AN ASSESSMENT OF RESEARCH ON 3D DIGITAL REPRESENTATION OF ANCIENT GREEK FURNITURE, USING SURVIVING ARCHAEOLOGICAL ARTEFACTS

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Abstract

Due to an acknowledged bibliographic amount of sufficient visual data in other forms of prehistoric -unique and sometimes fragmentary- artworks, representing Greek Neolithic, Cycladic and Minoan furniture, the support of a research dealing with the "3D digital representation" of such otherwise extinct furniture types, motifs and woodworking construction details, was engaged.
The methodology formulated, made good use of any kind of existing visual data, collected them under a well documented, interdisciplinary structure and exhibited its results in an understandable manner, in order to promote further scientific research. It was thus decided that its basic characteristics should be; ease of use by any potential user, continuous software support and continuity and a wider recognisability amongst the academic community. Therefore, as in various contemporary occurrences in similar researches and projects, one broadly used open source 3D graphics suite software - created and supported by Google - Google Sketchup® v.7.1 as well as Autodesk's® 3ds Max v. 10, have been utilized.

Περίληψη

Λόγω του αναγνωρισμένου πλήθους βιβλιογραφικών πηγών και επαρκών εικονιστικών δεδομένων σε άλλες μορφές προϊστορικών -μοναδικών και μερικές φορές αποσπασματικών- έργων τέχνης , που απεικονίζουν έπιπλα της ελληνικής Νεολιθικής, Κυκλαδικής και Μινωικής περιόδου , έκανε εφικτό να υποστηριχθεί μια ερευνητική εργασία που θα ασχολείται με την «τρισδιάστατη ψηφιακή αναπαράσταση», διαφορετικά ελλειπόντων τύπων επίπλων, μοτίβων και ξυλουργικών κατασκευαστικών λεπτομερειών.
Η μεθοδολογία που διαμορφώθηκε , έκανε ολοκληρωμένη χρήση των κάθε είδους υφισταμένων εικονιστικών πληροφοριών, τις οποίες συγκέντρωσε κάτω από μία καλά τεκμηριωμένη, διεπιστημονική διάρθρωση και παρουσίασε τα αποτελέσματά της με ένα κατανοητό τρόπο, προκειμένου να προωθηθεί η περαιτέρω επιστημονική έρευνα . Έτσι, αποφασίστηκε ότι τα βασικά χαρακτηριστικά της πρέπει να είναι: ευκολία στη χρήση από οποιονδήποτε ενδεχόμενο χρήστη, συνεχής υποστήριξη και ενημέρωση λογισμικού και ευρύτερης αναγνωρισιμότητας της μεταξύ της ακαδημαϊκής κοινότητας . Ως εκ τούτου , όπως και σε διάφορες σύγχρονες περιπτώσεις σε παρόμοιες έρευνες και εργασίες, μια ευρέως χρησιμοποιούμενη πλατφόρμα λογισμικού τρισδιάστατων γραφικών, ανοιχτού κώδικα - που δημιουργήθηκε και υποστηρίζεται από την Google – το Google Sketchup ® v.7.1 καθώς και το 3ds Max ® v. 10 της Autodesk, χρησιμοποιήθηκαν.

Keywords: Neolithic; Cycladic; Minoan; furniture; 3D digital representation; woodworking; Sketchup®; 3DS Max

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1. Introduction

The capabilities of computer graphics have evolved rapidly from simple imagery to complex representations and visual effects. Both 'virtual archaeology' and 'digital restoration' have emerged and have developed through interdisciplinary work. 3D digital representations acquired numerous applications in cultural heritage during the last decades and have been extensively supported in literature. Through such applications, it is possible to reconstruct and visualize monuments, artifacts, archaeological sites, etc., to create dynamic visual research models (Tsipotas & Michalaros 2012).

Sufficient imaging data (Mainas 2002; Richter, 1966; Baker 1966) on prehistoric Greek, Cycladic and Minoan, furniture, where no physical examples have survived, exists - represented in published archaeological artifacts - in order to support 3D digital representation of furniture types and enable research on motifs, construction and woodworking techniques (Tsipotas 2010; Mainas 2002; Richter, 1966; Baker 1966).

Original results and conclusions' suggestions throughout the article, as far as ancient furniture style and construction data are concerned, are singularly based on the unpublished PhD thesis by Tsipotas (2010), since only sporadic references - which hasn't

initially aided in the project's progress – furthermore exist about these periods' furniture in limited literary sources (Tsipotas 2010).

1.a. Aims and scopes

The primal and fundamental aim of this preliminary part of the project is to attempt to transform a theoretical area, due to the lack of tangible artifacts, to something more virtual, realistic and even tangible again. It is scholarly accepted in general, that such a task on humanities research and presentation could most successfully be attained by the use of 3-dimensional digital visualisation applications.

The basic principles do not only concern the creation of lifelike imagery, but manufacture realistic 3-dimensional models, recreating the actual construction and reviving the appearance of a piece in all its aspects if possible, thus versatile enough to support or reject theories, propel new ones and further promote interdisciplinary scholar research. Such tasks have been made feasible using the extensive published archaeological material incorporating abstract to realistic furniture representations (Tsipotas 2010).

The gap between theory and practice in rigorous academic application of 3D visualisation in such humanities projects has nevertheless to be addressed by the implementation of established standards, methods and software (Tsipotas & Michalaros 2012; Tsipotas 2010).

1.b. Problems regarding the history of ancient Greek furniture

Ancient Greek furniture history is scarcely and unclearly dealt in archaeological literature only and references result in a rather unlinked accumulation of information (Tsipotas 2010; Mainas 2002; Richter, 1966; Baker 1966). These information lack evidence beyond the archaeological point of view and mostly disregard any furniture design and construction assessment (Tsipotas 2010; Mainas 2002; Richter, 1966; Baker 1966). Additionally, original furniture pieces and fragments scarcely exist in various forms (Mainas 2002; Richter, 1966; Baker 1966). Last but not least, archaeological and human mean stature admissions have to be made (Tsipotas 2010).

2. Aims and scopes of the archaeological research

The aims and scopes of this project's archaeological research can be outlined as follows (Tsipotas & Michalaros 2012; Tsipotas 2010):

- Fully review the existing limited sources of ancient furniture and wooden constructions in the Greek area.
- Interpret and reveal forms, production, design, types and construction techniques of ancient Greek furniture.
- Create a distinct course of their development and production.
- Interconnect surviving archaeological data with a 3-dimensional visualisation methodology.
- Make use of computer aided methods for the representation and presentation of such information to the public and academic community in understandable, educational and further useful manners.

3. Review of the existing information

Extensive chronological and geographic gaps in "*Greek furniture prehistory*" are present, mostly due to the absence of consistent archaeological finds. Therefore, past suggestions of irregular progress, parthenogenesis of pieces and inconsistent production (Mainas 2002; Richter, 1966; Baker 1966), have to be more thoroughly examined under the light of new evidence. On the contrary, it should be traced if any acknowledged form resulted through specific progression (Tsipotas 2010).

4. Neolithic period

Figure 1. Clay figurine of a seated mother carrying her child. 3700 - 3300 B.C. Final Neolithic. Sesklo, Thesssaly. National Archaeological Museum (Theocharis 1973, fig. 56)

In the Early Neolithic period woodworking could not have been promoted into a definite occupation, due to the primitiveness of technology (Papathanasopoulos, 1996, 1981; Theocharis 1973, 1970; Hourmouziadis 1970; Tsountas 1908). In the Final Neolithic period though, the first use of the mortise and tenon joint can be implied (Tsipotas 2010; Papathanasopoulos, 1996, 1981; Theocharis 1973, 1970; Hourmouziadis 1970; Tsountas 1908). Nevertheless, it possibly originated in a much earlier period. (Papathanasopoulos, 1996, 1981; Theocharis 1973, 1970; Hourmouziadis 1970; Tsountas 1908) Furthermore, the Neolithic household implies simple, utilitarian wooden furniture constructions and a technological know-how and woodworking development further progressed during the Final Neolithic. Regardless, the stool representations in other forms of art (Fig. 1) do not reveal evident structural or stylistic evolution (Tsipotas 2010; Papathanasopoulos, 1996, 1981; Theocharis 1973, 1970; Hourmouziadis 1970; Tsountas 1908).

4.a. Neolithic period 3D furniture representations

It has been suggested that since rare furniture data lacks stylistic and technical information, the Greek Neolithic period furniture cannot so far be 3D digitally represented (Tsipotas 2010).

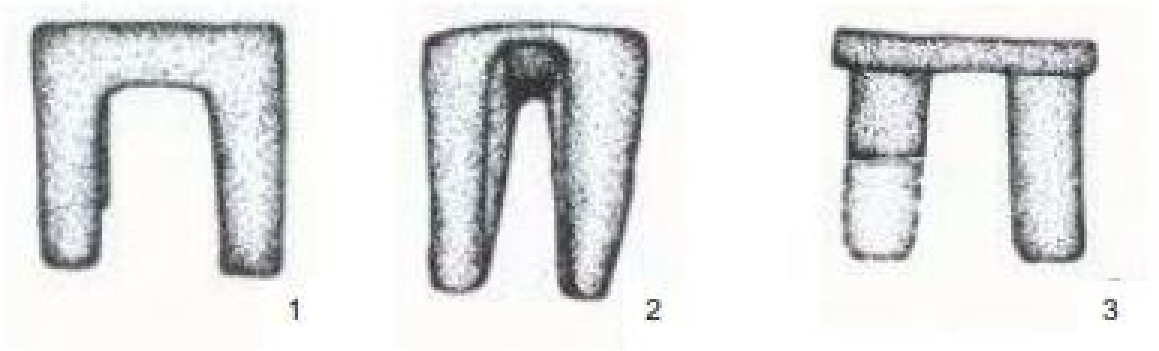

Figure 2. Types of stools. (1). J. Paul Getty Museum (Getz -Preziosi 1987 b, pg. 268 -269, no. 92 a-b). (2). Shelby και Lean Levy Collection, USA (Getz.-Preziosi 1987 b, pg. 264 - 265, no. 90a-b). (3). Private Collection, USA (Getz-Preziosi 1987 b, pg. 266 - 267, no. 91a-c) (author's graphic representations)

5. Early Cycladic period

5.a. Construction data

During the early Cycladic period, the stools' limited representations in marble statuettes imply a general similarity in forms, with nevertheless distinctive differentiations (Tsipotas 2010; Davis 1992; Marthari 1990; Getz-Presiozi 1987; Demargne 1964; Doumas 1990, 1983, 1970, 1968; Renfrew 1967; Zafiropoulou 1990). Respectively, the shape and thickness of the upper surface of the stools may indicate a specific construction method from a rectangular block of wood. Additionally too, rectangular stools with elongated front and back rails appear, foreseeing benches' construction (Fig. 3). A similar but lower stool further attests that pieces varying in dimensions must have been actually constructed (Tsipotas 2010).

5.b. Admissions

Admissions that have to be clarified about the early Cycladic period furniture are summarized by Tsipotas (2010) as follows:

- The solid stool, used until present, possibly proves the continuity of a well established, simple but functional type (Fig. 2).
- The earliest representations of chairs, in the modern sense, originate to the Early Cycladic culture.
- The use of seats with a high back is only evidenced in four examples (Figs. 4, 5), but it can be generalized by the widespread utilization of the type in contemporary surrounding civilizations.
- Chairs' depictions reproduce strict similarities of wooden originals.
- The Keros and Richmond distinctive types (Fig. 5) are dealt as customary constructions, despite their statuettes

Figure 3. Marble representations of stools. 2700 - 2600 B.C. Naxos Island, Cyclades. Naxos Museum. Center: Early Cycladic period. Teke, Crete. Heraclion Museum (Richter 1966, fig. 35)

controversial origin points.

- The structural elements of the two chairs in New York and Naxos (Fig. 4), strongly suggest that the second could have been the evolved technological form and a stylistic successor of the first.
- The identical back splats of the Keros and the Naxos examples (Fig. 6) can point out a stylistic feature which could substantiate an established "following function and construction" motif and design evolution.
- The curved pointed arch in the Keros and Richmond types possibly constitutes a usual form of the Cycladic design evolution.
- Stylistic predecessors of the above two types cannot be envisaged. A much hypothesized technological progress can only be suggested by simplifying the separate parts of the types.
- The components and construction methods of the unique Richmond example (Fig. 5, right) can also be traced in the established chair types.
- It could therefore be accepted that evolution could have been substantial in chair design and not characterized by isolated and unique examples.

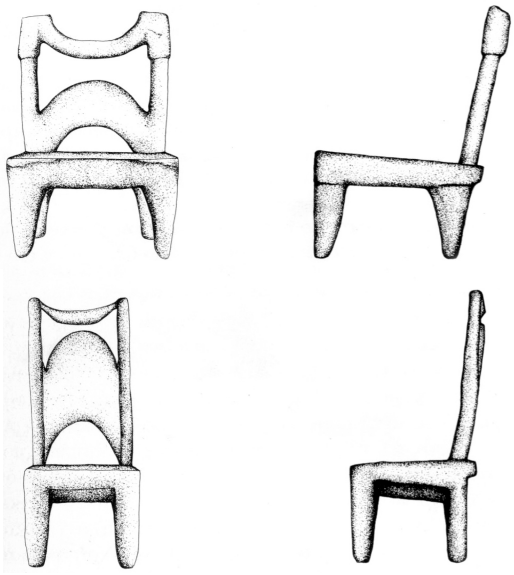

Figure 4. Two surviving types of Cycladic chairs (graphic representations). Up: Naxos island (Naxos Museum). Down: Unknown origin (Metropolitan museum of New York) (author's graphic representations)

5.c. Overall remarks

"Signs" of style development and technical evolution in furniture are probably revealed for the first time during the Early Cycladic period, but manufacture had possibly kept a local character as is also the case in Cycladic art in general and woodworking stylistic tradition appears unique. Therefore, previous suggestions about strictly utilitarian furniture pieces are controversial and specific designs of seating furniture could derive from the period's representations (Tsipotas 2010; Davis 1992; Marthari 1990; Getz-Presiozi 1987; Demargne 1964; Doumas 1990, 1983, 1970, 1968; Renfrew 1967; Zafiropoulou 1990). Additionally, a more elaborate joinery could be suggested, such as an accurate mortise and tenon joint, or a but-joint, since the use of bronze tools and development of ship building also imply a progressive advancement in furniture making. The similarity of the period's with present tools, also implies good quality and elegance, at least equal with contemporary non industrial handcrafted works (Tsipotas 2010; Agouridis 2001; Fusaro 2001; Tzalas 2001; Tranta-Nikoli 1999, Zafiropoulou 1990).

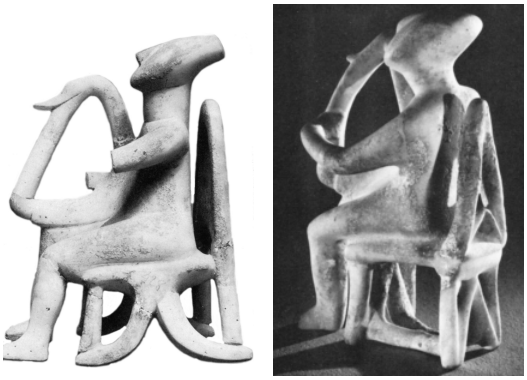

Figure 5.a,b. Marble chair representations. Left: Keros type (ca. 2500 B.C.). Keros Island. National Archaeological Museum,Athens (Richter 1966, Fig. 34; Mainas 2002, Fig. 3; Petrakos 1981, Fig. 6). Right: Richmond type (ca. 2500 B.C.). Southern Cyclades, Richmond Museum of Fine Arts, Virginia (Baker 1966, Fig. 383, 384)

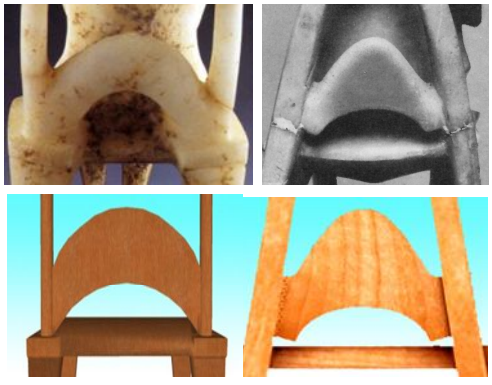

Figure 6. Comparison of the back splats of the statuettes and the 3D representations from Naxos and Keros Islands, respectively (Tsipotas, 2010; Baker, 1966; Theocharis 1973)

6. Ancient Greek furniture through 3-dimensional visualisation

6.a. 3D visualisation adopted methodology

It has been decided that the methodology adopted, should encompass ease of use for any potential user, continuous software support, continuity and availability of the software, and wide recognition amongst scholars and the public.

6.b. Sources - software - results

6.b.1. Google Sketchup® applications

A widely-used, open-source suite of 3D graphics software, Google Sketchup® v. 3.0 - 7.1 was used to present visual similarities, differences, structural details, problems and aesthetic issues relating to Greek furniture known only through surviving archaeological artifacts.
It is a rather simple platform but its capabilities are unlimited. It can rapidly generate near-lifelike objects in varied environments. It can co-operate with several other applications provided by the Sketchup® suite (see www.sketchup.com) for better rendering, animation, presentation or even modeling of stress distribution, and a number of other applications.

6.b.2. Google Sketchup® Results

6.b.2.1. Cycladic stools

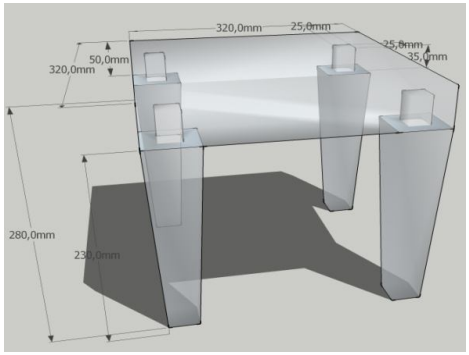

Figure 7. Sketchup® X-ray 3D model illustrating the suggested dimensions and joints of the actual construction of a Cycladic stool (Tsipotas 2010)

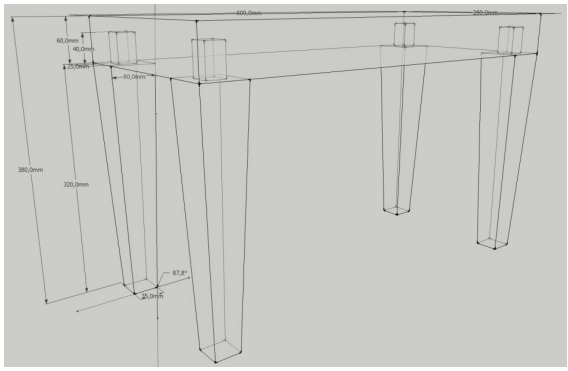

Figure 8. Sketchup® X-ray 3D model illustrating the suggested dimensions and joints of the actual construction of an elongated Cycladic stool (Tsipotas 2010)

6.b.2.2. Cycladic chair - Metropolitan type

Figure 9. Up: Sketchup® 3D representation of the marble chair represented in the Cycladic statuette at the Metropolitan Museum. Down: Construction detail of the marble original and its 3D representation (Tsipotas, 2010; Theocharis 1973)

Figure 10. Sketchup® 3D representation of the marble chair represented in the Cycladic statuette from Naxos island (Naxos Museum), shown in the inset photo image (Tsipotas, 2010; Theocharis 1973)

6.b.2.3. Cycladic chair – Naxos type
6.b.3. 3DS Max® applications

In response to the desire of making realistically enhanced 3D models, Autodesk® 3DS Max® 2010 Software v.12.0 was utilized. 3DS Max® is a powerful modelling, and rendering platform, providing lots of modelling abilities

Figure 12. 3ds Max® 3D representation of a marble chair represented in the Cycladic statuette of the Keros harpist (2500 B.C.), shown in the inset photo image (Tsipotas, 2010; Baker, 1966)

Figure 13.a,b. 3DS Max® 3D representation of the marble chair represented in the Cycladic statuette from Naxos island (Naxos Museum), illustrating the right side view (up) and front view (down) of the actual wooden construction with detailed texture

(www.autodesk.com). By using front and a side view reference images of the pieces and by following polygonal modelling steps, high resolution versatile chair models were reconstructed in accordance to the marble sculptures. 3DS Max® was used to further present visual similarities,

Figure 14. 3DS Max® 3D representation of the marble chair in the Cycladic statuette from Naxos island, illustrating a perspective view (Tsipotas 2012)

differences, structural details, problems and aesthetic issues relating to prehistoric Greek furniture known only through surviving archaeological artefacts. It is nevertheless acknowledged that the full scale of the -probably unlimited- capabilities of the software, are not so far exploited and go beyond this stage of the project and the present article.

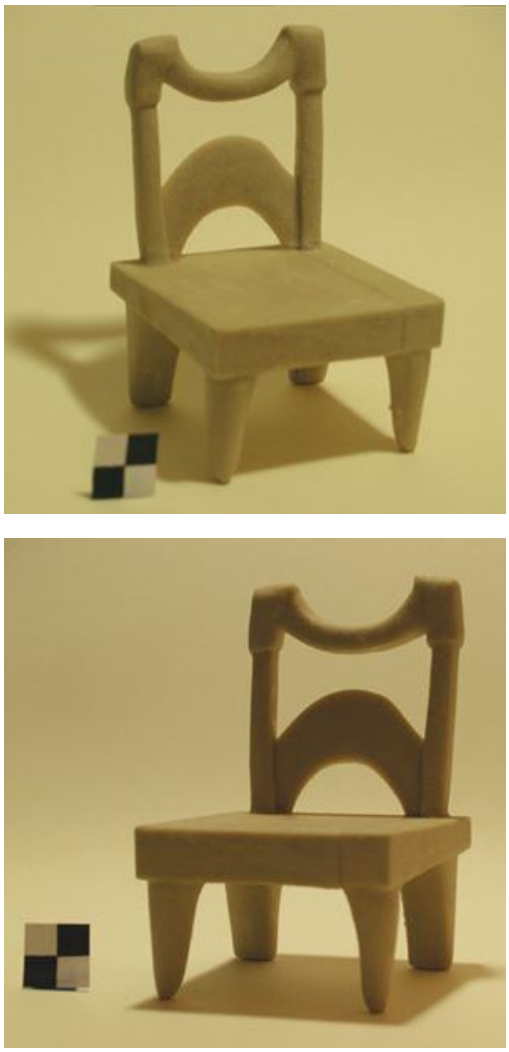

Figure 15.a,b. Final printed model of the marble chair represented in the Cycladic statuette from Naxos Island (Naxos Museum), created by 3DS Max® and printed by Zcorporation Zprinter® 450

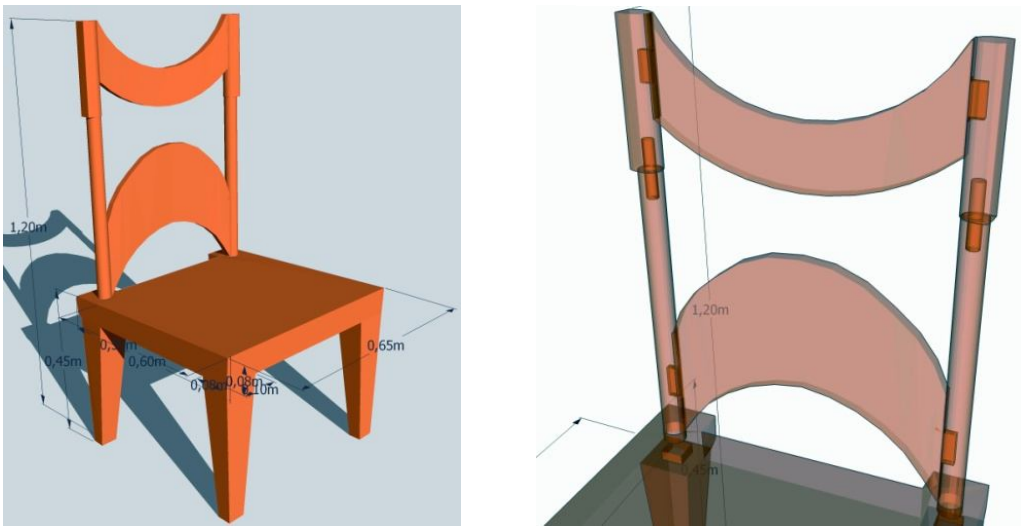

Figure 11.a,b. Sketchup® 3D representation of the marble chair representted in the Cycladic statuette from Naxos island (Naxos Museum), illustrating the suggested dimensions (left) and joints (right) of the actual wooden construction (Tsipotas, 2010)

7. 3D printing

The files created with 3D Studio MAX®, are currently going through a 3D powder printing process in order to produce scaled, physical, full color, 3 dimensional models. The 3D printer used is the ZPrinter® 450 by Zcorporation. Its features include 180,000 colors, 300 x 450 dpi sesolution, minimum feature size of 0.15 mm and full automation (automated setup and self monitoring / automated powder loading / automated powder recycling and removal / snap-in binder cartridges / intuitive control panel). The software used is the ZPrint™, which is a powerful, easy-to-use tool for preparing CAD files for optimal printing on 3D Systems 3D Printers. ZPrint can handle and manage a broad range of data formats including full-color files (http://www.zcorp.com/en/Products/3DSoftware/ZPrint/spage.aspx). 3D printing is taking place at "Wood and furniture design and technology" department, T.E.I. of Thessaly (former of Larissa).

The models are designated to progressively suit a wide variety of needs, from education to the department, continuation of the research through to any kind of presentation and exhibition purposes. Major advantages of 3D printing is that someone can hold a full color, realistic 3D model in his hands to impart infinitely more information than a computer image, obtain feedback, refine designs and repeat the printing cycle (http://www.zcorp.com/en/Products/3D-Printers/Advantages-of-3D-Printing/spage.aspx).

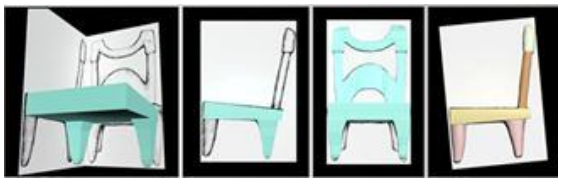

Figure 16. Stages of the 3D printer model, created with the printer's software

8. Project's conclusions and future prospects

A considerable number of pieces and motifs have already been represented with both softwares.

The project's most interesting results were the reproduction of manufacture and design elements of lost furniture types and the tracing of their possible stylistic and morphological evolution. Still images and animations were extracted for display and presentation purposes. Supplementary data generated by the project has additional significance for woodworking research in the Aegean basin. The author hopes that employment of such software will encourage a revival in historic construction techniques and design patterns.

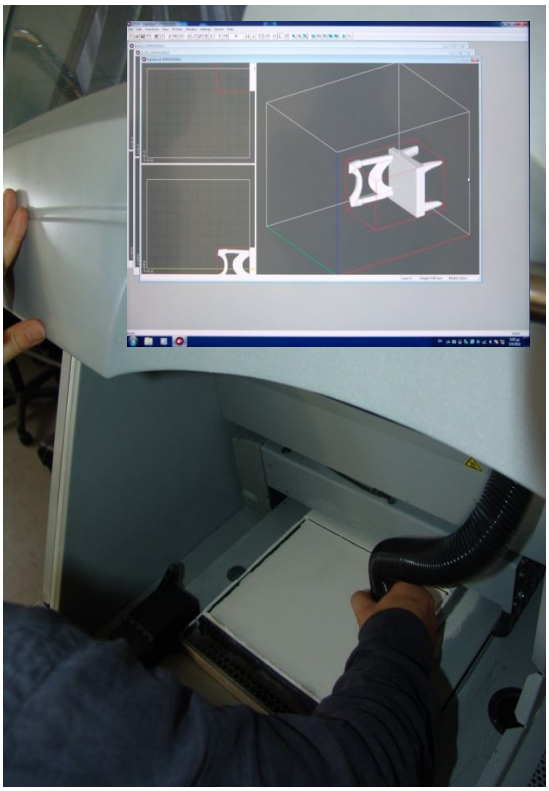

Figure 17. The 3D printer and printer software screen during the printing process

It is therefore eminent that a primary approach and setting for future use of this methodology has been established, in order to support specific similar subjects.

It has to be made clear though that any archaeological literature on the periods dealt, supporting the 3D representation of complete or fragmentary furniture types or motifs has already been used throughout this part of the project.

Thus, some future steps have been specifically discussed, designed and arranged as follows (Tsipotas & Michalaros 2012; Tsipotas 2010):

- Constant research for new archaeological evidence regarding woodworking and furniture.
- Further research on tool technology, which supported furniture craftsmanship.
- Further research on Egyptian furniture, craftsmanship and Minoan interconnections.
- Advancement of the furniture representations in all historical periods.
- Further exploitation of the softwares' capabilities, in order to recreate more accurate 3D representations in overall.
- Utilization of the 3D representations for the reconstruction of whole domestic interiors.
- Continuation of the 3D printing project, in order to create tangible scaled or even life-sized 3D models.

- Continuous update and improvement of the project's blog (www.greekfurniturehistory.wordpres.com) and site creation.
- Interdisciplinary co-operation with woodworking, archaeological and digital graphics professionals and parties for the proper exploitation, interpretation and dissemination of the sources and results of the project.
- Presentation to relevant forthcoming academic events for the establishment of research, economic or commercial co-operations.
- Search for funding.
- Creation of an ambitious, but nevertheless possible "Virtual Museum of Greek furniture history".

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