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ISSN 2729-7640

ALFA ARCHITECTURE PAPERS
OF THE FACULTY OF ARCHITECTURE AND DESIGN STU
www.alfa.stuba.sk

3/2022 (Vol. 27)
DOI: 10.2478/alfa-2022-0013

Editorial

Magdalena Celadyn

Architectural education requires constant updating of learning methods and the related professional knowledge as innovations are an intrinsic feature of this discipline. The transmission of this type of expertise into the learning process by way of published original research papers is a valuable procedure, offering architecture students an easily accessible source of substantial improvements in the acquisition of professional skills at this early level. Innovations in architecture, or an innovative approach to conventional and traditional problems in this discipline, seldom come about in a harmonized way, in terms of when they appear. Therefore, there is no way to create a coherent image of the relevant progress for the adepts of architecture. This necessitates they take a broad synthetic view, to effectively keep track of the increasing bulk of related knowledge enhancing their competences. The same refers to the readers of professional architecture periodicals.

The articles presented in this issue of ALFA journal discuss architectural design problems from both theoretical and practice-oriented perspectives. First, they consider the problems related to the architecture learning process, with emphasis on the improvement of the quality of higher education accomplished through the encouragement of the second-degree students' mobility, as well as through the promotion of an interdisciplinary approach to the architecture teaching framework. Secondly, they examine sustainable design strategies of providing occupants well-being along with a healthy indoor environment, created with environmentally friendly, natural renewable resources, and stimulating the users' cognitive and emotional as well as aesthetical experiences. Finally, they examine science-based and technology-driven questions associated with the forthcoming professional practise of architecture.

Dimitra Konstantinidou in the paper '*Architectural studies in the European Higher Education Area: Criteria for student degree mobility'* analyses criteria the undergraduate students of architecture apply when choosing among European higher education institutions to continue their studies. The study programmes offered, quality of the teaching process, renown of the chosen universities, and possibility for entering postgraduate study are considerations equally valued by potential students with the opportunity to establish and then continue their professional practice on site.

In her research for '*On the Edge - future adaptation challenges: The role of futurology, scenario planning methodology and off grid design in architectural and urban teaching'* Zdeňka Němcová Zedníčková investigates the possibilities of the enclosure within the teaching process of architecture and urban planning of the discipline of futurology, presented in the context of the UN 2030 Agenda for Sustainable Development as well as the UN Habitat III initiative. The author identifies the futurological method of scenario planning, and then examines the conditions of its presence in the adjusted architecture teaching framework. The article points at the off-grid design scheme as the most stimulating for the design of architectural and urban planning systems focusing on environmental sustainability issues.

In '*Linking virtual reality, architecture, and crime prevention for educational purposes*' Lucia Benkovičová refers to the digital technology-aided teaching process in the architecture discipline. The author investigates in particular virtual reality and augmented reality as learning and designing tools offered to architecture students. This research paper concentrates on the specific possibilities of these design tools as advanced instruments, enabling both architecture students and professionals to

make prior assessments of the quality of a built environment in terms of proper security measures for occupants and for crime prevention. Therefore, the article, in introducing the innovative objective of the VR as design tool, indirectly refers to issues of the positive perception of the building and its surroundings by its occupants, with place attachment effects.

Questions related to the shaping of a high-quality indoor environment through consequent introduction of natural resources are present in the article '*The positive impact of wooden material on educational processes in the environment of Slovenian wooden kindergartens'* by Jakub Hanták and Danica Končeková. The authors examine benefits from the vast implementation of wood as a building material in conceiving interior components of high formal and functional values, while providing users with psycho-physical comfort and multisensory experiences. The authors investigated the multidimensional impact of exposed wooden building material on children's cognitive, aesthetic, and emotional perception, in the context of stimulating educational processes in the complex learning and playing environment of selected kindergartens recently conceived in Slovenia.

'*In the pixel zone: Perception of digital design'* by Kateřina Tesařová is a continuation of the digital technology discussion. It concentrates on analysis of the term postdigital, which in the author's opinion is necessary to perception of digital design. The latter, covering the products and services forming the separate disciplines already an integral part of the present reality, gives users access to data resources through different digital interfaces. Considering the plenitude of constantly developing design disciplines of different character, the author postulates so as to create clear boundaries between graphic design and the theoretically and technically advanced version of digital design.

ISSN 2729-7640

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www.alfa.stuba.sk

3/2022 (Vol. 27)
DOI: 10.2478/alfa-2022-0014

Architectural studies in the European Higher Education Area: Criteria for student degree mobility

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Article information
Sent: Jun 6, 2022
Accepted: Aug 30, 2022

Abstract: The European Higher Education Area was implemented as a result of the Bologna Process and set the mobility of students and staff as its main goal, suggesting tools to facilitate it. The European Union has supported the suggested measures, as mobility can be a way to support a common European identity and a strategic way to improve the quality of higher education institutes. Architectural studies, due to their special character as both an art and a science discipline, are chosen as the education area most suited for mapping degree mobility and highlighting the characteristics that differentiate each school in terms of attraction to international students. How do architectural students select the school to continue their studies? On what criteria is that based? There were more than 351 schools of architecture in the European Higher Education Area with 49 participating countries at the time the research was conducted. Do international students choose them at the same degree? What makes a difference between them, causing some of them to become famous schools of excellence while others are barely visible in the international competition? To answer the above questions, a research based on two questionnaires was conducted during the academic year 2018-2019. The aim of both questionnaires was to map the state of the art in architectural studies and determine the criteria students value the most to make their choices at master studies. The process of combining the data collected from both questionnaires showed that the study programmes and the city or country of the school are the main reasons for master's students to choose a specific school and for schools to stand out. This is followed by the criteria: offered studies' quality, institution's reputation, teaching language, the host city's economy, giving students the possibility to work during and/or after studies, the offer of third cycle. The paper concludes suggesting changes schools could implement if they wish to get a better position in the competitive market of attracting international students.

Keywords: degree mobility, architectural studies, criteria, master's studies

INTRODUCTION

The European Higher Education Area (EHEA) (www.ehea.info) was implemented in 2010, after the signing of the Bologna Declaration in June 1999, with the cooperation of initially 29 ministries responsible for higher education in European countries – both members and non-members of the European Union. Nowadays members of the EHEA are 49 countries and the European Commission. There are also 8 consultative members (The European Student Union, UNESCO, The European University Association, and others) and some organizations which do not meet the members' criteria as partners. The target of the EHEA is to apply structural reforms and share tools and continuously adapt members' higher education systems, making them more compatible and strengthening their quality assurance mechanisms. The main goal is to increase staff and student mobility and to facilitate employability as stated on the EHEA's site. Mobility, as various research reports (European Union 2015, Erasmus Student Network, www.esn.org) showed, assists each participant in gaining experience and growing at a personal level, but most importantly, provides Higher Education Institutes with a tool to improve and take advantage of the experience that their staff and students gain while teaching or studying at other institutions. The distance from the home institution allows the recognition of its position in comparison with the host institution, making visible the strengths and weaknesses of each institution. Especially for architecture students, mobility broadens their thinking through the new cultural and academic environment of the host country. During their stay in the host country, language skills improve, which is positively attributed to the personal and professional development of the students. The benefits also include the creation of networks and collaborative relationships between students as well as the strengthening of their mature thinking and international orientation (Spiridonidis, 2002).

Some schools of architecture perceived the Bologna Process and the implementation of the EHEA as an opportunity to look ahead and ensure a better place in international competition, acquiring a contemporary European identity, useful and necessary for their status, while others encounter them with scepticism regarding the creation of a common system of studies (Spiridonidis, 2006). This scepticism opened a discourse, expressed through annual meetings of the European Network of Heads of Schools of Architecture (ENHSA), leading to feedback regarding the Bologna Process implementation in architectural studies. The changes suggested are the implementation of the

ECTS system, requiring at least 300 ECTS credits to access the architectural profession, a comparable and flexible set of skills achieved through programmes of integrated or two-cycle studies, and quality assurance of architectural programme studies. All of these can facilitate the mobility of students and boost the mobility of staff.

Regarding mobility for studies, UNESCO's data (UNESCO, 2022) show a great imbalance between incoming and outgoing students among the European countries, with some of these countries being neat exporters and others mostly student importers. In the last category, we see the United Kingdom, France, Germany, the Russian Federation, countries with well-organized higher education systems and great history in teaching, marketing of offered studies, and a high position in the HEI ranking systems. On the other side, small north European or former Soviet Union countries are mainly student exporters and struggle to compete at the internationalization level. Why are some schools so popular while others have fewer or no incoming students? On what basis do bachelor's degree holders choose the school for their master's studies? Which are the students' main criteria? Can the non-preferable institutions take some action to change the situation and attract international students and staff?

To map the mobility from the first to second cycle, we chose to research architectural studies. As the European Union considers architecture as one of the regulated professions and holding a 3-year bachelor's in architecture does not provide the holder with the right to work as a fully licensed architect, students tend to continue their study at master's or even doctoral level and combine that second or third study period with the experience of studying in another country. Architecture is a wide field of study, science, and art at the same time, and its students need a variety of stimuli and different experiences to broaden their horizons. Therefore, architecture students participate more than others in mobility programs, either during their first cycle, with exchange programmes such as Erasmus and Erasmus+, or during degree mobility, when the whole study period takes place in a different city or country than the one in which they got their former degree; the aforementioned data shows why architecture can be a good case study on degree mobility from bachelor (first cycle) to master (second cycle) degrees.

Various research (Altbach, 2001, 2007; Rachaniotis, 2013; Guerreiro, 2018) showed the criteria that may influence the choice of place and/or institution for second-cycle studies. These are: the quality of studies offered by a country or institution, the pre-colonial regime and the cultural or other relations between home and host countries, the need or lack of need for visa, the common language, the GDP of the host country, national security, economic growth, reputation of the HEI and its brand. Other students' selection criteria were the possibility of finding a job in the country of relocation after graduation, a fact related to the economic situation of the host country, as well as the possibility that a degree from a renowned university could enhance students' salary prospects and give access to more interesting jobs at the international labour market, and special and recognized prestige of the institution. These figures give a strong lead in developed countries, with English as the main spoken language (such as the United Kingdom) as well as those with former colonial relations (France, Spain). The paper unfolds as follows: presents research on architectural master students and architectural schools regarding mobility focusing on the criteria that push master students to specific schools.

METHODOLOGY

The research was completed in 2 questionnaires, collecting data during the academic year 2018-19. The first questionnaire was sent to 351 schools of architecture regarding the state of the art of the offered study programmes. We have collected 103 answers which is a quite representative random sample of almost all the EHEA countries. The questionnaire had 31 questions of various types: 6 questions were demographic or descriptive, 6 were answered by selecting population range, 12 allowed choices between 2 to 7 values, 6 regarded short growth and 2 were open questions. Fig. 1 shows the countries of schools participating in the research. The second questionnaire was addressed to master students from the 50 schools which responded to the first questionnaire and declared a number of incoming students. We have received 101 answers from master students in 12 countries. Our sample is random and statistically adequate, coming from an adequate random sample of schools, and had 15 closed questions with 2 to 7 choices, 11 questions were a short description, and one was a 5-degree Likert scale. The aim of the first questionnaire was to map the state of the art in architectural studies, showing the strong points each school has to offer. In the second questionnaire, master's students classified the reasons that influenced their choice of school, also giving data regarding their mobility.

At the beginning of both questionnaires, we asked for demographic data. For the schools, these were the institution's name and site, status, and the e-mail address of the person providing the answers. For students, we asked for information about sex, age, the city or country of secondary studies and first-degree school, to map their mobility. Important data regarding internationalization of schools came through the answer to how many graduates of the first cycle of other institutions continue their second cycle studies at the specific institution and how many of them were coming from other countries. These data showed about 20 schools with more than 30% of their second cycle students' population coming from other institutions, either from the same country or from abroad. The second questionnaire was addressed to architectural master students. As direct contact to master's students was impossible due to confidentiality issues, the questionnaire was sent to the 50 schools which reported incoming students to their master's study programmes in the first questionnaire, with a request to pass it on to their master's students. After the demographical questions, they noted the country in which they got their former degrees, such as high school and the first (bachelor) degree, to map the students' mobility patterns. The students' home country is shown on Fig. 2.

Students that participated in mobility programs, either short-lasting, such as in the Erasmus exchange program, or full degree, are more likely to participate in mobility programmes or stay in the host country after the end of their studies to work, as stated in former research (Wiers-Jensden, 2012). There was a specific question, "Will you stay in the country you study in case you get a job offer?" where almost 90% of the students answered "yes" or "maybe", showing that they are thinking positively about it. Through these answers, we verify the statements in articles regarding brain drain (Straubhaar, 2000; Breinbauer, 2007) and the wish of the graduates to stay and work in their student city, especially when the work opportunities in their home country are less favourable. Noting the mobility patterns, we found 58.41% of students who did not move from their home city at any stage of their studies, 20.79% who moved to another city within their country, and 20.79% who moved outside their home country for master's studies. That is close to the goal of 20% international mobility for students set by the European Union in the 2020 strategy (European Commission, 2010). As much as 11.88% came from countries outside the EHEA and Europe, showing that Europe approaches the goal to be a knowledge metropolis, attracting international students from all over the world.

Regarding the language of tuition, almost 40% of the students stated that the programme they attend is delivered in English and it is in the English-speaking programmes we find most of

the mobility students. The rest stated that the programmes are taught in the local language. Some countries offer local language lessons as part of their internationalization policies in support of the degree studies, allowing international students to participate in study programmes delivered in the local language. Trying to map the criteria students use to choose the school they continue their studies in, we asked the participants to grade on the Likert scale from 1 (not at all important) to 5 (extremely important) some criteria collected through literature review. Those criteria were (in random order): Country or city of studies, language of tuition, fees or cost of living, study programme, further education opportunities, good reputation of the Institution, labour market needs, friends or family in the city, counselling and disability support, job opportunities. The following table shows the answers received. For statistical reasons, 5 scales have been merged into 3.

Fig. 1. Countries participating in the research. (Source: Author created with mapchart.net)

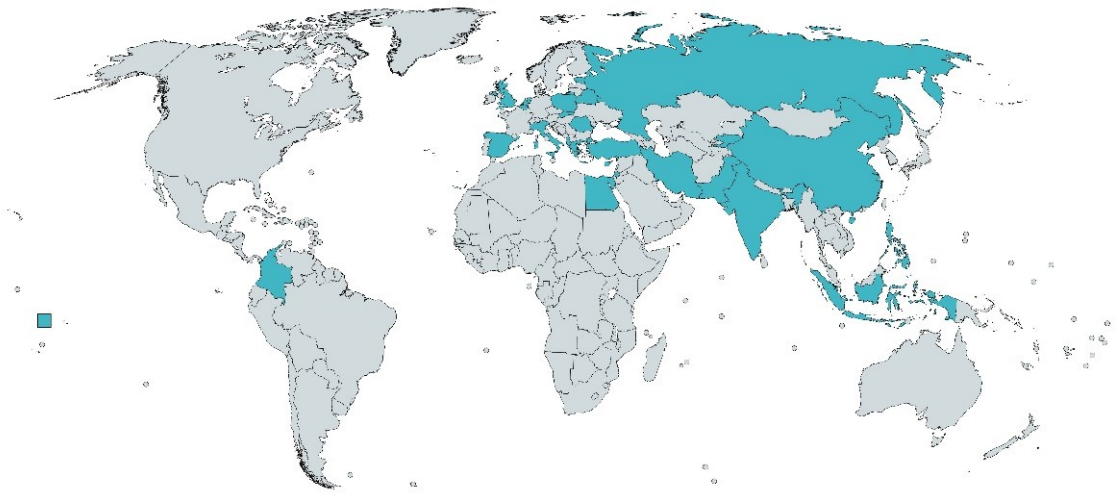

Fig. 2. Students' home country. (Source: Author created with mapchart.net)

Tab. 1. Students' answers to scaling criteria in %. (Source: Author)

	Not at all or not important	Important	Very or extremely important
Study programme	4	26.7	69.3
Country or city of studies	11	28	61
Institution's good reputation	14.9	24.8	60.4
Fees or cost of living	12.9	27.7	59.4
Job opportunities	15.8	24.8	59.4
Further education opportunities	16.9	29.7	53.4
Language of tuition	21.2	33.3	45.4
Labour Market needs	20.2	39.4	40.4
Family and friends in the city	47	30	23
Counselling and disability support	66.3	22.8	10.9

The first criterion is the study programme which was rated by 96.04% as "Important" or "Very or extremely important". In architecture, with so many parameters, the degree to which every school adopts each of the terms and the weight it gives to each strand gives the stigma of its curriculum based on the dipoles: artistic vs scientific, technological vs academic, specialization vs general education. As during the first cycle the basic knowledge of architecture is covered, at the master level deeper knowledge is acquired and schools provide specialization to respond to modern needs such as bioclimatic architecture, new materials, restoration, societal needs, etc. allowing students to build their individual curriculum according to personal inclination. Schools also point out their study programmes as their strong point in response to question 1 in the questionnaire, *"What do you think is your school's strong point in attracting students from other countries?"* They also stated the programmes focus on local culture (especially in countries or cities with great architectural history), interdisciplinary studies, diversity, studios, and workshops, the "Dortmunder Modell" that combines architecture and engineering, well-organized labs, and elements that characterize a study program, and are valued by students and teachers as well.

The country or city of studies and a good reputation of the school were chosen as "Very or extremely important" by 60.39% of the respondents. Some cities have the reputation of student cities as they have university campuses within the city and provide a special environment for their students. The high reputation of a school is also reflected in the degree it grants. Some grants are highly respected in the labour market, especially in architecture. Students know that and seek those 'famous' degrees, even if they must pay higher fees to retain them. Both criteria – the country or city and the school's reputation – were pointed out also by schools as their strong point in attracting foreign students. As much as 59.40% of the respondents rated fees and the cost of living as "Very or extremely important", without defining whether it is evaluated negatively for high costs or positively for the general economic situation in the country or city. Crosschecking with other parameters revelated that high fees are not a negative selection criterion, especially if combined with a great school reputation and curriculum. Students are willing to invest more money to gain a highly recognized master's degree that will lead them to a better career in the future.

Job opportunities, either during the study period or after graduation, are important to master students, as some of them prefer or have to work during their studies to cover their expenses. Some countries with good financial condition and developed economies attract students easily, as they may work during their study period or after they attain the degree and that is easier to find in developed countries in Central and Northern Europe. In addition, schools based in cities with developed economies cooperate with the industry, giving more training and job opportunities to their students and degree holders. The chance to continue their studies to the third cycle (doctoral studies) at the same school is also marked as important. Architecture, with so many themes to research, from new materials to restoration and new city plans and land use, is ideal for further research at the PhD level. Some schools offer well-organized and financially supported PhD research and that may add to the incoming mobility at second cycles.

The labour market needs may influence students to choose a specific school, as stated by 78.21% of the students. After the decade of financial worldwide crisis, architects take seriously the fields they can work in after graduating and choose schools that can provide the best study support and a degree that can open work opportunities in the future. Teaching in English is selected as "Important" or "Very or extremely important" by 77.23% of the students, ranked 7th among the criteria, but when crosschecked with the variable of participation in mobility, it was revealed that English as a teaching language is the 2nd most important criterion for mobile students. Mobile students consider instruction in an international language a plus for the school and tend to prefer it to the instruction in a language they do not speak. Schools also highly rank instruction in an international language as their strong point or as the point they need to change if they wish to attract international students.

The presence of family or friends is not highly rated. It receives only 52.47% as "Important" or "Very or extremely important". Master-level students are usually in their twenties and can live in a city with no family members to support (or control them). Students rated counselling and disability support the lowest. Architecture students may not be aware of the possibilities counselling can offer, to them it either refers to study choices or to support to find a workplace. To recapitulate, students choose schools that have exceptional study programmes, well-trained teaching staff with international experience, offer lessons in the English language, and are situated in regions and cities with high income. The possibility to work during the study period and continue to the third cycle is also a strong reason to choose a specific school.

DISCUSSION AND CONCLUSION

Combining the results of both questionnaires, to architectural schools and students, regarding the reasons students choose some schools over others, we see that both schools and students rank the curriculum or the study programme very high. A well-structured curriculum, with flexibility, originality, connection with the natural landscape, the city, and the country where the school is located, as well as new materials and state-of-the-art technologies and international design perspectives through participation in international competitions and related events, will allow students to create the study programme they wish to attend, according to their interests and create a unique architectural profile, boosting their career and support the school in attracting international students. Well-trained teachers, with international experience and great teaching methods, add to the school's value and attraction to students.

Regarding the city of the school, as mentioned both by schools

and students, most of the highly ranked schools are in capital cities, or cities with growing economies and influence within the country. That is a point that schools cannot control. Regarding financial growth, schools in cities with stronger economies tend to co-operate with developed and well-known businesses, giving their students the chance to work, even in short time practice and gain working experience, making it a strong point for their curriculum vitae. The chance to get to work with one of the famous teaching architects and pioneers of architecture is a strong point for choosing or not choosing a school. The school's reputation, as is known by graduates, works in favour of the already known schools. Students are affected by word of mouth of former satisfied students and successful graduate architects add points to the known schools. Less known schools mentioned as their weak points the need to work on their image and marketing, trying to make their school more visible and recognized worldwide. Research, publications, and media reports can help to this effect.

Pointing out the criteria students use to choose a higher institution for their second-level studies, and through it, the internationalization degree of the HEIs in the European Higher Education Area was the question of this research. The analysis showed that students prefer to continue to master-level studies at well-known schools, with exceptional curriculum or study programmes and famous architects as teachers. They wish to experience living in a developed economy country and city, where they can work during or after their studies and where they will have opportunities to continue their studies to the third cycle. Also, mobile students highly rate the programmes in English, as a criterion to choose a specific master's study programme abroad. Research has shown that some institutions attract a larger number of undergraduate and post-graduate students than others, as reflected in the number of applications submitted. The schools that are in capitals and/or urban centres stand out. If they have a study programme that stands out, they manage to gather large numbers of students from other institutions. English-language degrees and chances to work, during or after the study period, tend to attract international students.

Other, less favoured schools should keep in mind the criteria stated by the master students. A well-built curriculum, supported by international staff with pedagogical education, can attract more international students. Teaching in international languages, mainly English, can support the incoming degree mobility. The cooperation with businesses and industry, as well as other schools worldwide can make the school more visible across the country's borders. The internationalization policy, both at the country and the school level, can support the incoming mobility of students and staff in smaller schools. As the covid-19 pandemic changed the way with think in many aspects and accelerated the use of technology in education, new research on the same subject could deliver interesting results regarding physical degree mobility. Distance learning gains ground as compared to the typical forms of education. Even in architecture, with all the specialties already mentioned, master's studies can be offered that way.

Acknowledgements

I wish to thank all the teachers, administrative employees and employees or managers in international relations or mobility offices who took the time and effort to respond to the first questionnaire and the 101 master students who provided me with answers in the second questionnaire. I want to thank Constantin-Victor Spiridonidis, professor at Canadian University of Dubai (former professor at School of Architecture, Aristotle University of Thessaloniki, Greece) who supported me with constructive comments throughout my research.

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ISSN 2729-7640

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www.alfa.stuba.sk

3/2022 (Vol. 27)
DOI: 10.2478/alfa-2022-0015

On the Edge - future adaptation challenges: The role of futurology, scenario planning methodology and off grid design in architectural and urban teaching

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Article information
Sent: Jul 11, 2022
Accepted: Aug 30, 2022

Abstract: The article describes the role of thinking about the future and its importance in architectural and urban education. The first part deals with the scientific discipline of futurology and the possibilities of its use in architectural and urban practice. It covers topics that futurology makes available to architecture and their influence on the urbanized environment. It relates the creation of strategic visions for urban development with the UN 2030 Agenda for Sustainable Development and the UN Habitat III initiative. The second part is dedicated to introducing the futurological method of scenario planning, and its origin and use. It mentions so-called megatrends as the driving forces of future scenarios, effecting future challenges and threats that cities will have to deal with. Further, it provides insight into how this method can benefit architectural and urban work and represents the way it was used during architectural teaching. It reflects on the advantages of creating visions in the educational process. In the last part, it shows the off-grid design as a suitable simulator of structural and system thinking, leading to a better understanding of how complex architectural and urban systems function. It highlights the contribution of space architecture projects as a source of innovative thinking. It anticipates that working on space projects where self-sufficiency is a necessity can also benefit thinking about ecology, self-sufficiency, and the sustainability of settlements on Earth.

Keywords: adaptability, futurology, scenario planning, off grid, space architecture, moon base, architectural education

FUTUROLOGY

'Man has lost the capacity to foresee and forestall. He will end by destroying the Earth.'

Albert Schweitzer

All architects, in their work or design activities, from their very nature, think about the future and must include into their reflections or creative thoughts future events, and discover future problems and conflicts of all kinds, simply because the project when designed is not built and used at the same time, indeed often the process take years. Therefore, it could be said that futurology (the scientific discipline dealing with the direction of future development; such terms as prognostics and forecasting are also used for this discipline, which started to develop after World War II, fully developing its methodological foundations in the 1960s) is to some extent present in architecture as a permanent element, as architects, when designing projects, must confront their own ideas with future events in order to choose the best solution. They are setting the stage for future life, and the result can mean either easy or difficult work for builders, functional or problematic space for users, and a good or unpleasant environment for its inhabitants. So far this is happening mostly on an intuitive level based on accustomed solutions, which may no longer be suitable in the contemporary world's rapidly changing conditions.

What will our world, and our cities, look like in 15, 20, or 50 years? The built environment of cities is currently home to half of the world's population, which is likely to reach eight billion by the end of this year (2022). According to the UN (United Nations, 2018; Linden, 2013), the world's urban population is growing at a rate of 180,000 people per day, and by 2050 three-quarters of humanity will live in cities globally. In North America and Europe, 70-80% of the population already lives in cities; it is assumed that these regions are already stabilized, and a rapid increase of the population is not expected, but whether this will actually be the case depends on many circumstances. Developing countries, especially sub-Saharan Africa, are currently the most affected by urbanization. It is reported that the cities in these regions are now up to 40 times larger in area than they were in 1950. In Africa, 36% of the population now lives in cities, but 70% of them live in slums, and in some regions, this is even 90%. Altogether, in Africa, Asia, and Latin America, one

billion people live in slums. An estimated 3 billion people will require adequate and affordable housing by 2030. Cities are now home to 50% of the world's population. While they occupy only about 2% of the land surface overall, they are responsible for 60-80% of the world's energy consumption, 75% of resource consumption, 70-80% of the world's greenhouse gas emissions, and 70% of global waste. (United Nations, 2015, 2022)

Is it the easy availability of various services, resources, and the high concentration of products that puts urban dwellers at the top of the consumer chain, or a certain degree of self-sufficiency of the rural population that remains outside the statistics? And what will consumption, supply systems, and pollution look like when another 25% of the world's population moves to cities? Are cities as systems capable of absorbing such an increase? How will this affect the quality of life in cities? Climate change (IPCC, 2022) influences on our cities cannot be overlooked. Our cities suffer not only from extreme weather events as storms and floods, but especially from rising temperatures – the effect of Urban Heat Islands (UHIs) is more visible every year, due to lacking urban greenery. (Search for NBS nature-based solutions is currently on the rise.)

Acceleration of the global urbanization process, together with the growth of the world's population, climate change, environmental pollution, and new technologies, brings many challenges for cities to face. The Stress Nexus – energy/water/food supply – forms the very base for the functioning of our cities. Interrupting the supply of these elements is fatal. The dependence of cities or human settlement functionality on that entire system is critical. What is not often mentioned to cities' general inhabitants in connection with urbanization is the dependence of urban residents on the flawless functioning of a complex system of transport for energy, water, food, and waste and transport of people; everything must flow faultlessly from source to user. From time to time, a critical outage of some part of the system will reveal its vulnerability, though if it is repaired in time urban residents will not long remember it. But events that interrupt the faultless functioning of the system are becoming more frequent lately, caused either by already expected extreme weather events or by the previously unexpected pandemic.

For a person who has lived his whole life in the peace and in the comfort of a functioning urban system on planet Earth, it is difficult to perceive all the subsets of the system on which his own survival depends. Self-sufficiency seems a long-forgotten skill of past, related to a poor and simple lifestyle. But in light of unexpected events unfolding in our daily reality, it makes sense to be prepared for periods when the system will stop providing all necessary supplies. So it seems that the challenge for cities of the future could be to achieve the highest possible self-sufficiency in the energy/water/food system as well as in waste management (for an inspiration of good planning practice we can look to Singapore, the city incorporating the futurological method of scenario planning by Royal Dutch Shell into their urban planning process back in 1992). Architects and urban planners seem suitable candidates as experts capable of such a challenge, and architectural education should be the way to educate such professionals.

Designing self-sufficient, autonomous off grid systems or transforming the existing urban environment into a self-sufficient environment is a great challenge for architects and urban planners, but few have yet accepted it. So far, the percentage of architects who have embraced the challenge of 'sustainability' is quite small. Yet this is the mantra of our time, despite the fact that since the days of Agenda 21 (a non-binding United Nations action plan with regard to sustainable development, and a product of the Earth Summit, a UN Conference on Environment and Development, held in Rio de Janeiro, Brazil, in 1992 [UNCED, 1992]) the sustainability has become frequently used term in relation to architecture. Perhaps one reason for limited engagement could be the need to define better what exactly is to be 'sustained' and what needs to be abandoned under sustainability, because the current system of excessive consumption of non-renewable resources in which the civilized urban population finds itself is clearly not sustainable.

How should architects prepare for their profession, so their future work solves problems, rather than creating them? Do architects have to catch up to trends, or can they in fact set them? It is the role of architectural education to prepare future architects and urban planners for the challenges the future brings to cities. One proof of a university's quality is how well its graduates are prepared for the future. Architecture and urban planning, as well as other advanced disciplines, should also use forecasting or futurology to ensure their own safe development. Universities should first seek the best solutions for future events and facilitate their graduates' designing with responsibility toward future generations. From this perspective, it seems it could be beneficial for architects and urban planners to become familiar with forecasting methods or adopt some futurological methodology into their own design process.

In current architectural construction practice, it is not enough to be in touch with future needs just to respect the legislation, as this lags far behind real problems and changes. The biggest construction companies or major architectural offices can afford to pay consulting firms (like Arup.com [Arup, 2022]), and those active architects, who have time to study recent university research and publications or UN agendas, may have some insight. However, in general, production, architecture, and urban planning currently lack any friendly neighbour futurological guide and most often do not even realize the need for it. Universities and faculties of architecture should educate not only their students and graduates in this regard, but also practicing architects in their region. For there is a lack of a widely known or used platform that would provide easy orientation and guidance to an ordinary practicing architect as to developments, current events, and future directions, and help reveal the consequences of these developments on the lives of urban architecture users or city residents and provide a framework for critical evaluation of consequences and impacts. (Even the UN SDGs / 2030 Agenda for Sustainable Development – specifically Sustainable Development Goal 11, 'Make cities and human settlements inclusive, safe, resilient and sustainable' – provide little really practical and useful information for practicing architects. [United Nations, 2020] And in contrast the number of guide publications produced by UN Habitat III/The New Urban Agenda initiative is too large for easy access for practical information [Habitat III, 2016].)

The potential of cities to steer the direction of future development is not only through their economic power but also by example of innovative legislation, as we can see for instance in the activities of C40 Cities (A global network of mayors taking urgent action to confront the climate crisis; [C40, 2005]). And it is desirable for architects and urban planners to become active partners of politicians and economists in this respect, so strategic visions for transforming urban legislation are not just technocratic, but also take into account a wide range of factors that contribute to human life quality. Furthermore, it is at universities, especially faculties of architecture and urbanism, where such proactive attitudes should be formed, encouraged, and taught. Universities provide suitable facilities for the creation of multidisciplinary teams and interdisciplinary communication. So far, in some parts of the world, they continue to provide environments for freedom of expression and critical discussion,

and last but not least independence from lobbying pressures, to ensure objective professional quality.

SCENARIO PLANNING

'There is no guarantee that what works today will work tomorrow.'

Shell Scenario Team

Although there is no friendly neighbour futurological guide available to the architect or urban planner, every architect or urban planner can try to incorporate into their practice the futurological method of scenario planning (a method developed and first presented by Pierre Wack from Royal Dutch Shell in 1972, recently used mostly by economists and in strategic planning – see for example Shell scenarios [Shell, 2020] or scenarios by the Slovak Academy of Science's Institute for Forecasting [Filčák, 2017, 2020]) and to formulate future development ideas. Scenario planning is the practice of creating varying stories of possible future events based on a carefully selected list of driving forces, current tendencies (for example global megatrends – see below), and uncertainties in a set time frame. A scenario has to be rooted in the past as well as the present in order to extrapolate possible future events. Whereas current tendencies extrapolation and the worst possible scenarios reveal the challenges, threats, and opportunities, the optimistic vision scenario proposes how to solve them and creates a solid base for creating a design concept.

This method has the potential to clarify many controversial development issues by weaving a logical chain of causes and effects, putting data into context, and revealing the consequences of individual decisions. It works with variants of system development over time and can help optimize a design to respond to the various challenges the future will bring to cities. The scenarios can be adaptive or transformative depending on the purpose, and can warn us away from crises, bring out innovation possibilities, or just provide us with a 'to do list' and mark out steppingstones to the future we want. We know from experience that visions of the future can be achieved because they inspire and focus attention in a certain direction, even if the formal outlook can change according to a current style or fashion.

Futurological or forecasting studies reveal many important topics that might dominate in the future and influence how our reality is shaped. (For initial orientation in the topic see the activities of The Millennium Project, especially 'State of the Future reports' and 'The 15 Global Challenges' [Millennium Project, 2017; TVCHOSUN – TV, 2016, 2019], or works by the Slovak Institute for Forecasting [Lubyová, 2016; SAS, 2022]). Urban development will be further affected by more than just rural population migration into big cities or climate change; we must also take into account the impact of new technologies (see below). It is said that we are already at the breaking point of the exponential curve (processing speed curve over time) for increasing implementation of new technologies into practice. In their lectures, experts from various fields are coming up with assumptions that the degree of the human adaptability factor both in the labour process and in the adaptability of legislation will be insufficient due to the expected acceleration of innovations.

Let us imagine for example how self-driving cars, smart cities, the Internet of Things, and 5G networks as driving forces will transform the infrastructure, labour processes, and habits of residents in transport, shopping, and entertainment. Put this together with the growing trends of robotics and automation of work, artificial intelligence, and quantum computer advancements. Could this, for example, lead to such an unemployment rate that the subsequent social inequality would change the face even of Europe's seemingly stabilized cities? Will the concept of basic income be a suitable solution for this problem? What kinds of activities will then replace work no longer being done? (Bregman, 2018) And what about possible biological inequalities that could be caused by unequal access to new discoveries in prolonging healthy life expectancy or to genetic improvements. (Sinclair, 2019) Bearing in mind that the population's social, societal, and cultural status has influenced and continues to influence the face of the cities throughout the history, architects could help seek new solutions for these upcoming challenges. Even if it is not certain which influence will ultimately manifest the most, it is possible to prevent the worst scenarios through early response if we are ready and recognise the first signs.

Of course, there is a risk of incorrect judgment. Whether this be data in relation to climate change or to the increasing speed of new technologies implementation, not just the general population but also experts from unrelated fields who find it difficult to correctly evaluate their impact and consequences on our lives and the environment. Architects or urban planners must take into account a huge quantity of information inputs in their practice, and correct input data is crucial for proper understanding of the default state of the system with which they work. Trying to optimize the system without accurate input data is impossible and necessarily leads to erroneous conclusions. The ability to collect essential or key data for input analyses, and evaluate their importance and interrelationships, leading to obtaining decisive principles and information as a basis for creating a given project's concept, is then clearly reflected in the quality of the resulting work. So in order to achieve proper results, possible future events, challenges, and threats and opportunities revealed by scenarios should also be taken into account and integrated into the system.

'The future belongs to those who believe in the beauty of their dreams.'

Eleanor Roosevelt

ON THE EDGE

The author uses the development of visions and scenarios of possible future human settlements development not only in her own work, but also in her teaching in the architectural studio 'ON THE EDGE' at the Department of Urban Planning, Faculty of Arts and Architecture of the Technical University in Liberec, Czech Republic. In addition to standard current urban assignments, which themselves have an irreplaceable role in teaching, the 'ON THE EDGE' studio also offers a stable space for utopian, visionary, and futurological themes, for topics on the margins, for borderline themes, and for topics balancing on the edge that do not ride the wave of the mainstream architectural current but can still influence or enrich this work. The studio aims to provide the opportunity to freely develop one's own creativity, imagination, and innovative thinking rather than to train the acquisition of proven practices and approaches. This implies the possibility to question, examine, and check the validity of generally accepted opinions and fashionable or established attitudes in order to find and formulate one's distinctive view and ability to defend it.

This approach seems to be long valid in architectural education, as for example as Otto Wagner mentioned in his 'Inaugural address to the Academy of Fine Arts' – *'To third-year students I recommend solving a problem that you will probably never face in*

life, but whose design will help to fan the divine spark of imagination, the bright flame that should glow within you. At the Ecole des Beaux-Arts in Paris students annually try their hand at such exotic problems as a kind of training of the imagination for the budding art student. I can tell you from my own experience that I have on several occasions concerned myself with this type of problem and that the result has always been very useful.' (Wagner, 1894)

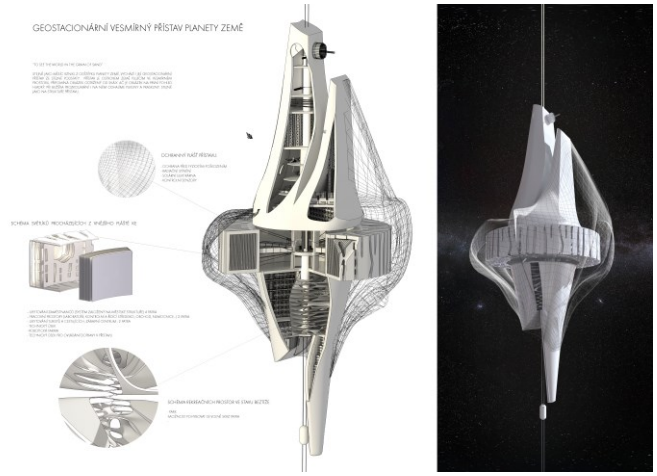


Fig. 1. Student work from Architectural studio 'ON THE EDGE'/Geostationary Space Port of Planet Earth (Author: Jana Šmejkalová, 2016; Source: Němcová Zedníčková)

Why undertake exploration expeditions to unexplored territories as part of the teaching process? Such assignments, freed from the binding stereotypes of everyday reality that incline to routine approaches, are an ideal simulator of conceptual, systemic, and structural thinking as a basic prerequisite for architectural and urban design, discouraging the automatic adoption of safe, proven procedures and attitudes, and thus encouraging the practice of independent critical thinking, helping form one's own attitude and distinctive view of architectural creation, and providing space for one's own 'architectural manifesto'. Further, working on an unrealistic project forces thinking outside the established framework, 'out of the box', and thus makes it possible to find new and unexpected solutions and approaches. This develops innovative thinking and imagination, which in turn can enrich one's own real architectural creation. Last but not least, the need to communicate new solutions and views of the world to others and to defend one's positions in the discussion tests communication and presentation abilities, skills an architect and urban planner cannot do without, as well as the ability to predict future development and the effects of time.

Visionary projects also provide the opportunity to become familiar with the Futurology and give a space to incorporate the futurological method of Scenario Planning into architectural planning process (Lüley, 2019). Scenario Planning is particularly beneficial in the analytical process, where it helps hierarchically structure input data and subsequently it is useful in the process of creation of the concept. At first it can help finding and detecting the problem, then it can be useful in search for the suitable solution. Knowledge of methods of anticipating future development possibilities and readiness to come up with solutions to problematic factors in time will enable a higher degree of adaptability. The ability to adapt and to think innovatively may then become, to some extent, a measure of survival. (Alvin Toffler developed thoughts about adaptability in his book Future shock back in the 1960s (Toffler, 1970) and more recently we encounter these ideas in the Yuval Noah Harari book 21 Lessons for the 21st Century (Harari, 2018).

With the future challenges mentioned above, strategic urban planning will need greater edification and truly practical approaches, with an understanding for how the urban metabolism functions (as where Abel Wolman developed and used this term in his work, The Metabolism of Cities [Wolman, 1965], and later other researchers have more clearly defined, as in The Changing Metabolism of Cities [Kennedy, 2007, 2011]), to be able to provide solutions for adaptation to approaching changes. Future visions, utopian projects of ideal cities and floating cities, and the settlement of the solar system, provide an opportunity for architects and urban planners to try to form their own versions of functioning systems, without the limits dictated by existing contexts or settlements. Such thought constructs of an ideal metabolism are not purposeless, because they teach sensitivities to perceiving patterns of system behaviour, which in turn fosters the ability to understand these patterns in the real world and understand the hierarchy of their functioning or reveal reasons for dysfunction.

OFF GRID

'If our long-term survival is at stake, we have a basic responsibility to our species to venture to other worlds.'

Carl Sagan

In particular, thinking about developing human settlements outside our home planet Earth is an excellent simulator and stimulator for systemic and structural thinking and critical thinking in general. Maintaining and developing life in the long term outside the protective arms of the Earth's atmosphere is a complex problem. Here architects – alongside classic subjects that they commonly deal with in their architectural projects such as the concept of spatial organization, its functions, character, morphology, materials, and construction – must consider topics that usually do not need to be addressed when building on Earth. Just to cite a few examples: construction in zero or low gravity; availability and transport of building materials; protection from radiation, extreme temperatures, vacuums, and micrometeorites; the influence of weightlessness on the human body and orientation in space; 'artificial' gravity; the influence of enclosed spaces and the proximity of a vacuum on the human psyche, and so on. These topics open up many unknowns, and filling gaps in the global knowledge is not a fruitless dream but rather an important initiator of the emergence of new technologies, processes, materials, and knowledge that enrich our daily lives. For architects or urban planners too, it can become a source of innovative attitudes and approaches that will positively influence how they perform in their own profession. It can also stimulate awareness of our industry's need for greater environmental friendliness.

The leading Japanese construction, architecture, and engineering companies Shimizu Corporation and Obayashi Corporation have incorporated this kind of thinking into their company profile. In 2014, Obayashi Corporation (Obayashi, 2014) presented The Space Elevator Construction Concept on their website. And Shimizu Corporation is taking on the challenge of innovative technologies, presenting on their web site proposals from a 'Shimizu Dream' division (Shimizu, 2022) focused on the future, with examples including OCEAN SPIRAL - Deep Sea Future City Concept, Mega-City Pyramid in Tokyo Bay, LUNA RING - Solar Power Generator on the Moon, Lunar Base and Space Hotel. Many other governmental and private initiatives are seriously considering building human settlements on the Moon. Moon base designs by ESA, NASA, and Bigelow Aerospace and Moon Village are just a few examples. In 2013 the renowned architects Foster + Partners joined with ESA to test the feasibility of 3D printing using lunar soil. This approach directly influ-

enced advancements in 3D printing use in architecture construction.

Fig. 2. Student work from Architectural studio 'ON THE EDGE'/HIVE 01 - Mining Station in Asteroid Belt (Author: Lukáš Dlabola, 2016; Source: Němcová Zedníčková)

Besides emergence of new technologies, these visionary approaches could also allow the Earth to be perceived as Spaceship Earth, as American architect and visionary Richard Buckminster Fuller popularized the term in his 1969 book Operating Manual for Spaceship Earth, and will lead to the revelation that our life support system is not unbreakable: *'This all brings us to a realization of the enormous educational task which must be successfully accomplished right now in a hurry in order to convert man's spin-dive toward oblivion into an intellectually mastered power pull out into safe and level flight of physical and metaphysical success, whereafter he may turn his Spaceship Earth's occupancy into a universe exploring advantage. If it comprehends and reacts effectively, humanity will open an entirely new chapter of the experiences and the thoughts and drives thereby stimulated.'* (Fuller, 1969) The Earth, our 'Hotel Mum' provides us with comfort that other planets of our solar system and open space cannot. There, creating a life support system will be entirely in our hands, and it will be necessary to control all its components, and their functioning and interactions. Reckless behaviour driven by short-term profit could be just as fatal as here on Earth.

When designing closed off grid systems on islands outside of the Earth's embrace, topics to incorporate into the design concept include much more than just energy production, sourcing materials for construction, water management, production and control of oxygen and nitrogen levels, air filtration and CO_2 extraction, food production and balanced varied diets, waste recycling, waste heat recovery, backup and repair ability of life support systems, sourcing and technology of producing spare parts and new daily use objects, replacement of fossil sources of raw materials, and selection of animal and plant species for coexistence. It also must address social status and social hierarchy, medical care and production of medicines, leisure and entertainment, relaxation, sport and necessary physical activity, reproduction, education, education and specialization, science, research and development, culture, politics, management, competence, communication, security, biological evolution, and more.

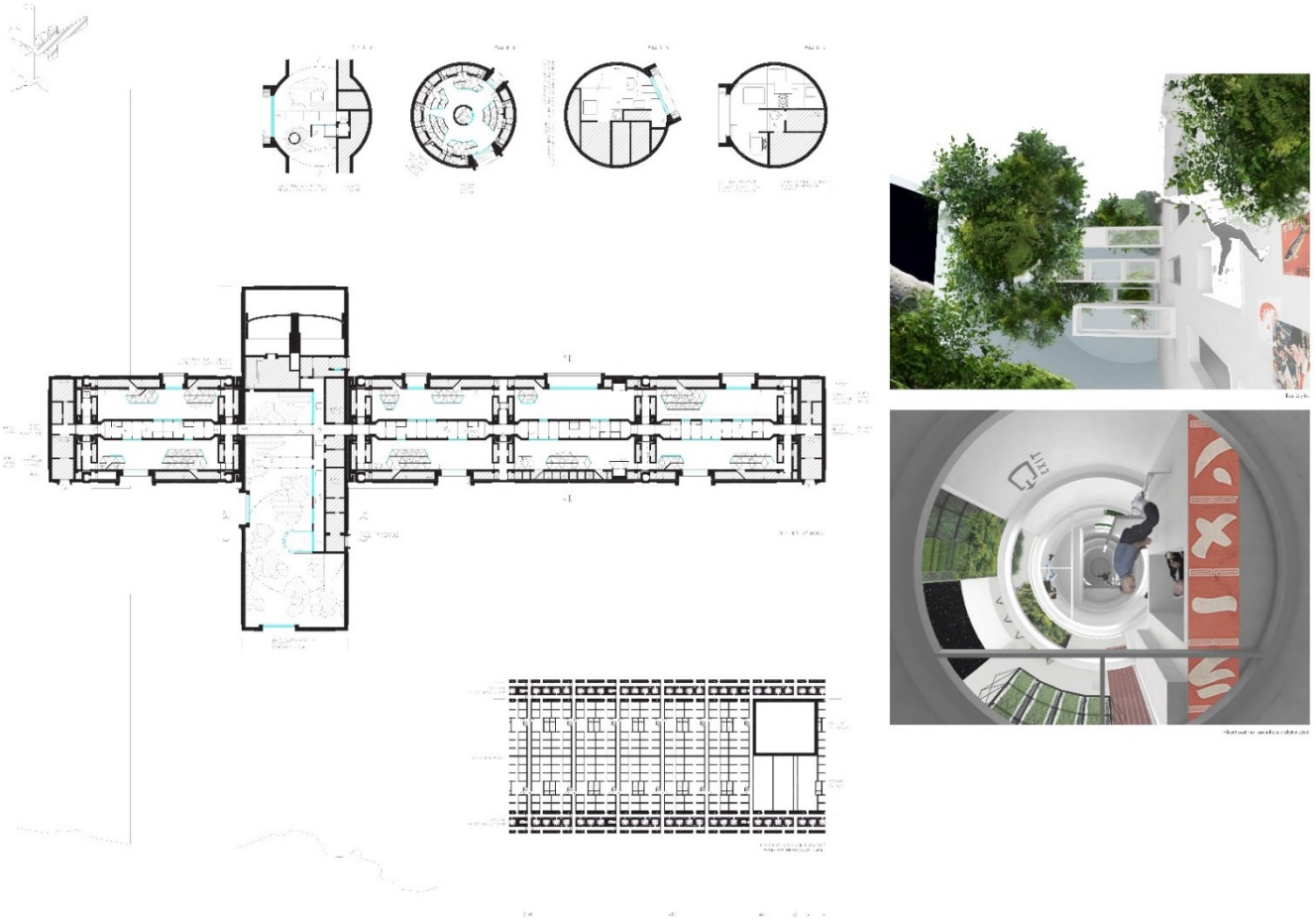


Fig. 3. Student work from Architectural studio 'ON THE EDGE' /MIKADO_04 - Mining Station in Asteroid Belt (Author: Samuel Nekola, 2016; Source: Němcová Zedníčková)

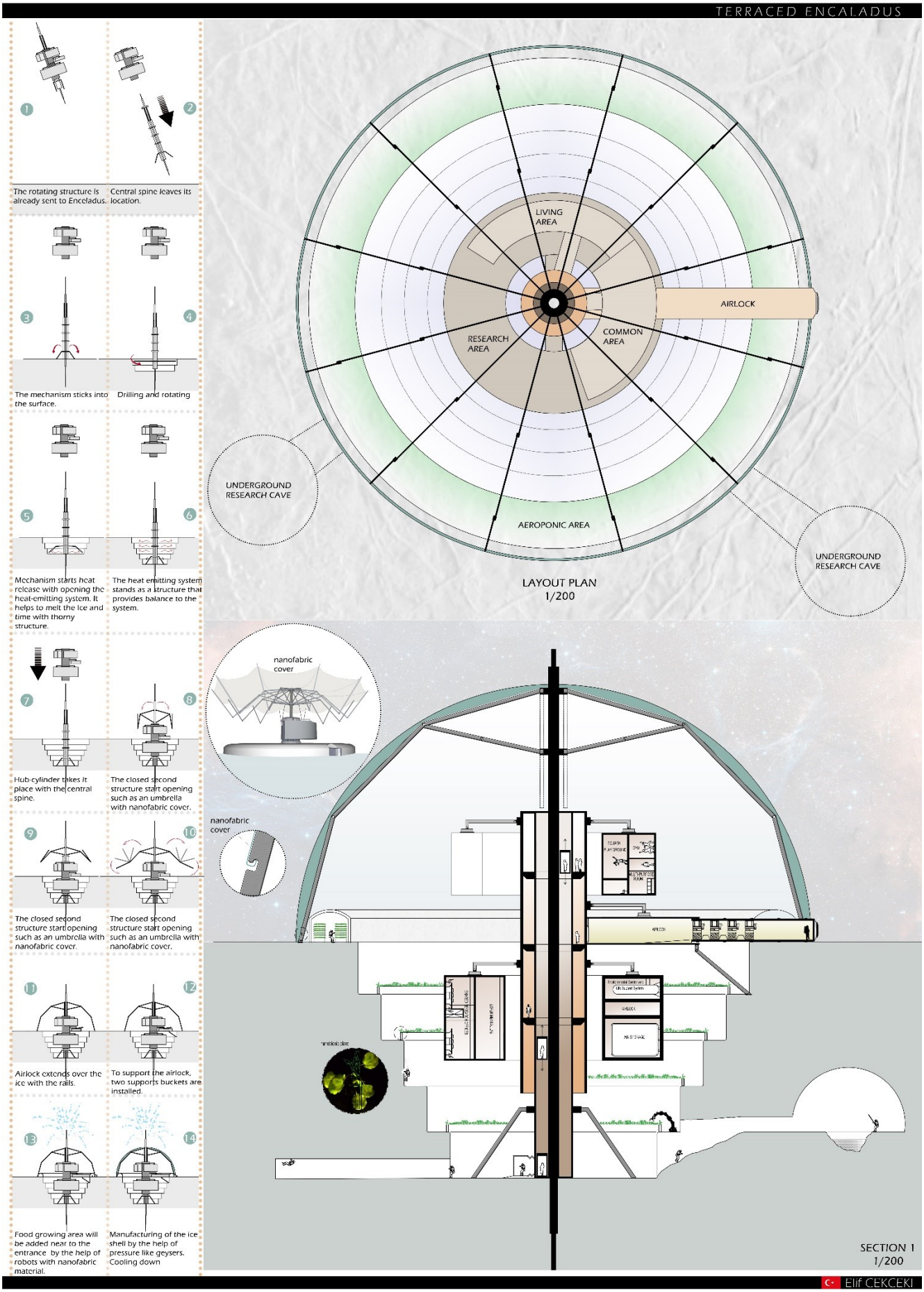


Fig. 4. Student work from Architectural studio 'ON THE EDGE'/Terraced Enceladus (Author: Elif Cekceki, 2018; Source: Němcová Zedníčková)

These and other themes or driving forces are puzzle pieces that, in various ratios, offer many different scenarios that humanity may embark on in the future. Resources and technologies are crucial to the human organism's survival in space, but quality of life, environment, and culture will define who a person becomes in this extreme environment. The extensive analyses required to process these topics reveals a wide range of information which an architect rarely encounters in common practice. They are serious enough to lead those who have gone through such a design process to be more sensitive to the environment in which we live, design, and build, and to respect for the environment in general. The intention is for the work on space architecture off grid projects to enrich not only the creation of visions of terrestrial ideal cities, but also real assignments. 'ON THE EDGE' studio work is focused on efforts to apply space innovations to terrestrial settlements, in the interest of their ecology or environmental friendliness, self-sufficiency, energy efficiency, social balance, etc.

Given the theme of settlement self-sufficiency, the benefit is the transfer of knowledge from space projects, where long-term self-sufficiency, sustainability, and total recycling are the foremost topic. This need not be just expensive high-tech sophisticated solutions that can be used by modern cities. On the contrary, simple DIY low-tech solutions accessible to all social classes can have a huge impact on, for example, improving the life quality of the one billion people who live in slum-like conditions. However, it also works in the opposite direction: designing the principles of self-sufficient communities in terrestrial conditions, independent of the external supply system, is in its way useful for space projects. The simplicity of the system limits the number of possibilities for critical failure. Visionary projects can be also beneficial on a purely theoretical level. With their visions, individual generations essentially create a list of attributes that the time and culture consider important for quality of life. In retrospect, we can separate the excesses of a time from the deeper qualities that pass through time and cultures. Today, it is clear that current visions must be not only ecological, and environmentally friendly, but should also actively contribute to repairing the damage that humanity has managed to do to the planet in pursuit of increasing profits. The above-mentioned considerations and assumptions led to the author's work on the creation of two moon bases.

'If we do not know to which port we are sailing, no wind will be favourable to us.'

Seneca

MOONFLOWER BASE // 2090

Experimental agricultural base with the hotel for scientific tourism (2015 - 2016)

2090: a time when Earth and Lunar space elevators have already been built; with a space station accommodating factory complexes in Earth orbit serving as a spaceport; with mining expeditions to asteroids; and the like. At this point Moon colonization will have entered the stage when it is possible to go beyond the simple and confined modules of the pioneering research, service, and mining bases. The reason is that these modules were not able to comply to long-term residence because of their minimized space, both in terms of the human psyche and as they provided only limited physical space, which could not sufficiently serve the increasing number of activities needed to ensure the Moon's independent sustainable development. The base was built for the purpose of developing self-contained life support systems. Its main activity is testing and innovating various ways to produce food within isolated systems, an artificial atmosphere, and low gravity to confirm the feasibility of ensuring a healthy and balanced diet in closed systems of perfect recycling, for multigenerational colonizing flights to distant solar systems. MOONFLOWER Base was for psychological reasons designed with special intention to the internal 'landscape'. This microcosm and its architectural elements provide symbolic pieces of terrestrial scenery. They represent such archetypes as a small village around a tribal tree, a valley surrounded by terraced mountain fields, a meadow encircled by a river, and a cave.

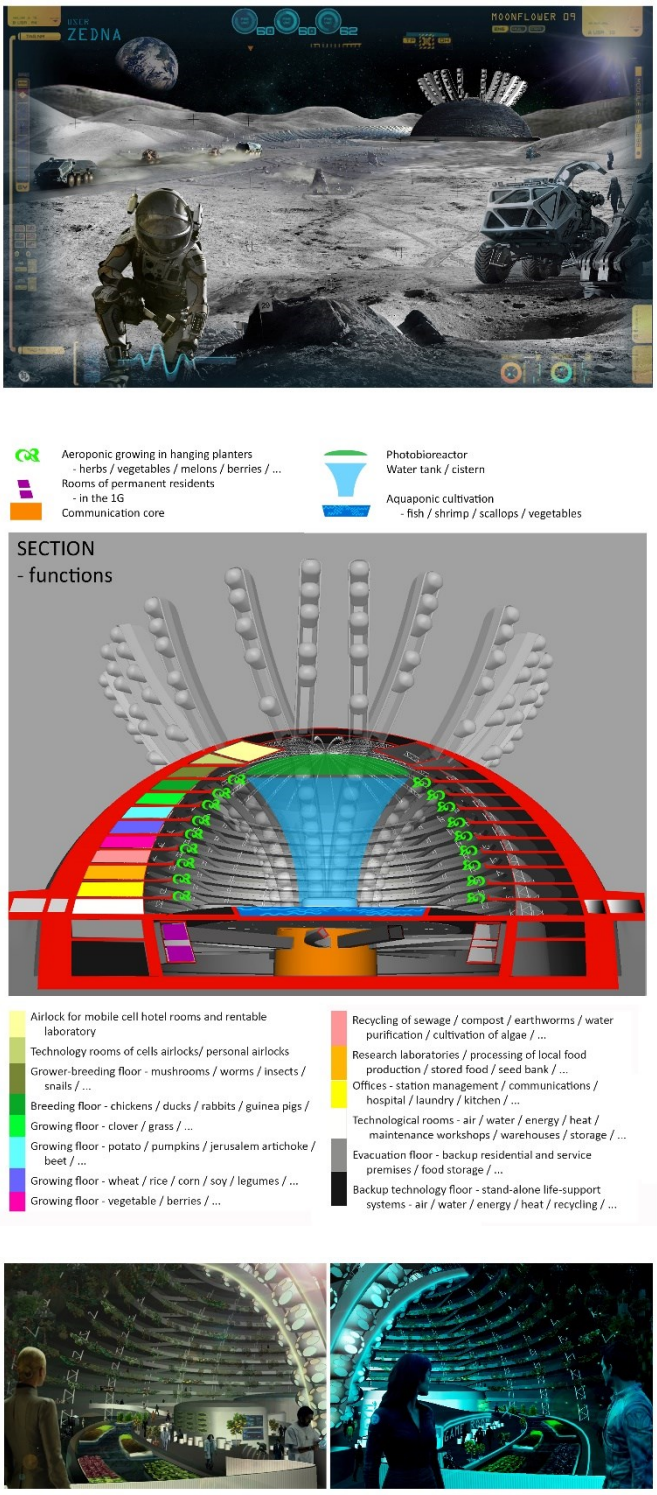


Fig. 5-7. Experimental Agricultural Base with Hotel for Scientific Tourism /MOONFLOWER BASE/2090 (Author: Zdeňka Němcová Zedníčková, 2016)

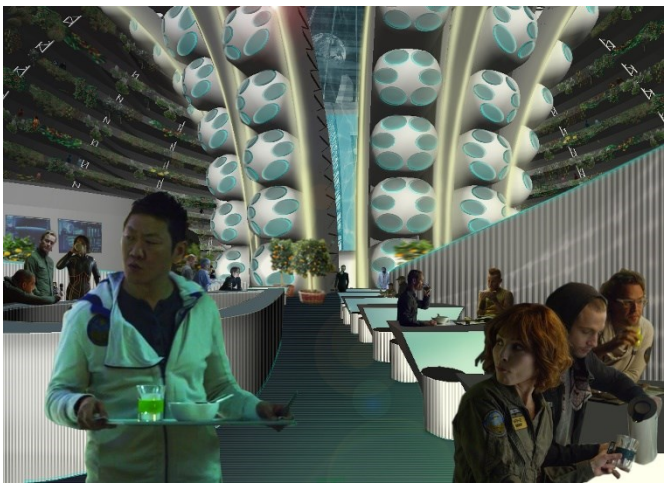


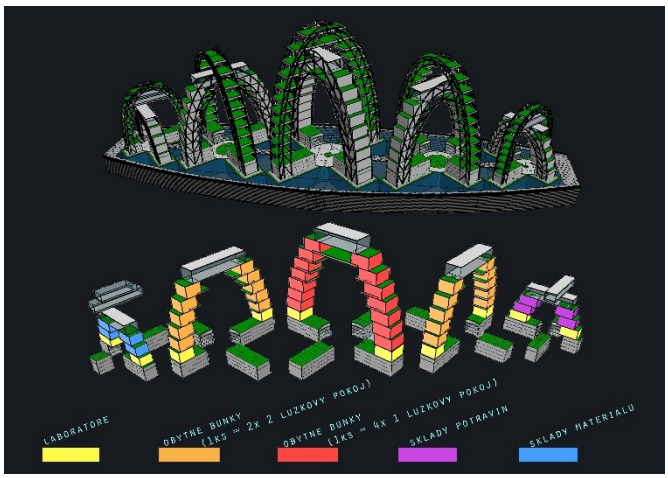
Fig. 8. Experimental Agricultural Base with Hotel for Scientific Tourism /MOONFLOWER BASE/2090 (Author: Zdeňka Němcová Zedníčková, 2016)

MOONWORM – NOMADIC MOON BASE

Self-sufficient exploratory scientific kinetic base traveling in Mare Imbrium (2017 - 2019)

Travelers who traversed the Earth's deserts headed from oasis to oasis, in order to replenish life-giving fluids and gain strength for journeying further. MOONWORM Base is an oasis in the wasteland of the lunar sea, but it travels together with travellers. MOONWORM is an exploratory science station that uses for its movement only the temperature difference during the moon's day and moon night, which makes it shrink at night and stretch during the day. The station forms a long-term self-sufficient micro ecosystem that simulates a cyclically dynamic nature-like environment. The base is like a living organism, with individual plants, animals, and humans in symbiosis. It is a large greenhouse, an oasis, a garden, and a landscape; it provides views from the tops of hills as well walks around the lake. The shrinking of the station, announcing the arrival of the lunar night, causes a 'change of the weather' in the interior: a dramatic moment accompanied by waves and wind. These natural or elemental manifestations are a sign of season's change: the end of 'summer' and the beginning of 'winter' or vice versa. The cyclical alternation of seasons gives life at the station the rhythm that normally accompanies our lives on Earth. There are symbolic references to the Earth's landscape.

Fig. 9. Self-Sufficient Exploratory Scientific Kinetic Base Travelling in Mare Imbrium /MOONWORM - Nomadic Moon Base (Author: Zdeňka Němcová Zedníčková, 2016)



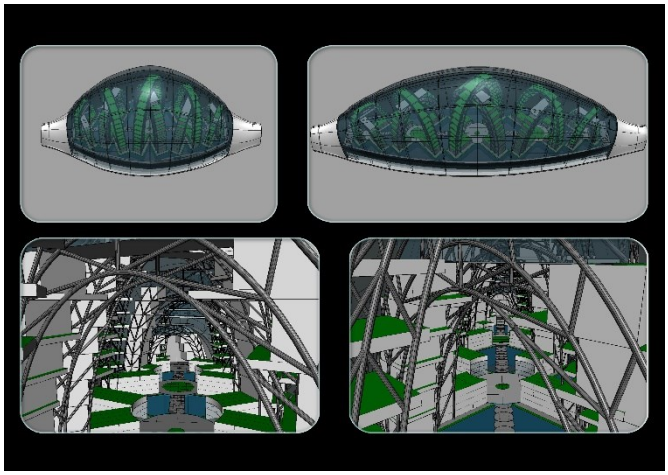


Fig. 10, 11. Self-Sufficient Exploratory Scientific Kinetic Base Travelling in Mare Imbrium /MOONWORM - Nomadic Moon Base (Author: Zdeňka Němcová Zedníčková, 2016)

Acknowledgements

The article was elaborated in the framework of an international mobility research and study stay at the Slovak University of Technology in Bratislava, Slovakia. It is based on the author's dissertation 'Architect in Media Network' (2012) and habilitation work 'Architecture and Futurology' (2020).

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ISSN 2729-7640

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OF THE FACULTY OF ARCHITECTURE AND DESIGN STU
www.alfa.stuba.sk

3/2022 (Vol. 27)
DOI: 10.2478/alfa-2022-0016

Linking virtual reality, architecture, and crime prevention for educational purposes

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Article information
Sent: Jul 19, 2022
Accepted: Aug 25, 2022

Abstract: This paper presents selected links between the complex fields of architecture, use of virtual reality (as a part of computer science), and their potential in helping tackle crime. The presented information sets a general background for the development of a put forward prototype of new immersive learning experience to provide deeper understanding of CPTED concepts to enhance the traditional curriculum and the overall retention of knowledge. In architecture, better computer technology raises the stakes. Architecture's side of communicating ideas and managing information has been reflected in BIM. Technology is one component of larger social, economic, and business revolutions that will continue to have a substantial impact on the markets in which architects deliver services. Technological progress enables blurring the boundaries between reality and the virtual world. It is a source of inspiration and some freedom in architectural design. The theory of education is also influenced by new technologies. There are scientific studies suggesting learning in virtual reality may be more efficient than in the real world. Current VR systems provide new features for perceptual expansion, for creative construction, and for unique social interactivity. There are now hundreds of university architecture programmes with VR and AR labs all over the world. We have also changed the way of designing of and thinking about our cities, including safety. The global nature of crime has brought international cooperation in the field of prevention, one example being the CPTED security concept. New visual stimuli, such as VR, may broaden our understanding of housing design, burglary risk and CPTED, and help prevent crime. VR has also pedagogical promise, as it can be used not only to assess hypothetical environments, but also to track, shape and affect subjects' thinking towards them. There are not many practical studies on the use of VR for this purpose, which points at a niche for more research to be conducted in this area.

Keywords: virtual reality, architecture, crime prevention, security, CPTED, CAAD, BIM, visualization, education

INTRODUCTION

Virtual reality (VR), *'the popular expression for what is generally referred to in the technical field as virtual environment'* (Stuart, 1996, p. 249), is a methodology originated in informatics, optics, and robotics (Jolivalt, 1995, p. 3). The term was used for the first time (in the context) by the CEO of California-based VPL Research Inc., Jaron Lanier (Stuart, 1996, p. xxviii), in the 1980s (Whyte, 2002, pp. 2, 15). The term cyberspace, which is frequently used as a synonym for VR in American technical literature, often defined as a space which spreads in another world of a computer, appeared for the first time in 1984 in Neuromancer, a science-fiction novel by William Gibson (Jolivalt, 1995, p. 107, 108). *'Although some techniques of VR were already explored in the late 1960'ies, it became a broadly known technology (in) 1980'ies.'* (Achten, 2007, p. 66) Virtual environments (VEs) require knowledge of various disciplines like mechanical, electrical, optical, and acoustical engineering, human factors, perceptual psychology, and computer science (Stuart, 1996, p. xix). Virtual reality has its foundations in computer graphics (Sobota, 2013, p. 3). At the end of the 1960s, a computer scientist, regarded as a pioneer of computer graphics (Aukstakalnis, 2017, p. 9), Ivan Sutherland demonstrated a new possibility that had to wait for about 30 years so that the *'modern technology could support effective and useful virtual reality systems.'* (Earnshaw, 1995, p. xxi) This creation was a pioneering VR system including the use of an HMD. It was quite primitive and heavy (Lanier, 2017, pp. 42, 192, 193). The original conference paper is available in Sutherland, 1968. There is a long history of further development in this area, especially with regard to the other devices available up to present, which is not the focus of this paper. The older references in this paper are still relevant today, since the basic principles of VR stay the same.

What needs to be highlighted is that VR users are placed in a completely other place that occludes the natural surroundings (Tustain, 2018, p. 155), *'VR is an alternate computer-generated world that responds to human interaction'* (Pérez Negrón, 2020, p. iii) and *'the virtual world is a digital representation of the real world'* (Tolnay, 2011). The user is necessarily immersed in the scene through special glasses and normally also headphones and is perceptually isolated from reality in a 360° view. Some interaction is needed (Whyte, 2002, p. 4). A typical classification of VR is desktop (non-immersive), augmented (semi-immersive), and immersive VR (IVR) (Rangel Bernal, 2020, pp. 3, 4; Pérez Negrón, 2020, p. 13). Technically, immersion is relat-

ed to the input and output devices. In VR for desktops, both worlds may be interacted with at once with the use of a keyboard, a monitor, a mouse, or a game controller. For augmented VR, the display is different (often a head-mounted display, a cave automatic virtual environment, possibly a data glove), and the reality is combined with computer graphics. IVR is *'an electronic simulation in which perspective images are generated in real time from a stored database corresponding to the position and orientation of the head of a user, who observes the images on a head mounted display, and in which three-dimensional sound cues are provided as well as a means for interacting with objects in the database.'* (Latham, 1995, p. 71) In IVR, one can interact solely with the VE. *'The more common input devices for IVR are the data glove and for the display, the HMD (...). Nevertheless, the users' immersion feeling can be attached to other factors, such as their willingness to believe that the virtual environment is real.'* (Rangel Bernal, 2020, pp. 3, 4) This all is illustrated in Fig. 1. Fig. 2 further sets VR into the full spectrum of reality, showing differences, which will be important to comprehend later in the text.

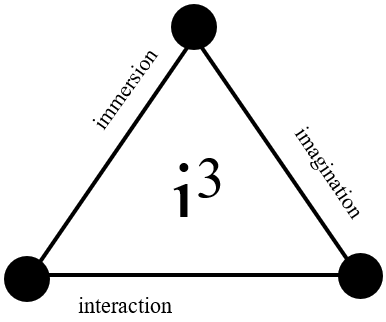

Fig. 1. Triangle of Prof. Grigore Burdea from the Rutgers University, USA, explaining three foundations of VR. (Source: Jolivalt, 1995, pp. 6, 7; redrawn by Lucia Benkovičová)

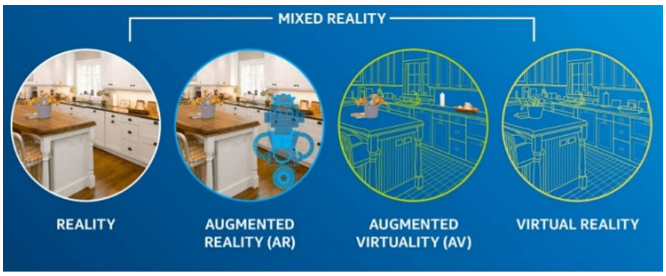

Fig. 2. Virtuality continuum introduced by Paul Milgram and Fumio Kishino in 1994. AR and VR are completely different in terms of their goals and ways of delivering the experience to the user (Elkoubaiti, 2018). (Picture source: Nova, 2018)

USE IN ARCHITECTURE

Simulations and visualizations

Peter Kamnitzer, head of the Urban Lab at the University of California in Los Angeles, USA, used an originally lunar mission simulator to create an interactive city environment. The joint project of UCLA, NASA, and General Electric was documented in a film titled City-Scape (1968; Fig. 3). *'This was the first time a simulator has been used to explore a digital model of a city. It is a surprisingly early example of the use of digital simulation techniques for general-purpose, interactive, spatial exploration.'* (McGreevy, 1993, p. 165) Kevin Hussey and his team from Jet Propulsion Laboratory later explored a digital 3D model of Los Angeles in California. *'They used a single Landsat picture and digital elevation data from the Defense Mapping Agency. They generated more than 3000 perspective images from the digital model and produced an animated virtual flight over the area.'* (McGreevy, 1993, p. 179)

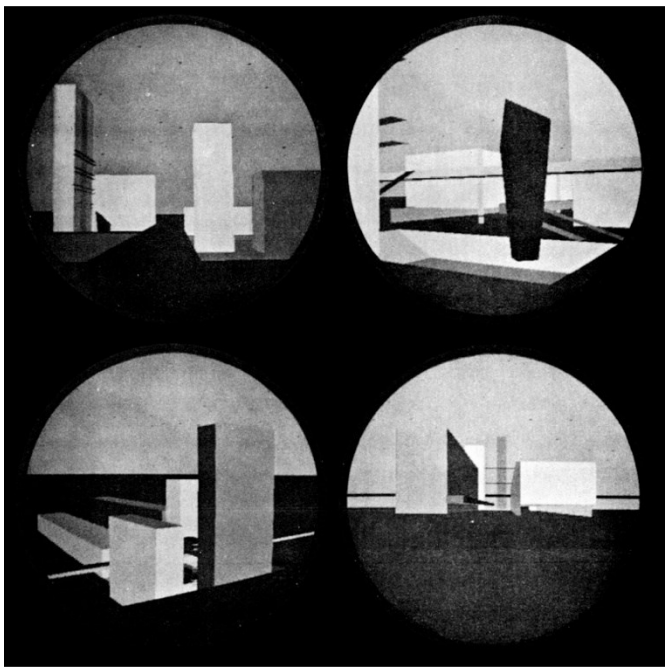

Fig. 3. Demonstration of the visualization subroutines of INTU-VAL, an online computer graphic program for iterative design and evaluation, in Cityscape, an experimental film both by Peter Kamnitzer, 1966–1968. (Source: picture from UCLA Architecture and Urban Design Special Collections; published in Roth, 2019)

In 1995, a relatively few people required great realism and speed (Wyvill, 1995, p. 43). *'The quality of computer visualization–both in terms of model-building ease and image realism–is continually improving.'* (Sanders, 1996, pp. 10, 11) This is still true in 2022. Once powerful computing hardware became more available, visualization started to have a competitive edge in many disciplines. It can be regarded as a part of a natural evolution in the whole computer industry. *'The overall computer graphics market has always been characterized by rapid growth and rapid changes.'* Prices getting lower and the increasing capabilities have had a principal impact on the market. Many disciplines overlap significantly. For instance, the visualisation market is an important multimedia component, while multimedia is also often used in graphics presentation, animation merges with science and multimedia, visualisation is a part of VR and so on. *'Texture mapping, for example, allows the users to apply different textures to design variables such as car interiors and building structures and gives them the highest level of realism possible.'* (Jern, 1995, p. 343) *'... indirect illumination substantially contributes to visual realism – in particular, for indoor environments, which are not directly illuminated by the sun.'* (Schmalstieg, 2016, p. 216)

'One of the best ways to help someone visualise a computer model is to make the model move. Well-choreographed animations, in fact, are one of the most compelling forms of digital media available to the architect. (...) The fluidity of the motion depends on how fast the individual frames are displayed and the amount of motion.' (Sanders, 1996, p. 174) Interaction is affected by the frame rate (...) and the system latency (Whyte, 2002, p. 20). The presence quality depends greatly on the fluidity of movements in a virtual world (Jolivalt, 1995, p. 22). The visual comfort is currently achieved with at least 60 frames per second (FPS), usual-

ly minimum 90 FPS. To improve realism, you need to add more of them. Resolution, refresh rate and a field of vision are also important in this regard (Jolivalt, 1995, p. 33). VR technology requires special knowledge (Sanders, 1996, p. 28). *'(...) construction of 4D-CAD models is labour intensive, and the use of virtual reality requires high skills and high investment.'* (Whyte, 2002, p. 66) VR instruments let users experience and move in 3D spaces before their physical construction. They are very useful for visualization in general and also for communicating proposed designs to the clients. (Sanders, 1996, p. 408) Despite the usefulness of advanced realism in VR for making an impression, *'there are concerns that its use might make it difficult to focus attention on the relevant issues at early stages and may make designs look fixed.'* (Whyte, 2002, p. 95) Furthermore, VR may show more than had been designed or possible, and there have also been some legal issues in this regard (Whyte, 2002, pp. 97, 118).

Arts, technology, and BIM

VR has attracted special attention in the arts community. At the beginning, practically no artists would have ever given up their traditional techniques for PCs. *'Today, that is beginning to change: the state of the art in computers had advanced far enough to have an impact and most importantly we have begun listening to the artists. Virtual reality ideas and technologies give artists new freedoms, new means of self-expression, and new ways to bring their skills to bear in the information world.'* (Wexelblat, 1993, p. 75) A PhD student of art (Maukš, 2022), a product designer graduating from the Faculty of Architecture and Design, Slovak University of Technology in 2022, who was researching the application of VR in the design process, still experienced quite a lot of trouble using VR from start to finish in his designs of motorcycles and car interiors despite being an advanced user, compared to traditional techniques used in the design process. One of the opponents of his thesis, Matej Dubiš, working in the car design industry, also said that using VR at their workplace professionally is, at least for now, also often a disappointment at the end, even though some semi-products often seem impressive on the surface to others not directly involved in the creation process. *'Although certainly not a substitute for many traditional methods, such tools are providing increasingly powerful supplements.'* (Sanders, 1996, pp. 10, 11)

In architecture, better computer technology has started to raise the stakes. It can win you a competitive advantage, help enter new market, improve value of your services, improve the work quality, or bring in new clients. (Sanders, 1996, pp. 1, 8) Software development companies also significantly push professional architects not to fall behind any new release and to buy a new product version or upgrade every year. The market moves fast, the risks are real and may be substantial. VR enables walkthrough simulations before the real construction of architectural design. Other examples include, but are not limited to, areas of entertainment, games, flight simulations, CAD/CAM, CFD (computational fluid dynamics), geoscience, GIS, financial analyses, medical, graphics art or scientific visualization (Jern, 1995, p. 344). *'Consultant engineers are using virtual reality to improve their reputation for technical expertise. Construction contractors and project managers are using it to reduce the risk of coordinating spatial layout and hence increase their profit margins. Real-estate owners are using it as they can afford to spend in capital in order to save it to optimize the use of their facilities by understanding the operational logistics.'* (Whyte, 2002, p. 70)

As for the CAD, the current trend is building information modelling (BIM), which is a way of creating architectural models with semantics. *'Architecture, after all, is a business of communicating ideas and managing information.'* (Sanders, 1996, p. 10) The term started to be used in the year 2000. *'The theoretical foundation exists much longer – at least 30 years – especially in academic research, where it was referred to as the virtual, central, or shared building model.'* (Achten, 2007, p. 53) Such models contain much knowledge and enable simulations and computations of the construction, costs, thermal performance, or interior climate. Interoperable software is the Achilles heel of the industry (Aukstakalnis, 2017, p. 360). It concerns using models by everyone in the building and construction industry in the same manner regardless of the software and hardware used. This issue is being solved internationally by open standardized industry foundation classes (IFC). (Achten, 2007, p. 55)

ARCHITECTURAL SPECIFICS

'Technology is (...) one component of larger social, economic, and business revolutions that will continue to have a substantial impact on the markets in which architects deliver services.' (Sanders, 1996, p. 3) Šimkovič (2010, pp. 30, 31) writes: The use of computer technology in architecture has come to the fore around 1980s, first as virtual visions of various fantastic shapes. The term digital architecture has become an umbrella term for a wide range of such new forms. *'Social and technological change has been gradually transferred to culture and architecture, creating a new language of expression commensurate with the time.'* The development continued after the Second World War in data processing, telecommunications, mass expansion of computers, and software development, after 1990 also in new (building) materials and construction technologies originally used in the automotive and shipbuilding industries. The improved software now enables the design and realization of complex irregular and curvilinear structures, composed of many different elements. In the 1990s, the first experiments in digital architectural procedures may be observed in the studios of Frank Gehry, Peter Eisenmann, Greg Lynn, UN Studio, FOA, or dECOi. This trend has continued also after 2000, when they were used more and more frequently and significantly for instance in studios Zaha Hadid, Toyo Ito, or Coop-Himmelblau. This is already extended parametric (algorithmic) architecture with its form generated by scripts written specifically for a project.

Technological progress enables blurring the boundaries between reality and the virtual world. It is a source of inspiration and some freedom in the application of non-traditional and innovative work procedures within architectural design. *'(...) mixed reality tools are getting into everyday practice and enable a more dynamic and realistic perception of virtual space. The perception of the world is manipulated through these technologies.'* VR is undoubtedly a powerful tool for both designers and architects with a significant impact on the creation process and the exploration of new ideas. The artificial-reality (AR) world, influenced by its users, has had a transformative effect on human communication, taking it in new and unexpected directions. It enables the users to experience several scenarios and worlds in one physical space, be it of artistic, educational, or entertaining nature. (Löffler, 2015, pp. 8, 9)

Computer-aided architectural design

'There are four basic activities that an architect engages in when designing with CAAD: modelling, representing, simulating, and designing. (...) Although sketching is an important basic skill for an architect, it has not been supported much by CAAD.' (Achten, 2007, pp. 10, 36) This is now partly possible also in VR, although in a completely different form. Design activities of an architect or a design team include analyses, syntheses, simulations, evaluations, and decision making (Achten, 2007, p. 110). *'The functional requirements of architectural design tools are necessarily more demanding than those of engineers.'* (Sanders, 1996, p. 4)

When it comes to quality in the AEC industry, it comprises conformance to requirements and customer satisfaction during the entire project life cycle (Sanders, 1996, p. 9). Even though today people have high expectations for realism (Schmalstieg, 2016, p. 45), it is not always the aim of computer-aided visualization: *'Most useful three-dimensional models of architecture will always be representational, not literal. And two-dimensional abstractions will always be extremely efficient forms of communication.'* (Sanders, 1996 pp. 236, 248) Architecture is not a business of making drawings but rather of managing also different kind of information (Sanders, 1996, p. 400), which can now be seen in BIM, probably in its fullest form with the combination of virtual, augmented, or mixed reality.

City models, real estate, and design

Inspired by virtual Seattle, VR has been used by the city of Singapore for growth. It helped *'Berlin plan restorations after the wall fell, (...): These renderings of Berlin were, (...), the first virtual worlds with real-time shadows and reflections.'* It was one of the most difficult things to create an accurate computer city model also later when creating a tool for the military. (Lanier, 2017, pp. 217, 220) Virtual reality shows its usefulness also in the real estate, where it is used very strategically to save time and money *'by allowing appreciation of the details and houses, such as size, textures, colours, and materials before physically changing them. It turns out to be quite feasible in recreating the real estate in a three-dimensional (3D) animation.'* (Pérez Negrón, 2020, pp. iii, iv)

Some researchers say that VR can be used by everybody, being a generic technology or interface to all construction applications. It is certainly used for a variety of tasks. *'Some see its use as a specialist activity and, as yet, no company is using it across all functions. Virtual reality is most widely used at the later stages of design, (...)'*, especially for testing and communication of design solutions, not so much for design generation (Whyte, 2002, pp. 1, 96) This is related to using VR to verify alternative designs and processes or simulations. Further, VR use seems to have more potential in large projects and reused design (Whyte, 2002, p. 124). There have been accusations of trying to replace the real world (Wexelblat, 1993, p. 146). However, this procedure is simply a tool, like a telescope or a movie, allowing us to view the world in new possible ways. *'Virtual practices are the next best thing to being there, but no one should pretend that they are the same thing as being there.'* (Sanders, 1996, p. 408)

Architectural education

The theory of education is influenced by new technologies. There are scientific studies suggesting VR learning may be more efficient than learning in the real world. In of them (Hassenfeldt, 2020), a 20-minute lecture and a lab were tested in an immersive VR group and in a real physical group with 57 students. Their knowledge results were assessed before and after the test with the same set of questions. Although there were no significant statistical differences between the groups' results, the completion was faster in the VR setting and it has been demonstrated that *'immersive learning environments in virtual worlds can enhance and augment education'* (Dede, 2009; Alessi, 2001; mentioned in Hassenfeldt, 2020). The retention of knowledge from a VR learning experience is also present (Balsam, 2019; mentioned in Hassenfeldt, 2020) and students show motivation for using VR (Ma, 2018; mentioned in Hassenfeldt, 2020). However, part of their attraction might be attributed to the newness of the experience and some users can experience blurriness, dizziness, or other discomforts. *'While many universities are moving towards online programs, students may have a more difficult time grasping material when it is difficult to perform physical labs that can only be done in person. VR could be the solution to that, especially as headset systems become more affordable and widespread. (...) Purchasing a VR headset could be a cheaper, more feasible alternative method of teaching some topics.'* (Hassenfeldt, 2020)

Educational programs and virtual workspaces are one of the possibilities of using mixed reality (MR) in the near future (Löffler, 2015, p. 9). VR has proved to be an effective adult learning environment not just for the U.S. Air force, where it saw one of its earliest applications. *'(...) it should be kept in mind that while research has proved that people could acquire spatial knowledge from virtual environments (VE), the rate of learning and accuracy of performance is almost always inferior to a real-world performance (Lessels, 2005). This statement is supported by Witmer and Kline (1998): 'Knowledge acquired from navigating through VR models appears to be similar to, but less accurate than, the knowledge acquired from navigating through the real world.'* (Whyte, 2002, p. 45) There are some studies that assert otherwise. For example, psychologists Goldin and Thorndyke (1982) had people touring an area by bus and another group experiencing the same place by watching a film. *'Though people gained spatial knowledge from both the bus tour and the film, they had different knowledge of the area. Participants in the film group identified tour locations and could remember the sequence of locations better than those who were on the actual tour. However, (...) there were significantly more subjects in the film group who were disoriented (...).'* (Whyte, 2002, p. 40)

'Current VR systems provide new capabilities for perceptual expansion, for creative construction, and for unique social interactivity. These characteristics of VR are relevant in three areas of educational theory: experimental education, constructivism, and social learning.' (Bricken, 1993, p. 201) Moreover, VR is the most humanistic approach to information, and it enables the users to change the world into a place where it is easier to learn: *'if you turn complicated data into a virtual place, a palace you can roam or a city you can tour, your brain remembers better and notices more'*. (Lanier, 2017, pp. 55, 132, 220) The potential of VR and AR in education can be seen also in mastering core skills in various settings, learning abstract concepts in complex fields (like architecture), or experiential child learning; *'One of the earliest and most successful application realms for virtual and augmented reality systems in education is the teaching of specific, tangible skill sets.'* (Aukstakalnis, 2017, pp. 299, 300)

Architecture students are faced with an immense learning task. *'On one hand, a key objective in most university programs is the development of skills required to combine concepts of space, form, materials, function, and aesthetics in the design of large, habitable structures. On the other hand, the student must learn to accurately translate and externalize these mental concepts to communicate the ideas and design intent to others.'* (Aukstakalnis, 2017, p. 304) For this purpose, mainly sketches, CAD and physical models, plans, sections, elevations, and renderings are used with accompanying text. It is difficult to combine all of it in order to see the whole design, validate and experience all its elements before the actual construction. *'This basic visualization and externalization problem has plagued the profession for centuries and extends far beyond a modern academic setting.'* (Aukstakalnis, 2017, p. 305)

Even though nowadays we have many other tools at our disposal assisting us in the visual analysis of architectural spaces, immersive systems are *'some of the first true solutions for visualizing, communicating, and experiencing design decisions at true scale'* (Aukstakalnis, 2017, p. 305). There are now hundreds of university architecture programmes with VR and AR labs all over the world. In 2022, Faculty of Architecture and Design,

Slovak University of Technology in Bratislava, Slovakia, also introduced a brand-new optional course Architecture and Mixed Reality (Fig. 4), supporting the transformative influence on many industries. This course is currently recommended to students in the 5th year of the 6-year study, while also being available to undergraduates and postgraduates. Its participants will master methods and procedures for using MR when presenting the results of architectural design using HMDs, tablets, MR and mixed media. The education aim is, in addition to more comprehensive preparation of students for the defence of their own studio and final theses, also their preparation for architectural practice and project presentations for investors, local government, professional and lay public. Compared to the education of architects abroad, in Slovakia, there is still certain lack of detail related to the issue described in the following section.

Fig. 4. Photo from the course of teaching and testing of virtual reality by architecture students, which took place at the FAD STU under strict anti-epidemic measures. The validity of presenting projects through mixed reality and the interest of students to interactively present their work at a distance has been confirmed here, as well. (Photo: Vladimír Hain, the course leader, 2022)

ARCHITECTURE ASSISTING IN CRIME ELIMINATION

General background

Criminality and violence are commonly perceived as some of the most serious dangers a human can encounter. Danger to one's health, life, property, and violation of social rules endanger basic human rights to a safe place, respect of freedoms and dignity. Losses on account of crime are enormous. Successful crime combat requires knowing the causes to be able to influence conditions which contribute to the emergence and existence of crime. It is a complex phenomenon affected by many factors. The usually-mentioned basic causes are unemployment, decline and malfunction of social control, social exclusion, anonymity of life and relationships, monotonous and untended environment, family problems, loss of identity, weakening of religious and moral values, as well as negative influence of violence in mass media. Crime is also to a considerable extent contingent on the environment where it emerges, spreads, and migrates.

Criminology distinguishes social, situational and victimization prevention. The specific issue mentioned above is mainly connected to situational prevention, which concentrates on crime, protection of public order, safety, health, life, and property. Its goal is to make criminal activities more difficult and to raise probability of offender detection. It is based on the knowledge that some types of crime appear at certain time, at some places, under certain circumstances and it is easier to change the situations by the mentioned means, including planning and regulation of physical and social environment, and thus prevent commitment of offences, than to control culprits by re-education and other social prevention measures. Its aim is to eliminate situational criminogenic factors, as much as possible. Its measures are often founded on criminological findings. Situational prevention methods are very effective in property crime prevention and the benefit is extended to health and life protection and intensification of the sense of security, especially if they are tailor-made to the structure, street, quarter, and town and possibly combined with social and victimization prevention measures. In connection with situational crime prevention, at all its levels it is possible to find many measures related to architecture (planning, lighting, fencing, access control systems, iron bars, locks, safes, alarm devices, resistant materials).

In many countries, crime prevention relies on combination of social prevention, abiding the law and designing the environment including all aspects of its design and management. Urban planning and architecture show a significant potential for crime prevention. There is a direct relation between crime and architecture of environment – its layout, quality, maintenance, and management. Urban planning and architecture provably exert influence over various types of crime and fear of it by influencing behaviour, access, choices and feelings of offenders, victims, residents, police etc. Some design features in certain situations worsen local crime problems. Quality architecture and urban design are also a preventive strategy for reducing the opportunities for committing crime.

Architecture and crime prevention also have another common characteristic feature, especially on the local level – it is the tailoring, which is one of the most important prerequisites for both to be beneficial and effective. All successful design solutions must be specified in view of the site. Successful, beneficial, and effective prevention must be designed directly with conditions of the territorial unit in mind. The focus of prevention system is on the local level. Human behaviour, particularly criminal behaviour, is inseparably conditioned by the situational context. According to a Norwegian architect Christian Norberg Schulz, the environment in architecture can be divided into physical, social, and cultural (Keppl, 2011). Safe environment in architecture can be defined from the point of view of fire safety, hygiene, and health unobjectionability. These kinds of environment fall into the category of physical environment. The topic is concerned with social environment. Safety can be defined as trust or confidence in protecting of personal belongings, property, and oneself.

The main role of architects is to create an artificial environment that provides a safe place to live – protected from climate conditions, weather, and from an enemy or intruder. The role of an architect is to incorporate the security info effective spatial and operational design, provide sightlines and access control, design proper positioning of vulnerable and reserved spaces, and through design features thoroughly coordinate safety technology and personnel. For an architect it also means to get a clear idea of the requirements, know the means, and understand the implications of each design. Security demands and desired ways of use of the structure and its environment need to be specified and taken into consideration as early as possible, optimally since the assignment. The reason is that for a town planner, architect, civil engineer, landscape architect, developer, builder, community groups and municipal corporations the most effective and least expensive way is to provide security in the early conceptual and design stages.

CPTED security concept

There are many advanced approaches to understanding and tackling crime. We have changed the way of designing of and thinking about our cities, including safety (Grogan, 2000; Montgomery 2013; mentioned in Mihinjac, 2019). *'For example, many city governments now employ Safe City plans with safety strategies and liveability indices in which they recognise the synergy between urban form, crime, and social conditions. They acknowledge that all these elements together impact safety and quality of life.'* (Mihinjac, 2019) *'Crime is a phenomenon as old as human civilization and widespread globally. The fight against crime oscillates between restriction and prevention. The global nature of crime, naturally, brings international cooperation in the field of prevention. A concrete example is the CPTED project - Crime Prevention Through Environmental Design.'* (Špaček, 2011, p. 4) Alternative terms may include Designing out Crime (DOC), Defensible Space, or Crime Prevention Through Urban Development (CPT-UD). This school of secure architecture has been tried and tested and it is well established (Armitage, 2018, pp. 286, 302). Crime and fear of it persists and is associated to significant direct and indirect monetary and social costs (Cozens, 2018, p. 64). CPTED can eliminate related security risks, vulnerabilities, as well as operation costs (White, 2014). It also deals with victimization and building a sense of community.

The CPTED movement officially emerged in the 1970s as an innovation aimed at the reduction of crime with mainly architecture, urban design (urban planning), psychology, criminology, and facility management coming together. However, a journalist Jane Jacobs addressed the issue and made some suggestions on how to make places safer already in her 1961 book titled The Death and Life of Great American Cities. Some of them include 'eyes onto the street' (Fig. 5), mix land use, community building and participation. Other books important in this regard are Crime Prevention Through Environmental Design by a criminologist C. Ray Jeffery from 1971 and Defensible Space by an architect Oscar Newman from 1972 (Fig. 6). '*From the earliest years the CPTED concept included ideas to motivate positive attitudes (later called "motive reinforcement") as well as ideas to reduce physical opportunities for crime (later called "target hardening") (Cozens, 2016)'*. (ICA, 2022) For later development of the concept see Fig. 7.

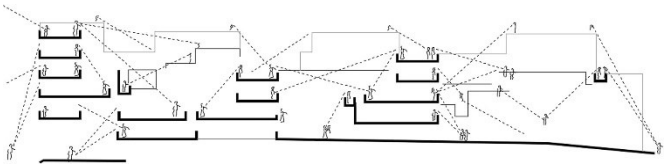

Fig. 5. Illustration of the eyes-on-the-street concept, which helps make places safer. (Source: De Jorge-Huertas, 2018)

The need for security has been a part of the development of cities. Today, security is often associated with bars and shutters on houses (not just on the ground level) and creation of private, closed, guarded enclaves surrounded by fences or walls (Fig. 6). Unfortunately, these measures may paradoxically sometimes increase the effectiveness of the attack. (Špaček, 2011, pp. 5, 6, 13) *'In terms of Maslow's hierarchy of human needs, neighbourhoods should be safe, healthy, and enjoyable. (...) It might be reasonably suggested that the Maslow needs are satisfied by all forms of CPTED.'* (Mihinjac, 2019) The CPTED philosophy is founded on the concept that *'proper design and effective use of a location's physical environment can lead to a reduction in the incidence and fear of crime as well as an improvement in the quality of life. (...) For a CPTED strategy to be effective, it must be comprehensive and integrated. (...) the goal of CPTED is to help protect a site against criminal activity while also making the same locations safe and inviting for legitimate citizens.'* (eSRX, 2022)

One of the guidelines is to structure an environment in ways that affect *'decisions that potential offenders make before committing any criminal acts.'* (Stewart, 2012) It goes hand in hand with good planning and making *'changes to the physical environment that allow for better physical and operational control of the property'*. This is not limited to creation of new environments. In fact, it is mostly used in redesign of venues using natural, mechanical, and procedural measures. *'However, you need to keep in mind that this concept may work better for new construction and remodels than for existing buildings.'* (White, 2014) Even though there are no strategies that would reduce all crime, what works best in practice is still the combination of all CPTED principles (ICA, 2022). More extensive theoretical background on CPTED can be found in my scientific monograph (Benkovičová, 2015) and on VR in my technical handbook (Benkovičová, 2021) used as a textbook by the Slovak University of Technology (based in Bratislava, Slovakia), both published mainly for Slovak and Czech readership (abstract and summary are available in English).

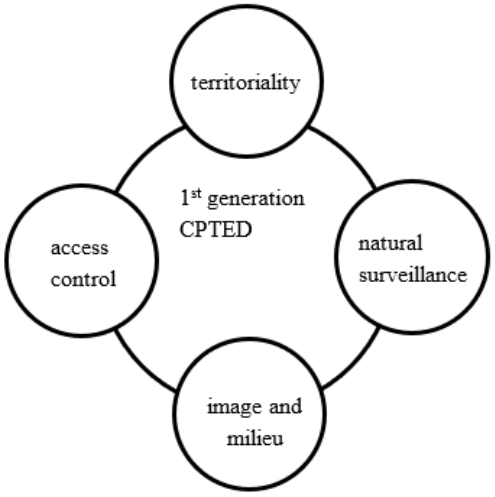

Fig. 6. First generation CPTED based on Newman's concept of defensible space as of 1972 that still constitutes solid foundations of the overall security concept. (Source: ICA, 2022; redrawn by Lucia Benkovičová)

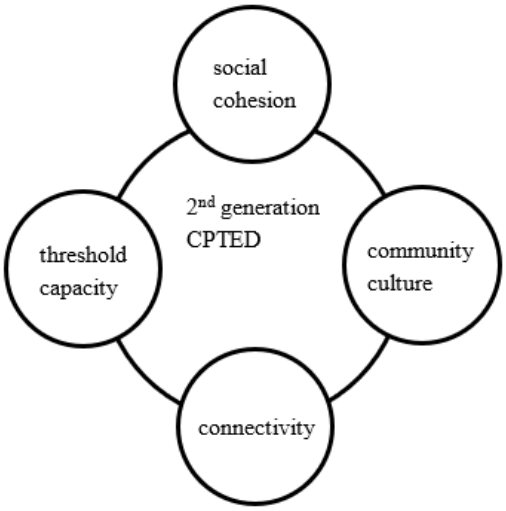

Fig. 7. Second generation CPTED, introduced by Cleveland and Saville in 1997, based on sociological research. (Source: ICA, 2022; redrawn by Lucia Benkovičová)

Fig. 8. This unusual see-through fence, located in Cambridge, UK, enables some mutual social control of the spaces that it divides. Its form further makes it more difficult to climb it over. It also serves as an easily remembered element in the wider surroundings, raising the sense of security when navigating the environment. (Photo: Lucia Benkovičová, 2013)

Exploration of VR potential for CPTED

We certainly know that VR (AR, MR) has got outstanding application both in architecture and the building (construction) industry, especially in the design process but also with respect to the final presentation (Sobota, 2013, pp. 129, 130). Cozens mentions a *'potential use of "new" visual stimuli in broadening our understanding of housing design, burglary risk and crime prevention through environmental design (CPTED)'* within exploration of imagery in VR and BIM for investigation of crime and more progressive CPTED use. These now commonly used technologies can improve our understanding of the links. He goes on to posit: *'Both VR and BIM arguably have potential use in exploring all types of crime and in enhancing the use of CPTED to deter such crimes. (...) BIM may serve as a new platform to enable additional types of CPTED design reviews (...)'*, especially for newly built structures. *'Potential contributions of VR in CPTED can go far beyond a high-quality visualization tool:'* it can be used in the design, evaluation, and training process (Noh, 2019, pp. 168, 169). There are not many practical studies on the use of VR for CPTED purposes. This fact does not diminish its usefulness and potential, and it rather points at a niche for more research to be conducted. However, *'(...) it is not an easy task to create the desired scene of reality that the researchers might want for their study.'* (Rangel Bernal, 2020, p. 8)

Be it in environmental psychology, architecture, urban design or urban planning, or criminology, it is usually necessary to study users' responses to the environment and its characteristics, which have not yet been constructed (Cozens, 2018, p. 66). The results of a study in landscape design by Seungmin Noh and Yumi Lee (Noh, 2019) showed that feelings experienced in the virtual environment generally matched with those experienced the field. When there was no match, the reasons for it were determined to be lack of details, insufficient mapping quality, and graphical issues in the VR model. This also involves higher demands on *'technical expertise in the production of the simulation for specific areas such as lighting and animation programming'. 'VR technology is considered to be highly useful to simulate real-life situations that are otherwise too costly or risky to experience.'* (Noh, 2019, p. 168)

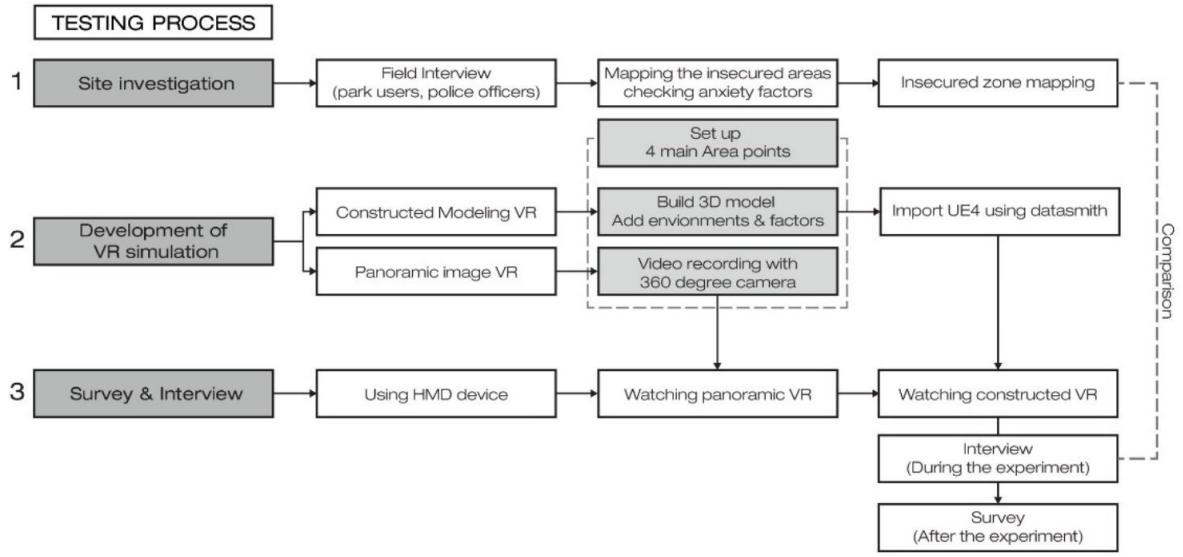

Fig. 9. Three stages of the testing process. (Source: Noh, 2019, p. 169)

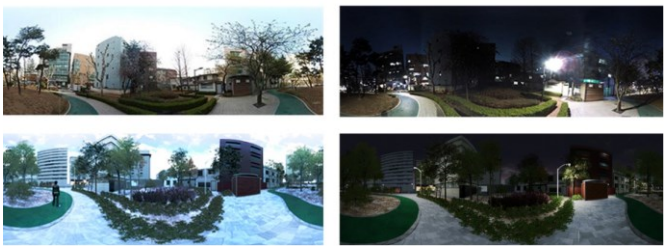

Fig. 10. Day and night scenes of image-based VR (above) and model-based VR (below). (Source: Noh, 2019, p. 170)

Fig. 11. Screen-captured insecure factors found in the studies areas. (Source: Noh, 2019, p. 172)

'(...) current CPTED approaches are criticized as the evaluation criteria merely focus on designing static elements (...) (Song, 2009). (...) In CPTED, it is important to consider dynamic environmental factors and ephemeral conditions (...), as well as static design elements.' (Noh, 2019) Land-use changes can also influence opportunities for crime. *'Indeed, the criminogenic capacity of the built form is not static–it is dynamic and ever changing.'* (Cozens, 2018, p. 73) My own comprehensive case study of a residential quarter conducted in 2012 (Benkovičová, 2015) reflected these dynamic factors and many others as well. The modification of the situations that should be taken into account, like light, shade, sound, weather, and movement, can be made easier and true danger can be avoided. This is thus useful for example at night, which is generally more dangerous and there are higher crime levels and higher crime anxiety than during the daytime (Fisher, 1992; Loewen, 1993).

One recent study has revealed that VR can *'effectively simulate a park to reveal the psychological anxiety that the elements and the environment of the park generated in park visitors. (...) Efforts have been previously made to utilize virtual reality technology and incorporate it into space design and CPTED design.'* (Noh, 2019; Fig. 9-11). In this study, a 20-minute realistic VR simulation in Unreal Engine 4 was employed for a CPTED evaluation of a high-crime city park. 30 participating students were wearing HMDs within a 3x3 m space and given questionnaires after the experiment; they were also interviewed during the experiment itself. Another study (Kavakli, 2004; mentioned in Noh, 2019) where a virtual environment was made by researchers in order to examine crime risk factors and provide an interface for training novices, which is of special interest to my own diploma thesis application design (prototype of new immersive learning experience to provide deeper understanding of CPTED concepts to enhance the traditional curriculum and the overall retention of knowledge; Fig. 12) being finalized by the end of 2022 in the study programme of Applied Computer Science at the Faculty of Informatics, Pan-European University in Bratislava, Slovakia. Moreover, a different study (Park, 2008; mentioned in Noh, 2019) suggests that simulation tools that utilize virtual reality and augmented reality technologies have the advantage that they can easily modify situations in a virtual environment while avoiding real danger or risk.

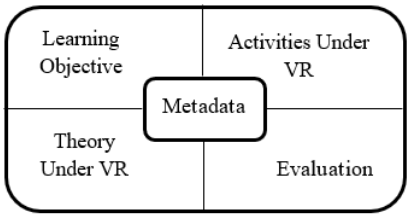

Fig. 12. Learning object model integrating VR. (Source: Munoz-Arteaga, 2020, p. 178; redrawn by Lucia Benkovičová)

SOFTWARE APPLICATION PROTOTYPE

The main goal of my own, recently developed application is studying of the information available in the created model environment to acquire knowledge from VE to be synthesised for later use in the real world. The goal is for users to learn, experience, practice, and review 12 specific tasks (listed in Fig. 13). These are especially impactful, educational, memorable, effective, and fun in VR, as has been shortly explained in the previous text. At a high level, during the app, its users will roam the scene freely to find all task windows (no matter their order) with the questions to ponder on the design of the built environment. The application category is education and training.

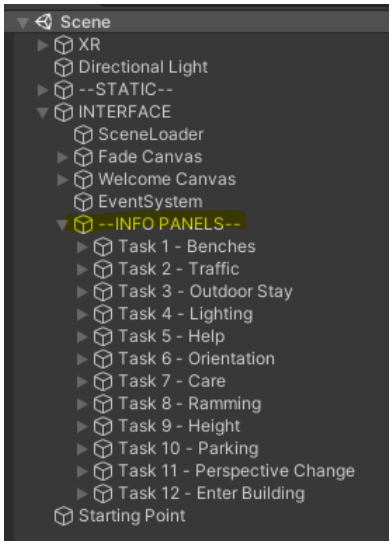

Fig. 13. Project hierarchy in Unity with highlighted task panels created in the 3D scene for VR in the given order. (Author: Lucia Benkovičová, 2022)

The following page details specification of the tasks (in Info Panels listed by names in Fig. 13) in my VR environment:

Task 1 – Benches: Are there enough benches to sit on? Are they placed well to enable natural surveillance? Can you find any security cameras? Is the street furniture in a good shape and of durable materials?

Task 2 – Traffic: Are there any sleeping policemen (speed bumps) or other elements of traffic calming to make the space safer?

Task 3 – Outdoor Stay: Attract the spaces the right amount and type of people to stay outside longer to perform desired activities? Are they easy to use by the disabled, elderly, and mothers with prams?

Task 4 – Lighting: Is the lighting of good quality along all routes, facades, and in front of all entrances? Is it constant or movement-responding?

Task 5 – Help: How easy it is to call for help? Would it be easy to get it anywhere?

Task 6 – Orientation: Is it easy to find your way in the environment and escape? Are there any visual barriers, cul-de-sacs, or potential places to hide?

Task 7 – Care: Is everything tended? Are there any other signs of physical or symbolic territoriality? How about signs of vandalism or overprotection (iron bars, high walls)?

Task 8 – Ramming: Are cars prevented from ramming or can anything absorb the collision?

Task 9 – Height: Are not any buildings too high to see what happens in the street from their inside? Does anything make buildings easier to climb?

Task 10 – Parking: Are the parking areas marked clearly and secured? How about their isolation, occlusion, and opacity of the surrounding walls?

Task 11 – Perspective Change: Once you have covered all the information panels in the scene, restart your exploration and, for a change, try to think as a villain, not a well-meaning visitor or a user!

Task 12 – Enter Building: Feel free to enter the building on the right if you like. This training, however, focuses on the exterior and there are thus no specific tasks to do inside.

Materials, data, and methods

The app, which is currently called 'VR edu CPTED' and has not been shared with anyone yet, takes place mainly in exterior of a town part with one central modern office building (with furnished interior) and a few surrounding buildings of non-specified use (originally with all textures office buildings and an apartment building) with a small network of roads (street- and bridge-level) and pedestrian spaces. This sample model's (Enscape, 2022) geometry, custom assets, and texturing have been created with Autodesk Revit (Fig. 14), BIM software helping AEC teams create high-quality buildings and infrastructure, and Enscape (a real-time rendering and VR visualization tool for BIM models) software in 2020.

Although the model itself is VR-ready (for Enscape, see Fig. 15), to be able to develop my own application in Unity, after many trials and errors (including testing different VR-development solutions), I first had to relocate the assets and textures in the Enscape plugin for Revit, then export the model using a specific workflow outlined in Fig. 16, and, finally, replace some of the textures and assets (by some more suitable from the Unity Asset Store). To be able to get at least some of the original exterior textures, I also had to export a selected 3D view of the Revit model as a DWFx file and import this file to SimLab Composer (3D software for importing models and then creating dynamic visualizations and renderings for interactive VR training sessions), where I packed the scene as an FBX file.

Upon unzipping the file, I had been provided with the textures. Then I drag-and-dropped this FBX file into Unity (without textures). After that, I extracted the materials and moved them into the Unity Materials folder. I set the material location to Use External Materials (Legacy). Once applied, the model started showing some original textures. Further, Colliders and Teleport Areas (with Fade) were added to some floor, road, sidewalk, topography, and stair objects, UI elements were created, and everything was configured and tested individually regarding functionality. Lots of other models had been explored before the final choice was made. I had been looking for a topic-specific architectural setting with more buildings at one place in VR quality with the possibility for reuse and/or publish for my educational purposes.

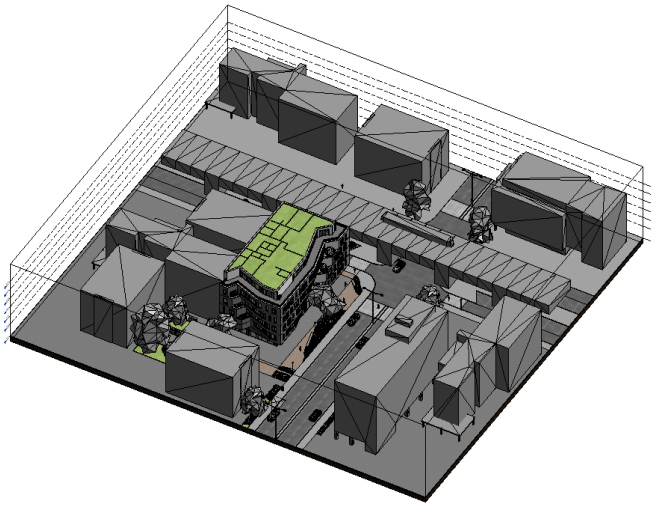

Fig. 14. A screenshot of the 3D model Starting View in Revit 2020, made by Lucia Benkovičová, 2022. (Model source: Enscape, 2022)

The application has been built in Unity 2020.3 with standard Player, Oculus XR Plug-in Management, and PC, Mac and Linux Standalone settings, targeting at 64-bit Windows OS. This experience is targeted at devices with 6 DOF giving users control over the movement and rotation. Each user needs an HMD tethered to a powerful computer. The application is optimised for use with Oculus devices. Oculus Rift is an example of a PC-powered VR (gaming) headset. It was introduced as a consumer version in 2016 and discontinued in 2021. The users should consult the current minimum system requirements required for their setup. A typical use case is intended to be an in-person English-speaking class with a teacher and necessary hardware available to use with guidance. Since there are relatively lots of users with vision defects (including myself seeing everything inside VR blurry), it needs to be added that: *'Individuals who are dependent on prescription glasses face considerable challenges when using modern stereoscopic head-mounted displays. In most instances, there is simply not enough eye relief available to accommodate the use of corrective lenses without severe discomfort or the potential for damaging the optics of both the HMD and the user's spectacles.'* (Aukstakalnis, 2017, p. 398) Those will most

probably need adapters for prescription lenses, which are currently available just for some models, to experience the scenes as they really are using a VR HMD.

Fig. 15. Exterior views of the model sample made in Enscape 3.1 for Revit, opened as a standalone application. (Screenshots: Lucia Benkovičová, 2022; Model source: Enscape, 2022)

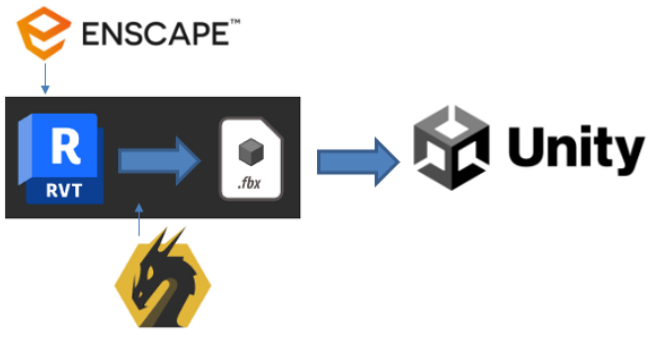

Fig. 16. Since there is currently no support for direct export from Enscape to Unity, the Revit model has been exported using the FBX Simlab export plugin for Revit, which resulted in losing all of the Enscape materials applied in the project sample. Unfortunately, no better way to export the model to Unity in order to preserve the highest quality has been found so far. (Author: Lucia Benkovičová, 2022)

Given that this app is targeting the Oculus Rift HMD, target metrics (Meta, 2022) were: 80-90 FPS, 500-1,000 draw calls (in Unity called batches) per frame, 1-2 million triangles (tris) or vertices (verts) per frame. The above-mentioned metrics have been tested using the Game Statistics and an FPS Overlay UI in the Play mode within all model parts, using the Oculus Rift HMD. As a result, some very detailed car objects have been removed to minimize polygon count. All lights are real-time. However, currently the only light source in the whole scene is a skybox from the Unity Store and all objects are marked as static for light optimisation purposes (preparation for light baking, which is generally recommended for most lights, using a minimal number of real-time or mixed lights). Light probes are not used for more realistic mixed lighting. For some actions, conditions, controls, and testing, some scripts, and prefabs from a Unity course (Unity Technologies, 2022) have been used.

Results

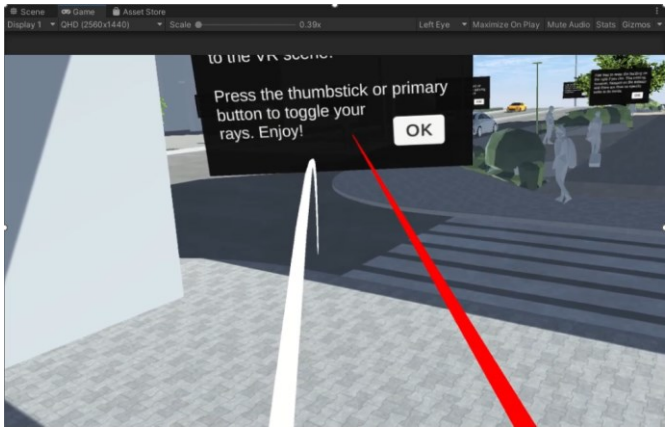

Fig. 17. A view from the Game mode in Unity with the headset on my head and both controllers in my hands (thumbs on the thumb sticks). The implemented ray interactors turn white from red when they reach something that can be interacted with. Here the left ray is ready for teleport, the red right ray is pointing at the Welcome Canvas in an area that cannot be clicked on for interaction with this object. (Author: Lucia Benkovičová, 2022)

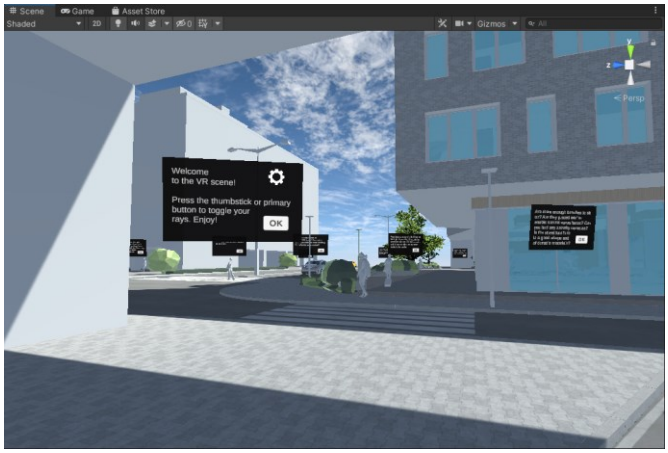

Fig. 18. A screenshot of the same model (geometry) in Unity, the chosen development environment, from the created Starting Point. (Author: Lucia Benkovičová, 2022)

The users can get around the scene with teleport as well as with continuous movement. They are not able to grab anything in the scene and there are no sockets used. However, Distance Grab is implemented but inactive since there are currently no objects to grab by hand. By default, both the left-hand and right-hand controllers have got a direct interactor. Both hands have got also ray interactors available – left one is used for teleportation,

right one for interaction with the world-space user interface. The rays are activated when the Oculus Touch Controller (primary or thumb stick button) is pressed and held (Fig. 17). There is small haptic and audio feedback when the user has made a selection and also when Hover State is entered. The main menu (object Welcome Canvas) is located by the Starting Point (Fig. 18) and, from the main menu, the user gets information on the implemented controls and can access the settings menu, where they can toggle between the Snap Turn (default setting, turning set to 30°, helps prevent motion sickness - nausea) and the Continuous Movement (for wider accessibility).

Within the Welcome Canvas, there are additional UI elements for resetting the scene to its default state (object Reset Background). The user can press a secondary button (B or Y on one of the Oculus controllers) or, alternatively, press the Oculus button to access the Reset View button. To exit the app, the user either needs to press the Oculus button and then the Quit button in the Oculus UI or close the app window using the computer. To make the user experience more accessible, efficient, and comfortable, all canvases (UI elements) are set to a comfortable eye-height for reading, you can use teleport to move around, switch between snap turning and continuous movement, possibly grab things by hand from afar, fading is used on scene load and for teleportation, and some LOD (level of detail) elements, like cars or trees, have been used. The application is currently being fine-tuned with more features and awaits its first students to test and use it.

CONCLUSION

As predicted (McGreevy, 1993, pp. 194, 195), VR has greatly influenced art, architecture, computer-aided design, communications, entertainment, education, scientific visualization, simulation, training, and many other fields. *'The physical environment can be manipulated to produce behavioural effects that will reduce fear and incidence of crime.'* (eSRX, 2022) As one of the media for data visualisation in 3D (Whyte, 2002, p. 19), visualization is an alternative method of their analysis (Grantham, 1993, p. 225) that can be used for problem solving. VR comes with safe experience of distant or dangerous locations (Bricken, 1991). It enables simulations of existing environments as well as gathering data normally impossible or improbable to get (Gutiérrez, 2002; mentioned in Rangel Bernal, 2020, p. 2). *'(...) VR has immense pedagogical promise, with the potential to not only assess hypothetical environments, but also to track, shape and inform subjects' thinking towards them. In sum, VR presents considerable opportunity to gain insights into the general perception and emotional responses of proposed designs (...), reduce prototyping costs and design faults (...), evaluate different scenarios against specific criminogenic variable and identify built environment variables associated with different types of crime.'* (Cozens, 2018, p. 70) There are not many practical studies on the use of VR for this purpose, which points at a niche for more research to be conducted in this area.

On the other hand, there are many approaches to learning (Aguirre, 2020, p. 134), individual preferences and combinations used. *'Research has shown that, after two weeks, we remember 10% of what we read, 20% of what we hear and 30% of what we see. This rockets to 90% for things we do. Learning can be more effective if it is experiential, which includes strategic problem-solving skills and critical thinking, tasks that virtual reality is perfectly suited for.'* (Tustain, 2018, p. 126) Furthermore, the greatest effectiveness in learning is usually achieved with different learning styles combined, involving hearing, seeing, and doing at once (Hain, 2020). VR incorporates all of them. *'VR's deep mission (...) was to find a new type of language, or really a new dimension of communication that would transcend language as we know it.'* (Lanier, 2017, p. 87) Understanding and using VR is starting to become a basic skill for an architect and the need has emerged to further the education in this regard.

Acknowledgements

The software development part of this work has been supported by the computing resources and a PC-powered VR headset lent by the Laboratory of Virtual and Augmented Reality of the Pan-European University in Bratislava, Slovakia, which is a part of the world VR laboratory network VR First. I have also made use of a sample model whose original geometry, custom assets, and texturing have been created with Autodesk Revit and Escape software with the kind permission of the company Enscape GmbH. I would like to extend my acknowledgment to the supervisor of my last two theses on VR, Dr Ján Lacko, the current dean of the Faculty of Informatics, Pan-European University, for his invaluable lectures on VR and 3D graphics in my previous bachelor and master studies of applied computer science. I wish to thank also my previous employers in company Capturing Reality (photogrammetry software developer for creating 3D models from photographs and/or laser scans), who hired me after my doctoral studies, for having provided me with versatile opportunities and trust in my abilities, top-level knowledge, and experiences for more than four years, and enabled me to build solid foundations for my direction to focus on in my future professional development.

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ISSN 2729-7640

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ALFA ARCHITECTURE PAPERS
OF THE FACULTY OF ARCHITECTURE AND DESIGN STU
www.alfa.stuba.sk

3/2023 (Vol. 27)
DOI: 10.2478/alfa-2022-0017

The positive impact of wooden material on educational processes in the environment of Slovenian wooden kindergartens

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Article information
Sent: Jul 17, 2022
Accepted: Aug 30, 2022

Abstract: Several scientific studies confirm that the colors, structures or materials used in the physical environment of interiors affect the human psyche. Wood, as a material applied in the interior spaces of buildings, is an attractor that, in addition to its static and structural properties with high environmental responsibility, also brings other benefits to users. It has a much greater impact on the society than we might think. The topic of applying sustainable materials and transforming them into newly-built, valuable and cultural architecture is currently also popular in connection with the new initiative the New European Bauhaus. The initiative has ambitions to use the existing national and international legislative frameworks, and to set sustainability rules with an interest in aesthetics and the involvement of communities in the creation of new living spaces. This paper aims to expand current scientific knowledge about the positive influence of wood material and its impact on educational processes in the architectural environment of kindergartens. Selected analyses and comparisons made it possible to assess whether the presence of wood material can positively affect the well-being of children in the physical environment of kindergartens. The article presents the results regarding children's sensory perception, the feeling of safety, the feeling of a peaceful atmosphere. It aims to prove that interiors with exposed wood can improve the quality of teaching, can support social interaction and playful learning of children. The wood material is characterized in the presented author's research as an interior, visible, massive material. Its design is authentic, with or without fine surface treatment, which does not degrade its visual-haptic-olfactory qualities. The study examines, analyzes and compares the architecture of kindergarten interiors in Slovenia. It interprets the results of practical research from the locations of Loče, Poljčane, Šoštanj, Polzela and Škofja Loka.

Keywords: well-being, influence of wood, kindergarten, new European Bauhaus, Slovenia

INTRODUCTION

The environment in which children grow up and spend their time constitutes a fundamental aspect of their knowledge, social and personality development. As in the case of adults, children today spend most of their time in man-made environments. Kindergartens and the physical environment of playrooms are places that significantly influence children. Therefore, such an environment should respect not only the physical but also the psychological needs of children. Recent research (Köhldorfer, 2010; Grote, 2021; Filová, 2019) partially proves that by applying natural materials and principles of biophilic design (which represents a holistic approach to the design of interiors and exteriors, where the core of interest is the person and the impact on their mental and physical well-being and health; in combination with an approach that takes into account the long-term impact on the natural environment, this is environmental design that strengthens the health of the individual [Janková 2017]) or restorative environmental design (which is a building design paradigm that combines sustainable building practices with building practices beneficial to the health of residents [Burnard, 2014]) it is possible to help to reduce children's absence from schools and improve health and psychological well-being and increase work performance and improve the results of not only adults but also children. The contact with wooden elements undoubtedly has an impact on people's emotional and physiological well-being (Kotradyová, 2015, 2016). The presented article is a partial result of doctoral research aimed at studying the positive influence of wood on the psyche of children and on educational processes in general. The study examines, analyzes and compares selected interiors of kindergartens in Slovenia designed by the studio KONTRA Arhitekti (former MODULAR Arhitekti) led by doc. Mojca Gregorski, who also focuses on the topic of educational facilities at the scientific - research level. The partial research presented in this paper provides the results from the locations of Loče, Poljčane, Šoštanj, Polzela and Škofja Loka. One of the goals of this research is to identify and summarize the opinions of teachers and educators, to present information about the educational potential of these institutions, to classify their atmosphere as perceived by the respondents, and to find out to what extent wood as a material has an impact on the educational processes.

METHODS

The empirical research included the use of a questionnaire in the local language. Due to the language barrier, it was impossible to conduct research using the oral interview method; for this reason, it was not possible to focus on children, but only on teachers and educators. The questionnaires always used questions to which the respondents could choose the answers Yes, No or I don't know. For all the questions asked, the respondents were asked to explain their choice (yes, no, I don't know) using key words. The case study presents the research carried out in six selected kindergartens (Tab. 1) designed by the well-known Slovenian architectural studio KONTRA Arhitekti (formerly MODULAR Arhitekti), represented by Mojca Gregorski, Matic Lašič and Miha Kajzelji, who create recognized wooden-structure architecture. Due to anti-pandemic measures, access to the buildings was significantly limited, which subsequently directly affected the quantity and the quality of the data obtained.

Tab. 1. The subject of the research were the following kindergartens in Slovenia. (Source: Authors, 2021)

Kindergarten	Address	Location
Vrtec Loče	Šolska ulica 2	Loče
Vrtec Poljčane	Dravinjska cesta 28	Poljčane
Vrtec Šoštanj	Kajuhova cesta 8	Šoštanj
Vrtec Polzela	Glavni trg 1	Polzela
Vrtec Škofja Loka	Partizanska cesta 1e	Škofja Loka
Vrtec Bršljin	Kočevarjeva Street 42	Novo Mesto

Four of the kindergartens in question were analyzed "in situ", the Kindergarten in Polzela sent the results of the questionnaire-based survey electronically due to anti-pandemic measures, the Kindergarten in Bršlinj refused to participate in the research. 65 teachers and educators participated in the study. The area of focus of the selected case studies was the atmosphere of schools and the proportion of exposed wood on surfaces in the interior of kindergarten buildings. The interviewees were asked questions as to whether wood as a material affects the degree of concentration, the mood, or the emotions of the child users. They were also asked to explain and describe in the questionnaire their observations and subjective feelings resulting from working with children in wooden buildings with an educational function.

RESEARCH

Vrtec Loče

The kindergarten located in the village of Loče, near the village of Poljčane, was built in 2018. The investor financing the state kindergarten in Loče is the city of Slovenske Konjice. The kindergarten was designed as a building with almost zero energy consumption, with a wooden skeleton structure forming a two-story wooden building of a compact shape; the wooden facade is a hint of its supporting building material (Fig. 1). The layout consists of five playrooms and a gymnasium (Fig. 2). All playrooms are connected with each other, have direct access to the exterior and a view of the surrounding nature. The interior has a strong educational character because the wood used in the interior touches on the themes of nature protection, the ecosystem, and educates users on sustainable behaviour and the environment. The material of visible wood is widely represented in the interior, not only in the visible layer of load-bearing walls, but also in ceilings, furniture, door, and window frames.

Educators and teachers most often stated that this visual material feels like being in someone's home, the school looks more welcoming, the wood “warms the space up”, it is pleasant to touch. Staying in the premises is very pleasant, wood calms and relaxes a person; the phrase "positive energy" was often used to name the feeling. With respect to the high likelihood of children screaming in such spaces, it seemed to the respondents that the presence of wood has a calming effect and does not significantly echo the sound as in the case of classic brick walls. According to the interviewed teachers, children of preschool age notice and observe everything; they even count the slats in the false ceilings or compare the knots. The survey also showed that kindergarten employees are also influenced by the positive effects of wood.

The fact that employees, educators, teachers feel comfortable in an environment with elements of wood also contributes to the positive atmosphere of the environment and the joy of children visiting this environment (this fact has also been proven in hospitals: if doctors feel good in the workplace, it has much better effects on patients than a top-class equipped room). As to negative connotations, we caught the answer that this natural material can allegedly cause or aggravate allergies. When asked what they would like to change in connection with the kindergarten's architecture, we did not catch any other negative associations with wood, only concerns about fire protection, which seem irrelevant to us. Other reservations about the architecture were: non-functional layout of the playrooms, lack of changing tables near the door, non-functional terraces on the first floor that are not covered, lack of flexible relaxation areas for individual relaxation.

Fig. 1. Kindergarten in Loče, wooden facade connecting the interior wood with the exterior. (Photo: Jakub Hanták, 2021)

Fig. 2. Hallway space and a view of the playroom with exposed wood in the form of CLT panels. (Photo: Jakub Hanták, 2021)

Vrtec Poljčane

Another researched interior was a kindergarten located in the village of Poljčane, just a few kilometers from the previous kindergarten building in Loče. The kindergarten was built in 2014 as a state institution and the investor was the municipality of Poljčane. Its concept is completely different from the previous example, but the architects are the same. The school is situated on a narrow, nearly 200-meter-long plot; the playrooms are optically interconnected, and each has a door leading to the garden outside. In addition to the window view of the garden, children have a view of the landscape thanks to the absence of a windowsill, which results in the blurring of the line between the interior and exterior (Fig. 3). The peculiarity of the building is the structurally demanding folded wooden roof made of CLT panels, designed based on the principle of an inverted roof. An interesting feature of the halls and corridors and classrooms is the high headroom; in the classrooms you can see half-floors (unfortunately with barriers, outside the principles of design for all) that are popular with children, intended only for healthy children. The individual areas are optically connected with other classrooms through "peepholes". (Fig. 4). There are wooden elements in the form of ceiling boards, partitions in interiors, stairs leading to the "children's mezzanine" (Fig. 5), or a perforated interior wall in the entrance hall that improves the acoustic conditions there (Fig. 6).

In the questionnaire, in connection with wood, we encountered answers that wood appears to be warm and natural, allows children to feel relaxed and open. The wood material has a stimulating effect on children and is important for their proper development and growth. The questionnaire indicated that the teachers perceive the wooden material as a material that evokes warmth and is natural; some respondents even claimed that, in addition to the feeling of warmth, wood gives a feeling of tenderness, beauty, calmness or even stability. Wood has a calming effect on teachers, and in this context, they emphasize the importance of visiting the forest as a place where one can mentally relax. In general, they perceive wood as a warm material. Children feel better because of the feeling of home; wooden walls are softer and warmer to the touch; children are proud of the kindergarten and like to go there. When asked what they would change in relation to the school's architecture, respondents offered no objection to wooden materials. Minor reservations were mentioned regarding the position of the coat hangers in front of the classrooms, or the large distance between the first and last classroom.

Fig. 3. Playroom space with a view of nature that takes into account the height of children (without a windowsill). (Photo: Jakub Hanták, 2021)

Fig. 4, 5. Above: Playroom space with "children's half-floor". Below: Wooden staircase leading to the "children's half-floor. (Photo: Jakub Hanták, 2021)

Fig. 6. Wooden perforated cladding, improving the acoustic conditions in the entrance hall. (Photo: Jakub Hanták, 2021)

Fig. 8. The interior of the playroom or classroom is largely filled with wooden materials. (Photo: Jakub Hanták, 2021)

Vrtec Šoštanj

Another object of study is a kindergarten in the village of Šoštanj, the state educational facility built in 2014, with the municipality of Šoštanj as the investor. The exterior design of the building does not indicate at all that it is a wooden structure (Fig. 7). On the contrary, the interior pleasantly surprises with wooden elements (Fig. 8). The architecture of the kindergarten is designed as a two-story building with simple volumes, consisting of cubes of playrooms or classrooms shifted in height and plan, between which there are spacious play terraces below and above each other. The questionnaire again captured statements that characterize wood as a material that has a very warm and soothing effect. Teacher Taja Kidrič claims: *"Man has always been connected to the forest, trees and nature. The forest and trees have always offered us protection and food, wood certainly has a good effect on psychological well-being"*, he continues: *"Wood has a very positive effect; the space seems more open, warmer and comfortable; wood as a material brings well-being to children, which indirectly affects their concentration during educational processes".*

Fig. 7. Kindergarten in the village of Šoštanj, the design of the facade of the school does not indicate that it is a wooden building. (Photo: Jakub Hanták, 2021)

Vrtec Polzela

The kindergarten in the village of Polzela was built in 2014, it was designed as a wooden extension to the existing kindergarten in the village; the investor was the municipality of Polzela. The roof of the kindergarten consists of several gables which are a natural continuation of the existing building (Fig. 9). The original building can be characterized as a prefabricated wooden structure with elements of brick walls; unfortunately, there is no visible wood in the interior. It can only be found in the new extension to the building. The roof is made of prefabricated sandwich wood panels used in the construction of shopping centres, which is an innovative and low-cost solution. The construction took only four months, including the modified outdoor playground. The extension expanded the original kindergarten with five new playrooms (Fig. 10), a gymnasium, a teacher's room, and an intergenerational centre. The questionnaire indicated that the wooden material has a warm effect not only on children but also on teachers and educators; its colour and texture calm them and gives them a feeling of a natural environment or a feeling of greater cosiness. When asked if they would change anything related to the architecture in their school, respondents offered no objections to wood as a material. Their reservations were directed exclusively towards construction-architectural solutions or technical installations.

Fig. 9. Kindergarten in the village of Polzela, the continuing morphology of the gables, expanding the former kindergarten building. (Photo: Miran Kambič, 2017)

Fig. 10. Interior of the kindergarten in the village of Polzela, panels with exposed wood induce a feeling of warmth in the users. (Photo: Miran Kambič, 2017)

Fig. 11. Kindergarten in Škofja Loka, wooden facade indicating the supporting wooden visual material. (Photo: Jakub Hanták, 2021)

Vrtec Škofja Loka

The kindergarten in Škofja Loka was built in 2019, on the site of the former barracks at the foot of Kamnitnik hill. The construction of the kindergarten was financed through the public sector, and it is a state kindergarten. It is designed as a two-story building of simple volumes, consisting of cubes of play classrooms shifted in height and plan. Between the cubes, there are spacious play terraces below and above each other, just as it was in the case of the kindergarten in the village of Šoštanj. The used wooden building material, which forms the primary essence of the building - a wooden building, is indicated by the wooden facade of the exterior (Fig. 11). In the interior, there is wooden look material on load-bearing walls, ceilings, furniture and window and door frames (Fig. 12), even in the flooring of playrooms (Fig. 13). Wooden elements can also be found in the interior furniture, which is supplemented with various wooden play elements, e.g. in the form of climbing poles (Fig. 14).

Fig. 12. Hallway space and a view of the playroom with CLT load-bearing panels with a fine finish. (Photo: Jakub Hanták, 2021)

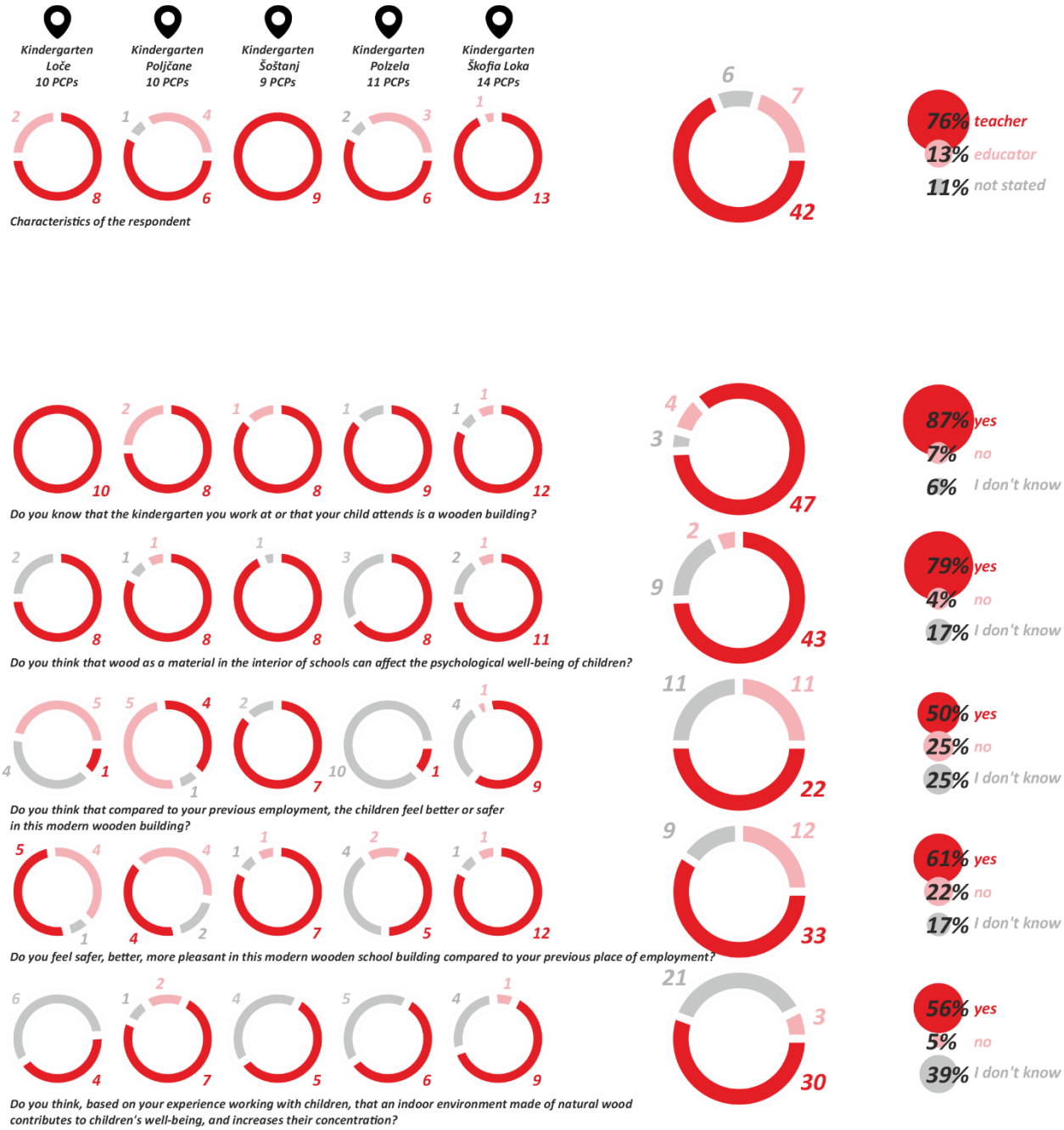
The questionnaire respondents are convinced that the wooden material in the interior of their school calms the children; it is not only the premises as such, but also the materials used in the premises which can make the children feel at home without appearing formal. The respondents also stated that wood and wooden surfaces have a positive influence on the children's concentration, because they have a warm, homely, and calming effect. Such statements were repeated many times despite the fact that the questionnaire was filled out by different respondents. Wooden surfaces are warmer and more pleasant to the touch, wooden material calms children and this is one of the prerequisites for their concentration on education. There was even an opinion that Montessori pedagogy promotes the use of wood and other natural materials in the environment of kindergartens; children are said to be able to calm down also when in contact with wooden toys. When asked if they would change anything about the architecture of their kindergarten, respondents had no objections to wood as a material. Their reservations were directed exclusively at the construction-architectural solutions, which are not the subject-matter of this article.

Fig. 13. Playroom space with wooden floor. (Photo: Miran Kambič, 2019)

Fig. 14. Interior furniture in the form of climbing poles. (Photo: Miran Kambič, 2019)

RESULTS AND FINDINGS

Tab. 2. Graphic interpretation of the obtained results from Slovenia (PCPs - participants). (Author: Jakub Hanták, 2021)



Kindergartens in this article were chosen because they characterize designing that uses the principles of biophilic and restorative environmental design. Based on theoretical knowledge and conducted case studies, several following findings can be derived. The presence of visible solid wood regarding the architecture of kindergartens seems desirable, which has also been confirmed by the results of the questionnaire (Tab. 2). The partial results from the questionnaire show that up to 79% of the interviewed teachers think that wood in the physical environment applied in the premises of their kindergarten affects the psychological well-being of children. More than half of the respondents are convinced that wood as a material increases children's concentration during educational activities, because the presence of wood makes children feel calm and this is one of the basic prerequisites for their concentration in the educational process.

CONCLUSION

The theoretical starting points and previous research activities, which partially touch on this topic, have offered other stimulating questions with which we would like to expand our research. The biophilic and restorative environment of kindergarten interiors should meet the needs of today's children in terms of their progress and development. And not only because contact with nature is gradually disappearing from the traditional and existing interiors of kindergartens, but also because such an environment can teach the children, make them responsible and prepare them for life with respect for both nature and for themselves. Based on the field research abroad, we have found that the questionnaire respondents are convinced of the benefits of using wooden material in the interiors of their kindergartens. They perceive wood as a far better choice than the use of conventional materials that make the interior impersonal, cold, or even hostile to the child users.

An interesting result of our research was also the finding that the Slovenian education system does not recognize crèches. Slovenian children attend kindergartens from an early age (from the first year of life - up to the age of six), and they are divided into two grades. This systemic solution does not stress children with a change of the environment, and already at an early age, when their perception of the world is most sensitive, they find themselves in an environment that, thanks to the materials in the physical environment, positively shapes them. However, we still feel that our research has some shortcomings as we have examined the effects of wood material only on a sample from Slovenia. We would like to expand our research with a survey of wooden kindergarten buildings in Austria and the Czech Republic and compare it with designs of Slovak kindergartens. The result will be a comparative study that synthesizes knowledge regarding the influence of wood as a material on educational processes in the context of the Central European region.

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ISSN 2729-7640

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ALFA ARCHITECTURE PAPERS
OF THE FACULTY OF ARCHITECTURE AND DESIGN STU
www.alfa.stuba.sk

3/2022 (Vol. 27)
DOI: 10.2478/alfa-2022-0018

In the pixel zone: Perception of digital design

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ARTICLE INFORMATION
Sent: Jul 20, 2022
Accepted: Aug 5, 2022

Abstract: Since the beginning of the millennium, the internet has undeniably influenced everyday life as well as the creative fields, in countless ways that have already been exhaustively discussed. In this paper, we discuss the term postdigital, which is relevant to anchoring the perception of digital design. Numerous theoretical works are dealing with the terminology of postdigital, with conceptualisations differing from one another. Postdigitality offers a set of speculative strategies with the intention of building a complex architecture for thinking and creating under contemporary conditions: how to critically consider, contextualize, and shift the perception of new technologies as part of the existing culture. Digital design has become an integral part of everyday reality: websites, mobile devices, tablets, but also products and services that use digital interfaces as interactive communication channels between a human and a machine. These interfaces require a specific approach to design. The term *digital design* covers the design of the entire range of digital products and services and is understood as a complex set of many disciplines: user interface, interaction design, information architecture, user experience design, visual design, web design, app design, or game design. The boundaries between the different areas of design are blurred and permeable, and although their mutual interaction can be beneficial, it is necessary to clearly differentiate between graphic and digital design. Digital design grows out of the principles of graphic (visual) design and introduces additional knowledge and very specific principles based on the nature of the digital medium and the transdisciplinary field of cognitive ergonomics.

Keywords: digital design, web design, postdigital, digital natives, communication design

INTRODUCTION

The perceived quality of content is often conditioned by visual presentation, which corresponds to the perception patterns of the youngest generations, where there are only a few seconds of time for infiltration of the mind. One of the most emblematic platforms of today, the web, offers the potential to address this shift in perception, making use of the principles of user interactivity. New rules and new ways of communicating content emerge on this transformative platform, exploring contemporary cognitive processes. The purpose of this paper is to provide insights into the currently forming discipline of digital design and its perception through the perspectives of postdigitality. The goal is to explore and discuss the term digital design in the context of its various applications and its positioning within the graphic design, from which it emerged. Specific focus will also be set on web design in order to enhance the understanding of one of the core areas of applied digital design.

IN THE PIXEL ZONE: ON THE CONCEPT OF THE TERM POSTDIGITAL

Since the beginning of the millennium, the internet has undeniably influenced everyday life, as well as the creative fields, in countless ways that have already been exhaustively discussed. In this section, we explore the term *postdigital*, which forms the base for anchoring the perception of digital design. There are numerous theoretical works dealing with the terminology of postdigital, with conceptualisations differing from one another. Thus, we do not attempt to find a universally valid definition of postdigitality or to list theoretical works and approaches devoted to it. We use the term postdigital in the context of theories that we find relevant to our work. We quote from the American art professor – Mel Alexenberg's *The Future of Art in a Postdigital Age* (2011), as well as from British authors – David M. Berry and Michael Dieter's *Postdigital Aesthetics* (Cramer, 2015). The notion of postdigitality is thoroughly explored on the online platform *Post Digital Culture*, which has been collecting articles and publications dealing with the phenomenon of postdigitality in a broad art-society context since 2013. Thus, we are supplementing our knowledge with other relevant sources.

"It is impossible to examine the world without examining the means by which we examine it." (Silverio, 2016, p. 112) The digitization of key aspects of our being is significantly shaping the ways we perceive and think through the things we are surrounded by (and saturated with). As Cascone notes in his essay on postdigital tendencies, *"The tendrils of digital technology have in some way touched everyone."* (Cascone, 2000, pp. 12-18) The fact that digital media and new technologies have been significantly reshaping patterns of perception for several decades now naturally leads us to what can be described as a critical reflection on the digital age. Exploring the implications of the digital age and seeking to understand the phenomena associated with it is thus best captured by the term postdigital.

This term does not refer to 'life after the digital', as its prefix might suggest, but expresses the digital age and confronts it with the present. In his book *The Future of Art in a Postdigital Age* Mel Alexenberg speaks in the context of the discourse of digital art practice about a kind of humanization of digital technologies, which, according to him, in our rapidly changing relationship to digital technologies and art forms are more concerned with the human rather than digital existence. He demonstrates this idea through the connection between humans and digital technologies: the exploitation of the potential of synaesthesia (haptic, kinaesthetic, auditory media experiences), the interaction between digital, biological, cultural, and spiritual spheres, and the artworks produced by alternative media through participation, interaction, and collaboration, in which the role of the creator (digital designer) appears in a new context. (Alexenberg, 2011, p. 10)

In the optics of Florian Cramer, the term postdigital – in its elemental essence – describes the chaotic state of media, art and design after their digitalization. He sees digitalization as an expansive disruption of the analogue world when society had yet to get used to new forms of content. The new media are united by their fundamental characteristic – they are based on the digital encoding of data. (Macek, 2013) The postdigital situation is no longer perceived as disruptive; on the contrary, it becomes the counterpart of the new media. (Cramer, 2015) The terminology associated with and used in relation to media of such nature is somewhat variable: new media (a term established by consensus by the professional community) are also referred to as interactive, networked, or digital media, thanks to the increasing possibilities of interaction between the user and the medium. Postdigital is therefore not to be understood as a term that refers to the use of new (hitherto unknown) tools – media, but as a term that absorbs the ubiquity of the digital, reflecting new contexts and ways of thinking about the media: the postdigital balances the digital.

Postdigitality offers a set of speculative strategies with the intention of building a complex architecture for thinking and creating in contemporary conditions: how to critically consider, contextualize, and shift the perception of new technologies as part of the existing culture. The post-digital condition must then be seen not only through the prism of theory. The essential takes place at the level of creative practice. The online platform *Post Digital Culture* represents an imaginary breeding ground for the cultivation and expansion of the concept of postdigitality, which is seen in this discourse as a very useful means of critical reflection on ideas related to the digital sphere. According to the authors of this platform, postdigitality is a constantly forming concept that does not have an exact and fixed meaning (as phenomena that can be included under this term are still happening around us), and therefore its openness and dynamic nature correlates with the form of the web (virtual) platform. It is the web as a presentational medium of today and web design as a product of digital design that are central to demonstrating the context of the postdigital conditions of design practice, which we understand in terms of the theories outlined above.

BETWEEN THE PHYSICAL AND THE VIRTUAL: DIGITAL DESIGN

Digital media

There are several names for communication media based on digital signals which were originally developed exclusively for computational tasks but which, as the development of digital computers in the 1950s and 1960s showed, are capable of carrying *de facto* any type of content. The most frequently encountered term in professional discourse is *new media*, which, however, causes a certain degree of controversy by the nature of its temporal relativity. As Jakub Macek points out, the adjective digital seems to be the most appropriate label for these media. (Macek, 2013, p. 19) Terminologically, it correlates best with our prism of the issue. Lev Manovich outlines five basic principles that are the determinants of digital media: numerical representation, modularity, automation, variability, and cultural recoding. (Manovich, 2018, pp. 33-49) These correspond to the primary features of digital media: we can copy them, search them (read them contextually), compress them, use various devices to reflect the fluidity of their composition and interact with them.

Digital design

"It may seem that the electronic media have already completely absorbed us, and that the virtual world is imperceptibly intertwined with our lives beyond the scope of our 'display'," (Noga, 2014, p. 8) Pavel Noga writes in his *Design on the Road*. The phrase 'on the road' seems appropriate for the development and acceleration of graphic design in today's context. The plethora of technological possibilities and the reality of the close presence of forms of digital communication has given rise to a new, dynamically developing discipline – digital design. The past exploration of the meaning (and nature) of the word design and its definition has been the subject of countless texts reflecting contemporary conceptions of design and the evolution of and debates about its central categories. In recent years, the overuse of the term has also been the subject of debate among the professional community. We believe that the phenomenon of oversaturation of the term design is closely related to the boom of digital technologies and the rise of amateur users and creators. This issue is also addressed by Robert Špaček in *The Mythology of Design.* (Špaček, 2011, pp. 105-113)

The historical anchoring of the origins of design as such is a very complex issue. The starting point for exploring design in its broadest possible context can be seen as the prehistoric record of the life of a human ancestor who created the fist wedge, a (communication) tool that became a model for multiplication. According to Kolesár, this refers to one of the elementary meanings of the word design. (Kolesár, 2009, p. 7) In *Diverse Tasks of Design Studies*, Victor Mragolin notes that the term design refers to both the activity itself and the resulting product. (Mragolin, 2005, p. 119) This is consistent with its definition according to the Cambridge International Dictionary of English, where the word design is both a verb and a designation of substance. Ľudovít Petránsky defines graphic design as one of the most essential parts of visual communication, which in an inventive way expands the possibilities in creating the cultural identity of society and man in its context – he points to the significant depth of the ontological rootedness of graphic design in the context of other artistic expressions. Graphic design reflects the scientific knowledge about human beings, it deals with the psychology of perception of shapes, colours and fonts and the laws of communication. (Petránsky, 1994, p. 39) It is an indisputable fact that digital technologies have fundamentally extended the range of action of graphic design. The question arises as to whether a digital designer can succeed merely with the knowledge of graphic

design principles and an understanding of the nature of the digital medium with which they are working (which is crucial for a digital designer).

It can be concluded that the boundaries between the different areas of design are blurred and permeable, and although their mutual interaction can be beneficial, it is necessary to clearly differentiate between graphic and digital design. Digital grows out of the principles of graphic (visual) design and adds to it specific knowledge as well as specific principles based on the nature of the digital medium. Digital design in the context of the postdigital age should thus be perceived from a broad perspective determined by the nature of the blurring of boundaries between individual disciplines and its understanding in contemporary discourse, crossing the territory of the digital and the physical, brought about by the internet in the last decade of the 20th century. This is evidenced by observing university studios focusing on digital production, but with heterogeneous names: Digital Design Studio at Tomas Bata University in Zlín, Graphic Design and New Media Studio at UMPRUM (Academy of Fine Arts, Architecture and Design in Prague), Visual Communication at Academy of Fine Arts and Design in Bratislava, etc.)

Our interest is focused on this emerging sphere of design, which originates from the nature of the new, a digital medium with a highly interdisciplinary nature: *"Design as culture is therefore related to disciplines that study human activity, for example sociology and anthropology, and to disciplines that deal with objects, e.g. art history or material culture."* (Kesner, 2000, p. 111) The object of interest in the study of art history is visual artefacts of aesthetic value that are excluded from the sphere of practical everyday life. However, the essence of graphic design, which also represents a visual object, lies in being an integral part of the existing and functioning of the everyday. From this perspective, graphic design is a part of visual culture, which in recent years has defined a new field for the study of the cultural construction of the visual not only in art, but also in the media and everyday life. The perspective of visual studies is to view culture as a system of relations and to analyse the forms of the represented and their meanings with respect to different media and forms of communication. *"Visual culture studies conceive media and images in their complex relationship and seeks to create a new discipline that transcends the traditional narrow conception of visual culture."* (Sturken, 2009, p. 464)

The changes in visual language brought about by the rapid emergence of digital media in everyday life are thus reflected in the professional discourse that speaks of the need to find new methods and approaches to presentation in virtual environments. Digital design has become an integral part of everyday reality: websites, mobile devices, tablets, but also products and services that use digital interfaces to communicate: *"It is always a dialogue between you and a machine that someone had to design."* (Marvan, 2017, p. 9) The term digital design therefore entails the design of the entire range of digital products and services and is understood as a complex set of many disciplines: user interface, interaction design, information architecture, user experience design, visual design, web design, app design, or game design. For example, the authors of the 2007 *Design Dictionary* (Erlhoff, 2007) do not provide a comprehensive definition of digital design; under this term, the dictionary refers to interface design and web design. While each of these disciplines is specific in its focus, it is not limited to its problems – there is a high degree of co-existence and conditional connectivity between the disciplines. In his dissertation *Action in Design,* Bohuslav Stránský answers the question of whether to distinguish digital design from graphic design, aiming to prove that digital design is an autonomous discipline that has its own unmistakable specificities and brings new demands on the designer, linked to the nature of the digital medium. Stránský considers the central theme of digital design to be the issue of human-machine interaction.

Nonlinearity as emblematic language of digital media

The language used by traditional visual media is of linear nature. Alongside it, a nonlinear interactivity is developing, characteristic of new media, which is determined by the nature of the hypertextual organisation of text and image: hypertext is inherently based on the contextual reading of the content. In practice, this means that the user becomes a co-creator of the content, choosing his or her own paths of consumption. This creates a plethora of scenarios with no clear beginning or end. In the context of the issues raised, Catherine McCoy points to the need to take cognitive psychology into account to help understand the processes of perception and processing of newly organised (nonlinear) information. (Poynor, 1998, p. 52) The cognitive abilities and perceptions of contemporary humans have naturally changed as a result of embedding digital technologies in everyday life. The accelerating volume of visual material and the speed of perceptual change can be defined as a dominant and highly topical feature of the contemporary visual environment. *"The visual experience of an increasing proportion of the population is thus determined by a 'digital logic' that mixes different forms and elements of perception and information transmission, erasing, or at least challenging the traditional order and contrast of image and word, of image and word culture."* (Kesner, 2000, p. 113)

As Ladislav Kesner observes, everyday consumption and the associated processing of visual information is increasingly displacing the vision of the static isolated image. Perception is fragmenting, turning into systematic cuts and ruptures, which entails a breakdown of observation skills, concentration, and attention. (Kesner, 2000, p. 111) Kesner also highlights the issue of perception of complex symbolic systems in the context of the influence of digital media on our perception and consumption of visual material. Design practice demands a new model of visual thinking, seeking new ways to shape and organize meaning in a digital interactive environment that offers the interpretation of meanings from multiple perspectives in parallel. Yet, new perceptual experiences and newly formed cognitive dispositions are transferred from the digital environment to everyday experience. Therefore, it would be appropriate to take these aspects into account in contemporary creative practice, as well as in mainstream promotion in virtual environments and standard public space. A new visual language should reflect the knowledge and experience of the new digital medium on the one hand, but on the other hand, it should accept and reflect by its nature the current cognitive abilities that can contribute to a more effective perception.

WEB DESIGN: LIVING ORGANISM AND PRESENTATION PLATFORM

On 30 April 1993, the Word Wide Web opened to the public for the first time; all the software needed to run the server, along with the first browser, were made available for free. This day can be described as the imaginary cradle of the web as we know it today, but also as the cradle of web design. The Word Wide Web has become an essential part of today – according to Siteefy statistics, 10,500 new websites are added to the internet every hour. (Huss, 2022) Although the coexistence of digital media with humans is constantly evolving, we are able to define the characteristics that, with new media, shape the unmistakable nature of digital (in this case, web) design. *"The digital image alerts us that its reality is necessarily artificial and absent. It is both here and not here."* (Mirzoeff, 2012, p. 46) Among the specifics of web design, which we have defined on the basis of our own practice and knowledge of professional literature, are: the conditional control of designers over the designed digital products, because they can

only conditionally define how the individual elements of their design will be displayed on the user's screen. As mentioned above, the medium of the web platform is highly nonlinear by its nature. It opens up the issue of contextual reading of content and raises the question of the degree of surface perception of content. This is very closely related to the interactive nature of the web, which is undeniably an elementary property of digital media. No previous media has managed to offer such a degree of interaction between itself and the recipient. Understanding the interface as a common boundary at which a user who wants to accomplish a task meets the product or artifact that is supposed to perform that task has increased user involvement in the design process. (Erlhoff, 2007, p. 225)

A change in the standardized perception of composition must be considered a significant feature. On the one hand, no single format can be defined (as is the case with print media), which corresponds to the wide variability of digital devices. In this context, we speak of the so-called responsive layout. The final image, perceived by the user, is composed by scrolling, clicking, etc., and therefore has the nature of non-definiteness and variability: for each user, the final image is different and inherently incomplete, as the screen of the digital device does not display the content in its entirety, nor does it give explicit instructions from where to where the content must be read. The distinctive feature that differentiates the web from previous media also occurs in the question of time and mutability**:** information and modules or additional elements can be modified, appended (edited) on the web in response to the current users' needs. This opens up the question of the limited lifespan caused by the outdatedness or obsolescence of a website, which is often solved in practice by redesigning the existing website. The original design can no longer be found (only in the 'inanimate' designs of the designer), as opposed to a book or tangible design product. Therefore, the launched website is not a definitive (immutable) medium – on the contrary, it functions as a living organism.

The two decades of its evolution have also had a significant impact on the role of the designer, who should reflect all the specificities that the digital medium brings and accept its evolution: *"The incredible technological possibilities and the virtually unlimited impact of all digital forms of communication today give every graphic designer the opportunity to influence public opinion. Then it's just a matter of not being afraid to take advantage of it, but at the same time not to abuse the design..."* (Noga, 2015, p. 22) So there is no doubt that the use of media in any branch of design changes the nature of the work. The field of digital design in general, as well as the process of designing the digital product is described in *Digital Design: Looking Beyond the Pixels* (Marvan, 2017). Concurrently, a traveling exhibition under the same title was created under the auspices of CZECHDESIGN and the UX Association, with a view to educate people about digital design. In the same year, the dissertation of the head of the Digital Design Studio at Tomas Bata University in Zlín, Bohuslav Stránský, entitled *Action in Design*, was defended. The thesis defines digital design as an emerging autonomous discipline, which differs in its specifics from the graphic design of printed media. From the point of view of narrative and contextual reading of a digital product, the thesis *Storytelling in the Digital Age,* authored by Paweł Ratajczyk (2018), deals with the issue of narrative and contextual reading.

DIGITAL NATIVES

Marc Prensky introduced this concept in his essay *Digital Natives, Digital Immigrants*, by defining generational differences in the perception of digital media. In the essay, he elaborates on the concept of 'digital natives', i.e. young people who have been surrounded by the world of digital technology since birth. Computers and the internet are a natural part of their lives, they have no direct comparison with analogue experience, and this creates new patterns of thinking and perception: *"Today's students are native speakers of a digital language."* (Prensky, 2001, p. 1) The authors of *The New Digital Natives* (Dingli, 2015) then elaborated the term in more detail and enriched it with the classification of 'digital natives' and the characteristic specifics associated with this generation. In Prensky's essay, we also encounter the term *digital immigrants,* which Prensky uses to refer to a group of people who were not born into a world pulsating with digital technologies, but only learned about its influence later in life.

COGNITIVE ERGONOMICS AND DIGITAL DESIGN

Cognition is a mental process that forms the basis of our abilities to perceive the world, remember, talk about our experiences, learn from them, and modify our behaviour based on them. Thus, every cognitive process serves to transform, reduce, elaborate, store, retrieve, and use sensory input. The subject of ergonomics is the relationship between technology and human behaviour. The etymology of ergonomics is based on two Greek words: *ergon* – work, and *nomos* – laws. In a nutshell, ergonomics is concerned with making technology work for people. The term cognitive ergonomics is a transdisciplinary field that deals with the degree of responsibility and suitability of a product to the cognitive abilities of its users. Thus, a wide range of design fields (e.g. user experience design, interaction design, emotional product design, visual communication design, etc.) can draw on insights from this field to ensure more effective usability. (Sougata, 2021)

Digital design in service of education

The importance of understanding cognitive ergonomics and implementing its principles through digital design for the purpose of improving the perception of educational content can be exemplified by awarded projects from this specific field of design. In the context of competitions and awards, a gradual increase in the autonomy of digital design can also be observed in the last few years in the domestic (Czech and Slovak) environment, such as *Národná cena za komunikačný dizajn [The National Award for Communication Design]*, awarded biannually, and the annual *Best in Design* competition with the *Communication Design* category. The *Národná cena za dizajn* award *[The National Design Award]* had no specific category for digital design until 2020. A new category called 'Digital' appeared for communication design works in the 17th edition of the competition. This category is designed for projects whose primary purpose is visual communication and interaction in digital media. The first winner of the 'Digital' category was a website with educational videos that brought art closer to its youngest recipients – *Podivuhodné dejiny umenia s profesorom Škrečkom [Strange Art History with Professor Hamster]* by Ondřej Horák and David Kalik (2019). Although the *Best in Design* competition does not have a specific category for digital design (digital products are categorised here under Communication Design), in the last three years the winning projects in this area have been dominated by digital design products: *Znakověda [Signology]* by Silvia Klúčovská (2020), *Česká vlajka.online [Czech Flag.Online]* by Julie Dítětová and Jáchym Moravec (2021), *Buď Digitál [Be Digital]* by Adam Komůrka (2021) and this year's web platform *Listovatel [Scroller]* by Karla Gondeková and Karolína Matušková (2022).

The free web platform *Listovatel [Scroller]* provides access to well-crafted worksheets for children. (Fig. 1) It was created to develop children's creativity and sensitivity to the world around them. *"We want to present the digital world as a useful medium, but one that children should learn to regulate so that the virtual world does not completely engulf them."* (Matušková, 2021) On the

contrary, the awarded *Podivuhodné dejiny umenia s profesorom Škrečkom [Strange Art History with Professor Hamster]* remains, by its nature, in the digital environment. It speaks to child percipients through educational animated videos accompanied by the character of Professor Hamster. The childlike playfulness here is supported by the web design itself, which includes an unobtrusive web animation of two hamsters playing ping-pong, whose game always continues with page scrolling. (Fig. 2) The website *Znakověda [Signology]* serves as an educational synesthetic aid that combines visual and haptic sensation, allowing the user to follow the movements exactly as instructed, with immediate correction. Therefore, it replaces the functionality of the course tutor. (Fig. 3) The website *Česká vlajka.online [Czech Flag.Online]* accumulates comprehensive rules for the use of the Czech national flag. It thus functions as the only comprehensible and comprehensive aid, dealing with the flag and explaining its correct use. We consider the above-mentioned projects to be appropriate demonstrators of the phenomenon of the humanisation of digital technologies, which reflect contemporary needs and exploit the potential of interaction between the digital, cognitive-ergonomic, and cultural spheres.

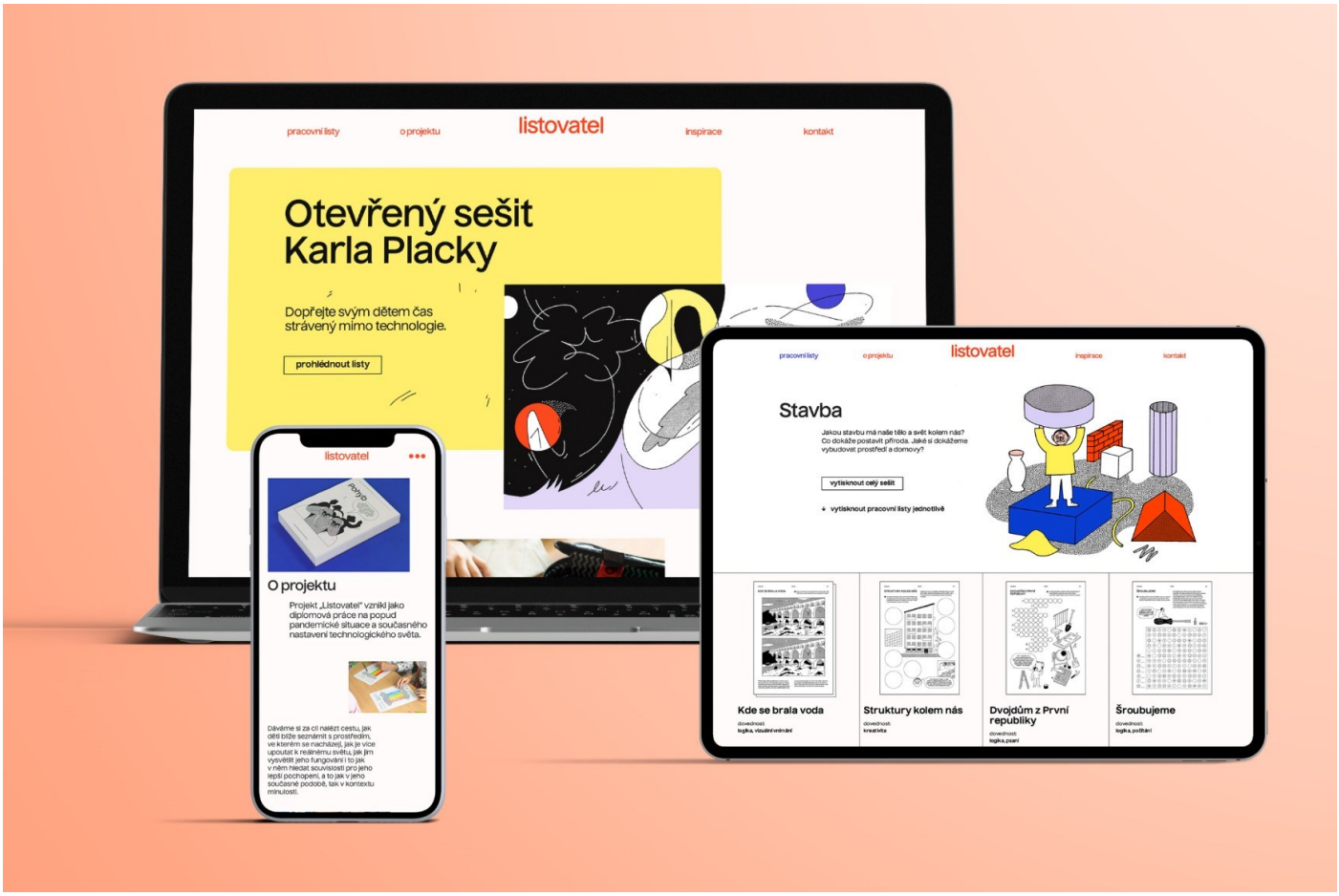

Fig. 1. 2022 *Best in Design* competition, winning web platform *Listovatel [Scroller]*. (Source: UMPRUM, 2022)

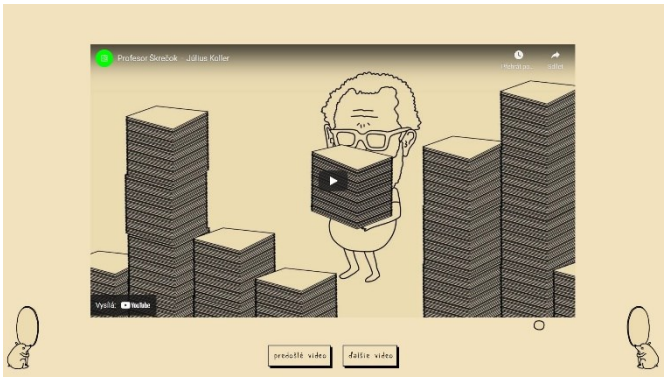

Fig. 2. Snapshot of the awarded website *Podivuhodné dejiny umenia s profesorom Škrečkom [Strange Art History with Professor Hamster]*. (Source: Koller, 2019)

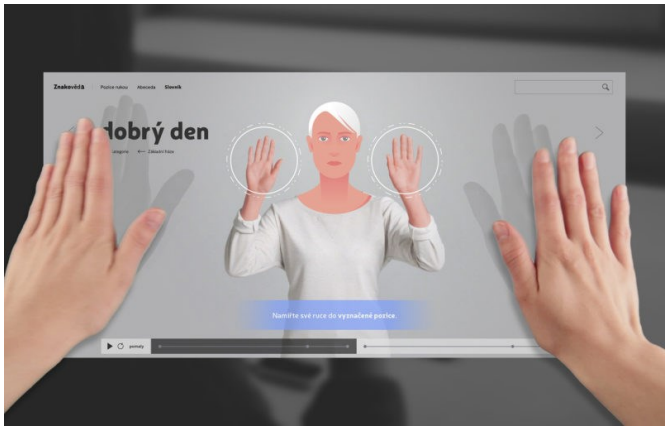

Fig. 3. Design of the award-winning project *Znakověda [Signology]*. (Source: Tomas Bata University in Zlín, Czech Republic, 2022)

CONCLUSION

The web as a work of digital design represents the most emblematic platform of today and definitely is one of the most freely composed, flexible, creative and interactive platforms the humankind has developed so far. It offers a versatile and multidisciplinary ground for exploration of forms for communication of various contents. It utilises and further redefines the principles of cognitive ergonomics. In its very nature, it can support the principles of democracy and also enables the demands of universal design to be satisfied. The flexibility and interactivity of the web has also great potential in the sphere of education and awareness building within diverse fields, which is also demonstrated by the number of awarded projects within digital design competitions. Contrary to other forms of graphic design or arts, both web design and digital design *per se* are unlimited in form, have a fluid composition and can be perceived very individually. New rules and new ways of communicating content emerge on this transformative platform, exploring contemporary cognitive processes.

Digital design reacts to the way of thinking of the so-called digital natives – young people who have been surrounded by the world of digital technology since birth. Computers and the internet are a natural part of their lives, they have no direct comparison with analogue experience, and this creates new patterns of thinking and perception. Digital design offers little limitation from the perspective of affordability and accessibility. At the same time, these are in fact also endangering, as incompetent designers have the same possibilities as those being competent – resulting in degradation of quality and increasing misuse for spreading of disinformation and deception. Such design benefitting particular social groups can be referred to as to *unpleasant design*. If we do not improve the awareness of the power of this media and do not educate the new generations about the need to critically filter information and regulate one's immersion into the digital world, it can affect the healthy development of the society. The digital world, which we created (and are still creating) might get too tempting by its lightness and carelessness in comparison to the reality of the physical world we are evolutionary destined for.

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ISSN 2729-7640

ALFA ARCHITECTURE PAPERS
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3/2022 (Vol. 27)

Summaries

ARCHITECTURAL STUDIES IN THE EUROPEAN HIGHER EDUCATION AREA: CRITERIA FOR STUDENT DEGREE MOBILITY

Dimitra Konstantinidou

Keywords: degree mobility, architectural studies, criteria, master's studies

The European Higher Education Area, implemented after the Bologna Process and with the assistance of the European Union, brought together 49 countries, both members and non-members of the EU, in an attempt to make the higher education system in these countries more compatible and facilitate the mobility of students and staff, while suggesting tools to facilitate it. The main points of the Bologna Declaration and the pillars of the European Higher Education Area are: comparable and understandable qualifications, the diploma supplement, two cycles of studies: 3 years for the bachelor and 2 years for the master degree, the Unified Workload Transfer System (ECTS), promoting the mobility of students and teachers, quality assurance with cooperation between institutions, and the promoting of the European dimension of higher education. Mobility, as various research reports showed, assists each participant in gaining experience and growing at a personal level, but most importantly, provides an easy tool for Higher Education Institutes to improve and take advantage of the experience that their staff and students gain while teaching or studying at other institutions. Mobility can be a way to support a common European identity and a strategic way to improve quality of higher education institutes, providing an opportunity for cooperation and creative comparison among them. Architecture, due to its special character as both an art and a science discipline, and also one of the regulated professions with specific characteristics regarding the duration and subjects to be taught, is chosen as the education area most suited for mapping degree mobility and highlighting the characteristics that differentiate each school in terms of attraction to international students. On what criteria do architectural students select the school to continue their studies? There were more than 350 schools of architecture (in 2018) in the European Higher Education Area. Do international architecture students choose them for second cycle studies in the same degree? What makes a difference between them, causing some of them to become schools of excellence selected by the majority of students while others are barely visible in international competition? The research was completed in 2 questionnaires, collecting data during the academic year 2018-19. The first questionnaire was sent to 351 schools of architecture. We have collected 103 answers which is quite a representative random sample of almost all the EHEA countries. The second questionnaire was addressed to master students from the 50 schools that returned the first questionnaire and declared incoming students, with 101 answers from master students from more than 20 countries. Our sample is random and statistically adequate, coming from an adequate random sample of schools. Pointing out the criteria students use to select the higher education institution for their second-level studies, and thereby the parameters the school can work with to achieve a better international recognition, is the question of this research. Combining the results of both questionnaires, one submitted to architectural schools and the other one to students,

regarding the reasons students select some schools over others, we see that both schools and students rank study programmes very high. As during the first cycle the basic knowledge of architecture is covered, at the master level deeper knowledge is gained and schools provide specialization to respond to today's requirements, allowing students to build their own curriculum according to personal inclination. Well-trained teachers, with international experience and great teaching methods, add to the school's value and attract students. From the viewpoint of location of the school, both students and schools mostly rank highly schools that are situated in capital cities, or cities with growing economies and cities with nationwide influence which is a parameter that schools cannot control. Regarding financial growth, schools in cities with stronger economies can co-operate with developed and well-known businesses, giving their students a chance to work. Students wish to experience living in a developed country and city, where they can work during or after their studies and can find opportunities to continue their studies to the third cycle. Students consider the cost of living and school fees, but do not define whether high or low is rated negatively or positively, having also in mind labour market needs. Students who participated in mobility at some stage of their studies, highly rate the teaching taking place in English, as a criterion to choose a specific master's study program abroad. The school's reputation, as is known by graduates, works in favour of the already known schools. Students are affected by word of mouth of former satisfied students and successful graduate architects add points to the known schools. Research, publications, and media reports can help to this effect. Schools failing to attract international students should keep in mind the criteria stated by the master students and make any necessary changes to cope with them. A well-built curriculum, supported by international staff with pedagogical education, international tuition languages – mainly English – and cooperation with businesses and industry, as well as other schools worldwide, can make them more visible across the country's borders.

ON THE EDGE - FUTURE ADAPTATION CHALLENGES: THE ROLE OF FUTUROLOGY, SCENARIO PLANNING METHODOLOGY AND OFF GRID DESIGN IN ARCHITECTURAL AND URBAN TEACHING

Zdeňka Němcová Zedníčková

Keywords: adaptability, futurology, scenario planning, off grid, space architecture, moon base, architectural education

The article describes the role of creative thinking about the future and its importance in architectural and urban education, and suggests ways how it could be implemented into the design process. The first part of the article, 'Futurology', deals with the scientific discipline of futurology and the possibilities of its use in architectural and urban practice. It asks what our world, and our cities, will look like in 15, 20, or 50 years with the global urbanization process accelerating, together with the growth of the world's population, climate change, environmental pollution, and new technologies, which will bring many challenges for cities to face. Additionally, it covers topics that futurology makes available to architecture and their influence on the urbanized environment. It relates the creation of strategic visions for urban development to the UN 2030 Agenda for Sustainable Development and the UN Habitat III initiative and looks back at Agenda 21, a non-binding United Nations action plan with regard to sustainable development. It appreciates that the challenge for cities of the future could be to achieve the highest possible self-sufficiency in energy, water, or food systems as well as in waste management. Finally, it examines the role of architectural education and how architects should prepare for their profession so that their future work solves problems rather than but creating them. The second part, 'Scenario planning', is dedicated to introducing of the futurological method of scenario planning, and its origin and use. It mentions so-called megatrends as the driving forces of future scenarios, effecting future challenges, threats, and opportunities that cities will have to deal with. It refers to scenarios by the Millennium Project, Royal Dutch Shell, and the Slovak Academy of Science's Institute for Forecasting. Further, it provides insight into how this method can benefit architectural and urban work and represents the way it was used during architectural teaching. It reflects on the advantages of creating vision in the educational process. The subchapter 'On the edge' describes how futurology and scenario planning were used in addition to standard current urban and architectural

assignments as a part of the teaching process in the architectural studio at the Department of Urban Planning, Faculty of Arts and Architecture of the Technical University in Liberec, Czech Republic. It suggests that such assignments, freed from the binding stereotypes of everyday reality that incline to routine approaches, are an ideal way to train conceptual thinking that discourages the automatic adoption of safe, proven procedures and attitudes, and thus to practice independent critical thinking. Then it explains how visionary projects provide an opportunity to become familiar with futurology and give space for incorporating the futurological method of scenario planning into the architectural planning process. Finally, it shows how this approach seems to have been long valid in architectural education, as for example as Otto Wagner mentioned in his Inaugural address to the Academy of Fine Arts in 1894. In the last part, 'Off grid', it shows off grid design as a suitable simulator of structural and system thinking, leading to a better understanding of how complex architectural and urban systems function. It highlights the contribution of space architecture projects as a source of innovative thinking, and that these topics opening up many unknowns and fill gaps in the global knowledge is not a futile dream, but rather an important initiator of the emergence of new technologies, processes, materials, and knowledge that enrich our daily lives. It refers to the leading Japanese construction, architecture, and engineering companies Shimizu Corporation and Obayashi Corporation and such of their space architecture projects as Obayashi's Space Elevator Construction Concept, and the Shimizu Dream projects of Luna Ring – Solar Power Generator on the Moon, Lunar Base, or Space Hotel. Attention is also given to Moon base projects by national or private space agencies like NASA and ESA or Bigelow Aerospace and Moon Village. It anticipates that working on space projects where self-sufficiency is a necessity can also benefit thinking about ecology, self-sufficiency, and the sustainability of settlements on Earth. Finally, it explains the intention of work on space architecture and off grid projects in architectural education to enrich not only the creation of vision of terrestrial ideal cities, but also real assignments. Work on two of the author's off grid Moon Base designs is described at the end of the article, based on the aforementioned considerations and assumptions: MOONFLOWER BASE / 2090 - Experimental Agricultural Base with Hotel for Scientific Tourism, and MOONWORM - Nomadic Moon Base, a self-sufficient exploratory scientific kinetic base traveling in Mare Imbrium. Both designs are based on fictional future scenarios. In these future stages, Moon colonization has gone beyond the simple and confined modules of the pioneering research, service, and mining bases. The reason is that these modules were not compatible with long-term residence because of their minimized space, both in terms of the human psyche and as they provided only limited physical space, which could not sufficiently serve the increasing number of activities needed to ensure the Moon's independent sustainable development.

LINKING VIRTUAL REALITY, ARCHITECTURE, AND CRIME PREVENTION FOR EDUCATIONAL PURPOSES

Lucia Benkovičová

Keywords: virtual reality, architecture, crime prevention, security, CPTED, CAAD, BIM, visualization, education

Technology is one component of larger social, economic, and business revolutions that will continue to have a substantial impact on the markets in which architects deliver services. Virtual reality (VR), the popular term for what is generally referred to in the technical field as virtual environment, is a methodology that originated in informatics, optics, and robotics. It has its foundations in computer graphics. The term was used for the first time (in the context) by the CEO of California-based VPL Research Inc., Jaron Lanier, in the 1980s. The term cyberspace, which is frequently used as a synonym for VR in American technical literature, often defined as a space which spreads in another world existing in a computer, appeared for the first time in 1984 in Neuromancer, a science-fiction novel by William Gibson. However, some VR techniques had already been explored in the 1960s. Technological progress now enables blurring the boundaries between reality and the virtual world. VR is an alternate computer-generated world that responds to human interaction and the virtual world is a digital representation of the real world. The user is immersed in the scene through special glasses and normally also headphones and is perceptually isolated from reality in a

360° view. Some interaction is needed. This paper presents selected links between the complex fields of architecture, use of virtual reality (as a part of computer science), and their potential in helping tackle crime. The presented information sets a general background for the development of a put forward prototype of new immersive learning experience to provide deeper understanding of CPTED concepts to enhance the traditional curriculum and the overall retention of knowledge. The theory of education is also influenced by new technologies. There are scientific studies suggesting VR learning may be more efficient than learning in the real world. Educational programs and virtual workspaces are one of the possibilities of using mixed reality in the near future. Current VR systems provide new capabilities for perceptual expansion, for creative construction, and for unique social interactivity. VR seems to be the most humanistic approach to information, and it enables its users to change the world into a place where it is easier to learn. The potential of VR and AR in education can be seen also in mastering core skills in various settings, learning abstract concepts in complex fields (like architecture), or experiential child learning. There are now hundreds of university architecture programmes with VR and AR labs all over the world. VR focuses its users more on the content and stimulation of their senses. It is a good tool to experience phenomena that are impossible or difficult to experience in the real world. Learning can be more effective if it is experiential, which includes strategic problem-solving skills and critical thinking – tasks that virtual reality is perfectly suited for. The greatest effectiveness in learning is usually achieved with different learning styles combined, involving hearing, seeing, and doing at once. VR incorporates all of them. Urban planning and architecture show significant potential for crime prevention. There is a direct relation between crime and architecture of an environment – its layout, quality, maintenance, and management. The main role of architects is to create artificial environment that provides a safe place to live – protected from climate conditions, weather, and from an enemy or intruder. We have also changed the way of designing of and thinking about our cities, including safety. The global nature of crime necessitates international co-operation in the field of prevention. An example is a CPTED (Crime Prevention Through Environmental Design) security concept. Alternative terms may include Designing out Crime (DOC), Defensible Space, or Crime Prevention Through Urban Development (CPT-UD). The CPTED movement officially emerged in the 1970s as an innovation aimed at the reduction of crime with mainly architecture, urban design (urban planning), psychology, criminology, and facility management coming together. There is potential for the use of 'new' visual stimuli in broadening our understanding of housing design, burglary risk and CPTED. These now commonly used technologies can improve our understanding of the links. Both VR and BIM can arguably be used to explore all types of crime and enhance the use of CPTED to prevent such crimes. VR technology is considered to be highly useful for simulating real-life situations that are otherwise too costly or risky to experience. Potential benefits of VR in CPTED can go far beyond a high-quality visualization tool: it can be used in the design, evaluation, and training process. There are not many practical studies on the use of VR for CPTED purposes, which points at a niche for more research to be conducted. VR has also immense pedagogical promise, with the potential to not only assess hypothetical environments, but also to track, shape and inform subjects' thinking towards them. In sum, VR offers a considerable opportunity to gain insights into the general perception of and emotional responses to proposed designs, reduce prototyping costs and design faults, evaluate different scenarios against specific criminogenic variables and identify built environment variables associated with different types of crime.

THE POSITIVE IMPACT OF WOODEN MATERIAL ON EDUCATIONAL PROCESSES IN THE ENVIRONMENT OF SLOVENIAN WOODEN KINDERGARTENS

Jakub Hanták, Danica Končeková

Keywords: well-being, influence of wood, kindergarten, new European Bauhaus, Slovenia

The environment in which children grow up and spend their time constitutes a fundamental aspect of their knowledge, and social and personality development. As in the case of adults, children today spend most of their time in man-made environments. Kindergartens and school playrooms or classrooms are places that significantly influence children. Therefore, such an environment should respect not only their physical

but also the psychological needs. The stay of children in preschool educational institutions such as kindergartens significantly affects their physical, social, emotional, but especially mental development, thus playing a significant role in their development and integration into the society. The feeling of well-being during the child's stay in preschool institutions also depends on the physical conditions of the environment, which has an impact on the children's daily activities and their mental and physical health. Recent research indicates that by applying natural materials and the principles of biophilic design or restorative environmental design, it is possible to reduce the absence of children from schools, improve the health, psychological well-being, increase work performance, and improve the results of not only adults but also children. Several scientific studies confirm that the colors, structures, or materials used in the physical environment of interiors affect the human psyche. Wood as a material applied in the interior spaces of buildings is an attractor that, in addition to its static and structural properties with high environmental responsibility, also brings other benefits to users, and thus has a great impact on the society. The topic of applying sustainable materials and transforming them into newly-built, valuable, and cultural architecture is currently also popular in connection with the new initiative of the New European Bauhaus. The initiative, which has ambitions to use the currently valid national and international legislative frameworks to link efforts to set sustainability rules with an interest in aesthetics and involvement of communities in the creation of new living spaces, is an ideal tool for the popularization of natural materials that can improve the quality of the physical environment in the premises of kindergartens. The contact with natural elements undoubtedly has an impact on the emotional and physiological well-being of children. The theoretical starting points and previous research, which partially touch on this topic, have offered other stimulating questions with which we would like to expand our research. The biophilic and restorative environment of kindergarten interiors should meet the needs of today's children in terms of their progress and development. And not only because contact with nature is gradually disappearing from the traditional and existing interiors of kindergartens, but also because such an environment can teach children, make them responsible and prepare them for life with respect for both nature and for themselves. The presented article is a partial result of doctoral research aimed at studying the positive influence of wood on the psyche of children and educational processes in general. The paper aims to expand the current scientific knowledge about the positive influence of wood material and its impact on educational processes in the architectural environment of kindergartens. Selected analyses and comparisons made it possible to clarify whether the presence of wood material can positively influence the well-being of children in the physical environment of kindergartens, improve their sensory perception, create a sense of safety, a peaceful atmosphere, and, in general, assist in improving the quality of teaching and in promoting social interaction and playful learning. The study examines, analyzes, and compares selected interiors of kindergartens in Slovenia designed by the Kontra studio headed by Mojca Gregorski, who also focuses on the topic of educational facilities at the scientific-research level. In the presented author's research, the wood material is characterized as an interior, visual, massive substance, in an authentic design, with or without a fine surface treatment, which does not degrade its visual-haptic-olfactory qualities. The partial research presented in this paper focuses on the results from the locations of Loče, Poljčane, Šoštanj, Polzela, and Škofja Loka. One of the goals of this research is to identify and summarize the opinions of teachers and educators, to present information about the educational potential of these institutions, to assess their atmosphere as perceived by the respondents, and to find out to what extent wood as a material has an impact on the educational process. Based on the field research abroad, we have found that the questionnaire respondents are convinced of the benefits of using wooden material in the interiors of their kindergartens. They perceive wood as a far better choice than using conventional materials. More than half of the respondents are convinced that wood as a material increases children's concentration during educational activities because the presence of wood creates a sense of calm in children, and this is one of the basic prerequisites for their concentration during the educational process.

IN THE PIXEL ZONE: PERCEPTION OF DIGITAL DESIGN

Kateřina Tesařová

Keywords: digital design, web design, postdigital, digital natives, communication design

The quality of content perception is often conditioned by visual presentation, which corresponds to the perception patterns of the youngest generations, where there are only a few seconds of time for immersion in memory. One of the most emblematic platforms of today – the web – offers the potential to address this shift in perception, making use of the principles of user interactivity. New rules and new ways of communicating content emerge on this transformative platform, exploring contemporary cognitive processes. The purpose of this paper is to provide insights into the currently forming discipline entitled digital design and its perception through the perspectives of postdigitality. Since the beginning of the millennium, the internet has undeniably influenced everyday life as well as the creative sphere, in countless ways that have already been exhaustively discussed. In this paper, we discuss the term postdigital, which is relevant to anchoring the perception of digital design. There are a number of theoretical works dealing with the terminology of postdigital, with different conceptualisations differing from one another. Postdigitality offers a set of speculative strategies with the intention of building a complex architecture for thinking and creating under contemporary conditions: how to critically consider, contextualize, and shift the perception of new technologies as part of existing culture. The postdigital condition must then be seen not only through the prism of theory. The essential takes place at the level of creative practice. The notion of postdigitality is thoroughly explored on the online platform Post Digital Culture, which has been collecting articles and publications dealing with the phenomenon of postdigitality in a broad art-society context since 2013. Digital design has become an integral part of everyday reality: websites, mobile devices, tablets, but also products and services that use digital interfaces as interactive communication channels between a human and a machine. These interfaces require a specific approach to their design. The term digital design entails the design of the entire range of digital products and services and is understood as a complex set of many disciplines: user interface, interaction design, information architecture, user experience design, visual design, web design, app design, or game design. The boundaries between the different areas of design are very blurred and permeable, thus creating the necessary need to define strict boundaries between graphic and digital design. Digital grows out of the principles of graphic (visual) design and adds to it additional knowledge and very specific principles based on the nature of the digital medium. One of the most emblematic platforms of today, the web, is highly nonlinear by its nature. It opens up the issue of contextual reading of content and raises the question of the degree of surface perception of content. This is very closely related to the interactive nature of the web, which is undeniably an elementary property of digital media. No previous media has managed to offer such a degree of interaction between itself and the recipient. Due to this shift in the standardized perception of composition, it is one of the significant features to be considered. Another distinctive feature that differentiates the web from the previous media also occurs in the question of time and mutability: information and modules or additional elements can be modified, appended (edited) on the web in response to the users' current needs. This raises the question of the limited lifespan caused by the outdatedness or obsolescence of a website, which is often solved in practice by redesigning the existing website. The original design can no longer be found (only in the 'inanimate' designs of the designer), as opposed to that of a book or tangible design product. Therefore, the launched website is not a definitive (immutable) medium – on the contrary, it functions as a living organism. Marc Prensky introduced the concept of "digital natives" by defining generational differences in the perception of digital media. These are young people who have been surrounded by the world of digital technology since birth. Computers and the internet have been a natural part of their lives, they have no direct comparison with analogue experience, and this creates new patterns of thinking and perception. Digital design offers little limitation from the perspective of affordability and accessibility. Simultaneously, these are in fact also endangering: because of these factors, it can easily be misused for spreading of disinformation and for deception e.g. by misusing principles of cognitive ergonomics. Meaningless replication and copying of design principles without understanding them leads to degradation of presentation quality of the content. If we do not improve the awareness of the power of this media

and do not educate the new generations – those digital natives (but also the generations of "digital immigrants") – about the need to critically filter information and regulate one's immersion into the digital world, it can have a negative effect on the development of the society. The digital world we have created (and will continue to create and form) might get too tempting for its lightness and carelessness in comparison to the reality of the physical world we are evolutionary destined for.

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ISSN 2729-7640

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3/2022 (Vol. 27)

Summary of approved PhD theses

Andrea Ďurianová
Filip Maukš
Adam Tóth

THE DIY PRINCIPLE IN THE CONTEMPORARY RESIDENTIAL INTERIOR

Mgr. art. Andrea Ďurianová, ArtD.

Producing objects for one's own consumption is a major strand in the historical development of material culture. Making things with one's own hands can be considered a natural means to satisfy human needs. In the present time, this form of production is covered by the term "do-it-yourself" (DIY). DIY has become a global social phenomenon, especially thanks to the opportunities enabled by the Internet. Websites provide a lively forum for discussion, sharing ideas, how-to guides, and galleries of the results of DIY projects. The subject of our research was the historical context, as well as the current starting points, motivations, and inspirations of so called do-it-yourselfers, especially in connection with the DIY home improvements. An interdisciplinary approach and a combination of several research methods were chosen for these purposes. The results of quantitative research carried out using the form of a questionnaire point to the significant benefits that self-production brings to individuals. The DIY home improvement can be a means of individual self-realisation and self-expression and is also related to subjective experience of craft activity. Qualitative research provides a view of current DIY home improvements in terms of unique stories of addressed do-it-yourselfers, who also work in creative professions. Personal statements about the DIY projects in the homes of a jeweler, designer, sculptor-designer, sculptor-ceramicist, architect, creator, and graphic designer-builder approach the researched issue primarily as an individual experience, which is shaped by various circumstances, but also previously gained experience. Research findings contribute to a better understanding of DIY production in the context of design as an academic discipline.

PhD thesis approved at the Faculty of Architecture and Design STU in Bratislava, Slovakia, in the study programme Design

APPLICATIONS OF VIRTUAL REALITY IN THE DESIGN PROCESS

Mgr. art. Filip Maukš, ArtD.

The research focuses on the use of virtual and mixed reality in transport design. Virtual reality hardware and software advancements also enable more extensive use of this technology in the design process. The possibility to visualize new designs in real scale is especially useful with larger objects, such as cars and motorbikes, in case of which the preparation of a physical model requires a significant amount of resources and work hours. Another advantage of virtual reality is the wide range of options for data configuration. 3D data of a new car exterior can be visualized through VR software in various colours and materials. Models can be placed and viewed in a studio or any outdoor environment. It is also possible to change individual parts in real time (e.g. lights, bumpers, etc.) and thus review design variants more quickly and efficiently. We can find similar configurators on car manufacturers' websites, where a customer can enter their chosen equipment specifications, based on which the configurator generates a rendering of the new car's exterior and interior. Car interior must be shaped to meet ergonomic requirements of a human body, while it also comprises a user interface for human-machine interaction. When testing car interiors in virtual reality, an ergonomically

adjustable structure – a simulator – is used. Modular simulators offer various levels of complexity. They include seats, a steering wheel, armrests, pedals, centre consoles, etc. All these elements are configurable according to the manufacturer's car model series portfolio. The primary feature of the simulator is its synchronization with virtual data. The person sitting inside the simulator is shown the new design in virtual reality and they are able to interact with it through the physical simulator. In this mixed reality scenario, the virtual steering wheel lines up with its physical counterpart to provide haptic feedback. The technology that combines a physical simulator with 3D digital data is applied in the author's doctoral thesis to visualize new motorcycle designs. A variable motorcycle simulator was constructed to simulate ergonomics of various types of motorcycles. The beginning of the thesis contains an overview on virtual reality technology. It classifies virtual and mixed reality in the reality-virtuality continuum and provides examples of other interactions between real world and virtual data. HTC and Oculus are companies that raised VR awareness among the consumers. The HTC Vive headset combined with HTC Tracker are used in the doctoral thesis to create mixed reality and explain its principles. The new VR hardware (i.e. headsets) options are involved with software development. Gaming engines like Unreal Engine and Unity, originally developed for creating computer games, are now used in the automotive industry. The software combines quality visualizations with the programming capabilities to programme material configurators or simulate door animations, car roof unfolding, interior mood light changes, and other featured simulations. The "VR – Application and Transport Design" section presents practical and conceptual examples of virtual reality application in development process. An important field where VR keeps improving is creative work. Hence, virtual reality is used not only for final visualization but also as a tool to capture the first thoughts or creating multiple variations of a design idea. Hand-sketching using paper and pen or digital sketching on a graphic tablet still dominate this field. VR modelling software (e.g. Gravity Sketch) is now being developed to enable virtual reality sketching. The user is able to capture an idea of a design directly in 3D space. "Research and Design" summarizes the results from the process of a motorcycle design using VR tools. First, a variable structure had to be constructed to simulate different types of motorcycles. The simulator was then synchronized with 3D data of an electric sports bike and, using the Unreal Engine software, a configurator for changing body and wheel colours was programmed. The simulator was then brought inside the VR modelling software Gravity Sketch. Sketching a motorcycle in real scale around a physical simulator allowed us to mount on and test the new design from the perspective of a rider, from the first sketch. During the last phase students from ŠKODA atelier were involved in the VR project. Each selected student was given an Oculus Quest headset. Consulting and modelling took place in virtual reality using Gravity Sketch co-creation mode and lasted for the whole semester.

PhD thesis approved at the Faculty of Architecture and Design STU in Bratislava, Slovakia, in the study programme Design

RESIDENTIAL COMPLEX AVION IN BRATISLAVA: INTERIOR AND ITS IDENTITY

Mgr. art. Adam Tóth, ArtD.

The dissertation deals with research of the interior of the functionalist residential complex Avion, designed by the architect Josef Marek in 1932 in Bratislava. Since 1985, Avion has been declared a national cultural monument. The research focus is on the factors of interior identity, responsible for the characteristic atmosphere of the interior. The hypothesis assumes that the material factor is the building's interior, the emotional factors are the inhabitants of the complex and how they perceive the interior. Research identifies individual elements of the building interior, and the hierarchy of their value is determined, necessarily taking into account the criteria of monument protection as well as the criteria of housing quality with respect to the current dwellers. The basis of the work is the theory of interior design and current standards for housing, the theory of protection of modernist architecture and restoration of interior in such buildings. Sources of knowledge are scientific works of Slovak and foreign authors and executed examples of renewal are compared with the author's own research of the interior. The design concept, which

is based on the theoretical part of the work, includes the design of: the communication space, formerly existing portal, passenger elevator, and the visual identity of the Avion residential complex. The dissertation is looking for a solution that will ensure the quality of housing, safe operation in the building. At the same time, the monumental values will be preserved, and the genius loci of the interior will be supported.

PhD thesis approved at the Faculty of Architecture and Design STU in Bratislava, Slovakia, in the study programme Design

ISSN 2729-7640

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ALFA ARCHITECTURE PAPERS
OF THE FACULTY OF ARCHITECTURE AND DESIGN STU
www.alfa.stuba.sk

3/2022 (Vol. 27)

ARCHITECTURE PAPERS
OF THE FACULTY OF ARCHITECTURE AND DESIGN STU

volume 27
year 2022
number 3

PUBLISHED BY
Faculty of Architecture and Design STU
Námestie slobody 19, 812 45 Bratislava, Slovakia
www.fa.stuba.sk
tel.: +421 257 276 178 | +421 949 015 316
e-mail: alfa@fa.stuba.sk
IČO: 00397687

and

Sciendo; De Gruyter Poland Sp. z o.o.
Ul. Bogumila Zuga 32A, 01-811 Warsaw, Poland
https://www.sciendo.com/
tel.: +48 227 015 015
KRS: 0000055478
NIP: PL 9521878738

August 2022

PUBLISHED ONLINE QUARTERLY
ISSN 2729-7640

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