

## Modern methods of diagnosis of wood condition of ancient sculptures

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**Abstract:** The diagnosis of the state of object behavior and range of pest control and consolidation is an important element of conservation work. The aim of the study was to determine the internal state of preservation of the object and verify the effectiveness of restoration procedures using X-ray computed tomography methods. Computed tomographic studies were conducted at a medical computer tomography device 4th generation of General Electrics. Reconstructing the inner parts of the sculpture, showed it was overall in a very bad state, the development of wood decaying fungi and xylophagous insects. Based on tomographic studies it has been determined that the material used was a dual-core trunk with numerous knots.

*Keywords:* wooden sculpture, computed tomography, wood conservation, ancient wood

### INTRODUCTION

An important element of conservation work is the diagnosis of the state of object behavior. It involves specifying the amount of damage and the determination breaking factor (eg. fungi, insects). It is necessary to define the scope of conservation efforts to control pest and consolidate of the object. Earlier experience in detecting biodegradation in wooden objects using X-ray methods (Krajewski, Witomski 2004 Krajewski, Witomski 2005a, Krajewski Witomski 2005b, Krajewski, Witomski 2005c) and computed tomography (Biegański and others 2003 Krajewski and others 2005d, Krajewski and others 2005 Witomski and others 2008 Witomski and others 2010) led our interdisciplinary team to use computed tomographic methods. The study was conducted on an antique wooden sculpture most likely from Małopolska workshop at the turn of the sixteenth and seventeenth centuries and coming from a parish church founded by St. Lawrence Deacon and Martyr in Czerniejewo. The aim of the study was to determine the internal state of preservation of the object and verify the effectiveness of restoration procedures using X-ray computed tomography methods.

### METHODOLOGY

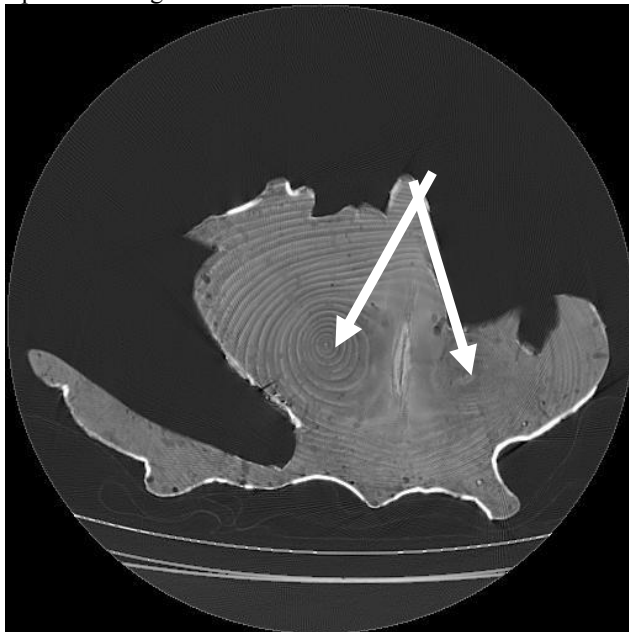
Computed tomographic studies were conducted at a medical computer tomography device 4th generation of General Electrics (photo 1.) With X-ray tube 07 x 04 mm with a voltage of 140 kV and 200 mA, and a detector with 685 channels.



**Fig.1.** The tomographic study

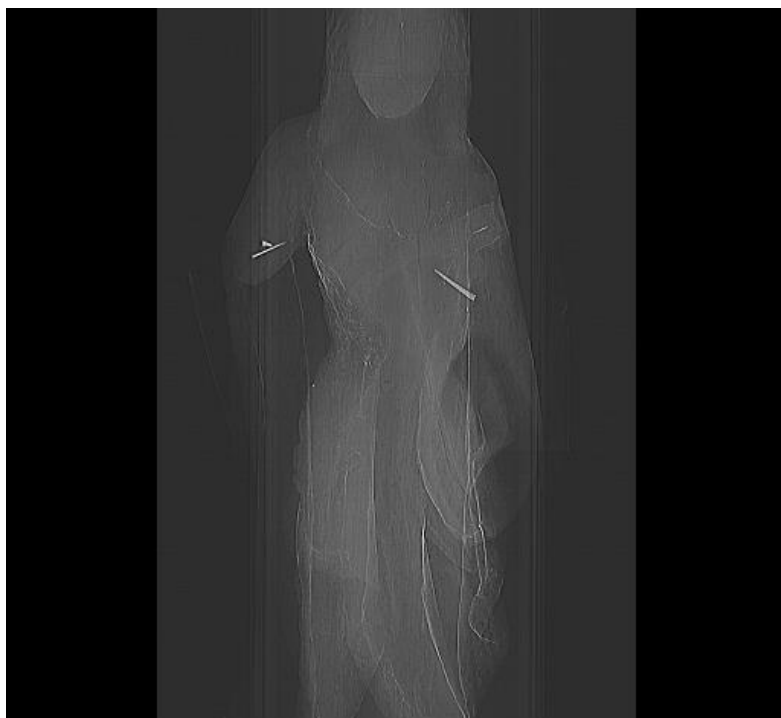
## RESULTS AND DISSCUSION

Detailed studies of the sculpture surface and tomographic reconstruction of the interior, led to a number of significant findings. To develop the body, chisels were used for gouging, traces of which are visible on the base and knife acute-angled to the curving of the hair. Based on tomographic studies it has been determined that the material used was a dual-core trunk with numerous knots (fot.4.), which from the point technical efficiencies shall be considered detrimental to the wood. Duel core was located in the deeper layers of wood, which in the sculpture corresponds to the waist - breast. At the same time, this type of wood structure ,the flattening the trunk and larger density grain - was useful for the woodcarver to develop the upper part of the figure.



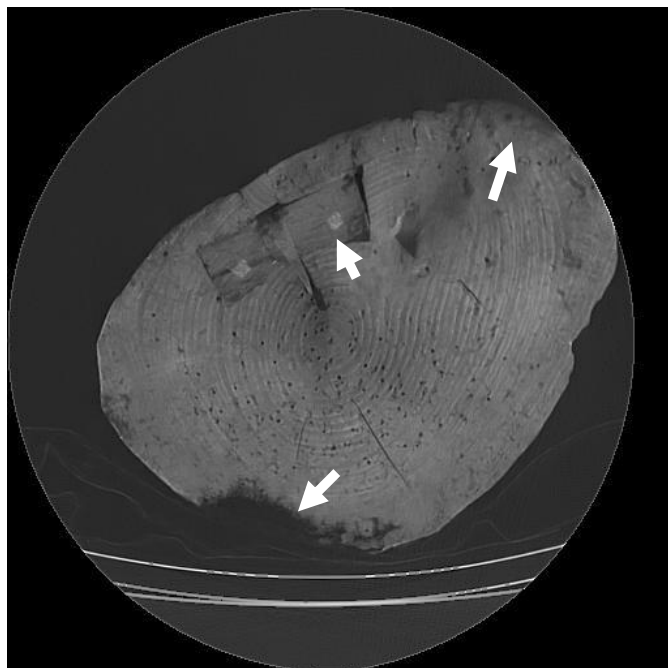
**Fig.4.** X-ray tomography reconstruction at waist level - chest.

Reconstructing the inner parts of the sculpture, showed it was overall in a very bad state. The observed inner deep side of damage indicated prolonged exposure of the object a number of destructive factors such as climate, variable conditions of humidity and temperature, the development of wood decaying fungi and xylophagous insects. The loss of local structural properties of the material, accompanied the occurrence of cracks and splits (face), and cavities of various natures. Photos Tomographic highlighted the short crack primarily formed at the surface and long transverse fold under the left arm, pasted canvas. A fairly large crack was found in the base of the shoe heels, as shown in the photo of the surface of the base (fot.3.). Tomographic studies have confirmed the presence of numerous feeding insects (common furniture beetle, death watch beetle) and exemplified their distribution throughout the body (fot.3., 4.). On the basis of a well defined range of symptoms, the distribution of brown rot (fungi of the Basidiomycota class) in base (fot.3.) was evident.



**Fig.2.** X-ray tomography reconstruction. Visible fastening metal studs.

The tomograms also showed the arms and hands were clamped to the body using oak dowels, which were replaced by recycled steel, and forged Studs (fot.2.). Moreover, on top of the head the original hole closed wooden stake was found. No corresponding opening in the base shows that the statue was not made in the so-called benches. According to medieval workshop tradition, this type of figure was attached to the special benches during process. The branches have the possibility of rotation in horizontally and vertically. The vertical arrangement served the implementation of general drawings and preliminary development of a solid, horizontal detailed surface exploration model. Items added were joined by pins. The work carving the sculpture was finished with wedges plugging holes in the head and the base. Cracks sealed with linen cloth, with a rather loose weave were found in the wood knots .



**Fig.3.** X-ray tomography reconstruction. Visible partial wood replacements, feeding insect and fire distribution brown rot

## CONCLUSION

- Wood used to construct the object was quite low quality. Knots and Duel core were evident.
- Inactive xylophagous insect were found in the whole cross-section of the object.
- There was a brown rot in the base of the sculpture.
- The object shows signs of previous repairs (partial wood replacements).
- Paints on the surface of the object contains heavy metals.

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**Streszczenie:** *Współczesne metody oznaczania stanu zachowania historycznych rzeźb.* Ważnym elementem podczas prac konserwatorskich jest diagnostyka stanu zachowania obiektu. Polega ona na określeniu rozmiaru zniszczeń oraz oznaczeniu czynnika niszczącego (np. grzybów, owadów). Jest to niezbędne do określenia zakresu prac konserwatorskich zmierzających do dezynsekcji i wzmocnienia obiektu. Wcześniejsze doświadczenia związane w wykrywaniem biokorozji obiektów drewnianych przy pomocy metod rentgenowskich, oraz tomografii komputerowej skłoniły nasz interdyscyplinarny zespół do wykorzystania metod tomograficznych. Badania prowadzono na zabytkowej rzeźbie drewnianej najprawdopodobniej powstałej w warsztacie małopolskim na przełomie XVI i XVII a pochodzącej z kościoła parafialnego pod wezwaniem Świętego Wawrzyńca Diakona Męczennika w Czerniejewie. Celem pracy było określenie wewnętrznego stanu zachowania obiektu oraz sprawdzenie skuteczności przeprowadzonych zabiegów konserwatorskich metoda tomografii rentgenowskiej.

**Słowa kluczowe:** historyczne rzeźby, tomografia komputerowa, konserwacja drewna, stare drewno

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