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NEW SOLUTION – CULTIVATION OF SOFT FRUITS AND VEGETABLES IN A SUPERSKYSCRAPER IN HONG KONG

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Abstract

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Tnis new solution – cultivation of soft fruits and vegetables in a superskyscraper in Hong Kong is *based on the theory of inventive steps of the author.*

New solutions have direct impact on the design of details for superskyscrapers, including the design of details which improve the cultivation of soft fruits and vegetables in superskyscrapers.

The subject of this scientific research is the creation of a new solution for cultivation of soft fruits and vegetables based on the theory of inventive steps of the author. This paper has the aim to fill the gap in theoretical knowledge in the sphere of innovation design, which so far has represented a considerable hurdle for the creation of new innovative solutions with inventive step.

Key words: new solution; soft fruits; vegetables; theory; inventive step

Introduction

A crucial moment in the creative process is the achievement of competitiveness through innovative solutions with inventive step (Aeksandrov, 2014). According to the Bulgarian Law on patents this is characterized by novelty, inventive step and industrial applicability (Bulgarian law on patents, 2006).

The scientific method can be defined as a "series of steps leading to the acquisition of knowledge" (Scientific Method, 2017). The innovation method represents a series of phases, including *compulsory inventive steps*, which lead to a positive technical effect bigger or at least the same as the one present in the world level of technology. Due to the fact that architecture represents a synthesis of function, construction, form, building materials and other technologies (UACG, 2017), innovative design can be regarded as a complex of innovative solutions with or without inventive step.

To a greater extent the inventive step affects the constructional solutions, the selection of building materials and the technology for execution of the form of details (i.e. the building) and to a lesser extent the inventive step affects the functional solutions. In this regard, Ching (Ching, 2014) discusses the proportions of the building material which depend on its strength.

The creation of a new solution for cultivation of soft fruits and vegetables in superskysrapers with inventive step is based on the innovation process which consists of 6 phases:

Characteristic Phases of the Innovation Process

● ***Phase 1. Selection of the document or documents, which describe the existing worldwide level of technology:***

- identification of the existing worldwide level of technology regarding the given design task (preferably, here must be taken into consideration the newest solutions, projects and realizations);

– compulsory verification of the level of technology in the International patent classification system (International patent classification system, 2017).

● ***Phase 2. Transition from innovative solutions to innovative solutions with inventive step:***

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– selection of suitable abstract geometric shapes according to the creative vision of the architect;

– transformation of abstract shapes into specific architectural forms according to the respective construction norms;

– planning of the development of the new creative solution according to the design task by selecting methods for realization of the innovative solution with inventive step – with one, two or more steps;

– programming of architectural creativity as a consequence of using unexpected combinations of objective characteristics of form and the means for aesthetic organization according to well-known and novel technical characteristics of the elements of the building – function, construction, building materials and technologies, etc. which create the inventive steps.

● ***Phase 3. Methods for developing inventive steps:***

– by using traditional constructions, building materials and accompanying technologies, etc., well-known technical characteristics are combined, ranked in a new way in order to create unexpected connections;

– by using of untraditional constructions, new building materials in the covering of the building, according to existing building technologies, etc.

– by using untraditional constructions, new building materials for the covering of the building, according to new building technologies, etc.

– by including new technical characteristics, e.g. which are simultaneously parts of the building and the systems for solar heating, etc.

– the influence of the building material, the choice of constructive solution as well as the application of a suitable building technology are crucial for an adequate end result.

● ***Phase 4. Steps of the appraisal of the achieved results:***

– decision on whether the unexpected combinations lead to a positive technical effect bigger or at least the same as the one present in the world level of technology;

– positive decision on the influence of the inventive steps over the form design;

– decision on whether the unexpected combinations can transform the shortcomings of the environment into advantages of the innovative solution, e.g. mist vapor can be liquefied and stored as water in tanks, situated inside a building whereas this water can be used to irrigate rooftop gardens and other green areas, etc.

● ***Phase 5. Description of the benefits of the solution:***

– the solution to a defined design task reflects the combination of the well-known and novel characteristics, found in the patent claims; these combinations challenge the shortcomings of the existing worldwide level of technology, while offering benefits according to the solution of the author.

● ***Phase 6. Framing of the patent claims:***

The patentability of a given solution can be achieved by:

– selection of the most relevant well-known technical characteristics, found in existing patent solutions;

– correct ranking of the unexpected combination of well-known and novel characteristics, found in the patent claims;

– citation of used reference documents.

Achieving Competitiveness in Architectural Design through Innovative Solutions with Inventive Step

Human civilization has developed thanks to innovations. Every architecture style is more innovative as improved construction capacity gives the opportunity to better develop building technology and the art of construction. Innovative design requires the ability to implement traditional and novel achievements in science and technology in the creative solutions. Therefore, the phenomenon of transition from innovative solutions without inventive step to innovative solutions with inventive step on the one hand depends on the existing level of technology, which can materialize the respective technical characteristics of a given solution, and on the other hand depends on the creativity of the authors. Another crucial factor is the correct formulation of the set design tasks.

Programming of Architectural Creativity

The most important element of innovative design with inventive step is the development of unexpected combinations while solving the problems set in the design task. This requires professional knowledge, capabilities and talent, as well as the ability to presume the unexpected combinations of technical characteristics in accordance with the respective objective characteristics and means for aesthetic organization. With a bigger number of innovative solutions, greater is the probability for a given innovative solution to stand out. On the other hand, innovative solutions can be restricted in number but their positive effect can be considerably bigger than the one present in the existing world level of technology.

Creative Solution

The uniqueness of a solution is investigated by the state expertise of the Patent office. It is compared to the technical characteristics of the closest existing solution in the International patent classification. The state patent experts can chose one or several documents (patent, patent application, publications in journals, etc.) if they decide that the existing characteristics can be combined. As a result of their investigation, the state patent experts confirm of rejects the patentability of the innovative solution.

Efficiency of an Innovative Solution

According to the Law on patents, patented inventions should be characterized by novelty, inventive step and industrial applicability (Bulgarian law on patents, 2006).

The novelty of a given solution may not be evident from the existing level of technology in the respective area. Therefore, the combinations of technical characteristic may not be findable, i.e. they may not be found in the same form in the innovative solution. However, the operation of these combinations should ensure a positive technological effect with a minimum consumption for labor, energy and natural resources. Innovative solutions can be considered efficient as well even if they require high financial resources but nevertheless solve a problem that is of high importance and have not been solved for a considerably long amount of time. The use of existing well-known characteristics in a new direction is also typical in contemporary innovative design.

New Solution – Cultivation of Soft Fruits and Vegetables in Superskysrapers

The design of gardens for cultivation of soft fruits (e.g. various sorts of berries, etc.) and vegetables in horseshoe-like tubular elements, situated outside of the skyscraper's main body allows for an attractive new approach to be implemented, whereas the gardens are situated in immediate vicinity to the inhabitants of the skyscraper. The idea to be implemented requires a technical solution with the characteristics of an invention, which represents an essential part of the theory of inventive steps of the author. The theory of inventive steps, which considerably contributes to the design of competitive architectural solutions for construction details is described in the dissertation work of the author (Aleksandrov, 2014).

The "new design" of buildings, constructions and construction details emerges as a result of innovative form-formation and includes:

– innovative solutions without inventive step (Yanko Aleksandrov, 2017a)

– innovative solutions with inventive step (Yanko Aleksandrov, 2017b)

– a synthesis of the two above-mentioned types.

Previous Level of Technology

First example:„Dynamic Tower" by David Fisher (Figure 1)

With a unique rotation technology allowing every floor to be rotated by voice command, the inhabitants can easily change the view, to turn towards or away from the sun, to make their apartment slowly rotate for 3 hours, creating an impression that the world rotates around them (Dnevnik, 2008).

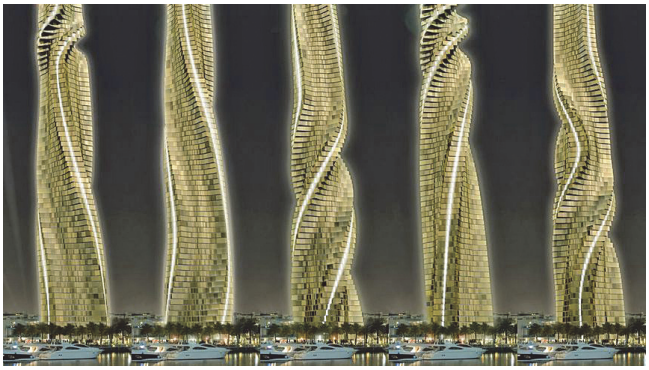

Fig. 1. „Dynamic Tower" by David Fisher. Dubai, 2008

Second example: „Turning Torso" by Santiago Calatrava (Figure 2)

Basing on existing characteristics and using them in a new way (rotation, twisting, sliding, etc. of forms) is typical for Calatrava. The objective characteristics of shape and the means for its aesthetical organization are in strong interconnection (Calatrava, 2016).

Fig. 2. Turning Torso (Calatrava, 2005) and Superskyscrapers Hong Kong (Aleksandrov et al., 2013) Two twisted shapes with different partition

The "Turning Torso" consists of 9 "cubes", each divided into 5 floors with multifunctional use. The form of the "cubes" resembles the pentagonal vertebrae of the human spine, which has inspired Calatrava. The useable area of each floor is 400 sq. m. Most importantly, there are no real moving elements in the building – actually the shape of the building itself creates the feeling of dynamic movement (Calatrava, 2016).

Description of the Inventive Steps for Creating a New Solution for Growing Soft Fruits and Vegetables in Skyscrapers

There are three options:

– first option – creating a claim (for originality of an innovative solution without inventive step) (Aleksandrov, 2017a)

– second option – creating a patent claim (in case of an innovative solution with inventive step) (Aleksandrov, 2017b) or

– third option – combining the claim for originality of the innovative solution with the patent claims for an innovative solution with inventive step.

Hereby is reviewed the third option (which has been filed as a patent claim).

General independent claim

A well-known skyscraper exists ("Turning Torso") which represents a parallelepiped (objective property) that is divided into several volumes along the its height of the building, which is made of one-dimensional elements (objective property), while the parallelepiped is put under torsion (action) whereas in the new solution the parallelepiped is replaced by a triangular prism put under torsion (action), whereas the horizontal one-dimensional elements are replaced by inclined horseshoe-like one-dimensional elements with variable section of tubular type (first new technical characteristic), which lean on the edges of the triangular prism, whereas these tubes build a dynamic order, with variable period and inside the tubes are situated *floors with vegetable gardens* and near the edges are situated tortuous vertical one-dimensional elements of tubular type with permanent section (second new technical characteristic), where are situated tanks for collection and storage of rainwater (third new technical characteristic).

Dependent claims (based on the "Turning Torso" skyscraper)

First independent claim

The new solution is characterized by the fact that the horizontal one-dimensional elements of an existing well-known skyscraper ("Turning Torso") are replaced with horseshoe-like one-dimensional elements with variable section of tubular type (first new technical characteristic). The tubes have a transparent covering of the walls which overlook the building itself and white covering with reflective properties of the walls which are turned to the outside, whereas the white reflective covering is situated on a movable stretched surface.

Second dependent claim

The tortuous one-dimensional elements of tubular type with constant section (second new technical characteristic) have a funnel-like end by their upper side.

Third dependent claim

In the tanks for rainwater storage (third new technical characteristic) are situated first tubular serpentines, connected by circulation pumps with second tubular serpentines, situated under the root system of the vegetables in the gardens.

Fourth dependent claim

Over the tanks for rainwater storage are situated water turbines.

Fifth dependent claim

The inclined horseshoe-like one-dimensional elements with variable section (first technical characteristic) which lean on the edges of the triangular prism are also hanged on temporary horizontal circular tubular beams, which are fixed to the horizontal flood constructions of the floor, whereas these beams lean on a spatial bracket.

Sixth dependent claim

The tubular beams are first connected with the water tanks, which collect the rainwater on each floor, and then are connected with the inclined horseshoe-like one-dimensional elements with variable section (first new technical characteristic) whereas the water in them is meant to be used for the irrigation of the gardens situated inside.

Seventh dependent claim

On the tortuous vertical one-dimensional elements with constant section (second technical characteristic) are situated external elevating platforms, which ensure the elevation of a part of the horseshoe-like one-dimensional elements with variable section and are embraced by movable "collars" whereas these "collars" are fixed to the tortuous vertical one-dimensional elements with constant section (second new technical characteristic) in the zone of connection of their common contact surfaces, while the "collars" represent 8-like connecting elements.

Required operations for the implementation of the process of innovative design

1. Choice of pre-existing level of technology.

2. Identification of significant differences between the existing level of technology and the new solution of the author based on:

2.1. Description of the objective characteristics and new objective characteristics

– description of unexpected combinations of well-known and new objective characteristics

– description of unexpected combinations of well-known and new means for aesthetical organization

– final result – an original solution with an unexpected aesthetical effect.

2.2. Description of technical characteristics

– description of the well-known technical characteristics of the pre-existing level of technology

– description of the novel characteristics, proposed by the author's solution

– description of the unexpected combinations of well-known and new technical characteristics

– final result – a positive technical effect which is bigger or at least equal to the world level of technology.

Defining the main task and the sub-tasks

They main task is to create a skyscraper with tortuous body, embraced by stretched one-dimensional elements with internal spaces, where gardens for fruits and vegetables will be situated.

The sub-tasks to be solved are:

– the plants should be irrigated by a system for rainwater drip irrigation, whereas the rainwater should be collected and stored in specially designed tanks

– the plant roots should be heated by a system of tubular serpentines, whereas the rainwater should serve as heath carrier

– the falling rainwater should set in motion water turbines, situated under these water tanks on every floor of the skyscraper

– the stretched one-dimensional elements are hanged on the edges of a triangular prism

– the mounting of the tubular elements is realized with the help of elevator platforms, moving along stretched one-dimensional elements with constant transverse section, situated near the edges of the triangular prism.

Advantages of the solutions (proving the positive technical effect, which is bigger or at least equal to the world level of technology, basing on the choice of the closest pre-existing level of technology)

A skyscraper with tortuous body is created, whereas there are gardens situated outside its main body, hanged on one-dimensional elements with variable transverse section with internal floor spaces, meant for the integration of fruit and vegetable gardens.

A system for drip irrigation of the plants in the gardens is implemented, whereas is allows the collection and storage of rainwater in specially-designed tanks, situated inside of stretched one-dimensional elements, which form an integral part of the edges of the tortuous triangular prism.

The *heating of the root system of the plants in the gardens* is realized with the help of tubular serpentines which use the rainwater as a heat carrier.

Water turbines, situated on every floor of the skyscraper are set in motion by the falling rainwater and provide a system for autonomous energy supply of the building.

The spatial stability of the stretched one-dimensional elements is achieved with the help of a balancing system, whereas the elements are hanged on the edges of the triangular prism on the one hand, and are suspended with the help of tubular beams to the foreheads of the floor constructions of the tortuous body of the skyscrapers on the other hand.

Conclusions

The premises for cultivation of soft fruits and vegetables in skyscrapers becomes an integral part of their structure.

The unexpected combination of well-known technical characteristics and new technical characteristics define the number of inventive steps – one, two or more. These inventive steps are placed in the characterizing part of the patent claims, according to the patent application for a building, construction or detail.

The pre-existing level of technology and the new innovative solutions should be objectively different, whereas the innovative solution should meet the set task in a new way and with new means.

The innovative solution should be regarded as unity of inventive steps, which approach in a new way the function, construction, building material, building technology, etc. depending on the requirements of the set task (Figure 3, 4 and 5).

New and original architectural solutions are possible also without the inclusion of new technical characteristics but these solutions occur as a result of unexpected combinations of objective characteristics of shape and the means for its aesthetical organization.

The highest degree of innovativeness is achieved when these unexpected combinations for achieving originality and uniqueness of the architectural solution are combined with the unexpected combinations of well-known technical character-

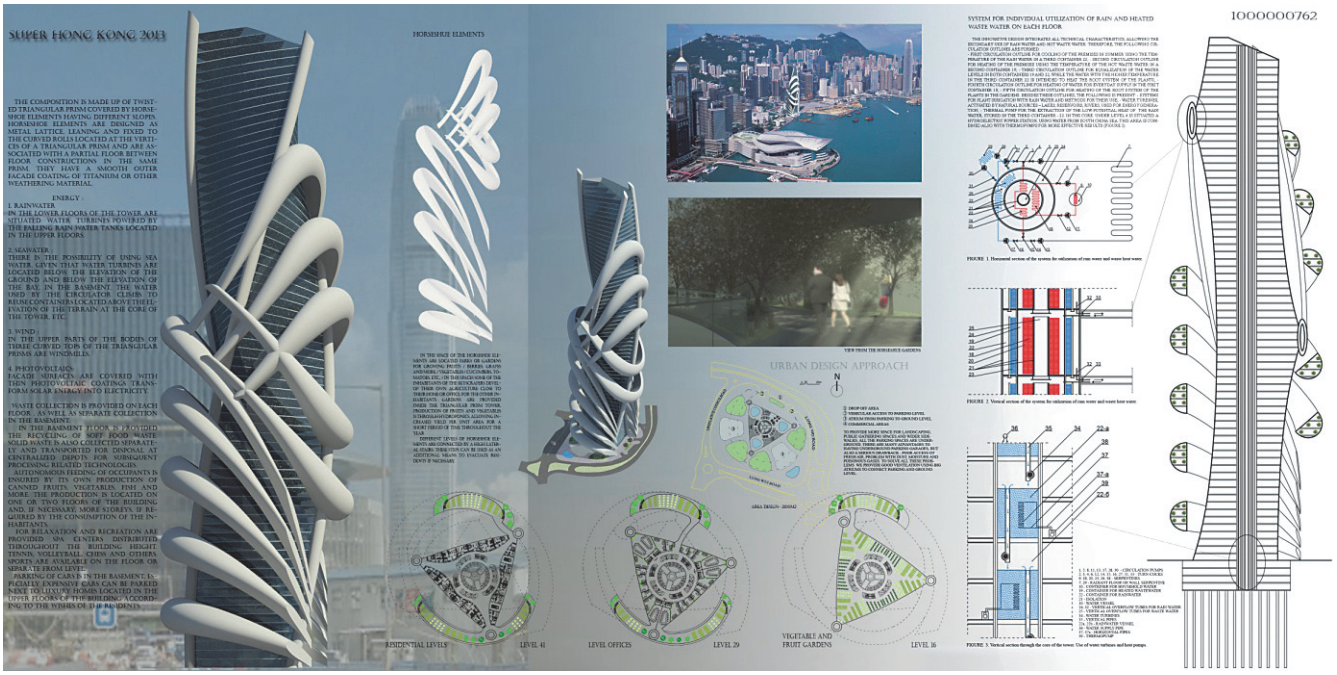

Fig. 3. Hong Kong. Arcology superskyscraper. International competition (Aleksandrov et al., 2013)
A solution of the author and his team
The vegetable gardens are placed in horseshoe-like tubular elements, situated outside of the main skyscraper body

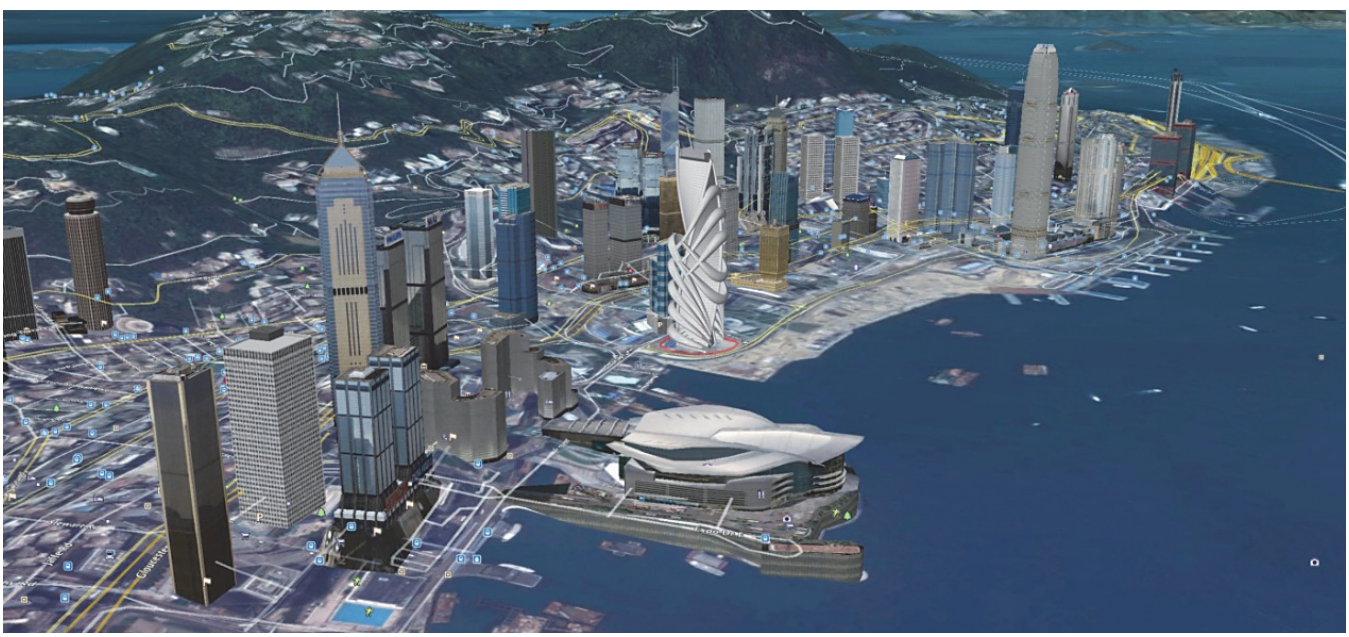

Fig. 4. The skyscraper with fruit and vegetable gardens is harmonically integrated into the residential environment of Hong Kong (Yanko Aleksandrov et al., 2013)
Vertical gardens for growing fruit and vegetables are situated in inclined horseshoe-like one-dimensional elements with variable section (first new technical characteristic), which lean on the edges of the triangular prism, whereas these tubes build a dynamic order, with a variable period (Aleksandrov et al., 2013)

Fig. 5. Educational facilities inside the skyscraper (Yanko Aleksandrov, 2017-3)
On the last floor of the skyscraper is situated a school without classrooms for children aged 6 – 12. The aim of this school is with the help of modern interactive technologies to raise the appreciation of little children for the environment and nature, whereas visits to the vertical gardens are included in the teaching program

istics, and the new technical characteristics, characterizing the patent claims in the patent application. Thus, a high degree of competitiveness of the architectural solutions can be achieved.

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