Basic reflections on the implementation of different 3D technologies co-operating in the architectural design process

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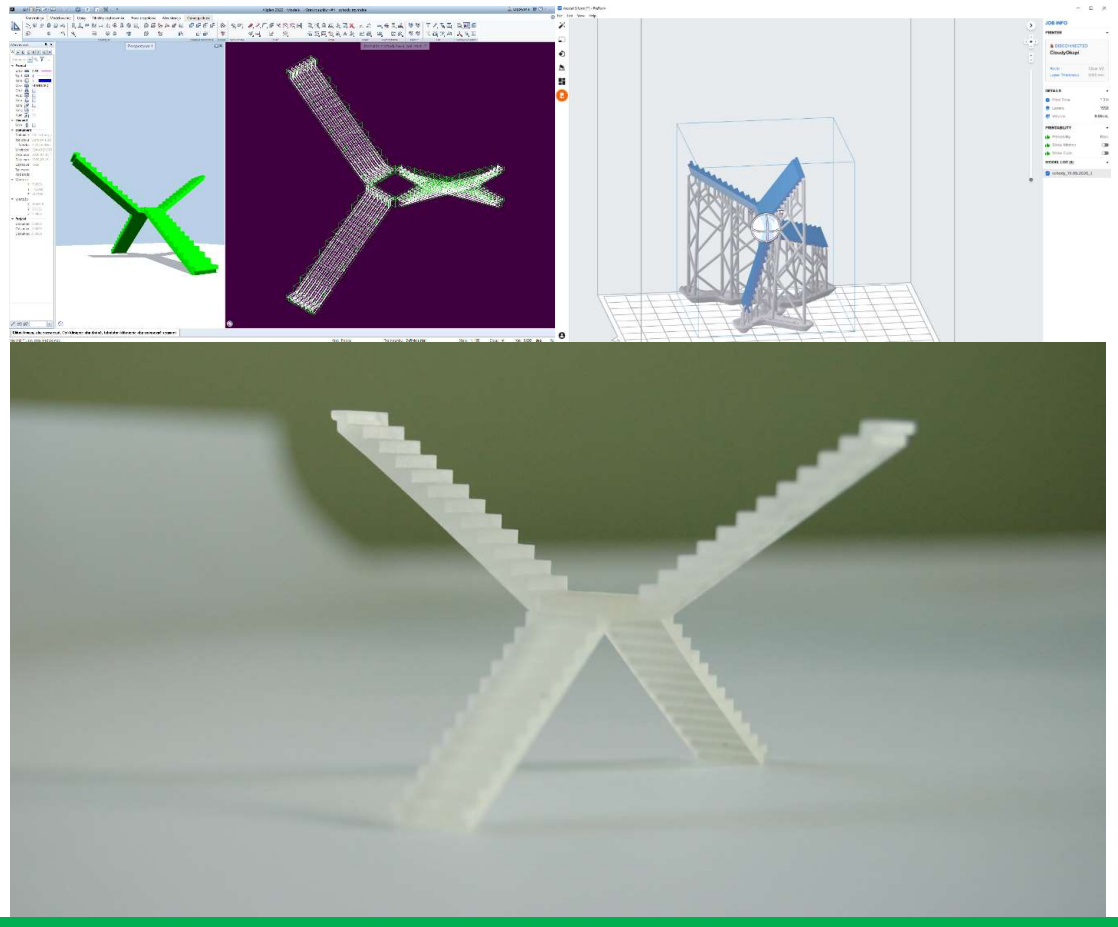
Introduction



The constant progress of technique is inevitable nowadays and seems to be the same in a predictable future. The observation of this phenomenon leads us to formulate a few reflections on it. The use of advanced technologies causes a clearer detachment of production processes from human work.

Modeling cross stairs and the 3D print of it

Robotics and automation were initially supposed to facilitate the production of elements, but over time they began to replace humans more and more. Will there be a place for human work in the future? It is already being pushed out of many bastions in which it was supposed to be indispensable. Can such phenomena be noticed in design?

Examples of 3D prints of ready-to-use 3D models

3D print of roadside shrine (made at conception stage) and photographies of the real object during its erection in Nowy Dwór near Toruń (author: A. F. Furmanek)

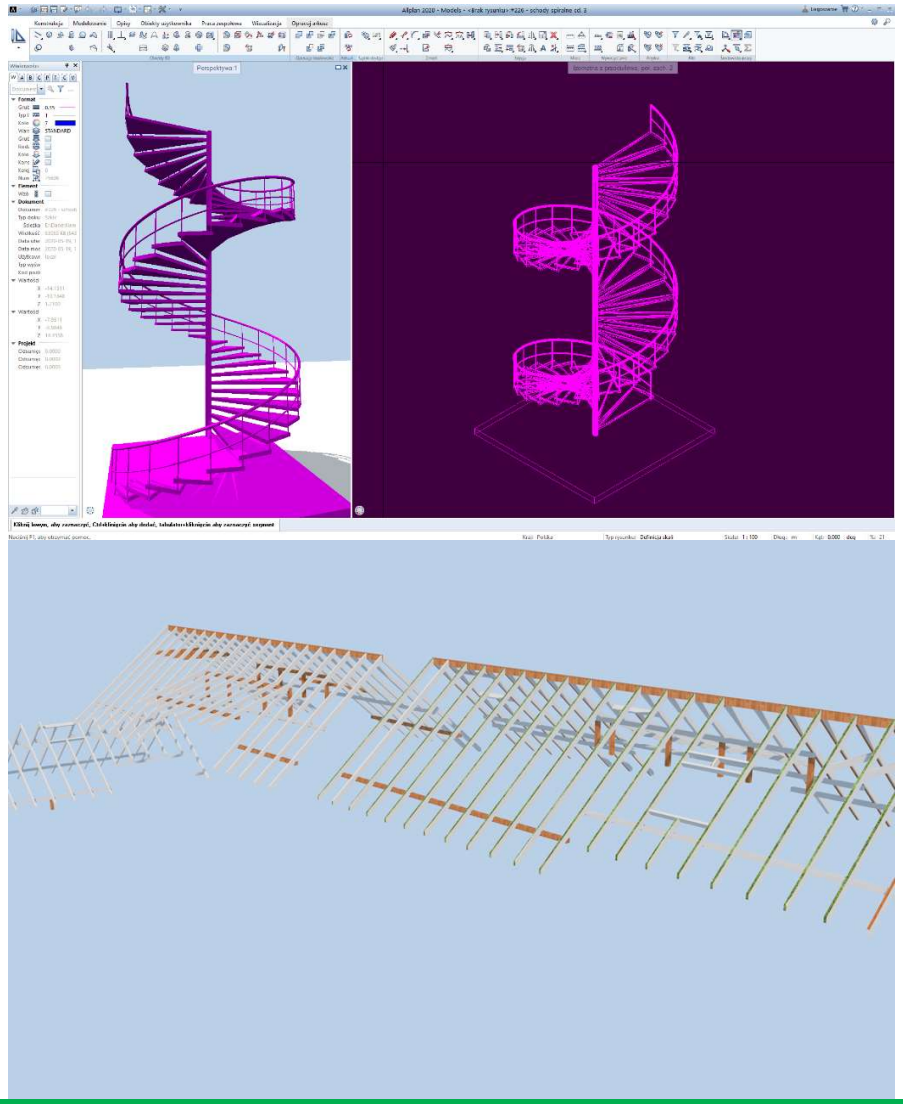
Will the machine replace the creator? The development of artificial intelligence (AI) shows that it is possible. Complicated algorithms are already able to compose a piece of classical music. In the case of architecture, architects are still in the lead, however, one has to take into account the conquest of this field by AI.

Three-dimensional modeling and visualisation

Three-dimensional digital modeling has been known and used in the design and construction industry for decades. Gradually, at that time, architects moved away from drawing boards, replacing them with computer stations. Rapid progress has been made in the computing capabilities of computers from their inception to today. It's easy to predict that this trend will continue in the future.

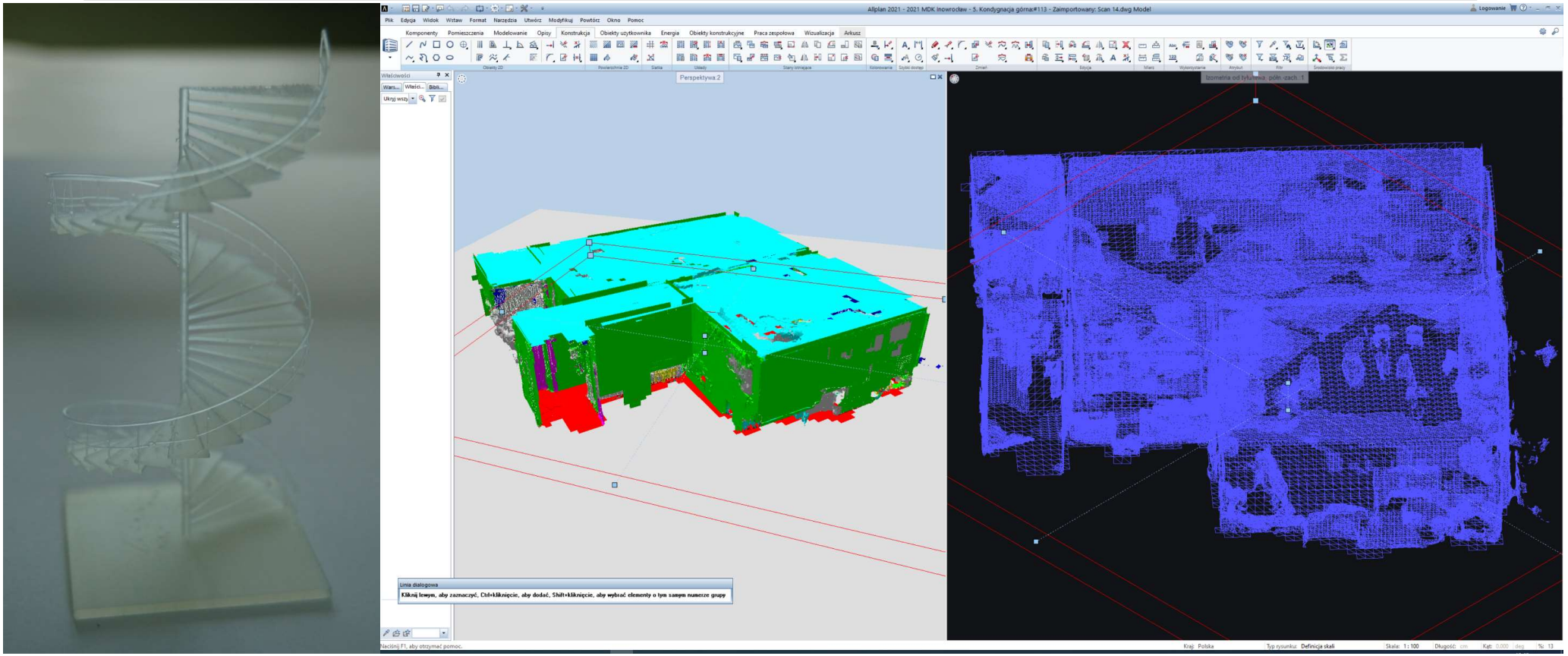
Example of computer visualisation of existing buildings
at Poznańska street in Toruń (prepared in Allplan Architecture)

What once seemed impossible or at least unprofitable is standard today. An example may be the use of specialized software to create three-dimensional solids mapping the designed building objects. The so far dominant CAD (Computer-Aided Design) technology is gradually giving way to BIM (Building Information Modeling), which is a kind of continuation of the former, but it is better connected with the issue of parametric design.

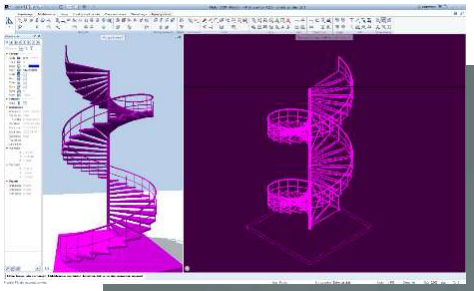


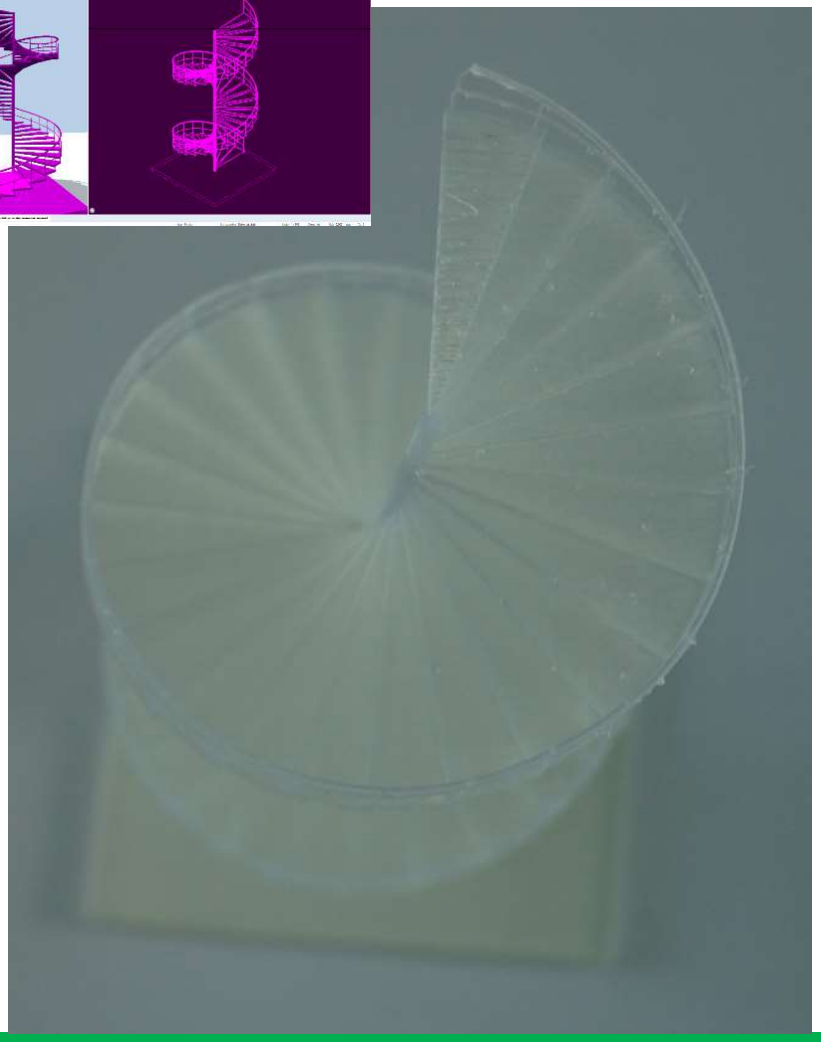
Examples of modeling and visualisation of architectural elements – a spiral staircase and a roof truss (prepared in Allplan Architecture – program of Nemetschek Group)

Other 3D technologies connected to design branch



Examples of 3D printing (left) and effects of 3D scanning (perspective and axonometry views in Allplan Architecture computer program)

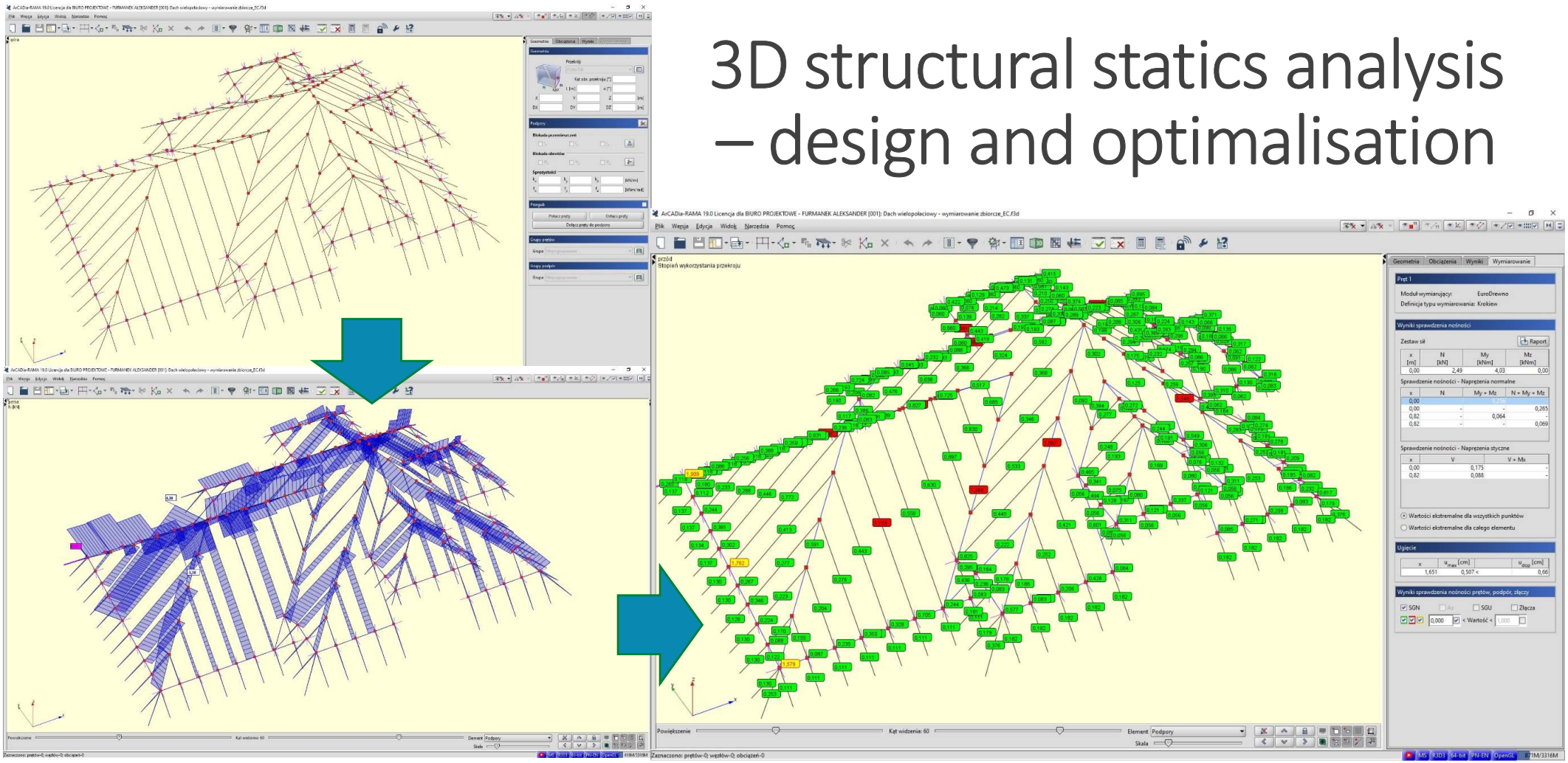




Nowadays, you can observe the gradual displacement of people from factories due to the replacement of human work with various types of machines, such as robots, multi-axis CNC machine tools, or computers with more and more computing power and better software for specialized applications. Such progress gradually provides to further automation of building process.

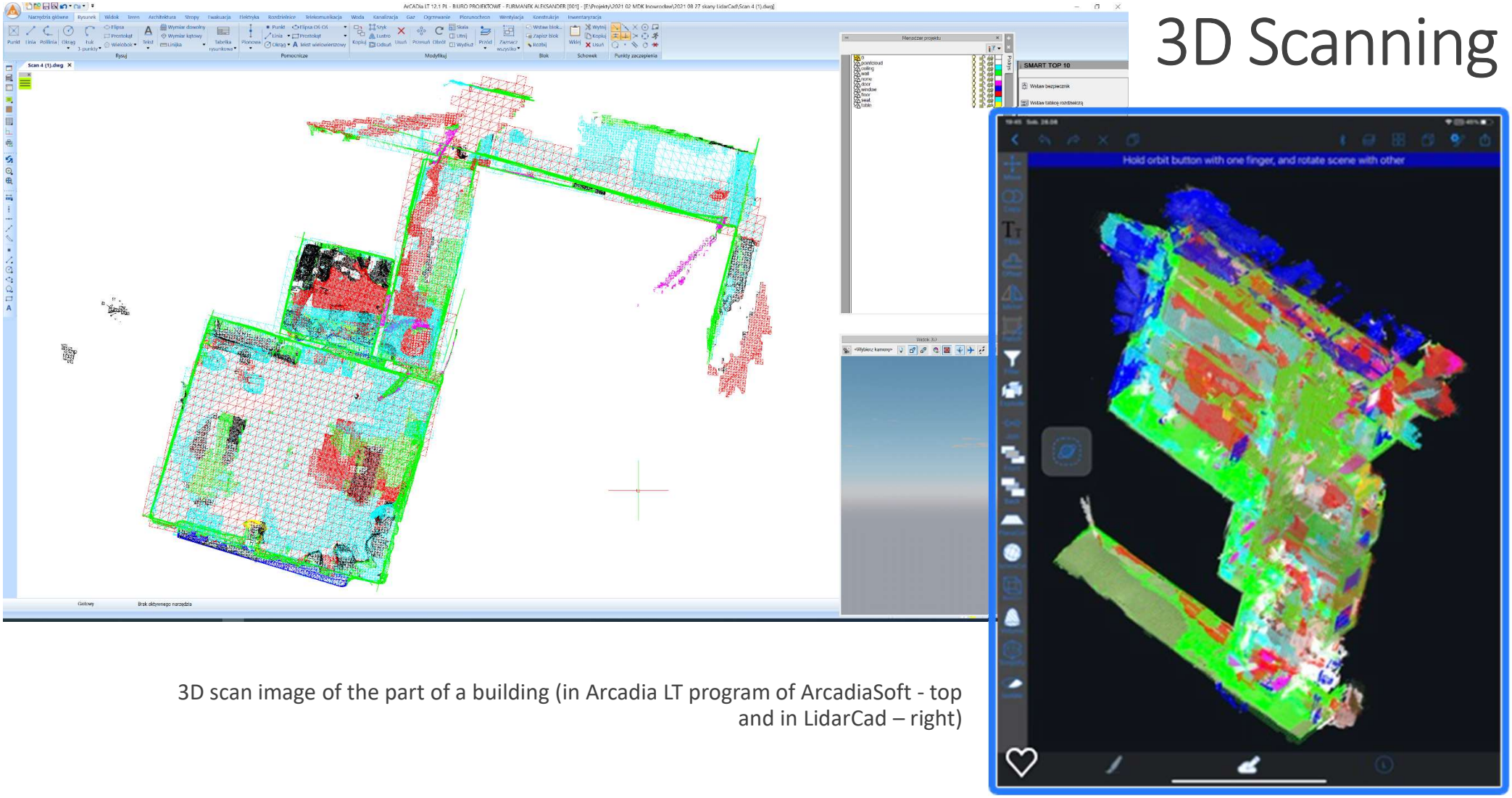
3D print of spiral staircase (designed in computer application – left top)

3D structural statics analysis – design and optimalisation



Example of structural statics analysis in Rama 3D, the program of ArcadiaSoft (geometry, load and stress of structure cross-sections)

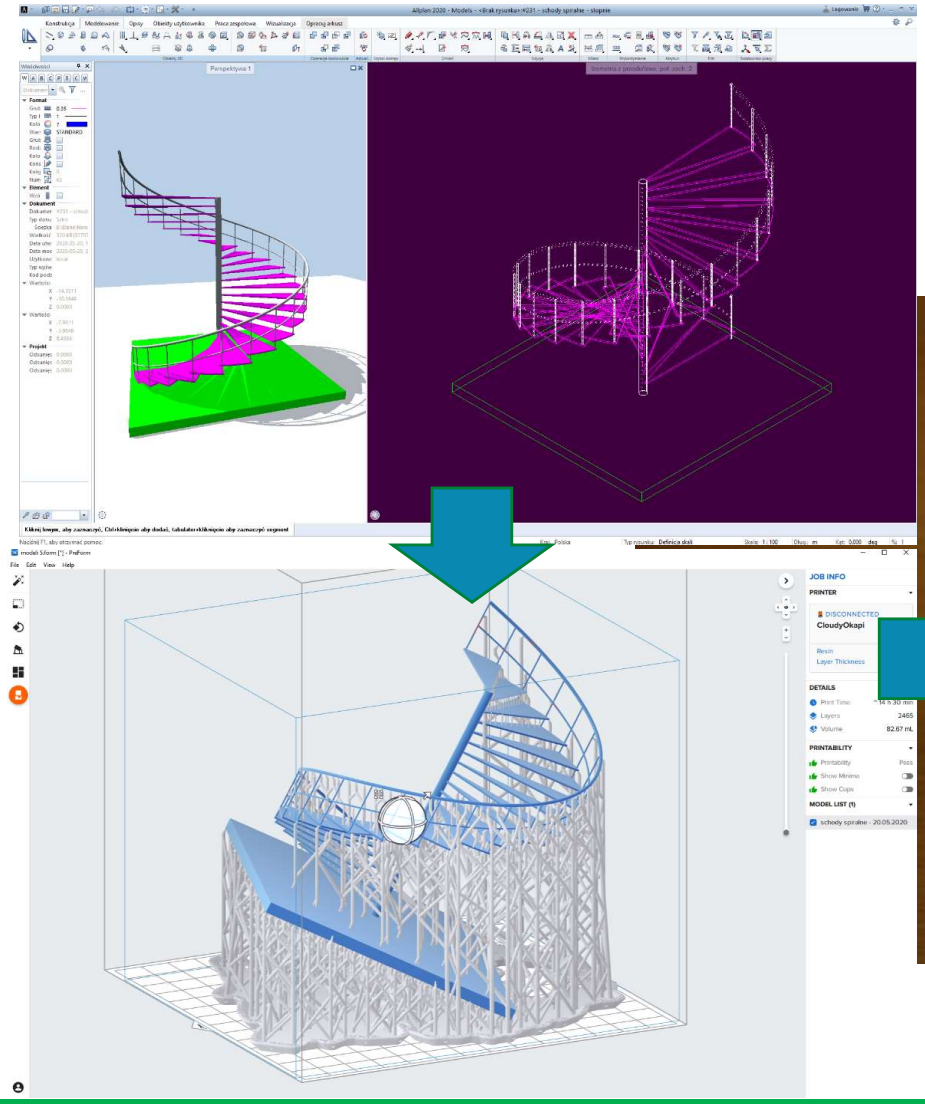
3D Scanning

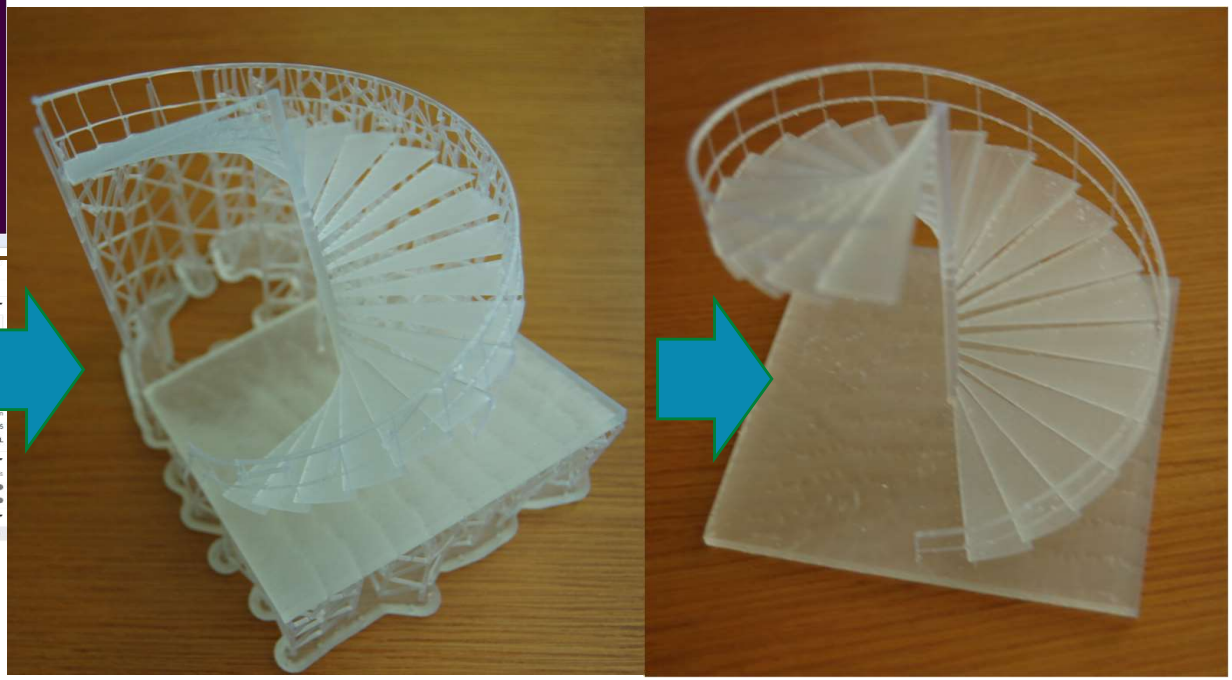


3D scan image of the part of a building (in Arcadia LT program of ArcadiaSoft - top and in LidarCad – right)

3D Printing

3D printing usely needs a few steps, incl. laborious manual **post-processing**





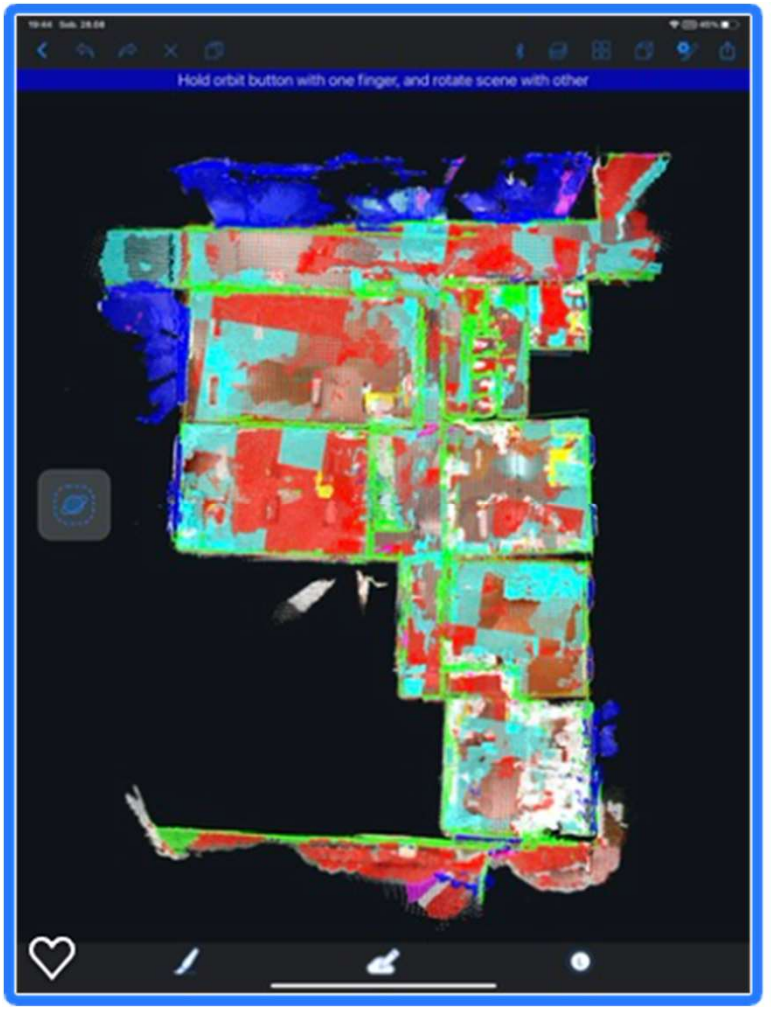
A few basic steps of preparing a 3D print of spiral staircase (design in computer application, adding supports and setting orientation, raw print and ready model)

Results and discussion

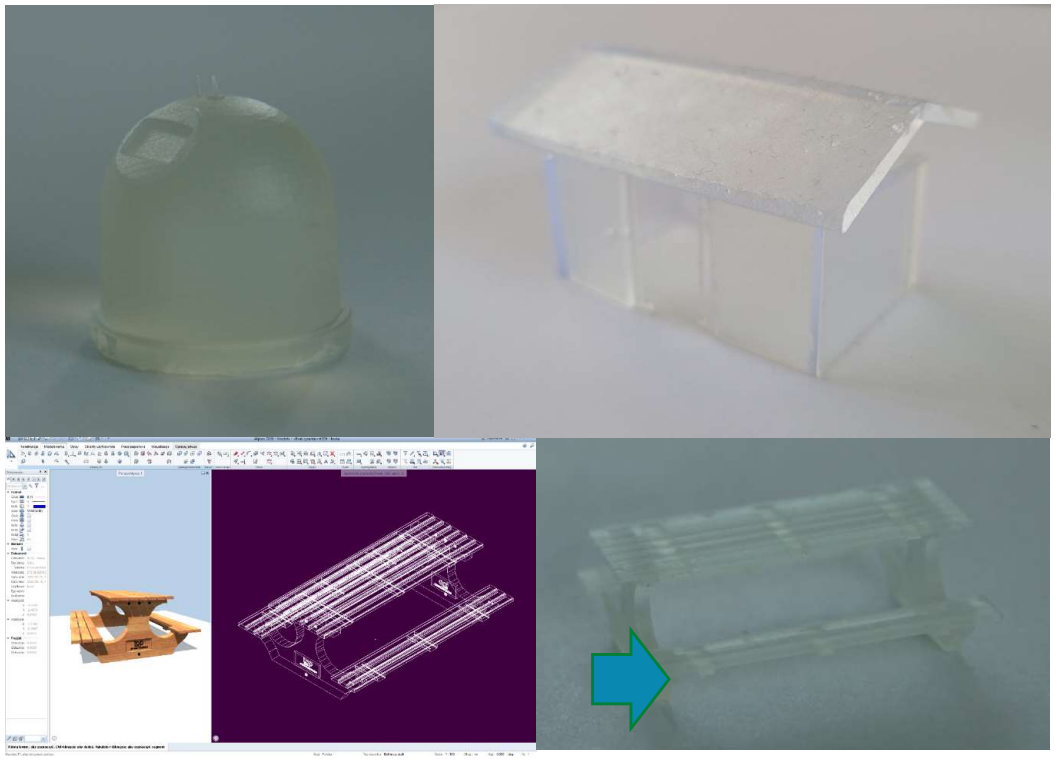
A certain disadvantage of professional solutions such as machines or advanced software is their availability. These are often very expensive solutions. On the one hand, the high cost of acquiring these tools means that progress is made in different ways - slower in poorer areas and faster in richer countries. Maintenance and software costs obviously aren’t cheap.

Example of computer visualisation – perspective view of the part of Poznańska street in Toruń (prepared in Allplan Architecture)

Artistic skills favor the ability to create interesting architecture. During the initial stages of shaping the contours of a future building, designers still use manual techniques of imitating creative thought, especially drawing. This is due to the knowledge gained from both their masters and their own experience, which tells them that it has a better effect.



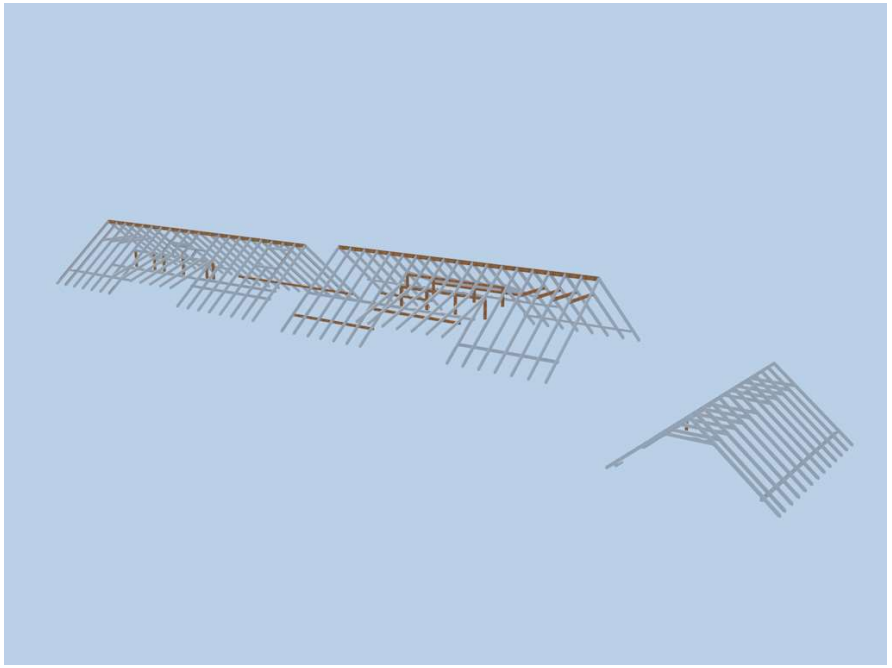
3D scan image of the part of a building (in LidarCad)



Examples of 3D printing

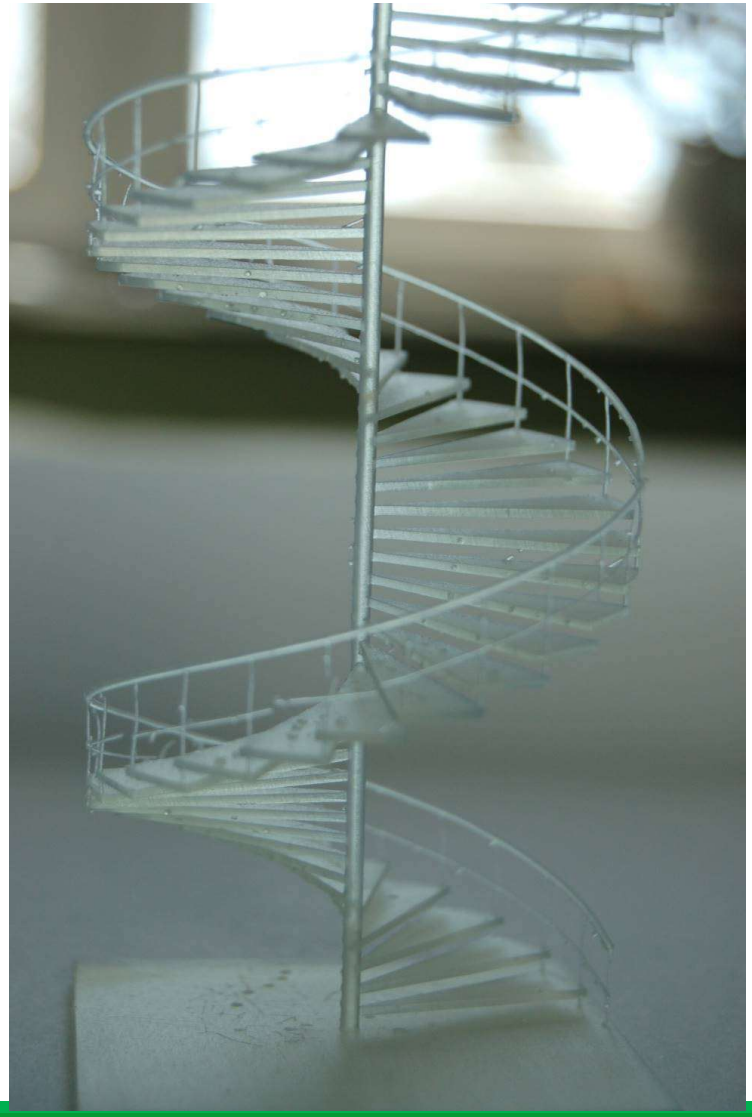
There is plenty of benefits of combining different 3D methods, using a model originally developed for a different application, it can be for instance an implementation in a different technique or using a ready-made solution. It is worth remembering that in the case of a modeled object, it is possible to use one model multiple times, e.g. for mass production. Another advantage is possibility of veryfing correction of a model and finding collisions inside.

Of course, this is not an iron rule, but it is not uncommon that a unique mind-hand connection implies the creation of a work of architecture. Objects created solely with the use of computers often seem to be deprived of this difficult to grasp element that causes them to not fully achieve what architecture can be.



Computer visualisation of a roof truss

The main drawback is the degree of complexity and the number of activities necessary to create a model in a given programming environment. There is also a less obvious question about, broadly speaking, creativity. For centuries, freehand drawing has been the basis for educating architects. This is not a coincidence. Often people who draw well in college later become great architects.



3D print of spiral staircase

Besides, the implementation of 3D techniques may include, among others issues of energy efficiency, construction costs, insolation analysis, shading outline, or issues of individual industries. This can be ensured by solutions available in the serial version of specific software or, for example, by an appropriate overlay for a computer program.

Examples of 3D prints - roof trusses

Example of computer visualisation – perspective view of the part of Poznańska street in Toruń (prepared in Allplan Architecture)

Thanks to computerization, various additional analysis became more available, which were not performed due to their labour consumption, especially when they were not obligatory.

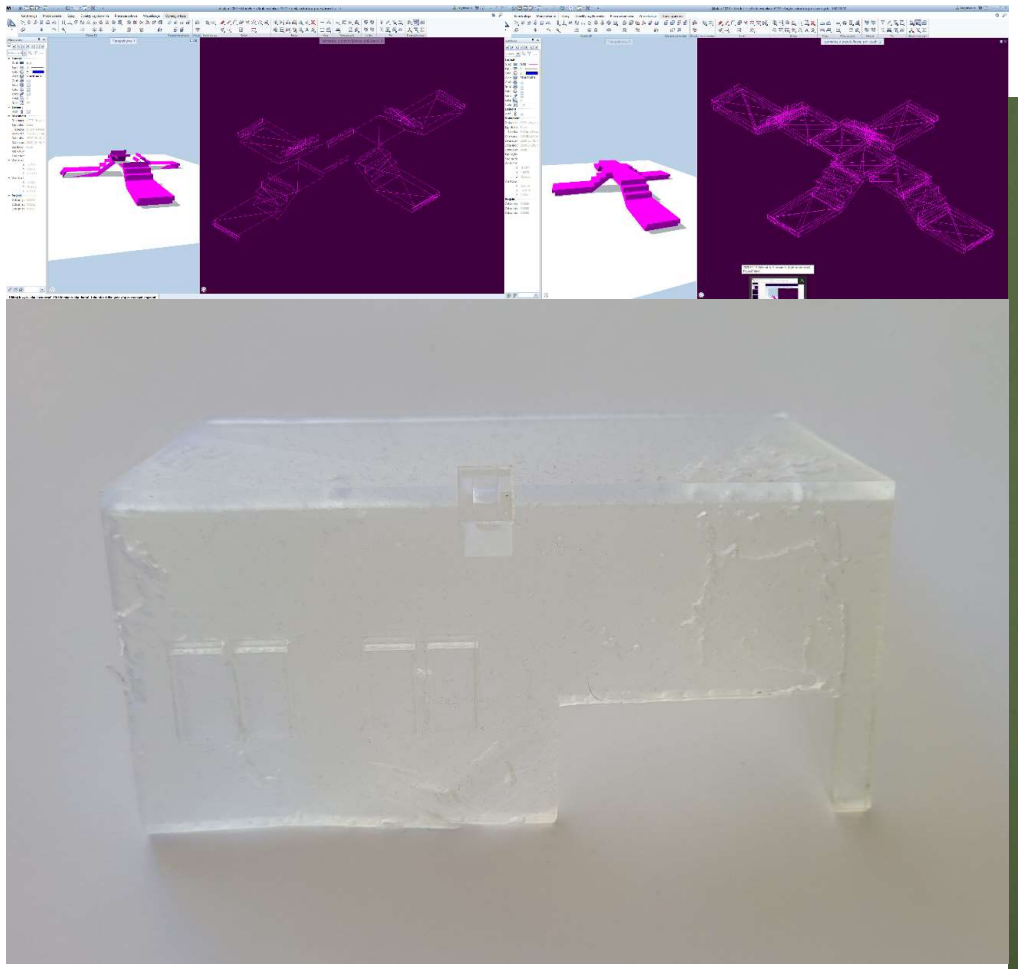
Advantages of 3D technologies at individual stages of the investment process

- planning and design
- realisation and production of building elements (perhaps entire buildings in the future)
- maintenance, building management

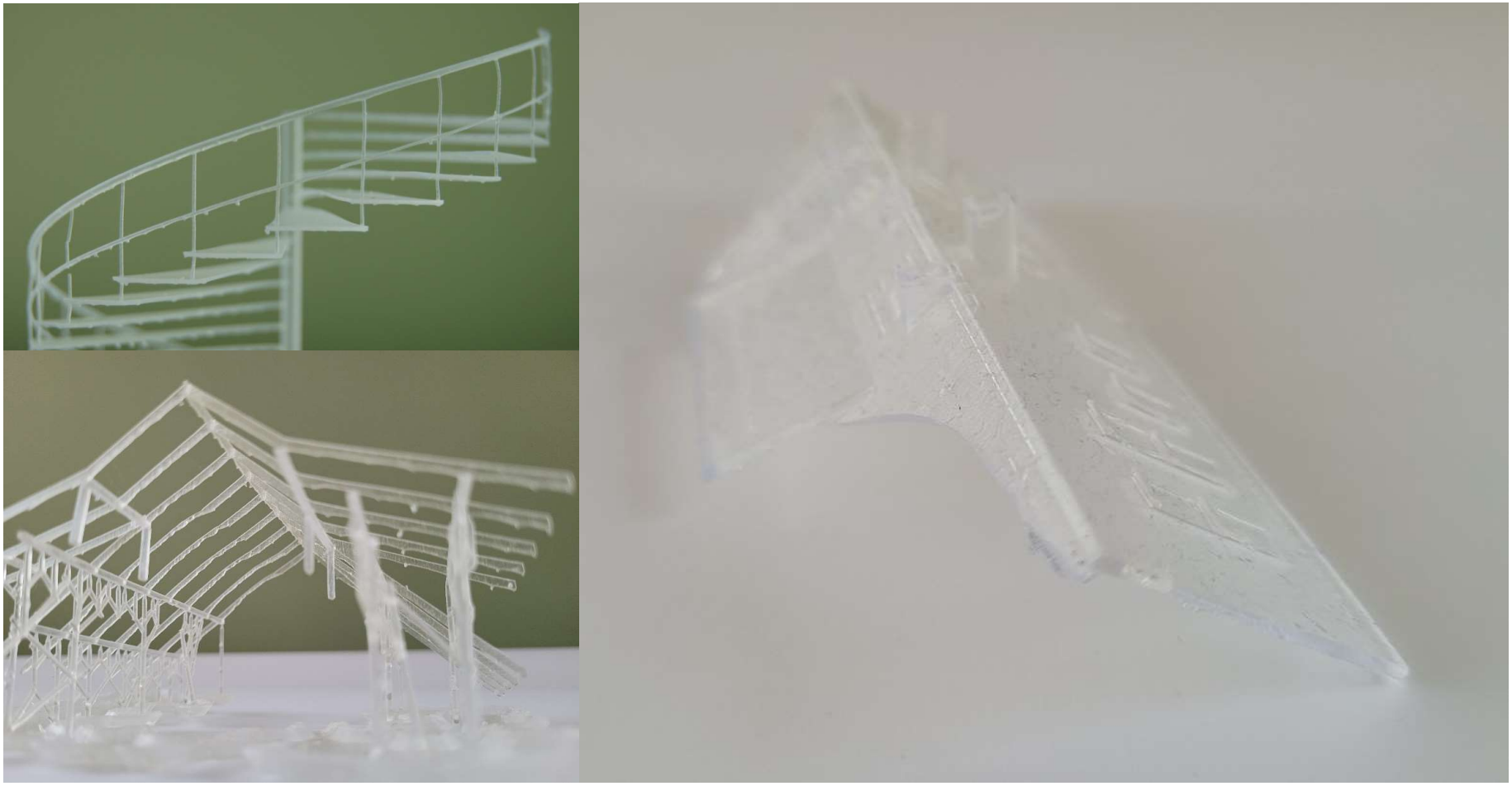
All the stages of implemetation of 3D technologies can be broken down into sub-stages or separate branches, divisions, methods. However, the taxonomy presented above points to some steps that seem important. The first is to create a digital three-dimensional model. This is a necessary stage that cannot be skipped.

The 3D technologies are increasingly used in the design process. They are more compatible with each other than before. They allow you to save labour, accelerate the implementation of tasks, as well as to optimise the designed buildings in many respects related to construction, prefabrication or energy efficiency, to name just a few. An important, although not very common, advantage of technological innovations is their use not only during design and construction, but also during the maintenance of ready-made buildings.

Problems



Errors during preparation (top left) and 3D printing (bottom and right)

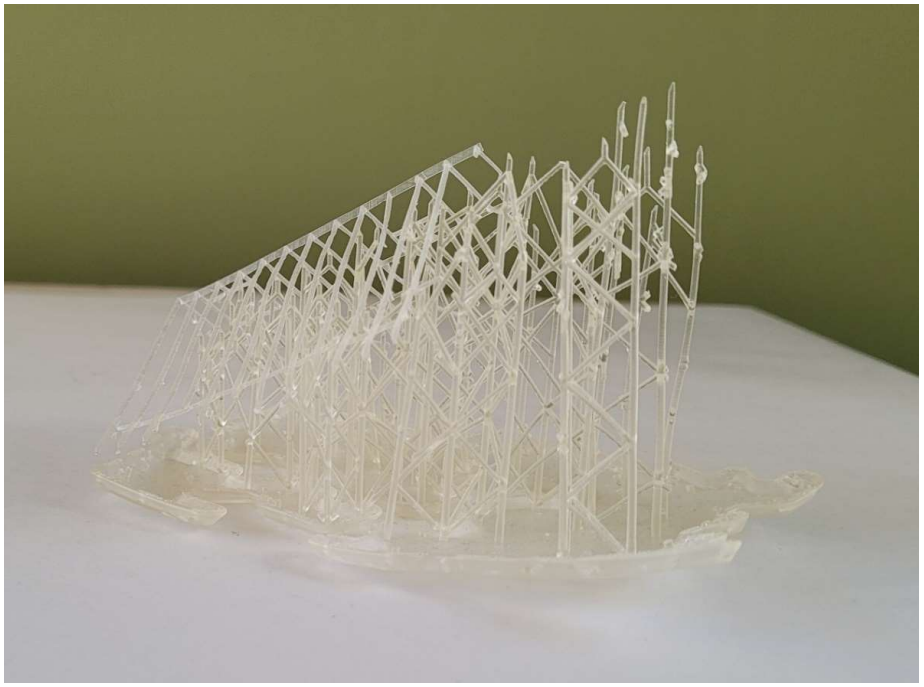


Errors and abnormalities are not too rare in 3D printing, especially they may occur in flabby elements

Conclusion

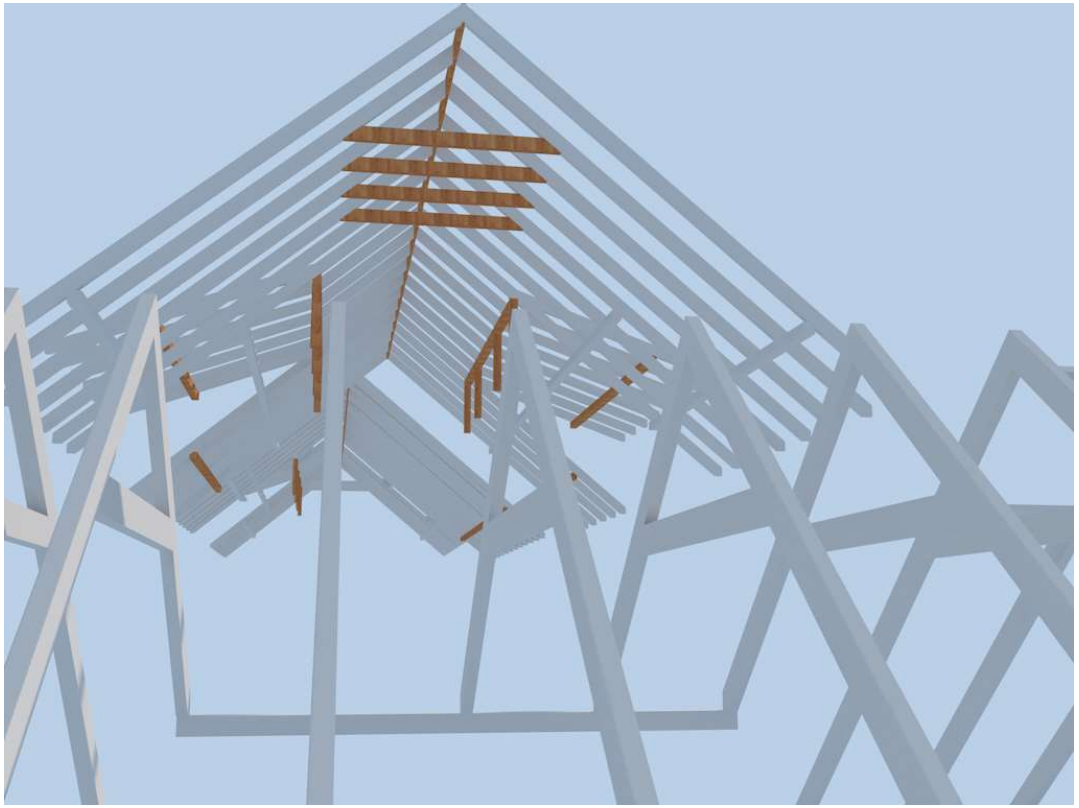
Examples of 3D printing

As you know, architecture is not only science, but also art. Can we fully automate it? You can imagine that in the near or distant future a project will be created entirely by devices – computers with appropriate applications, probably using machine and deep learning, as well as artificial intelligence. Will it then be a work of art or just a product of technology? Theorists will argue about this.



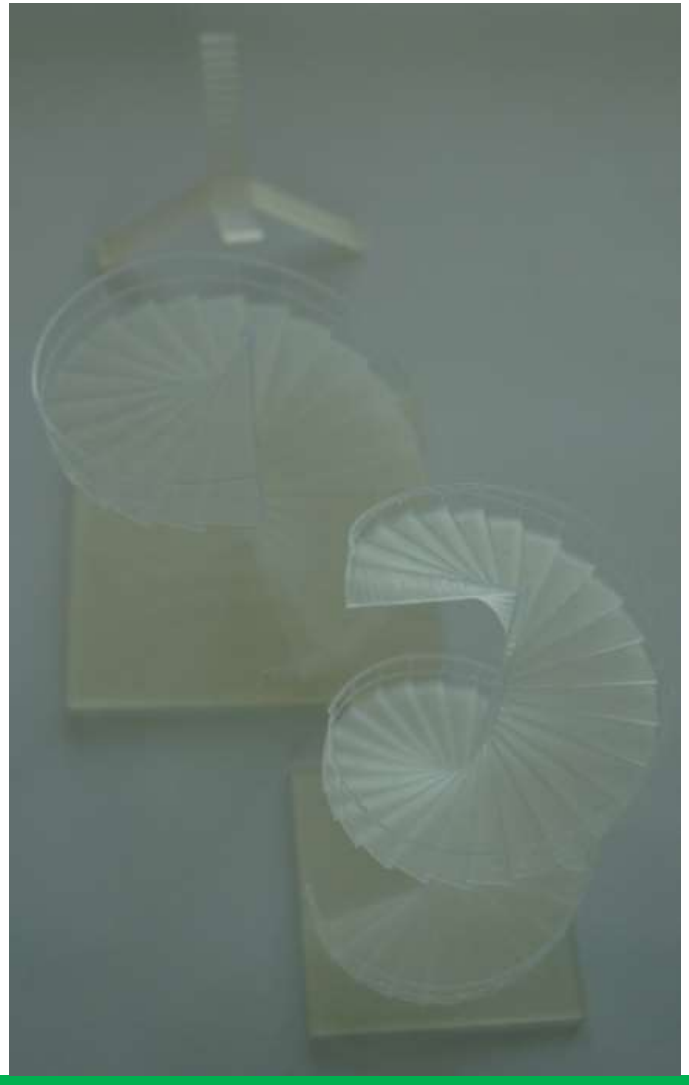
Raw 3D prints usely need removing supports

The boundaries of art in the twentieth century have been greatly expanded, including thanks to Marcel Duchamp provoking the world public opinion with his works and thoughts. One cannot forget about his successors, who continue to free the understanding of what is art from the usual patterns. An open question remains whether and when technological revolutionists will attempt to create a building **without human intervention**?



Computer visualisation of a roof truss

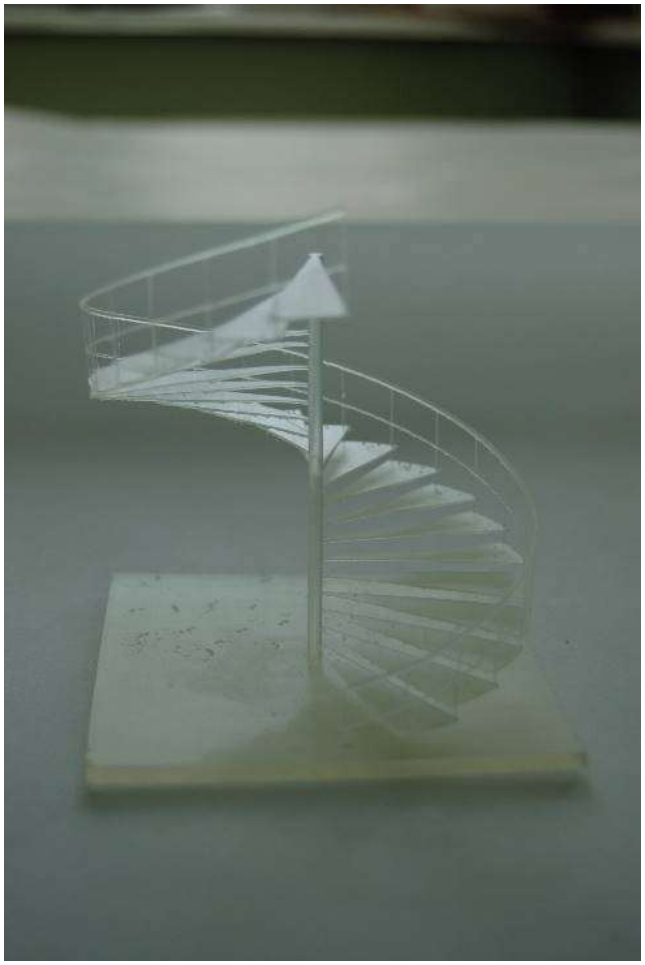
Other barriers to this goal are gradually being removed. It happens partly involuntarily, and the largest share of it is the private sector, in particular global and local corporations that usually deal with only a certain part of the market, e.g. computer software for construction industry specialists.



The small steps of individual units scattered around the world are gradually becoming more and more intertwined and make such futuristic visions as the idea of designing and building without human intervention more and more real, perhaps in the not too distant future.

Thanks to the implementation of modern 3D techniques, it is possible in many cases to significantly accelerate the optimization of a building object in relation to the specific problems posed.

Examples of 3D printing



3D print of spiral staircase

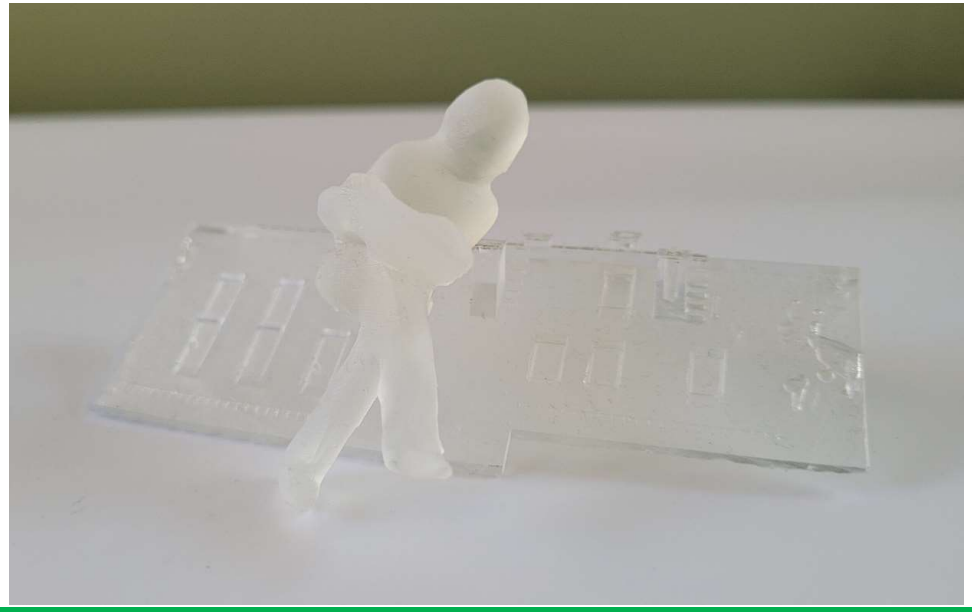
This can be ensured by solutions available in the serial version of specific software or, for example, by an appropriate overlay for a computer program.

This is in line with a global trend. In more and more new industries and more and more technological innovations are being implemented, which are mainly aimed at automating production, limiting human work by replacing it with robots, machines, computers or other devices. The scale of this process in the world varies.

3D prints of spiral staircases

The leading countries in this field are, of course, the most economically developed and industrialized countries. It is a new revolution, or at least the next stage of the industrial revolution, which completely changed the ways of producing goods and, by the way, entire societies, and entailed unimaginable changes in almost every area of life.

The best example of this is BIM, which facilitates the management of previously in this technology designed objects. In the future, it will be much easier to design the adaptations of such buildings and to store information of changes which were made. This approach fits in with the idea of management of change, which can be included in an even broader aspect among the paradigm of **sustainable development**.



It is definitely not the time yet when a sketchbook should be replaced by any computer application. Similarly, in the field of design, man still wins over the machine, what is not so obvious in many other areas.

THANK YOU FOR YOUR ATTENTION!

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