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10th INTERNATIONAL CONFERENCE "RESEARCH AND DEVELOPMENT IN MECHANICAL INDUSTRY"

RaDMI 2010

In Memoriam of Prof. dr Georgios Petropoulos

PROCEEDINGS

Volume 1

Editor:
Predrag V. Dašić

1

16-19. September 2010.
Donji Milanovac, Serbia

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P R E F A C E

The First Conference ″Research and Development in Chemical and Mechanical Industry″ - **RaDMI 2001** was held upon the initiative of Predrag Dašić and prof. dr Miroslav Radovanović in Kruševac from October 22-24, 2001.
Until now, 9 conferences were realized. The conference accepted and published over 1.500 papers, from which 1.100 were from abroad from 40 various countries of the world. Total number of authors and coauthors is over 2.000. Papers of the 8th conferences were published in 16 proceedings in hard copy and 8 proceedings in electronic form (CD-ROM). Amount of printed material was approximately 11.000 pages. Some papers from the 8th International conference RaDMI 2008 will be printed in special issue of international journal from SCI-E paper ″Strojniški Vestnik – Journal of Mechanical Engineering″ Vol. 55, no. 2 (2009) (Web site: http://en.sv-jme.eu/).

Tenth International Conference ″Research and Development in Mechanical Industry″ **RaDMI 2010** will be held on 16–19th September 2010 in Donji Milanovac, Serbia.

Topics of the Conference RaDMI 2010 are:

- **Plenary Session:** Invitation papers, with 18 papers;
- **Session A:** Research and development of manufacturing systems, tools and technologies, new materials and production design, with 52 papers;
- **Session B:** Transport systems and logistics, with 9 papers;
- **Session C:** Application of information technologies in mechanical engineering, with 23 papers;
- **Session D:** Quality management, ISO 9000, ISO 14000, TQM and management in mechanical engineering, with 49 papers;
- **Session E:** Application of mechanical engineering in other industrial fields, with 50 papers.

The aim of organizing the Conference is: animating scientists from the faculties and institutes and experts from the industry and their connecting and collaboration, and exchanging the experiences and knowledge of domestic and foreign scientists and experts.
On behalf of the organizers, we would like to extend our thanks to all organizations and institutions that have supported the initiative to have this anniversary gathering organized. We would also like to extend our thanks to all authors and participants from abroad and from the country for contribution to this conference.

This Tenth International Conference RaDMI is entirely dedicated to the late Prof. dr Georgios Petropoulos, our friend and active participant in all the previous conferences.

Donji Milanovac, September 2010.

CHAIRMAN OF ORGANIZING COMMITTEE

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Donji Milanovac
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"Research and Development in Mechanical Industry"
RaDMI 2010
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WOOD FURNITURE PARAMETRIC MODELING AS AN INTERIOR DESIGN STRATEGY

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Summary: *Product shaping is an important phase of the design process. Theory of product shaping is scientific discipline which studies approaches and methods applied in product development and this theory is applicable to the parts and assemblies as well. Part and assembly modeling is final operation of shape forming process. That is the phase when product gets its final, defined 3D shape. Compute Aided Design (CAD) technologies which support parametric part modeling as a support to the design process, give following advantages: time necessary to design family of similar parts is significantly shorter and quality of products is the same or better than during design part by part. This paper gives a glance on parametric modeling and its application in wooden furniture manufacturing as an interior design strategy.*

Keywords: *Wood furniture design, Interior design, 3D parametric modeling*

1. INTRODUCTION

It's the information revolution that is metamorphosing product development, architecture and urban design. Digital technologies are transforming the nature and intent of architecture and creativity, blurring the relationships between matter and data, between the real and the virtual and between the organic and the inorganic and leading us into the area from which rich, innovative forms are emerging. At the end of 20th century, humanity's concept of space has suddenly experience a great change with the arrival of the Internet. Cyberspace or networked space now exists alongside actual space. Computer simulation technology has allowed building to be create in virtual space that were never intended to actually be constructed. This virtual space has not only influenced the direction of architectural design, but has overturned our existing spatial theories, interior design and furniture design.
The success of particular furniture has always depended on the quality and range of the connections it makes, or the designer is able to make through it, while addressing a specific need. At the functional level, furniture makes physical and psychological connections with its form and material. At the same time, it may embody meanings and values which connect with the user at an intellectual, emotional, aesthetic, cultural and even spiritual level. Over the past 150 years, the evolution of the chair has paralleled development in architecture and technology and reflected the changing needs and concerns of society to such an extent that it can be seen to encapsulate the history of design. While the digital architecture is a revolutionary factor, none of which can be ignored, the furniture themselves express the coherence of emergence in the digital architecture era. Figure1 demonstrates the historical context of furniture design from Art & Craft Movement to Virtual Furniture Design.

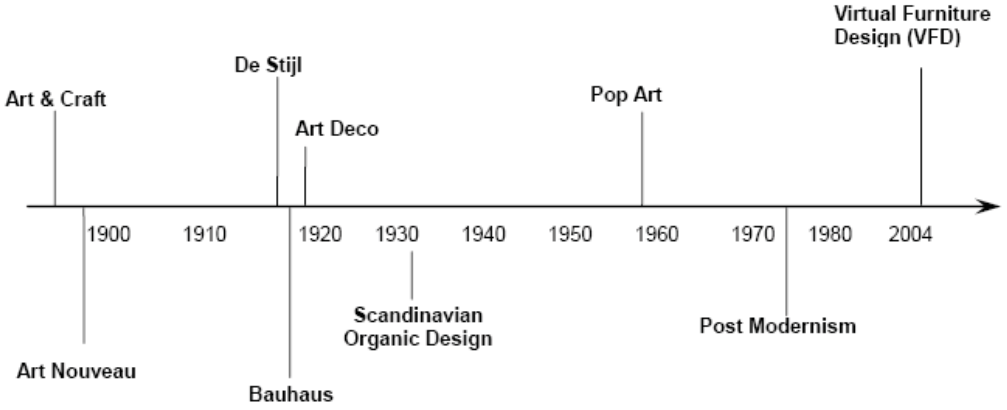

Figure1: The historical context of furniture design

2. THE FURNITURE DESIGN STRATEGY IN DIGITAL ARCHITECTURE ERA

The digital design media and digital construction methods have liberated form and space in architecture, and have turned architecture into more of pure art form than previously. The digital architecture has been changing the design materials, and appearance of architecture, which are main factors to furniture design. There features are: generative & Sculpture form, free form, carries of visual information and interactive environment.
Through the exploration above, we may induce that the digitalization goes wild and be more intangible. The existing furniture design strategy can no longer satisfy the multiform representation of architecture in real and virtual world.

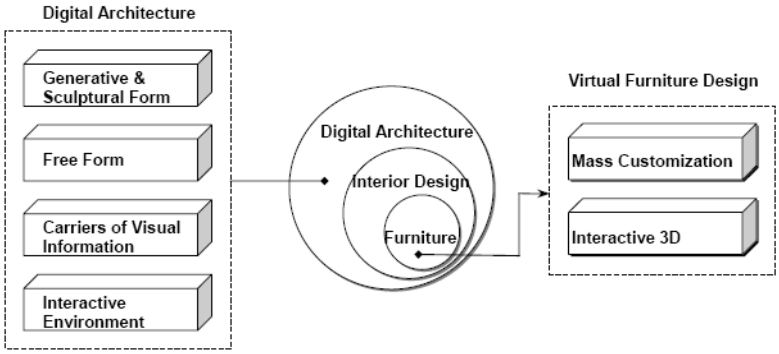

Figure 2: The furniture design strategy in digital architecture era [15]

The goal was to provide business customers and consumers with a differentiated, low-cost product with input from the customer and efficient production and delivery using information and manufacturing technology. The mass customization paradigm is one of the methods for creating customer-centric product. Figure2 explains the two different ways the production process can be triggered by transforming customer data into production data or by making inquiries of the customers.
Mass customization is ability to quickly and efficiently build massively usable and customized product. It uses all the techniques presented so far for the build of standard products and extends that to custom products. These products can be customized for individual customers or niche markets, such as version optimized for certain market segments, industries, regions, or countries.
Mass customization may need effective web sites through configurators convert order entry data into parametric CAD models, CNC programs, electronic manual instruction, supplier pull signals, and shipping instructions.
The most advanced configurators can display solid models and advanced graphics to show the customer what the contemplated product will actually look like. For very new products, this visualization capability can help early customers understand and comprehend new concepts and approaches. This can help get early feedback from customers. Web-based configurators offer the tantalizing prospect of customers not only placing their own orders but also “designing” their own products, all through automatic systems that are carefully constructed to allow ease of use and permit only valid product configurations. Different categories of key value attributes can be distinguished and each type has implications for product design, process design, and inventory.

3. MODELING IN WOOD FURNITURE MANUFACTURING

Parametric modeling of wooden furniture is very useful approach in furniture manufacturing since schemes and models used in this area are similar and belong to a family of similar parts. Wood based panels for furniture manufacturing are delivered as 2750-2800 mm long and 2070-2120 mm wide, depending on the manufacturer of wood panels. For further furniture manufacturing it is necessary to prepare these panels to adequate dimensions. Common usage of these panels is usually below 90% what makes them more expensive then they are. Manufacturing program of a furniture factory is usually adjusted to a single wood panel's manufacturer, but unexpected contract canceling between them might be a problem if furniture factory is not capable to quickly transform existing documentation according to the proposal of a new panel distributer. One way to prevent delays in work of such a factory is parametric modeling of parts and assemblies.
It is a powerful service for the panel-based furniture that is typically manufactured by CNC machines. We first build a digital 3D model with all the parts required to build the actual product. We then use this model to generate subsequent manufacturing data and drawings for precise and fast production. 3D virtual models are developed in some CAD application (Inventor, SolidWorks etc.) and they have numerous applications (Figure 3). These models can give final – technological documentation, lists of parts, and numerous details such are: price of a product, mass, density, volume etc. For example, furniture factory must make a business proposal in a few hours and parametrically modeled parts and assemblies can ease that problem and make a proposal possible in a few minutes. Price, as a prime factor of any proposal, is given in seconds. Development of montage schemes is crucial in furniture design process as well. Furniture should be home friendly and every buyer has different taste for his living space. Parametric modeling can provide fast adjustments and buyer can easily give brief overview to a manufacturer what does he wants to see in his home. 3D renderings give realistic images of furniture. Developed models can be converted into the STEP or IGES files and easily used in any other application, such is 3D planner – used for living space planning.

Figure 3: Application of 3D model

In children, living and bed room primary furniture can be described as a member of a family:
- lockers,
- commode,
- show case,
- wardrobes,
- closets.

4. 3D PARAMETRIC MODELING OF THE WOOD PANEL FURNITURE

There are several types of wooden panels in corpus manufacturing program (Figure 4):
- floor of the roof,
- back sides,
- separating verticals,
- separating horizontals,
- divisions,
- wings (application with glass),
- masks.

Figure 4: Model of commode with 2 wings and 2 drawers

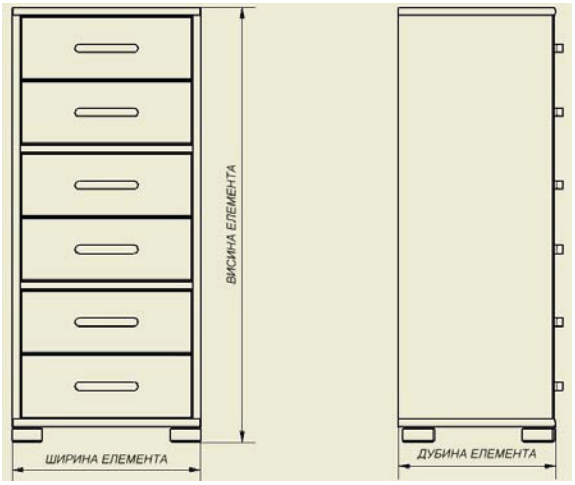

Figure 5: An example of the furniture

A single corpus element has corpus and color. One corpus is considered to consist of: floor roofs, back sides, separating verticals, separating horizontals and divisions. All of them are made in décor of beech, light ash, oak and sweet cherry.
Every element has its length, width and depth.
Manufacturing program considers raster between drilled hole of 32 mm precisely defined with the distance of masks and edges from the roof floors and separating horizontals. For parametric modeling of these elements, it is important to accept several standard heights of elements that will fulfill functionality and ergonomic criteria.
Width of elements is defined with the model of furniture: if it is one winged, two winged etc. Two winged furniture can be a variant with separating vertical or without it. If we use the separating verticals, that makes six possible widths of corpus elements. If we consider the orientation of the wood it can be said that width of the panel is the length of the floor panel.
Depth of the furniture gives functionality. Program has two options. So, lockers, commodes and show cases have smaller depth while closets and wardrobes have greater depth. Depth determines the width of the floor, back side, divisions, separating horizontals and separating verticals.
Parametric model generation is possible on 2 different ways. First approach uses a template of the model created in CAD and systematic parameters are read over dll files by the CAD application.
Another approach uses Microsoft Excel file as a database where parameters of the model are inserted .Previously modeled basic models of furniture, parametrically connected one to another are already in the M. Excel. After start of the CAD application, in this case Autodesk Inventor, CAD connects to the M. Excel file, starts a template of the model and updates it according the data from the Excel.
For parametric modeling of the furniture, it is used second approach. Since every element has its dimensions in the Excel table (Figure 5) these are the main parameters necessary for modeling. For quick exchange and program adjutancy with new cutting schemes (for panels) 3 parameters are used: length, width and depth.

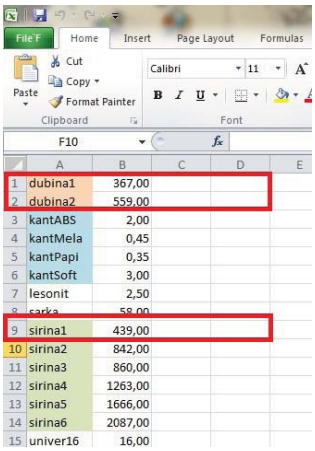

Figure 6: Basic parameters

Checking the adequate parameters it is possible to choose characteristic parameters of the furniture. These parameters are responsible for further manipulation of the furniture data. Figure 7 gives and example how parameter exchange involves the shape of the furniture and its elements.

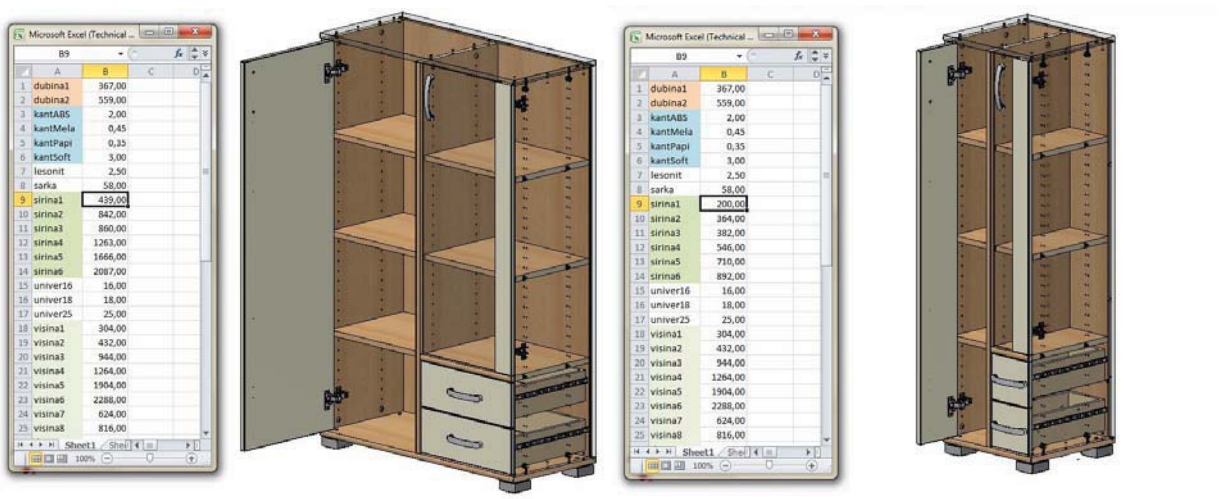

Figure 7: An example how parameter exchange involves the shape of the furniture and its elements

Parametric modeling eases the changes in technological documentation of a certain part of the furniture what is the main goal of parametric modeling in manufacturing of the wood furniture.
Figures 8, 9, 10, 11 give example variants for the lockers, commodes, wardrobes and closets. Numerous variants are made and converted into adequate model capable to be inserted into interior design software (3D planner) and further more used for custom development. Buyer can create his own children's room, bedroom, without even coming to the factory. Parametric modeling has enabled virtual world to improve realistic word without increasing the price of the furniture.

Figure 8: Lockers

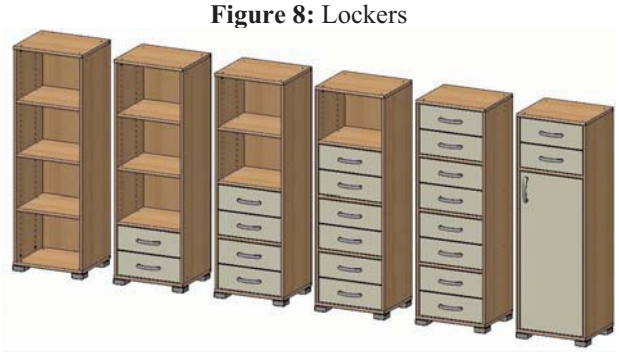

Figure 9: Commode

Figure 10: Chases

Figure 11: Wardrobe

After analysis of the market, management can easily change parametric modeled furniture and adjust the factory to the new market demands. On the demand side of the industry, market research suggests that customer value is made up of seven components (Figure 12). Price, Product Quality and Design have been identified as consumers' primary value drivers, helping to explain the increased market share captured by fashionably designed affordable, high quality imports.

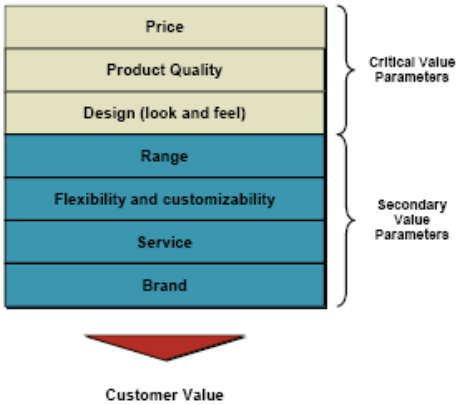

Figure 12: Customers' decision making parameters while buying furniture

Explicit and adequate help to customers give software for interior design with furniture and accessories Libraries with sofas, chairs, tables, beds, desks, storage items, home office items, and more. These software enable customers to choose items from pre-arranged furniture groupings – bedroom sets, dining and living areas, and more. They enable customers to resize furniture, to create any custom size – height, width, depth, thanks to the parametric modeling of furniture.

Figure 13: Wood living room furniture from a program KIKI

5. CONCLUSIONS

The digital architecture has been playing an important role not only in architecture design but also in visual communication design and virtual furniture design. Through the exploration and the implement of virtual furniture design, we can conclude that:
1. The generative form and free form give architecture and furniture more dimensions on creation new form of representation.
2. Usage of CAD drastically decreases the time necessary for the furniture design and direct influence on the design process increases the quality of the system. Parametric furniture modeling put its advantages to the design process and helps engineers of every class and type get better products.
So, the biggest advantages of the furniture parametric modeling are:

- It saves money since there is no need for the probe manufacturing (0 series). Errors and difficulties can be seen on the virtual furniture model and simulated.
- Better, easier and faster optimization of the process and products.
- Easy and fast solution change during furniture design process.
- Designer can easily redefine and change construction if product manufacturing process changes.
- Easier and simpler work on technological documentation creation.
- It is easy to create family of similar parts that differ one from another only in dimensions,
- It is easy to determine the price of every part or an assembly. If we pay attention to the application on the furniture manufacturing it is important to note that price is calculated as a price per surface. It is important to determine the surface that has been used what is not so easy to do without virtual models.

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