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THE NEW USING OF THE „BIS MACHINE“ METHOD ON SCULPTURAL HERITAGE – ŠIBENIK CATHEDRAL PROJECT

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Abstract. Important projects in cultural heritage reconstruction relating to St Jacobs church in Šibenik have provided new options for the „BIS Machine” methodology. The first steps in this work have been the validation of the 3D model and the production of replicas of several sculptures from the main portal. These tasks have been helpful in further developing the application of the „BIS Machine“ and, with the aid of the informatics technology, have enabled many questions concerning the production of copies or replicas to be answered.

Key words: BIS Machine, replica, cultural heritage, sculpture, cathedral, informatics, research, 3D model, graphic data

INTRODUCTION

Numerical and visual validations of 3D models and replicas created with various tools, measurements and controlled procedures, are stages in projects engaged high quality scanning, 3D modelling and replica production. As the result of using of integrated sophisticated and expensive methods must be products good enough to replace originals, cause of many threatened reasons as exposed to weather, damaged or other negative impact.

This paper describes the database applied to reconstruction of sculptural units on St. Jacobs Cathedral in Šibenik, as a part of a system designed and based on „BIS Machine“ methodology. Experiments with positive/negative results in the sense of the form are one of the aims of a new research working projects on architectural and sculptural units from St. Jacob church.

APPLICATION OF NEW TECHNOLOGIES – BIS MACHINE METHOD

The application of new technologies in the protection of monumental heritage is becoming a key factor in the process of management and preservation of human culture and civilisation values.

“BIS machine“ it is the method composed of three phases enables of the documenting and makes virtual „the solid“ CAD model (the virtual standard), over selections of materials and technologies, to the creation of replica or the original copy with a very large precision.

Advantages of BIS machine are precision, significantly shorter design terms, simplicity, transparency in all project design phases, lower design prices, data capture without physical contact of object, possibility of quality objects design in the case not existing object parts, data base formation and infinite replication possibility, complete computer & Hi-Tech environment, interdisciplinary project tasks. These means that the BIS machine method is the original method of applying various technical resources and units in complete informatics data environment with purpose to register and ensure the protection and management, particularly of cultural heritage.

The advantage archived by the development of this method is significant and could be described in terms of professional potentials and also in terms of supporting further research regarding to:

– creation of high precision permanent documentation (1000 : 1);

– creation of a management system for object documentation in line with the protection policy for individual artefacts, partially or integrated as a whole (BIMS) – Building Integrated Management System;

– computer 3D image of the object for the purpose of creating replacements for damaged parts by a large number of iterations until expert consensus is reached on acceptance of final version;

– generation of replicas of high precision, depending on the choice of material and technology (up to 0.001 mm precision);

– presentation of an approach to valuable objects through a virtual information transfer, providing for global accessibility of the treasures of world heritage, irrespective of social and material status of the public;

– introducing new directions for exploring global art in the fields of science and economy (e.g. tourism), as well as new concepts of protection and safety.

In comparison with classical methods of the replica production, and of protection and preservation of monumental heritage, this method enables the following:

– accurate measurement of the object (precision up to 1 μm) without the use of any invasive method (show in a sample), thus providing for protection against damage;

– introduction of integrated BIMS, including all aspects: managerial, constructional, architectural, informational, restoration, user, etc.;

– generation of highly precise “3D virtual model” as the basis for the preparation of the required permanent, highly detailed documentation;

– complete technological preparation (permanently preserved) for the production of highly precise replicas, including the possible computer simulation of possible replacements for damaged sections;

– generation of replicas ("original copy") using the same type of material and at high precision (up to 1 μm), providing for infinite duplication of the same quality level;

– acceleration of the replica production, with significant reduction of preparation costs;

– reduction of insurance costs for exhibitions and for insurance against devastation (to the point of exhibiting replicas – "original copies");

– permanent databases and documentation with simple preservation of data.

The whole process of a reconstruction project can be described in 3 phases:

1. Graphic data input via photogrammetric imaging or scanning of an object or photogrammetric development of other graphical data resources (photographs, scans etc.). The accuracy of graphic data input and processing is up to 1000 : 1, which means that the first phase of graphic data preparation is characterized by a precision 1000 times higher than the natural environment.

2. Computer 3D modelling aiming to develop a very precise object model, such as might be produced using CAD or other software tools. There are several software firms whose programs enable not only CAD but CAM as well, i.e. a complete CAE (e.g. CATIA, PROE, UG etc.).

3. Development of the object via a special and sophisticated CNC device, adapted to the material of the given object and which requires complex CAM program development and preparation. The device produces an object with micron precision and manufacturing speed over 1000 times higher than by manual production.

The same object cannot be produced by hand in this accuracy level.

STUDY OF THE ŠIBENIK CATHEDRAL AND OTHER RELEVANT PROJECT

Research for the Šibenik Cathedral project aimed to show the possibilities related to 3D digitalisation, in terms of imaging, measuring, verification and validation of procedures relating to management of the monument and some of its valuable artefacts. The focus for this research on the cathedral is the western portal, a very valuable complex composition that served as the main gate of the Cathedral entrance (fig. 1). It consists of 12 highly valuable statues, of the Apostles (fig. 2), placed in niches especially constructed and prepared for them (figures 3 and 4). The question is whether to return such valuable sculptures to their portal places or replace them with precise replicas made from the same material (a special type of stone). The history of one statue (fig. 5, 6, 7, 8) is known in detail.

As a result, this study had three focuses:

– Comparison of deviation of the replica made by a standard method with new 3D model;

– Comparison of deviation of the replica made with new technology with 3D model and replica produced with old fashion method;

– Comparison of replica produced by support of BIS Machine method with other replica produced with standard method.

Fig. 1. Cathedral in Šibenik – The main gate of the Cathedral entrance

Ryc. 1. Katedra a Szibeniku – wejście główne

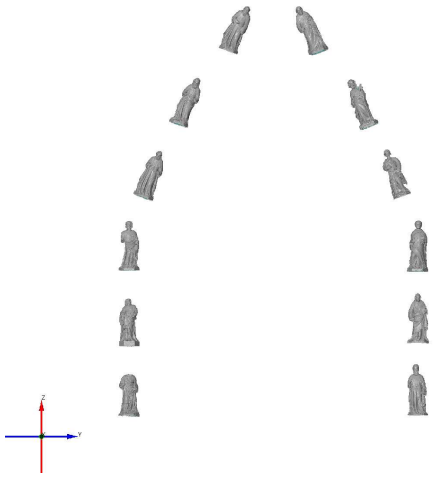

Fig. 2. The 12 Statues of the Cathedral's Portal in Šibenik – "The Twelve Apostles"

Ryc. 2. Rzeźby w postalu katedry w Szibeniku – „Dwunastu Apostołów"

Fig. 3. The Apostle and a niche for him

Ryc. 3. Rzeźba apostoła wraz i nisza na nią

Fig. 4. The Apostle placed in the niche

Ryc. 4. Rzeźba apostoła umieszczona w niszy

Fig. 5. A photogrammetric image an original statue

Ryc. 5. Fotogrametryczny widok oryginalnej rzeźby

Fig. 6. A photogrammetric image of a stone replica of the statue

Ryc. 6. Fotogrametryczny widok kamiennej repliki rzeźby

Fig. 7. Overlay of original statue (in red) and a stone replica (in gray)

Ryc. 7. Powierzchnia oryginalnej rzeźby (na czerwono) i kamiennej repliki (na szaro)

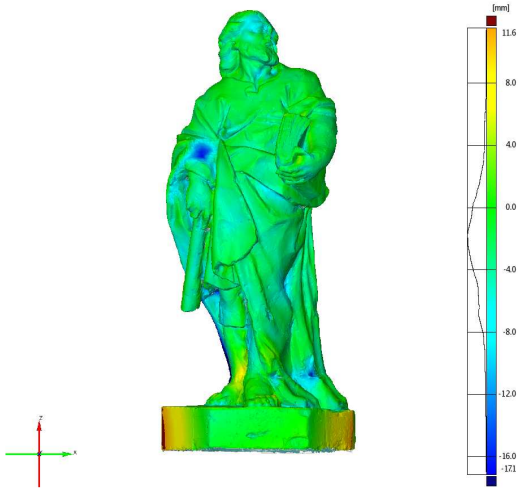

Fig. 8. The results indicate surface deviation of a stone replica into original statue as a colourful map

Ryc. 8. Rezultaty oznaczające odchylenia powierzchni repliki kamiennej w stosunku do rzeźby oryginalnej jako mapa barwna

The Best Fit method (deviation square minimization) was applied in the study. The results (described below) were obtained using colour maps of the differences and its analysis.

STUDY RESULTS

The Best Fit method applied in the course of the research allowed conclusions to be drawn regarding the application of the new technologies. This indicated extraordinarily great differences compared to the original when the traditional replica production method is used (fig. 7). The rapid prototyping method produced minimal deviations (fig. 8). This is especially noticeable in the 2D section analysis (fig. 9). Also other presented examples (fig. 10–22) confirm significant advantages of new technologies and BIS Machine method.

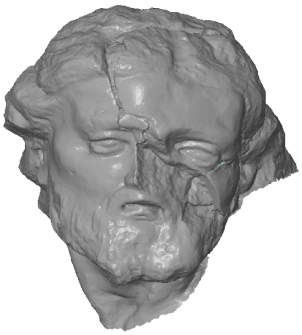

Fig. 9. ATOS photogrammetric image one statue – original

Ryc. 9. ATOS fotogrametryczny widok jednej z oryginalnych rzeźb

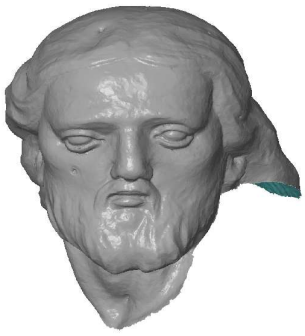

Fig. 10. ATOS photogrammetric image one statue – a stone replica

Ryc. 10. ATOS fotogrametryczny widok rzeźby – replika kamienna

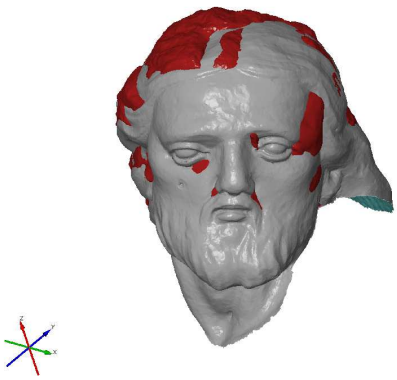

Fig. 11. Overlay of original statue (in red) and stone replica (in grey)

Ryc. 11. Powierzchnia oryginalnej rzeźby (na czerwono) i kamiennej repliki (na szaro)

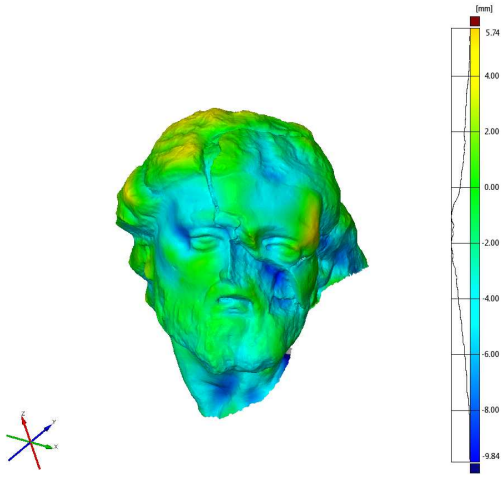

Fig. 12. Results indicate surface deviation of stone replica to original statue – colour map

Ryc. 12. Rezultaty oznaczające odchylenia powierzchni repliki kamiennej w stosunku do rzeźby oryginalnej jako mapa barwna

Fig. 13. ATOS photogrammetric image one statue – original

Ryc. 13. ATOS fotogrametryczny widok jednej z oryginalnych rzeźb

Fig. 14. ATOS photogrammetric image one statue – BIS replica

Ryc. 14. ATOS fotogrametryczny widok rzeźby – replika BIS

Fig. 15. Overlay of original statue (red) and BIS replica (in grey)

Ryc. 15. Powierzchnia oryginalnej rzeźby (na czerwono) i repliki BIS (na szaro)

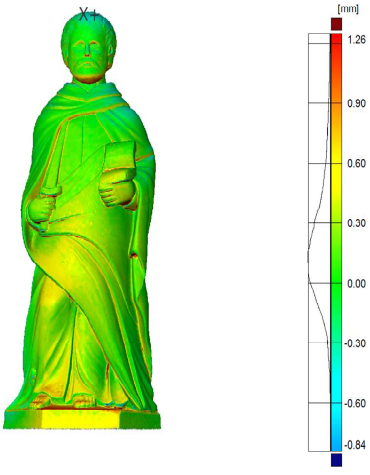

Fig. 16. Results indicate surface deviation of BIS replica to original statue as colour map

Ryc. 16. Rezultaty oznaczające odchylenia powierzchni repliki kamiennej w stosunku do rzeźby oryginalnej jako mapa barwna

Fig. 17. ATOS photogrammetric image one statue – original

Ryc. 17. ATOS fotogrametryczny widok jednej z oryginalnych rzeźb

Fig. 18. ATOS photogrammetric image one statue – BIS replica

Ryc. 18. ATOS fotogrametryczny widok rzeźby – replika BIS

Fig. 19. Overlay of original statue (red) and BIS replica (in grey)

Ryc. 19. Powierzchnia oryginalnej rzeźby (na czerwono) i repliki BIS (na szaro)

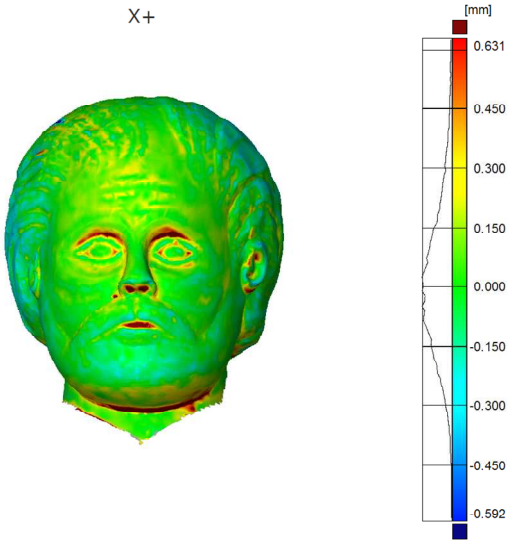

Fig. 20. Results indicate surface deviation of BIS replica to original statue – a colour map

Ryc. 20. Rezultaty oznaczające odchylenia powierzchni repliki BIS w stosunku do rzeźby oryginalnej jako mapa barwna

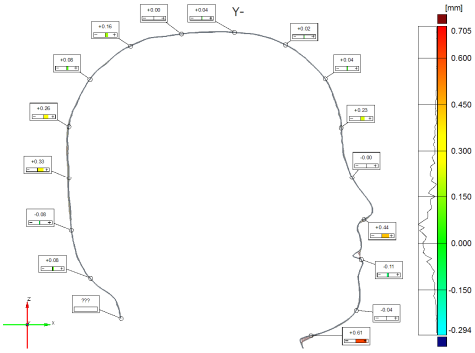

Fig. 21. Results indicate surface deviation of BIS replica to original – section analysis

Ryc. 21. Rezultaty oznaczające odchylenia powierzchni repliki BIS, w stosunku do rzeźby oryginalnej – analiza przekroju

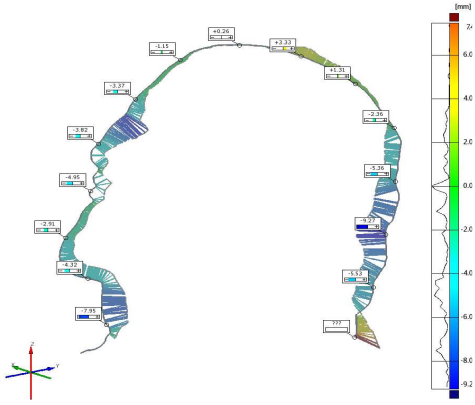

Fig. 22. Results indicate surface deviation of stone replica to original – section analysis

Ryc. 22. Rezultaty oznaczające odchylenia powierzchni repliki kamiennej, w stosunku do rzeźby oryginalnej – analiza przekroju

CONCLUSION

Analysis and comparison of these results obtained from the research indicate that the application of the new technologies is completely viable in the field of cultural monument protection from perspective of replica production, as well as imaging, measuring, verification and validation of the procedures. This enables better management of the monument and some of its high valuable artefacts. Also series of new questions arise and new trends in technology development would be regarding to such subjects as:

1. Evaluation of immovable objects and units of cultural heritage;
2. Insurance policy of cultural heritage objects;
3. Security and protection of cultural heritage;
4. Data base and 3D model of cultural heritage objects as main focus of management and protection policy;
5. Cultural heritage management and protection is also a profit project for community
6. New opportunities for expert study of cultural heritage objects supported by strong 3D model and management system.

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ZASTOSOWANIE „BIS MACHINE" DO REKONSTRUKCJI RZEŹB – PROJEKT DOTYCZĄCY KATEDRY W SZIBENIKU, CHORWACJA

Streszczenie. Istotny dla ochrony rekonstrukcji kulturowego dziedzictwa projekt, jakim jest katedra św. Jakuba w Szibeniku (Dalmacja), stał się wyzwaniem dla określenia nowych możliwości zastosowania metodologii wykorzystywanej w „BIS Machine". Pierwszym krokiem w tej pracy było zatwierdzenie modelu 3D i produkcja replik kilku rzeźb z głównego portalu kościoła. Zadanie to stało się pomocnym w dalszym rozwijaniu zastosowań „BIS Machine" i z pomocą technologii informatycznych, umożliwił uzyskanie wielu odpowiedzi na pytania związane z produkcją kopii i replik rzeźb w ogólności.

Słowa kluczowe: BIS Machine, replika, dziedzictwo kulturowe, rzeźba, katedra, informatyka, badania, 3D model, dane graficzne