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Project of instrumentation of cyclic multiple-spindle driller aimed at improving its machining efficiency*

Projekt opremanja viševretene bušilice radi povećanja njezina učinka*

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ABSTRACT • *The basic element of each multiple-spindle driller is its working unit also called drilling head. The use of multi-spindle drill heads enables simultaneous drilling of holes arranged in rows, which makes such drillers much more efficient than one-spindle drillers. However their defect is the lack of possibility to make holes in stud elements. Passage drillers are particularly affected by this problem and this is why research on this machine-tooling was undertaken. The project enables widening technological possibilities of multiple-spindle /gang/ drilling machines. This paper deals with the presentation of some types of tooling.*

Key words: *multiple-spindle drilling machine, instrumentation, effectiveness*

SAŽETAK • *Osnovni dio svake viševretene bušilice jest njezina radna jedinica koja se naziva glava za bušenje. Uporaba viševretenih bušilica omogućuje simultano bušenje rupa u redovima, što čini takve bušilice učinkovitijima od jednovretenih bušilica. No njihov je nedostatak nemogućnost bušenja rupa u četvrtastim drvnim elementima. To je osobito velik problem kad je riječ o bušilicama za prolazne provrte, što je razlog da se u području te vrste obrade provode intenzivna istraživanja. Projekt pridonosi proširenju tehnoloških mogućnosti viševretenih bušilica, a u radu se razrađuju neke mogućnosti njihova opremanja.*

Ključne riječi: *viševretena bušilica, opremanje, učinak*

1 INTRODUCTION
1. UVOD

Multiple-spindle drillers can be included into basic woodworking machines used in furniture industry; however their machining range is limited to making holes and most frequently for dowel or screw connections (Kien, 2003; Lisican et al, 1996; Siklienka and Sajbanova, 2002).

Drilling of holes' sockets is still one of the basic technological operations performed in furniture industry. Dowel joints, commonly used in furniture constructions, and different kinds of fittings, which require performing of various sockets and holes, basically can be divided into:

– constructional (e.g. dowel connections, Confirmat screw connections)
– for fitting (e.g. holders, locks, hinges (fig.1))

Speaking of drilling, in a considerable number of cases of standard machining, the so called series dril-

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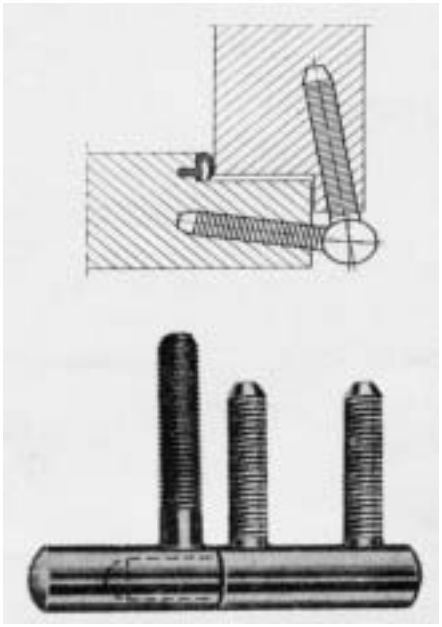

Figure 1 An example of door hinges
Slika 1. Primjer vratnih šarki

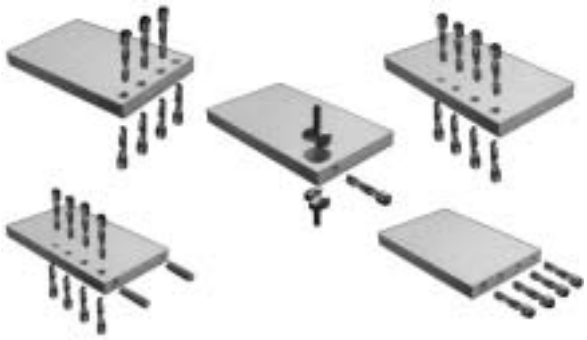

Figure 2 Examples of drillings in furniture units
Slika 2. Primjer bušenja dijelova namještaja

ling can be encountered. In such cases holes are arranged in rows, usually in straight line.

Wide application of wood product boards especially in constructions of cabinet furniture resulted in a wide use of joint hinges (e.g. eccentric joints). Such joints require many series drillings and compound drillings (Fig. 2). All the above mentioned aspects have resulted in a dynamic development of multi-spindle drilling machines.

Figure 3 Cyclic multiple-spindle drillers (Vitap- Italy)
Slika 3. Ciklične viševretene bušilice (Vitap- Italija)

Figure 4 Passage multiple-spindle drillers (Biesse- Italy)
Slika 4. Viševretene bušilice za prolazne rupe (Biesse- Italija)

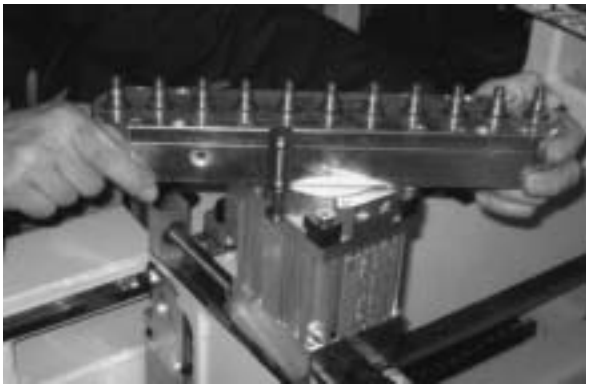

Figure 5 Example of head passage of multiple-spindle driller
Slika 5. Glava viševretene bušilice za prolazne rupe

Multiple-spindle drillers can be divided into two groups (Lisičan et al, 1996; Siemiński, 1991):
– passage – used in production lines
– cyclic – used for small series; flexible approach to furniture production.

The most important part of each multi-spindle driller is its working unit - the driller head (Fig. 5). The efficiency of this type of heads in such machines has been considerably improved and the machining time shortened in comparison to one-spindle drillers (Fig. 6).

Increasing application of dowel and metal joints (e.g. Confirmat screws) in skeleton constructions made impossible the use of one-spindle drillers with conventional equipment. This can be illustrated by drilling in

Figure 6 One-spindle driller
Slika 6. Jednovretena bušilica

Figure 7 Specialised cyclic multiple-spindle machine (Knoevenagel - Germany)
Slika 7. Specijalizirana ciklična viševretena bušilica (Knoevenagel - Njemačka)

Figure 8 Examples of holes drilled in scantlings - square timber
Slika 8. Primjer rupa izbušenih u četvrtačama

narrow units especially in the fronts (Kien,1996; Kien, 2003; Kien, 2000; Osajda and Wieloch, 2005).

Sometimes there are situations when holes are drilled in ++ areas lying at an angle to other surfaces of the machined object (e.g. when units are connected by splayed joints). Although there is a possibility of head adjustment to different angles (e.g. 45°), difficulties arise in positioning and fixing the machined objects. It enables a wider use of standard cyclic multi-spindle driller instead of an expensive specialised one (Fig. 7).

Further to the above reasons, in a furniture factory which has no specialised cyclic multi-spindle driller (e.g. Fig. 7) at its disposal, the holes in units are drilled one by one by a one-spindle driller (Fig. 6) or by a horizontal drill-moulder. However, this is a labour consuming method with low efficiency, and what is more it often requires the use of special equipment.

Arrangement and number of heads and spindles in these heads in majority of multi-spindle drillers encourage their use in atypical machining operations especially in drilling holes in scantling units with the use of additional equipment.

Based on the above considerations, a project of special instrumentation was elaborated in the Department of Woodworking Machinery and Basis of Machine Construction at the Agricultural University in Poznañ aimed at improving technological possibilities of holes drilling in scantling units.

The aim of this paper was to design machining instrumentation (two handlings) that would enable the use of a cyclic multi-spindle driller with the performance efficiency, which cannot be obtained with the standard equipment. Such performance mainly consists of simultaneous drilling of several holes in side surfaces of scantling units like sill or table legs as well as drilling holes with skew axis to the unit surface.

2 CONCEPT AND DESIGN OF INSTRUMENTATION
2. KONCEPT I RAZVOJ OPREME

Before developing the design, the following fore-designs were made (Dobrzañski, 1981; Kien, 2003; Osajda and Wieloch, 2005):

– Adjustment of the design of DCWGW - 19 multi-spindle driller (Polish product).
– Enabling drilling of holes with skew axes (angle range from 30° to 75°), situated on the surface of square timbers usually at the axis distance smaller than module “32”.
– Machining of several units simultaneously.
– Adding instrumentation consisting of one or several components. The application of suggested solutions provides no adaptation of the drilling machine.
– Adjustment of drilling to work with instrumentation depends on limited disassembly, or change of location of its components. Quick return to the basic version of the machine should be possible any time.
– Utilization of the existing fixing system (Osajda and Wieloch, 2005).

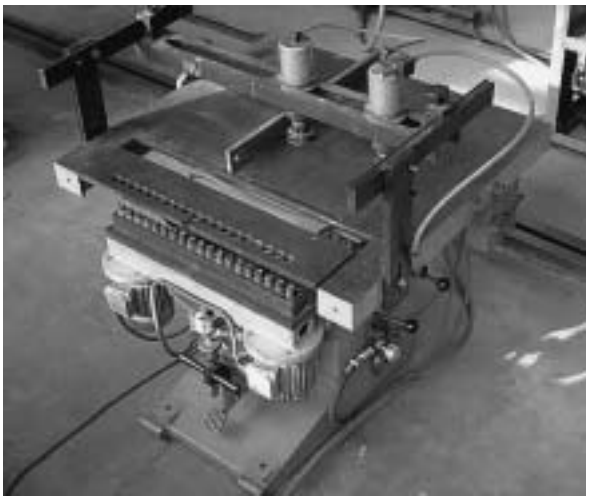

Figure 9 Cyclic multi-spindle drilling machine - type DCWGW-19
Slika 9. Ciklična viševretena bušilica, tip DCWGW-19

3 PROJECT RESULTS
3. REZULTATI PROJEKTA

3.1 Holder of cyclic multi-spindle driller
3.1. Držač ciklične viševretene bušilice

The most important element of instrumentation shown in Figure 10 is a movable system of two boards consisting of the footing (Dobrzañski, 1981) and upper

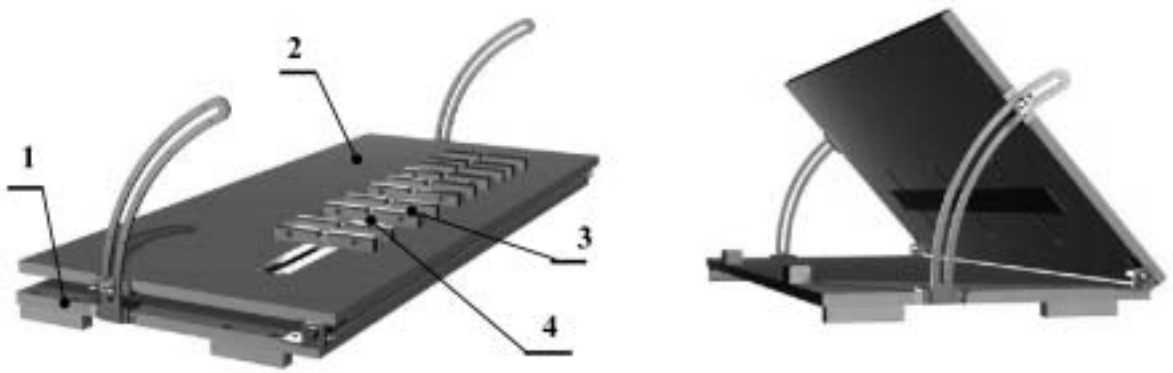

Figure 10 Prototype instrumentation of cyclic multi-spindle drilling machine
Slika 10. Prototip opreme za ciklične viševretene bušilice

board (Kien, 1996). The footing of the holder, made of MDF board, is used for fastening the holder to the work table of the drilling machine. The upper board - also made of MDF board – is equipped with support blades (Kien, 2003) and blade clamps (Kien, 2000) that can be regulated.

After fixing tightly the holder to the machine body and providing appropriate deflection of the upper board, depending on machining conditions, machined units have to be put in the right place. The instrumentation enables simultaneous drilling of five units. The machined objects are inserted from the top between the support blades and blade clumps. The spring situated in the clamp body causes pressure on pressure blade, which enables its movement in a pre-set range and its constant contact with the machined unit. The heads of machined units have to be adequately pushed to the resistance blade of the machine as shown in Figure 10. After fixing the units, the drilling operation of all units starts simultaneously. During the drilling cycle, the units are immobilized by pneumatic clamps of the drilling machine with pressure blades.

After having performed the sockets, the driller heads withdraw to the initial position after which machined units are removed and the next units are inserted into the holder. The following drilling cycles are performed in the same way as described above.

4 CONCLUSION
4. ZAKLJUČAK

1. The designed holder of DCWGW- 19 cyclic multi-spindle driller enables drilling of holes at angles from 30° to 75° to surface areas of square timber units.
2. Taking into consideration the vertical movement of the working unit in the range of 60 mm, there is a possibility - after having used the holder – of drilling holes in skew surfaces at optional distances.
3. The holder enables drilling of non-square timber units of the following dimensions: (20-100) x (20-100) x (200-500); the drilling operation of all (5) units starts simultaneously.

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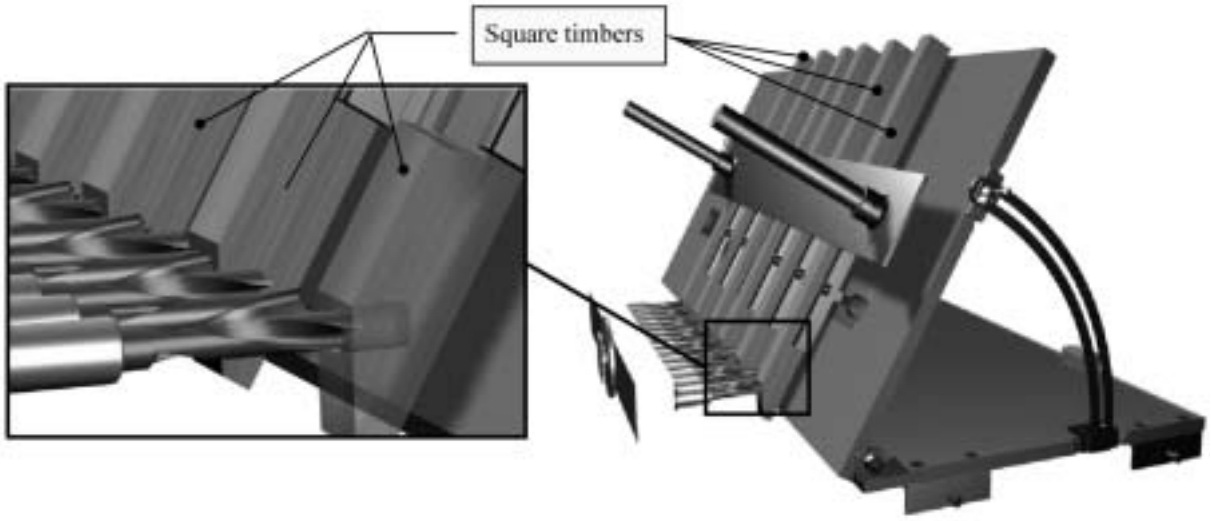

Figure 11 Simulation of use of instrumentation of cyclic multi-spindle drilling machine
Slika 11. Simulacija uporabe opreme cikličnih viševretenih bušilica

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