INTERSECTII
INTERSECTIONS
http://www.intersections.ro

# Expert systems in the BIM environment.

Oleksiy Levchenko[1], Tetyana Kashchenko[2]
[1]*Department of Informational Technologies in Architecture, Architectural faculty, Kyiv National University of Construction and Architecture, 03680, Ukraine*
[2]*Department of Architectural Design of Civil Buildings and Structures, Architectural faculty, Kyiv National University of Construction and Architecture, 03680, Ukraine*

## Summary

*In modern architectural practice, it is important the availability of software that makes it possible to compare design alternatives, gives quickly assessment of the architectural object - comprehensive or by individual components, makes energy modelling and resource balance, thermal parameters, optimises the form. System quality assessment of project increases with the expansion of technologies, the introduction of Building Information Model (BIM) and Building Energy Model (BEM). According to qualimetric analysis this project evaluation allows operating with the value of the floor space standard unit to the total building area, attractiveness and the level of investment risk.*

*The analysis is carried out at the level of 3D inspection of architectural and structural elements and at the level of structural parametric data that accompany these three-dimensional data for architectural, structural and engineering components of buildings and structures.*

*Expert System Allcheck in BIM-design environment allows to search "collisions", errors and to perform rapid analysis of structural elements incorporated in accordance with the regulations and requirements of government control and examination.*

*On a base, Allcheck ("Allbau Software") is executed verification of additional data (attributes) filling in accordance with the detailing project degree of LOD (Levels of Detail) according to interaction standard BIM-software based on data format IFC.*

*The development of Allcheck plugin would expand the number of inspections and the options: to add a groups of audits by regulatory requirements on the AX-3000 basis, to supplement verifying of thermal performance, the functional properties of space - regulatory indoor temperature and energy consumption, which enables approach to "zero energy" and rapid formation of energy passport of the building.*

KEYWORDS: informational technologies in architecture, Nemetschek Allplan, Allcheck, Building Information Model (BIM), Building Energy Model (BEM).

ISSN 1582-3024

INTERSECTII
http://www.intersections.ro

Oleksiy Levchenko, Tetyana Kashchenko

## 1. INTRODUCTION

The end of the 20th - early 21-st centuries, connected with the rapid development of information technologies, was marked by the appearance of a fundamentally new approach to architectural and construction design.

The BIM (Building Information Modelling) concept allows a team of authors - architects and engineers - to work together on a project, creating a computer model of a new building that carries all the information about a future site.

Leading developments in the field of BIM in the territory of the European Union belongs to Nemetschek concern and their partner Allbau Software GmbH (the head - Vladimir Shkatov [1]), in Ukraine it is the "Allbau Software Competence Center in Ukraine" (the head - Yuri Smirnov [2]). The company develops researchers in the field of BIM and is engaged in its own projects, both the creation of expert systems and the expansion of Allplan functionality in accordance with government regulations.

Experience in the study and implementation of BIM Allplan Nemetschek is presented in the manual "Collection Allplan. A short course of the BIM. Theory and Practice" [3] and displays the fullness and the need for this concept in a modern design.

When using BIM technologies, the amount of information processed increases significantly. With information modelling, an object-oriented digital model of the whole object is created, and a model of its construction process can also be developed. Given the complexity of such models, a large number of elements, a variety of requirements for them there is a need for control.

The control provides for synchronous or post-project analysis of compliance with the tasks, architectural and construction norms and rules. This function is performed by the Allcheck module developed for Allplan and Planbar [4].

## 2. DESCRIPTION OF THE SOFTWARE SOLUTION

Allplan is a comprehensive solution that unites all the sections of the building design: architecture, reinforced concrete structures, engineering systems of buildings, general layout, construction volumes, cost estimation and estimates, metal structures, design.

ISSN 1582-3024

Work on the project is carried out simultaneously, it is possible to see the changes made by engineers of related specialities, and also some changes can be applied to the whole complex project.

Intelligent building objects are interconnected, therefore it is possible to effectively design engineering systems, to check the heat losses of the building when changing the planning decision, transform the architectural model into a calculation model for SCAD, LIRA and the program from Nemetschek - SCIA Engineer, for constructive calculations in accordance with the norms [5].

Allcheck is a customizable expert system for monitoring architectural and design solutions in Allplan.

Allcheck is a plugin, which allows finding errors in projects before the beginning of construction and installation works. The program is able to perform a thorough check of the information model of the object, identify collisions, check the model's compliance with the requirements of the BIM standard and regional design standards, compare models and extract all necessary information.

Allcheck's capabilities allow for automated testing, analysis and quality control of information models. It is also possible to partially correct models according to specified rules. The plugin is intended for both designers and experts.

Most often, errors are considered in such situations:

- collisions between elements;
- design errors in violation of design standards;
- errors in filling in the attributes [6].

A working group of Allbau Software specialists, led by A. Baranetsky, E. Medyanik, O. Levchenko developed a new version of "Checks in Allcheck, AllPlan 2016-2017".

This Allcheck plugin allows you to validate the BIM model for the Allplan environment, and verify compliance with the current rules and regulations of the regional architectural and structural design.

Prior to the conversion of "Checks in Allcheck, AllPlan 2016-2017" included:

- Architectural checks;
- Structural checks;
- Precast checks.

To the Architectural checks are included 33 control positions, to the Structural checks- 13, to the Precast checks – 8.

The main positions of Architectural checks include: door opening area, rooms situation, height of elements and rooms (fig. 1), area of passages to openings (fig. 2), rooms without openings (fig. 3), rooms without doorways (fig. 4), rooms without window openings, intersections (fig. 5), analysis of identical rooms,

ISSN 1582-3024

identical rooms in groups (fig. 6), rooms without finish floor, wall, ceiling (fig. 7), specification of attributes for window openings and for doorways, elements in openings (fig. 8).

Structural checks mainly control thus positions: vertical and horizontal load-bearing elements, walls and beams parameters, curvilinear architectural elements, starter bars, concrete cover, load-bearing elements with no reinforcement in it.

Precast checks mostly control the multiplicity of sizes of walls, floor slabs and openings in them, erection joint between walls, the general rule for checking the attributes, fixtures are within the formwork of the element, correspondence between 3d attributes and catalogue.

General rules determine the general procedure for verification.

For the analysis accuracy by controlling positions it is defined:

- Description of checked element or collision;
- Checked elements;
- Exceptions (no exceptions or exceptions with their respective descriptions);
- The purpose of checking the mutual collision.

In the case of finding an error, a detailed description of the error will be displayed in the lower part of the “Results” window and the image in the Allplan window is scaled to the invalid element, which is highlighted in red. The degree of criticality of the checks is output after the description of the error.

Every user can add and edit both the list of rules and the check criteria (tolerances) in each rule, and the check criteria can also be edited.

Thus, the structure of this plugin allows conducting a comprehensive verification of the project, as accurately as possible to take into account the requirements of architectural and building standards, as well as flexibly respond to individual requirements when designing.

## 3. CASE STUDY INVOLVING BEM (BUILDING ENERGY MODELING)

The plugin is planned to be developed in future and supplement the list of possible checks. The current direction of development of the plugin is checking the parameters of buildings related to energy efficiency.

The main categories of inspections can be:

- exposition of areas or rooms, which is related to the solar radiation gains;
- compactness of building;

ISSN 1582-3024

*Expert systems in the BIM environment.*

- thermal characteristics of structures according to the type of building;
- heat bridges;
- checking for collisions of engineering systems associated with energy efficient equipment - heat pumps, heliocollectors, heat exchangers and others.

Additions to the plugin, related to energy-efficiency, are focused on the use of new standards for thermal insulation of buildings in Ukraine. Also in the plugin, it can be taken into account typological features of the building - residential or public buildings.

This type of inspection in systems of BIM-design should be important in the development of BEM (Building Energy Modeling) for the design of energy-efficient buildings.

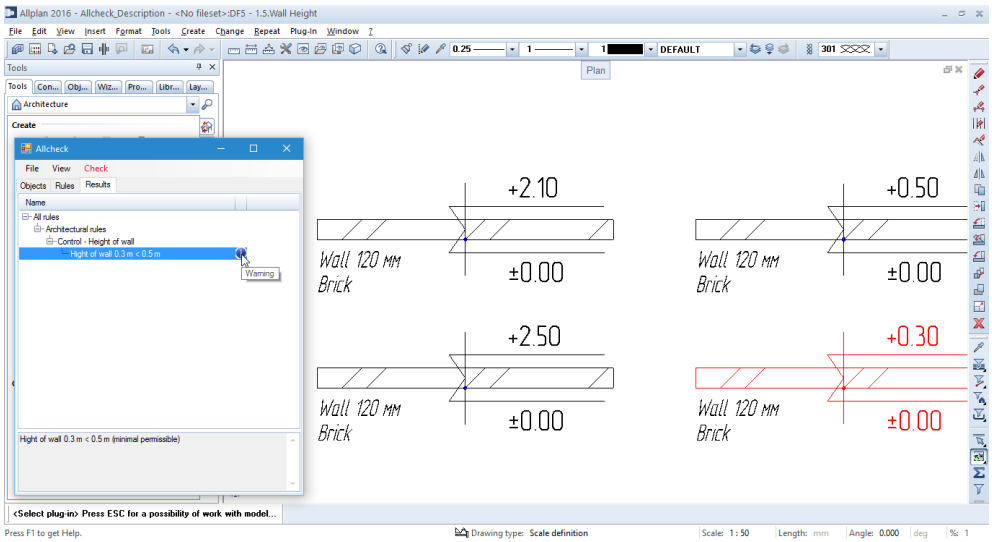


Figure 1. Architectural checks. 1.5. Wall Height

ISSN 1582-3024

INTERSECTII
INTERSECTIONS
http://www.intersections.ro

Oleksiy Levchenko, Tetyana Kashchenko

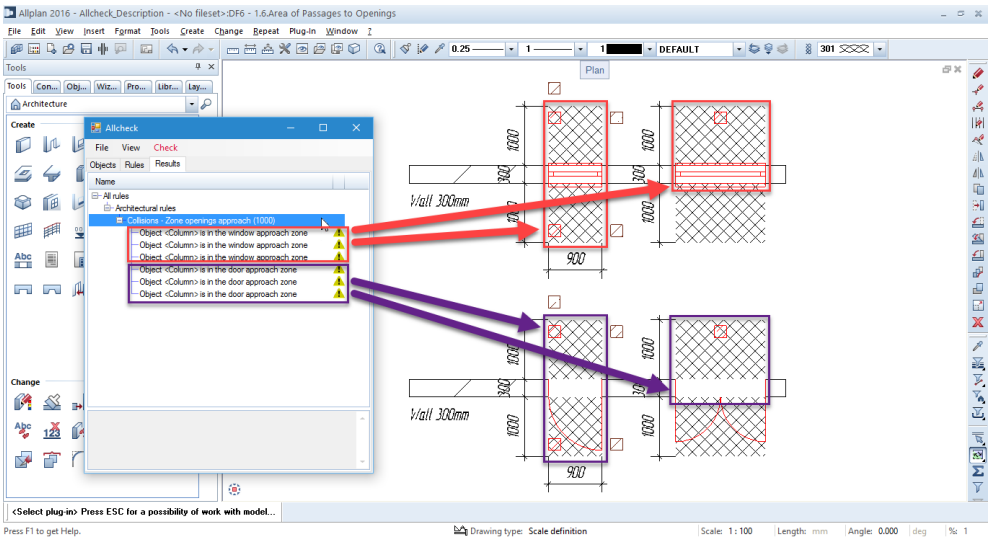


Figure 2. Architectural checks. 1.6. Area of Passages to Openings

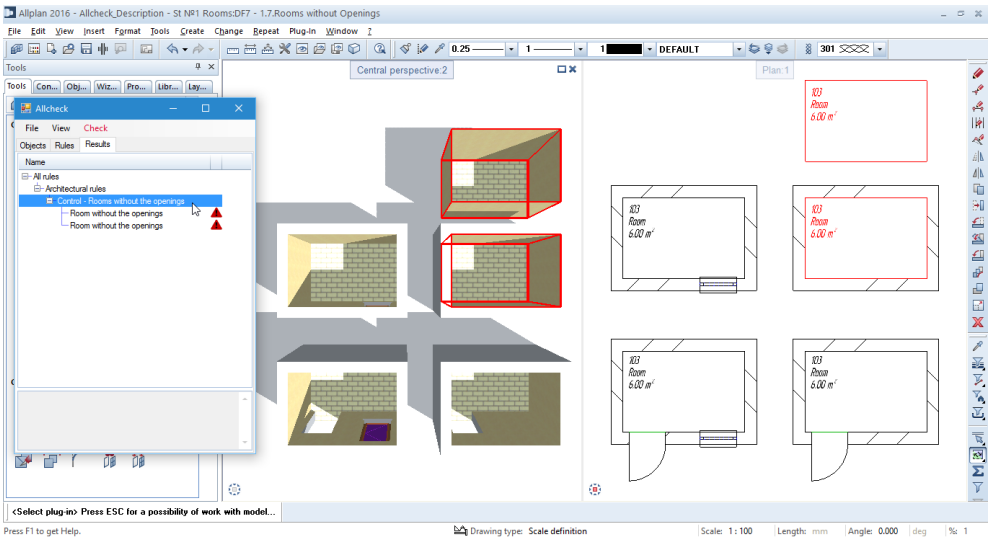


Figure 3. Architectural checks. 1.7. Rooms without Openings

ISSN 1582-3024

*Expert systems in the BIM environment.*

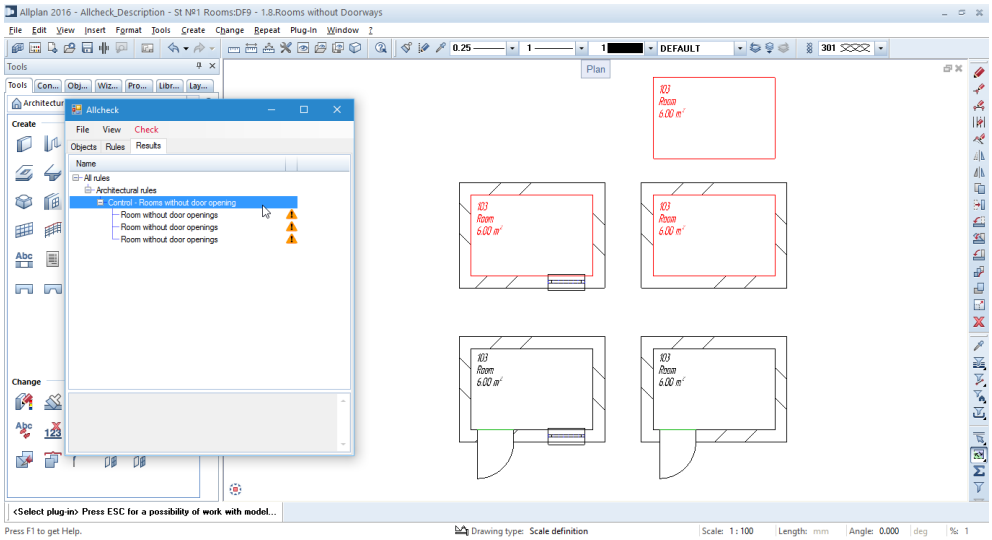


Figure 4. Architectural checks. 1.8. Rooms without Doorways

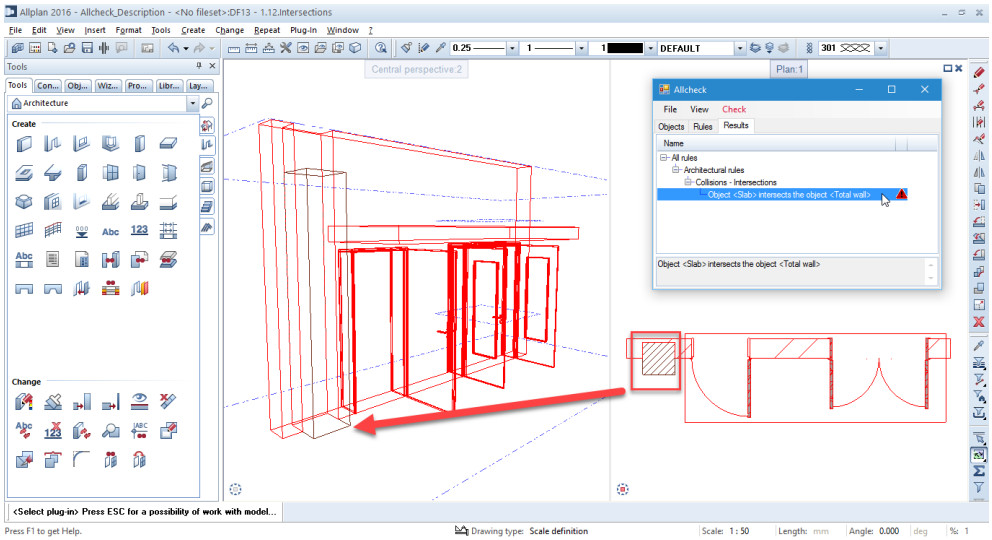


Figure 5. Architectural . 1.12.Intersections

ISSN 1582-3024

INTERSECTII
http://www.intersections.ro
INTERSECTIONS

Oleksiy Levchenko, Tetyana Kashchenko

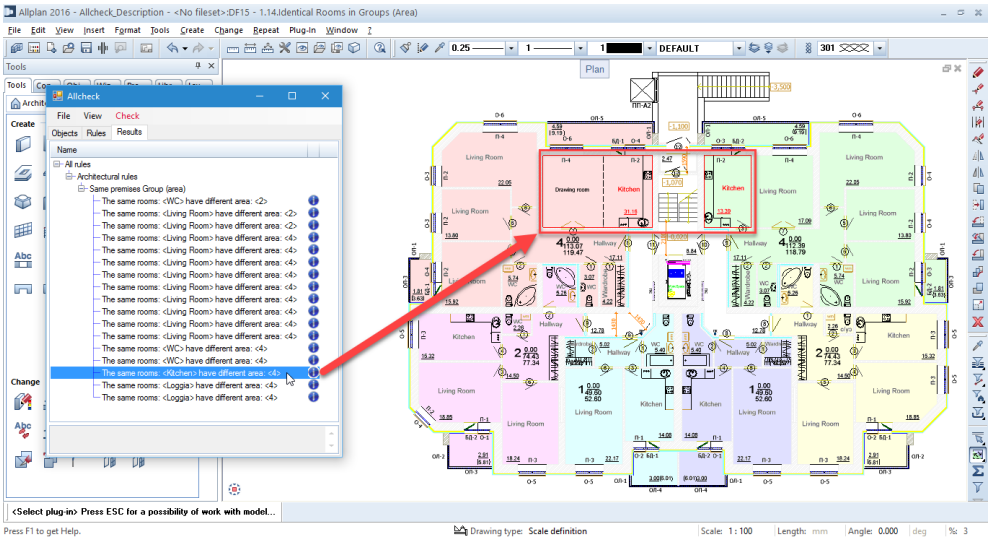


Figure 6. Architectural checks. 1.14.Identical Rooms in Groups (Area)

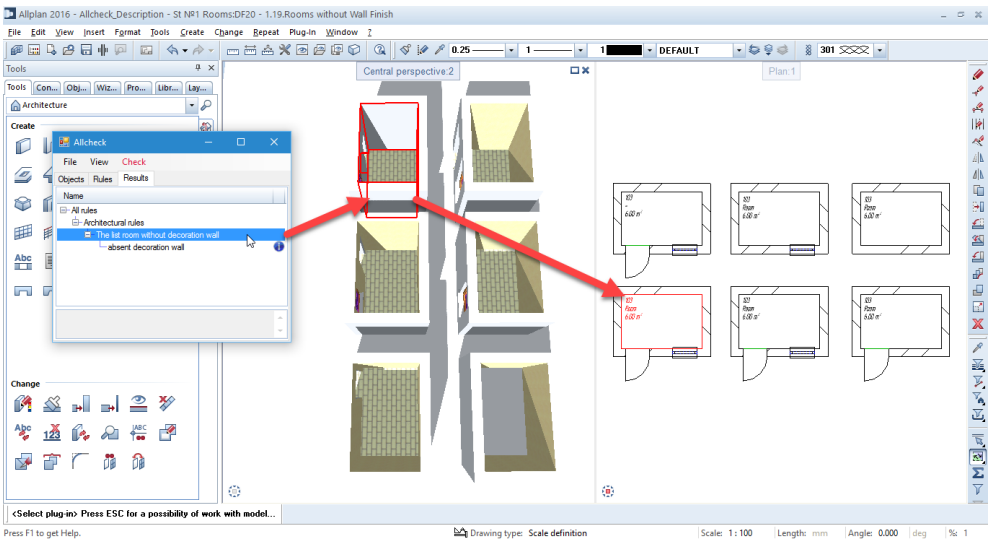


Figure 7. Architectural checks.  1.19. Rooms without Wall Finish

ISSN 1582-3024

*Expert systems in the BIM environment.*

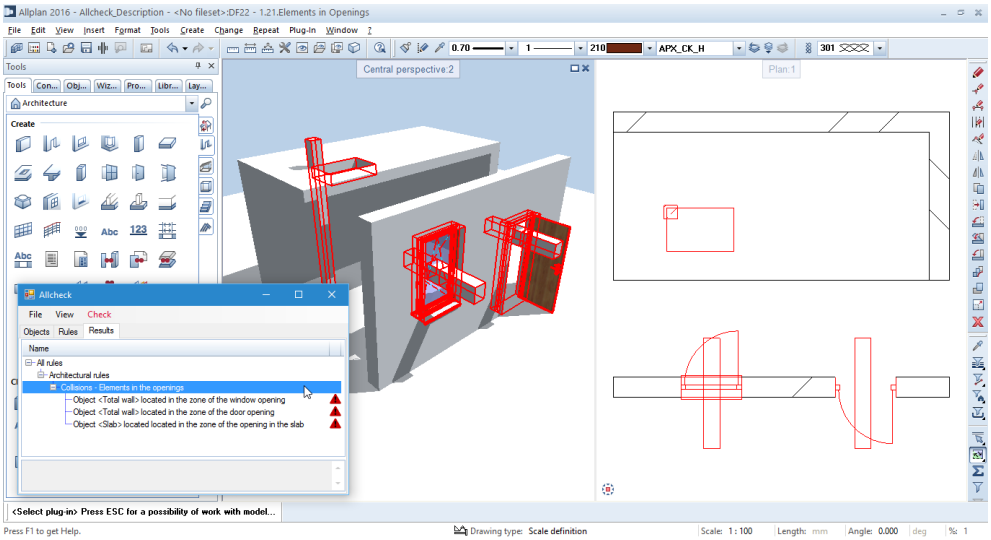


Figure 8. Architectural checks. 1.21.Elements in Openings

## 4. CONCLUSIONS

Proposed Allcheck plugin "Checks in Allcheck. AllPlan 2016-2017" allows an operative analysis of the design solution or project analysis for the presence of design errors ("Human Factor"). The analysis of the design solution can be carried out at different stages, including at the early stages of project development, which significantly improves the design quality. This plugin is a multifunctional tool for architects, engineers, experts. The ability to customise the rules and parameters of the assessment allows you to adapt it to local architectural and construction norms and rules. Using plugin "Checks in Allcheck. AllPlan 2016-2017" significantly speeds up the design process, improves the accuracy and overall quality of the project documentation, helps to design modern complex architectural objects.

### Acknowledgements

The authors are grateful for the help and support in the work of Allbau Software GmbH Director V. Shkatov and the head of the Allbau Software Competence Center in Ukraine, Y. Smirnov.

### References

1. http://www.allbau-software.de
2. http://www.allbau-software.de/index.php/kontakt.html
3. http://www.allbau-software.de/index.php/podderzka/download/dokumentatsiya/file/141-sbornik-allplan-kratkij-kurs-bim-teoriya-i-praktika.html

ISSN 1582-3024

4. http://www.allbau-software.de/index.php/produkty/allcheck.html
5. http://www.allbau-software.de/index.php/produkty/allplan.html
6. http://www.allbau-software.de/index.php/produkty/allcheck.html
7. Levchenko O. *BIM concept and demoecological approach as architectural and landscaping aspect of the formation of the urban environment*. - Modern problems of architecture and urban planning, Scientific-technical edition. - K .: KNUCA, 2016.- #46.- p.107-111.
8. Levchenko O. *Using IFC format in BIM technology. "Information technologies of modern architectural design"* - Modern problems of architecture and urban planning, Scientific-technical edition. - K .: KNUCA, 2015.- #39.- p.106-111.
9. Kashchenko O.V., Mikhailenko A.V., Kashchenko T.O., Antao A. *Information technologies at architectural education*. — Kharkiv: "Operativnaya poligrafiya", 2015. — 120 p.

ISSN 1582-3024