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INNOVATION APPROARCHES TO BUILDING PROJECT PREPARATION AND REALIZATION

INNOWACYJNE PODEJŚCIA DO PRZYGOTOWANIA I REALIZACJI PROJEKTU BUDOWLANEGO

Abstract

The paper deals with progress of constructions designing principles. There are described innovation milestones in designing systems field, which come from standard manual designing, through CAD systems designing, till the newest BIM technologies. The 3D parametric object simulation has abilities increasing not only the designing quality, but also the effects of whole building process. The newest trends in designing technologies provide the effective building management, not only effective designing, by qualitative innovation of 3D designing systems and their integration with other building parameters (costs, time schedule) calls also 5D technology.

Keywords: CAD, BIM, 3D design, 5D technology

Streszczenie

Artykuł omawia postęp w dziedzinie zasad projektowania budowlanego. Opisane zostały przełomowe innowacje w zakresie systemów projektowania od standardowego ręcznego projektowania poprzez systemy CAD do najnowszych technologii BIM(modelowania komputerowego). Trójwymiarowa wizualizacja przedmiotu nie tylko poprawia jakość projektowania, ale wpływa także na cały proces budowy. Najnowsze kierunki w technologiach projektowych zapewniają efektywne zarządzanie procesem budowy poprzez jakościowe innowacje systemów trójwymiarowych oraz ich integrację z innymi parametrami budowy (koszty, harmonogramy), co nazywa się również technologią 5D (pięciowymiarową).

Słowa kluczowe: CAD, BIM, projekt 3D, technologia 5D

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1. Introduction

The ability for prediction of all parts of construction project has hardly improved over past seventy years. In fact, the situation has got dramatically worse. According to The Economist Magazine, 30% of the construction process is rework, and 60% of labor effort is wasted. There is also a 10% loss due to wasted materials. Current technologies for managing the construction process are proving inadequate for addressing the increased complexity of buildings and the incessant market demand for shorter timescales. Todays technologies for managing the construction process are not very effective.

2. The building project specification

Construction project presents a very difficult and extensive system of construction processes. Nowadays the emphasis is on the preparation phase and management skills of construction participants more than ever. Whole construction project is very complex and complicated according to [2]:

- the great number of construction participants,
- opposite purpose of construction participants (related to time and cost especially),
- complicated legislation and contracts between construction participants,
- frequent changes in construction plan by construction participants,
- construction participants are involved into other projects (with other construction participants).

The one of the traditional classification of activities, which is connected with building--up, is made from point of individual building participants. These participants are defined in various laws and regulations as persons, who are responsible for particular activities of building process. Among the main participants of building processes belong:

- investor – as a person, who is investing the financial resources (for purpose of profit, public or other benefits),
- contractor – as a person, who is the building realize for and who is responsible for its preparation, realization and giving into utilization according a law,
- customer (user) – as a person, who will use the result of project (in some cases is contractor, investor and users of building the same person),
- suppliers – as people or subjects, who are contracted to some admission in the frame of preparation and realization activities which are connected with building-up. Here belong:
  - designer – as a person, who is providing for investor following his conceptions and requirements (specifications) the building design (he is responsible for it according the law) and all requirements, which are connected with project documentation processing for area and administrative procedure for all professions (water, heating, gas, power line, …) and operative complex documentation,
  - main (general) supplier of building works – as a person, who is responsible for building performance (organization, management, coordination of building works and other activities at building site) according law,
  - subsuppliers (of main supplier, generally) – as people, who are provided the special works or works, which the main supplier do not have needed capacity for,

- engineering supplier – as a person, who is providing the project and building works as well (by own capacity, but more frequently by subdeliveries) – so called supplier engineering, or person, who is provided the investor matter (permission arrange, suppliers selection, making contracts, …) – so called investor engineering,
- building products suppliers and all goods connected with building as well,
- technological equipment suppliers of building and technological completes
- and other suppliers from various institutions, who give the references, expert opinions, metering and testing to individual building activities, when it is necessary.

The professional organisations are more intensive started in building market, except the traditional participants of building process. These organisations are aimed at project management, developers or facility management. These participants make the presumption for more effective utilization of building projects management forms, which expect using of latter and more integrated software backgrounds.

3. Present and future of construction process management

Present way of processes is linked with preparation and realization of construction project could be characterize as a serial (linear) process. From that point of view we can characterize these activities.

There are typically milestones in construction process – important chronological moments. They generally characterize which group of activities must be done before next group of activities could start. Typical example: you must have finished project documentation, before you start dealing with estimating of project. Also carriers of single activities groups are generally various project participants, which use generally they own, different and frequently incompatible techniques and tools [1].

Present model of activities sequences on project could be characterized as a model, which is (Fig. 1):

- linear – serial, that have effect on preparation and realization building length,
- error prone, of record from individual participant of the process,
- unidentified risks, as a consequence of the lack of activities coordination between single project participants,
- ineffective from the cost, time and resources view.

The fact is that we could spend less time with using information technologies for design and estimating at this present model. But there is still insufficient reversibility of this system.

All participants have to realize, that only through the joint efforts and logically substantiated compromises they could reach the result, which will satisfy their purposes, which they were going into project. However that expects common language, in meaning same acceptable information and data about constructions, elements, materials, methods, costs etc.

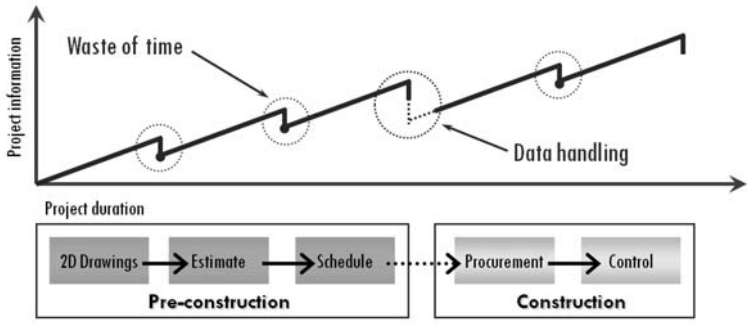

Fig. 1. Present way of data handling

Rys. 1. Obecny sposób obróbki danych

Next that expects parallel modeling all aspects of construction process. Already during modeling constructive solution of the building there is parallel estimating of the costs for each building element, which materials will be used. It is possible to parallel modeling progress of realization construction, included demand on single construction factors (labor, machinery, materials, money,…).

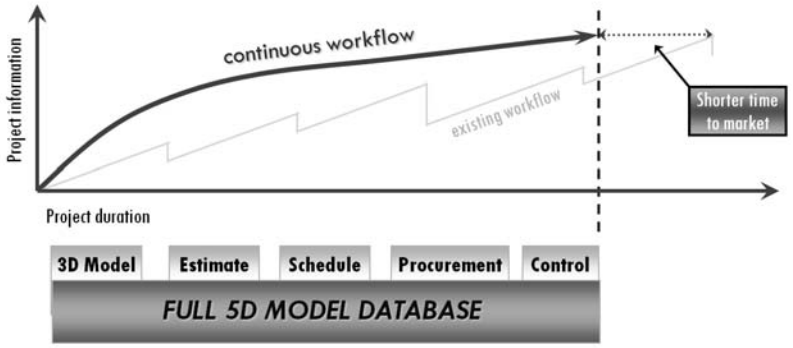

Fig. 2. Future way of data handling

Rys. 2. Sposób obróbki danych w przyszłości

Nowadays is more important to pay attention at risks of the projects, according to organization, economic, technical, technological, but also safety matters. If some risks become real, all of them reflects in costs and into time, exception from irreversible matters (such as job-related injury or death of worker). Because of that we need to consider (simulate) risks, primarily so-called speculative, at those parameters, if we improve one parameter (reduction of constructive time) the second parameter could get worse (job--related injuries at construction site) [3]. Such developed system for preparation and realization of construction expects following addition (Fig. 2):

- parallel construction data processing, from its design to realization of designed construction solutions, if we eliminate collisions at designing, spending on construction in the face of designed construction,
- united (integrated) information and data base about all constructive elements (characteristics of materials, costs, operation processes, demands on constructive factors,...),
- reversibility of the system, possibility of project goals simulation (costs, time, specification,...), but also on partial constructive and technological solutions,
- elimination of "chronic" risk spots at construction project,
- predictability of project progress.

4. Construction participants software backgrounds

For the beginning period of using computer aid design is specific, that each construction participants used different software tools (foundation engineering, stress analysis, distribution of water, electricity, estimating, schedule,…). After a short time some software tools were integrated into complex software tools (stress analysis + construction part + professions, estimate + schedule). As a starting point of computer aid design, we can set computer aid design in two dimensions (2D), using software tools such as AutoCAD, Micro Station, Nemetchek. Increased complexity of buildings and market demands calls for more integrated software tools, which create background with unitary source of information and data about structural elements and constructions. The software background with these demands is 3D information model, which can be linked with facility management and virtual building software tools.

Nowadays is characteristic in changing software tools from 2D systems to 3D systems (Allplan, ArchiCAD, Autodesk Revit). These software tools are using BIM technology (Building Information Modeling). BIM can be used to demonstrate the entire building life cycle including the processes of construction and facility operation (Fig. 3). Quantities and shared properties of materials can easily be extracted. Scopes of work can be isolated and defined. Systems, assemblies, and sequences are able to be shown in a relative scale with the entire facility or group of facilities. The first implementation of BIM was under the Virtual Building concept by Graphisoft's ArchiCAD. ArchiCAD provides the potential for a virtual information model to be handed from design team (architects, surveyors, consulting engineers, and others) to contractor and subcontractors and then to the owner, each adding their own additional discipline-specific knowledge and tracking of changes to the single model. The Virtual Building approach also means that you can make changes at any time maintaining the integrity of documents, without risking costly errors or costing you productivity [3].

Virtual Building represents a central database of 3D model data. From this can be extract all the information needed to completely describe design – complete plans, sections and elevations, architectural and construction details, bills of quantities window/door/finish schedules, renderings, animations and virtual reality scenes. That means while you are designing, ArchiCAD is creating all the project documentation so there is little repetitive and tedious drafting work. Comprehensive schedules and bills of materials are available for builders and sub-contractors, as well as drawings of scale-sensitive details. Builders can

plan tasks, create time-based animations and document any phase of a building's construction or demolition. And developers can use the photo-realistic renderings for a sales brochure. ArchiCAD stores all the information about the building in a central database; changes made in one view are updated in all others, including floor plans, sections/elevations, 3D models and bills of material (http://www.graphisoft.com).

According to long time dominance 2D computer aided design, switching into 3D computer aided design is very slow. But nowadays technology is much more developed. In present time, the available technology can be specifics like switching between 3D technologies to 5D technologies.

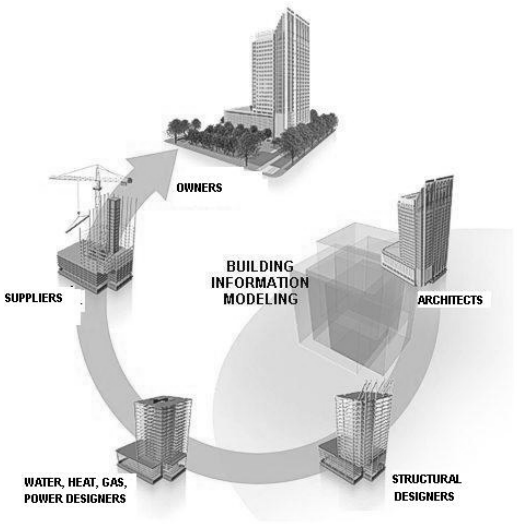

Fig. 3. Building information modeling

Rys. 3. Komputerowe modelowanie budynku

5. 5D technologies – challenge for complex construction process management

The construction industry is changing rapidly. The increased demand for efficiency, shorter delivery times, and higher quality is pushing owners and contractors to adopt new business models and technologies which will give them a competitive advantage. The integration of processes and improved communication throughout the design-to--construction life cycle has proved to be an essential part of this change. Integrated Project Delivery and BIM technology are today's buzz words, and the necessity of a truly integrated social-BIM platform becomes evident [4].

Vico's next generation 5D BIM solution was created for this need. Vico Office™ is purpose-built for construction, and is designed as a tightly-integrated, BIM-neutral platform to which multiple types of BIM models can be published, synthesized, and augmented with cost and schedule information. To maximize efficiency and meet the distinctive needs of the various construction process trades and phases, Vico Office is structured in a modular

way, providing you with a tailored, yet expandable solution and a consistent, easy to use environment. Using Vico Office, building owners and general contractors can collaborate efficiently, improve predictability, reduce risk, manage cost, and optimize schedules on large, complex building projects. Vico Office consists of a core module – the system's cornerstone – and a set of discipline-phase-specific complementary modules, all tightly integrated in the same environment (Fig. 4). Since every Office component shares the same integrated database, total homogeneity of the information is always guaranteed. The unified user interface and the consistent structure ease the implementation of new modules and accelerate the learning process.

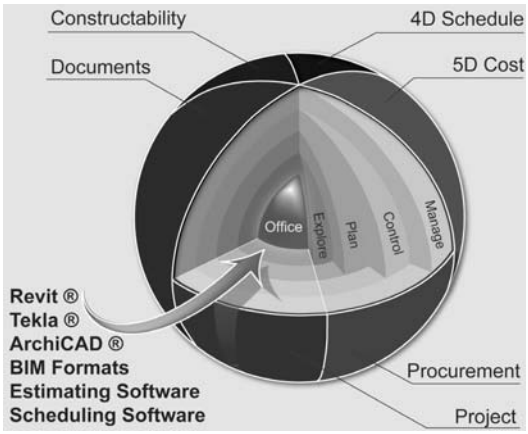

Fig. 4. Description of 5D-BIM environment

Rys. 4. Opis środowiska 5D-BIM

The Vico Office modules support the various functions involved in a BIM project and provide for each function distinct modules for exploring, planning, controlling, and managing the construction process. Each added module leverages the data, further increasing BIM process efficiency. Vico Office's unified structure matches the Integrated Project Delivery methodology and enables a beneficial social-BIM environment.

The Vico Office environment enables internal and external collaboration. The integrated environment, the number of parties involved, and the data ownership issues, require a flexible, collaboration technology. With Vico Office, project team members can work simultaneously on the same project and benefit from an on-line feedback and up-to-date information.

The Vico Office Suite consists of a core module and a set of discipline-specific application modules. Each Vico Office application shares access to the same, integrated, project database thus ensuring a change in one place is reflected everywhere. The User Interface across all the modules is consistent, predictable, and highly visual. As a result users can quickly learn and use the system, moreover they retain their knowledge over extended periods of non-use. The Vico Office Suite is comprised of applications, or modules, that address specific disciplines or areas of interest across the project team.

The Vico Office Client module is the central access point for models and model information. From here the user creates a project, manages the versions of published models coming into that project, performs reporting, and accomplishes viewing, navigation, and other filtering/selection.

Vico Takeoff Manager performs automated quantity takeoff from the model. The user creates takeoff items, visually verifies model elements included in the quantities, and manually subtracts or adds model elements in quantity calculations.

Vico Cost Explorer allows users to set up target costs, compare versions of estimates, and create reports and visual comparisons. All targets and comparisons can be specific to any level in the project's location hierarchy.

Vico Cost Planner allows users to create and edit assemblies and components for purposes of completing cost estimates. The formula editor is entirely new and highly visual making Cost Planner a complete and easy-to-use cost estimating application.

The Vico LBS Manager allows users to create zones, or location breakdown structures, which can easily tie to the project's task schedule. Hierarchical location breakdown structures allow flexibility in mapping tasks to assemblies and components.

Vico Constructability Manager allows users to create, track and report constructability issues. Clash detection is semiautomated to include user validation and the creation of any new constructability issue. Users can also manually create constructability objects inserted into the model to flag non-geometric (i.e. non-clash) issues.

Vico Control is a unique location-based construction management system. Incorporating locations, quantities, and crew productivity rates in Controls FlowlineTM view produces clear and accurate projects schedules based on derived durations for each task.

Vico Change Manager automates the process of checking one construction drawing set against another for revisions. Change Manager processes hundreds or thousands of drawing files automatically to identify changes to existing drawings, new drawings added to the set, or old drawings missing from the set.

6. Conclusions

The paper deals with building projects risks issue from point of individual partners of project. The newest trends in field of software products will be analyzed. These software products support a building projection following more complex information about construction elements. This way of projection allows a simulation of building costs parameters and building schedule parameters already in the stage of constructional model. Only this approach in project preparation provides a minimize of needed projects actualization in building course, risk minimize of next building and successful and effective building completion, following planning building parameters.

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