REAL VIRTUALITY IN PRODUCTION ENGINERING

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Abstract: *3D planning gradually becomes the standard not only at the universities or research institutes, but in companies too. By the tools of the virtual reality new factories are planned, machines, as well as conveyors, transport systems, energy wiring etc., are located. A problem comes, when already existing construction is not 3D digitized, but only in 2D. Then often the 2D is transformed into 3D, which is not accurate. For this reason this article describes the new technology for digitizing of already existing constructions*
Key words: *Real virtuality, digital factory, simulation*

1. INTRODUCTION

Recently much has been spoken about a concept of digital factory. Some commercial companies offer this concept in the form of an integral package of software products, which are integrated together and they work on the united information database. The slogan of the digital factory is „solutions for building products more quickly and more efficiently“. The computer aid of such products is often offered in areas, which are shown in Fig. 1.

Fig. 1. Concept of digital factory from DELMIA

With help of such a product a company is able to digitize the whole documentation and it can control and simulate the production on-line. What is not implemented in these products? The tool, which can digitize the already existing constructions (halls, objects, warehouses) in a company.

Present companies have had the constructions already digitized, but only in 2D. 3D models are used only exceptionally by robot simulation or by dealing with questions of the ergonomics. The present trend is, that in 3-5 years the 3D planning would become a standard in many companies. Already nowadays there are companies e.g. VW, which have done this step. Studies have shown, that in the automobile industry it is possible to save minimal 3% of investment. American companies have come close to 10% of investment. This reality is partially caused because of not keeping the deadlines of the projects and the project costs are higher than planned. The main reason is the space problem, which is recognized too late and this requires complicated and expensive solutions. One of the reasons, why the 3D planning is not so massively expanded in the companies, is the fact, that the already existing constructions are not digitized in 3D and they are digitized by conventional tools, which are expensive and requires much time. For this reason a new technology for the constructions digitizing is presented in this article.

2. HOW TO ACHIEVE THE 3D MODEL ?

There are some possibilities to achieve 3D model of an already existing construction. Most frequently the conventional tools like meters, in the best case the laser meters are used. The most modern tool for such digitizing is the laser scanner.

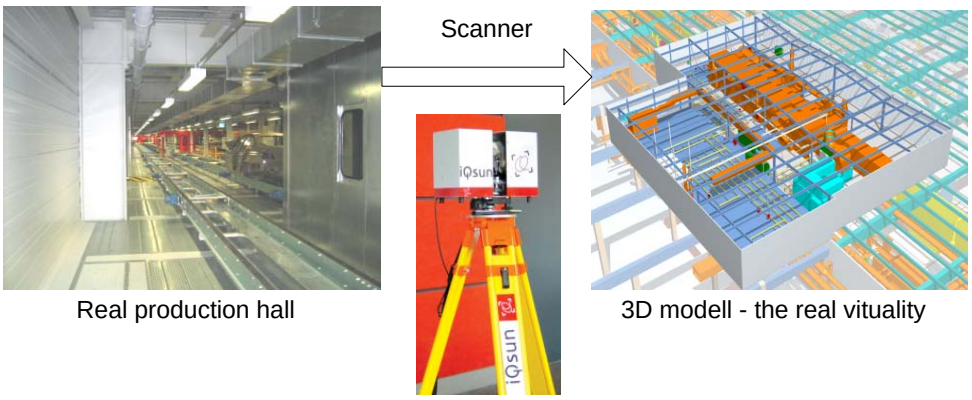

Fig. 2. Digitizing process

The digitizing process can be divided into three steps as follows:

- Scanning preparation - Implementation and surveying of the factory reference grid.

- Laser scanning of the as-build-state of the plant.
- Creation of the Realistic 3D-Plant-Model in the customer's target planning environment.

First step – Scanning preparation

The described technology allows a high measurement accuracy of constructions to 3 mm (when planning, the accuracy of mostly 2-5 cm according to usage is sufficient). This accuracy is influenced by the quality of scanning preparation.

At the beginning it is needful to agree the all the conditions with the customer. To clear, what the customer expects from the virtual 3D model and for what the model will be used in future. Each customer has specific demands, from which the whole scanning process is dependent. It depends on the fact, if the model will be used for a production reorganization or production planning, for building the object library or for static analysis of the constructions. It is important to agree the details and accuracy of the model and what is needful for the model to include.

To build the 3D model, it is needful to scan the production hall. Before this step the reference points have to be positioned all over the hall, thereby the factory reference grid is built. Every reference point is placed in space and it has its own coordinate and marker. This forming of the reference grid is then used by the connection (registration) of scans and it specifies the future virtual model. In the future the factory utilizes the reference grid for the precise location of production facilities, conveyors and transport systems, etc., which were built in the 3D model.

By the location of reference points it is important to point so that such reference points will be in sufficient number, which is necessary for the accurate scanner location in space. From one scanning position it is important to see minimal 4 reference points, which have to be in distance less than 15 metes from the scanner.

The number of reference points is dependent on the hall size and on the level of the model detailedness. For instance, in the hall of 300 x 100 meters with 2 floors (together 60.000m2) with the hall grid 12 meters x 8 meters were used 800 reference points altogether.

Second step – Laser scanning

The second step is the scanning of the as-build-state of the plant. For scanning we use the laser scanner, which has the following parameters:

- Resolution 29 Mio Points per Scan (eff.), 8.000 Points horizontal, 4000 Lines vertical, Panorama view of 360°, vertical view of 330°, Measurement-speed of more than

180.000 points per second, Accuracy (linearity) of 3 mm on 50 m distance, range 80m, Photorealistic 360 º Grey Scale Pictures.

This high capacity really allows a quick, accurate and full scanning of the whole construction. The scanning result is not a black-white photography, but the real representation of 3D measured points, approx. 1/9 of the whole panoramic picture.

Every pixel of this scan has 5 attributes: reflection, x, y, z - coordinates, distance from the laser scanner. After scanning of the whole construction it is needful to link all the scans together. This process builds the panoramic picture and every pixel represents one coordinate in the hall. For linking the scans and their view, for navigating in the scanned hall, for the distance and dimension measurement of objects and for export into a CAD system the software iQscene is used. In the above example it was needed to make 400 scans for both floors.

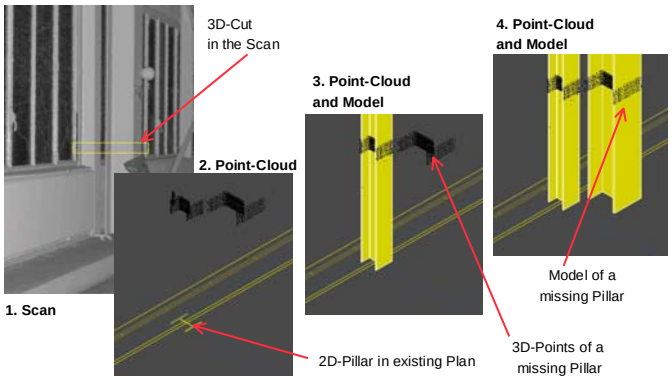

Fig.3. Example of pillars modeling (data export from iQscene into CAD system)

Usually the data are exported into AutoCad, Microstation, Intergraph, CATIA, etc. It is important that by 3D scans a completely a new medium is obtained, which represents the natural picture of reality. In comparison to 3D CAD model (it represents the ideal virtual reality) is received the new value – „real virtuality".

Third step - Modeling of the Realistic 3D-Plant-Model

By modeling we come out from the scans of exported points (iQscene) and not from a 2D existing layout, which is often at disposal. The main reason is that it is needful to model the real construction and not an ideal design, which the 2D layout represents.

The realization of the described way of the object digitizing is relatively demanding on time. The modeling process can be accelerated by effective 3D object libraries. In the following Fig.4. the library TriCAD-MS for the support of modeling in Microstation is shown. This library contains a big catalog of 3D objects, e.g. pipes, ventilation systems, electrical wiring, various steel constructions, conveyors, transport systems, etc.

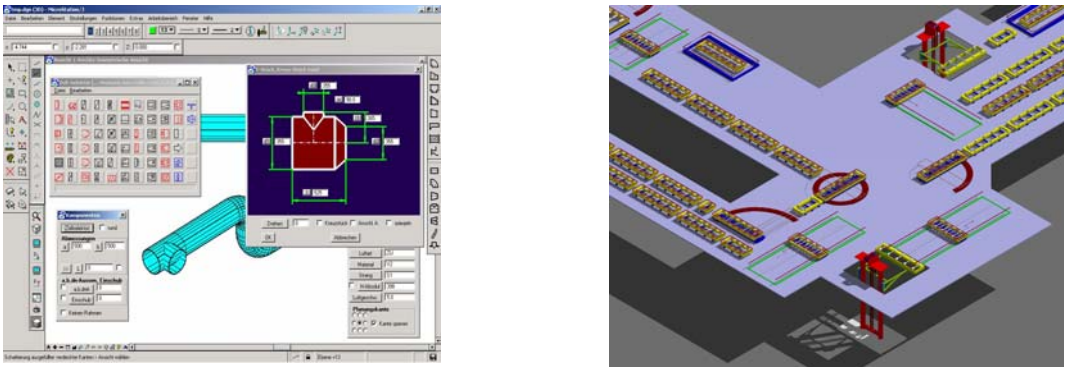

Fig.4. 3D objects library in TriCAD

3. TABLES UTILIZATION POSSIBILITIES OF THE VIRTUAL 3D MODEL

Factory reference grid

- Fixed located points build the reference grid for the whole measurement in the factory.
- Gives precision to 3D scanning and serves for machines and equipment location.

Finding out the collisions

- 3D data are the basis for finding out the collisions.
- The most important source for saving, more than 2% of costs of the company investment, could be saved thanks to collisions finding out.

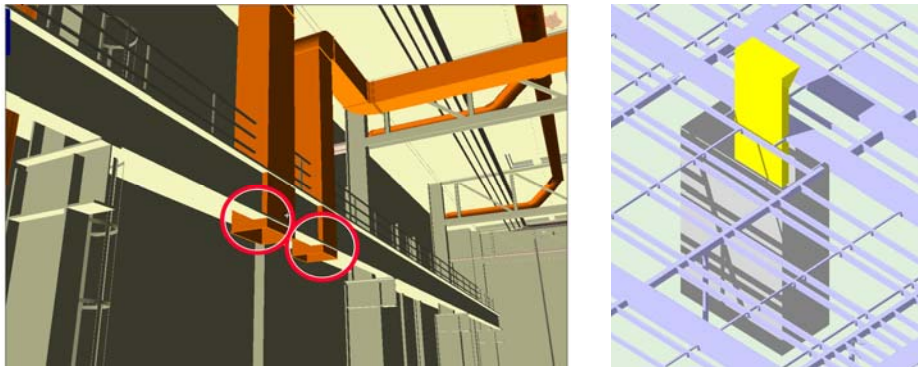

Fig.5. Collisions in 3D model

Mistakes of 2D layout

- 2D layout is not the same as reality.

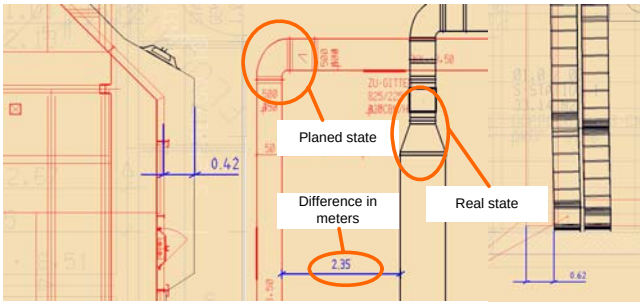

Fig.6. Example of mistakes

3D objects library

- Virtual 3D factory is an effective way how to create a specific parametric 3D library, which can be used in CAD or in another design software.

Using the virtual 3D model by supplier

- 3D model can be utilized directly by the supplier. For instance, we model a tunnel in which we want to build a conveyor. The supplier does not have to come and measure the tunnel, but he works with the 3D model dimensions.

Others

- All needful factory dimensions are immediately accessible – location of machines, conveyors, transport systems, etc.
- We know the location of the engineering networks e.g. water, air, gas, sewage or electrical wiring.
- There are accessible all the restrictions, which could occurr by the design and which are invisible by 2D layout.
- 3D model can be used in connection to simulation - Witness 3D, eM-Plant, QUEST.
- Quick application of changes.
- Factory visualization.

4. CONCLUSION

Described technology for scanning and modeling opens up the beginning of the high effective, accurate and detailed digitizing of already existing factory as well as a new one. This technology describes the first time a practicable way to wide-raging realization of 3D planning. This technology should be not substituted by the "virtual reality" – but it can – thanks to close reality, be described as a "real virtuality". This technology is new, but it has been used by all the German automobile producers as well as in other industries. The customer received all 3D-Laserscans with iQscene-Surveyor-Software for the measurement and planning in the 3D factory representation and the real 3D-model of the factory in CAD-System according to own selection.

5. REFERENCES

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