

## 4D and 5D applications in BIM technology

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### Abstract

This paper is about the integration of design, costing and scheduling within a BIM workflow. The authors have developed an application supporting CAD based cost estimating and allowing users to produce quantity takeoffs directly from a virtual building model. Moreover, the data from the cost estimate directly serves as a preliminary information source for automated scheduling. The authors address several issues including additional design parameters and conclude by describing their own solution.

*Keywords: BIM, estimating, cost analysis, time analysis, bill of quantity*

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### 1. Introduction

In Poland, the vast majority of projects are planned using 2D documentation standards. The number of contractors using 3D modelling to better visualize complex structures is growing. However, the possibilities of 3D software are used to a limited extent in the integrated design, not to mention the construction phase. Currently the information that can be directly derived from the model is not used to create or update the cost estimates. In general, these data should be converted to or produced in a different format, wasting time and incurring costs, not to mention the possible loss of important information. The combination of 4D and 5D applications and BIM technology allows users to determine a cost estimate and scheduling plans based on the data obtained from the building model using an integrated CAD environment.

### 2. The usefulness of BIM model according to Przydatność modelu BIM w integracji branż

In comparison to traditional CAD systems, in which geometrical and topological properties of the model are very well described, BIM models contain a lot of additional information [1]. Especially interesting in this case is the information that facilitates the basis for the integration of industries. First of all, a BIM model has a structure that reflects the composition of a building. This structure is hierarchical, and its basic building blocks are equivalent to real elements, including their properties. IFC is the open ISO standard used for communicating and storing this information, facilitating the exchange of multi disciplinary BIM models. The IFC format can cover a wide range of data, but various CAD/BIM systems do not fully comply to this standard. As a result, a lot of data fields and element properties remain empty. Some of this missing data can be entered manually by the designer. However, in practice, many data turns out to be false, and therefore unreliable. This issue has to be taken into consideration by application developers, who, for example, develop tools for 4D and 5D analyses based on BIM models. The OpenBIM Initiative [2] is a good example of a program which

focuses on the correct use and exchange of information within a model based workflow. This paper addresses the workflow and a possible solutions for utilizing the full potential of three dimensional modelling, including additional variables such as costs (4D) and time (5D) .

### 3. 2D CAD, 3D, 4D, 5D

BIM technology may in fact be associated with 2D, but three dimensions offer many advantages, of which visualization and coordination are the most common ones. However, BIM also facilitates the introduction of additional parameters that are of great importance to the decision and investment process such as time and cost, which are responsible for another "D" [3]. Before calculating the cost and time of the investment, a bill of quantities is produced, which includes complete list of building materials (pieces, weight, volume, area, etc..) and the number of works. The cost and time variables are thus interrelated and to some extent dependent on this information. The Polish construction industry uses a directory called KNR (Katalogów Nakładów Rzeczowych), defining the construction effort. On this basis it is possible to perform a full calculation of costs and schedule, provided that the required quantitative data is separated based on its model structures [4].

### 4. Automation of calculation

The solution that the authors consider to be "elegant" is the automation of design "design-to-cost" and/or timing using the libraries, classification, pricing and specifications that are consistent with each other and in applications for various industries (Fig. 1 ). Obstacle to the full automation (where it is possible and reasonable) in Polish conditions is the lack of standards and classifications available in BIM technology. An additional handicap is existing software's inability to attach the universal library of structural elements from independent software vendors. For these reasons, the application presented in this paper does not perform cost calculations fully automatically. For both the takeoff and determination of parameters for the workload requires manual processing from the user.

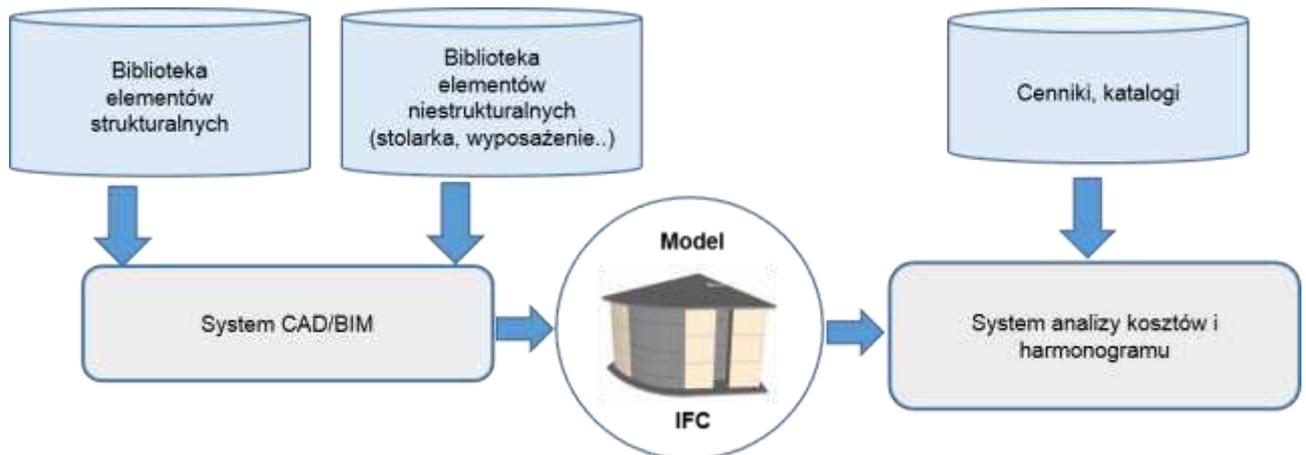


Figure 1 Integration of costing and scheduling with designing

The fully automated version of the solution illustrated in Figure 1 requires the addition of libraries, handling the digital identifiers that allow matching elements used in the design of price lists and other data. Having no Polish counterpart of e.g. OmniClass available [5] is a very significant obstacle in this case.

### 5. ZUZIAbim, the first Polish 5D application

Considering the limitations that have been addressed a system has been developed that provides the possibility of analysing cost and scheduling information based on virtual building models. An IFC File Browser was developed, with the possibility of a comprehensive selection and visualization of the model. The IFC model may include information from a single discipline, for example architecture or MEP systems, but it can also contain a combination of information from the different construction disciplines. The Browser works with a cost estimation tool and allows you to automatically move specific information (e.g. volume, area, and length) from selected elements. The information included in the system catalogues facilitates assessment of the cost at the end of the process. The schedule is determined in the following order which is the commonly accepted order in Poland: and some basic data and a list of work and time-consuming hardware and the operating parameters are automatically generated. Such a method and sequence of calculations provide a quick and easy installation and reduce the number of data entered by the user providing more efficiency as compared to other known solutions [6].

### 6. Summary

The authors developed the first Polish suite of applications that integrate design, scheduling and costing. The applications facilitate the work for cost estimators and construction managers working with the BIM technology. Unfortunately, for further automation of calculations the required norms and standards for the Polish construction market are currently completely absent.

The authors draw attention to it in the belief that the essence and power of BIM lies in open formats for data exchange and interoperability, as exemplified by the OpenBIM initiative rather than building one system for which BIM is mainly an advertising slogan.

You should also pay attention to the logistics and organizational aspects accompanied by BIM, which is associated with concepts such as IPD, IFD, IDM [7].

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