Involvement of Smart Cities Citizens to Global Cooperation in Research and Education in Space - Architectural and Urban Conditions

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Abstract. The global dimension of human existence is not only perceptible from our communication skills, mobility and our impact on the environment within our planet Earth. If we want be involved in process of Space exploration at least somewhat successfully, it is necessary to responsibly enter into the process of education and research in the smart cities such as Bratislava. Astronomy education and research must to involve a construction of planetariums. Planetarium must be able to educate, enlighten, entertain and inspire to space understanding, so planetariums must be interactive. So if Bratislava is a smart city, it must build such Planetarium.

Keywords: Space exploration · Astronomy education · Planetarium · Planetarium presentation · Interactive

1 Introduction

The world around us is not only ordinarily perceptible surroundings of our human life, it is not only the environment in which we live, work or spend our leisure time. Our living environment has a much broader scope and it also has this broad framework, the impact of our operations. The global dimension of human existence is not only perceptible from our communication skills, mobility and our impact on the human environment within our planet Earth. We are part of a much broader existential framework, and we are increasingly able to get to know him, to interfere into it and influence as well as its present and especially the future. The existence of the human race (present and future) is associated with this framework and it is therefore necessary to take for his influence on the due share of responsibility. This responsibility has its specific projections in our activities, including the expansion of the ability to explore this vast space environment, the processes that take place in it and our place in them.

Space exploration is not just a job narrowcasting top scientists. Discoveries and exploring space through space probes create opportunities relating to the understanding of our past, present and possible future developments and thus affect all of us. New knowledge gained space missions as recently observation of Ceres Dawn explorer, whether culminating overflight of the probe New Horizons in the vicinity of Pluto, the former eighth planet of the solar system, its surprising revelations global layman but

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A. Leon-Garcia et al. (Eds.): Smart City 2015, LNICST 166, pp. 774–782, 2016.
DOI: 10.1007/978-3-319-33681-7_68

also the professional public. Ability to engage as much as possible to research these processes is an essential requirement for every developed, smart society, particularly in the field of scientific and technical cooperation on space programs. Our entry into this research, whether participating in the project Rosetta and its journey to Comet 67P/Churyumov–Gerasimenko, [7] or the status of cooperating state with ESA (European Space Agency), is an example of the positive results of our relationship to space exploration.

2 Learning Space – Astronomy Education

The Exploring the universe is not only the greatest adventure in which human had embarked, but it's also expanding horizons of knowledge to hitherto unforeseen distance. If we want be involved in this process at least somewhat successfully, it is necessary to responsibly enter into the process of education and research in the smart cities such as Bratislava. Its scientific, academic and research capacity it suitable also for the important place in international cooperation in education, enlightenment and understanding of our role in the Today, however, "the conditions for discovering, exploring and learning about the universe especially are not comparable to those, that existed in Bratislava in the 20 s of the 18th century", [8] when an astronomical observations Samuel Mikovíni (about 1686 - March 23, 1750) set up his own observatory in apartment on Laurinska street. Today's night sky of the capital is significantly affected by the disturbing light, known as light pollution, so it is necessary to direct astronomical observations complement by the representation and simulation of space.

Archimedes is credited with the first device demonstrating planetary motions about 250 B.C. Later, Ptolemy's globe is alleged to have even demonstrated the precession of the equinoxes. "The next improvement came with the enlargement of the globes. The most famous, the Gottorf globe constructed in the middle 17th century *(The original globe was built between 1654 to 1664 in Gottorf on request of Frederick III, Duke of Holstein-Gottorp.),* was about 4 m in diameter, weighed over 3 tons, and could seat several persons inside on a circular bench. The stars were holes in the globe. Other globes like the Gorroro sphere were built, one of the last being the Atwood globe in 1913 for the Museum of the Chicago Academy of Sciences. With a diameter of almost 5 m the Atwood globe shows 692 stars, and a moveable light bulb represents the Sun. Apertures along the ecliptic, which can be uncovered as necessary, represent the planets" [1].

With the coming of the Copernican idea and with advances in instrument - making, various models of the planetary system were constructed as teaching devices. These are called "orreries" in English. The first orrery that was a planetarium of the modern era was produced in 1704, and one was presented to Charles Boyle, 4th Earl of Orrery (28 July 1674–28 August 1731) — whence came the name. The orreries reached their culmination in the large ceiling orreries at Munich (since destroyed), Chapel Hill, and New York. Meanwhile, elaborate astronomical clocks were developed showing various sky events. Thus the stage was set for the entrance of the next advance (Fig. 1).

Orbitoscope, invented about 1912 by Prof. Eduard Hindermann in Basel is generally considered as the first projection device for showing planetary motions.

Fig. 1. Mechanical model demonstrating the Copernican system dating about 1780 [2]

The instrument is driven by springworks and has two planets revolving about a central Sun. A small light bulb on one of the planets projects shadows of the other two objects in the directions they would be seen from that planet, reproducing accurately the retrograde loops and speed changes. This ingenious device is useful for instruction, but of course had many shortcomings.

The idea of realistically reproducing the sky in detail is due to astronomer Max Wolf, involved with the Deutsches Museum. The museum was the brainchild of Oskar von Miller, an engineer interested in all aspects of science. He founded it in 1903, but the opening of a building on an island in the Isar River as its new home in Munich, planned for 1916 was postponed due to the war. The fully constructed museum finally opened in 1925. In 1913, Wolf had suggested to von Miller the idea of a device for his museum which would reproduce not only the stars but also the planetary motions von Miller approached the well-known optical firm of Carl Zeiss in Jena, and they agreed to look into the problem.

About March 1919, Walther Bauersfeld, chief design engineer and later director of Carl Zeiss, hit upon the idea of projection of the celestial objects in a dark room. The original plan had been for some sort of globe similar to that of Gottorf. The new idea[1] simplified things immensely. The mechanism could be on a small scale and easily controllable. In August 1923, a 16 m dome was set up on the roof of the factory in Jena, and the first Model I projector was installed. The "Wonder of Jena" had its first unofficial showings there. Then the instrument was taken down, shipped to the Deutsches Museum, and installed there in a 10 m dome.

The planetarium so impressed many scientific and civic leaders in Germany that in the few years following the first Model I, several other cities ordered and received projectors. Dusseldorf installed a Model I, then replaced it with a Model II which Zeiss

[1] Applying also the Rudolf Straubel's concept that the fixed stars should be projected from the central apparatus [3].

had developed in the meantime. (This planetarium had a 30 m dome, one of the largest ever constructed, and totally destroyed in the war.) The Model II (Fig. 2) was the large dumbbell-shaped projector which everyone has since identified with Zeiss.

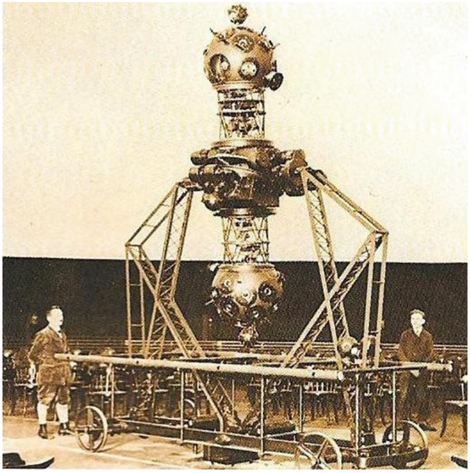

Fig. 2. Universal projection instrument in the Jena Zeiss Planetarium in 1926 (produced by Zeiss during the 1920s and 1930s) [2]

Even in the 1920 s the first planetariums were built outside Germany (the Rome planetarium opened in 1928, and the Moscow planetarium in 1929). On May 5, 1930, the Adler Planetarium in Chicago greeted its first visitors in US.

Since then, it was built more than 2,000 planetarium equipped with projector devices of different types, sizes, and made by more of manufacturers (about a third of the Zeiss), with more and more sophisticated technology. “Planetariums for decades have been created to serve the cause of astronomical enlightenment-to offer people knowledge and understanding and a sense of place in a universe far bigger than themselves. It’s an important role and one that we continue to play-changing, we hope, as times, technology, education, and our view of the universe change” [4].

Construction planetariums in the United States posted the largest growth after 1957. “On October 4th of that year, the Soviet Union successfully launched the first artificial satellite and surprised the free world with its advanced technology. America was shocked out of its complacency, and a few months later placed its own satellite into orbit. And so, the technological contest had begun. America found itself and its educational program wholly inadequate to meet this challenge. It was apparent to the nation’s legislators and educators that from that time forward, the United States, by accepting the space challenge, must also accept the responsibility of educating its people to the space environment. Astronomy and space science impregnated almost every field of learning, and an understanding of them became essential to the country’s well being. It penetrated the nation’s history, economics, foreign policy, and all branches of its science and industry. In the schools, the teachers became victims of the times – totally unprepared to answer the probing questions of the students. Parents were suddenly confronted with the excitement their children found in the drama of the space age, but like their children's teachers, could not nurture the enthusiasm of their inquiring minds… Everyone was getting into the scene with seemingly every community thinking that they needed a planetarium. Also, of the 700 plus **planetariums that had been built** by 1970" [4].

Clearly, planetariums represent one of the biggest and most visible avenues for presenting astronomy and related subjects to the public-surpassable. This gives planetariums an enormous potential for supporting both formal and informal astronomy education. Astronomy education and research compounded by the enormous construction of planetariums, the US showed progresses in this field.

Our society in this field lags far behind, Slovakia is currently operating seven small planetariums (projection dome with a diameter of 8 or 10 m), of which no one in Bratislava. According to the civic association Slovak planetarium: "Bratislava is the only capital city in the European Union, which has no observatory or planetarium. Approximately 600,000 residents in the Bratislava region does not have any public astronomical workplace, although astronomy is a part of the curriculum and visit the planetarium is specifically recommended for students 4th and 9th class of primary schools. Planetarium presentation of geography and astronomy helps students quickly master the valuable and lasting curriculum. The potential for the use of the planetarium is not only almost 500 schools in the Bratislava region, but also for individual visitors, families and tourists. Three-quarters of the more than 100,000 students in Bratislava consists of primary school pupils and secondary school students, so the target group of 4th class elementary school students represents at least 300 excursions every year" [5] to space exploration.

3 Opportunities to Participate in Global Cooperation - Current Issues in the Planetariums Profession

James. G. Manning, President of International Planetarium Society, addressed to the Education Symposium of the Astronomical Society of the Pacific, June 24, 1995: "In defining the role that planetariums play, it's useful to review their strengths. We all know that planetariums can reproduce the night sky for any place on earth on any day of the year for many years past and future, creating a view that simulates the three-dimensional "backyard" sky. And that they can accurately reproduce the apparent motions and cycles of the sky-in speeded-up fashion so people can see what happens over time. But planetariums also create environments that encompass the audience, bringing them into the experience in a way that classroom, book, television or computer screen cannot. They can combine and effectively use audiovisual technology to help create these experiences. And they possess tremendous flexibility in how these audiovisual resources can be used. First and foremost, we strive to educate, in ways ranging from curriculum-based school lessons to popular-level programs. We also strive to enlighten, which I think is not quite the same as to educate; we want people not just to know but to understand and to incorporate this understanding in their lives. And yes, many of us also try to entertain-on the principle that you catch more flies with honey, that learning ought to be fun, and that people probably learn more when they're enjoying themselves. And not least, we strive to inspire. Our time with people is brief, and it is perhaps less important that someone remembers the diameter of Jupiter than that he or she remembers Jupiter as a neat planet, and buys a book or enrolls in a class or comes to the next star party to learn more-or takes time to look for it on the next clear night" [4].

In setting these goals, planetariums operate in all three realms of learning: in the thought-processing of the cognitive realm; increasingly in the psychomotor area as we offer more interactive experiences involving physical action; and we also operate in the affective realm, the realm of feelings, as we encourage greater appreciation and enjoyment of the sky and try to cultivate a sense of the adventure of science. The importance of equipping planetariums in addition to traditional also a digital technology is a clear role today. It's, along with installing other interactive technologies, seat buttons which allow the audience the active participation to events in dome-theater.

The versatility of current combination planetarium is well documented several examples. The staff at the US Air Force Academy Planetarium uses its facility extensively for hands-on lessons of a special kind: Air Force cadet training in topics ranging from aeronautics to survival skills using a compass and the planetarium sky, Jack Dunn at the Mueller Planetarium in Lincoln, Nebraska, US has developed a program for people with visual impairments such as retinitis pigmentosa, using the intense light of lasers to create starfields and visual effects that give them back a night sky they thought was to them lost forever.

The scientific community in planetariums trying to regularly check their sources about the latest information from space to pass on to the public, help each other through organizations such as the International Planetarium Society and its affiliated planetarium associations worldwide. Our opportunities for active participation in this organization are slims without modern planetarium Bratislava.

4 Urban and Architectural Planetarium Solutions Conceivable in Bratislava

The issue of the location of the planetarium in Bratislava dealt teams of students and teachers of the Faculty of Architecture for several times. In 1996 conceivable connection with the planetarium observatory in Koliba – Stráže, who studied with students Pavel Nahálka. Unfortunately, the plot with ideal orientation to cardinal points, with excellent terrain morphology, as a beautiful view has become building plots for luxury villas and not intended for public facilities.

Another combination of features that would allow the positioning of the planetarium in place at the heart of the city was to create a science center. His ability to include other activities such as exhibitions, leisure and education, were investigated since 2005 especially near high schools and universities, and recreational areas. Eva Oravcová with students examined the localization of such buildings, for example on both sides of the Danube River, including the area of the former stone quarry. Suitable we can evaluate student projects according to the position within the city: Trnavské mýto, Šancová, Radlinského, Imricha Karvaša streets and Kollar square.

The teachers from the Institute of Civic Structures with your students in 2015 verified the possibility to build a planetarium with observatory or with research or science center in the area of the Comenius University and Slovak University of Technology in the Mlynská dolina (Fig. 3). This site was chosen along with the civic association Slovak planetariums. Its location is particularly suitable especially in terms of connection to the scientific and educational activities (near the faculties of two universities, Slovak Academy of Sciences, Botanical Garden, Zoo), transport accessibility (motorway exit, urban public transport, cycling and walking routes) and also the appropriate orientation and slope of the terrain.

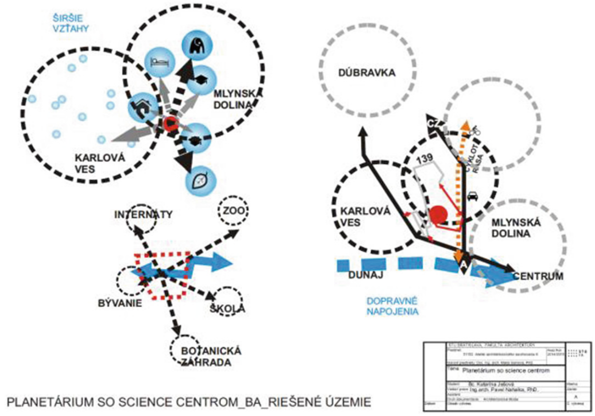

Fig. 3. Student analysis of planetarium site Mlynská Dolina, student Katarina Ješová, tutor Pavel Nahálka, 2015

In this area planetarium or science center could become an important landmark, especially because of its significant architectural form (Fig. 4). It could become a symbol of smart cities, a symbol of technological advancement and international scientific success Bratislava (Fig. 5).

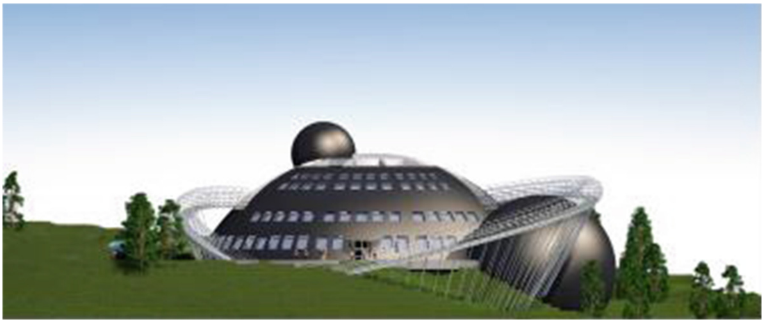

Fig. 4. Study of planetarium architectural form, Alzbeta Komorná student, Pavel Nahálka tutor, 2015

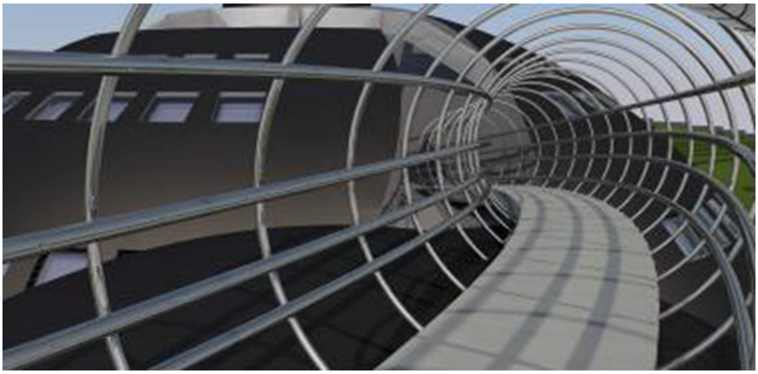

Fig. 5. Study of planetarium architectural form, Alzbeta Komorná student, Pavel Nahálka tutor, 2015

In architecture, the planetarium will dominate in particular the main areas of the building - dome planetarium hall with a diameter of 17 m with 150 seats for spectators with staggered pattern. Estimated hybrid planetarium technology (Optomechanical plus digital projection) should be from the current industry-leading manufacturers (Fig. 6), well known companies that make (or have made) planetarium projectors include Carl Zeiss Jena (Germany), Spitz (US), Goto and Minolta (Japan), Evans & Sutherland (US), and Ohira Tech (Japan).

Fig. 6. Hybrid planetarium technology in Planetarium Johana Palisy, Ostrava, CZ

Planetarium activity is planned for seven days a week in three working daily changes. Integrant of the professional staff work is also the preparation of planetarium operations in cinema, respectively lecture hall, experimentarium space for interactive exhibits, an observatory and observation terrace, scientific laboratory - a space for research training and group experiments, exhibition hall and other spaces.

5 Conclusion: The Necessity of the Involvement Bratislava in the World Network Planetariums

Slovakia is proceeding on the route to successful implementation into the global scientific space community. Slovak Organisation for Space Activities (SOSA) has been active in various types of space activities or space-related activities, including launching of stratospheric balloons, development of the first Slovak suborbital rocket ARDEA or development of spaceflight simulator. SOSA together with technical universities in Bratislava, Košice, and Žilina and handful of private companies are currently developing first Slovak satellite skCUBE, which is planned to be launched in 2016. In February 2015, "Slovakia has signed European Cooperating State (ECS) Agreement with the European Space Agency (ESA) and Slovak scientists already participated on some high-level space projects, e.g. Rosetta mission" [7].

We are lagging behind the popularization of space research and its spread among young people, in particular with regard to the need for international cooperation in technological advances. It is evident that to improve this situation in our nation's capital would help to build a really dignified stand of space science - Planetarium in Bratislava.

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