Upward Spiral: The Story of the Evolution Tower

Philip Nikandrov

The Evolution Tower, Moscow, set off a wave of imitators when its design was first revealed in 2004, but it took another 12 years for it to come to fruition. Through the economic crisis and many subsequent design team iterations, the essential twisting form has endured. The appropriately named final product demonstrates the persistent value of a strong concept. The tower, against many odds, has definitively spiraled upward and taken its place in the city's skyline.

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With 25 years of international experience in architecture, Philip Nikandrov is a leading architect specializing in large-scale, complex and unique projects in the high-rise typology. His design approach shows a route between contextualism and minimalism, achieving complexity through simplicity. On joining RMJM in 1997, Nikandrov served as senior designer and project architect on some of the most prestigious projects, working in the firm's offices in the United Kingdom, the Middle East, and Russia. In 2011, Nikandrov joined GORPROJECT as its chief architect and continued delivering his designs, including the Evolution Tower, Moscow, and Lakhta Center, St. Petersburg (currently under construction), set to become Europe's next tallest skyscraper.

Introduction

The spiraling 246-meter Evolution Tower is located in the Moscow-City high-rise business district on the Presnenskaya Embankment along the Moscow River. The new multi-function center occupies a 2.5-hectare area, 80% of which is a landscaped terraced civic plaza. The plaza is an integral part of the development, forming its central open public space. It includes a 10-meter-high ceremonial staircase, leading from the embankment and the pedestrian Bagration Bridge over the Moscow River to the higher terraced levels, as well as landscaped areas with green lawns, trees, water features, travelators, and feature light boxes (see Figure 1).

Under the plaza, a two-story retail mall connects the Evolution Tower with a metro station and the lower level of the Bagration Bridge, thus integrating the new development into the larger Moscow-City district, where 7 of the 10 highest European skyscrapers are located, housing more than four million square meters of office and retail areas, with associated transport and engineering infrastructure.

Part of Phase 1 of the project, the Evolution Gallery Mall within the podium houses a food court and a 6,000-square-meter family entertainment and educational center, where kids can learn about various professions to earn "points" and spend them on the rides (the first such center of that format in Moscow).

Figure 1. Evolution Tower, Moscow – aerial view

The 82,000-square-meter office tower has 52 levels, with each level rotated three degrees from the previous and the overall twist reaching 156 degrees clockwise. With the world's largest cold-bent glazing, the tower façade provides a seamless floating reflection that rotates the panoramas of the Moscow skyline vertically. The reflected clouds moving up the surface enhance the dynamic visual impact of the twisted tower, an unprecedented optical effect on this scale (see Figure 2). The tower's crown, with a supporting steel structure made of two twisted arches, provides a helipad at the very top, as well as an open observation roof deck at level 52 featuring the best panoramas of the Moscow riverside, with views towards the historic city center (see Figure 1).

From the very beginning, the developer and architects set an ambitious goal: to create a recognizable and symbolic building that would be a new icon of contemporary

Moscow. From the onion domes of St. Basil's Cathedral to the iconic Tatlin Tower concept, Russian architecture has long been obsessed with spirals. At the most basic level, the twisting, sculptural DNA-shaped Evolution Tower symbolizes the progress of humankind through its achievements in construction.

However, the original concept of the spiral tower on this site, City Palace Tower, conceived in 2005, was inspired by quite a different metaphor. In 2004, Moscow city authorities had planned the construction of the Wedding Palace: a registry office and ceremonial space within a 16-story, 30,000-square-meter building. The winning entry of the international competition held by the developer Snegiri Group in 2004 proposed a balanced composition of "twisting crystals" – two fully glazed towers of different height, with a slight twist in the geometry of the opposite façades.

A Design Evolution

The original concept, developed by the author in collaboration with RMJM, secured the contract and later led to a series of iterations and design alternatives, combining the city authorities' ambitions to impress the world with an iconic wedding palace building and the developer's intentions to increase the total gross and rentable areas to make the project financially viable. Finally, both parties united around a sketch of two twisted ribbons elevated from the Yin and Yang symbols, where black and white represented the groom and bride embracing each other in dance.

The original manifestation of the duality and union symbolized by Yin and Yang as groom and bride was overly literal and, rendered in black and white, looked a bit like a penguin. So after a few further distillations, a more restrained and stylish sculptural composition emerged, with the wedding palace housed under the curved atrium glazing of the "bride's skirt" (see Figure 3).

The design of the tower crown was further improved by separating two ribbons with the

Figure 2. Evolution Tower, Moscow. © Igor Butyrskii

Figure 3. The City Palace Tower concept developed by RMJM showing the "bride's skirt."

"veil of the bride" above the sky bar. The Wedding Palace was a 2,000-square-meter "socially orientated" locomotive, hiding behind its atrium glazing the 80,000-square-meter office tower rising above it.

In 2006 the updated concept received planning permission, and in 2008 the tower construction permit was finally granted. Construction on the Phase 1 podium structure had started in 2005, and the perimeter diaphragm wall was built back in 1997 for a completely different project on the same plot. This gave the team a certain heritage to deal with, including the obligations imposed by the municipality to provide the link between the metro station and pedestrian bridge over Moscow River. This was done with a temporary structure before the final construction documentation was approved by the State Building Control.

In late 2008, the entire investment plan collapsed under the wave of the world economic crisis, construction was frozen, and the project was suspended until the market revived in 2011. The developer managed to change the pool of investors and realign the financing. The credit line provided by the bank required extremely fast construction speed, so the scheme underwent a number of optimizations, aiming to build a unique and complex tower at the cost and within the construction program of a conventional extruded-rectangle tower.

The project team changed, adding a new lead architecture firm and a new contractor, and drastic design changes followed the new functional program and revised design brief. City authorities had by this time lost their interest in developing the Wedding Palace in the middle of a business center, where traffic jams can ruin wedding processions, and the City Palace Tower subsequently lost its title and core function.

In 2011 the revised, now 100% office building was rebranded as Evolution Tower, together with the elimination of the

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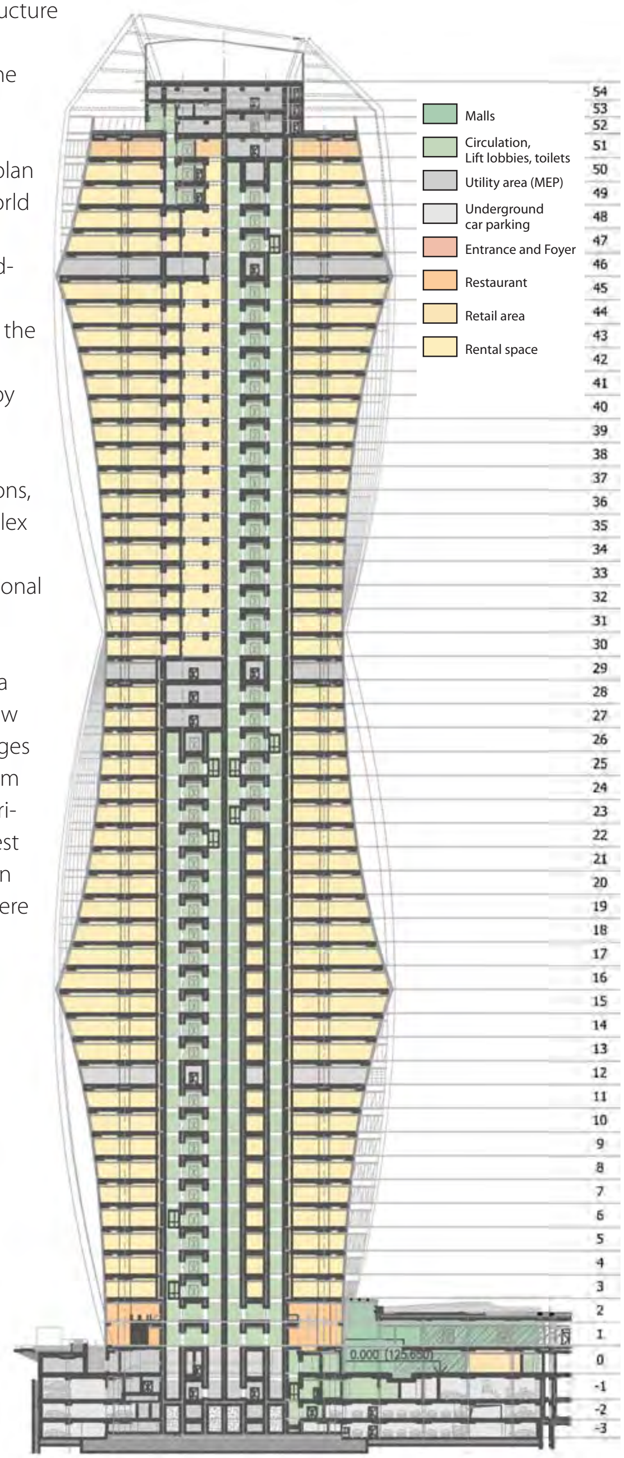

Figure 4. Typical section

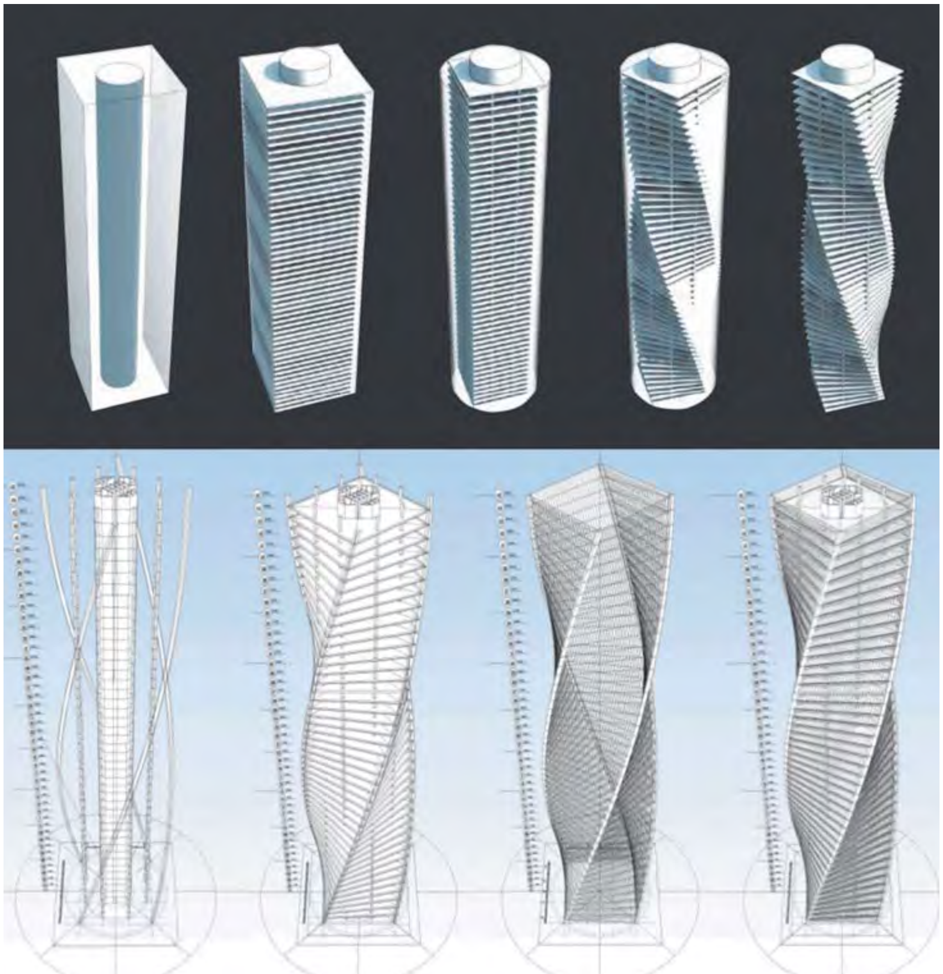

Figure 5 . Evolution Tower geometric transformation concept.

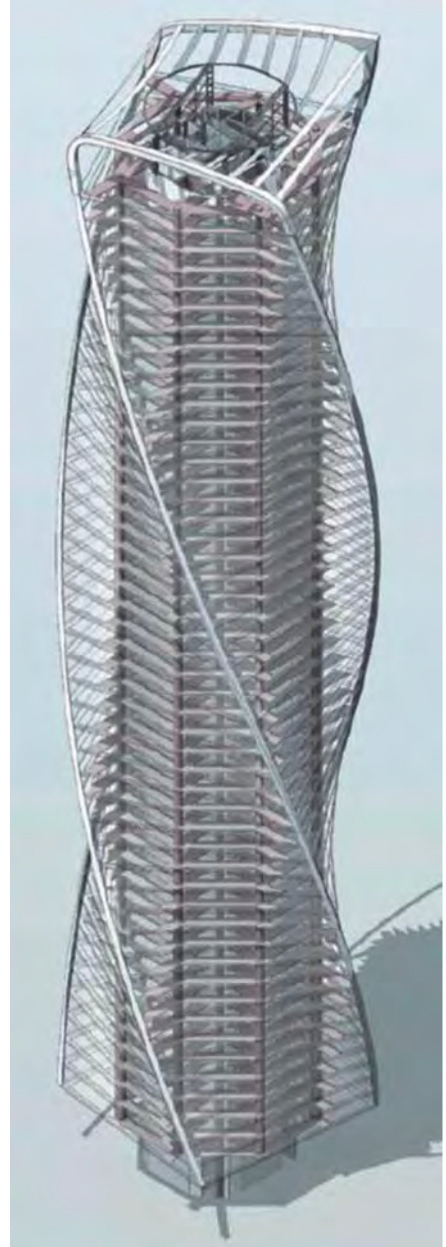

Figure 6 . Evolution Tower structural scheme.

Wedding Palace component and top spaces for post-ceremonial celebrations. The lower atriu -skirt and the crown were lost; the faceted façade was totally redesigned as a smooth glass surface. A decentralized services-engineering concept was eliminated in favor of a more conventional centralized system, which required the addition of an additional three plant levels. The vertical transportation system that had been based on double-decker elevator cabs was replaced by a different system, which required the redesign of the core layout.

The New Design Concept and Challenges for Structural Engineering

All of this resulted in the addition of five more floors (from level 47 to 52), leaving practically none of original concept intact, except for the spiraling shape and a structural scheme with gridlines. The fully reconsidered design concept, based on a metaphor of an evolutionary spiral, features the white façade ribbon wrapping over the roof in a form of 90-degree twisted infinity symbol, which speaks of the scientific concept of evolution and celebrates the development of human civilization.

This simple and innovative design was based on principles of twisting square-shaped floor plates with a vertical reinforced-concrete frame, supported by a central core and eight columns in an octagonal arrangement, with continuous beams and four spiraling columns at the corners (see Figure 5). The proposed structural scheme, with its cantilevered continuous concrete beams and cantilevered floor slabs, appeared to be simple, efficient and economical (see Figure 6). The simplicity of a fully concrete tower structure with no outrigger levels saved a lot of time and money on the construction budget. But even if the structural concept was simple, the requirement that the floor slab layout change 52 times made pouring the concrete a logistical challenge.

The solution was found in an innovative formwork system that could create core walls and floor slabs in one pour, with each floor divided into three sections. Four hydraulic self-climbing system units were used to make large working platforms, where the top three floors under construction are tightly enclosed with a rail-climbing protection panel, which also provides wind protection and formwork for the four twisting corner

Figure 7. RCS protection panel unit enclosing the top three floors under construction. © PERI GmbH

Figure 8. Inclined positioned RCS protection panel. © PERI GmbH

Figure 9. RCS landing platform. © PERI GmbH

columns (see Figure 7). The units, propelled by hydraulics, climbed the constant twist of the building where the installed rail-guided system (with inclined rails connected to the building frame by slab shoes) ensured a fast and safe ascent (see Figure 8). Landing platforms climb on rails hydraulically with the help of mobile climbing devices, and without a crane. On the sides of the building, rail-climbing system (RCS) platforms provide temporary storage areas and move loads (see Figure 9). This bespoke self-climbing formwork system achieved an impressive maximum framing speed of six days per floor, with an average speed of seven days per floor.

The 12 concrete columns and central core are supported by the 3.5-meter-thick raft over piled foundations. It took 48 hours to pour 8,000 cubic meters of concrete for the raft. Eight circular columns at 15-meter intervals vary in diameter from 2.1 meters at the bottom to 1.2 meters at the top.

Safety

The tower has significant safeguards against potential fire or terrorist attacks. Its "passive protection" consists of a four-hour fire rating on all bearing structures and staircase walls, which significantly exceeds the time needed to evacuate the building.

"Active protection" consists of fire engineering equipment, including a sprinkler system throughout, as well as local powder- and gas-based fire suppression systems, mechanical smoke extraction from the core, pressurized stairwells, public address and egress management systems, fire and smoke detectors, and the permanent monitoring of the structural frame elements and building services as part of its building management system (BMS). Category 1 electrical supply from two independent sources is supported additionally by diesel generators and Uninterruptible Power Supply (UPS) batteries. The water supply and district heating are also supported by redundant incoming lines. Ventilation and air-conditioning are designed based on a generous ratio of 60 square meters per person. Most of the building's engineering systems and telecommunications specifications not only comply with class "A" standards, but exceed them.

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A Unique Envelope

The unique tower envelope emphasizes the lightness and dynamics of the form, as it appears to defy gravity. The idea of a 200-meter sculpture, crafted of materials traditionally believed to be fragile and inflexible, symbolizes the evolutionary spiral as the pinnacle of progress and the power of human intellect, challenging the forces of nature and the laws of physics. The original façade concept and innovative construction technologies allowed the team to create a visually organic and flowing 3D form.

The double-curved tower envelope is provided by cold-bending reflective glass units. The curtain wall uses flat, double-glazed units cold-formed in 3D within the aluminum frame to avoid the visual effect of "stepping" in the geometry. This approach appeared to be both a more energy-efficient and cost-effective solution than the stepped curtain wall units previously applied in some twisted, unitized façades. During factory fabrication, the glass unit is placed in the twisted aluminum frame horizontally and then takes its curved shape as a consequence of its own weight, without any thermal treatment. Maximum corner deformation does not exceed 50 millimeters relative to the opposite corner of the unit. Finally, the façade looks like a continuously twisted spiral glass surface. Currently, this curtain wall is the world's largest cold-bent façade in terms of the area in one building. The glazed ribbon, with a constant leaning angle of 14 vertical degrees at the corners, creates a stunning optical illusion, reflecting the surrounding cityscape vertically, with a 90-degree twist (see Figure 10).

Evolution Tower's total façade area is 40,500 square meters, including 34,500 square meters of the typical façade areas from level 3 to level 51. On each floor, the curtain wall consists of 108 parallelogram façade panels 4.3 meters high and 1.5 meters wide. Twenty-seven of the panels have two different sizes that vary with the twist angle, from +14 to -14 degrees, which complicated the construction logistics (see Figure 11).

However, the implementation of this façade structure was successful due to the selection of a skilled design-build contractor for the production of the curtain wall, atrium glazing, and canopies/entrances. The aluminum profiles were extruded in Russia at a specially arranged production line. Despite the glass units' fabrication in Germany, with all associated delivery costs and customs duties, the overall façade cost per square meter remained within the budget of a

Figure 10. The tower's twisting curtain wall creates an optical illusion.

Figure 11. Evolution Tower façade panels.
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Figure 12. The tower crown, during construction. © Denis Lukyanov

Figure 13. A terraced podium provides a transition from river level and contains a two-level mall with access to metro lines and the pedestrian bridge. © Gorproject

"standard" benchmark high-rise tower. Double-glazed units with energy-efficient multi-functional glass provide the energy efficiency and thermal insulation parameters (U-values) similar to those of standard triple-glazed units, as are normally used to withstand Moscow's harsh winters, but with less weight than would be typical for a panoramic floor-to-ceiling application.

The glass unit formula, with a heat-strengthened triplex exterior and tempered glass interior, allows bending of the unit in the installation position to achieve the required façade geometry, while providing additional safety to the envelope. In case of damage, the tempered glass, five times the standard strength, is designed to facture into small pieces, and the triplex lamination film prevents shards from falling out.

The Crowning Achievement

The tower crown, representing the bent of a striped ribbon façade, consists of two 41-meter-span twisted-steel arches, with interim steel supports cantilevered from the central cylindrical concrete core walls, and four smaller arched supports beneath the white steel ribbon stripes (tubular frames filled with perforated steel sheets) (see Figure 12). The twisted steel arches were designed and manufactured in Piedmont, Italy, delivered to Moscow in pieces for easy transportation by trucks, and then finally assembled on the roof by being bolted from the inside.

The parapet glazing surrounding the rooftop open-air observation deck on level 52 is made of cold-bent (tempered triplex) glass with motorized foldable top elements. This allows easy access for the Building Maintenance Unit (BMU) cradle over the parapet. The bespoke BMU system, with three articulated crane arms and a 300-kilogram auxiliary hoist, follows the complex twisting form of the façade in order to guarantee proper access for maintenance and cleaning of the curtain wall. The special cradle has been designed to reach all the positions along the façade without physical impact on the curtain wall. This is achieved via safety straps, push locks and sockets incorporated in each curtain wall unit, special sticks, and soft rubber rollers that prevent any scratches or other damage from the cradle's contact with the fragile envelope of glass, and with pressure caps and soft aluminum cladding.

The Podium

The podium's terraced and landscaped roof, part of a new civic plaza, provides public space for recreation activities, greenery, fountains/water features, open outdoor cafés, and more (see Figure 13). The podium retail mall skylights and entrance porticos/canopies that rise above the plaza as accents also serve as light boxes for the plaza's architectural lighting. Fritted glazing captures the light from LED wall-wash lamps that change colors. Skylights and entrance canopies are built as whole-glass structures consisting of planar glazing on spiders with the bearing structures (beam-fins and vertical mullion fins) made of triplex glass with stainless-steel fittings (see Figure 14).

To improve the stiffness of the structural glass fins, a triplex lamination interlayer film was used. Skylights and canopy roofs are made of triplex glass with electrical heating, preventing ice and snow cover on the exterior and water condensation on the interior of the glass. The glass is covered with an energy-saving frit pattern, decreasing solar radiation gain while preserving transparency and sufficient light penetration.

Vegetated green roofs over the retail mall and integrated coil floor heating under the landscape plaza levels use grey water in winter to melt the snow and ice for the safety of pedestrians. Four outdoor travelators move people between terrace levels of the plaza (a 10-meter height change) and operate through extreme winter conditions.

Vertical Transportation

The original tower's vertical transportation (VT) concept had 12 lift shafts with standard double-decker elevators. However, during the construction stage tender the VT scheme was replaced by the TWIN system, the first elevator system to have two cabs running independently, one above the other, in the same shaft. This technology has many advantages over conventional elevator systems, including reducing waiting and travel times to a minimum due to an intelligent destination selection control system monitored by a computer set to optimize the travel logistics between calls.

The use of TWIN elevators saved two shafts within the core. The ultimate deployment consisted of 10 TWINs traveling at up to seven meters per second, instead of 12 double-decker cars as specified in the original concept, freeing up additional useful MEP shaft space across all floors. TWIN technology also contributed to the overall project sustainability with lowered power consumption per passenger. The "separated" cabs in the TWIN system are much lighter than double-decker cabs, hence requiring lower wattage and resulting in less power consumption. The cabs are in fact similar to single-cab elevators, so the maintenance cost is less than that of the bespoke double-deckers, due to availability of cheaper standard spare parts.

Conclusion

The organic twisting silhouette stands out against the background of extruded glass towers, greatly contributing to the overall composition of the Moscow-City high-rise cluster. The Evolution development delivered a significant open public space on the landscaped roof of the retail mall. The synergy of that mix, combined with a large underground carpark complemented by the direct link to the metro station and pedestrian bridge, secured the project's successful completion.

The bold shape and timeless aesthetics brought commercial success for this project, with the tower being fully acquired for a corporate headquarters even in the context of poor demand in the Moscow office market.

Before its completion, the sculptural spiral of Evolution Tower, often appearing in commercials, posters and magazines, became a new icon for modern Moscow as the symbol of its business ambitions and fast development. The Evolution Tower also became a monument to the courage of its developer and investors, who placed a great deal of trust in their architects, engineers and contractors. Together, all undertook the challenging adventure of designing and building this unique and innovative skyscraper for the capital of Russia.

Unless otherwise noted, all photography credits in this paper are to the author.

Figure 14. Podium retail mall skylights.

Project Data

Completion Date: 2015
Height: 246 meters
Stories: 55
Total Area: 82,000 square meters
Use: office
Owners: City-Palace LLC; ZAO Snegiri Development; Transneft
Developer: ZAO Snegiri Development
Architects: GORPROJECT (design); RMJM (design)
Structural Engineers: GK-Techstroy (design); Gorproject (engineer of record)
MEP Engineers: Renaissance Construction Company (design); Metropolis (engineer of record); Gorproject (engineer of record)
Main Contractor: Renaissance Construction Company
Other CTBUH Member Companies: Permasteelisa Group (cladding); Sika Services AG (sealants); thyssenkrupp (elevator)

*The design of Evolution Tower was the result of a unique partnership between the design architects and an artist, Karen Forbes, a Scottish based artist and Head of Drawing and Painting at Edinburgh College of Art.

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