UDC 684.4 *Assoc. prof. S.A. Grytsak, assoc. prof. G.V. Somar – UNFU, Lviv*

TECHNICAL AND ECONOMIC ANALYSIS METHODS OF MANUFACTURING CURVED BLANKS

In this article are present of the ways to get curved pieces. For comparison selected four variants of the technological process: Cutting out of curved pieces from glued on the smooth surface of panel; Cutting out of curved pieces sections, glued in length on toothed tendons; Bending of solid wood; Bending with simultaneous gluing. The basis of calculations chosen curved work piece, calculated the need for raw materials, developed technological processes, calculated energy needs, calculated the cost-effectiveness of each option. The priority of making curved pieces by bending solid wood on a number criterion was proved.

Keywords: wood, bending, curvilinear workpieces, technology, analysis.

Modern Furniture production observed a wide variety of designs shapes and sizes, high quality of workmanship, original design. To ensure these options in goods are increasingly using parts of curved shape. In our opinion, the most complete classification methods of manufacturing curved pieces presented Voytovych and Gayda [1-12]:

- The cutting of massive workpieces (sawing, milling, milling copying, sharpening).
- By bending (solid wood, with simultaneous gluing, sawed pieces, weaving).
- By pressing (solid wood, flat blanks, wood-adhesive composition).
- By burning of laser.

The last two methods are not widely used because it has a number of shortcomings that limit the use of tanbarks. Therefore, they will not analyze.

The raw material for the manufacture of curved blanks obtained by the first and the second method is used, respectively, solid wood and sliced or rotary veneer. The process in each case is different, and for its implementation need specific equipment, certain size of plant, specific power inputs and other factors. No clear data on the efficiency of different methods for curved shape pieces.

The technological process of manufacturing a curved piece from solid wood includes: sawing straight piece; creation of base surfaces; gluing pieces in the panel; technological shutter; calibration of panel; layout and sawing curved piece; primary processing of the workpiece; provide blank forms of detail.

The process manufacturing of bent piece of solid wood includes: making straight piece; plasticizing it before bending; bending; drying; primary processing of the workpiece; provide blank forms of detail. The process of manufacturing the curved pieces by bending thin layers of wood with simultaneous gluing them requires the following operations: manufacture thin layers of required size; applying glue; the formation of the package; bending the package while gluing it in the block; technological exposure of primary processing of curved units; provide blank forms of detail.

Given the above, we can draw the following conclusions:

- modern furniture and other wood products are increasingly use parts curved shape;
- there are some ways to manufacture parts curved shape;
- each method has the special characteristics: raw materials (lumber or piece of solid wood, rotary or sliced veneer); the cost of raw materials per unit of output; technology, tools and equipment; size of shop; auxiliary shops, offices and services; number of employees and their qualifications; power inputs (electricity, steam, water);
- the total for each method is surgery to provide of the workpiece shape of detail;
- as a result – each method has different efficiency (cost) of production;
- definitive data on the efficiency of a method of obtaining blanks curved shape there.

The aim of the development process is the production of finishing pieces curved shape. Shape of pieces is important, because it affects a large extent the structure of the technological process, the content of technological operations, methods of processing workpieces and overall efficiency of the process.

They chose a blank rectangular cross-sectional shape curved in the shape of a semicircle with the internal radius of 200 mm. Work piece dimensions: length – 688 mm, width – 33mm thickness – 19 mm. This blank can be used as a side-bar, or armrest bar or blank of chair seat. In this paper selected four options for making curved shape of the work piece (Table. 1).

Table 1. Methods manufacturing of curved pieces

Version number	Content Works
Variant I	Sawing straight blanks, primary processing, adhesive gluing on the width on the smooth surfaces, technological exposure, sawing curved pieces (Fig. 1), the primary processing of workpieces.
Variant II	Sawing straight blanks, primary processing, milling finger joint, bonding pieces in length on finger jointin form piece, technological exposure, sawing curved pieces (Fig. 2), the primary processing of workpieces.
Variant III	Sawing straight blanks, blanks plasticizing, bending of solid wood, drying preparations, primary processing of workpieces.
Variant IV	Layout of veneer, cutting of veneer, applying adhesive, forming of glue package, pressing, cutting units, primary processing of the workpiece.

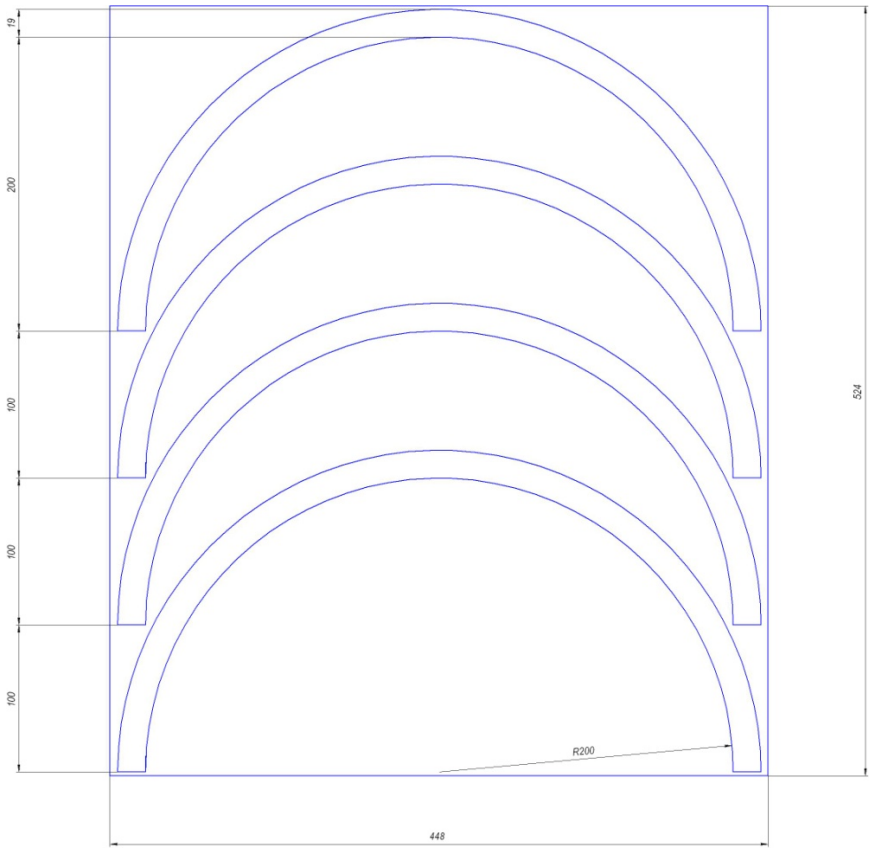

Fig. 1. Scheme obtaining of blank from panel board obtained by gluing bars on the smooth surface at width.

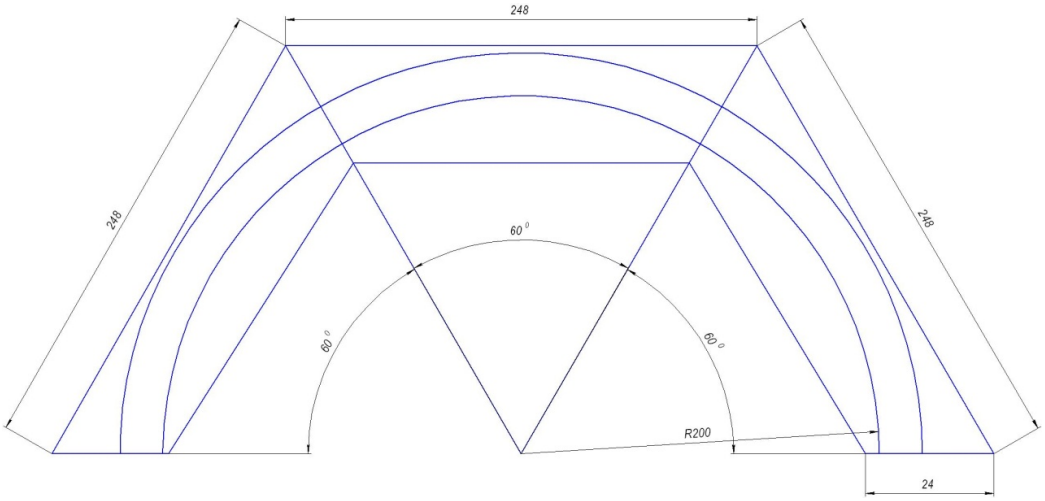

Fig. 2. Scheme obtaining of blank from panel obtained by gluing bars finger joint in length

The comparative analysis should be carried out by comparing the characteristics of the process that uniquely characterize of it. One of the main parameters in our opinion, is the cost of production per unit. For it obtain necessary: to calculate the need for raw materials (Table 2); work out technological process; determine the list of technological equipment and workplaces (Table 3); determine the optimal production program; determine the need for labor (Table 4); determine the size of the building department (Table 5); calculate energy needs (electricity (Table 6), steam (Table 7), water (Table 8)); determine the cost of labor protection, safety and environmental protection.

Table 2. Summary norms of raw materials for productioncurved pieces.

№	Materials name	Unit	Consumption of materials		
			Ontne work-piece	On the program for 100000 pcs	Optimal program
1	2	3	4	5	6
Variant I (cutting)					115000 pcs
1	Hardwood lumber thickness 40 mm	m^3	0,00522	522	600,3
2	Polyvinyl acetate glue	kg	0,031	3100	3565
Variant II (cutting)					110000 pcs
1	Hardwood lumber thickness 25 mm	m^3	0,00484	484	532,4
2	Polyvinyl acetate glue	kg	0,009	900	990
Variant III (bending of solid wood)					180000 pcs
1	Hardwood lumber thickness 25 mm	m^3	0,00128	128	230,4
Variant IV (bending while gluing)					270000 pcs
1	Hardwood slise veneer, 0,8 mm	m^2	0,104	10400	18720
2	Rotary veneers from birch	m^3	0,00090	90	162
3	Urea glue	kg	0,046	4600	8280
4	Glue thread	kg	0,00012	12	21,6

Table 3. Summary list of production equipment

	Variant I		Variant II		Variant III		Variant IV	
№	Name of equipment	∑	Name of equipment	∑	Name of equipment	∑	Name of equipment	∑
1	Hand-operated crosscut off saw	1	Hand-operated crosscutoff saw	1	Hand-operated crosscutoff saw	1	Workplace for mark out	1
2	Quartering saw, trimmer	1	Quartering saw, trimmer	1	Quartering saw, trimmer	1	Guillotine shears	1
3	Hand jointer	1	Universal circular saw	3	Autoclave	1	Veneer composer	1
4	Workplace for applying of glue	1	Molding machine	1	Bender, bending rig	1	Roller glue spreader	1
5	Clamping machine	4	Workplace for applying of glue	1	Drying chamber	1	Workplace for formation of packages	1
6	Hand jointer	1	Clamping machine	8	Handjointer	1	Press (40 pieces – 4 daylight)	1
7	Thicknesses machine	1	Handjointer	1	Thicknesser machine	1	Band mill (resaw)	1
8	Workplace for marking	1	Thicknesser machine	1	Molding machine	2	Universalcircularsaw	2
9	Band mill (resaw)	1	Workplace for marking	1	Universalcircularsaw	1	Handjointer	1
10	Springle moulding machine	1	Band mill (resaw)	1			Thicknesser machine	1
11	Universal circular saw	1	Molding machine					

Table 4. Calculating the number of workers

Variantof process	Number of workplace	Number of workers, people
I	13	9
II	20	13
III	10	7
IV	11	6

Table 5. Summary list of production area, m^2

№	Assignment area	VariantI	VariantII	VariantIII	VariantIV
1	Area occupied by facilities and workplaces	191,5	250,8	169,7	131,3
2	Input the storehouse	11,43	10,14	4,39	4,34
3	Storehouse before glueing	1,32	1,18	---	1,55
4	Place the technological exposure	1,32	1,18	---	0,9
5	Production workshop area	333,2	430,5	287,2	225,6
6	Area of sanitary and other offices	72	72	72	72
7	Area (size) of shop	432 (12x36)	504 (12x42)	360 (12x30)	360 (12x30)

Table 6. Summary list of the annual electricity needs, kWh

Variant process	Power electricity	Electricity for lighting and sanitary facilities	Total
I	42610,4	8259,0	50869,4
II	58431,2	9603,6	68034,8
III	52215,6	6914,4	59130,0
IV	67619,8	6914,4	74534,2

Table 7. Summary list of the annual consumption of steam

№	Type of consumption	Annual consumption of steam, tons/year			
		I	II	III	IV
1	Technological needs	---	---	631,2	300,8
2	Heating and ventilation	153,9	183,3	122,0	124,6
3	Domestic needs	6,8	9,8	5,3	4,5
	Total:	160,7	193,1	758,5	429,9

Table 8. List of water consumption

Variant process	Technology needs	Domestic needs	Against fire needs	Total
1	2	3		4
I	---	146,3	23	169,3
II	---	211,3	23	234,3
III	---	113,8	23	136,8
IV	9,9	97,5	23	130,4

The subject of research is the formation of the cost of production (production costs) curved wooden pieces under conditions different technological approach to manufacture. Background research is no debate because the enterprise cost as a whole, and individual processes in particular, play a significant role in its activities. They limit profits and thus affect the amount received for the further development of the enterprise resources. The enterprises costs the determine the minimum price of products under the break-even point or an additional request – a variable cost and widely used in pricing if the use of the planned profit and profitability. On the other hand, the costs of the enterprise determine its price competitiveness, the use of price methods of competition and stock financial strength of the available market conditions [4].

Value is not only the total value of the enterprise costs, but also their structure, on the one hand, points out features of the enterprise and its shortcomings, on the other – describes the capabilities of its development and potential risks. The structure of the full cost per unit of output clearly shows their distribution by divisions and functions of the company, and also allows you to identify the reserves to reduce costs.

One of the key issues in the theory of cost are factors that influence on their formation. Recognition of the impact of factors on the cost, they allow accounting costs affect the company. The impact of factors on costs expressed quantitatively and qualitatively. Alone impact can be strictly deterministic or correlation, not always linear character. Among the factors that affect the cost of enterprise, distinguish: prices of resources and their quality, the actual value of resources, employment intensity of labor and machinery and the corresponding level of productivity, organization of production, scale of enterprise, production program, and other. Analysis of the cost of technological process manufacturing of the curved pieces are an important part of the total production cost management. This manufacturing process can be performed using different technologies, which differ in resource consumption. Selection of the optimal technology options, depending on the price of certain types of resources and the necessary economies of scale may be the manufacturer of that blanks taking into account other limiting factors. For financial analysis of the costs of production variants of curved pieces should set certain parameters of the source data that are relevant to the settlement date for each of them: prices of raw materials; transportation and procurement costs for raw materials (12,0 % of their purchase price); reverse the price of waste (for remanufacturing , for fuel); standard stock of raw

materials for the uninterrupted organization of the process (30 days); average wages of one production worker; average tariffs for energy; cost of 1 m^2 production area of shop; depreciation deductions (passive of fixed assets – 7,76 % active part of fixed assets (equipment) – 21,93 %); equipment cost (average for local dealers of various firms – manufacturers); purchase and installation costs for the process equipment (20,0 % of their value); repair costs (4,5 % of the assets); the cost of labour protection (7,0 % payroll of major workers); other expenses (administrative, maintenance and shop equipment, etc. – 15,0 % of the previous costs).

Given the above, it was determined the cost structure of production of curved wooden pieces for different variants of the process (Table 9).

Table 9. The cost structure of manufacturing curved wooden pieces for different variantsof the process (%%)

№	Elements of cost	Project variantstechnology			
		I	II	III	IV
1	Materials (net return of waste)	72,5	66,3	57,1	59,4
2	Energy costs	1,5	2,1	6,8	6,1
3	Wages of production workers with deductions	8,7	13,3	14,5	13,3
4	Depreciation and repair costs	3,8	4,6	7,2	7,8
5	Other expenses	13,5	13,7	14,4	13,4
	Total:	100,0	100,0	100,0	100,0

Financial and economic aspects of comparative analysis can be the key to manufacturers in the decision on the optimal variant of the process for change of certain macroeconomic conditions. Another important, for any investor index is a measure of capital intensity (or the amount of investment costs per unit of output).

Therefore, to ensure the completeness of this comparative analysis it will add two more specific (for 1 blank) parameters: performance (or the efficiency of use of production space) and capital intensity (or the amount of investment costs per unit of output) (Table 10). To calculate this index options for the project took into account the investment costs for the construction of production facilities and the necessary equipment, and the cost of raw materials for the production of billets at the rate of creation of the 30-day reserve (investments in working capital). However, these costs amount to the amount of total investment for each of the variants. Dividing it into optimal program, we get an indicator of capital intensity per unit. These calculations indicate the undoubted advantage of the last (IV) version of the technology in two given criteria: efficiency of production area and the level of unit production costs.

Table 10. Specific indicators of capital intensity and productivity products

Indexes	Variant I	Variant II	Variant III	Variant IV
Production cost, $/pcs	3,32	3,27	0,99	0,61
Productivity (removing products from 1 m^2 of production area) pcs/m^2	266	218	500	750

Adding to this figure calculated earlier figures material capacity, wages capacity, power capacity and a mort capacity, can present them in the form of graphics for your specific economic indicators (Fig. 3).

Plots demonstrates a significant difference between the options for raw materials intensity (raw materials) and capital intensity (investment property). Changing macroeconomic conditions that may result in increasing the value of these resources will spur

the adoption of the manufacturer of the decision on choosing the optimal variant manufacturing technology of curved pieces.

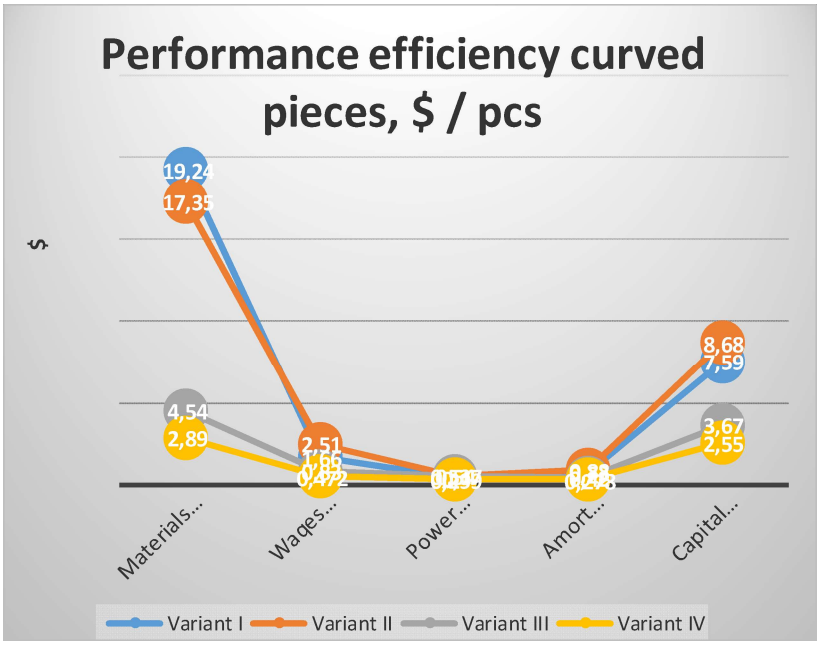

Fig. 3. Specific indicators of production capacity resources for the various versions manufacturing process

From the above graph shows that the most attractive options for process manufacturing curved pieces is an variant III and IV. In terms of appearance and workmanship bending curved pieces of massive wood (variant III) has clear advantages on all levels.

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Доц. С.А .Грицак, канд. техн. наук;
доц. Г.В. Сомар, канд. техн. наук – НЛТУ України

Техніко-економічний аналіз способів виготовлення криволінійних заготовок

Проаналізовано способи отримання криволінійних заготовок. Для порівняння вибрано чотири варіанти технологічного процесу: випилювання криволінійних заготовок із склеєного на гладку фугу щита; випилювання криволінійних заготовок із ділянок, склеєних по довжині на зубчатий шип по формі заготовки; гнуття масивної деревини; гнуття з одночасним склеюванням. За основу розрахунків вибрано криволінійну заготовку, розраховано потребу в сировині і матеріалах, розроблено технологічні процеси, розраховано потребу в енергоносіях, розраховано економічну ефективність кожного варіанта. Доведено пріоритетність виготовлення криволінійних заготовок гнуттям масивної деревини за рядом критеріїв.

Ключові слова: деревина, гнуття, криволінійні заготовки, технологія, аналіз.

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Master's degree V.A. Koryachko; assoc. prof. A.S. Kushpit;
assist. O.M. Kushpit; assoc. prof. Yo.V. Andrashek – UNFU, Lviv

THE STUDY OF THE BLOCKBOARD SHAPE STABILITY DEPENDING ON THE DESIGN

The existing designs of blockboards are analyzed. Experimentally investigated was the influence of the core structure of blockboard and methods of joining its elements on the shape stability and dimensional change after the manufacture.

Keywords: wood, blockboard, core, structure, shape stability.

Relevance of the problem. Currently, manufacturers of panel-form materials are developing new materials for the purpose of obtaining various designs, environment-friendly and with the possibility of expanding the scope of application. However, the ordinary blockboards (coreboards), which are often used, for example, for the manufacture of the door leaf, do not become irrelevant.

One of the problems in the production is to ensure the dimensional stability and shape of the blockboard, which is important during its operation.

The purpose of the study was to determine the characteristics which are important during operation – warping and waviness – depending on the design of the blockboard.

Studies were conducted to determine the shape stability of such boards for various design options, as well as calculations were made to determine the economic feasibility of manufacturing such material. The object of the study was a blockboard – panel of strips (block), sandwiched between two layers of rotary-cut veneer.

Analysis of the research and publications. Despite the variations in colour and texture offered by manufacturers of laminated chipboard, modern furniture design dictates fashion for style solutions. This can be, for example, large working surfaces of a large thickness. There is a growing demand for lightweight construction materials, allowing to significantly reduce the use of wood and logistical costs of the furniture parts