SPRAWOZDANIA ARCHEOLOGICZNE 74/2, 2022
PL ISSN 0081-3834
DOI: 10.23858/SA/74.2022.2.2831

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IMAGE COMMUNICATION AND CONTEMPORARY VISUALISATION IN THE POPULARISATION OF ARCHAEOLOGY

ABSTRACT

Markiewicz M. 2022. Image communication and contemporary visualisation in the popularisation of archaeology. *Sprawozdania Archologiczne* 74/2, 7-28.

In modern society where images begin to play a dominant role in the cognitive process, the use of visualisation as a carrier of information about archaeological research becomes more and more important. The main aim of this article is to consider visualisation as a method of education and protection of cultural heritage, as well as the role of image communication in popularising archaeology. These issues will be subject to a critical discussion in terms of advantages, possibilities and challenges resulting from the use of 3D reconstruction of prehistoric objects in museology, the Internet and popular science publications. In order to understand the idea of image communication in popularising the archaeological heritage better, an example of visualisations comprising a graphic part of museum exhibitions will be presented.

Keywords: image communication, visualisation, museology, popularisation of science, archaeological heritage
Received: 02.09.2021; Revised: 13.04.2022; Accepted: 03.07.2022

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INTRODUCTION

The aim of the article is to present the role of visualisation, which is one of the forms of visual communication, in popularising archaeology in museum exhibitions, on the Internet and in popular science publications. Communicating information about the past through spatial reconstructions is an extremely important educational method that propagates knowledge about the need for protection of cultural heritage. The implementation of the set research task requires understanding of what "computer visualisation" and "image communication" are. According to the definition, visualisation is the process of presenting information in a visual way, using digital technologies (London Charter 2009). It is therefore a technique of producing images as a method to create, analyse and convey various messages and meanings. Visualisation is also a graphical representation of information. This means that it performs the same functions as any other pictorial representation. *Image (visual) communication* is this sphere of human activity, the distinguishing feature of which is the transmission of information by affecting the sense of sight (Zajączkowski 2000, 5).

In archaeological research, the methods of data visualisation are currently used in *Geographic Information Systems* (GIS), geophysical analyses, field survey (remote sensing), 3D scanning, photogrammetry, computer simulations and for 3D modelling. The last method of research-three-dimensional modelling, which enables the creation of visualisations of archaeological features, will be discussed further in this paper. Using 3D graphic software, *i.e.* "Autodesk Maya", "Blender" or "Google SketchUp" it is possible to design and model 3D objects in detail.

3D modelling is the basis of two methods of presentation used, among others at museum exhibitions, *i.e.* VR (virtual reality) and AR (augmented reality) techniques (these techniques need to be discussed separately, so in this article they will only be mentioned as one of the visualisation methods). With appropriate simulation of the senses, both of these methods create an illusion of reality. In VR technique, the perception of reality is based solely on virtual, computer-generated information. Conversely, AR combines the real environment, such as the image from cameras, with the digital image, *i.e.* 3D graphics (Anders and Zwirowicz-Rutkowska 2017, 8-9, 12). VR and AR users can get to know the ancient world with the help of screens or special goggles and motion controllers.

According to the architect Sławomir Kowal (2015, 26-28), the message contained in the digital visualisation depends on the purpose for which the model was made and on its degree of similarity to the original. If the goal is to recreate the appearance, we call such a model *iconic*. When the model was created to reflect the principles of operation of the original, it is then an *analogue* model. A *symbolic* model is one that illustrates abstract features and principles. Finally, the *imaginative* model is most often used in archaeological visualisation. It is created on the basis of subjective presumptions and judgments about the lost area of historical reality. The imaginative model requires a creator to formulate

hypotheses that facilitate the understanding the relationship between archaeological features, creative complement and the image, based on imagination and knowledge. The reconstruction of the missing data results either from the logic of the system, such as the analysis of the object as a whole, or is based on the experience and knowledge of a researcher using analogies to build the model.

The use of three-dimensional modelling techniques in archaeology dates to the 1980s. These oldest spatial images are quite simple and do not look as realistic as they would today. Computer technology has developed rapidly since the 1990s. In 1990, Paul Reilly (1991, 133-139) introduced the term *virtual archaeology*, referring to the use of 3D modelling to record and analyse the results of archaeological research. Currently, three-dimensional images, created with the help of specialised software, are extremely realistic and resemble photographs. Most of the digital visualisations are posted on the Web. Thanks to the Google SketchUp software, a lot of digital 3D models are created. Collections of three-dimensional objects can be viewed, among others on Sketchfab (2022).

Computer programs for creating 3D graphics support and modernise activities for the protection of archaeological heritage (see for example, Sylaiou and Patias 2004; Hermon and Kalisperis 2011; Barceló 2014; Markiewicz 2014; 2018; 2022; Georgopoulos and Stathopoulou 2017). Three-dimensional reconstructions are an effective means of conveying information about the past. Although archaeologists use this software to test hypotheses and verify data in their research work, digital imaging is primarily intended for the use of the general public. It is through visualisation that an observer/recipient attempts to seek for meanings and values in a given artefact of the archaeological heritage (Szrajber 2016, 24).

Archaeology aims for the protection of cultural goods to provide the public with knowledge of the past (Kobyliński 1998, 9; Pawleta 2016, 119, 120; Vincent *et al.* 2017). In Article 7, of the so-called *Lausanne Charter* (1990), the International Charter for the Protection and Management of the Archaeological Heritage, adopted in 1990 by the International Council on Monuments and Sites ICOMOS at the conference in Lausanne, we read that "the presentation of the archaeological heritage to the general public is an essential method of promoting an understanding of the origins and development of modern societies. At the same time it is the most important means of promoting an understanding of the need for its protection."

One of the tools for creating archaeological knowledge is 3D computer modelling. UNESCO points to goods created and functioning in a virtual environment as an important element of the cultural heritage. In the document of October 15. 2003 – Charter on the Preservation of Digital Heritage (2003), UNESCO has formulated postulates for the protection of the digital heritage, including visualisations, which are a means of popularising knowledge about the past. The term *virtual heritage* in this document is used not only in the context of digital representation of ancient and cultural heritage, but also as having intrinsic value (Koszewski 2015, 104). Likewise, paragraph 5 of the "Cracow Charter" of 2000 states "In the protection and public presentation of archaeological sites, the use of

modern technologies, databanks, information systems and virtual presentation techniques should be promoted" (Vademecum 2015, 136).

Modern computer techniques with their ongoing development and improvement allow the general public to familiarise themselves with the resources of cultural heritage in an appealing and interesting way. Spatial visualisations displayed at museum exhibitions, on the Internet and in popular science publications undoubtedly contribute to broadening knowledge in the field of archaeology. Nonetheless, it should be noted that incorrectly made three-dimensional reconstructions that have not been supported by appropriate documentation and knowledge in the field of archaeology may contribute to the dissemination of false iconographic messages. In response to the critical voices in the archaeological community regarding the spatial visualisation of historic objects, an international team of researchers from the Department of Digital Humanities at King's College in London and Science and Technology in Archaeology and Culture Research Centre of The Cyprus Institute, created a set of recommended principles in 2009 (the so-called London Charter).These principles should ensure a reliable application of computer-based visualisations in research, the analysis and interpretation of monuments as well as the protection of cultural heritage. They define control mechanisms that enable the verification of the historical reliability of 3D models. The Charter draws attention to the necessity to document the computer reconstruction process and interpretation processes. In another part of the document, we read that it should be remembered that the visualisations are to facilitate the interaction with inaccessible, lost and previously exposed to destruction historic objects. Research projects must consider the cognitive benefits that can be derived from computer-based visualisations of historic objects.

IMAGE COMMUNICATION AS A MEANS FOR CONVEYING INFORMATION ABOUT ARCHAEOLOGICAL HERITAGE

Contemporary culture is considered a visual/pictorial culture. Since the mid-twentieth century, the primacy of visuality has been growing: the process is known as the "iconic turn" (according to G. Boehm 1992) or the "pictorial turn" (according to W.J.T. Mitchell 1994). Thanks to the Internet, the global circulation of images is expanding, there is a rapid development of media and new technologies. Ernst H. Gombrich (1990, 312) stated that we live in the age of visualism because we are constantly "bombarded" with images. That's why the image is slowly becoming the basic means of interpersonal communication. Visual messages function independently of the verbal sphere or in parallel to it and they are becoming elements of the iconosphere, *i.e.* the whole of the human visual environment (Porębski 1972, 18). Particular attention is drawn to the motive of replacing our surroundings with images, *i.e.* 3D visualisation, simulation or virtual and augmented reality (VR, AR).

Nowadays, it is essential to popularise the past by means of spatial visualisation. Digital reconstruction plays a communicative, scientific and cognitive role. More and more often the image replaces the word, strongly appeals to the human imagination, and quickly becomes memorable. In the visual culture, we can experience the past with the help of our senses (Szpociński 2009, 227-236; Pawleta and Zapłata 2012, 1172; Pawleta 2014, 182, 183). The possibility of showing the results of archaeological research in the form of a pictorial message, *i.e.* visualisation, cannot be overestimated both as a research tool and as a means of popularising historical knowledge (Koszewski 2015, 95).

Modern culture has a significant impact on creating and receiving visual messages. According to the mathematical theory of communication, a set of data containing information (message) must be conveyed using the right medium, *i.e.* channel and code (the model developed by C.E. Shannon and W. Weaver [1949] also includes the concept of information noise disturbing the message). The code should be common for the sender and the recipient, so that the recipient reads the message in accordance with the intention of the sender (Koszewski 2015, 96, 97). In the idealised version, the recipient of the archaeological visualisation could be the whole populace, but in reality many people will not receive such information or will reject it as as irrelevent. Disturbances in popularising archaeology through digitally created images are the reason it is ineffective. The barriers may be some characteristics of the sender and recipient and the differences between them. Features of the sender that prevent proper reception include the unreliability and inconsistency of the information provided. In the case of the recipient, the barrier may be, among others, reluctance to the subject. The remaining obstacles are the differences in the hierarchy of needs and values between the sender and the recipient (Kozakiewicz 2012, 648). Archaeological visualisation is addressed to a wide and diverse group of people, the group is difficult to define precisely. Unfortunately, the wider the range of the message is to be, the less intellectual demands should be placed on the collective addressee. An image is the simplest means of conveying information intellectually that involves basic process of cognition and meaning-making for humans. It should be noted, however, that perception is not only the result of the senses, but also a reflection of previous experiences and cultural codes. The content of perception, therefore, is determined not only by the ability to perceive, but mainly by culture. As Ludwik Fleck put it, "to see, you have to know". It is culture that has the final word in shaping what and how is given in the act of seeing (Rydlewski 2016, 12, 13).

Digitalisation brings a chance to enter the hitherto hidden dimension of visibility. From the perspective of the viewer-oriented theory, it can be said that digital images introduce us to a new dimension, offer a new level of vision, and provide an additional point of reference that goes beyond the perspective of visual perception (Stawowczyk 2002, 149, 156). It should also emphasized that a very realistic visualisation carries the risk of falsifying history. Spatial visualisations are immersive images. According to L. Wiesing (2012, 123) "An immersion image shall mean this kind of images that make the observer believe that a thing showed in a depiction is really present". The authors of 3D models strive to make

the visualisation they create as realistic as possible. The digital image is like hyperreality. It is difficult to distinguish between preserved and reconstructed elements. It happens the visualisation is so idealised that the viewers, when they encounter the 'original' at a museum exhibition, feel disappointed. This phenomenon can be defined as the *aestheticisation of the past*, as the type of activities that lead to the colouring of reality (Pawleta and Zapłata 2011, 347; Rączkowski 2018, 229).

Modern imaging techniques allow researchers to re-construct, digital images of past, because, as Włodzimierz Rączkowski (2018, 225) put it, 'visualisations in archaeology are an imagined, modelled world materialised with the help of computer technologies'. In modern science, the problem of the system of representing these images remains open. Can visualisations created with the help of computers, which do not exist in the real world, be considered images or only the effects of algorithmic processes (Baudrillard 2001; Stawowczyk 2002, 53-54)? This kind of images Jean Baudrillard (2001) called a *simulacrum*. According to him it is a depiction that does not have any reference to substantial reality. This means that it is a copy, without the original.

Nowadays, it is postulated to re-conduct the discussion about the image and imagery. Currently we are dealing with two opposing attitudes in science: from admiration for new media, to the feeling of crisis or even the end of the image. H. Belting (2007, 50) asks 'Can we still talk about an image as if it could still be related to an object that expresses its relationship to the world in it ?' He notes that the virtual image negates the analogy with the empirical world. The image no longer exists in the traditional sense (image-reflection), because due to new technologies the classic 'combination between the image, the subject and the object' Is broken. Despite the so-called technological revolution, the methods of researching archaeological sources will remain unchanged. The traditional research method based on the analysis of the acquired knowledge is independent of the technology that only supports thought processes (Kowal 2015, 21).

ARCHAEOLOGICAL VISUALISATION IN THE MUSEUM. CASE STUDY

An example of the use of three-dimensional visualisation to present the results of archaeological research in museum exhibitions are digital reconstructions of several graves from the Hallstatt period necropolis in Domasław.

The cremation cemetery from the Early Iron Age (750 – to around 450 BC) was discovered in the south-western part of site No. 10/11/12 in Domasław in the district of Wrocław (Fig. 1).The research was conducted by the Institute of Archaeology and Ethnology of the Polish Academy of Sciences in Wrocław. Over eight hundred graves were examined, of which around three hundred were chamber burials, very richly equipped. People buried in this necropolis belonged to an outstanding stratum of the society at that time. This ceme-

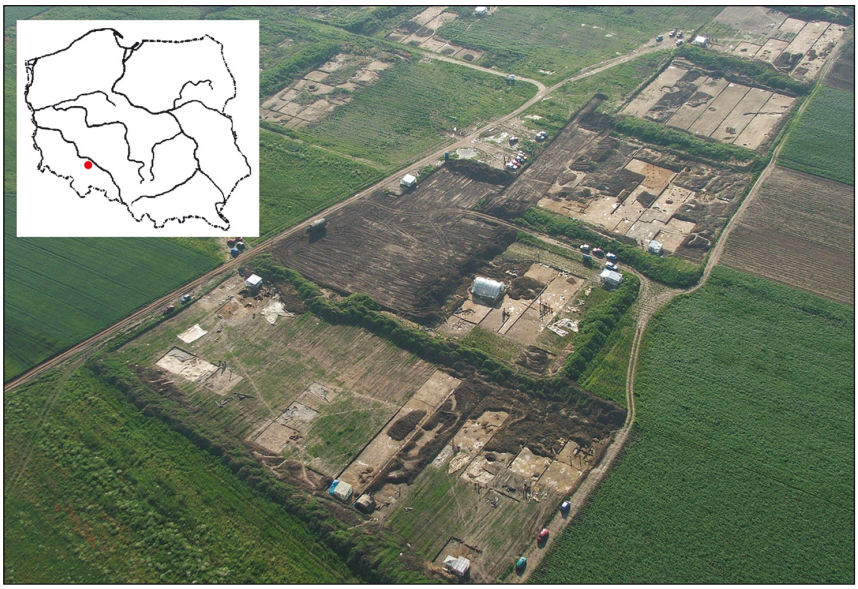

Fig. 1. Archaeological research at the site No. 10/11/12 in Domasław, Wrocław county (photo: J. Zipser; archives of IAE PAS in Wrocław)

tery stands out against the background of other sites in Poland and Central Europe. The uniqueness of this discovery is demonstrated by the unusual grave architecture, as well as the number and variety of items used in burials (Figs 2, 3). In the graves, in addition to clay vessels (from a few to over fifty), there were products made of gold, amber, glass, bronze and iron items, *i.e.* vessels, tools, weapons (including seven swords) and ornaments (Gediga and Józefowska 2018a; 2018b; 2018c; 2019, 2020; Gediga and Józefowska *et al.* 2020 – further literature there).

Immediately after the end of archaeological research in 2008, the artefacts from Domasław were presented at exhibitions at the Commune Office in Kobierzyce ("Treasures of the Kobierzyce Land"), the Museum in Biskupin ("Silesia – the Province of Hallstatt Culture"), and in 2014 at the Silesian Museum in Katowice ("Hallstatt Province – Silesia"). In 2014, the employees of the Archaeological Rescue Research Team of the Institute of Archaeology and Ethnology of the Polish Academy of Sciences and the City Museum in Wrocław prepared an exhibition "Domasław – Necropolis of Aristocracy from the Early Iron Age (8th-6th Century BC)" from the collections obtained during the research. This exhibition in 2014-2020 was shown in several cities in Poland, incl. in the Archaeological Museums in Wrocław, Poznań, Łódź, Kraków and Gdańsk, as well as in the Upper Silesian Museum in Bytom, the Leon Wyczółkowski Museum in Bydgoszcz, the Museum of Jan Dzierżon in Kluczbork, the Fr. Dr. Władysław Łęga Museum in Grudziądz, the Museum of

Fig. 2. Chamber tomb No. 521 discovered during excavations carried out in the Early Iron Age cemetery in Domasław (photo by A. Zwierzchowska; archives of IAE PAS in Wrocław)

Fig. 3. Chamber tomb No. 4270 discovered during excavations carried out in the Early Iron Age cemetery in Domasław (photo by A. Zwierzchowska; archives of IAE PAS in Wrocław)

Fig. 4. The exhibition "Domasław – the Necropolis of the Aristocracy from the Early Iron Age (8th-6th Century BC)" at the Leon Wyczółkowski District Museum in Bydgoszcz (photo W. Woźniak; MOB archives)

Opolian Silesia in Opole and also in museum exhibition halls in Gliwice, Racibórz, Prudnik and Będzin.

The exhibition presenting the most valuable artefacts discovered during the excavation works, was supplemented with numerous illustrations (boards) and photographs, in which the authors of the research recorded the chamber tombs that no longer exist today. For the purposes of the exhibition, a traditional reconstruction of an Early Iron Age burial was prepared and taking into account the undoubted attractiveness of digital visualisations, 3D models of selected graves were made (Fig. 4). Spatial reconstructions have been realised in a form that allows them to be made public in the form of Internet presentations and multimedia exhibitions.

Three-dimensional reconstructions were made with the use of 3D graphics software – *Autodesk 3ds Max* with the *V-ray Adv for 3ds max (Chaos Group)* rendering engine. Thanks to the latest digital techniques, the chamber graves No. 521 (Figs 5, 6) and No. 4270 (Fig. 7) were recreated. The intention of the three-dimensional reconstruction was to present the appearance of the graves spatially with regard to the arrangement of the grave goods. Creating 3D visualisations of the burials from Domasław, as faithful to reality as possible, was also guided by educational and popularising goals.

The resulting spatial visualisation of the cremation burials reflects the current state of knowledge. The spatial presentation of the structure of the Hallstatt graves allows the recipient

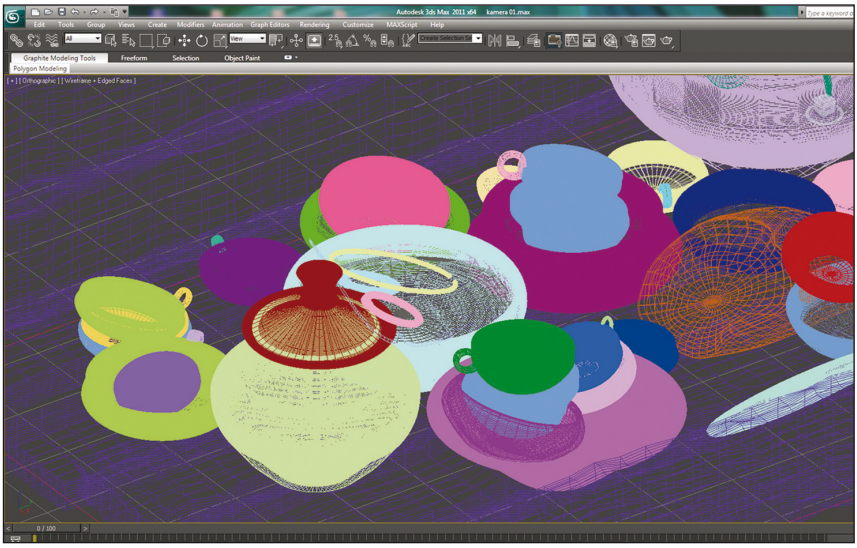

Fig. 5. Three-dimensional model of the tomb No. 521
(made by M. Markiewicz; archives of IAE PAS in Wrocław)

to better understand the message. Thanks to spatial imaging, we can "see more" than when the analysis of the results of archaeological research lacks this visualisation. The 3D model made it possible to accurately trace the method and sequence of placing individual vessels into the chamber, as well as the arrangement and distribution of the remaining grave goods. The third dimension opened up new possibilities. People see the world in three dimensions, therefore the process of creating a spatial model often leads to additional discoveries that may change the perceptual comprehension of a given issue (Stróżyk 2012, 252). In this case, the three-dimensional model of the grave becomes a source of new understanding because visualisation allows us to discover the so far hidden dimension of visibility and thus our perception is broadened.

According to P. Sztompka (2006, 16) in the visual era in which we live today, contemporary sensitivity and the way of perception are moving from verbal to visual. Archaeology also departs from traditional record and looks for multidimensionality. It develops the pictorial, graphic and spatial side of the message (Minta-Tworzowska 2011, 322). However, it should be remembered that the three-dimensional models of graves are an interpretation of archaeological data. They are a construct, a computer-generated vision. This message is only one of the possible options and it cannot claim to be historical evidence. The three-dimensional images of the burials from Domasław were presented in such a way that the recipient could read the information in accordance with the intention of the sender-researcher. A visual message does not require specialist preparation for reading it. The image in the form of a visualisation is complete, which means that it leaves no room for

Fig. 6. 3D visualisation of the chamber tomb No. 521
(made by M. Markiewicz; archives of IAE PAS in Wrocław)

Fig. 7. 3D visualisation of the chamber tomb No. 4270
(made by M. Markiewicz; archives of IAE PAS in Wrocław)

a wider interpretation. It is the researcher who imposes a vision of the recreated object. As Włodzimierz Rączkowski (2018, 232) put it:

> "the visualisation, once prepared, becomes a kind of 'obligatory' representation of a given object/site/landscape. According to M. Heidegger, it 'covers' a real object and makes it difficult to create new, alternative imaginations. The visualisation created and 'devoted' to the recipient as a form of interpretation of reality, although it is subject to the recipient's assessment, it also acquires a kind of agency. By its sheer existence, it shapes/influences our imagination in some way."

Therefore, when formulating a visual message that carries information about the cultural heritage, the creator must maintain a critical distance from the analysis performed. It should be remembered that the obtained results are not a reproduction of the past, but a plausible version of it (Koszewski 2015, 99). Based on similar sources, different visions of the same archaeological site can be built. The process of data interpretation and processing depends on the researcher, which means that the finally created 3D model is marked by decisions made by the author (Szrajber 2014, 115). Thus, the 3D visualisation of the graves from Domasław was created based on the sum of knowledge and abilities that the graphic-reconstructor possesses, making it something subjective and individual. Moreover, it should be noted that the three-dimensional reconstructions are aimed primarily at a recipients who do not have adequate historical knowledge. They are unable to evaluate critically the vision presented to them. The ability to understand and notice messages presented in a visual form is the domain of the so-called "visual literacy", *i.e.* a set of acquired competences in the field of interpretation and creation of an imagery message (Koszewski 2014, 102). These competences are crucial when it comes to visualising archaeological objects. This applies to both the creators of spatial historical reconstructions and their recipients. It is archaeologists and museum professionals who are responsible for the quality and reliability of the message. It seems that digital spatial images of historic buildings should not exist without verbal description. Correct reading of the information contained in the image depends primarily on the knowledge possessed by the recipient, and only thanks to it, can one count on the correct reception of the content contained in the visualisation. In postmodern society, popularising the past by means of visualisation is extremely important. However, it should be ensured that the content conveyed in these images is accompanied by an appropriate commentary. It is extremely important to consider the influence of contemporary culture on the creation and reception of visual messages while making visualisations. Recognition of effective ways of coding image messages and creating a precise message, adequate to cultural conditions, are important aspects of the effectiveness of activities in popularising knowledge.

VISUALISATION AND POPULARISATION OF KNOWLEDGE

What is *popularisation* and what role does it play in research and protection of the cultural heritage? Popularisation is an activity aimed at introducing and explaining to people to whom it is addressed the concepts related to a given field and getting them to further expand their body of knowledge and use their own potential. Popularisation activities are part of marketing activities and, in addition to their educational and cultural role, they also fulfil an informative function. Science can be popularised by appropriately influencing the recipient's thinking, attitudes, opinions and behaviours (Kozakiewicz 2012, 645, 646). The development of civilisation has led to the formation of many ways to impact the beliefs and thinking of people. The examples may be teaching or impingement through the image (advertising, film or television). Promotion of archaeology using visualisation in museology, popular science publications or the Internet (websites, social media and blogs) is shaping the viewer's awareness through intellectual and emotional factors, because when convincing, it affects not only the intellect, but also feelings. The process of influencing recipients consists of several stages:

– influencing the perception of a given group of people,
– transformation of beliefs and opinions,
– shaping the desired attitude,
– the emergence of expected behaviours.

In the case of archaeology, the expected behaviours of recipients include participation in discovering the past and the willingness to expand knowledge and own abilities (Kolczyński and Sztumski 2003, 10, 29; Kozakiewicz 2012, 647). The conducted research shows that the archaeological community in Poland feels obliged to popularise archaeological knowledge, both in relation to the research they conduct and the general knowledge of archaeology. However, researchers should be supported by cultural institutions and journalists (Report 2021, 48).

Education should play an important role in popularising archaeology. However, the research carried out in 2007 on a group of 226 Poles showed that as many as 90.4% of respondents learn about archaeology from television (the research was carried out by means of a telephone questionnaire interview. They covered all voivodeships of Poland). Based on the survey, it was found that museum exhibitions, book publications and then the Internet are important in popularising archaeology (Kozakiewicz 2012, 649). Similarly, the NEARCH survey conducted by the Harris Interactive Research Agency from December 29, 2014 to January 6, 2015 on 4,516 adults from nine European countries (including Poland; a sample of approx. 500 people) showed that in Poland 89% of respondents watch films about archaeology, 72% visit exhibitions and 68% read books or archaeological journals (*Kajda et al.* 2017, 101, 108). The media, however, represent one-way communication. Other types of dissemination activities, such as exhibitions and lectures, are a model of two-way communication, which is easier to understand the information being communicated

(Kozakiewicz 2012, 649). As already mentioned, archaeologists and museum staff are responsible for impartial and reliable knowledge about the past. In postmodern society images become the basis of communication, hence the great influence of television and the Internet in popularising archaeology. Photographer Andreas Feininger aptly noted that "[...] people are becoming more anxious today, impatiently waiting to move on. The language of words – reading – is slow and therefore generally loses its importance in favour of the language of image – television" (after: Sztompka 2012, 21, 22). Due to the universal nature of the message and the use of images and sounds, television has a strong influence on emotions. However, despite its culture-forming and educational mission, like the Internet, it is not free from archaeological pseudo-information.

Thanks to the Internet, everyone can examine 3D reconstructions. The Internet has become an important tool of global communication serving to popularise knowledge about the past and cultural heritage. The network is currently one of the best sources of knowledge about archaeological research to a mass audience. This is a positive phenomenon, but it requires a critical attitude towards the increasing amount of data. After entering search terms related to the subject 3D model into the Google search engine, over 2.5 billion websites appear! The huge resources of graphics on the Web are not free from disinformation, false or manipulated images. Unfortunately, the repeated duplication of unreliable information creates the danger of perceiving it as true. In this case, we are dealing with an information crisis and a phenomenon that can be called visual overload.

Contemporary museum exhibitions are saturated with new technologies, which is in line with the expectations of visitors to these institutions (Chlebicki and Kowalska 2016, 220). The presentation of exhibits in a traditional, static way is slowly becoming a thing of the past. The authors of the exhibitions focus on the multi-sensuality of the museum. Visitors to the exhibition not only want to see the artefacts, but also expect interactivity. Therefore, at the exhibitions, beside the sense of sight, hearing and touch are also activated. The Stefan Woyda Museum of Ancient Mazovian Metallurgy in Pruszków (Woyda Museum 2022) and the M. Radwan Museum of Ancient Metallurgy of the Świętokrzyski region in Nowa Słupia (Radwan's Museum 2022), popularise knowledge of iron metallurgy in Barbarian Europe, combining traditional display methods with state-of-the-art technology to create a narrative appreciable with all the senses. These modern exhibitions function as educational centres. In order to arouse interest among viewers, exhibition creators use numerous forms of communication, *i.e.* text, sound and image in the form of 3D visualisation and animation. Traditional museum exhibitions are diversified with virtual models which, combined with authentic artefacts, provide viewers with fuller and more interesting information (Chowaniec 2010, 146, 180).

Virtual reality (VR) and augmented reality (AR) technologies are increasingly used in museum exhibitions. The interactive properties and immersive contact with the digital environment give the feeling of being present in the virtual world. These systems allow users to have direct contact with 3D models and to manipulate them, *i.e.* navigation in

real time (Zawadzki and Filipczuk 2014, 227). With the help of VR and AR, through interactive exploration of virtual, computer-generated worlds, museum visitors can learn about prehistory. Therefore, new technologies used in the exhibitions play not only educational but also entertainment functions, becoming a way of spending free time.

The growing popularity of multimedia creates new opportunities for the promotion of archaeology. New media make it possible to present in a simple way complicated processes (*i.e.* the development of settlement over time, the role of stratigraphy) and methods (*e.g.* aerial archaeology), and also facilitate the presentation of artefacts in a broader social, historical or economic context (Economou 2003, 371, 372). Interactive multimedia applications used to convey information about archaeological research take many forms such as computer games to VR and AR technologies and create a specific relationship between education and entertainment. The boundary between learning and enjoyment is often blurred, leading to the emergence of artistic visions and creative interpretations of the past that deviate from the historical truth. The public presentation of archaeology must combine teaching with the imaginative use of multimedia that will encourage the audience to explore the past actively and enjoyably.

An example of an exhibition where digital technologies dominate is the display under the Old Market Square in Krakow. The underground exhibition presents both the history of Krakow and its connections with the commercial and cultural centres of medieval Europe (Kraków 2022). One is introduced to the past history of the Old Market Square with the help of multimedia kiosks, where the viewer can watch the virtual reconstructions, 3D models of monuments and substantive texts presenting the history of old Krakow. In the exhibition, images are displayed on a water curtain (fog screen), and the atmosphere of this place is built with the help of sound.

A similar project is accessible in Wroclaw. In the Royal Palace (Branch of the City Museum of Wrocław), the exhibition "1000 Years of Wrocław" presents the history of the city from the Middle Ages to the present day (Wrocław 2022). Thanks to the visualisation at the City Museum of Wrocław, visitors can learn about the most ancient history of the city. Many specialists in various fields such as archaeology, history, history of art and architecture were involved in the three-dimensional reconstruction of the pre-chartered city of Wrocław (10th century – 1226; Kuroczyński and Madera 2012, 381-414). The reconstruction of urban structures was highly labour-intensive, time-consuming and costly. The problem that the authors had to deal with was to show the history of the city in a 3D animation that lasts only a few minutes. There was a dilemma how to select the information. Which information is the most important? Which information should be chosen and which, unfortunately, to skip? With this type of visualisation, there is often a compromise between graphic designers and specialists from other fields. The image created is very effective, but the information provided is sometimes incomplete.

Interactive exhibitions definitely attract visitors, but new technologies should not replace traditional ways of displaying, but only diversify them. To meet the expectations of

viewers, museums conduct professional sociological research. Audience surveys are a valuable source of knowledge about the preferences and expectations of museum visitors (Kajda *et al*. 2017).

M. Stróżyk (2012, 255, 256) asked the respondents two questions in an online survey on the public perception of the reconstruction of archaeological objects:

1. What is your attitude towards recreating of historic objects (the archaeological, historical ones)?

2. What form of reconstruction: a – traditional or b – virtual is more attractive for you?

In response to the first question, 86.29% of the respondents stated that their attitude to the restoration of historic objects was positive. On the other hand, 81% of respondents stated that the traditional, *i.e*. real, form of reconstruction is more attractive to them. Only 19% of the respondents were in favour of a virtual, digital form of reconstruction of historic buildings. The survey, in which 124 people participated, did not take into account the division into social and age groups, *i.e*. factors differentiating the approach to a given topic. It should be expected that a decade after the survey was conducted, the preferences of the respondents have changed. Among young people, the percentage in favour of virtual reconstruction would probably be higher. In recent years, the process of digitising society has accelerated rapidly. Not without significance for this development was, among others, COVID-19 pandemic, which led to the global increase in the role of the Internet in education and culture.

In line with the requirements of the present day, visualisation offers a method of education about the past world and archaeology of interest to the younger generation. The knowledge of the past contained in the images helps to develop a special sensitivity and competence that can be called historical imagination. Through the contact of the viewer with the visualisation, an interest in the past is born, which, in turn, increases the awareness of the public regarding the need to protect cultural heritage.

CONCLUSIONS

Since the 1970s, as Gottfried Boehm (2014, 172) put it, images have had a good streak. The digital revolution has increased the role of the image in the modern world. New visual technologies have meant that "the world has become an image" (Heidegger 1977, 143). Thanks to modern visualisations, our perceptual abilities are expanding, new visual stimuli create our perception and cognition. Graphic programs are becoming an invaluable tool for scientists who can test hypotheses in areas such as architectural resolutions, the reconstruction of historic objects and the transformation of settlements over time and who can popularise the results of their research. As a result, digital images become new forms of narration that allow us redefine the prehistoric world (Minta-Tworzowska 2011, 323-324). Visualisations created with the use of computer graphics are a form of interpretation,

showing an image of the past from the perspective of modern image thinking, namely discursive thinking. The new technology in this case has broadened our perception.

Digitally produced images fulfil important social and educational functions. Visualisation is a simple form of transferring knowledge to a greater number of recipients, as well as helping to obtain information from museum professionals and archaeologists. Therefore, the main goals of the popularisation of archaeology, through 3D visualisations, at museum exhibitions, media and popular science publications, are primarily education about the past, as well as informing recipients about the results of excavation works. These activities are intended to help the public understand historical processes. Disseminating knowledge about archaeology arouses curiosity and contributes to creating a positive image of this discipline of science. The more people are interested in the past, the stronger the need to protect the archaeological heritage.

Visualisations popularising archaeology are presented on the Internet, on monitor screens (*e.g.* multimedia kiosks) at museum exhibitions, or in the form of printouts in popular science publications. However, 3D models can also be used to build mock-ups using 3D printing technology (López-Menchero Bendicho *et al.* 2017, 41, 42), and they can also be the basis of other, previously mentioned, methods of presentation, *i.e.* the techniques of virtual reality (VR) and augmented reality (AR). Modern technological achievements also allow for the publication of spatial models in the form of holograms with the use of appropriate projectors. It should be noted that cultural heritage objects, mainly architecture, recreated using 3D graphics software, are used in computer games (*e.g.* "Assassin's Creed") and 3D animations (*e.g.* "Asterix and Obelix"). The presented spatial reconstructions are extremely attractive for viewers due to their interactivity and photorealism. As the researcher of image culture Nicholas Mirzoeff (2016, 20) put it, "whether we like it or not, the emerging global society is a visual society". It seems that contemporary archaeology must correspond with popular culture (Holtorf 2007). The image becomes the essence of the most important social process – interpersonal communication. Visualisation used in museology reaches the mass audience in an engaging way, which is why it perfectly fulfils the tasks of presenting and popularising knowledge about archaeological heritage in society.

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