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CONCEPTION OF AN EXPERT SYSTEM MODEL OF FURNITURE FINISHING TECHNOLOGIES

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Abstract: *The paper presents methods for developing a database to provide a basis for a complex application for technological design of the furniture products finish considering specific factors related to the nature of surface, type of finishing, coating materials used, finishing process etc. Next step is creating tables and establish the main properties of the fields, establishing relationships (links) required for the creation of a database with the possibility to modify and complete it, according to new emerging technologies and the use of new equipment or devices. It also presents methods of operating and fast information of finishing technologies and easy ways to establish correctly and accurately, the technical documentation, the operating plans or even calculations necessary to determine the technical and economic parameters.*
Keywords: *expert system, furniture, finishing technologies*

1. INTRODUCTION

The paper presents methods for developing a database to provide a basis for a complex application for technological design of the furniture products finish. The finishing technologies structuring and codifying are tried until the establishment of operational sheets specific to a technology of finishing a furniture mark. Characteristic elements are noted in the database, which should be taken into account in order to get to a finishing technology depending on specific factors related to each type of finishing, the nature of surface, technological film-forming material, applying method, desired aspect, methods and machines used etc. MS Office is used in two selection variants with Access and Excel.

2. CONSIDERATIONS ON THE EXPERT SYSTEM FROM THE FURNITURE INDUSTRY

Starting from defining an expert system, as a complex application or a software programme, which explores much knowledge in order to obtain new conclusions about activities difficult to interpret, using methods like human experts use, a number of programmes is tried to be created to establish the finishing technology specific to a certain type of product, corresponding to certain machines from a furniture factory or furniture workshop. An expert system may be successful for solving problems without a deterministic algorithmically solution.
The main features of the expert systems are: a database (knowledge base), together with a deduction algorithm specific to the reasoning method.
The first applications of artificial intelligence were done by the expert systems, which mimes the human reasoning for specific duties in restrained domains. The expert systems are a domain of artificial intelligence, the IT branch that follows the development of 'intelligent' programmes and applications.
An expert system is made of the following main components: the knowledge base, the inference motor, the interface with the user, the module of knowledge enrichment and the explicative module.
The knowledge base is good for keeping all the elements of knowledge (facts, rules, solving methods) specific to the application domain, taken from human experts or from other sources; and the inference motor represents a programme in which the control, procedural and operational knowledge has been introduced, with the help of which the knowledge base is exploited for reasoning in order to obtain solutions, recommendations or conclusions.

The interface with the user allows the dialogue with the users during the consulting sessions, as well as their access to the facts and basic knowledge for adding to or updating the base.
The knowledge enrichment module helps the expert user to introduce in the base new knowledge under an accepted form by the system or to update the knowledge base, and the explicative module has the role of explaining to the user both data that the system has and its reasoning for getting solutions during the consulting sessions.
This paper is meant to make in a simplified form an application to support the technological engineers from factories or wood industry workshops, especially those for furniture making. The application refers to choosing and adapting the specific finishing technology of a furniture product depending on the classic finishing technologies and the machine systems of every production unity.
After establishing the finishing technology the connection with the finishing operation sheet is realized and the order of the operations, the types of the used materials, the specific consume and the parameters of the work regimes could be established. When using the MS Office as support for the operational sheets, with word or excel documents hyperlink or VBA macro commands may be used. In the second case, simple algorithms may be conceived for realizing different specific technological calculations depending on the parameters indicated in the finishing operational sheets. Another variant may be realized by means of the Access database management medium. All the necessary elements for the knowledge base will be created in this case, under the form of some tables that take into account the elements of specific technologies for finishing the furniture products.

3. THE STUDY OF FINISHING TECHNOLOGIES IN THE WOOD INDUSTRY

Within the technological process of furniture making the finishing domain includes the specific activities of applying and processing the film, after the technological steps of shaping and grinding have been done, then the technological process is continued with the steps of assembling, general mounting and packing.
Making the technological documents by means of the computer is a difficult activity which tries to realize a systematization of all the necessary data, of organization so that these data could be accessible to the computer working methods. Taking into account the differences of technical endowment from the finishing sector of different industrial unities, the data systematization and programme conceiving (software, interface) must be done so that it could allow any time modification and have a higher grade of generality in order to solve many types of problem and should also be permissive in order to allow any modification that might appear from the point of view of both material replacing and modernization through the acquisition of new machines and technologies.
The influence factors that must be taken into account for establishing correctly the type of finishing technology are: the finished surface nature, the type of surface finishing, the luster level of the film surface, the type of the used film-forming materials (the category of materials depending on the chemical composition and type from the basic groups) and the applying procedure of the film-forming material.
Starting from the analysis of the main influence factors a selective algorithm has been established for the selection of the finishing technology, being based on three stages. During the first one, a separation of the finishing technology is done according to the nature of the finishing surface and there are three surface categories, massive wood, veneered panels and un-finished panels. During the second stage, the technologies are sub -classified within each category of support (the surface nature) according to the finishing type (clear or opaque), the surface luster (luster, matt, semi matt), the category of the used film-forming materials (varnish or nitrocellulose, carbamide, polyester etc. enamel) and to the used finishing technology type. The third stage starts from the general technology, as finishing type, and the used specific type of varnish or enamel, the finishing procedure (immersion, pulverization, casting, lamination) are mentioned, having as a result a specific finishing technology including an operational sheet to establish the order of technological operations, the used materials and specific consumes, mentioning the working regimes at the level of every technological operation (viscosity, working speed and feed rate, temperature and drying time etc.), according to the machines used in every production unity. Using this algorithm could modernize and optimize the preparing fazes of the finishing technologies, the time of making the finishing operational sheets is reduced, this documentation being necessary and compulsory for the technological design of every furniture product.

Nitrocellulose, polyurethane, polyester, acrylic, carbamide products, hydrodiluting products, coloring products and products for special effects are recommended as technological materials currently used for finishing the furniture products.

The finishing through pulverization can be realized both manually and automatically. The application through pulverization could be a regular one but with finishing materials specific to vertical application, tixotropic ones, so that a great quantity of material could be applied without leaks. Pulverization finishing in static field with fitted installations or portative devices is based on the fact that the used varnish must have the ability to conduct the current and the pulverization pistol should send the electrostatic load necessary to be attracted by the object to varnish within the lines of the static field, between the pulverizer and the object to be finished (preferably a chair) fitted to the ground. The material consumption is reduced with 50-80%. There are many known finishing procedures in static field: Ransburg, Lurgi, AEG, Fischer etc. Another finishing method is through immersion (Flow Coating), and the chairs and other furniture products are stained and primed on this installation. Another finishing method is done with the CEFLA automated varnishing installation, having a mechanism of displacement and rotation. There are two pulverization pistols on this finishing installation, which have their own band-pass for the assembly marks and drier and the finishing is done in two passes. In the case of the manual pulverization systems, the Airmix pistol could be used for mono or multicomponent materials. Another finishing system through pulverization is the Airless system, which does the pulverization by forcing a liquid (varnish, enamel, dye etc.) to pass through a narrow passage (choke) at a high pressure. The material atomization is done without using supplementary air. The pumps pull the material out of a container and put it off through a hose to the pistol at a high pressure. For the conventional pulverization system, the atomization is done by mixing air and the film-forming material out of the pulverization pistol. The material gets out through a choke at a low pressure and is atomized by air.

4. THE REALIZATION OF THE DATABASE MODEL STRUCTURED ON THE FINISHING TECHNOLOGIES

To realize a database with the finishing technologies in the furniture processing industry, MSAccess tables have been created, being necessary for the codified structure of all the known finishing technologies. When completing this database with new values corresponding a new technology or modifying the material basis by acquiring new finishing lines or modern machines which result in the modification of the technological parameters, the database tables could be modified or completed. The following tables have been created: IMTypeTechnology, SupportNature, FinishingType, FilmLusterType, VarnishType, FinishingTechnologyType, TypeVarnish, CoveringType, FinishingProcedure, SpecificFinishingTechnology and SupportType. The influence factors of the finishing technologies have been introduced in these tables under a codified form and the main and secondary keys have been established, being necessary to connect the table fields to the relations for establishing the finishing technologies for every furniture mark.

The IMTypeTechnology includes the fields for the technology types and their codes, IMTypeTechnology and IMCodeTypeTechnology respectively, having the values PREL, SLEF and FIN. The table SupportNature refers only to finishing technologies and has the fields CodeTypeTechnology, SupportNature and CodeSupportNature, having LM for MassiveWood, PF for VeneeredPanel and PNF for NonVeneeredPanel. Within the table which refers to the finishing type an indexed codification is realized according to the support nature so that there are the values Opaque and Clear for the fields FinishingType, and the values OPAC1, OPAC2, OPAC3, TRANS1 and TRANS2 for the field CodeFinishingType. The indexed codification is continued to the next table FilmLusterType, which has the values Luster, Matt and SemiMatt for the field FilmLuster and the field CodeFilmLuster has the indexed values L11, L21, L12, L22, L3, M11, M2, M12, M22, M3, SM1 si SM2. These codifications will be indexed in the table VarnishType within the field CodeVarnishType(Enamel) with the corresponding index from CodeFilmLuster completed with the codification of the varnish or enamel type from the field VarnishType(Enamel), values of the type LN11, LC11, LPU11, LPS11, LN12, EN11, EC22, EC32, etc. being obtained. The table FinishingTechnologyType continues the connection of the previous table through the field CodeVarnishType(Enamel) to the field FinishingTechnologyType and CodeFinishingTechnologyType respectively, which draws near the known finishing codifications. This is followed by the table VarnishType that gives values to the fields VarnishType and CodeVarnishType.

After establishing the relations between the tables, the management, analysis and this database use may be done in order to set the specific finishing technology of each furniture product. Reports may be created to be specific to a certain finishing type and be used for making the finishing operational sheets. Figure 1 presents the

modalities in which the database has been conceived under the form of tables and the way in which the connections between them have been realized.

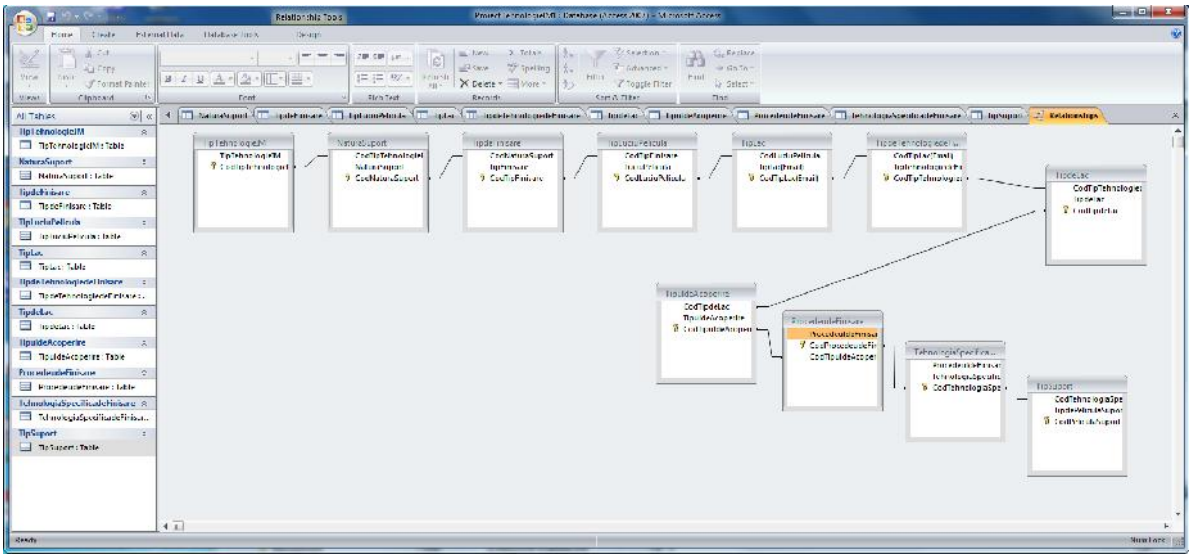


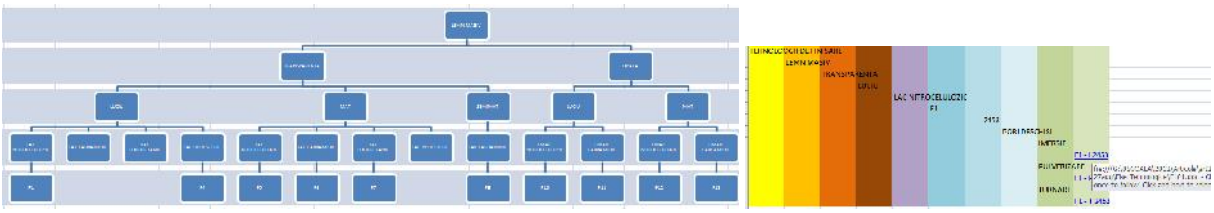
Figure 1: The relations between the database tables of the finishing technology

With their help through the other elements specific to the databases managed through Access, reports, predefined interrogations, any necessary information could be obtained rapidly for establishing the finishing technologies for each furniture mark.

Another method of searching and choosing a finishing technology may be realized with the help of MSOffice Excel. The specific elements presented above for all the finishing types are introduced in indented cells, taking care that all the influence factors of the same type are positioned in the same column. After completing them with all the data of the finishing technologies, a spreadsheet is obtained with hundreds of data lines. The data cells are grouped by putting together the farther lines and continuing with the closer levels. A spreadsheet is obtained with the elements specific to the influence factors grouped on 7 - 8 positions that could be hidden or displayed, depending on the studied case. In order to select the desired technology the specific influence factors are released, with the desired values for the technology to be applied to the mark through the finishing operational sheet.

These elements may be seen in figure 2, being grouped according to some logically shortened elements as in figure 2.a and grouped into positions as in figure 2.b.

In order to analyse more rapidly the finishing technologies, different color codes are applied to influence factors of the finishing technology and the variant corresponding to the mark finishing would be released. The last cell is selected to have a connection (hyperlink) to the finishing operational sheet.



a. b.

Figure 2: Finishing technologies; a. structured diagram of the finishing technologies (a part); b. the grouping of the finishing technologies according to the influence factors.

4. CONCLUSIONS

The design of the finishing technologies for furniture with the help of the methods presented above is extremely useful because it allows the selection of the desired technology for choosing the desired influence factors, among the alternatives from the level of the database created with the main types of finishing technologies. The presented methods may be easily enriched with new variants and the latest news in the finishing sector. After the selection of the specific finishing operational sheet, the specific consumption of material, consumed energy, workmanship and the finishing parameters for the machines corresponding the finishing line etc

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