UDC 674.093.6:674.061.2
Assist. Ya.V. Matsyshyn; assoc. prof. V.O. Mayevskyy;
stud. A.M. Del Rio – UNFU; assoc. prof. S.I. Bilyk – KNUCA

SPECIALIZED SOFTWARE FOR SIMULATION OF LUMBER CROSS-CUTTING PROCESS

A specialized software "SAWing lumber" which simulates the process of cross-cutting of lumber into dimension stock (blanks) was developed, guided by the decision of fuzzy expert system that concerns the choice of the current cross cutting pattern. Classes diagram as well as, the work algorithm and rules of use of software interface are provided. The process of cross-cutting into blanks is simulated with the help of software. Simulation results confirmed the adequacy and the practical value of the software.

Keywords: software, simulation, lumber, cutting, blanks, non-defective pieces, cutting pattern, expert system, fuzzy logic.

The topicality of problem. In order to research and analyze various technical processes, objects and systems, the simulation process has been increasingly applied for this during past decade. In the case when the researched object is subjected to mathematical description, the analytical (mathematical) modeling is used, and when it is poorly formalized, then it is subjected to simulation modeling. Sn simulation modeling, the researched system (object) is replaced by a model which accurately describes real system. Aimed at obtaining information about system, the experiments are conducted with real system [1, 2]. In simulation it is necessary to select systems that simulate not only the physical (or other) nature of the particular subject area, but the mechanism of the human mind to solve specific problems, these are so-called expert systems (ES) [2].

In the ES, the main attention is paid to the reproduction of problem-solving method by means of computer technology used by the expert as an implementation of expert's thinking. In the paper [3], the ES is developed with the usage of fuzzy logic in order to take effective current decisions regarding the selection of lumber cross-cutting scheme (non-defective pieces) into blanks. For taking such a decision, fuzzy expert system (FES) is guided by the following factors: the size of defect less raw materials obtained when cutting (Z), a number of actually sawn out blanks of each size - quality group (Q) and the expected number of non-defective pieces of a certain length (N).

The result of FES usage is the determination of numerical value of blank priority in cutting (P). However, individual current solution of this system makes it impossible to analyze the process of cutting as a whole. Such analysis can be conducted by simulating the cutting process with the help of FES from entry point of the first non-defective pieces cutting areas until the point when blanks are sawn out.

In order to solve this problem it is appropriate to create a specialized software that would allow us to conduct a simulation. It is necessary to mention that during the operation of the software after every decision to saw out a specific blank it is important to enumerate variables that govern the FES.

Thus, **the aim of the paper** is to create a specialized software for simulation process of lumber cutting on the basis of decisions taken by FES [3].

The development of specialized software. Software SAWing_lumber (programming environment – Eclips Ide Gallileo, programming language - Java, jdk 1,6), developed in UNFU, and created for simulation modeling of cross-cutting lumber into blanks. Classes diagram developed by specialized software SAWing_lumber is shown in Fig. 1 and general block scheme of the algorithm of its operation is provided in Fig. 2.

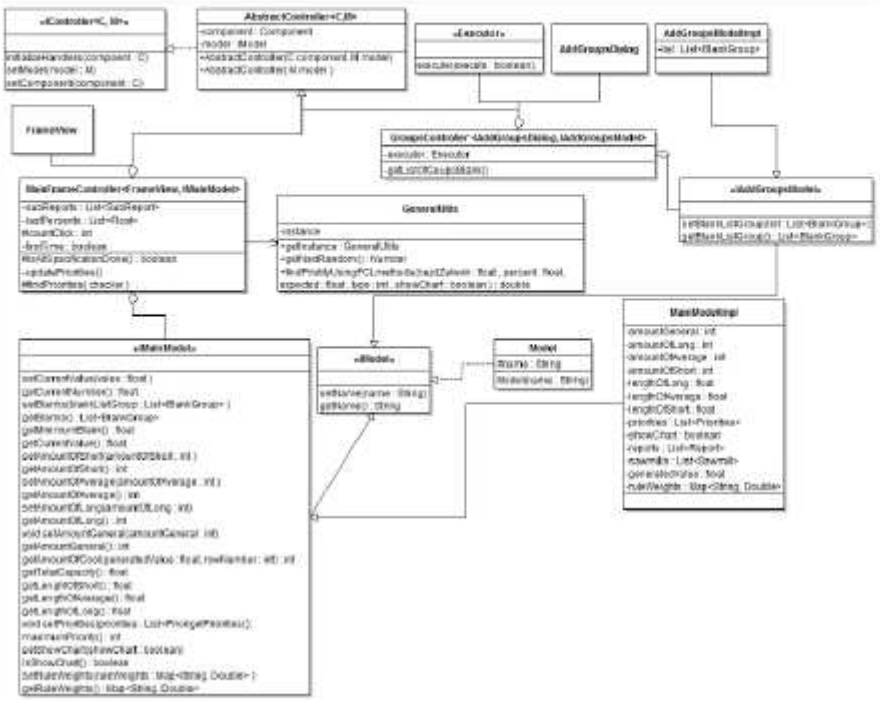

Fig.1. Classes diagram of specialized software SAWing_lumber

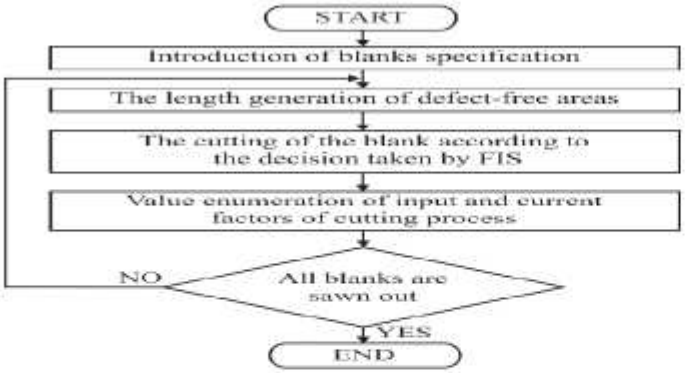

Fig.2. The block-scheme of the algorithm of software SAWing_lumber operation for simulation process of lumber cross-cutting on blanks

As can be observed from the block scheme (Fig. 2), before the beginning of simulation, the specification of blanks should be entered. Firstly, we choose the number of groups of blanks to be sawn out in the main software box of SAWing_lumber (Fig. 3) and then enter their dimensional characteristics and volume (quantity).

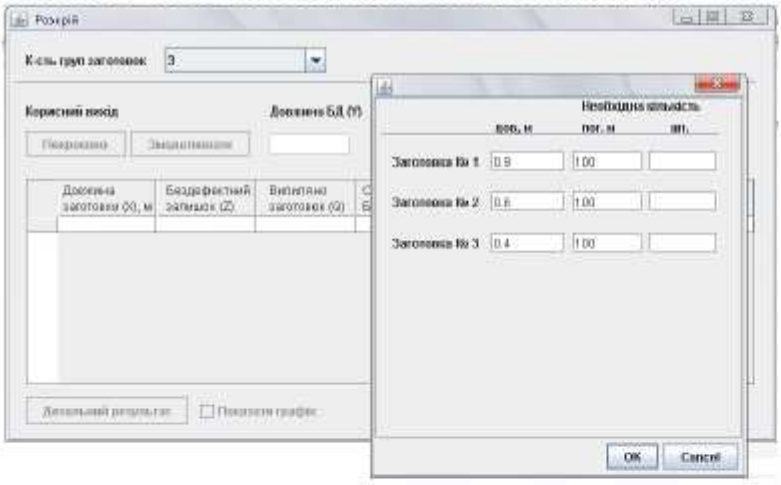

Fig.3 The dialog box for entering of blanks specification

After entering the blanks specifications, one has to proceed to simulation modeling process. The developed software SAWing_lumber allows conducting of simulation modeling in incremental and automatic modes. Incremental mode (Fig. 4) is implemented by pressing the button "Покроково". After each pressing the button "

Покроково" with the given range of lengths of non-defective pieces single value of its length is being generated. Then, the blanks priorities are being determined and the decision to saw out blank the priority for which will be the largest is taken. In this mode, it is possible to monitor the changes in the value of linguistic variables Z, Q, N at any step in the simulation process, with the help of which a numerical priority value P is determined.

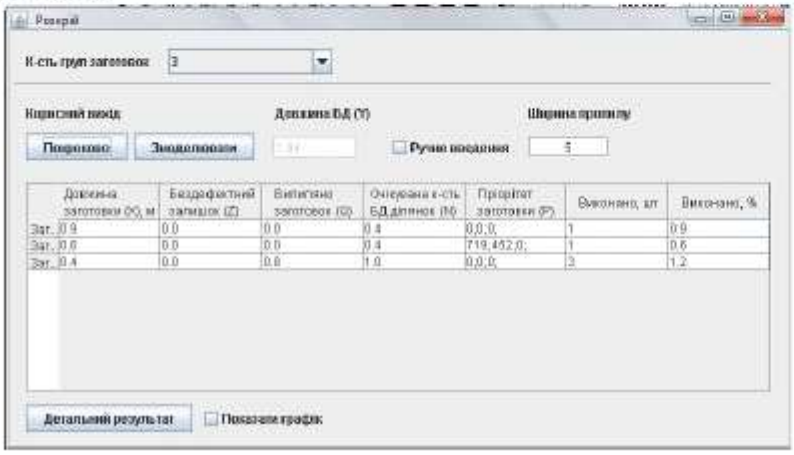

Fig. 4. View of the main box in incremental mode

In automatic mode (button "Змоделювати"), the program SAWing_lumber automatically generates the lengths of non-defective pieces and models the process of cutting into blanks until the specification of blanks is completed (Fig. 5).

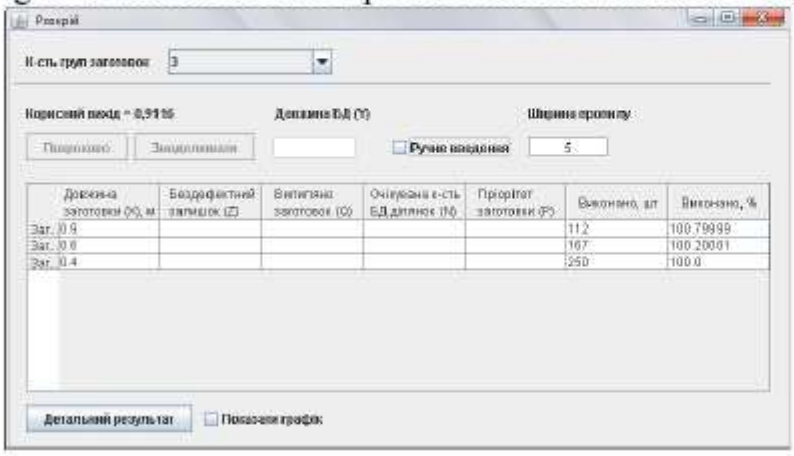

Fig. 5. View of the main box in an automatic mode

After modeling, the index value of specified blanks output from non-defective pieces is obtained. The possibility to examine detailed results of cutting (Fig. 6), which can be exported into MS Exel, is provided in SAWing_lumber.

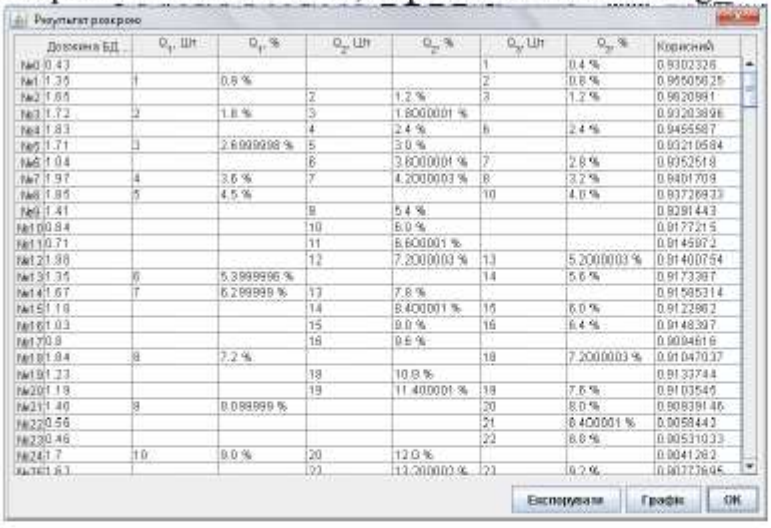

Fig. 6. View of desktop window with the detailed results of lumber cutting on blanks

Simulation of cross-cutting lumber by means of the developed software SAWing lumber. In order to check the adequacy of the software process operation, the process of lumber cutting (non-defective pieces) is modeled on blanks of three typical sizes l1, l2, and l3. The length of the first two blanks is accordingly preset l1 = 1.2 m and l2 = 0.8m and the length of the third blank will be changed l3 = (0.2; 0.4; 0.6 m). In the process of simulation modeling it is necessary to analyze the dependence of the coefficient of specified yield blanks on their specification. According to the accepted specification, it is necessary to saw out blanks of three typical sizes in such amount: Q1 = 200 lm; Q2 = 200 lm; Q3 = 200 lm. The width and thickness of blanks is identical, so the number of blanks to be sawn out is provided in linear meters. The lengths of non-defective pieces are generated accidentally from the range: 0.2 ... 2.0 m. Simulation results are summarized in Table. 1 and are shown in the diagram (Fig. 7). In order to reduce the influence of accidental distribution of lengths of non-defective pieces, the index of the specified blanks output is taken from five experiments for each specification.

Table 1. Modeling results of cross-cutting process of non-defective pieces into blanks by means of software SAWing_lumber

The blanks length,m	It is necessary to saw out blanks, lm	The coefficient of specified yield blanks
1,2/0,8/0,2	200/200/200	0,85
1,2/0,8/0,4		0,76
1,2/0,8/0,6		0,74

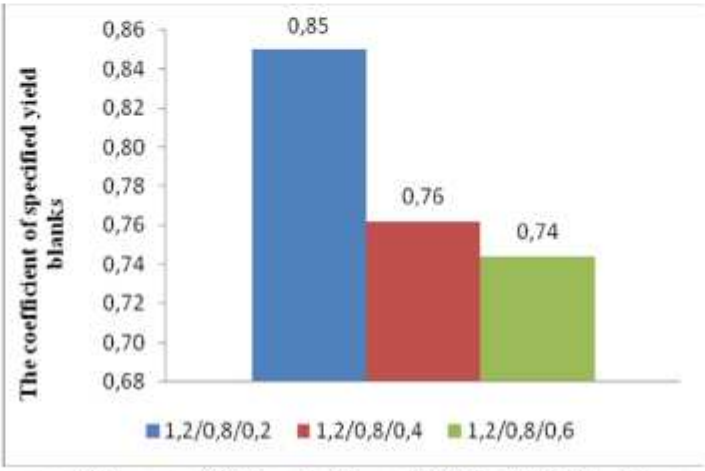

Fig.7. The dependence of the coefficient of specified yield blanks on their specifications

The results of the modeling (Table 1 and Fig. 7) show that with the increasing length of the shortest blank in the specification, the index value of specified output decreases. This is caused by the volume increase of raw materials due to the fact that the non-defective pieces, the lengths of which are less than the length of the shortest blank, are unsuitable for their cutting. These results confirm the adequacy of functioning of the developed software SAWing_lumber and appropriateness of its use for scientific and practical purposes. For the efficiency of software SAWing_lumber should make settings of FES [4, 5], and compare the results with actual results of cutting.

Conclusions:

1. A specialized software SAWing_lumber for simulation modeling process of lumber cross-cutting into blanks. Modeling results of dependency of specified output of blanks on their specifications were confirmed by the adequacy of its work.

2. The developed software is created without usage of expensive software that increases its value.

3. The software SAWing_lumber operates the data that can be obtained directly in the real cutting process of lumber on blanks, which indicates the possibility of its application in a real production environment of cutting.

4. For increase of the efficiency of software SAWing_lumber it is necessary to make FES settings and compare the results with actual results of cutting.

References

1. **Стеценко І.В.** Моделювання систем: навч. посіб. [Електронний ресурс, текст] / І.В. Стеценко ; М-во освіти і науки України, Черкас. держ. технол. ун-т. – Черкаси : ЧДТУ, 2010. – 399 с.

2. **Сявавко М.** Інтелектуалізована інформаційна система «Нечіткий експерт» / М. Сявавко – Львів: Видавничий центр ЛНУ ім. Івана Франка, 2007. – 320 с.

3. **Мацишин Я.В.** Нечітка експертна система для моделювання процесу поперечного розкрою пиломатеріалів на заготовки / Я.В. Мацишин // Науковий вісник НЛТУ України : зб. наук.-техн. праць. – Львів : РВВ НЛТУ України. – 2012. – Вип. 22.15. (in press).

4. **Панкевич О.Д.** Діагностування тріщин будівельних конструкцій за допомогою нечітких баз знань: Монографія. / О.Д. Панкевич, С.Д. Штовба. – Вінниця: УНІВЕРСУМ-Вінниця, 2005. – 108 с.

5. **Митюшкин Ю.И.** Soft Computing: идентификация закономерностей нечеткими базами знаний: Монографія. / Ю.И. Митюшкин, Б.И. Мокин, А.П. Ротштейн. – Вінниця: УНІВЕРСУМ-Вінниця, 2002. – 142 с.

УДК 674.093.6:674.061.2

Асист. Я.В. Мацишин; доц. В.О. Маєвський; студ. А.М. Дель Ріо – НЛТУ України; доц. С.І. Білик д-р техн. наук – КНУБА

Спеціалізоване програмне забезпечення для моделювання процесу поперечного розкрою пиломатеріалів

Розроблено спеціалізоване програмне забезпечення “SAWing_lumber” яке моделює процес поперечного розкрою пиломатеріалів на заготовки керуючись ріненням нечіткої експертної системи стосовно вибору поточної схеми розкрою. Наведено діаграму класів, описано алгоритм роботи та правила користування інтерфейсом програмного забезпечення. За допомогою програмного забезпечення змодельовано процес поперечного розкрою пиломатеріалів на заготовки. Результати моделювання підтвердили адекватність та практичну цінність програмного забезпечення.

Ключові слова: програмне забезпечення, моделювання, пиломатеріал, розкрій, заготовка, бездефектна ділянка, схема розкрою, експертна система, нечітка логіка.

UDC 674.028.9.

Competitor R.S. Marunych – UNFU

A STUDY ON THE ISSUE OF ADHESIVE JOINTING DURABILITY AND THE WAYS OF THE DURABILITY PREDICTION

The paper deals with the analysis of glueing process, considers the adhesives that are used in woodworking industry. The problems associated with studying adhesive jointing durability have been examined. The main means and ways of enhancing the adhesive jointing durability are described.

Keywords: adhesive jointing, durability, adhesive, ageing process, stresses, operating conditions, prediction.

It is difficult to imagine the modern furniture making process without application of various kinds of adhesive. By way of glueing, one can obtain new forms of ware de-