировало на протяжении последней половины 20-го века в стремлении точно визуализировать поверхность различных территорий и объектов. Со временем 3D-лазерное сканирование стало менее сложным и легко доступным, оно стало популярной технологией для сбора данных "как есть". Технологические достижения в области качества данных, обработки программного обеспечения и простоты использования быстро расширяют область применения 3D-лазерного сканирования. В этой статье будут рассмотрено программное обеспечение AVEVA E3D, используемое в 3D-лазерном сканировании.

Keywords: 3D modeling, AVEVA E3D, laser scanning, three-dimensional model, LFM-server

Introduction. AVEVA E3D software has a narrow focus on creating three-dimensional models of oil and gas industry objects. Thanks to the expanded functionality, it became possible to design models of any complexity with detailed drawing of all significant parts. Also, the information content has become more structured, new information standards have appeared, which started the process of integrating digital models with real production facilities.

Main part. Creating a technical model in AVEVE E3D starts with registering a new project in the database. The project is created by a network administrator. Its task is to develop the structure of future project, create user accounts, and ensure information security [1]. After project is set up, it is given a name, number, and description. Figure 1 shows the program's start window. It is used for project selection, user authentication, database selection (MDB), and work modules (Model, Draw, Isodraft, Monitor). Special attention should be paid to the MDB string, since it specifies the groups of databases required for modeling. The abbreviation MDB translates as "Multiple databases", which store the created models in the process of operation. This structure is convenient for organizing large projects and allows you to control access to information. A set of databases is developed individually for a specific object and is the intellectual property of developers [2].
AVEVA Everything 3D is divided into modules for performing various functions for manufacturing a 3D model of an industrial object. Modules and their functions:

- Model for 3D modeling;
- Draw for the production of 2D drawings;
- Isodraft for the production of isometric drawings;
- Spool for creating pipeline designs.

The program structure is also divided into disciplines depending on specifics of modeling objects. There are many disciplines, but only the following will apply:

- The Equipment discipline is responsible for creating equipment objects (pumps, tanks, etc.);
- The Structures discipline combines all metal structures, beams, supports, and bases;
- The Pipes discipline creates pipes, gate valves, valves, and other elements associated with pipelines.
- The CableSystem discipline is responsible for the application of power lines, connecting them to electrical equipment and transformers.
- The HVAC discipline is necessary for building ventilation systems.

Based on these disciplines, users are classified into categories of modeling objects. Standard categories are: Equipman, Steelman, Pipeman, Cableman, Admin. The selected user can create, modify, or delete items in loaded database only if they are a member of Team that owns the database. Otherwise, the database will be opened in read-only mode. Each project database belongs to a "Team" defined by administrator.

Before uploading point clouds to AVEVA E3D, you must perform a format conversion. The initially processed point cloud has the .pts format. AVEVA only supports the .lfd format. Format conversion can only be performed via the LFM server. This server is not included in basic SOFTWARE package and is purchased separately.

LFM-server is able to compile and manipulate large data sets obtained by high-resolution scanning. This program has the same basic functions as LeicaCyclone, which is able to process scans and combine them. However, LFM is inferior to Cyclone in some aspects. Navigation through the server workspace (figure 2) is specific and does not resemble similar programs. Also, some useful functions that greatly simplify processing of scans are missing here. Because of the more productive processing method, LFM-server is only used at the cloud export stage [3].
Before you start converting formats, you need to upload point clouds to the program database. This is done in the standard way via control panel. Point clouds are represented as a list of scanner stations. As soon as scans have been imported to new group, generation setup starts. Setting up generation means selecting the following settings: export folders, where the final result will be stored; cloud cropping zones, if you want to remove unnecessary areas; full or partial cloud resolution; preserving photorealism. After configuration, a Dataset is created via the Generation toolbar. Before starting, make sure that there is free space on disk. When everything is ready, process of generating the cloud in .lfd format begins. When processing scans of 235 GB cable laying (CTI) and petroleum coke calcining installations (PCCP), the generation took one full day.

Before starting the simulation, you need to create a SITE workspace in AVEVA, where all subsequent point clouds will be added. Import of converted clouds is performed by creating a laser model. In the General tab, select the CreateLaserModel option, and then specify the location of the .lfd file.

Equipment items include all devices that are directly involved in production of petroleum products. The equipment includes tanks, pumps, generators, distillation systems, etc. The actual type of equipment in the program is represented by a three-dimensional model consisting of geometric primitives. The primitives presented in the form of cubes, cylinders, cones, tori, pyramids, solids of revolution and extrusion. The level of detail of hardware model depends on project requirements. As you can see in figure 3, primitives act as building blocks.
Hardware elements (EQUI) are created in zone hierarchy element. EQUI elements can have one or more additional nested elements (SUBES). SUBES are used when dividing an object into a main part and a secondary part, such as supports. In addition to the usual primitives, there are also negative ones. They create holes with shapes similar to regular shapes [4].

There are a couple of ways to create hardware. The main method is modeling from primitives. This method is useful when creating a single piece of equipment with constant dimensions. After creating a ready-made model, you can add it to the library (StandardModelLibrary) and use it in other projects. You can manage the creation process using a graphical editor. Also, user can change the position of objects, adjust their dimensions, Orient them in the desired direction, and so on.

The second method is to create from templates or directories. Standard templates contain information about the object. It is also possible to parameterize elements of template equipment to change the size. Templates (catalogs) are developed by "catalogers" who re-create equipment, set its parameters, fill in the database of attribute information, and provide access to catalogs.

Each model has an attribute table that contains its unique code, name, type, owner (user), function, and goal. In addition to General information, it is possible to add specific information such as volume, area, and state (figure 4). The structure of attribute table is important, since it will be used for integration with monitoring system for installations at the NCP.
After the hardware has been created, the user needs to save changes via the main menu and click on the GetWork icon there. This function allows you to see your simulation results to colleagues working in parallel with you in the program. Figure 5 shows the point cloud that the simulation ran through. Initially, point clouds do not have such a clear image of objects. For better display quality, a function of the choice of site of interest (region of interest) has been used. You can select a plot using a three-dimensional shape. The shape can be enlarged, stretched, and moved by the arrows until it outlines the desired area. Next, you select the detail of drawing the cloud and start applying the settings. All points left outside the zone disappear from the workspace. Displaying a large number of points requires good hardware, since the process loads RAM. The larger the area of interest, the slower the interaction with other tools will be.

![Figure 5. Point cloud of the simulated zone](image)

The simulated tanks have actual dimensions and locations. The attribute information contains names of tanks, their description, volume, and characteristic indicators (figure 6). Additional information was taken from the installation drawings.

![Figure 6. Model of the equipment: tanks and supports](image)

Creating metal structures, panels, and staircases belongs to the section Structure Modeling. This section is divided into the following administrative elements: Structure (STRU), Framework (FRMW), and Subframework (SBFR). Structure contains the Framework and Subframework, where all metalwork objects are created. The SBFR element is optional; it performs the same function as in hardware modeling. Before you start modeling, you need to think about the storage structure and names of elements in the project tree. The correct structure makes it easier to create drawings and project documentation in the future. There are four bookmarks in Structural modeling:

1) SECTIONS – the tab contains tools for creating linear profiles. Depending on the selected specification and settings, you can design I-beams, channels, corners, and other elements. To ensure that the model meets state standards, the main design parameters are set in the catalog database. Catalog databases record geometric parameters of simulated profiles, their
manufacturing materials, connection types, and auxiliary elements. After that, types and sizes of the required profiles will be available in the program. During modeling, various manipulations with structures can be carried out (Figure 7).

2) PLATES – the creation of flat elements. For example, when modeling sites, when the supporting structures are ready, a panel is placed on top as an overlap. Border panel, you can choose the control points of the elements or along edges of profiles. Panels are not catalog items and do not link to a database. Therefore, the panel properties are set manually during creation. The panel specification can be set as a selection from a range of panel thicknesses, or thickness can be specified manually by entering a numeric value.

3) WALLS AND FLOORS - creating walls, floors and screeds. It was not used during the simulation.

4) STAIRS LADDERS HANDRAILS - creating staircases, stairs and handrails. This tab allows you to quickly create stairs of any configuration, but only if the design of the stairs is in the catalogs. Catalog development of stairs is a time-consuming process, and due to their wide variety, the question arises about the feasibility of this work. Therefore, it was decided to create stairs by modeling through the Sections and Plate tabs. An example of the created metal structures can be seen in figure 8 [5].

Figure 7. Modeling of metal beams

Figure 8. Models of metal structures
In any project along with the other steps in the simulation, binding equipment pipelines is the largest amount of time. In a pipe structure, the main element is the Pipe element (a system of interconnected branches), which contains any number of branches. In turn, the branches contain pipeline components such as flanges, gaskets, bends, tees, fittings, and so on.

Pipeline modeling begins by specifying location of the beginning and end of pipe. The pipe branch has a HEAD and TAIL. First, specify location of the head, which can be set by coordinates, graphic binding, or specifying inset element. The end of the pipe is determined in the same way.

When a branch has a head and tail specified, a dotted line is drawn between them to represent the shortest path of the pipeline application. The line will hang until the beginning and end of pipe are connected. When connecting, types and diameters of the pipe parts must match. The next step is to create a series of components (fittings) in branch that define its desired geometry. Before you start creating it, you need to determine which components are present in the point cloud. At this stage, the question arose about determining the diameter of the pipe under the insulation layer. For this purpose, drawings of pipelines connecting the installations were raised. There was also a problem of missing parts of a certain state standard, in particular flanged gate valves, but in the course of work these nuances were resolved. When choosing a fitting, there is no need to choose their dimensions, since the parameters are automatically selected from the catalog database. Figure 9 shows the process of attaching pipe corners to the head flange.

As you know, when installing pipelines, it is not always possible to adhere to the project drawings. Due to some factors, the pipe overpass may settle, bend and change its position in space. The task of the Modeler is to show a real picture of the state of factory objects, but due to limitations in software capabilities, this is not always possible. AVEVA has developed the QuickPipeRouter tool for creating pipe slopes and turns. This tool allows you to route pipe laying with slopes. Using the navigation arrows, you can set the angle and length of the pipe direction (figure 10).

QuickPipeRouter has the ability to automatically insert bends or turns, which allows you to visually assess whether there is enough space for components. Figure 11 shows the result of modeling pipelines [6].
Conclusion. According to this method, the modeling process is performed. Due to the clear interface and structure, working in the AVEVA E3D program is convenient and easy. Also, a large set of tools allows you to create atypical models and elements.

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