(REVIEW ARTICLE)

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Digital technologies in preserving craft tradition: integration of 3D modeling and machine processing in a church woodcarving workshop

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Abstract

The article examines the experience of implementing digital technologies in a church woodcarving workshop that carries out a full cycle of work on the design and manufacture of iconostases and interior ensembles of Orthodox churches. Key aspects of integrating 3D modeling, libraries of standard elements, and machine processing with hand carving are analyzed: their impact on quality, timelines, project manageability, and the preservation of artistic identity. In the case study of implemented projects, it is shown that the combination of CAD/CAM tools, digital libraries of ornaments (including motifs of Victorian carving), and an established production discipline makes it possible simultaneously to reduce technological risks, increase execution accuracy, and maintain the craft iconographic tradition.

Keywords: Church Woodcarving; Iconostasis; 3D Modeling; Digital Technologies; CAD/CAM; Machine Processing; Preservation of Tradition; Full-Cycle Workshop

1. Introduction

The integration of digital technologies into craft and artistic-production practices has become one of the key trends of recent decades. In architectural and design environments, CAD/CAM systems, parametric modeling, 3D printing, and milling are widely used. However, in the field of traditional church art and woodcarving, such tools until recently were perceived with caution, since there was a risk of "depersonalization" of carving, a reduction in the spiritual and artistic depth of works, and the loss of authorial stylistics.

Church woodcarving workshops operating in a full-cycle format (from the architectural and artistic concept of an interior to installation and handover of the object) found themselves in a situation where, without digital technologies, it is difficult to ensure the required level of manageability, accuracy, and predictability of timelines while maintaining a high artistic standard.

The purpose of this article is to describe the experience of integrating 3D modeling and machine processing in a church woodcarving workshop specializing in iconostases and interior ensembles, as well as to show how digital tools can support the craft tradition without disrupting it.

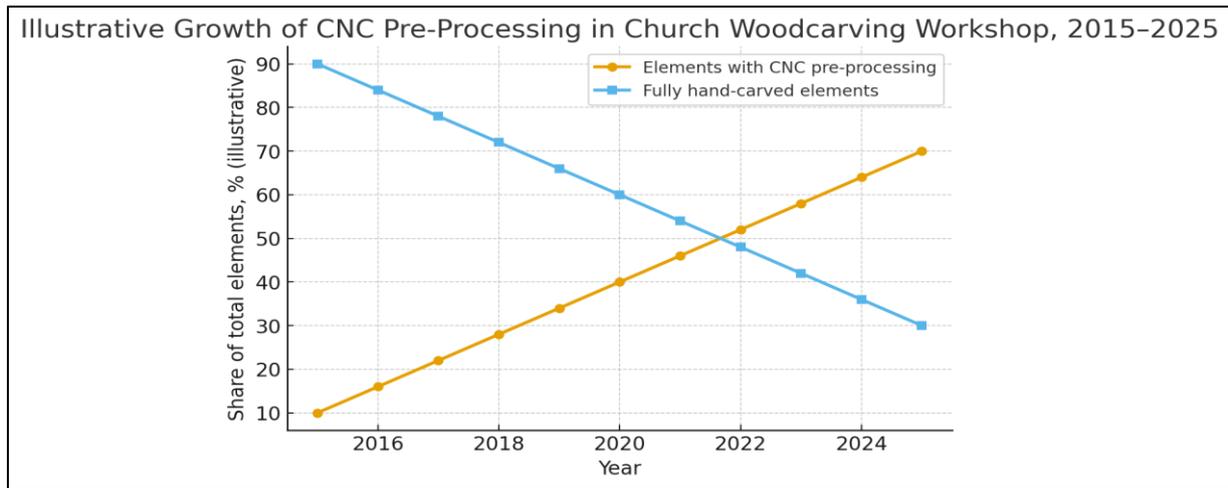* Corresponding author: Andrei Afanasev

Figure 1 Illustrative growth of CNC pre-processing in a church woodcarving workshop (2015–2025)

2. The digital workflow of the workshop: from sketch to machine

A modern full-cycle workshop in the field of church woodcarving forms an end-to-end digital workflow that integrates:

- Architectural and artistic design;
- 3d modeling and visualization;
- Preparation of manufacturing data (cam);
- Quality control and feedback from completed projects.

At the initial stages, an architectural and artistic concept is developed: the type of iconostasis is defined (tier structure, proportions, character of columns and cornices), the system of carved interior elements, and their relationship with the architecture of the church. This concept is then translated into a three-dimensional model, in which the following are refined:

- Scale and proportions;
- Depth of carving and projection of elements;
- Interaction with existing structures and painting.

The 3D model serves as the source material for CAM preparation: on its basis, machining paths are generated for machines (milling, panel-cutting, and others), after which the blanks are transferred to the carver for refinement and manual completion of the form.

Thus, the digital workflow does not replace craftsmanship but structures it: the machine performs the rough and highly repeatable high-precision part of the work, while hand carving preserves the plastic expressiveness and individuality of the image.
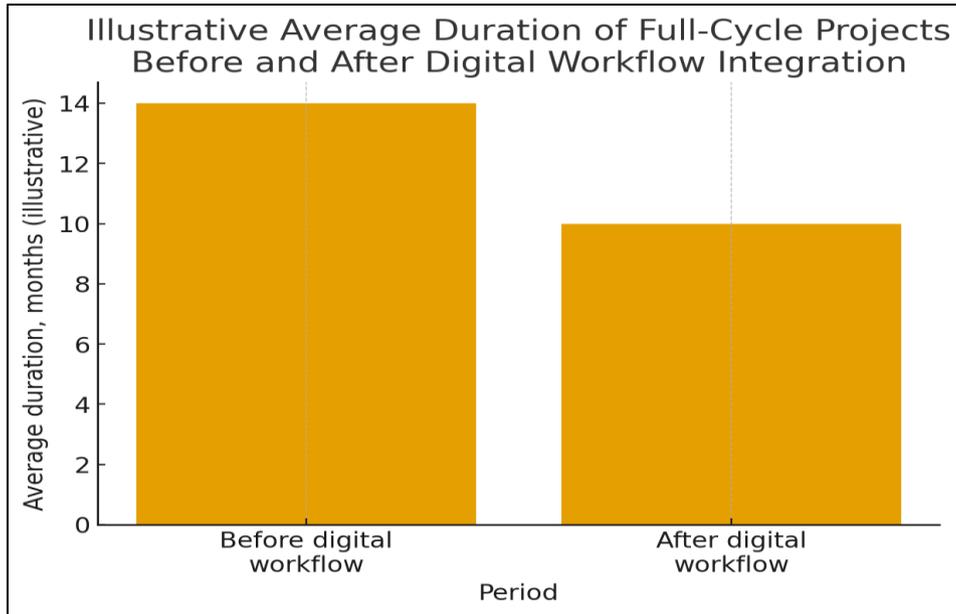
Figure 2 Illustrative average duration of full-cycle projects before and after digital workflow integration

3. Libraries of digital elements and motifs of Victorian carving

One of the key tools for integrating digital technologies into church woodcarving is the use of libraries of standard elements: capitals, column bases, cornices, ornamental bands, panels, and decorative appliqués.

Such libraries make it possible to:

- Offer a wide range of choices to the client;
- Accelerate the design process;
- Ensure stylistic coherence of the interior;
- Reduce the risk of structural and technological errors;
- Rely on proven solutions when working under tight deadlines.

Of particular interest is the inclusion in these libraries of motifs inspired by Victorian carving: complex vegetal ornaments, geometric interlacings, and characteristic profiles of moldings and cornices. With careful adaptation, these motifs are organically combined with the Orthodox tradition, enhancing the sense of depth and multilayered richness of the interior, especially in churches whose architecture bears features of eclecticism or historicism of the late nineteenth and early twentieth centuries.

The digital library addresses several tasks simultaneously:

- It preserves the stylistic unity of the workshop's portfolio (the repeatability of a recognizable "handwriting");
- It records successful solutions that emerged in specific projects and makes them available for subsequent reuse and development;
- It simplifies the client's selection of the required elements by providing visual material in digital form.

4. CAD/CAM and execution quality: precision, repeatability, control

The integration of CAD/CAM tools into the technological process of the workshop has a direct impact on production quality and manageability at every stage. Several key aspects can be identified.

4.1. Geometric precision and joint fitting

When working with large iconostases and interior ensembles, the precision of joints is of particular importance: the fitting of cornices, columns, frames, panels, and railings. Dimensional errors lead to deformations, cracks, and problems during installation.

The generation of machining paths based on a 3D model makes it possible to minimize such errors:

- Repeated elements (for example, a series of columns or panels) have identical geometry;
- The profiled part of the carving produced by the machine maintains the specified parameters;
- Tolerances are incorporated into the model rather than being determined "by eye" at the manufacturing stage.

4.2. Managing ornamental complexity

Machine processing makes it possible to realize complex multi-level ornaments that, if executed exclusively by hand, would require a disproportionate increase in time and cost. At the same time, final refinement and the "revitalization" of the ornament remain the responsibility of the carver, which helps to avoid the characteristic "sterility" of purely machine-made forms.

4.3. Quality control and feedback

The digital workflow facilitates the accumulation of technical and artistic feedback:

- Joints that caused problems during installation are documented;
- Areas where machine processing proved insufficient or, conversely, excessive are analyzed;
- Library elements and technological maps are adjusted.

Thus, each new batch of products becomes not an isolated episode but a step in the development of the workshop's overall knowledge base.

5. The impact of digitalization on project timelines and economics

The implementation of digital tools inevitably affects both the scheduling and economic aspects of projects. The practice of a full-cycle workshop demonstrates several stable effects.

5.1. Reduction of design time

The use of element libraries and established 3D templates for typical iconostasis configurations (single-tier, three-tier, five-tier) reduces the time from initial sketches to an approved 3D model. This is especially noticeable when working on projects where the architectural scheme repeats previously encountered church types.

5.2. More accurate assessment of labor intensity

The linkage "3D model — machining paths — workshop process charts" makes it possible to more accurately estimate labor hours required for production:

- Machine workload is forecast;
- The volume of hand carving is planned;
- Time buffers for possible adjustments are incorporated.

As a result, the risk of underestimating or overestimating budgets and timelines is reduced.

5.3. A sustainable order portfolio

Predictability of timelines and quality of work contributes to the formation of long-term trust on the part of clients. This, in turn, creates conditions for a sustainable order portfolio over a horizon of several years, including large-scale projects.

6.   Preserving craft identity: risks and strategies

The main question in the implementation of digital technologies in church woodcarving is how to avoid the loss of craft identity and the transformation of unique interiors into a standardized "product."

Several strategies can be identified to mitigate these risks.

- ●   Division of functions

The machine performs the preparatory, repetitive, and geometrically complex part of the work, while the final plastic modeling and detailing remain the responsibility of the carvers.

- ●   Priority of artistic intent over technology

Digital libraries and technological constraints do not dictate the composition of icons or the overall structure of the interior; they serve an already established architectural and artistic concept.

- ●   Development of an authorial style

The library of motifs, including reinterpreted elements of Victorian carving, is formed around the workshop's authorial "handwriting." What matters is not mechanical variability, but a coherent visual language that is recognizable across different projects.

- ●   Educational component

Carvers and designers master digital tools not as a replacement for craftsmanship, but as an additional language. Working with 3D models and machine equipment becomes part of professional culture rather than an external requirement.

7.   Conclusion

The integration of 3D modeling, libraries of digital elements, and machine processing into the work of a church woodcarving workshop demonstrates how digital technologies can become a resource for the preservation and development of craft tradition.

The experience of a full-cycle workshop shows that:

- ●   The digital workflow "sketch — 3D model — CAM — production — installation" increases accuracy, manageability, and predictability of projects;
- ●   Libraries of ornamental and structural elements make it possible to combine historical motifs (including those of Victorian carving) with the Orthodox iconographic tradition into a unified artistic language;
- ●   The combination of machine processing and hand carving makes it possible to realize complex ensembles without reducing the artistic level;
- ●   Product-oriented and managerial approaches based on digital tools do not abolish craftsmanship, but create a stable technological and organizational environment for it.

In the context of growing interest in church construction and the restoration of sacred interiors, it is precisely such hybrid workshops—combining tradition, digital technologies, and production discipline—that are capable of ensuring high artistic results and the long-term development of the field.

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