DRVNA INDUSTRIJA

ZNANSTVENO STRUČNI ČASOPIS ZA PITANJA DRVNE TEHNOLOGIJE • ZAGREB • VOLUMEN 60 • BROJ 3
SCIENTIFIC AND PROFESSIONAL JOURNAL OF WOOD TECHNOLOGY • ZAGREB • VOLUME 60 • NUMBER 3

60

Cinnamomum camphora Nees et Eberm.

3/09

UDK 630*8+674 CODEN: DRINAT ISSN 0012-6772

UDK 630*8+674 Coden: Drinat ISSN 0012-6772

DRVNA INDUSTRIJA

ZNANSTVENO-STRUČNI ČASOPIS ZA PITANJA DRVNE TEHNOLOGIJE
SCIENTIFIC AND PROFESSIONAL JOURNAL OF WOOD TECHNOLOGY

IZDAVAČ I UREDNIŠTVO
Publisher and Editor's Office
Šumarski fakultet Sveučilišta u Zagrebu
Faculty of Forestry, Zagreb University
10000 Zagreb, Svetošimunska 25
Hrvatska - Croatia
*Tel. (*385 1) 235 24 30*

SUIZDAVAČI
Co-Publishers
Exportdrvo d.d., Zagreb
Hrvatsko šumarsko društvo, Zagreb
Hrvatske šume d.o.o., Zagreb

OSNIVAČ
Founder
Institut za drvnoindustrijska istraživanja, Zagreb

DRVNA INDUSTRIJA *je časopis koji objavljuje znanstvene i stručne radove te ostale priloge iz cjelokupnog područja iskorištavanja šuma, istraživanja svojstava i primjene drva, mehaničke i kemijske prerade drva, svih proizvodnih grana te trgovine drvom i drvnim proizvodima.*

Časopis izlazi četiri puta u godini.

DRVNA INDUSTRIJA *contains research contributions and reviews covering the entire field of forest exploitation, wood properties and application, mechanical and chemical conversion and modification of wood, and all aspects of manufacturing and trade of wood and wood products.*

The journal is published quarterly.

OVAJ BROJ ČASOPISA SUFINANCIRA:

Belišće

Sadržaj
Contents

NAKLADA (Circulation): *700 komada* · **ČASOPIS JE REFERIRAN U (Indexed in):** *CA search, CAB Abstracts, Compendex, DOAJ, EBSCO, Forestry abstracts, Forest products abstracts, Geobase, Paperchem*, SCOPUS · **PRILOGE** *treba slati na adresu Uredništva. Znanstveni i stručni članci se recenziraju. Rukopisi se ne vraćaju.* · **MANUSCRIPTS** *are to be submitted to the editor's office. Scientific and professional papers are reviewed. Manuscripts will not be returned.* · **KONTAKTI s uredništvom (Contacts with the Editor)** *e-mail: editordi@sumfak.hr* · **PRETPLATA (Subscription):** *godišnja pretplata (annual subscription) za sve pretplatnike* **55 EUR**. *Pretplata u Hrvatskoj za sve pretplatnike iznosi 300 kn, a za đake, studente i umirovljenike 100 kn, plativo na žiro račun 2360000 - 1101340148 s naznakom "Drvna industrija"* · **ČASOPIS SUFINANCIRA** *Ministarstvo znanosti, obrazovanja i športa Republike Hrvatske.* · **TISAK (Printed by)** - *DENONA d.o.o., Ivanićgradska 22, Zagreb, tel. 01/2361777, fax. 01/2332753, E-mail: denona@denona.hr; URL: www.denona.hr* · **DESIGN** *Aljoša Brajdić* · **ČASOPIS JE DOSTUPAN NA INTERNETU**: *http://drvnaindustrija.sumfak.hr*

DRVNA INDUSTRIJA · Vol. 60, 3 · str. 133 - 194 · jesen 2009. · Zagreb
REDAKCIJA DOVRŠENA 1.9.2009.

Richard P. Vlosky[1], Todd Shupe, Qinglin Wu

Perceptions & use of termite resistant treated wood products. Part I: The perspective of homeowners in Formosan subterranean termite infected States

Percepcija i uporaba drvnih proizvoda zaštićenih od termita. Dio I: Stajališta vlasnika kuća u državama zaraženim podzemnim termitima iz porodice *Coptotermes*

Original scientific paper · Izvorni znanstveni rad
Received – prispjelo: 19. 3. 2009.
Accepted – prihvaćeno: 16. 7. 2009.
*UDK: 630*841; 630*845.3*

ABSTRACT • *Formosan subterranean termites (Coptotermes formosanus Shiraki), is estimated to cause hundreds of millions of dollars in losses annually in North America. Unlike most subterranean species, Formosan termites often build nests (cartons) in living trees and wooden buildings, and even penetrate plaster, plastic, asphalt, mortar, creosote, concrete, and rubber to reach wood. The study addresses issues that U.S. home owners consider in evaluating whether to buy or build homes that are built with termite resistant building materials. The sample frame for this study consisted of a random sample of 5.000 home owners in the region where Formosan subterranean termites are a current or potential problem. When examined by state, 50 percent of respondents in Hawaii said termites have damaged the home they currently live in followed by respondents from Louisiana and California. On average, respondents indicated that preservative pressure treated wood and regular fumigation as being most effective in protecting a house against termites and only 8 percent of respondents said they would not pay a premium for a guaranteed termite-free new home.*

Key words: *termites, United States, wood products, home owners, loss*

SAŽETAK • *Utvrđeno je da podzemni termiti (Coptotermes formosanus Shiraki) u Sjevernoj Americi svake godine prouzroče stotine milijuna dolara štete. Za razliku od drugih vrsta podzemnih termita, termiti iz porodice Coptotermes često grade gnijezda u živim stablima i drvenim građevinama, a mogu prodrijeti kroz žbuku, plastiku, asfalt, kreozot, beton ili gumu da bi doprli do drva. U studiji se analiziraju stavke koje vlasnici kuća u Sjedinjenim Američkim Državama uzimaju u obzir pri odluci o kupnji ili gradnji kuće od drvnog materijala zaštićenoga od termita. Uzorak za istraživanje dobiven je slučajnim odabirom 5 000 vlasnika kuća u regiji u kojoj su navedeni termiti ak-*

[1] Authors are professors at Louisiana Forest Products Development Center, School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, Louisiana.
[1] Autori su profesori u Centru za razvoj šumskih proizvoda, Školi za obnovljive prirodne resurse i Poljoprivrednom centru Sveučilišta u Louisiani, Baton Rouge, Louisiana.

tualni ili potencijalni problem. Analiza studije pokazala je da 50 % ispitanika u državi Hawaii potvrđuje oštećenost kuća u kojima trenutačno žive s termitima, a slijede ih ispitanici iz država Louisiane i Californije. U prosjeku, odgovori ispitanika upućuju na to da su impregnacija i fumigacija drva najučinkovitiji načini zaštite od termita. Samo 8 % ispitanika odgovorilo je da ne bi platilo dodatnu premiju za kuću potpuno zaštićenu od napada termita.

Ključne riječi: *termiti, Sjedinjene Američke Države, drvni proizvodi, vlasnici kuća, šteta*

1 INTRODUCTION
1. UVOD

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, are found throughout the tropical and temperate regions of the world, but they are more prevalent in tropical and subtropical areas (USDA Forest Service 2001). The genus *Coptotermes* contains the largest number of termite pests (28 species) among the >2.500 termite species worldwide, and the Formosan subterranean termite, *Coptotermes formosanus*, is the most widely distributed and most economically important (Su and Scheffrahn 2005). This destructive species was apparently transported to Japan prior to the 1600s and to Hawaii in the late 1800s (Su and Tamashiro 1987). By the1950s, it was reported in South Africa and Sri Lanka. During the 1960s it was found in Texas, Louisiana, and South Carolina (Su and Scheffrahn 2005). In the United States, the highest hazard areas are in the southeastern states and California. Subsequent colonies were found in New Orleans and Lake Charles, LA, in 1966. Today, *C. formosanus* has rapidly expanded its geographic domain throughout the southern United States and Hawaii. They have been reported in all southern states from Texas to Florida and north to North Carolina (USDA ARS 2008). At least one colony has been found In California (Shupe and Dunn 2000). Their distribution will probably continue to be restricted to southern areas because their eggs will not hatch below about 20° C (68° F) (Protective Packaging, Ltd. 2007).

The degree of damage to homes and forests caused by Formosan termites has been significantly deepened due to the rapid increase of the termite colonies and its absolute population. While native subterranean termite colonies support an average of 300.000 workers, Formosan colonies can average millions of workers, and Formosan queens can produce 1.000 eggs a day (Termite Institute 2008). The New Orleans (Louisiana) Mosquito and Termite Control Board reported that a colony of Formosan termites could consume 0,014 m^3 of wood per month. They are able to hollow out walls of new buildings in three months. As of the first of 2005, the invasive Formosan subterranean termites are found in about one-half of the Parishes (counties) of Louisiana. The termites have also been found throughout the southeastern United State and southern California (Ring 2005). Devastation caused by this insect throughout North America has been estimated to be hundreds of millions of dollars yearly (Potter 1997). It is estimated to cost consumers in New Orleans alone over 300 $ USD million annually (Lax and Osbrink 2003).

Conventional treatments for termite prevention include the use of chemically treated soil barriers, spot treatments with aerosols, liquids or dust targeting infested sites, and wood preservatives or termiticides. However, the ability of Formosan termites to make nests above ground in trees or homes through interior tunnels in wood makes prevention and control of termites very difficult, and conventional treatments even ineffective, because the structural wood is vulnerable once termites gain entry. Facing these problems, the Louisiana Legislature enacted Act 486, Senate Bill No. 373 (1999) which notes that the construction lumber and sheathing materials (plywood and oriented strandboard) should be treated to be termite-resistant. The ultimate solution to termites is to make wood inedible or to stop using wood or wood products in construction.

Treated lumber can be considered a mature product. This claim can largely be supported by the competitive markets for treated lumber. In the U.S. treated lumber competes against internally (one preservative versus another) and against non-wood alternatives such as steel, plastic, and concrete, depending on in service requirements. Treated wood has been the subject of a great deal of media coverage in recent years. The coverage has been largely negative and has resulted in increased concern and distrust of the wood preservation industry by the general public.

Sinclair and Smith (1990) found that the retail customer of treated lumber products is not fully informed about the proper use, handling and disposal of these products. In spite of the negative publicity surrounding treated wood Vlosky and Shupe (2002) found that homeowners have a generally positive opinion of the safety and performance of preservative-treated wood. A large majority of respondents indicated a positive overall perception of treated wood in that they were willing to use the product inside or near their home. The major reasons for those unwilling to use treated wood were due to perceived livability and health concerns.

The study we conducted addresses issues that U.S. home owners consider in evaluating whether to buy or build homes that are built with termite resistant building materials. By understanding the current perceptions and attitudes on these issues from this group, companies involved in the wood preservation industry will be better positioned to gauge potential participation in this arena. For example, builders may develop market initiatives if it is found that there is a desire from homeowners to have options in structural panels that are termite resistant. Additionally, treaters and chemical manufacturers can benefit from this study by better understanding market conditions which, in turn, can help them to develop effective market and product development strategies.

Figure 1 States infested with Formosan subterranean termites (Ring, 2005)
Slika 1. Države sa zarazom podzemnim termitima (Ring, 2005)

The objective of the study was to identify the factors that affect potential usage of termite resistant structural panels and other treated wood products in the region of the United States that is impacted by the Formosan subterranean termite. We examined the perspectives of home owners to better understand: 1) Basic understanding of the treated wood market space; 2) Incentives for usage; 3) Barriers and concerns that may preclude usage; 4) Willingness-to-pay for termite resistant wood products and; 5) Identify market potential for termite resistant structural panels and other treated wood products.

2 MATERIALS AND METHODS
2. MATERIJALI I METODE

Mailed questionnaires were used to conduct the study. This method is a cost-effective means of data collection and affords a high degree of anonymity. Mail surveys are also less limited by rigid time constraints that can impede the effectiveness of other survey methods. Sampling, survey procedures, follow-up efforts and data analysis were conducted in accordance with well-documented and verified mail survey techniques. The following sections elaborate on these procedures.

Based on the literature, past research, and an iterative process with study clients, a list of topics and questions were generated. The survey was reviewed and revised by the researchers and study clients. In addition, a pre-test sample was conducted with 30 homeowners randomly selected from the sample pool to check for readability and clarity. An iterative process resulted in the final questionnaire. Survey recipients were provided with the following definition of Treated Wood: "Wood in which preservatives have been added to improve resistance to termites and decay."

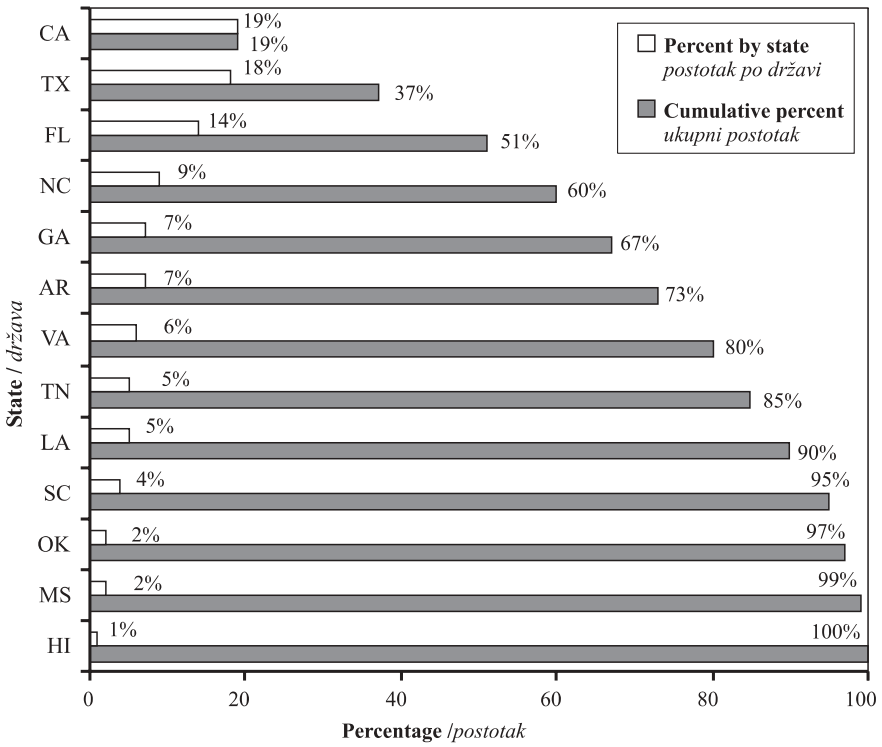
The sample frame for the study consisted of a random sample of 5.000 home owners in the study region. The study region included states where Formosan subterranean termites exist (Ring 2005) (Figure 1) as well as selected states on the periphery. The mailing list was purchased from Best Mailing Lists, Inc., a national list provider. All survey recipients were identified by name.

Questionnaire quantitative data was coded and entered into the Statistical Package for the Social Sciences (SPSS) for analysis and interpretation. Data entry was closely supervised to ensure accuracy. Descriptive and frequency statistics were generated for the quantitative data; qualitative information from open-ended questions was analyzed to discern common themes or concepts.

3 RESULTS AND DISCUSSION
3. REZULTATI I DISKUSIJA

After accounting for undeliverable surveys and recipient requests to be removed from the mailing list, the adjusted response rate was 10 percent (438 respondents). Over two-thirds of respondents are in 5 of the 13 states included in the homeowner study (Figure 2). California led with 19 percent of respondents, followed by Texas (18 percent) and Florida (14 percent). Thirty-seven percent of respondents plan to buy a new home in the next year and they lived an average of 12 years in the home they currently own.

- Twenty-nine percent of respondents are female.
- The ages of respondents ranged from 21 to 85 with a mean of 47
- Twelve percent of respondents are high school graduates; 30 percent have some college; 33 percent have a college degree and; 25 percent have an advanced degree
- Eighty-six percent of respondents are white, 4 percent are African-American, 4 percent are Asian, 2 percent are Hispanic, 1 percent is Native American, and 2 percent are Other
- Average income is 98.150 $ USD.



CA – California, TX – Texas, FL – Florida, NC – North Carolina, GA – Georgia, AR – Arkansas, VA – Virginia, TN – Tennessee, LA – Louisiana, SC – South Carolina, OK – Oklahoma, MS – Mississippi, HI - Hawaii

Figure 2 Respondents by state (n = 438)
Slika 2. Postotak ispitanika po državama (n = 438)

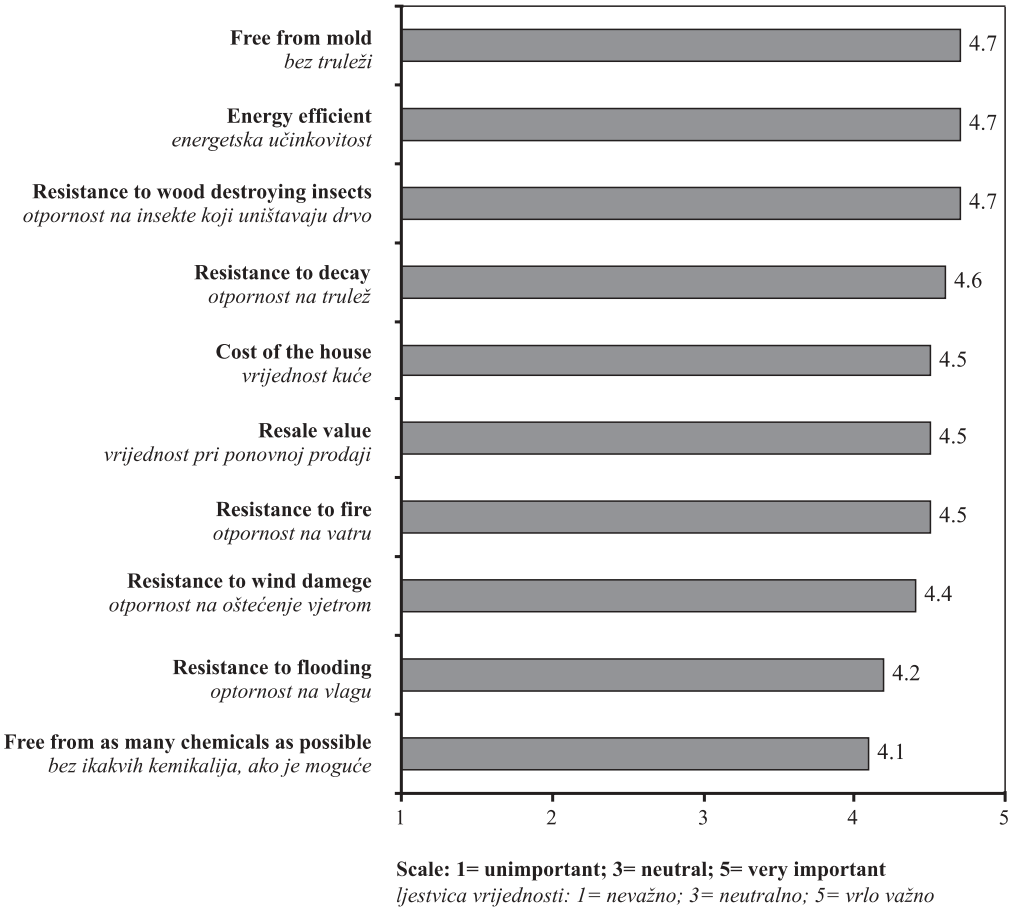


Figure 3 Importance of construction criteria (n = 438)
Slika 3. Važnost konstrukcijskih kriterija (n = 438)

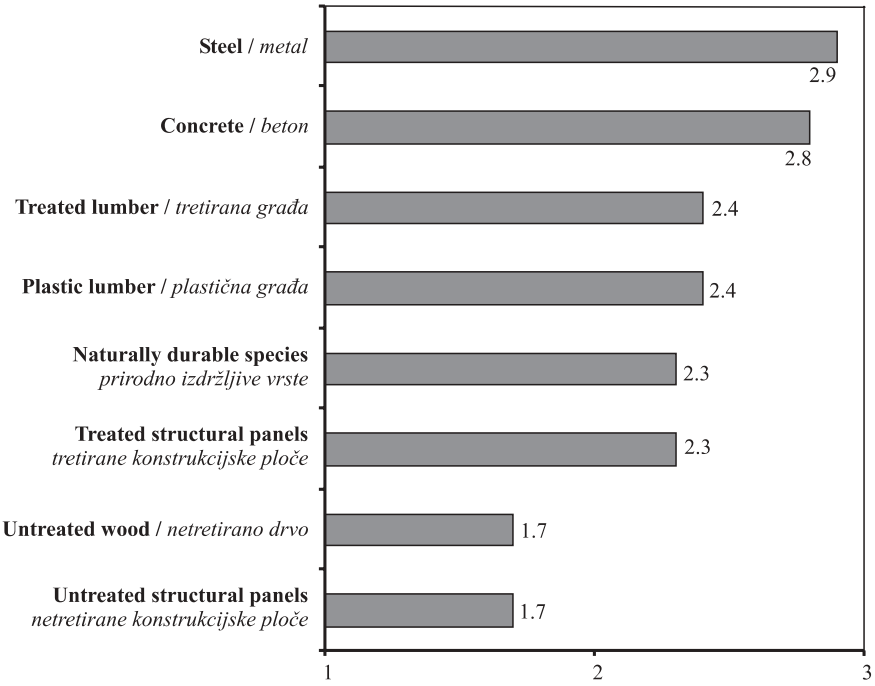


Figure 4 Perceived durability of building materials (n = 438)
Slika 4. Trajnost gradbenih materijala prema mišljenju ispitanika (n = 438)

3.1 Building materials and construction
3.1. Gradbeni materijal i gradnja

Respondents were asked to indicate the importance of the different construction criteria they use when buying or building a new house. A scale of 1=very unimportant to 3=neutral to 5=very important was used. Figure 3 shows the rank of these criteria by mean importance. Of note to the treating industry is that the highest ranked criterion is treated-wood-related, to be free from mold. Additional points to note are that resistance to wood destroying insects was ranked 3rd and resistance to decay was ranked 4th.

Durability is an important concern for homeowners. We asked about the perception that respondents have about the number of years different competing materials would last in unexposed structural home applications (Figure 4). The choices were on a scale of: 1=0-10 Years; 2=11-25 Years and; 3=More than 25 years. Steel (2,9) were ranked as having the greatest longevity. Treated lumber was ranked third (2,4) and treated structural panels was ranked 6th.

3.2 Treated wood products
3.2. Zaštićeni drvni proizvodi

With regard to treated wood, we first asked if respondents would be willing to live in a house partly fabricated with treated wood. Ninety-three percent said yes. For the 7 percent that said no, concerns about chemicals in treated wood products were cited as their major concern. We followed up with a question asking about respondents'' overall perception of treated wood (Figure 5). Only 3 percent of respondents had an extremely negative perception while 32 percent had an extremely positive perception of treated wood. Then, we

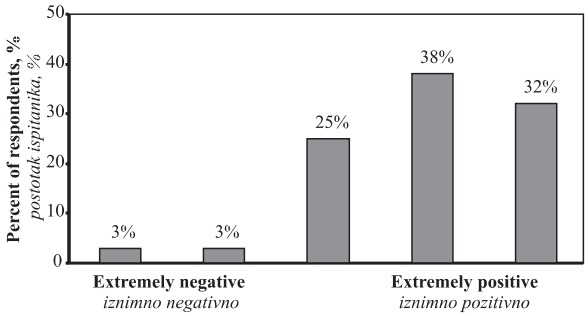


Figure 5 Overall perception of treated wood (n = 436)
Slika 5. Opća percepcija zaštićenog drva (n = 436)

wanted to see if respondents were familiar with various chemicals and compounds used in wood preservation. Respondents were most familiar with creosote (64 percent of respondents) and chromated copper arsenate (CCA) (37 percent) (Figure 6).

Respondents were asked if they used or specified treated wood products for applications in their homes (Figure 7). Landscaping timbers were most cited by 58 percent of respondents. Decks and outside stairs followed with 53 percent. From an expanded list of products, respondents were asked to identify applications where they believed that treated wood *is appropriate* independent of whether they had used these products in their own homes (Figure 8). Treating landscape timbers and decking/outdoor stairs topped the list with at 87 percent closely followed by fence posts/rails with 86 percent of respondents.

As indicated previously, treated wood safety is an issue for consumers. Using a 5-point scale, we asked respondents to indicate their level of agreement or disagreement with statements regarding treated wood application safety. The results in Table 1 are ranked with the

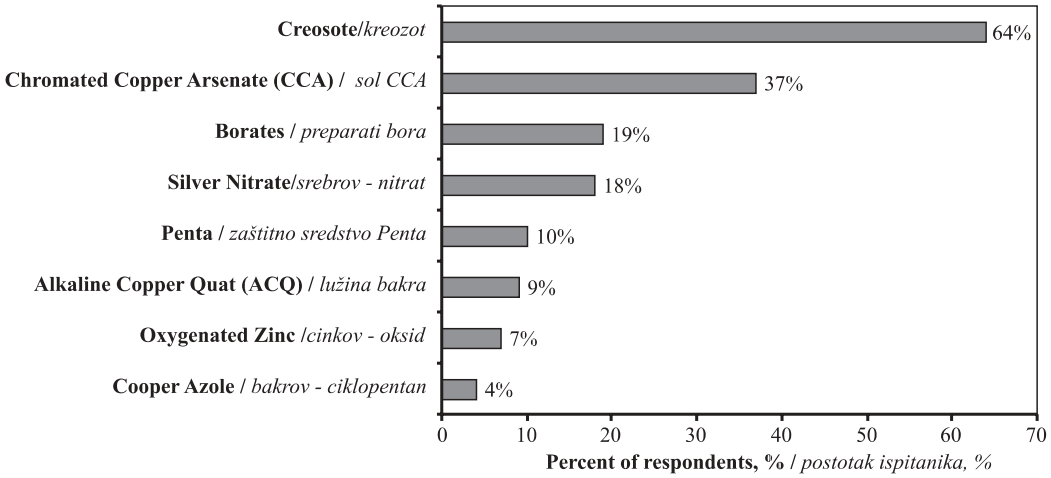


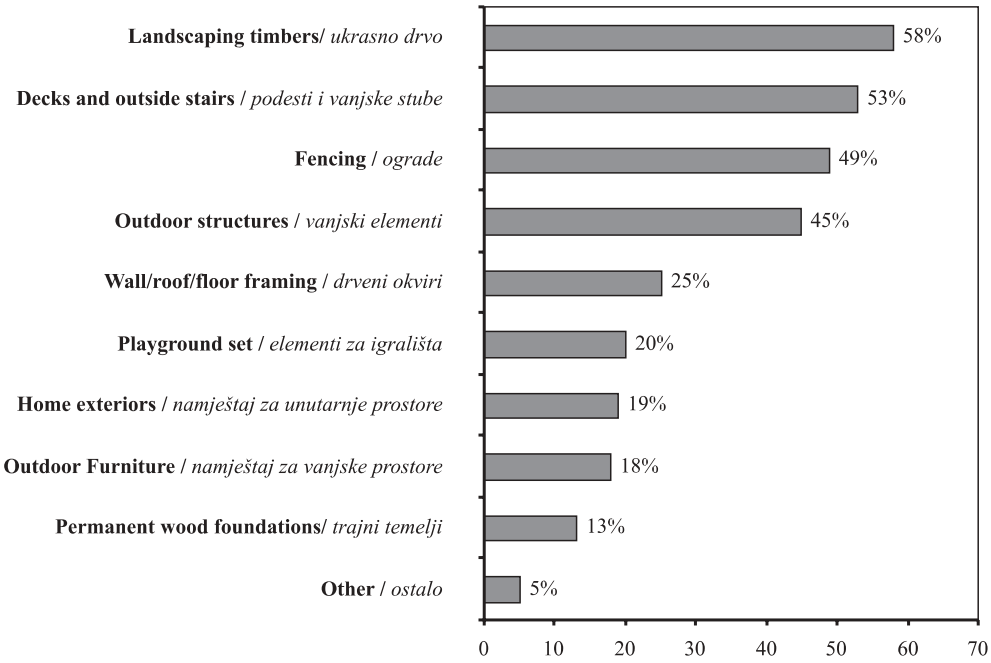
Figure 6 Familiarity with wood treating chemicals (n = 438) (multiple responses possible)
Slika 6. Obaviještenost o kemikalijama za zaštitu drva (n = 438) (moguće je više odgovora)

strongest level of agreement (somewhat agree + strongly agree) at the top. Overall, respondents are in agreement that treated wood is safe if handled and disposed of properly. Sixty-two percent of respondents agreed that treated wood is safe for human contact in outdoor applications but only 34 percent agreed that treated wood was safe to residents for indoor structural applications. Overall, when taking into account the neutral responses, respondents have a favorable view of treated wood safety for most applications posed to them.

Respondents were asked if they thought that some types of treated wood are safer than others. Twenty-three percent of respondents said yes but 65 percent were not sure. This clearly indicates the need to educate homeowners regarding different preservative treatments and associated applications. For those respondents that said yes, we asked what they thought makes one kind of treated wood safer than another. The most cited response was "chemicals used". Forty-six percent of respondents said that they would like more information on proper use, handling and disposal of treated wood. This presents another opportunity for treated wood manufacturers and preservative providers to educate builders and architects on the benefits of using treated wood.

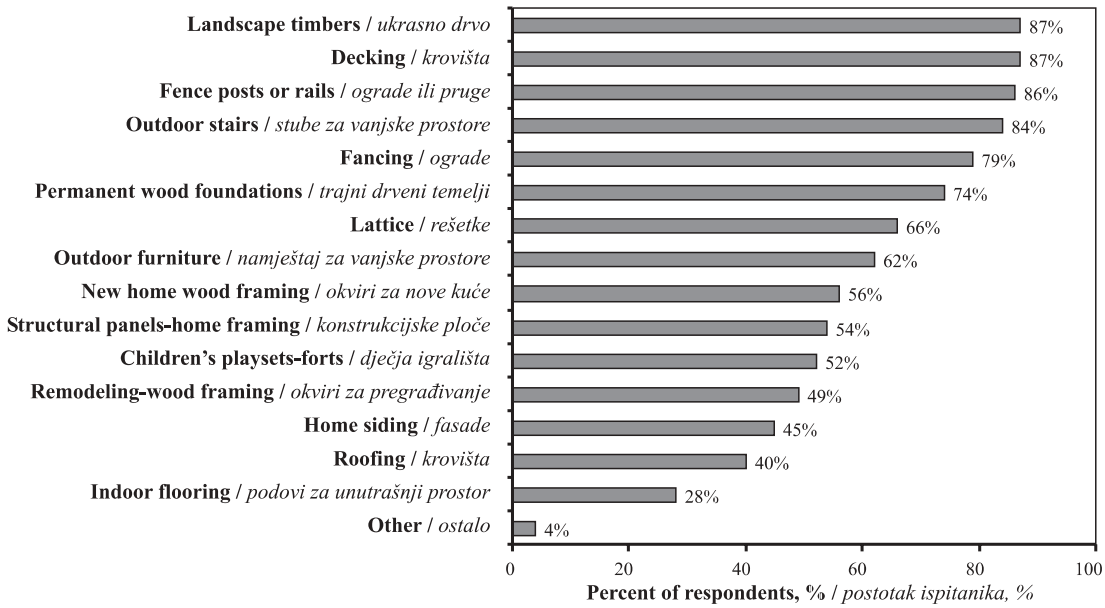
3.3 Termites
3.3. Termiti

Thirty percent of respondents said termites have damaged the home they currently live in. Of these, 21 percent said they knew what types of termites these



Other / *Ostalo*
Barns */ staje;* Boat dock / *dok;* Bottom plate on addition */ osim na dnu;* Bulkhead / *pregrada;* Cabinet base / *podloga*; Deer stands / *nastambe za divljač;* Detached shop / *samostojeće trgovine;* Dog house */ kućica za pse;* Farm buildings / *objekti na farmama,* Garage interior / *interijer u garažama;* Garden / *vrt;* Greenhouse / *staklenik;* Outdoor storage buildings */ vanjski skladišni prostori;* Planter boxes */ posude za cvijeće;* Retaining well / *bunar;* Structural applications / *konstrukcijska primjena;* Subfloor / *međupod;* Veranda / *veranda*

Figure 7 Treated wood applications used by respondents (n = 422) (multiple responses possible)
Slika 7. Zaštićeno drvo prema uporabi u ispitanika (n = 422) (moguće je više odgovora)



Other/ *ostalo*
Any wood near or at the ground level / *bilo koje drvo u blizini zemlje ili na zemlji*; Any wood product outdoor */ bilo koji prozvod za vanjski prostor*; Anything where the wood is exposed or available to above or below ground termites / *sva mjesta gdje je drvo iznad zemlje ili u zemlji izloženo ili može biti izloženo djelovanju termita*

Figure 8 Treated wood applications deemed appropriate by respondents (n = 437) (multiple responses possible)
Slika 8. Primjena zaštićenog drva koju ispitanici smatraju primjerenom (n = 437) (moguće je više odgovora)

were. Most cited were subterranean termites (12 respondents) and dry wood termites (5 respondents). When examined by state, 50 percent of respondents in Hawaii said termites have damaged the home they currently live in (Figure 9). Hawaii was followed by Louisiana and California (43 percent of respondents said it was a problem in each state). Tennessee was represented by the smallest percent of respondents (8 percent). Previously, we talked about building materials in the context of durability. In this section we asked respondents specifically about the efficacy of different building and construction materials protection against termites in general. Using a 3-point scale of protection against termites (1=does not protect at all; 2=protects

Table 1 Treated wood safety for selected applications (n = 438)
Tablica 1. Sigurnost zaštićenog drva za određenu primjenu (n = 438)

	Strongly Disagree *Uopće se ne slažem*	**Somewhat Disagree** *Uglavnom se ne slažem*	**Neutral** *Neutralno*	**Somewhat Agree** *Uglavnom se slažem*	**Strongly Agree** *U potpunosti se slažem*
entirely safe with proper use, handling and disposal *potpuno sigurno za odgovarajuću uporabu, rukovanje i odlaganje*	2%	9%	19%	38%	32%
safe for outdoor human contact applications *sigurno za vanjsku primjenu i kontakt s ljudima*	6%	10%	23%	34%	28%
is an acceptable material to use for new home construction framing *prihvatljiv materijal za konstrukcije novih kuća*	6%	4%	33%	30%	29%
safe to builders *sigurno za graditelje*	6%	11%	25%	36%	22%
safe to be near pets or farm animals *sigurno za kućne ljubimce i životinje na farmi*	9%	14%	28%	31%	18%
safe to children for outdoor play equipment *sigurno za djecu na dječjim igralištima*	13%	14%	25%	29%	19%
safe to residents for indoor structural applications *sigurno za stanovnike pri unutarnjoj strukturnoj primjeni*	11%	15%	30%	17%	17%
does not emit odors *ne ispušta mirise*	11%	22%	41%	19%	8%

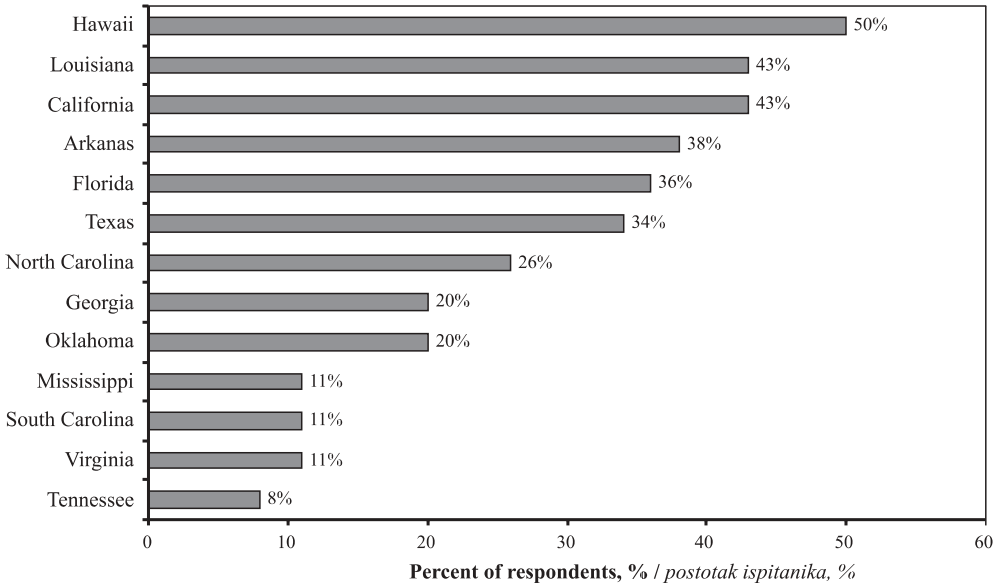


Figure 9 Termite damage encountered by state (n = 438)
Slika 9. Zastupljenost šteta prouzročenih termitima analizirana prema državama (n = 438)

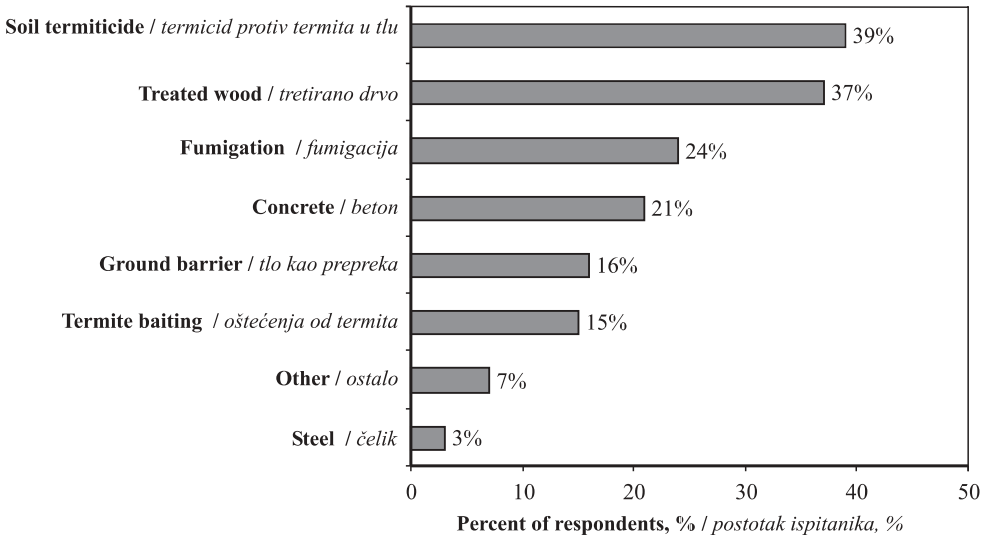


Figure 10 Actions taken to prevent termite attack (n = 411) (multiple responses possible)
Slika 10. Način prevencije napada termita (n = 411) (moguće je više odgovora)

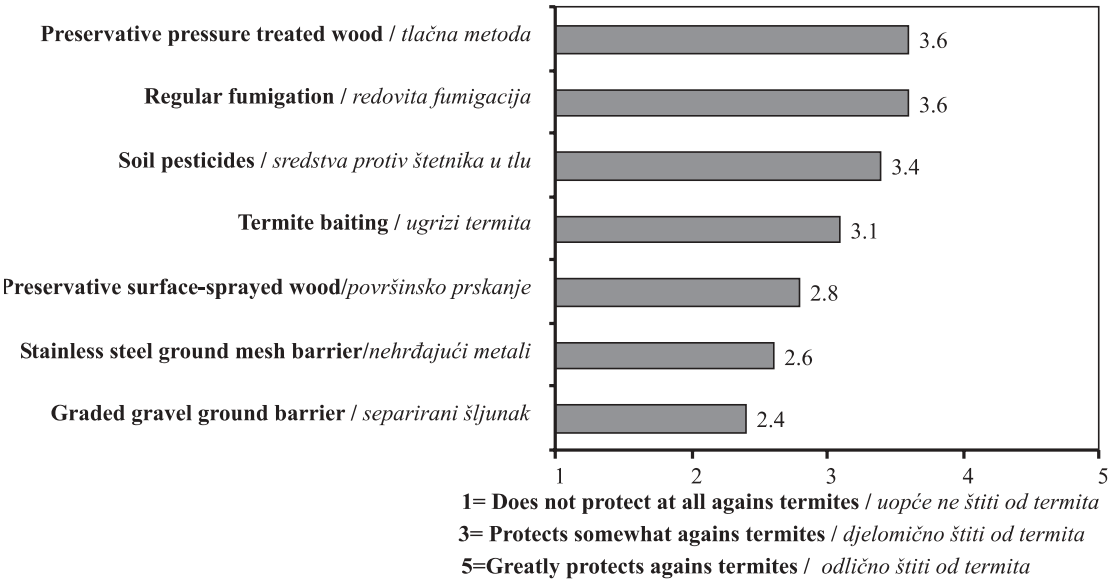


Figure 11 Effectiveness of activities and treatments for termite protection (n = 437)
Slika 11. Učinkovitost prevencije i zaštite drva od napada termita (n = 437)

Table 2 Respondent customer willingness to pay a premium for a termite-free new home (n = 426)
Tablica 2. Odgovori o premiji koju su kupci spremni platiti za zaštitu od termita pri kupnji novog stambenog prostora (n = 426)

	For a 10-year termite free home i would pay *Za kuću 10 godina sigurnu od termita platio bih*						
Percent premium *postotna premija*	0%	2.5%	5.0%	7.5%	10.0%	12.5%	More than / *više od* 12.5%
House cost, USD *cijena kuće, USD*	80.000 $	82.000 $	84.000 $	86.000 $	88.000 $	90.000 $	More than / *više od* 90.000 $
Percent of respondents *postotak ispitanika*	8%	27%	31%	14%	10%	5%	6%

Table 3 Mean annual number of applications and costs for termite applications (multiple responses possible)
Tablica 3. Srednji godišnji broj provedenih zaštita od termita i godišnji trošak tih zaštita (moguće je više odgovora)

Application/Activity *Zaštita /aktivnost*	**Number of respondents** *Broj ispitanika*	**Number of applications annually (mean)** *Broj provedenih zaštita (srednji)*	**Mean annual cost (USD)** *Srednji godišnji trošak (USD)*
Fumigation / *cijanizacij*a	58	1.5	319
Termite baiting / *uništenje termita*	49	2.2	275
Home perimeter treatment *zaštita vanjskog ruba kuće*	92	2.0	219
Soil Termiticide *zaštita tla termicidima*	102	1.6	205

somewhat; 3=significantly protects), steel and concrete were ranked highest (2,9 and 2,8/3,0, respectively). Plastic lumber was third (2,5/3,0) followed by treated wood (2,4 / 3,0).

Seventy-five percent of respondents have taken some type of action to prevent attack by the termites in homes they own. Figure 10 shows the actions that respondents have taken. The use of soil termiticides was the most cited (39 percent of respondents) closely followed by the use of treated wood (37 percent of respondents). On average, respondents indicated that preservative pressure treated wood and regular fumigation as being most effective in protecting a house against termites (3,6 on a 5-point scale of protection effectiveness) (Figure 11).

In order to develop a perspective on the cost premium the homeowner market places on termite prevention, we asked respondents how much of a premium they thought their customers would pay for an assured termite-free new home for 10 years over a home that does not carry this guarantee. For this exercise, a house was hypothetically priced at 80.000 $ USD (Table 2). Only 8 percent of respondents said they would not pay any premium for a termite-free house. Fifty-eight percent of respondents said they would pay a premium between 2,5 percent-5,0 percent and 35 percent said they would pay a premium of 7,5 percent or more.

Respondents were asked the number of termite preventative applications they use on their homes annually as well as the annual cost for these applications. As seen in Table 3, on average, 58 respondents pay 319 $ USD annually for fumigation, 49 respondents pay 275 $ annually for termite baiting, 92 pay 219 $ USD/yr. for home perimeter treatment and 102 pay an average of 205 $ USD/yr. for application of soil termiticides.

4 CONCLUSION
4. ZAKLJUČAK

In this study we examined a number of homeowner perceptions, concerns and behaviors regarding termites and the potential for using treated wood to keep termites at bay. The particularly insidious Subterranean Formosan Termite (SFT) is currently a significant problem for homeowners in the Southern United States and is a potential issue for those residing in other U.S. geographic areas in the future.

Termites are a major problem for respondents. Ninety-two percent said they would pay a premium for a new home that had a 10-year termite-free guarantee. In addition, many respondents are paying between 205 $USD and 319 $USD annually for termite prevention. This is big business.

An understanding of termite, building material durability, and treated wood issues from the point-of-view of homeowners in locations most prone to termites, and the SFT in particular, can homeowners themselves to better understand the breadth of the issue and to provide potential solutions. In addition, a myriad of corporate sectors can benefit from this information. These include exterminators, termite prevention material manufacturers, and closer to home, treated wood chemical preservative manufacturers and treaters. In this article, and the subsequent Part II of the study that

examines the same issues from the perspective of U.S. home builders and architects in SFT infested areas, we provide unbiased and useful information that can be use in marketing, corporate strategic planning, and public policy decision making.

5 REFERENCES
5. LITERATURA

1. Lax, A.R.; Osbrink, W.L.A. 2003: United States Department of Agriculture – Agriculture Research Service research on targeted management of the Formosan subterranean termite *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae). Pest Manag Sci 59:788–800.
2. Potter, M.F. 1997: Termites. In: (D. Moreland, ed.) *Handbook of pest control*, 8th ed., GIE Publishing Co. Cleveland, OH. pp. 233–333.
3. Ring, D. 2005: Distribution of Formosan subterranean termites. Available online at: http://www.lsuagcenter.com/en/environment/insects/Termites/formosan_termites/Distribution+of +Formosan+Subterranean+Termites.htm. LSU AgCenter. Baton Rouge, La. Accessed August 11, 2008.
4. Shupe, T.F.; Dunn, M.A. 2000: The Formosan subterranean termite in Louisiana: implications for the forest products industry. Forest Prod. J. 50(5):10-18.
5. Sinclair, S.A.; Smith, P.M. 1990: Product awareness and physical risk perceptions of consumers of treated lumber. Wood Fiber Sci 22(1):80-91.
6. Su N-Y.; Scheffrahn, R.H. 2005: Formosan Subterranean Termite, *Coptotermes formosanus* Shiraki (Insecta: Isoptera: Rhinotermitidae). EENY-121. Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published: January 2000. Revised: March 2005.
7. Su, N.-Y.; Tamashiro, M. 1987: An overview of the Formosan subterranean termite in the world, pp. 3-15. In: M. Tamashiro and N.-Y. Su [eds.], Biology and control of the Formosan subterranean termite. College of Trop. Agr. Human Resources, Univ. of Hawaii, Honolulu, HI.
8. Vlosky, R.P.; Shupe, T.F. 2002: Homeowner attitudes and preferences for building materials with an emphasis on treated wood products. Forest Prod. J. 52(7/8): 90-95.
9. *** Louisiana Legislature, 1999: Senate Bill 373, Act 486. Available online at: http://www.legis.state.la.us/bills/byinst.asp?sessionid=99RS&billtype=Act&billno=486. Accessed July 12, 2009.
10. *** Protective Packaging, Ltd. 2007: Formosan termite information and research sites. Available online at: http://www.pplfieldliners.com/formosan_termite.htm. Accessed August 11, 2008.
11. *** Termite Institute, 2008: Types of Termites By Region. Available online at: www.termiteinstitute.com. Accessed August 21, 2008.
12. *** USDA ARS. 2009: Infestation map. Available online at: http://www.ars.usda.gov/is/br/fullstop/infestationmaps.htm
13. *** USDA Forest Service, 2001: Pest Risk Assessment of the Importation into the United States of Unprocessed Eucalyptus Logs and Chips from South America. Forest Products Laboratory General Technical Report FPL-GTR-124.

Corresponding address:

Professor RICHARD VLOSKY, Ph.D. FIWSc

Louisiana Forest Products Development Center
LSU AgCenter
Baton Rouge, Louisiana 70803 USA
e-mail: vlosky@lsu.edu

Kristina Bičanić, Denis Jelačić[1], Vanja Gašparić[2], Vesna Carev-Laškarin, Miljana Kocbek-Nižetić[3]

Identitet poduzeća u preradi drva i proizvodnji namještaja Republike Hrvatske

Corporate identity in wood processing and furniture manufacturing in the Republic of Croatia

Izvorni znanstveni rad · Original scientific paper
Prispjelo – received: 14. 5. 2009.
Prihvaćeno – accepted: 16. 7. 2009.
*UDK: 630*79*

SAŽETAK • *Identitet poduzeća mnogi su autori definirali na različite načine i njegove jedinstvene definicije nema, ali to su svakako povijest, okruženje, dosadašnji razvoj i prepoznatljivost poduzeća. U ovom radu istraživali smo poimanje identiteta poduzeća unutar poduzeća za preradu drva i proizvodnju namještaja u Republici Hrvatskoj. Istraživanje je provedeno uz pomoć anketnog upitnika, koji je sadržavao opće informacije o poduzeću i deset pitanja vezanih za poimanje identiteta poduzeća. Anketirano je 210 poduzeća za preradu drva i proizvodnju namještaja, od kojih je na anketu odgovorilo njih 43 (20,47 %), a u razmatranje je uzeto njih 35 (16,67 %). Dobiveni su podaci statistički analizirani i uspoređeni primjenom χ^2-testa. Rezultati pokazuju da se definiranje pojma identiteta poduzeća u preradi drva i proizvodnji namještaja u nas najčešće poistovjećuje s vizualnom prezentacijom poduzeća, njegovim imidžem te prepoznatljivošću i različitošću na tržištu. Istodobno, najveći broj ispitanika smatra da identitet poduzeća u najvećoj mjeri čine dizajn poduzeća, vanjska komunikacija poduzeća i njegova filozofija.*

Ključne riječi: *identitet poduzeća, prerada drva i proizvodnja namještaja, poimanje identiteta poduzeća*

ABSTRACT • *Corporate identity was defined differently by different authors and its unique definition was not established, but it is most certainly the soul of each enterprise that is based on history, environment, previous development and recognition on the market. This paper deals with the perception of corporate identity in wood processing and furniture manufacturing companies in the Republic of Croatia. Research was conducted as a survey using questionnaires containing general information about the enterprise and 10 questions regarding the perception of corporate identity. 210 enterprises for wood processing and furniture manufacturing were surveyed and 43 (20.47 %) of them answered to all the questions, of which 35 (16.67 %) were taken into consideration. The given data were analyzed statistically using χ^2-test. The results showed that corporate identity in Croatian wood processing and furniture manufacturing companies was mostly defined by and identified with the company's visual presentation, image and recognizability and differentiation in the market. At the same time, most surveyees thought that corporate identity is mostly made of the company's design, company's external communication and its philosophy.*

Keywords: *corporate identity, wood processing and furniture manufacturing, perception of corporate identity*

[1] Autori su asistentica i izvanredni profesor na Šumarskom fakultetu Sveučilišta u Zagrebu, Hrvatska. [2]Autorica je studentica doktorskog studija i zaposlena je u Ministarstvu regionalnog razvoja, šumarstva i vodnoga gospodarstva, Zagreb, Hrvatska. [3]Autorice su zaposlene u Agenciji za podršku informacijskim sustavima i informacijskim tehnologijama (APIS IT, d.o.o.), Zagreb, Hrvatska.

[1] The authors are assistant and associate professor at the Faculty of Forestry, University of Zagreb, Croatia. [2]Author is PhD student and employed in Ministry of Regional Development, Forestry and Water Management, Zagreb, Croatia. [3]The authors are employed with the Agency for Information Systems and IT Support (APIS IT, d.o.o.), Zagreb, Croatia.

1. UVOD
1 INTRODUCTION

Identitet poduzeća jest područje kojim se menadžment koristi pri donošenju odluka o strategiji nastupa na tržištu. Riječ je o strategiji nekonfliktne usporedbe s konkurencijom, usporedbe pojedinih značajki poduzeća i njihovoj dvosmjernoj komunikaciji prema okruženju. To je strategija na kojoj se gradi imidž i reputacija poduzeća na tržištu. Na temelju te strategije planira se buduća konkurentska pozicija i prevlast na tržištu.

Identitet daje poduzeću značajke koje je katkad teško vrednovati jer su kvalitativne prirode, no postavljene su na realnim osnovama i uz pomoć njih poduzeće se izdvaja od konkurencije na tržištu i dobiva jednoznačni i prepoznatljiv karakter. Identitet poduzeća može se promatrati s tri gledišta (Matova 2005).

S gledišta dizajna riječ je o poistovjećivanju poduzeća s njegovim logom, vizualnim identitetom, strukturom i imenom. Dizajn poduzeća i njegova grafička prezentacija razlikuju poduzeće od konkurenata na tržištu te kupcima i korisnicima usluga daju mogućnost da brzo i jednostavno prepoznaju poduzeće.

Stručnjaci za grafički dizajn i marketinšku komunikaciju stvaraju kompleksan način komunikacije koji mora biti konzistentan i trajan, te time uspostavljaju komunikaciju poduzeća, tj. način dvosmjernog komuniciranja s okruženjem, odnosno komunikaciju prema van, za partnere i konkurente, te komunikaciju prema unutra, za uposlenike u poduzeću.

Identitet poduzeća s treće razine gledišta promatra se kao interdisciplinarni pojam koji obuhvaća kompleksnu kombinaciju aktivnosti komunikacije i vizualizacije usmjerenu i prema van i prema unutra (van Riel, Balmer, 1997).

2. PROBLEMATIKA I CILJ ISTRAŽIVANJA
2 PROBLEM AND AIM OF RESEARCH

Postoji mnogo definicija identiteta poduzeća. Prema jednoj od njih identitet poduzeća je strateški planirano predstavljanje poduzeća utemeljeno na filozofiji poduzeća, njegovoj viziji i dugoročnim ciljevima koji moraju biti potvrđeni unutarnjom i vanjskom komunikacijom (Horakova i dr., 2000). Prema drugoj identitet poduzeća je misao, duša i glas poduzeća (Balmer, Soenen, 1998; Balmer, 2001). Treća definicija kazuje da su identitet poduzeća simboli kojima se poduzeće koristi kako bi se samoidentificiralo među potrošačima (Baker, Balmer, 1994), dok je prema Bedrnovoj i Novom (2002) identitet poduzeća strateški koncept unutarnje strukture, funkcioniranja i vanjske prezentacije konkretnog poduzeća na tržištu.

Identitet poduzeća može biti monolitni, što znači da se poduzeće koristi istim identitetom na svim svojim područjima djelovanja. To može biti prodaja proizvoda različitog spektra pod istim imenom i znakom. Prednost takvog identiteta jest da uspjeh jednog proizvoda ili područja djelovanja može povući za sobom poistovjećivanje i drugih proizvoda s tim uspjehom, a istom komunikacijom poduzeće se obraća svim partnerima. Identitet znaka (unikatni identitet) dijametralno je suprotan monolitnome, što znači da se svako područje djelovanja svojim identitetom izdvaja od drugih subjekata iste korporacije. Time je svaki proizvod ili područje djelovanja zaslužno za svoj uspjeh, ali njegov neuspjeh neće utjecati na druga područja djelovanja ili proizvode. Treći je sustav diversifikacijski identitet, koji je kombinacija monolitnoga i unikatnog identiteta. Iako djeluje pod istim znakom korporacije, i s istim grafičkim dizajnom, svaka djelatnost ima svoj pristup i svoju komunikaciju s okruženjem (van Riel, 1995).

Cilj ovog istraživanja bio je utvrditi postoji li u poduzećima sustavan način rada na izradi prepoznatljivog identiteta, kakvo je razmišljanje vezano za identitet poduzeća kao jednu od strateških aktivnosti za poboljšanje pozicije na tržištu, kako uposlenici u pojedinim poduzećima definiraju identitet poduzeća i što ga čini te vide li kvalitetan i prepoznatljiv identitet među konkurentima u preradi drva i proizvodnji namještaja.

3. METODA ISTRAŽIVANJA
3 RESEARCH METHOD

Kako bi se postigli ciljevi istraživanja izabrana je metoda anketiranja. Osmišljen je anketni upitnik (Matova, 2008) kojim su se trebali dobiti odgovari na pitanja vezana za identitet poduzeća i njegovo poimanje u preradi drva i proizvodnji namještaja Republike Hrvatske. Anketirano je 210 poduzeća od kojih je na anketu odgovorilo njih 43 (20,47 %), a u razmatranje je uzeto 35 upitnika (16,67 %) zato što preostalima primarna djelatnost nije u području prerade drva i proizvodnje namještaja.

Nakon anketiranja dobiveni su podaci statistički obrađeni u programima Excell i Statistika, a značajnost razlika u odgovorima na pojedina pitanja utvrđena je uz pomoć χ^2-testa. Jednadžba za izračun vrijednosti χ^2 glasila je:

$$\chi^2 = \sum_{i=1}^{R}\sum_{j=1}^{C}\frac{(n_{ij} - E_{ij})^2}{E_{ij}}$$

pri čemu su:
R – broj redova
C – broj stupaca
n_{ij} – vrijednost u i-tom redu i j-tom stupcu
E_{ij} – očekivana vrijednost u i-tom redu i j-tom stupcu.

Očekivana vrijednost E_{ij} izračunavana je prema izrazu:

$$E_{ij} = \frac{n_i n_j}{n}$$

pri čemu su:
n_i – zbroj vrijednosti u i-tom redu
n_j – zbroj vrijednosti u j-tom stupcu.

Hipoteza H_0 glasila je da ne postoji značajna razlika na postavljena pitanja među kojima postoji veza, a negativan odgovor na postavljenu hipotezu bio je onaj za koji je koeficijent statističke ovisnosti bio $p<0,05$.

Upitnik o identitetu poduzeća (Corporate identity)

Opće informacije o poduzeću

Naziv poduzeća:
Pravni oblik poduzeća:
Klasifikacija djelatnosti poduzeća:
Broj uposlenika:
Slogan poduzeća (ako ga poduzeće ima, molim, upišite ga):
Sjedište:

Na pitanja odgovorite na osnovi prakse u vašem poduzeću. Ako na pitanje 1 odgovorite s „ne“, tada na pitanja 4 do 10 odgovarajte u skladu s vašim mišljenjem o tom problemu, onako kako vi to shvaćate.

1. **Ima li vaše poduzeće „identitet poduzeća“ (Corporate Identity)?**
   (Ako odgovorite s „ne“, prijeđite na pitanja 4 do 10)
   ☐ da ☐ da, samo neke dijelove ☐ ne ☐ ne znam

2. **Ima li vaše poduzeće izrađen manual identiteta poduzeća u tiskanomu ili elektroničkom obliku?**
   ☐ da ☐ ne ☐ ne znam ☐ drugo (molimo navesti)

3. **Držite li se u potpunosti manuala identiteta poduzeća u vašem poduzeću?**
   ☐ da ☐ ne ☐ ne znam ☐ samo nekih dijelova

4. **Kako biste svojim riječima definirali „identitet poduzeća“?**
   Identitet poduzeća definiramo kao (možete navesti i više mogućnosti):
   ☐ vizualnu prezentaciju poduzeća (logo, boje poduzeća, tipizirani memorandumi poduzeća, cjeloviti dizajn dokumenata poduzeća navedenih u manualu dizajna poduzeća)
   ☐ imidž poduzeća
   ☐ interaktivnu sliku (unutarnju i vanjsku) o poduzeću
   ☐ lojalnost uposlenika, njihovu odanost – angažiranost u poduzeću
   ☐ karakterističnu sliku, raspoznavanje, različitost poduzeća na tržištu
   ☐ odnose poduzeća s javnošću
   ☐ postojanje kulture, vrijednosti, filozofije/strategije, vizije, misije poduzeća
   ☐ reputaciju poduzeća
   ☐ zbroj karakteristika izdvojenih iz osobnosti poduzeća
   ☐ reklamnu kampanju poduzeća
   ☐ postojanje ekološkog i socijalnog aspekta u poduzeću
   ☐ kvalitetnu (kreativnu i korektnu) komunikaciju
   ☐ drugo (molimo navesti):

5. **Što po vašemu mišljenju čini identitet poduzeća (možete navesti i više mogućnosti)?**
   ☐ dizajn poduzeća (ime, logo/simbol, slogan, memorandumi, boje, web stranica, raspon proizvoda, uniforme poduzeća/odjevne i druge)
   ☐ interna komunikacija (komunikacija s menadžmentom i među uposlenicima)
   ☐ vanjska komunikacija (marektinška komunikacija – komunikacija poduzeća prema javnosti, prema kupcima, prema dobavljačima i sl.)
   ☐ neizravna komunikacija (kad o vašem poduzeću govore drugi, primjerice mediji)
   ☐ vrijednosti koje poduzeće objavljuje i do kojih drži
   ☐ misija poduzeća (što nudimo, kakvi smo i sl.)
   ☐ vizija poduzeća (kamo stremimo, što želimo postići i sl.)
   ☐ filozofija poduzeća (osnovne ideje, tko smo, što želimo postići i kako, koje vrijednosti i norme poštujemo i primjenjujemo u našem radu, u kojem prostoru djelujemo, u kakvom okruženju, s kakvom realizacijom, menadžerski ciljevi)
   ☐ suradnja s menadžementom
   ☐ suradnja s uposlenicima (u poduzeću ili s kupcima i dobavljačima i sl.)
   ☐ organizacijska struktura poduzeća
   ☐ struktura proizvoda i programa
   ☐ strategija poduzeća
   ☐ marketinška strategija
   ☐ poštovanje etičkih normi u poduzeću
   ☐ ciljevi poduzeća
   ☐ identitet djelatnosti poduzeća (u smislu utjecaja na identitet poduzeća)
   ☐ povijest poduzeća, osnivač poduzeća, zemlja osnivanja poduzeća (vezano uz identitet poduzeća)
   ☐ identitet nije ničim uvjetovan
   ☐ drugo (molimo navesti):

6. Mislite li da se identitetom poduzeća može upravljati?

☐ da ☐ ne ☐ ne znam

Ako se identitetom poduzeća može upravljati, tko upravlja tom aktivnošću mMožete označiti više mogućnosti)?

☐ vlasnik
☐ viši menadžment
☐ srednji menadžment
☐ niži menadžment
☐ odjel marketinga
☐ uposlenici
☐ drugi (molimo navesti)

7. Koje su glavne prednosti (dobit) identiteta poduzeća za poduzeće (po vašemu mišljenju)?

☐ jednoznačnost vizualnog identiteta poduzeća (jasno korištenje i zaštita upotrebe loga, boja i sl.)
☐ potpora odnosima s javnošću
☐ tvorba imidža i reputacije poduzeća
☐ motivacija uposlenika i njihova identifikacija s poduzećem, zadovoljstvo uposlenika
☐ veći financijski učinak poduzeća
☐ utjecaj na vrijednosti, kulturu, misiju i cilj poduzeća
☐ potpora znaku proizvoda
☐ prepoznatljivost na tržištu (laka identifikacija među konkurencijom)
☐ potpora poziciji na tržištu (u usporedbi s konkurecijom)
☐ potpora odnosima s kupcima
☐ potpora reklami i marketinškoj komunikaciji
☐ privlačenje budućih uposlenika u poduzeće
☐ nema prednosti (dobiti)
☐ drugo (molimo navesti)

8. Prema kome je, po vašemu mišljenju, identitet poduzeća usmjeren (na koga osobito)?

☐ uposlenicima
☐ kupcima
☐ vlasnicima, dioničarima, financijskim institucijama
☐ menadžmentu poduzeća
☐ konkurenciji
☐ trećim skupinama (nevladinim organizacijama, javnim institucijama i sl.)
☐ drugima (molimo navesti)
☐ medijima
☐ širokoj javnosti
☐ stručnoj javnosti
☐ lokalnoj javnosti
☐ vladi, državi
☐ nikome

9. Shvaćate li identitet poduzeća kao dugoročni strateški koncept?

☐ da ☐ ne ☐ ne znam
☐ drugo (molimo navesti)

10. Za koje poduzeće (domaće ili strano) među drvoprerađivačkim poduzećima možete reći da ima profiliran i jak identitet?

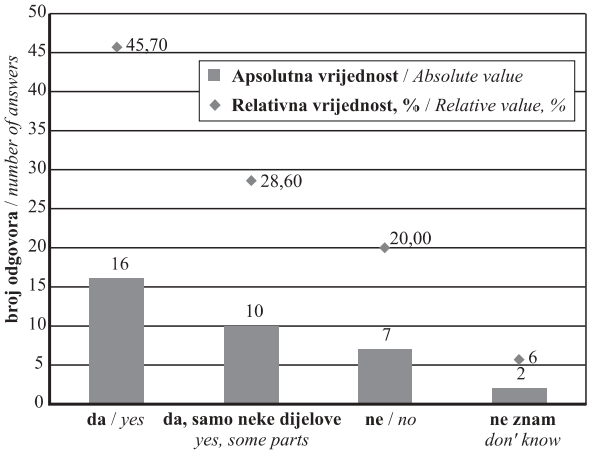
Molimo, navedite ime tog poduzeća / tih poduzeća.

a) .....
b) .....
c) .....

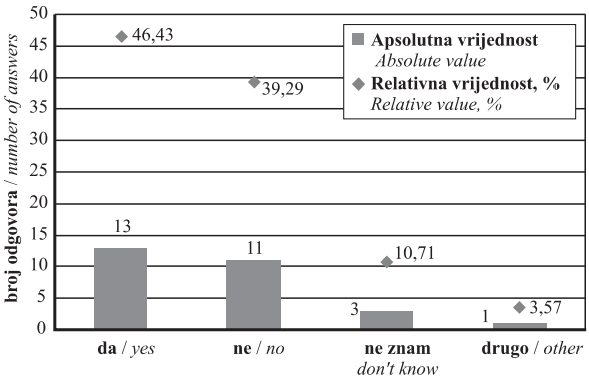
4. REZULTATI I DISKUSIJA
4 RESULTS AND DISCUSSION

Prema općim podacima o poduzećima dobivenih anketom, utvrđeno je da je na anketni upitnik odgovorilo deset mikropoduzeća (1-10 uposlenika) ili 28,57 %, 11 malih (11-50 uposlenika) ili 31,43 %, 8 srednjih (51-250 uposlenika) ili 22,86 % i 6 velikih poduzeća (više od 250 uposlenika) ili 17,14 %. Tri od njih bila su dionička društva, a ostalo su bila društva s ograničenom odgovornošću. Samo je pet poduzeća navelo slogan s kojim se pojavljuju ili su prepoznatljivi na tržištu.

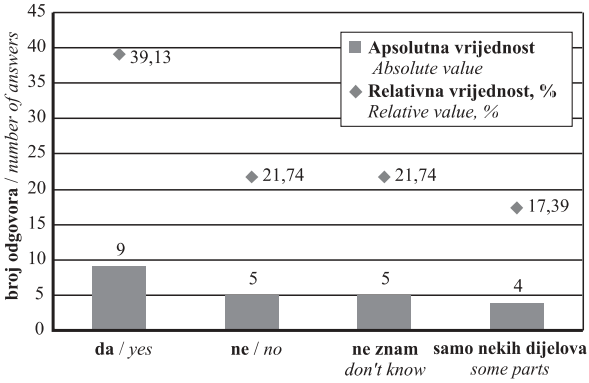
Odgovori na pitanje 1 - Ima li vaše poduzeće svoj identitet? prikazani su na slici 1. Potvrdno su odgovorili ispitanici iz 16 poduzeća, 10 ih smatra da identitet ima samo djelomično, 7 poduzeća nema identitet, a 2 su ispitanika odgovorila da ne znaju.



Slika 1. Ima li vaše poduzeće „idenitet poduzeća"
Figure 1 Does your company have „Corporate Identity"



Slika 2. Ima li vaše poduzeće manual ideniteta poduzeća
Figure 2 Does your company have Corporate Identity Manual



Slika 3. Držite li se manuala ideniteta u poduzeću
Figure 3 Does your company use Corporate Identity Manual

Odgovori na pitanje 2 - Ima li vaše poduzeće izrađen manual identiteta poduzeća? prikazani su na slici 2. Potvrdno je odgovoreno u 13 poduzeća ili 46,43 %, negativno u 11 poduzeća ili 39,29 %, „ne znam" su odgovorila 3 ispitanika, a jedan je odgovorio da u poduzeću imaju nešto drugo umjesto manuala identiteta.

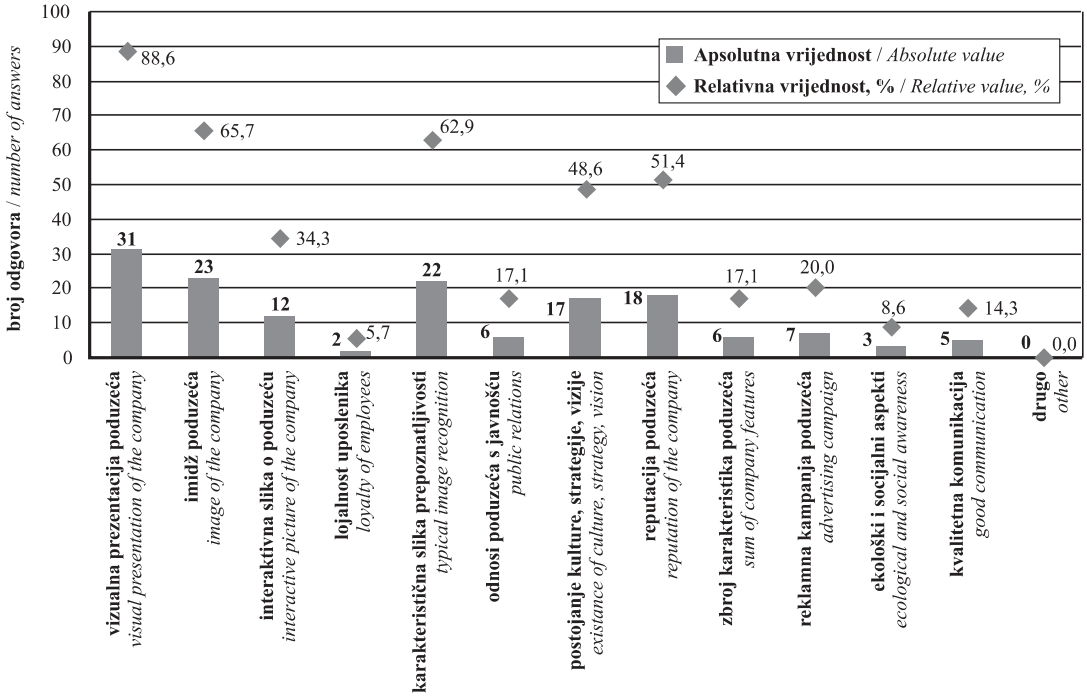
Na pitanje Držite li se manuala identiteta u vašem poduzeću? devet je ispitanika odgovorilio potvrdno, pet je odgovorilo negativno, pet je odgovorilo da ne zna, a četiri ispitanika odgovorila su da se manuala drže samo djelomično.

Na četvrto pitanje - Kako biste svojim riječima definirali identitet poduzeća? najviše je ispitanika pojam identiteta poduzeća izjednačilo s vizualnom prezentacijom (88,60 %), zatim s imidžem poduzeća (65,70 %) te karakterističnom slikom o poduzeću, odnosno prepoznatljivošću na tržištu (22 ispitanika ili 62,90 %). Najmanje ispitanika smatra da se pojam identitet poduzeća može opisati pojmom lojalnosti uposlenika (dva ispitanika), odnosno ekološkim i socijalnim aspektom (tri ispitanika).

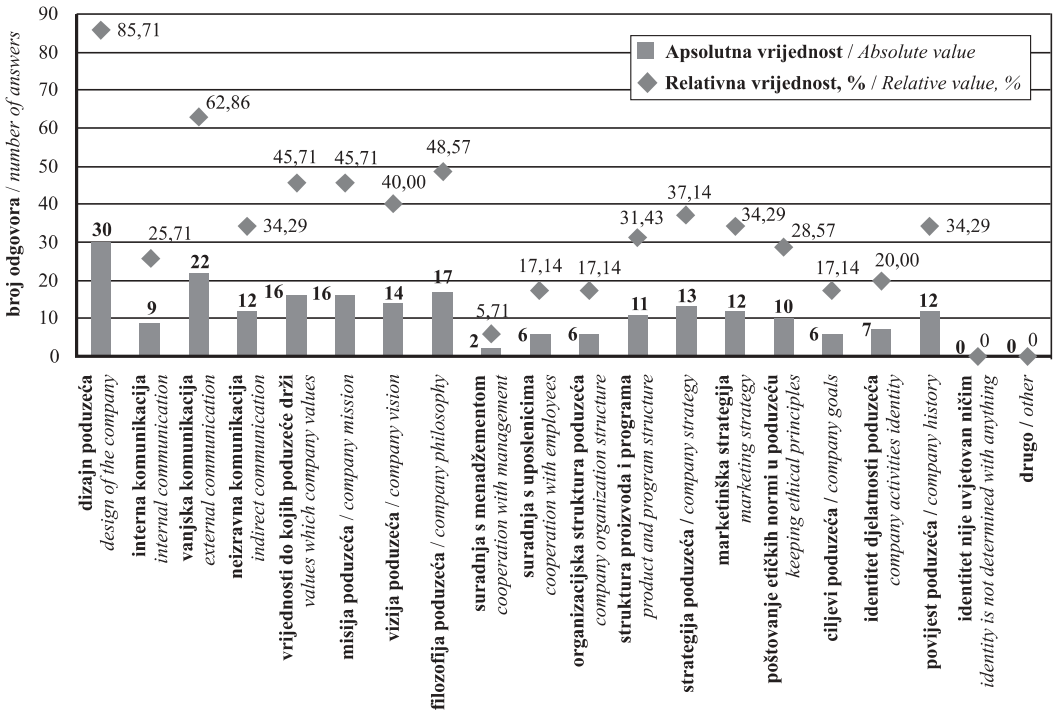
Kao odgovor na peto pitanje ispitanici su u 85,71 % slučajeva izjavili da dizajn poduzeća čini identitet poduzeća. Dvadesetdva ispitanika ili njih 62,86 % smatra da identitet poduzeća umnogome ovisi o komunikaciji s okruženjem (vanjskoj komunikaciji). Podjednak broj ispitanika misli da filozofija poduzeća (njih 17), misija poduzeća (njih 16) i vrijednosti do kojih poduzeće drži (16 ispitanika) čine identitet poduzeća. Najmanji broj ispitanika, samo dva, misli da suradnja s menadžmentom čini identitet poduzeća. Rezultati su grafički prikazani na slici 5.

Na inicijalni dio 6. pitanja - Mislite li da se identitetom poduzeća može upravljati?, svi su anketirani odgovorili potvrdno. Na potpitanje Tko bi trebao upravljati identitetom poduzeća? odgovori su bili različiti, no većina ispitanika smatra da bi to trebali biti vlasnik ili viši menadžment.

Na 7. pitanje - Koje su glavne prednosti identiteta poduzeća? anketirani su odgovarali vrlo različito. Međutim, većina se složila da su to prepoznatljivost na tržištu (88,57 % ispitanika) i izgradnja imidža i reputa-



Slika 4. Kako biste opisali pojam identiteta poduzeća
Figure 4 How would you describe the term *corporate identity*



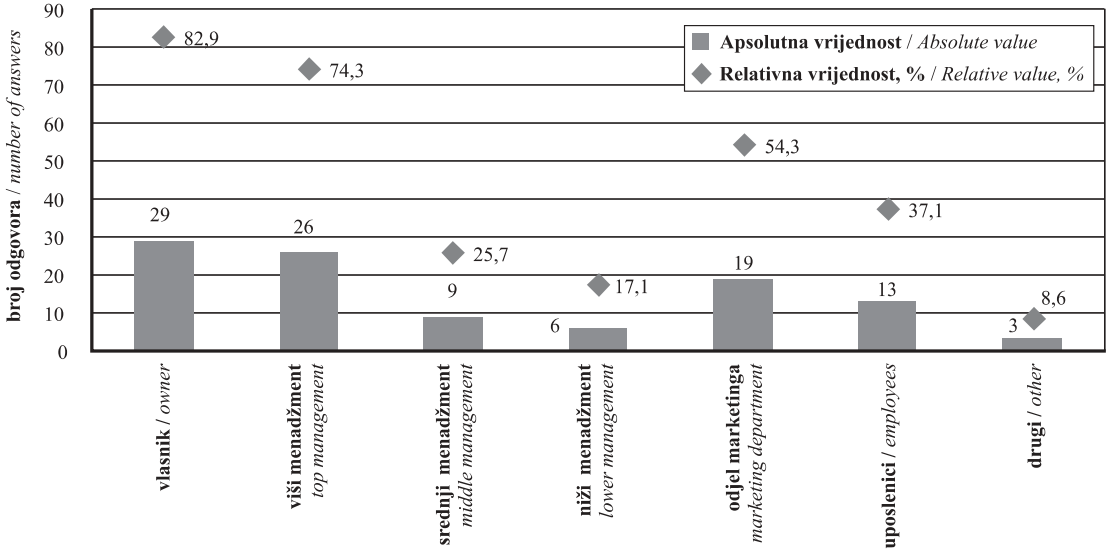
Slika 5. Što čini identitet poduzeća
Figure 5 What does *corporate identity* consist of

cije (82,86 %). Među značajnije prednosti mogu se svrstati još i potpora poziciji na tržištu (65,71 %) te jednoznačnost vizualnog identiteta (60,00 %).

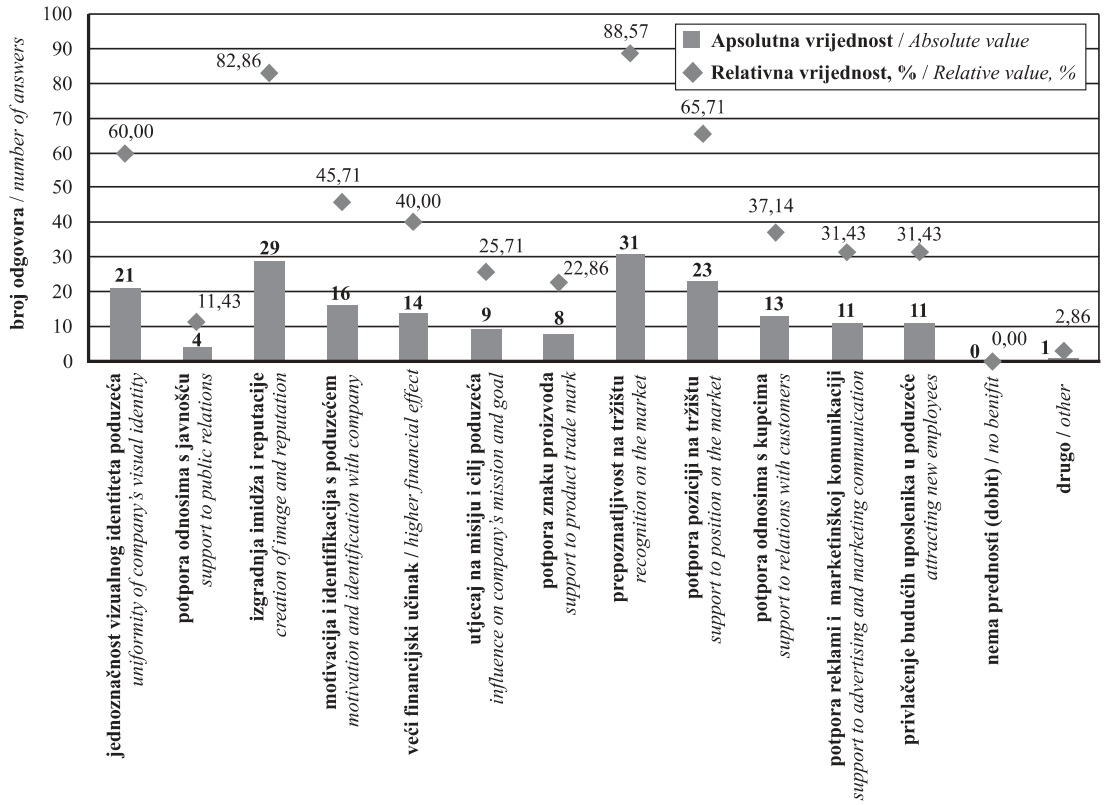
Usporede li se odgovori na 4. pitanje (Kako biste opisali identitet poduzeća?) i na 7. pitanje (Koje su glavne prednosti poduzeća s identitetom?), odnosno odgovori da se identitet poduzeća definira kao imidž i odgovori da je najveća prednost poduzeća s identitetom stvaranje imidža i reputacije, primjenom χ^2-testa ustanovljeno je da nema značajne razlike između ta dva odgovora. Iz tablice 1 vidljivo je da 57,14 % ispitanika koji identitet poduzeća definiraju imidžem, smatra da su stvaranje imidža i reputacije dobit za poduzeće. Samo 8,57 % poduzeća nisu opisali identitet imidžem i ujedno smatraju da imidž nije zaslužan za rezultat na tržištu. Test je pokazao da nema značajne razlike između tih dvaju odgovora, pa možemo zaključiti da identitet poduzeća definiran kao imidž znatno utječe na odgovor da je jedna od glavnih prednosti poduzeća stvaranje imidža i reputacije. Rezultati testa prikazani su u tablici 1.

Na pitanje 8 – Prema kome je identitet poduzeća usmjeren? svi su anketirani izjavili da je usmjeren prema kupcima, a 51,43 % ispitanika smatra da je osobito usmjeren prema široj javnosti.

Uspoređivali smo odgovore anketiranih na pitanja 7. i 8. te smo došli do zaključka da među njima postoji značajna razlika. Naime, na pitanje 7. 31,43 % ispitanika odgovorilo je da je potpora reklami i marketinškoj komunikaciji jedna od dobiti identiteta poduzeća. Istodobno, 29 % njih na pitanje 8. odgovorilo je da je identitet poduzeća usmjeren prema medijima.



Slika 6. Tko bi trebao upravljati identitetom poduzeća
Figure 6 Who should manage corporate identity



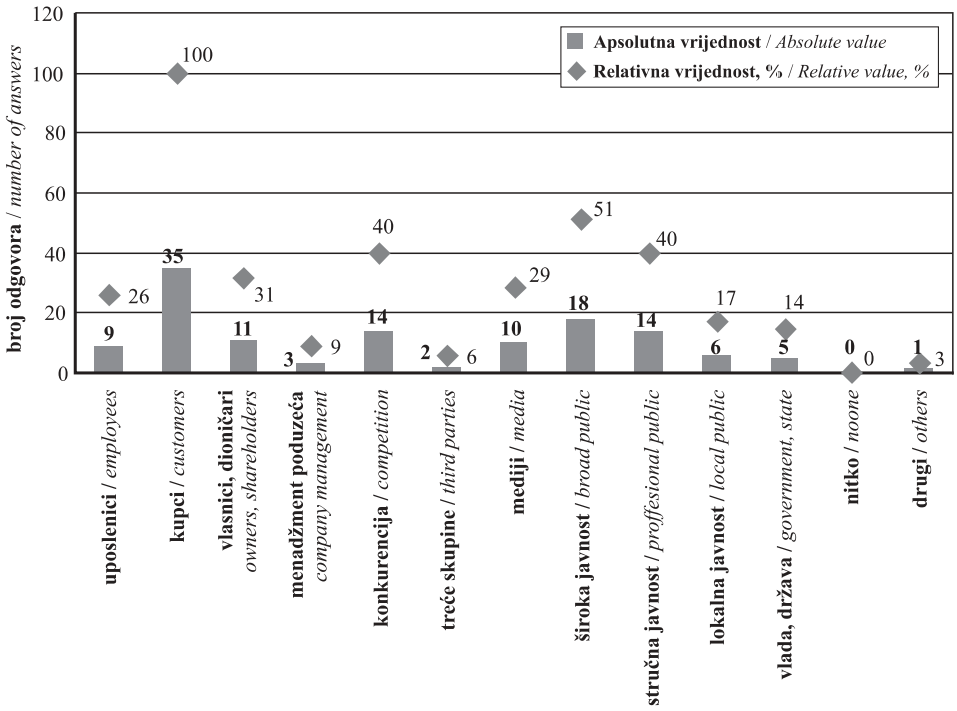
Slika 7. Koje su glavne prednosti poduzeća s identitetom
Figure 7 What are the main benifits for companies with corporate identity

Samo je 20 % onih koji su na te dijelove i u pitanju 7. i u pitanju 8. odgovorili potvrdno, tj. koji smatraju da je potpora reklami i marketinškoj komunikaciji jedna od dobiti identiteta poduzeća, te da je identitet usmjeren prema medijima. Velik dio ispitanika, njih 60 %, na te je dijelove pitanja 7. i 8. odgovorilo negativno. Usporednim testom došli smo do zaključka da postoji značajna razlika između ta dva odgovora (tabl. 2).

Također je utvrđeno da postoji značajna razlika u odgovorima na pitanja 7. i 8. vezano za uposlenike poduzeća. Naime, u odgovorima na pitanje 7. 45,71 % ispitanika smatra da je jedna od prednosti koje identitet poduzeća pruža motivacija uposlenika i njihova identifikacija s poduzećem, odnosno zadovoljstvo uposlenika. Na pitanje 8. (prema kome je usmjeren identitet poduzeća), samo je 26 % ispitanika smatralo da je identitet poduzeća usmjeren prema uposlenicima. Motivacija uposlenika, predanost radu i njihovo zadovoljstvo rezultira zadovoljenjem potreba potrošača. Nažalost, samo je 20 % ispitanika shvatilo da identitet treba biti usmjeren prema uposlenicima, te da se zadovoljenjem njihovih potreba otvara mogućnost postizanja pozitiv-

Tablica 1. Usporedni test odgovora na pitanje 4 i pitanje 7
Table 1 Comparison test for answers to question 4 and question 7

Imidž (4) *Image (4)*	**Izgradnja imidža i reputacije (7)** *Creation of image and reputation (7)*		**Zbroj reda** *Sum in a row*
	ne / *no*	da / *yes*	
apsolutna frekvencija odgovora "ne" / *Absolute frequency "no"*	3	9	12
relativna frekvencija po stupcu / *Relative frequency by column*	50,00 %	31,03 %	
relativna frekvencija po retku / *Relative frequency by row*	25,00 %	75,00 %	
ukupna relativna frekvencija / *Total relative frequency*	8,57 %	25,71 %	34,29 %
apsolutna frekvencija odgovora "da" / *Absolute frequency "yes"*	3	20	23
relativna frekvencija po stupcu / *Relative frequency by column*	50,00 %	68,97 %	
relativna frekvencija po retku / *Relative frequency by row*	13,04 %	86,96 %	
ukupna relativna frekvencija / *Total relative frequency*	8,57 %	57,14 %	65,71 %
ukupna apsolutna frekvencija / *Total absolute frequency*	6	29	35
ukupna relativna frekvencija / *Total relative frequency*	17,14 %	82,86 %	100,00 %
$\chi^2 = 0{,}7237$, $p = 0{,}3730$, $df = 1$			



Slika 8. Prema kome je usmjeren identitet poduzeća
Figure 8 To whom is corporate identity directed

nih rezultata na tržištu. Rezultati usporednog χ^2-testa prikazani su u tablici 3.

Na pitanje 9 (smatrate li identitet poduzeća dugoročnim strateškim konceptom) od 35 ispitanika uključenih u razmatranje njih 34 odgovorilo je potvrdno, a samo je jedan ispitanik izjavio da identitet poduzeća ne smatra dugoročnim strateškim konceptom.

Ispitanici su na 10. pitanje odgovarali tako da su samostalno upisivali one tvrtke u preradi drva i proizvodnji namještaja za koje smatraju da imaju profiliran i jak identitet. Među 35 anketnih upitnika u njih šest nije bilo nikakva odgovora, a u odgovorima ostalih 29 ispitanika našlo se 27 poduzeća za preradu drva i proizvodnju namještaja, odnosno trgovačkih kuća. Od tih 27 poduzeća 15 je domaćih, a 12 inozemnih. Najčešće su se spominjala imena Tvina i Ikee (po osam puta), te Finvesta, Spačve i Mebla (po tri puta).

5. ZAKLJUČAK
5 CONCLUSION

Identitet poduzeća je instrument koji je na međunarodnom tržištu uobičajen. Sve jača konkurencija i oštrija bitka za svakog kupca ili korisnika usluga dovodi poslovanje na višu razinu i tjera poduzeća da se svojim identitetom služe sve češće i na sve više razina.

Problem je u tome što hrvatske tvrtke za preradu drva i proizvodnju namještaja, kao uostalom i mnoge

Tablica 2. Usporedni test odgovora na pitanje 7. i 8.
Table 2 Comparison test for answers to question 7 and question 8

Potpora reklami i marketinškoj komunikaciji (7) *support to advertising and marketing communication (7)*	**Mediji (8)** *media (8)*		**Zbroj reda** *sum in a row*
	ne / *no*	da / *yes*	
apsolutna frekvencija odgovora "ne" / *Absolute frequency "no"*	21	3	24
relativna frekvencija po stupcu / *Relative frequency by column*	84,00 %	30,00 %	
relativna frekvencija po retku / *Relative frequency by row*	87,50 %	12,50 %	
ukupna relativna frekvencija / *Total relative frequency*	60,00 %	8,57 %	68,57 %
apsolutna frekvencija odgovora "da" / *Absolute frequency "yes"*	4	7	11
relativna frekvencija po stupcu / *Relative frequency by column*	16,00 %	70,00 %	
relativna frekvencija po retku / *Relative frequency by row*	36,36 %	63,64 %	
ukupna relativna frekvencija / *Total relative frequency*	11,43 %	20,00 %	31,43 %
ukupna apsolutna frekvencija / *Total absolute frequeny*	25	10	35
ukupna relativna frekvencija / *Total relative frequency*	71,43 %	28,57 %	100,00 %
$\chi^2 = 9{,}6648$, $p = 0{,}0019$, $df = 1$			

Tablica 3. Usporedni test odgovora na pitanje 7 i pitanje 8
Table 3 Comparison test for answers to question 7 and question 8

Motivacija uposlenika i njihova identifikacija s poduzećem (7) *motivation of employees and their identification with company (7)*	**Uposlenici (8)** *employees (8)*		**Zbroj reda** *sum in a row*
	ne / *no*	da / *yes*	
apsolutna frekvencija odgovora "ne" / *Absolute frequency "no"*	18	1	19
relativna frekvencija po stupcu / *Relative frequency by column*	69,23 %	11,11%	
relativna frekvencija po retku / *Relative frequency by row*	94,74 %	5,26 %	
ukupna relativna frekvencija / *Total relative frequency*	51,43 %	2,86 %	54,29 %
apsolutna frekvencija odgovora "da" / *Absolute frequency "yes"*	8	8	16
relativna frekvencija po stupcu / *Relative frequency by column*	30,77 %	88,89 %	
relativna frekvencija po retku / *Relative frequency by row*	50,00 %	50,00 %	
ukupna relativna frekvencija / *Total relative frequency*	22,86 %	22,86 %	45,71%
ukupna apsolutna frekvencija / *Total absolute frequeny*	26	9	35
ukupna relativna frekvencija / *Total relative frequency*	74,29 %	25,71 %	100,00 %
$\chi^2 = 9{,}1003$, $p = 0{,}0026$, $df = 1$			

druge, pogrešno razumijevaju identitet poduzeća i stavljaju naglasak isključivo na vizaulizaciju i marketinšku komunikaciju, što je vidljivo iz rezultata istraživanja. Najviše je ispitanika pojam identiteta poduzeća izjednačilo s vizualnom prezentacijom (88,60 %), zatim sa imidžem poduzeća (65,70 %) i karakterističnom slikom o poduzeću, odnosno prepoznatljivošću na tržištu (62,90 %). Ispitanici su u 85,71 % odgovora naveli da dizajn poduzeća čini njegov identitet, dok njih 62,86 % smatra da identitet poduzeća umnogome ovisi o vanjskoj komunikaciji. Prema rezultatima istraživanja glavne su prednosti poduzeća prepoznatljivost na tržištu (88,57 % ispitanika) i izgradnja imidža i reputacije (82,86 %), a svih 100 % anketiranih smatra da je idenititet poduzeća usmjeren prema kupcima, dok 51,43 % ispitanika smatra da je osobito usmjeren prema široj javnosti. Ako tvrtke ne shvate identitet poduzeća kao multikomponentni koncept, neće se moći nositi se s konkurentima na međunarodnom tržištu.

Izgradnja identiteta poduzeća dugotrajan je proces koji ima pravila, zahtijeva donošenje pravodobnih i kvalitetnih odluka te uključivanje menadžmenta u proces u cjelini. Pravi rezultati mogu se vidjeti tek nakon tri do pet godina, a neke prednosti nije moguće kvantitativno ocjeniti jer su velikim dijelom emotivne prirode.

Kupci i korisnici usluga sve više pozornosti pridaju tradicionalnom ponašanju poduzeća i svoje odluke donose na temelju simpatija. Povjerenje, iskustvo, simpatije i kompetencije karakteristike su koje poduzeće stječe, a identitet poduzeća predstavlja ih interno i eksterno.

6. LITERATURA
6 REFERENCES

1. Baker, M.J.; Balmer, J.M.T. 1994: Visual identity: trappings or substance? European Journal of Marketing, 31 (5-6): 366-372.
2. Balmer, J.M.T. 2001: Corporate identity, corporate branding and corporate marketing, Seeing through the fog. European Journal of Marketing, 35 (3/4): 248-291.
3. Balmer, J.M.T.; Soenen, G.B. 1998: A new approach to corporate identity management. In Interational centre for corporate identity studies: Working paper, 1998/5.
4. Bedrnová, E.; Nový, I. et al. 2002: Psychologie a sociologie řízení. 2, prošireno izdanje. Management Press, Praha.
5. Horáková, I.; Stejskalová, D.; Škapová, M. 2000: Strategie firemní komunikace. 1. izdanje, Management Press, Praha.
6. Maťová, H. 2008: Tvorba podnikovej identity ako súčasť marketingovej stratégie podniku v podmienkach DSP, disertacija, Tehničko sveučilište Zvolen, Zvolen.
7. Maťová, H. 2005: Audit podnikovej identity. In Marketing a obchod 2005: Modelovanie využitia zdrojov a uplatnenia produktov na trhoch EÚ: Zbornik međunarodnog znanstvenog savjetovanja, Zvolen, Bratia Sabovci, 194-198.
8. Maťová, H. 2005: Vzájomný vzťah podnikovej identity a podnikového dizajnu. In Globalizácia a jej sociálno-ekonomické dôsledky ´05: Zbornik međunarodnog znanstvenog savjetovanja, II. dio, Rajecké Teplice, Žilina: EDIS, 51-55.
9. Van Riel C.M.B.; Balmer J.M.T. 1997: Corporate Identity: the concept, its measurement and management. European Journal of Marketing, 31 (5/6): 340-355.
10. Van Riel, C.M.B. 1995: Principles of Corporate Communications. Prentice Hall, London.

Corresponding address:

Associate Professor DENIS JELAČIĆ, PhD

Department for Production Organization
Faculty of Forestry
University of Zagreb
Svetošimunska 25
HR-10000 Zagreb
Croatia
e-mail: jelacic@sumfak.hr

HRVATSKO ŠUMARSKO DRUŠTVO

- Hrvatsko šumarsko društvo ima izvor u Hrvatsko-slavonskom gospodarskom društvu, koje je na inicijativu šumara osnovano u Zagrebu 1841. godine.
- Početak rada Hrvatskoga šumarskoga društva 1946. godine.
- Izdavač znanstveno-stručnoga glasila "Šumarski list" od 1877. godine
- 1996. godine osnivanje Akademije šumarskih znanosti

HRVATSKO ŠUMARSKO DRUŠTVO

168 godine djelovanja

3000 članova

ŠUMARSKI LIST

133 godine neprekidnog izlaženja

IMENIK HRVATSKIH ŠUMARA

13966 osoba

www.sumari.hr

Tibor Alpár, István Rácz[1]

Production of cement-bonded particleboards from poplar (*Populus euramericana* cv. „I 214“)

Proizvodnja drvno-cementnih ploča od topolovine (*Populus euramericana* cv. „I 214“)

Original scientific paper · Izvorni znanstveni rad
Received – prispjelo: 1. 4. 2009.
Accepted – prihvaćeno: 16. 7. 2009.
*UDK: 630*863; 674.816.2*

ABSTRACT • *The aim of our research was to develop a method for producing cement-bonded particleboards (CBPB) at the lowest possible cost. There are two possibilities for using poplar as raw material, and for using a new combination of chemicals as additives, the solution of calcium-chloride and calcium-formate instead of water glass. The present technology uses exclusively Scots pine (Pinus sylvestris) chips, which is getting increasingly expensive. The price of the new additive is lower, as well as the price of poplar compared to Scots pine. As a result of our research, the costs of CBPB production can be reduced. Physical and mechanical properties of the boards usually improved rather than deteriorated.*

Keywords: *cement-bonded particleboards, calcium-chloride, calcium-formate, poplar, scots pine, water glass*

SAŽETAK • *Cilj provedenih istraživanja bio je pronaći način proizvodnje drvno-cementnih ploča (CBPB) za koji će biti troškovi najmanji. Dvije mogućnosti za sniženje troškova jesu uporaba topolovine kao drvne sirovine za ploče te primjena nove kombinacije kemikalija – otopine kalcijeva klorida i kalcijeva formata umjesto vodenog stakla. U dosadašnjoj tehnologiji proizvodnje drvno-cementih ploča koristilo se isključivo iverje borovine (Pinus sylvestris), koje je svakim danom sve skuplje. Cijena topolova iverja u usporedbi s iverjem borovine niža je, kao i cijena predloženoga novog aditiva. Istraživanje je pokazalo da troškovi proizvodnje drvno-cementnih ploča na opisani način mogu biti smanjeni, a fizikalna i mehanička svojstva ploča ostala bi nepromijenjena ili bi se poboljšala.*

Ključne riječi: *drvno-cementne ploče, kalcijev klorid, kalcijev format, topolovina, borovina, vodeno staklo*

1 INTRODUCTION
1. UVOD

One of the most important aims of panel producers is to decrease the costs of raw materials and the costs of production itself. Of course this should be done by keeping the quality at a high level. Recently in Hungary cement-bonded particleboards (CBPB) have only been produced from Scots pine (*Pinus sylvestris*), whose procurement is increasingly difficult and hence the

[1] Authors are associate professor and PhD student at University of West Hungary, Faculty of Wood Sciences, Institute of Wood and Paper Technology, Sopron, Hungary.
[1] Autori su izvaredni profesor i student doktorskog studija na Sveučilištu zapadne Mađarske, Fakultet znanosti o drvu, Zavod za tehnologiju drva i papira, Sopron, Mađarska.

energetic use of forests and its price is also increasing. So it would be important to find an alternate wood species and develop possible modifications of production technology of new raw material.

These researches were based on domestic poplar clones (like sp. *Pannonia* or *euramericana*), because they are available in larger amount, and are suitable for plantations. On the other hand based on earlier researches these species can be suitable to produce CBPB because of their low inhibitor content (Takats, 2008). Also besides traditional water-glass (Na_2SiO_3) additive alternate chemicals were investigated: a solution of calcium-chloride and calcium-formate.

An earlier study (Illés, 2004) was made in this subject at the University of West Hungary. The author mixed poplar (I-214) with Scots pine in different ratios but used only water-glass as additive and made only single layer boards. The results were not clearly positive in case of bending strength.

Conventionally Scots pine chips are the raw material for CBPB. The wood must be debarked, because the bark contains more inhibitors, which prevents cement from hydration (Winkler 1998). These inhibitors are mostly in water soluble hemi-cellulose. The bark content of the raw material must not exceed 5%. The wood harvested in autumn or in winter contains less inhibitor (Alpar and Nádor, 2000). Logs harvested in other periods should be stored for two months. (Alpar, 2008)

The particles are mixed with Portland cement, chemicals and water. Conventionally water-glass is added to the mixture to accelerate the setting of Portland cement (Alpár, 2000). After blending a three layered mat is formed by two wind formers and one mechanical former.

The mats are piled and pressed together with steel plates in batches (Hadnagy, 1983). The fixed stocks are later placed for 8-10 hours in a curing chamber where the temperature is 70°C and the relative humidity is 80-85%. After this time the boards are self-bearing, but they have to be stored for two weeks until cement reaches its final strength. (Alpár and Nádor, 2000)

Typical composition of CBPB (Alpár, 1998):
- 20% wood particles
- 60% Portland cement
- 20% water and additives

Main properties of CBPB:
- 1200-1300 kg/m^3 density,
- 10 MPa bending strength (at 10% moisture content),
- 1-2.5% thickness swelling.

The aim of the present research was to develop CBPB which fulfills all the standard requirements from alternate raw materials.

2 MATERIALS AND METHODS
2. MATERIJALI I METODE

Raw materials used in experiments:
- Scots pine (*Pinus sylvestris*) particles
- I214 poplar (*Populus euramericana* cv. „I 214“) particles,
- CEM I 42.4 Portland cement,
- calcium-chloride ($CaCl_2$),
- calcium-formate ($C_2H_2CaO_4$),
- water-glass (Na_2SiO_3).

For the researches FALCO Zrt. bought I214 poplar pulpwood from winter harvest, and the logs were stored debarked for 2 months. The conventionally used Scots pine was treated in the same manner. Following this particles were made in the production line.

Before board production, laboratory hydration tests were made to examine the effect of cement hydration on different wood species and additives. Hydration was tested by measuring hydration temperature of the prepared samples during the first 24 hours of hydration

Table 1 Raw material requirements of water-glass (WG) added boards
Tablica 1. Količine sirovine za proizvodnju ploča s dodatkom vodenog stakla (WG)

	Surface layer raw materials for 1 board *Količina sirovine za površinski sloj jedne ploče*					
Mark / *Oznaka*	100SP_WG	80SP_WG	60SP_WG	40SP_WG	20SP_WG	0SP_WG
Scots pine, g / *borovina, g*	466	372	279	186	93	0
Populus I214, g / *topolovina I214, g*	0	85	171	256	342	427
Cement, g / *cement, g*	1027	1027	1027	1027	1027	1027
Water-glass, g / *vodeno staklo, g*	30	30	30	30	30	30
Water, g / *voda, g*	554	562	570	577	585	593
	Core layer raw materials for 1 board *Količina sirovine za središnji sloj jedne ploče*					
Mark / *Oznaka*	100SP_WG	80SP_WG	60SP_WG	40SP_WG	20SP_WG	0SP_WG
Scots pine, g / *borovina, g*	325	260	195	130	65	0
Populus I214, g / *topolovina I214, g*	0	61	122	182	243	304
Cement, g / *cement, g*	684	684	684	684	684	684
Water-glass, g / *vodeno staklo, g*	20	20	20	20	20	20
Water, g / *voda, g*	355	359	363	368	372	376

Table 2 Raw material requirements of calcium-chloride and calcium-formate (CC) added boards
Tablica 2. Količine sirovine za proizvodnju ploča s dodatkom kalcijeva klorida i kalcijeva formata (CC)

	Surface layer raw materials for 1 board *Količina sirovine za površinski sloj jedne ploče*					
Mark / *Oznaka*	100SP_CC	80SP_CC	60SP_CC	40SP_CC	20SP_CC	0SP_CC
Scots pine, g / *borovina, g*	466	372	279	186	93	0
Populus I214, g / *topolovina I214, g*	0	85	171	256	342	427
Cement, g / *cement, g*	1027	1027	1027	1027	1027	1027
Calcium-chloride and calcium-formate, g *kalcijev klorid i kalcijev format, g*	40	40	40	40	40	40
Water, g / *voda, g*	544	552	559	567	575	582
	Core layer raw materials for 1 board *Količina sirovine za središnji sloj jedne ploče*					
Mark / *Oznaka*	100SP_CC	80SP_CC	60SP_CC	40SP_CC	20SP_CC	0SP_CC
Scots pine, g / *borovina, g*	325	260	195	130	65	0
Populus I214, g / *topolovina I214, g*	0	61	122	182	243	304
Cement, g / *cement, g*	684	684	684	684	684	684
Calcium-chloride and calcium-formate, g *kalcijev klorid i kalcijev format, g*	27	27	27	27	27	27
Water, g / *voda, g*	348	352	357	361	365	369

with 15 min sampling frequency by an ALMEMO 8590-9 type data acquisition module. The maximum temperature and the time required for reaching this maximum temperature were noted and compared. Particles for the surface layer were used depending on their specific surface area. The ratios of compounds were the same as the recipe in board production (Table 1 and 2). The marks are set up as follows: percentage of Scots pine to I214 poplar – e.g. 60% of Scots pine and 40% of poplar makes 60SP - plus type of curing additive - WG for water-glass and CC for combination of calcium-chloride and calcium-formate. In this case the mark is: 60SP_WG or 60SP_CC depending on the additive.

During laboratory board production different ratios of wood species were used (100% - 80% - 60% - 40% - 20% - 0%) and from each type two boards were pressed parallel in one press to have more test pieces. The thickness was chosen for the most commonly used board thickness of 12 mm. The experiments were made with both types of additives: first with conventional water-glass and then with a 3% water based solution of a 3:1 mixture of calcium-chloride and calcium-formate (CC). Wood-cement ratio 1:2.6 was chosen. The moisture of the total mixture was 44%. During the research three layered boards were pressed from different particle sizes in the core (2-5 mm) and surface (<2 mm) layers. The ratio of the core and the surface layers were 30% - 40% - 30%.

The calculated amount of raw materials was measured on a balance with an accuracy of ±0.01 g. The raw material for the core and surface layers was blended separately by a mixer. The mat was formed manually into a frame with dimensions of 400 x 400 mm. The mats were pressed in a Siempelkamp laboratory press at specific pressure of 4.8 N/mm^2 and at room temperature for 14 hours. After this the boards were stored for two more weeks before being tested under standard climate conditions (65%, 20 °C). Longer pressing time was used to compensate the lack of climate in curing chamber.

Finally the most important physical and mechanical tests were made on the experimental boards. For each test 7 test pieces were cut from each board, so 14 test pieces were measured from each board type. Mechanical tests were made by an INSTRON 5566 universal material testing device. The tested features were: thickness swelling (EN 317:1998), density (EN 323:1995), bending strength (EN 310:1999), modulus of elasticity (EN 310:1999) and internal bond (EN 319:1998). The years of the above mentioned norms are the years of implementation of EU norms in Hungary.

3 RESULTS AND DISCUSSION
3. REZULTATI I DISKUSIJA

The results of preliminary hydration test are shown in Table 3. It can be concluded from these results that there is no disadvantageous effect of poplar on curing of cement, hence there is only a slight difference regarding T_{max}, and there is no difference regarding t_{Tmax}, so it is suitable to produce CBPB.

Table 4 presents a summary of the results of physical and mechanical tests. This will be followed by diagrams for detailed evaluation.

The changes of mechanical properties caused by the mixing ratio of two wood species are shown in Fig. 1 to 3. Each diagram shows the percentage of Scots pine to I214 poplar on the X axis: e.g. 60% means 60% of Scots pine and 40% of I214 poplar. The color of bars shows the additives: WG for water-glass and CC for combination of calcium-chloride and calcium-formate.

Table 3. Results of hydration test of analysed boards
Tablica 3. Rezultati hidratacijskog testa analiziranih ploča

Sample ID / *Redni broj uzorka*	1	2	3	4	5	6
I214 poplar**, g / *topolovina I214, g*	34	-	34	-	-	-
Scots pine**, g / *borovina, g*	-	41	-	41	-	-
Cement, g / *cement, g*	81	81	81	81	107	107
Water-glass, g / *vodeno staklo, g*	3	3	-	-	4	-
CC*, g	-	-	3	3	-	4
Water, g / *voda, g*	54	46	54	46	58	58
T_{max}, °C	29.3	25.8	29.9	26.7	29.6	32.6
$t_{T_{max}}$, min	75	75	75	75	855 (14.25h)	720 (12.0h)

* CC = 3% water based solution of a 3:1 mixture of calcium-chloride and calcium-formate / *CC – 3 %-tna vodena otopina smjese kalcijeva klorida i kalcijeva formata u omjeru 3:1;*
** technical dried mass with moisture content / *tehnički suha masa sa sadržajem vode*

By increase of the poplar ratio, the properties were generally also increased, although this tendency was not clear in every case. The maximum values were found at 40/60 and 20/80 mixing ratio of Scots pine/I214 poplar particles. The use of calcium-chloride and calcium-formate instead of water-glass improved the mechanical properties of the boards almost in every case.

The results show that by adding poplar the strength of the CBPB will increase, although in case of 100% of poplar the values show a little drop. These results are a bit surprising because the strength of poplar itself is usually below that of pine. The reason for the increase of strength lies in the shape of particles: the Scots pine has straight elements with smooth surface and the poplar has long, wavy and "hairy" elements so these can provide better matting and linking. When used, the solution of calcium-chloride and calcium-formate increased the mechanical properties of boards compared to those made with conventional water-glass.

The standard for CBPB (EN 634-2:2007) has the following requirements: minimum bending strength of

Table 4 Summarized results of mechanical tests
Tablica 4. Rezultati ispitivanja mehaničkih svojstava

Bending strength / *Savojna čvrstoća*, MPa						
Mark / *Oznaka*	100SP_WG	80SP_WG	60SP_WG	40SP_WG	20SP_WG	0SP_WG
MOR	11.60	11.36	12.70	14.09	13.27	13.48
St.Dev.	1.7828	1.3788	1.3834	1.1449	2.3405	1.4429
Mark /Oznaka	100SP_CC	80SP_CC	60SP_CC	40SP_CC	20SP_CC	0SP_CC
MOR	12.02	12.61	13.17	14.86	15.31	13.83
St.Dev.	1.4575	0.9153	2.5549	1.6030	1.2308	1.9513
Modulus of elasticity / *Modul elastičnosti*, GPa						
Mark / *Oznaka*	100SP_WG	80SP_WG	60SP_WG	40SP_WG	20SP_WG	0SP_WG
MOE	4975.315	5527.935	4928.413	5152.907	5032.9	5194.5
St.Dev.	603.032	347.672	715.911	393.095	649.228	576.890
Mark / *Oznaka*	100SP_CC	80SP_CC	60SP_CC	40SP_CC	20SP_CC	0SP_CC
MOE	5 228.66	5078.312	5097.013	5734.434	5838. 696	5062.716
St.Dev.	710.769	490.071	784.608	370.115	572.410	348.743
Internal bond / *Čvrstoća raslojavanja*, MPa						
Mark / *Oznaka*	100SP_WG	80SP_WG	60SP_WG	40SP_WG	20SP_WG	0SP_WG
IB	0.53	0.65	0.67	0.63	0.67	0.66
St.Dev.	0.0679	0.0888	0.1001	0.0465	0.0886	0.0636
Mark / Oznaka	100SP_CC	80SP_CC	60SP_CC	40SP_CC	20SP_CC	0SP_CC
IB	0.68	0.68	0.69	0.77	0.92	0.68
St.Dev.	0.0734	0.1144	0.0908	0.0886	0.0683	0.1032

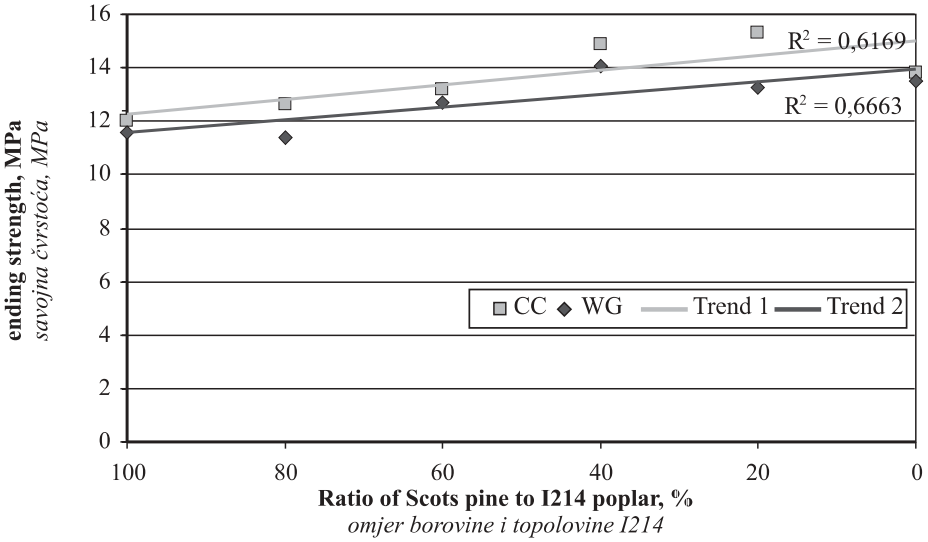


Figure 1 Bending strength of boards made from Scots pine and I214 poplar with regard to additive (WG or CC)
Slika 1. Savojna čvrstoća ploča izrađenih od borovine i topolovine I214 s različitim primjesama (WG ili CC)

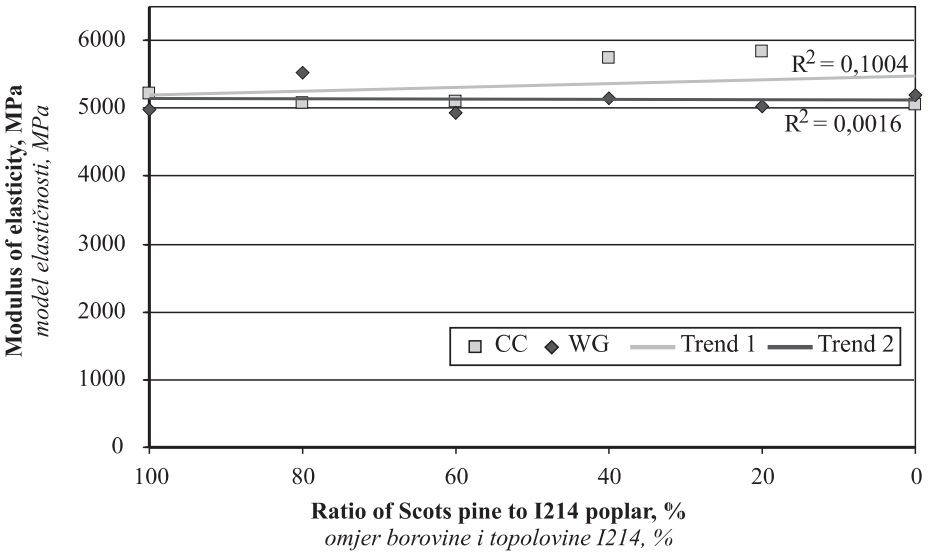


Figure 2 MOE of boards made from Scots pine and I214 poplar with addition of WG or CC
Slika 2. Modul elastičnosti ploča izrađenih od borovine i topolovine I214 s različitim primjesama (WG ili CC)

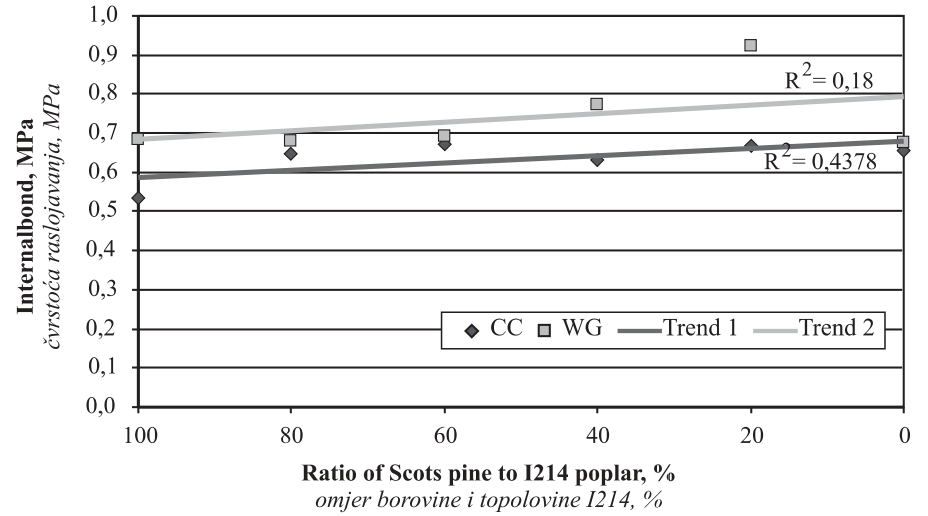


Figure 3 Internal bond of boards made from Scots pine and I214 poplar with addition of WG or CC
Slika 3. Čvrstoća raslojavanja ploča izrađenih od borovine i topolovine I214 s različitim primjesama (WG ili CC)

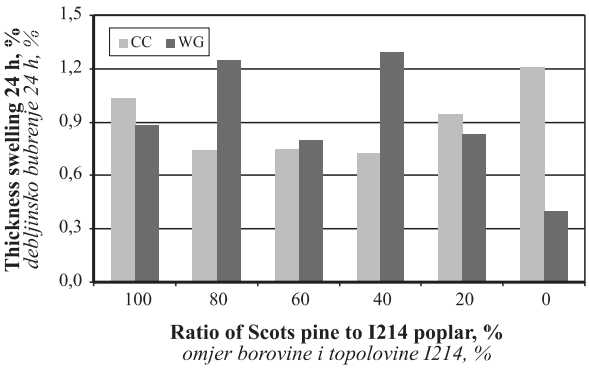


Figure 4 Thickness swelling of boards made from Scots pine and I214 poplar with addition of WG or CC
Slika 4. Debljinsko bubrenje ploča izrađenih od borovine i topolovine I214 s različitim primjesama (WG ili CC)

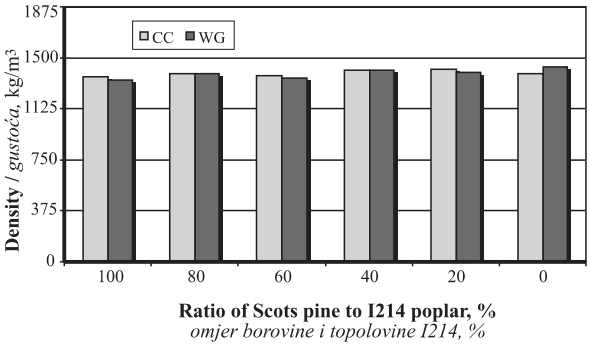


Figure 5 Density of boards made from Scots pine and I214 poplar with addition of water- glass or CC
Slika 5. Gustoća ploča izrađenih od borovine i topolovine I214 s različitim primjesama (WG ili CC)

9 MPa, minimum modulus of elasticity of 4500 MPa for the first class and 4000 MPa for the second class, and minimum internal bond of 0.5 MPa. These requirements were fulfilled by all experimental boards.

The changes of physical properties caused by the mixing ratio of two wood species are shown in Fig. 4 to 5. The density of the boards was around the standard requirement as desired. Regarding thickness swelling no tendencies were found, but all the values were much below the standard requirement (EN 634-2:2007) of maximum 1.5 %.

Based on this research it is recommended to replace or partly replace the expensive Scots pine with I214 poplar, because its use will result in the same quality of CBPB. It might be considered to replace water-glass with the combination of calcium-chloride and calcium-formate because this additive has increased the strength of the boards even in case of conventional Scots pine.

Before changing the technology, industrial-scale experiments should be made based on these laboratory results.

4 CONCLUSION
4. ZAKLJUČAK

During this research CBPB were made by using a mixture of Scots pine and I214 poplar in different mixing ratios and an alternate additive was also examined - the solution of calcium-chloride and calcium-formate. It can be concluded from the results that it is possible to produce CBPB from poplar with the same properties as, or even better than, from pine. The new additive has also improved satisfactorily the board properties. The reason for this is the better mineralization of wood elements and the hindering the sugars to be solved. The results also show economical advantages as poplar pulp wood was about 30% cheaper than Scots pine in Hungary at the time of the research.

Acknowledgement
Zahvala

This research was supported by
– ERFARET 2.1.3. "Utilization of quality and small diameter wood in board industry"
– FALCO Zrt., Szombathely.

5 REFERENCES
5. LITERATURA

1. Alpár, T. 1998: Production and improvement of properties of cement-bonded particleboards In: Solymos Rezső editor: Environment friendly forestry, game management and wood industry, MTA, Budapest, p. 269-275. (Hungarian).
2. Alpár, T. 2000: Accelerating methods for cement curing in production of cement-bonded particleboards. Ph.D. thesis, UWH, Sopron. (Hungarian).
3. Hadnagy, J. 1983: Production and utilization of particleboards. Műszaki Könyvkiadó, Budapest, p. 373. (Hungarian).
4. Illés, Zs. 2004: Production of cement-bonded particleboard from waste wood. Diploma thesis, UWH, Sopron. (Hungarian).
5. Winkler, A. 1998: Particleboards. Dinasztia Kiadó, Budapest, 181. (Hungarian).
6. Takats, P. 2008: Inorganic bonded composites. Szaktudás Kiadó, Budapest, p. 39. (Hungarian).
7. Alpar, T. 2008: Practices in fiberboard and particleboard production, UWH, Sopron, p. 36-37. (Hungarian).
8. Alpár T., Nádor L. 2000: Technical manual for BISON CBPB production line at FALCO Co. (Hungarian).

Corresponding address:

Associate Professor TIBOR ALPÁR, PhD

University of West Hungary
Institute of Wood and Paper Technology
Bajcsy-Zs. U. 4.
H-9400 Sopron, HUNGARY
e-mail: atibor@fmk.nyme.hu

Ivica Župčić, Goran Mihulja, Slavko Govorčin, Andrija Bogner, Ivica Grbac[1]

Zavarivanje termički modificirane grabovine

Welding of thermally modified hornbeam

Prethodno priopćenje · Preliminary paper
Prispjelo – Received: 19. 2. 2009.
Prihvaćeno – Accepted: 16. 7. 2009.
*UDK: 630*824.4; 674.028.1*

SAŽETAK • *Tehnika rotacijskog zavarivanja primjenjuje se pri zavarivanju moždanika (klina) u podlogu. Tijekom zavarivanja zbiva se kemijsko fizički proces koji nastaje kao posljedica trenja zbog rotacije moždanika i utiskivanja u statičnu podlogu, uz određeni zador.*
U radu su prikazani rezultati zavarivanja moždanika u podlogu od termički modificirane (grabovine obrađene na temperaturi od 200 °C u trajanju 48 h) i nemodificirane grabovine. U nemodificiranoj je grabovini izvlačna sila (moždanika iz podloge) veća (prosječno 84 %) nego u modificiranoj. To je posljedica manje krtosti i cjepivosti nemodificiranog drva te kraćeg trajanja procesa zavarivanja (utiskivanja moždanika).

Ključne riječi: *zavarivanje drva, moždanici, termička modifikacija, grabovina*

ABSTRACT • *Welding of dowels in the base is carried out by technology of rotation welding. During welding, a physical-chemical process takes place as a result of mechanical friction because of dowel rotation and impression into the static base with the set tightness.*
This article shows the results of dowel welding in thermally modified (treated at the temperature of 200°C for 48 h) and non-modified hornbeam base. Embedded force (dowel out of base) is grater with non-modified hornbeam (on average 84 %) than with modified hornbeam. This is the effect of less brashness and cleaving of non-modified wood and shorter time of welding (dowel impression).

Key words: *welding wood, dowels, thermal modification, hornbeam*

1. UVOD
1 INTRODUCTION

Zavarivanjem drva omogućuje se spajanje dvaju ili više elementa drva ili drvne ploče bez upotrebe ljepila. Spajanje drva klinovima, bez ikakva lijepljenja i zavarivanja, bilo je korišteno stoljećima. Odnedavno je napredovala jednostavna tehnologija spajanja uz pomoć klinova jer se klinovi (moždanici) zavaruju i tako čine čvrsti spoj. Rotacijsko zavarivanje moždanika bez adheziva rezultiralo je nastankom spojeva znatne čvrstoće. Zavarivanje drva određeno je temperaturom, topljenjem nekih amorfnih polimernih tvari i vezanjem drvnih stanica jedne do druge u strukturi drva. Metodom zavarivanja uz pomoć vibracija drveni elementi međusobno vibriraju, zbog čega se pojavljuje trenje između površina koje se dodiruju, razvija se toplina koja „omekša i rastali" strukturu stanica drva, a vlakanca drva međusobno se isprepletu. Isti se proces zbiva pri rotacijskom zavarivanju. Zbog hlađenja struktura drva otvrdnjava i nastaje čvrsti spoj (zavar).

Jones i Pizzi (2007) istraživali su kako hladna i kipuća voda utječe na čvrstoću zavarenog spoja modificiranog drva sitkanske smreke. Uzorci su bili modificirani temperaturom 210 – 240 °C te kemijski (acetilacijskim sredstvom te sredstvom na bazi alkohola). Rezultati istraživanja pokazali su veću čvrstoću spojeva termički modificiranog drva i kemijski modificiranoga (na bazi alkohola) za vrijeme izlaganja u kipućoj vodi (2 sata). Nemodificirani uzorci imali su najveću čvr-

[1] Autori su, redom, asistent, docent, docent, izvanredni profesor i profesor Šumarskog fakulteta Sveučilišta u Zagrebu.
[1] Authors are assistant, assistant professor, assistant professor, associate professor and professor at the Faculty of Forestry, University of Zagreb.

stoću u normalnim uvjetima, dok su kemijski modificirani uzorci (modificirani acetilacijskim sredstvom) pokazali najveću čvrstoću pri izlaganju u hladnoj vodi.

Termička modifikacija je postupak kojim se bez unošenja dodatnih kemikalija, samo uz utjecaj topline, tlaka i vlage, mijenja kemijska struktura staničnih stijenki. Kombiniranjem vrste medija za grijanje, vremena trajanja procesa, završne temperature te vrste drva koja se modificira (glavnih parametara modifikacije), dobivaju se željena svojstva modificiranog drva. Promjenom kemizma stanične stijenke smanjuje se njezin afinitet prema vodi te poboljšava dimenzionalna stabilnost. Termičkom modifikacijom mijenja se kemijska struktura u staničnoj stijenci, smanjuje se njezin afinitet prema vodi te se poboljšava dimenzionalna stabilnost. Smanjenje sadržaja vode u drvu smanjuju se i tlakovi para ispod nepropusnih debelostjenih premaza. Smanjenjem veličina bubrenja i utezanja smanjuju se naprezanja u sustavu premaz-površina drva te mu se produljuje vijek trajanja, kao i od takvog drva izrađenih proizvoda (Hasan i Despot, 2008).

Prema istraživanjima Živkovića i dr. (2008) rezultati pokazuju veliko smanjenje točke zasićenosti vlakanaca (prosječno 15 %) i sobnog ravnotežnog sadržaja vode (prosječno 3,5 do 5 %) pregrijanog drva u usporedbi s prirodnim. Ti se podaci odnose na jasenovinu i bukovinu obrađenu na dvije temperaturne razine, 190 i 210 °C. Koeficijenti utezanja pregrijanog drva nisu smanjeni u usporedbi s nemodificiranim drvom, ali je apsolutno smanjenje vodoupojnosti za 50 % rezultiralo povećanjem dimenzijske stabilnosti drva za 60 %.

Toplinska obrada drva pridonosi manjoj vodoupojnosti, poboljšava dimenzijsku stabilnost, povećava otpornost drva prema biološkoj razgradnji. Osim toga, smanjuju se mehanička svojstva takvog drva, promjena boje na suncu nije stalna i drvo širi miris paljevine u prostor (Jirouš-Rajković i dr., 2007). Miris zavarenog drva vrlo je sličan mirisu toplinski obrađenog drva samo je znatno slabijeg intenziteta.

S obzirom na to da se zavarivanje bukova moždanika u podlogu od hrastovine ili bukovine (tvrde vrste drva) u prethodnim istraživanjima pokazalo uspješnim (Župčić i dr., 2008), cilj ovog rada jest istražiti mogućnost zavarivanja moždanika u podlogu od grabovine, utvrditi postoje li razlike između zavarivanja moždanika u termički modificiranu i nemodificiranu grabovinu te odrediti optimalno vrijeme utiskivanja moždanika.

2. MATERIJALI I METODE RADA
2 MATERIALS AND APPLIED METHODS

Istraživanja zavarivanja moždanika u podlogu od grabovine, koja je prethodno obrađena toplim zrakom (termički modificirana na temperaturi 200 °C u trajanju 48 h) i grabovine koja nije bila tretirana provedena su na Šumarskom fakultetu Sveučilišta u Zagrebu. Modifikacija je rađena za komercijalne svrhe tako da su svi detaljniji podaci tijeka modifikacije tajna proizvođača. Drvo je prosječno imalo šest godova po centimetru a tekstura je bila radijalno-tangentna (modificirani i nemodificirani uzorci) s obzirom na smjer zavarivanja.

2.1 Ispitni uzorci
2.1. Test samples

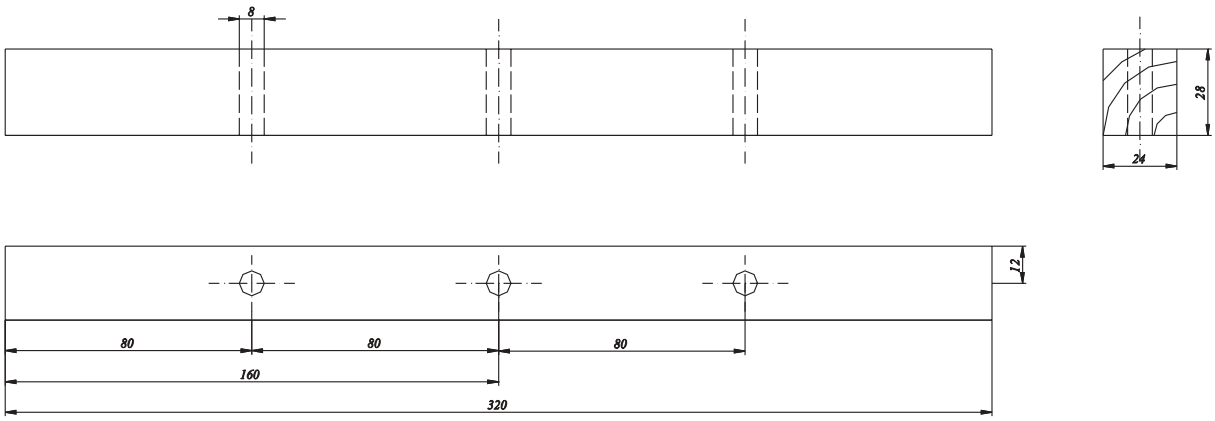
Uzorci su bili izrađeni od modificirane i nemodificirane grabovine dim. 320 x 24 x 28 mm i u svakom su uzorku izbušene po tri rupe promjera 8 mm. U netretiranu grabovinu u podlogu je zavareno 12 moždanika (četiri uzorka s tri rupe u svakom). U termički tretiranu grabovinu ukupno su zavarena 24 moždanika (osam uzoraka s tri rupe u svakome).

Bukovi moždanici bili su nažlijebljeni (komercijalno ih je bilo lako nabaviti), srednjeg promjera 10,02 mm. Prema Pizziju i dr. (2003), zador od 2 mm optimalan je zador, jer ako je on veći ili manji, izvlačna se sila smanjuje. Bukovi moždanici duljine 120 mm rotacijom su utiskivani u provrt na dubinu 20 mm. Frekvencija vrtnje moždanika iznosila je 1520 o/min. Parametri zavarivanja bili su jednaki za modificiranu i za nemodificiranu grabovinu samo je bilo promjenjivo trajanje procesa zavarivanja.

Na slici 4. prikazan je uređaj uz pomoć kojega su moždanici zavarivani za podlogu. Vrijeme trajanja utiskivanja (zavarivanja) bilo je promjenjivo, u rasponu

Slika 1. Materijal za izradu uzoraka (termički tretirana i netretirana grabovina)
Figure 1 Material for production of test samples (modified and normal hornbeam)

Slika 2. Obrađeni ispitni uzorci
Figure 2 Made test samples



Slika 3. Ispitni uzorak za određivanje izvlačne sile
Figure 3 *T*est sample for determining the embedded force

od 1,1 do 1,6 s za nemodificiranu grabovinu i 1,5 do 2,8 s za modificiranu grabovinu.

Nakon utiskivanja uzorci su kondicionirani (temperatura 23 °C, relativna vlaga zraka 50 %) šest dana. Nakon završetka kondicioniranja ispitivana je izvlačna sila na kidalici tvrtke Wolpert.

2.2. Određivanje sadržaja vode
2.2 Determination of moisture content

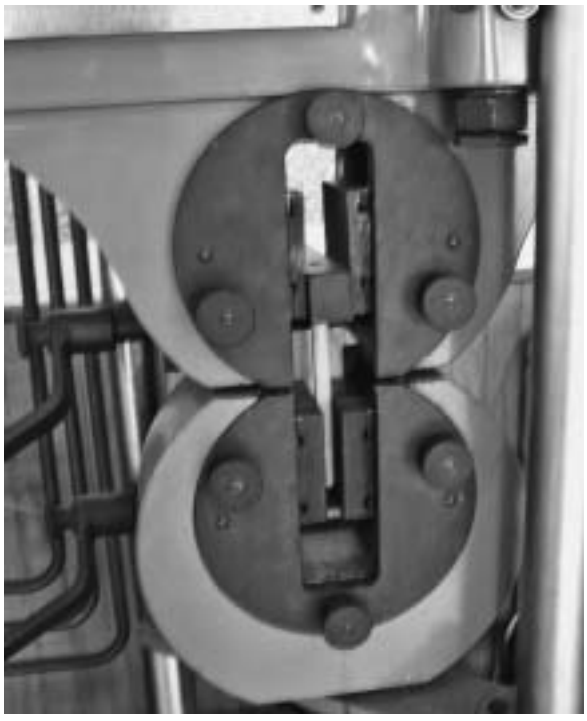
Nakon završetka ispitivanja izvlačne sile za svaki je uzorak određivan sadržaj vode. Na udaljenosti 50 mm od oba kraja uzorka ispiljene su po dvije probe kojima je odmah određena masa (vaganjem) te su stavljeni u sušionik. Svi su uzorci osušeni na 0 % sadržaja vode (103 ± 2 °C) do konstantne mase. Sadržaj vode određivao se prema HRN ISO 3130 : 1999. (hrvatska norma za određivanje sadržaja vode za ispitivanje fizikalnih i mehaničkih svojstava drva).

Prosječan sadržaj vode za nemodificiranu grabovinu iznosio je 7,9 % (min. 7,8 % a maks. 8,1 %). Sadržaj vode za termički modificiranu grabovinu bio je znatno niži, samo 3,1 % (min. 3,0 a maks. 3,3 %), što je vrlo značajna razlika. Modificirani i nemodificirani uzorci bili su u istim klimatskim uvjetima (šest dana) te je modificirana grabovina imala gotovo 2,5 puta manju vlagu od obične grabovine. Prije zavarivanja uzorci su držani u sobnim uvjetima oko 30 dana, ali sadržaj vode u drvu nije mjeren.

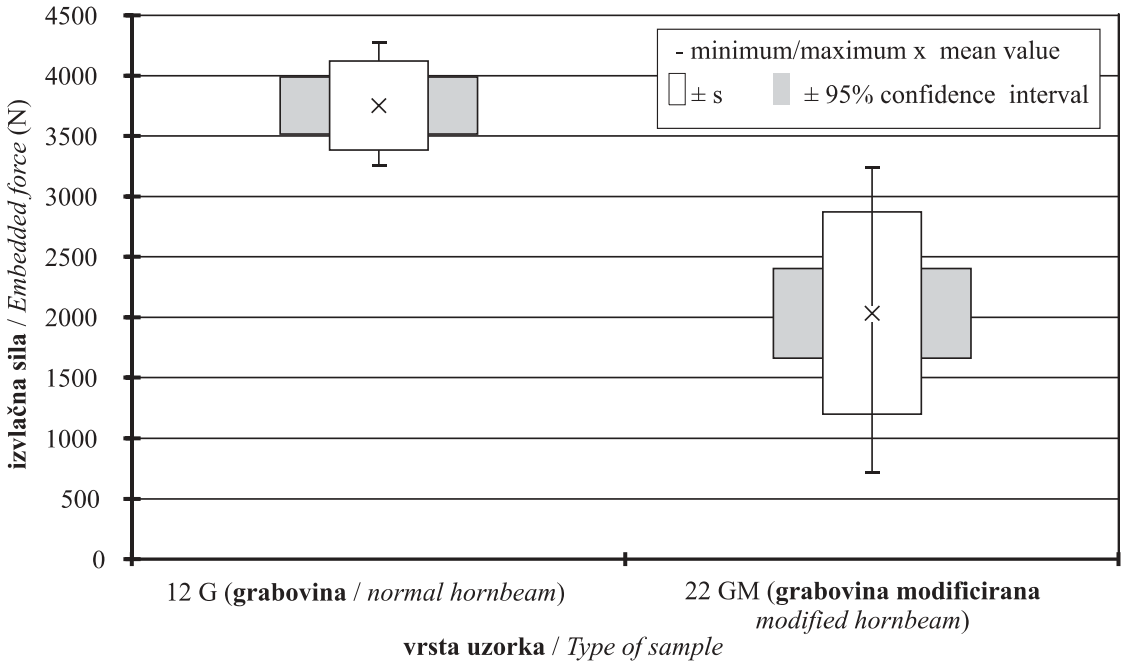
2.3. Određivanje gustoće
2.3 Determination of density

Nakon što je određen sadržaj vode u drvu na istim je probama određena gustoća drva prema HRN ISO 3131 : 1999. (hrvatska norma za određivanje gustoće drva za ispitivanje fizikalnih i mehaničkih svojstava drva).

Slika 4. Zavarivanje moždanika za podlogu
Figure 4 Welding of dowels into the basis



Slika 5. Ispitni uzorak u uređaju za ispitivanje izvlačne sile (kidalica)
Figure 5 Test sample in the device for the determination of embedded force



Slika 6. Statistička usporedba izvlačnih sila za modificiranu i nemodificiranu grabovinu
Figure 6 Statistical comparison of embedded force for modified and normal hornbeam

Prosječna gustoća (ρ_0) nemodificirane grabovine iznosila je 0,74 g/cm³ (min. 0,72 g/cm³, a maks. 0,75 g/cm³). Prosječna gustoća modificirane grabovine je 0,73 g/cm³ (0,69 g/cm³, a maks. 0,80 g/cm³), što je neznatno manje (prosječno 0,55 %) od nemodificirane grabovine.

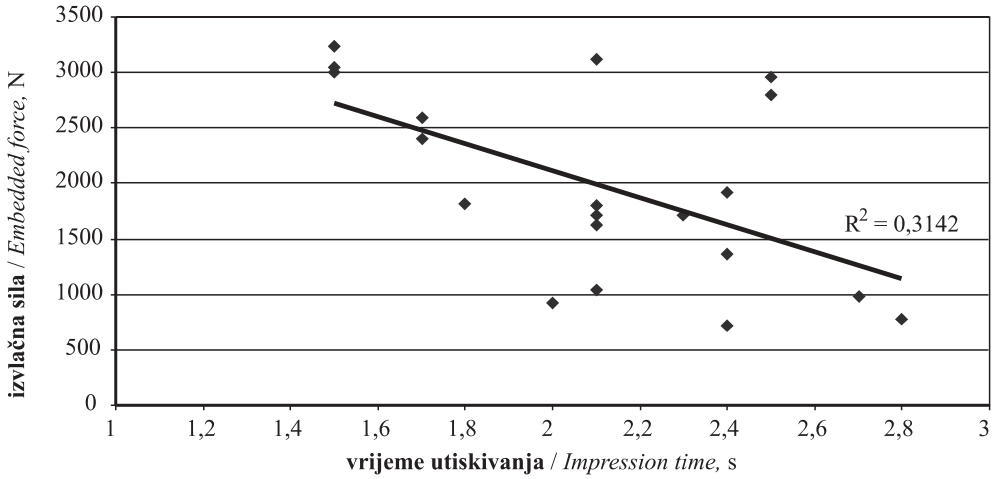
3. REZULTATI ISTRAŽIVANJA I DISKUSIJA
3 RESEARCH RESULTS AND DISCUSSION

Rezultati ovog istraživanja pokazali su veću izvlačnu silu na nemodificiranoj grabovini nego na modificiranoj (sl. 6). Drvu se modifikacijom povećava krtost pa dolazi do loma vlakanaca, a ne do ispreplitanja, što je rezultiralo smanjenjem izvlačne sile zavarenog moždanika. Smanjenje mehaničkih svojstava u smjeru vlakanaca i okomito na njih, slabljenje otpornosti na cijepanje te znatan porast krtosti posljedica su termičke modifikacije (Feist i dr., 1987; Rapp i dr., 2001). Veće rasipanje podataka za modificiranu grabovinu objašnjava se time što je i vremenski interval procesa zavarivanja trajao dulje.

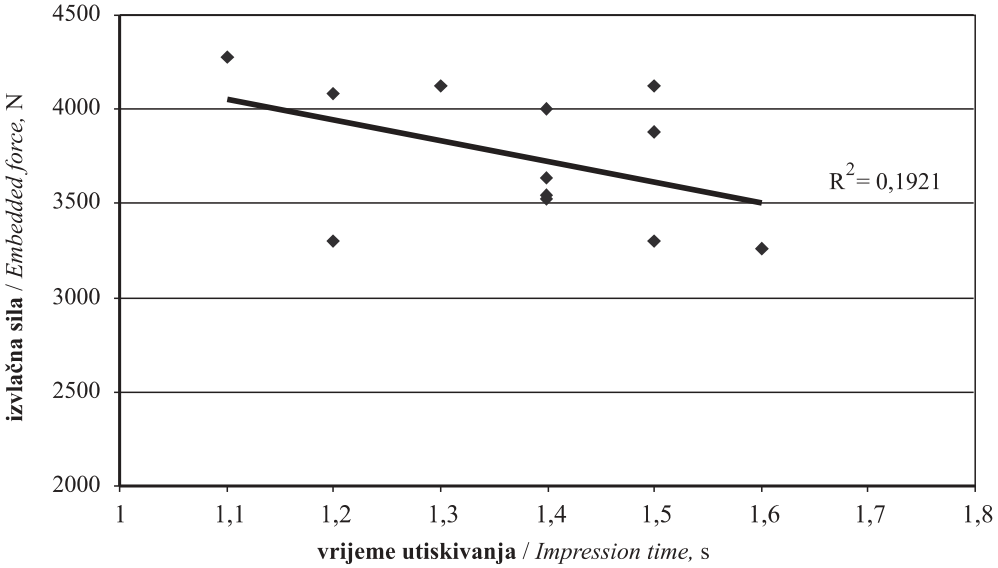
Pri zagrijavanju drva bez kisika najprije se razgrađuju hemiceluloze, zatim celuloza te na kraju lignin (Tjeerdsma i dr., 1998). Upravo je ta razgradnja celuloze jedan od čimbenika koji utječu na čvrstoću zavarenog spoja.

Prosječna površina zavarenog spoja nemodificirane grabovine iznosila je 569,36 mm², pa je prosječna čvrstoća zavarenog spoja 6,6 N/mm². Prosječna površina spoja modificirane grabovine bila je 564,23 mm² (manja), na što uvelike utječe trajanje procesa zavarivanja i krtost podloge. Prosječna čvrstoća zavarenog bukova moždanika u modificiranu grabovinu iznosila je 3,6 N/mm².

Brzina (vrijeme) utiskivanja drvenog čepa (moždanika) u podlogu izravno utječe na čvrstoću zavarenog spoja (Ganne-Chedeille i dr., 2005). Iz dijagrama na slici 7. (modificirana grabovina) vidljivo je smanjenje izvlačne sile s povećanjem vremena utiskivanja. Korela-



Slika 7. Usporedba izvlačnih sila i vremena utiskivanja za modificiranu grabovinu
Figure 7 Comparison of embedded force and impression time for modified hornbeam



Slika 8. Usporedba izvlačnih sila i vremena utiskivanja za nemodificiranu grabovinu
Figure 8 Comparison of embedded force and impression time for normal hornbeam

cijski koeficijent (r = 0,56) pokazuje značajnu povezanost vremena utiskivanja i izvlačne sile. Što je brzina utiskivanja manja, to se razvija veća temperatura na kontaktnim površinama, pa može doći do paljenja drva, a time i do smanjenja izvlačne sile. Vrijeme utiskivanja nije moglo biti manje od 1,5 s jer su nastajale pukotine na uzorku. Za vrijeme trajanja zavarivanja od 1,5 s moždanik napravi 38 okretaja, što prosječno iznosi 0,53 mm pomaka po svakom okretaju. Ako zavarivanje traje 2,8 s, tada moždanik napravi 70,9 okretaja uz prosječni pomak od 0,28 mm po jednom okretaju.

Pri tom postupku zavarivanja cjepivost drva vrlo je važno mehaničko svojstvo, koje određuje vrijeme utiskivanja moždanika. Što je to vrijeme kraće, kraće je i trajanje samog zavarivanja, ali su veća opterećenja na bočne površine rupe i uzrokuju pukotine na uzorku. Nastane li pukotina u smjeru zavarivanja, proces se prekida i izvlačna sila moždanika naglo pada. Kad bi poprečni presjek uzoraka bio veći, vjerojatno bi trajanje zavarivanja moglo biti kraće a time bi i rezultati izvlačne sile bili bolji (veći).

Za nemodificiranu grabovinu interval utiskivanja iznosio je od 1,1 do 1,6 s. Koeficijent korelacije (r = 0,44) pokazuje da je riječ o slabo koleriranim podacima povezanosti vremena utiskivanja i izvlačne sile. Trajanje zavarivanja od 1,1 s znači da moždanik napravi 27,9 okretaja ili pomak od 0,72 mm po jednom okretaju, dok za vrijeme trajanja od 1,6 s moždanik napravi 40,5 okretaja ili pomak od 0,49 mm po okretaju. S obzirom na dimenzije uzorka, vrijeme utiskivanja nije moglo biti kraće od 1,1 s zbog pojave pukotina, ali i maksimalno trajanje utiskivanja od 1,6 s daje zadovoljavajuću izvlačnu silu s obzirom na to da je riječ o slabom koeficijentu koleracije.

4. ZAKLJUČAK
4 CONCLUSION

Većina dobrih svojstava termički obrađenog drva ne dolazi do izražaja u procesu zavarivanja. Jedan od razloga smanjenja izvlačne sile termički obrađenog drva u usporedbi s neobrađenim jest smanjenje nekih mehaničkih svojstava takovog drva. Na temelju rezultata provedenih istraživanja može se zaključiti sljedeće.

- Bukovi se moždanici mogu uspješno zavariti u termički modificiranu i u nemodificiranu (običnu) grabovinu.
- Eksperiment je pokazao da moždanici zavareni u nemodificiranu grabovinu imaju veću izvlačnu silu (prosječno 84 %) nego moždanici zavareni u termički modificiranu grabovinu.
- Brzina utiskivanja moždanika (trajanje procesa zavarivanja) uvelike utječe na izvlačnu silu i što je to vrijeme dulje, sila je manja (to posebno vrijedi za modificiranu grabovinu). Ako se poveća vrijeme utiskivanja, na uzorku se u smjeru zavarivanja pojavljuju pukotine koje smanjuju izvlačnu silu.
- Istraživanje je pokazalo da je trajanje zavarivanja od 1,1 do 1,6 s za nemodificiranu grabovinu optimalno, a za modificiranu je grabovinu najkraće trajanje zavarivanja 1,5 s.
- Sadržaj vode u drvu termički modificirane i nemodificirane grabovine značajno se (prosječno 2,5 puta) razlikuju nakon kondicioniranja (šest dana).

5. LITERATURA
5 REFERENCES

1. Feist, W. C.; Sell, J. 1987: Weathering Behaviour of Dimensionally Stabilized Wood Treated by Heating under Pressure of Nitrogen Gas, Wood and Fiber Science, 19 (2):183-195.
2. Ganne-Chedeille, C.; Pizzi, A.; Thomas, A.; Leban, J.M.; Bocquet, J.-F.; Despres, A.; Mansouri, H. 2005: Parameter interactions in two-block welding and the wood nail concept in wood dowel welding. J. Adhesion Sci. Technol., 19 (13-14): 1157 - 1174.
3. Hasan, M.; Despot, R.; 2003: Termički modificirano drvo – materijal današnjice, Les – wood, 55 (3): 342-345.
4. Jirouš-Rajković, V.; Turkulin, H.; Živković, V. 2007: Metode poboljšanja svojstava građevnog drva, Drvna industrija, 58 (1): 23-33.

5. Jones, D.; Pizzi, A. 2007: Frictional welding of dowels into modified wood. Proceedings of the 5 th COST E34, Bonding of Modified Wood, September 6 th, University of Ljubljana, Biotechnical Faculty, Bled-Slovenija, 13 - 19.
6. Pizzi, A.; Properzi, M.; Leban, J.M.; Zanetti, M.; Pichelin, F. 2003: Mechanically – induced wood welding. Maderas. Cienca y tecnologia, 5 (2): 101-106.
7. Rapp, A. O.; Sailer, M. 2001: Oil-heat-treatment of wood – process and properties, Drvna industrija, 52 (2): 63-70.
8. Tjeerdsma, B.; Boonstra, M.; Pizzi, A.; Tekely, P.; Militz, H. 1998: Two-steps heat-treated timber: molecular-level easons for wood perfomance improvement. Holz Roh-Werkstoff, 56 (3): 149-153.
9. Živković, V.; Prša, I.; Turkulin, H.; Sinković, T.; Jirouš-Rajković, V. 2008: stability of heat treated wood, Drvna industrija, 59 (2): 69-73.
10. Župčić, I.; Mihulja, G.; Bogner, A.; Grdić, D. 2008: Welding dowels in the transversal cross-section of solid wood. Proceedings of International conference: Wood is good - properties, technology, valorisation, application: University of Zagreb, Faculty of Forestry, UFI-Paris, Zagreb, October 17 th 2008, 105-112.
11. Župčić, I.; Mihulja, G.; Bogner, A.; Grbac, I.; Hrovat, B. 2008:Zavarivanje masivnog drva, Drvna industrija, 59 (3): 113-119.
12. *** HRN ISO 3130 : 1999. (hrvatska norma za određivanje sadržaja vode za ispitivanje fizikalnih i mehaničkih svojstava drva)
13. *** HRN ISO 3131 : 1999. (hrvatska norma za određivanje gustoće drva za ispitivanje fizikalnih i mehaničkih svojstava drva)

Corresponding address:

Assistant IVICA ŽUPČIĆ, BSc

Department of Furniture and Wood Products
Faculty of Forestry
University of Zagreb
Svetošimunska 25, p.p. 422
HR-10002 Zagreb, Croatia
e-mail: zupcic@sumfak.hr

Jan Bomba[1]

Sawmilling in the Czech Republic

Pilanarstvo u Republici Češkoj

Review paper · Pregledni rad
Received – Prispjelo: 12. 3. 2009.
Accepted – Prihvaćeno: 23. 7. 2009.
*UDK: 630*822.03; 630*832; 674.093*

ABSTRACT • *This article deals with the development of sawmilling over the area of the Czech Republic from the invention of the waterwheel drive until the present day. This survey is based on the writings of various Czech authors who were engaged, or still are, in this subject. The two most common types of machines in water-driven sawmills were both used at that time: the single-blade vertical frame saw and, less often, the horizontal saw. The development of the steam engine drive can be traced to the second half of the 19th century, while electric power generation with a dynamo was first introduced to some mills at the turn of the 20th century. During the 19th century, a new sawing machine was developed: a multi-blade frame saw with all-metal construction. As it turned out, this type of machine dominated the entire 20th century. In the year 1918, an independent Czechoslovakia was established, and sawmilling, just like other branches of industry, thrived in the new environment. Alas, the favorable conditions for development were impaired by World War II, and soon after that by nationalization and an imposed, centrally-planned economy. In the period 1945 – 1948, during overall nationalization, most sawmills were either closed or converted to other operations. The timber industry was not classified as an important sector and was therefore one to be reduced. Compared with the number of sawmill units in 1925, there was a sharp drop of 80% in the early 1950s, and as much as 90% in 1986. Nevertheless, the velvet revolution in 1989 restored freedom of enterprise and Czechoslovakian traditions. Wood processing experienced an outstanding revival and restructuring of the entire industry.*

Key words: *Czech sawmilling industry, development, sawmills, sawmilling products, technology*

SAŽETAK • *U radu je predstavljen razvoj pilanarstva na području na kojemu se danas nalazi Republika Češka, i to od vremena pogona vodenim kolom do danas. Rad je utemeljen na objavljenim tekstovima autora koji su se bavili ili se još uvijek bave tom temom. Najčešće upotrebljavani strojevi u vrijeme pogona vodenim kolom bili su jednolisna pila jarmača i, nešto rjeđe, horizontalna pila. Parni se pogon u pilane uvodi u drugoj polovici 19. stoljeća, a električni pogon na prijelazu iz 19. u 20. stoljeće. Tijekom 19. stoljeća razvio se novi pilanski stroj: višelisna pila jarmača s metalnim okvirom. Taj je stroj bio dominantan tijekom 20. stoljeća. Godine 1918. ustanovljena je neovisna država Čehoslovačka i pilanarstvo se, kao i druge industrije, razvijalo u novom okruženju. Na taj je razvoj znatno utjecao Drugi svjetski rat, nacionalizacija koja je uslijedila te planska ekonomija. Od 1945. do 1948. godine, tj. u vrijeme nacionalizacije, brojne su pilane zatvorene ili prenamijenjene. Prerada drva nije smatrana važnim sektorom gospodarstva i stoga je reducirana. U usporedbi s brojem pilana i količinom prerađenog drva 1925. godine, u ranim 1950-tim godinama 20. stoljeća zabilježen je pad od 80 % te pad prerade drva od čak 90 % u 1986. godini. No 1989. godine uspostavlja se sloboda poduzetništva i, ponovno, čehoslovačka tradicija. Industrija prerade drva oživljava i počinje restrukturiranje cjelokupnoga industrijskog sektora.*

Ključne riječi: *češko pilanarstvo, razvoj, pilane, pilanski proizvodi, tehnologija*

[1] Author is assistant at Department of Wood Processing, Faculty of Forestry and Wood Sciences, Prague, Czech Republic.
[1] Autor je asistent u Zavodu za obradu drva Fakulteta šumarstva i drvne tehnologije, Prag, Republika Češka.

1 INTRODUCTION
1. UVOD

Wood is a natural material and presents a great variety of characteristics. Throughout the history of woodworking, each specific feature influenced the technology used to process it, which had a related impact on the social distribution of labor, and especially on the development of specialized crafts and trades. New modern wood processing technologies, which continue the old craftsmanship traditions, go hand-in-hand with the implementation of skills and experience arising from new developments in the industry, as well as in other industries. Nevertheless, converting a natural product (trees) into a useful technical material is far from easy. Sawmilling processes should primarily homogenize the mechanical and structural characteristics of wood into a technically defined material. Last but not least, the operational waste should be converted into raw materials for further processing. Timber production (beams, planks, deals and battens, etc.) from round wood is probably one of the oldest technologies, along with stone working, that people managed to master. At the very beginning, the required profile was made by cutting a piece of round wood with primitive tools. A new stage in this development came with the introduction of sawing, which initiated higher productivity, material savings and the possibility of making thinner products (Friess, 2003).

Sawmilling and wood processing have a long tradition in the Czech Republic. However, that tradition was interrupted during the communist era following the Second World War, when our economy was incorporated into the complex of RVHP (Council of Mutual Economic Aid) and our woodmilling industry was relegated to a low priority class. After independence was gained, our private enterprise boomed in the area of woodmilling as well, but the lost continuity soon started to create problems for many of the new entrepreneurs in that branch of industry, despite the seeming ease and simplicity of initial operations. There is quite a good raw-materials base for the wood processing industry in our country, with annual felling output of about 14mil cubic meters of wood. More than 40% of that volume is processed through sawmilling technology. Wood, as a natural material, is now also increasingly used by the building industry, which had neglected wood applications dramatically in the past and looked for various substitute materials. The wood processing industry is on track to match that new trend, but catching up with the Western European countries will take some time.

2 WATERMILLS AND SAWMILLS
2. MLINOVI I PILANE

The first sawmills with mechanical propulsion were linked to the water corn mills which were introduced into our country from Anatolia. The oldest recorded information on watermills across our country dates back to the 11th century (Štěpán *et al*, 2000).

Sawmilling became the most common side operation of watermills in the submontane and mountainous regions. The sawmilling operation was usually separated to the outdoor area of the corn mill to prevent vibration transfer within the mill structure (see Fig. 1). Further wood processing activities were adopted: bark-crushing (for tanning shops), grinding of sawdust and charcoal for gunpowder production, wood-turning, and wood-wool production (Štěpán *et al*, 2000).

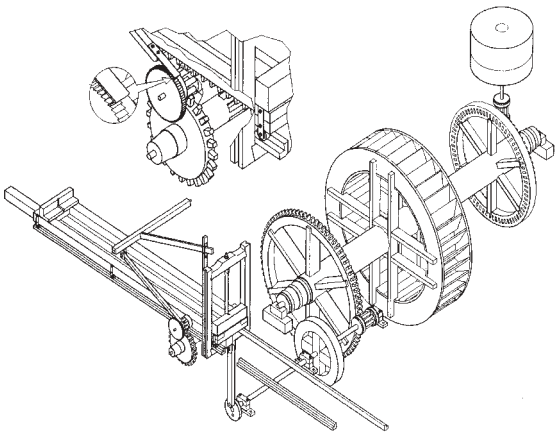


Figure 1 Peg gear driving a corn mill and sawmill added later in 19th cent. (Štěpán *et al*, 2000)
Slika 1. Zupčasti prijenos snage i gibanja za pogon mlinova i pilana u 19. stoljeću (Štěpán *et al*, 2000)

The importance of sawmilling in the 18th and 19th centuries can be grasped after realizing the enormous quantity of buildings that had to be constructed at that time. Different business strategies could already be distinguished. Sawmills integrated with corn mills operated within a system called "sawmilling for wage" – i.e. customers sent their own round wood to the mill for processing. Specialized water-driven sawmills operated commercially, mostly purchasing raw round wood for stock. Propelling more machines was achieved by installing a cascade of waterwheels, in cases where the topography and water resources allowed for such an arrangement (Friess, 2006). In the 1830s, the development of a new highway network created opportunities for new wood markets. In addition to a widening of the domestic market, wood began to be exported. Not only lumber but also special products, e.g. trunks up to 50 m long for masts, were shipped to Hamburg. Historical sources have records on the sawmill boom from the end of the 19th century, which give detailed examples from the hilly regions of Bohemia; they say that sawmills were as close to each other as the slope of the river allowed. Common machinery in those sawmills: single-blade vertical frame saws "a single" (Augsburg type) and "Wallachian" (Venetian type). The first type was driven by an usual waterwheel via spur gear (with wooden pegs) to get the saw crankshaft speed in the range of 60 to110 rpm. The second type was used mostly in the Moravia region. The drive for an overshot waterwheel was smaller because the strong stream of falling water provides the required speed without a gear. These sawmills were being built as independent plants until the beginning of the 20th century (Fig. 2). As late as 1925, there were statistical records of over 1000 such sawmills in Bohemia and Moravia. However, by the middle of the 20th century those plants had

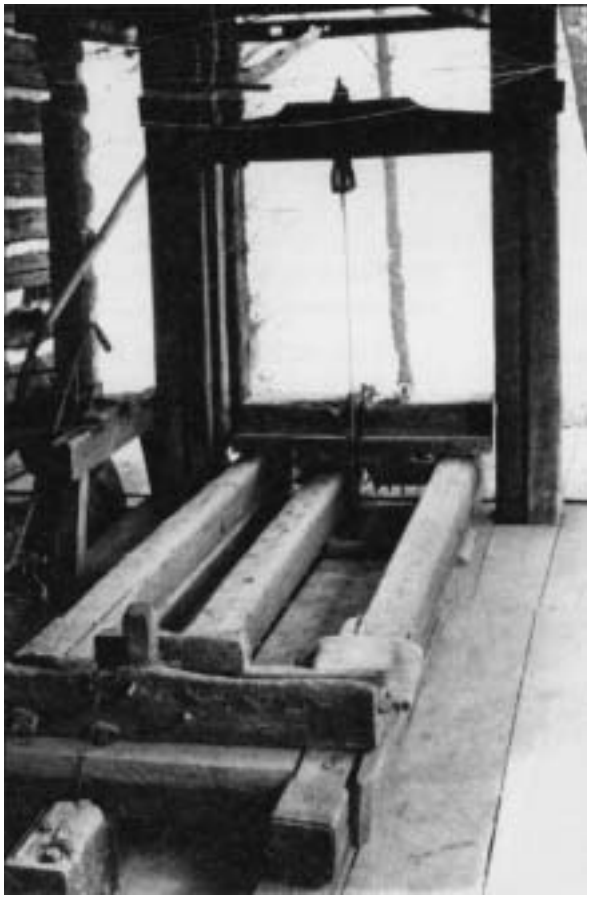


Figure 2 Water-driven single blade sawmill restored at a watermill in 1796 (Štěpán *et al*, 2000)
Slika 2. Vodom pogonjeni pilanski stroj s jednim listom pile iz 1796. godine (Štěpán *et al*, 2000)

perished. The new vertical multi-blade frame saw, of all-steel construction with feeding rolls, had prevailed. This saw had been designed and further developed throughout the 19th century, so that by the turn of the 20th century, its principle design was more or less identical with contemporary machines (Friess, 2003).

Millers and "hatchet-men" mostly built vertical "singles" but sometimes also horizontal single-blade machines (Fig. 3). These were useful for processing

Figure 3 Water-driven sawmill with a horizontal blade built at Dolní Sloupnice in 1854; moved to the Open-Air Museum of Folk Architecture Vysočina (Štěpán *et al*, 2000)
Slika 3. Vodom pogonjena pilana s horizontalnim listom pile izgrađena u Dolní Sloupnice 1854. godine; premještena u Muzej narodne arhitekture na otvorenome u Vysočini (Štěpán *et al*, 2000)

very large diameter trunks, which remained fixed onto the support while the cutting position was adjusted by a moving frame with a horizontal blade, controlled by a hand-crank (Štěpán *et al*, 2000).

The wooden construction of the sawing machine (some of them operating until the middle of the 20th century) usually allowed for the installation of one cutting blade only. The number of blades used to be limited because the wooden peg gears could transfer a maximum power of 4-6 HP, and so it was not possible to install more blades onto one frame. This became possible only after the introduction of steel cogged wheels and band wheels for transmission. But the wooden "singles" machines could work in pairs, or even in a line installed in one building, if there was an adequate water power source. This is documented in drawings of the well-known "Čeňkova" sawmill from 1856, where two waterwheels with diameter of 350 cm and width of 185 cm powered four "singles" for an increased mill output. (Fig. 4) (Štěpán *et al*, 2000).

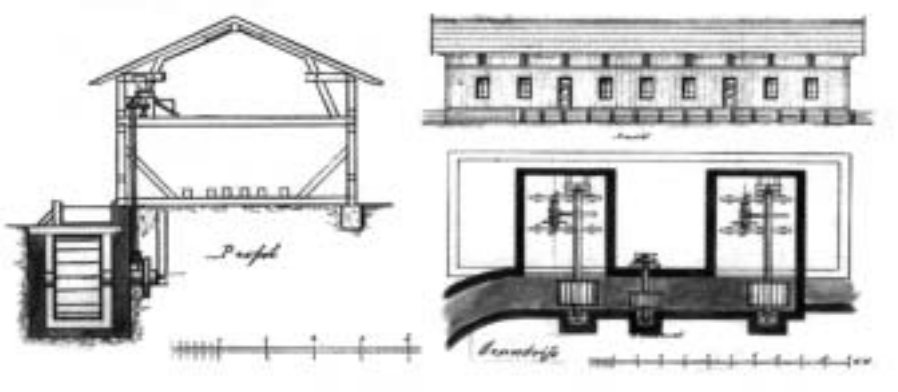


Figure 4 Building plan: a sawmill with four single-blade frames, supplemented with one corn mill installed in the attic; two large waterwheels powered four saw frames, and one smaller waterwheel drove a millstone (Štěpán *et al*, 2000)
Slika 4. Plan gradnje pilane s četiri jednolisne jarmače i jednim mlinom instaliranim u potkrovlju; dva velika vodena kola pogone četiri jarmače, a manje vodeno kolo pogoni mlinski kamen (Štěpán *et al*, 2000)

Table 1 Number of sawmills in 1925
Tablica 1. Broj pilana 1925. godine

Country *Država*	**Propulsion** / *Pogon*			**Machinery** / *Stroj*			
	water *voda*	steam *para*	electro *električna struja*	single-blade *jednolisni*	frame *jarmača*	circular *kružna pila*	band *tračna pila*
Bohemia	1 261	429	77	675	1 422	1 339	106
Moravia	495	205	11	330	604	558	43
Silesia	120	77	6		330	5	4
Total / *Ukupno*	1 876	711	94	1 005	2 355	1 902	153
	2681			5416			

Source: Friess, 2003

The core machinery of the water-driven sawmill also used to have supplementary equipment, e.g. edging circular saws or grinding stones. Hand-driven winches were used for pulling trunks into the sawmill shop.

There was also a specialized type of sawmill – shingle mills, which replaced the hand cutting of shingles. The oldest record about them that we have dates back to 1824. They became common, however, in the middle of the 19th century. The equipment of those shops included a circular saw, grooving machine, and occasionally a mechanical planer. They produced shingles until the end of the Second World War (Štěpán *et al*, 2000).

3 SAWMILLING IN THE 20th CENTURY
3. PILANARSTVO U 20. STOLJEĆU

3.1 Sawmilling history up to 1989
3.1. Povijest pilanarstva do 1989.

Steam engine propulsion (mostly loco-mobile) enabled the spread of sawmills even into areas with few water power resources, but with advantageous supply and marketing conditions (Fig. 5). The wood industry Yearbook of 1925 fixed the total number of sawmills in Bohemia and Moravia at 2 681 (Tab. 1). In 1930 there were only 1 874 sawmills registered in Bohemia and Moravia, but this number only includes plants with more than 10 employees.

Similarly to the solid Czech technological background, adequate round wood production and marketing conditions also created a favorable climate for sawmill operations. Pre-war Czechoslovakia used to be a significant European timber supplier, exporting its production to Germany, Austria, Italy, France, England, the Netherlands, and so on; (Friess, 2003).

Companies were also interested in importing, especially exotic woods. Although woodworking machinery and tools were produced domestically, modern machines and technology were imported as well, especially from Scandinavia (Friess, 2003).

Favorable conditions and promising developments were impaired by World War II, and soon after that by nationalization and the imposition of a centrally planned economy. During nationalization, most sawmills were either closed or converted into other substitute operations, because the timber industry was not classified as an economic sector of national importance. Production of woodworking machinery survived in the product mix of two large engineering companies (Královopolská strojírna Brno and TOS Svitavy) and on a small scale in the maintenance shops of wood processing companies (Friess, 2003).

Table 2 Sawmills in 1947 (before nationalization)
Tablica 2. Pilane 1947. godine (prije nacionalizacije)

Sawmills / *Pilane*	**Number** / *Broj*
Czech mills / *češke pilane*	37
Moravia-Silesia mills / *moravske pilane*	25
State forest and farm / *državne šume i farme*	130
Other private / *privatne pilane*	1586
Total / *Ukupno*	1778

Source: Friess, 2003

Figure 5 Archbishop steam sawmill in Chvalčov (Kozlanský, 1947)
Slika 5. Nadbiskupska parna pilana u mjestu Chvalčov (Kozlanský, 1947)

The era of nationalization and central economic management meant the destruction of nearly all traditional forms of skills and experience transfer, which was common in the woodworking trade of the past; these transfers continued without any disruptions in neighboring countries (Friess, 2003).

In 1947, before complete nationalization, 1 778 sawmills were operating across the area of the present-day Czech Republic (Tab. 2) (Friess, 2003).

Table 3 Survey of sawmills by processed wood volume in 1970
Tablica 3. Pilane prema obujmu prerađenog drva 1970. godine

Wood enterprise *Poduzeće*	**mills** *pilane*	**Sawing volume in 1000 m^3/year** / *Prerađeni obujam u 1000 m^3/godini*								
		< 3	3-5	5-10	10-15	15-20	20-30	30-40	40-50	> 50
Středočeské	18		1	6	4		4	3		
Jihočeské	35	1	2	11	14	1	2	1	1	2
Západočeské	31	2	2	12	9	2		1	1	2
Severočeské	16		1	1	4	3	3	2		2
Východočeské	25	1		5	10	5	3	1		
Jihlavské	15			4	5	3	3			
Středomoravské	20			7	6	1	3	2		1
Severomoravské	34		2	4	9	8	3	3	2	3
Solo	4			1	2		1			
Total number	198	4	8	51	63	23	22	13	4	10

Source: SDP, 1971

Table 4 Number of sawmills in 1986
Tablica 4. Broj pilana 1986. godine

Wood enterprises / *Poduzeća*	**Number** / *Broj*
Středočeské	15
Jihočeské	29
Západočeské	26
Severočeské	12
Východočeské	20
Jihomoravské	33
Severomoravské	29
SOLO	4
Total / *ukupno*	168

Source: Friess, 2003

Soon after, at the beginning of the 1950s, between 400 and 500 sawmills were operating in our country (5,100 in Austria at that time, and even more registered sawmills in Germany) (Pražan *et al*, 2007). The number of sawmills in 1970 is given in Tab. 3.

The peak concentration can be seen from the number of sawmills in 1986: approx. 168 sites (plants within VHJ DP) (Tab. 4). Nevertheless, there were some smaller sawmills, outside the centrally managed wood processing industry, which operated inside agricultural co-ops – JZD or other state forest enterprises. However, the centrally managed sawmills accounted for all planned processing of round wood, and outsiders had to search for other wood resources, mostly of "non-standard" quality. The scheduled 168 sawmills processed 90% of available round wood (Bomba *et al*, 2009).

3.2 Sawmilling history from 1989
3.2. Povijest pilanarstva od 1989. godine

Since the beginning of the 1990s, the wood processing industry has been undergoing major restructuring. Large state-owned enterprises were breaking up into smaller independent companies during the restitution and privatization stage. Some companies were doing well at that time because of their flexibility and good marketing strategies, in both the developing economic environment and Czech timber trade. Foreign trade, however, which was focused mostly on stable Western European markets, was dying out, and finally the structure of its sales force collapsed. Only large-scale producers were able to manage their own marketing (Fig. 6). In addition to independent trading on foreign markets, new mediation agencies were emerging. The segments of established customers were stable and solvent, so there were no strong oscillations in the volume of timber marketed (Janák, 1999).

Sawmilling was becoming a lucrative enterprise. Some sawmills, which had closed in previous years, re-opened and tens of new small sites appeared, processing mostly round wood. They were either new owners of woodland given in restitution, looking to profit from processing their own wood, private entrepreneurs, or limited liability companies, taking the opportunity to achieve a quick return on capital by buying and processing the available round wood. The latter group of businessmen organized their business according to the principle "build cheaply to make money fast", which had the following effects: most of the newly-constructed mills put into operation had a low or even primitive technical and technological level; a high rate of manual work providing low productivity (mainly between 1990 – 1993); marketing problems for Czech producers of machinery and technological equipment, causing their productions to shut down; increase in processing capacity to about 145–160% of the level at the end of the 1980s; decreasing availability of round wood, which led to sharp price increases on the free market; new operations were often owned and managed by people without experience and adequate education in wood processing, and in some extreme cases even by people without any interest in wood processing technology (Janák, 1999).

Figure 6 Čáslav Sawmill (taken by author)
Slika 6. Pilana Čáslav (foto: Bomba)

Figure 7 One of the largest plants in the Czech Republic – Paskov (TL, 2008)
Slika 7. Jedna od najvećih pilana u Republici Češkoj – Paskov (TL, 2008)

4 RECESSION
4. RECESIJA

In the second half of 1992, a downturn in the timber trade struck not only our country, but also Western European markets. In 1995, the balance of sawn and round wood prices was disturbed. Because of a fall in timber prices on Western European markets, where most Czech sawmills directed their exports, the export prices of sawn wood started to go down as well (Pražan, 2003).

Some sawmills closed, while others struggled to keep going, went into debt with financial institutions and their wood suppliers, and finally had to close their doors as well. Small and medium-sized firms were even more affected, as were companies which had a narrow selection of products, and could not promote salable products to compensate for the losers. Alas, after the preceding developments, most entities were in such a situation. Later on, the plants were sold for a bargain. Some foreign investors also began looking for these bargains, especially for larger plants with a cheap labor force, which could become quite lucrative for them (Janák, 1999).

5 NEW MILLENIUM
5. NOVO TISUĆLJEĆE

In the year 2003, construction of a new mega-sawmill got underway in Paskov (Fig. 7). In the years that followed four more such mega-structures were completed – the last examples of capacity concentration in Western Europe. Currently in the Czech Republic there are 5 mega-sawmills, which had an annual round wood capacity of 4 060 000 cubic meters of wood in 2007 (Pražan *et al*, 2007).

From a global perspective, foreign markets are essential for these large companies. Having secured adequate raw material resources of the required quality and logistics supply, they are always able to meet their customer's needs quickly and economically (Janák, 1999).

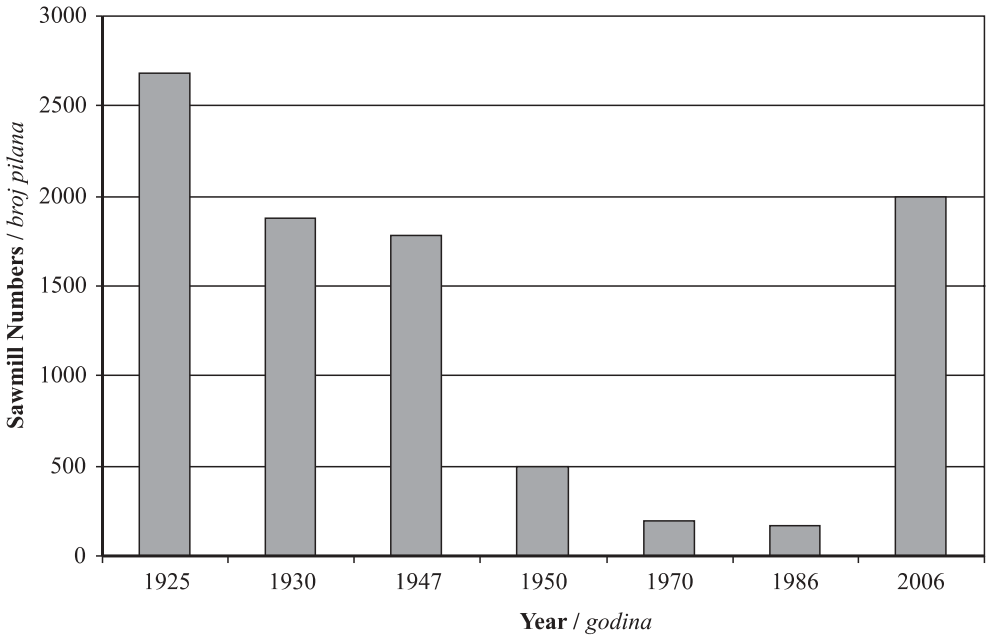
When large-scale producers focus on large contracts, it is favorable for more than just their own effective operations, due to the "economy of scale" effect. They can cover large volumes with a narrow range of products, and there is no need for producers to follow the "everybody makes everything" path, as is often the case. Small special orders and customized production for small customers can be allocated to small suppliers. These suppliers do not stand a chance of competing in the area of bulk contracts with the same product lines as large sawmills. Accepting small orders for a wide range of products is more favorable for smaller producers (revenue) and their customers as well (flexibility, delivery time). After all, some atypical sizes (e.g. long building lumber) cannot be made at large sawmills at all. Competition between medium (large) and small sawmills could be less intense, to the benefit of both sides (Janák, 1999).

No further construction of large-scale sawmills inside the Czech Republic is planned (Pražan *et al*,

Table 5 Breakdown of sawmills in 2007
Tablica 5. Ukupni prorez pilana 2007. godine

Size *Veličina*	**Capacity** *Kapacitet*	**Number** *Broj*	**Aggregate capacity, m^3/year** *Ukupni kapacitet, m^3/god.*	**Share of the total, %** *Udjel u ukupnom prorezu, %*
largest / *najveća*	> 500 000	5	4 060 000	54
large / *velika*	50 000 - 110 000	8	670 000	9
medium / *srednja*	20 000 - 49 999	30	1 050 000	14
small / *mala*	10 000 - 19 999	60	750 000	10
smallest / *najmanja*	< 9 999	1 400 - 2 000	1 000 000	13
Total / *Ukupno*		1 503 - 2 103	7 530 000	100

Source: Pražan *et al*, 2007



Note: in 1930, only mills with over 10 employees are recorded; in 1947, the number of mills is recorded before total nationalization; in 2006, the number of sawmills is estimated.
Opaska: za 1930. godinu zabilježene su samo pilane sa više od 10 zaposlenih; za 1947. godinu naveden je broj pilana prije potpune nacionalizacije; za 2006. godinu broj pilana je procijenjen

Figure 8 Graph of sawmill development in the Czech Rep. from 1925 to 2006 (Bomba *et al*, 2008)
Slika 8. Promjena broja pilana od 1925. do 2006. godine

2007). An actual breakdown of sawmilling plants is given in Table 5.

Among large and medium-sized sawmills in the Czech Republic, there are about 1 700 small and very small sawmills, scattered over the whole country (Pražan *et al*, 2007), which process local round wood resources and supply customers who are either very near or not far away. Some of the mills have a long tradition in their neighborhoods, and their existence and operation is often a link in the chain of local operations of further producers.

Development in the Czech Republic is presented in Fig. 8.

6 CURRENT MARKET SITUATION
6. TRENUTAČNA SITUACIJA

During recent years sawmilling companies have experienced many ups and downs. For these companies, not only the round wood – timber price balance, but also the demand for sawn timber is crucial, especially on foreign markets. Because of the steadily falling price of building timber, 2005 was an unprofitable year. 2006, thanks to the rising prices of timber, marked a turning point for an even better 2007 after the sharp fall of round wood prices. However, in the 4th quarter of 2007, prices of round wood went up again dramatically, while timber prices fell. This negative trend continued during 2008 with the effect that most sawmill companies barely broke even (with zero profit). The reason for the steady fall in building timber prices has been sluggish marketing of timber on foreign markets, especially due to the mortgage crisis in the American market, which is now spreading to Europe. The prolonged swings of the market pendulum, bringing about turbulent periods of profit and loss, are making the sawmilling companies establish operational reserve funds and carefully judge all investment projects. Most companies now only process that product line which is vital to keeping their operations running (Truhlářské listy, 2008).

7 STATE OF TECHNOLOGY
7. STANJE TEHNOLOGIJE

7.1 Large-scale sawmills
7.1. Vrlo velike pilane

These plants are equipped with the most sophisticated technology of renowned machinery manufacturers. The core operation of these plants is based on aggregate processing lines, comprising chipping machines and circular saws. Bucking, sorting and stacking operations are regularly automated. High-capacity drying chambers and sometimes other supplementary production are also common equipment in these plants (Fig. 9).

7.2 Large and medium sawmills
7.2. Velike i srednje pilane

Considering the competitiveness of domestic sawmills, it is necessary to judge their actual state as well as possible modifications. Sawmills of that class usually operate with an annual capacity of processed round wood within the range of 20 000 to110 000 m³/year. Their core equipment is a frame saw - usually twins, which stems from a Czech tradition of producing quality machines with lower investment demands. Bucking and edging centers are separated and have manual

Figure 9 Stock-yard of Chanovice sawmill (photo by author)
Slika 9. Stovarište trupaca u pilani Chanovice (foto: Bomba)

handling. Size sorting is usually mechanized but quality sorting and stacking is manual. Although only larger plants have adjusting centers, driers are rather common equipment. Some plants also have impregnating troughs. The average equipment age is approx. 30 years. When the production efficiency of our plants is compared with foreign counterparts we find lower productivity, i.e. demands for higher specific staffing. That trend is also sustained by the higher unemployment rate and lower labor costs in our country. Our plants have the advantage of being able to process a larger range of timber length (from 3 to 6 meters, while foreign plants often can only process 4 meters). Equipment that is functional but mainly highly amortized will soon require refurbishment and exchange of machinery in a great number of plants. Replacing existing technologies with more productive ones, e.g. aggregate processing lines, is not usually a realistic solution – it calls for large-scale reconstruction and high investment costs. Another reason for that situation is the raw materials base, which is currently about 30–35% below the total processing capacity of sawmills. Implementing new band head saw technology instead of using frame saws has little impact on productivity, but there are other obvious advantages like flexibility, improved accuracy and the ability to saw large diameter round wood. Restructuring the bucking and edging operations is undoubtedly realistic, and can save a considerable amount of labor. Manipulating and sorting round wood is usually done on stationary or mobile manipulation lines.

7.3 Small and very small sawmills
7.3. Male i vrlo male pilane

These sawmills have similar machinery and equipment to that of medium-sized plants. The distinction is their lower capacity, adapted to the lower degree of mechanization of the sawing machine, or to lower performance models (Fig. 10). Manipulation of wood in the sawing shop is mostly done manually by means of track carts. When reconstructing such plants it is possible to suggest preserving the equipment, however the rate of horizontal band saw installations will rise (especially with very small plants). Many small plants also have drying chambers. Recently, a lot of small processors have bought impregnating troughs for treating building timber. Forklifts are used for manipulation.

Figure 10 Small frame saw (photo by author)
Slika 10. Mala pila jarmača (foto: Bomba)

8 VISIONS FOR THE FUTURE
8. VIZIJA BUDUĆNOSTI

Very small plants (up to a round wood capacity of 3,000 m^3/year) will continue to emerge and vanish according to their competitiveness with bigger rival companies. They will still run at lower operating costs but will lack the ability to complete larger batches and gain supply and financial reliability. Nevertheless, they can operate well in other arenas like processing wood "in wage", i.e. round wood in possession of the customer. A different scenario can also not be ruled out – the medium and larger plants may continue to close, and their capacity of processing the major share of round wood may be taken over by those small and very small sawmills.

For securing sawmilling operations, some kind of linking will be necessary between round wood suppliers and sawmilling companies (either on a contractual or proprietary basis). Effective logistics in the supply chain, up to an uninterrupted sawing operation, will be a necessary, but not the only, prerequisite for effective production (Janák, 1999). The general situation in the forest industry does not assure an adequate availability of round wood. It is difficult to forecast the peak of its price rise as well as further developments in the timber market (Truhlářské listy, 2008). If any company is able to make some investments, then the money will be spent for upgrading production, not increasing capacity. Most probably, in the upcoming years companies will tend to keep their money in reserve funds (Truhlářské listy, 2008).

9 CONCLUSION
9. ZAKLJUČAK

Sawmilling and wood processing have a long tradition in the territory of the present-day Czech Republic. The first sawing machines were constructed at water-wheel-driven corn mills. There were also some watermills, but such propulsion proved rather weak and unreliable in our environment. In the middle of the 19th century, steam engine propulsion enabled sawmills to spread into areas closer to consumers, in spite of the lack of water. At the turn of the 20th century, the onset of electrification initiated the installation of dynamos in hundreds of watermills. The "first" Czechoslovak Republic enabled the last boom of the sawmill industry. Then the Second World War, followed soon after by nationalization and a centrally planned economy, caused a sharp drop in sawmilling capacity and depressed the entire sawmilling industry. After the velvet revolution in 1989, many new small sawmills appeared and at the same time, a lot of large plants were closed. Sawmilling became a lucrative branch of profiteering. The 1990s were characterized by a turbulent restructuring of the woodworking industry, and this development is ongoing. The Czech Republic came back into the European economic environment, and this will inevitably require further restructuring of our woodworking industry. In any case, it is hard to compensate for missing producers through technology. Reconstruction of existing sawmills will also be very slow due to a general lack of capital. Some reopened sawmills are at the technological level of the 1930s, but they do not have managerial staff with the experience of experts back then. Lack of technical literature is also critical, since the fall of the industry sector affected publishing, as a result of negative developments in the woodworking industry (Friess, 2003).

The global economic recession, which started in 2008 and will surely continue in 2009, brought problems to sawmilling, and it is very difficult to forecast further developments (Bomba *et al*, 2009).

10 REFERENCES
10. LITERATURA

1. Bomba, J.; Friess, F. 2009: The development of sawmill industry in the Czech Republic [Czech]. In *Lesnická práce: Journal of Forest Science and Practice,* 2 (89): 32-33.
2. Bomba, J.; Šedivka, P.; Böhm, M. 2008: The development of sawmill industry in the Czech Republic with a view to their capacity and master machine. In *Coyous 2008. Conference of young research scientists.* Czech University of Life Sciences Prague. Faculty of Forestry and Wood Sciences: 17-25.
3. Friess, F. 2003: *Sawmilling I*. [Czech], University mimeographed. Czech University of Life Sciences Prague. Faculty of Forestry and Wood Science, p. 13-22
4. Friess, F. 2006: C*orporation size and strategy in sawmill industry* [Czech]. Prague: PowerPoint, p. 2 – 39
5. Janák, K. 1999: The state of sawmill industry in the Czech Republic [Czech]. In *Lesnická práce: Journal of Forest Science and Practice,* 5 (78):
6. Kozlanský, K. 1947: *Reconstruction of sawmills and wood-working enterprises* [Czech]. 1st. Ed. Prague: Jaromír Dolenský, Printing Office in Prague II, p. 109
7. Pražan, P.; Příkaský, F. 2007: The present state and development of sawmill industry in Central Europe and the Czech Republic with the focus on small and medium sized enterprises [Czech]. In Proceedings of W*ood-Working Industry in the Czech Republic - present and future development of this industry.* Brno, p. 21-30.
8. Pražan, P. 2003: The development of sawmill industry in the Czech Republic and its impact on wood price [Czech]. In *Lesnická práce: Journal of Forest Science and Practice,* 9 (82):
9. Štìpán, L.; Křivanová, M. 2000: *Work and life of millers and millwrights in Bohemia* [Czech]. Prague: Argo, p. 7 – 130. ISBN 80-7203-254-2
10. ***2008: Considerable impact of long-term problems in state forests on sawmill production. In *Truhlářské Listy*, 12 (16): 42-46.
11. Federation of wood-working corporations in the Czech Republic: 1971
12. ***http://www.pilavystrkov.cz/historie.php [cited 2009-02-17]

Corresponding address:

Ing. JAN BOMBA

Czech University of Life Sciences Prague
Fakulty of Forestry and Wood Sciences
Department of Wood Science and Technology
Kamýcká 1176, 165 21 PRAHA 6 – Suchdol
Czech Republic
e-mail: bomba@fld.czu.cz

LABORATORIJ ZA ISPITIVANJE NAMJEŠTAJA I DIJELOVA ZA NAMJEŠTAJ

Kvaliteta namještaja se ispituje i istražuje, postavljaju se osnove normi za kvalitetu, razvijaju se metode ispitivanja, a znanost i praksa, ruku pod ruku, kroče naprijed osiguravajući dobar i trajan namještaj s prepoznatljivim oznakama kvalitete. Kvalitete koja je temelj korisniku za izbor namještaja kakav želi. Taj pristup donio je Laboratoriju za ispitivanje namještaja pri Šumarskom fakultetu međunarodno priznavanje i nacionalno ovlaštenje te članstvo u domaćim i međunarodnim asocijacijama, kao i usku suradnju s njemačkim institutom LGA. Laboratorij je član udruge hrvatskih laboratorija CROLAB čiji je cilj udruživanje hrvatskih ispitnih, mjeriteljskih i analitičkih laboratorija u interesu unaprjeđenja sustava kvalitete laboratorija te lakšeg pridruživanja europskom tržištu korištenjem zajedničkih potencijala, dok je Šumarski fakultet punopravni član udruženja INNOVAWOOD kojemu je cilj doprinijeti poslovnim uspjesima u šumarstvu, drvnoj industriji i industriji namještaja s naglaskom na povećanje konkurentnosti europske industrije.

Istraživanje kreveta i spavanja, istraživanja dječjih kreveta, optimalne konstrukcije stolova, stolica i korpusnog namještaja, zdravog i udobnog sjedenja u školi, uredu i kod kuće neka su od brojnih istraživanja provedena u Zavodu za namještaj i drvne proizvode, kojima je obogaćena riznica znanja o kvaliteti namještaja.

- ovlašteni laboratorij za ispitivanje kvalitete namještaja i dijelova za namještaj
- istraživanje drvnih konstrukcija i ergonomije namještaja
- ispitivanje zapaljivosti i ekologičnosti ojastučenog namještaja
- sudska stručna vještačenja
- ispitivanje materijala i postupaka površinske obrade

Dobra suradnja s proizvođačima, uvoznicima i distributerima namještaja čini nas prepoznatljivima

Znanje je naš kapital

CROLAB LGA INNOVAWOOD euroinspekt drvoiontrola

385.1.235.2454.tel
385.1.235.2531.fax
lin@sumfak.hr
www.sumfak.hr

SVEUČILIŠTE U ZAGREBU
ŠUMARSKI FAKULTET
ZAVOD ZA NAMJEŠTAJ I DRVNE PROIZVODE
Svetošimunska c. 25, p.p. 422
HR-10002 ZAGREB

Mihály Varga, Etele Csanády, Zoltán Kocsis, Zalán Koppány Kovács[1]

Simulation in Wood Industry. Part I

Simulacija u drvnoj industriji. Dio I.

Professional paper · Stručni rad
Received – prispjelo: 18. 11. 2008.
Accepted – prihvaćeno: 16. 7. 2009.
*UDK: 630*79*

ABSTRACT • *The aim of our project was to answer the question of our multinational window and door hardware manufacturing company as to whether it was worth building a new hall and increase the output or not. Of course there were also other important questions to answer, such as what kind of array of manufacturing machines should be, what is the minimum number of employees (including employee redundancy), what is the right timing for incoming parts and outgoing products, etc. Such questions are usually hard to answer with classical methods. Therefore we have choosen other ways to solve the problem: the solution was to create a simulation model and simulate all processes in order to get the required results and answers. For this project we used the program SIMUL8 Company's SIMUL8 Professional.*

Key words: *simulation, flow-simulation, utilization, throughput*

SAŽETAK • *Cilj projekta bio je odgovoriti na upit multinacionalne tvrtke za proizvodnju prozora i vrata o isplativosti izgradnje novoga proizvodnog pogona i povećanja opsega proizvodnje. Usto je trebalo odgovoriti i na još niz pitanja, npr. koji je najbolji raspored strojeva, koliki je najmanji potrebni broj zaposlenika, koje je pravo vrijeme ulaska materijala u proizvodnju i izlaska gotovih proizvoda i sl. Na takva pitanja obično je teško odgovoriti uz pomoć klasičnih metoda. Stoga smo izabrali drugu metodu rješavanja postavljenih problema. Izradili smo simulacijski model i simulirali sve procese u proizvodnji kako bismo dobili tražene rezultate i odgovore. Za realizaciju simulacije primijenjen je program SIMUL8 Company's SIMUL8 Professional.*

Ključne riječi: *simulacija, simulacija toka, primjena simulacije, protok podataka*

1. UVOD
1 INTRODUCTION

1.1 What is simulation
1.1. Što je simulacija

Simulation is the imitation of some real thing, state of affairs, or process. The act of simulating something generally entails representing certain key characteristics or behaviours of a selected physical or abstract system. Of course there are many different definitions of simulation, but we mostly deel with the software SIMUL8, that specializes in discrete event simulation as described below.

1.2 Discrete event simulation
1.2. Simulacija diskretnih događaja

A simulation is a computer model that mimics the operation of a real or proposed system, such as the day-to-day operation of a bank, or the running of an assembly line in a factory, or the staff assignment of a hospital or call center.

The model is time based, and takes into account all the resources and constraints involved, and the way these things interact with each other as time passes. Simulation also builds in the randomness you would see in real life. For example it does not always take exactly 5 minutes for a customer to be served and a customer

[1] Authors are professor, associate professor and PhD students at University of West Hungary, Faculty of Wood Sciences, Institute of Machinery, Sopron, Hungary.
[1] Autori su profesor, izvaredni profesor i studenti doktorskog studija na Sveučilištu zapadne Mađarske, Fakultetu znanosti o drvu, Zavodu za tehnologiju drva i papira, Sopron, Mađarska.

does not always arrive every 15 minutes. This means that the model can really match reality - so something you try in the model will behave the same way as it would in real life.

With simulation you can quickly try out your ideas at a fraction of the cost of trying them in the real organization. And, since you can try ideas quickly, you can have many more ideas, and gain many insights, into how to run the organization more effectively.

1.3 Working of simulation
1.3. Provedba simulacije

When you click the run button in a simulation model you see the work you do (products, patients, paper work, etc.) move around the organization. The clock in the corner of the screen tells you what the equivalent time would be in the real system.

Simulation is animated. This enables visualization of a new facility and a greater ability to visualize the impact of experiments in an existing facility. You can see key bottlenecks, over-utilized resources and under resourced elements of a system.

The software automatically collects performance measures as the model runs so that you can not only see visually what will happen, you can also get accurate numerical results to prove your case.

Typical outputs include:
- Inventory
- Throughput
- Bottleneck utilization
- Productivity

Typical inputs include:
- Cycle time
- Staff levels
- Arrival/order rates
- Average order size

1.4 Possibilities of simulation
1.4. Mogućnosti simulacije

There are many scenarios that can be simulated. As a general rule systems that involve a process flow with discrete events can be simulated. So you should be able to simulate any process of which you can draw a flowchart.

The processes you will gain most benefit from simulating are those that involve change over time and randomness. For example a gas station. Nobody can guess at exactly what time the next car will arrive at the station, whether it will decide to purchase gas only, etc. It is not possible to model complex dynamic systems like this effectively in any other way.

1.5 Reasons to simulate
1.5. Razlozi za simulaciju

There are many process improvements you can make using simulation: higher quality and efficiency from capital assets, better management of inventory, higher return on assets - this list is endless. However, some of these improvements could be made without simulation, so the real question is 'Why use simulation instead of another method?'

Simulation vs. real life experimentation

Cost: Experimenting in real life is costly. It is not only the capital expenditure of hiring new staff or purchasing new equipment but also the cost of the effects of these decisions. What if you fire 3 employees and then find you cannot cope with the workload and you loose customers? The only cost with simulation is the software and the man hours required to build the simulation.

Repeatability: In real life it is really difficult to repeat the exact circumstances again so you only get 1 chance to collect the results and you cannot test different ideas under exactly the same circumstances. So how do you know which idea is really the best. With simulation you can test the same system again and again with different inputs.

Time: If you want to know whether hiring another 3 doctors will reduce patient waiting lists over the next 2 years you will actually have to wait for 2 years. With simulation you can run 2, 10 or even 100 years into the future in seconds. So you get the answer now instead of when it is too late to do anything about it.

Simulation vs. other mathematical modeling techniques

Interaction of Random Events: Some other mathematical tools can mange to effectively model a steady state scenario but only simulation lets you build in random occurrences like a machine breaking down and see the effects of this further down the line. The more complex the scenario is the more these tools fall down and simulation is the only answer.

Non Standard Distributions: Many mathematical techniques force the model builder to describe a situation as an approximation, it takes an average of 5 minutes to serve each customer. In real life this is not the case. It takes 3 minutes to serve the customer if they have 4 items, it takes 7 minutes if they have 20 items. Approximate mean results such as resource utilization time and customer waiting time are all inaccurate. Only simulation gives you the flexibility to describe events and timings as they actually are in real life.

Makes you think: Simulation provides a vehicle for a discussion about all aspects of a process. The rule

Table 1 Used parts
Tablica 1. Upotrijebljeni dijelovi

	Machine ID / *ID stroja*			
	1	*2*	*3*	...
Part ID ID dijela	100065	100065	100065	...
	100066	**100066**	**100066**	...
	100086	**100086**	**100086**	...
	100087	100087	100087	...
...	...	...	...	...

Part ID – A globally unique part identifier (number) in the ERP system / *ID dijela – jedinstveni broj dijela proizvoda u ERP sustavu;* Machine ID – A globally unique machine identifier (number) in the ERP system / *ID stroja – jedinstveni broj stroja u ERP sustavu*

Table 2 Probability profile of the product structure
Tablica 2. Profil vjerojatnosti strukture proizvoda

	Machine ID *ID stroja*	**Probability** *Vjerojatnost*	**Machine ID** *ID stroja*	**Probability** *Vjerojatnost*	**Machine ID** *ID stroja*	**Probability** *Vjerojatnost*	...
	1	%	*2*	%	*3*	%	...
Product ID	**230639**	23,32	260298	17,71	260298	17,71	...
ID proizvoda	260299	34,71	260299	34,71	260299	34,71	...
	260300	17,68	260300	17,68	260300	17,68	...
	260307	4,8	260307	4,8	260307	4,8	...
...	...	...	...	...	...	...	...

Product ID – A globally unique product identifier (number) in the ERP system / *ID proizvoda – jedinstveni broj proizvoda u ERP sustavu;*
Machine ID – A globally unique machine identifier (number) in the ERP system / *ID stroja – jedinstveni broj stroja u ERP sustavu*

and data collection forces you to consider why elements work in a certain way, if they could work better. It also brings to the surface inconsistencies and inefficiencies especially between different sections of a process that work independently. Sometimes the simulation does not even have to be finished and the framework it has provided to think through the issues reveals the solution.

Communication: As simulation is visual and animated it lets you clearly describe your proposal to others. Its more convincing than just displaying the end results as people cannot see where these came from. Simulation is so effective in communicating ideas that many companies now use it as a sales tool to sell their products.

2 MATERIAL AND METHODS
2. MATERIJAL I METODE

2.1 Realizing the simulation
2.1. Realizacija simulacije

If we want to realize a simulation, the first thing we should do is to understand the situation. In this particular case as, mentioned above, our partner was a multinational market-leader hardware-manufacturing company that wanted to know whether it was worth building a new hall and increase the troughput or not. In the new hall there are about 30 hardware-manufacturing machines of 6 types, with more than a 1000 connections between them, resulting of course in different kinds of simulation parametres and different kinds of goals. There is, however, a common goal between them and this is to maximize the troughput. Of course, it is not always certain that this can be achived by the sum of local troughput maximums.

2.2 Concept and model
2.2. Koncept i model

The simulation model is based on the SIMUL8 toolkit library, as well as on the customer needs. In this case the main concept was to develop a simulation, which can be easily used and which has a widely reusable output.

Further to the above, we created some simple, but marginal *parametres* that are easy to obtain, and with them the output values of the simulation represented the reality. There are two kinds of parametres: *global* and *local*.

With *global* parametres, you can obtain the following:

– What are the parts necessary for any product to be assembled (Table 1)

With this option we can define an array of parts that are needed in the simulation at all. This array is the base of a generator script, which generates the SIMUL8 objects with the proper parametres (i.e. Part Number) that represents the real-life parts.

– What kinds of products to be produced and in what ratio

In this array we can define what kind of product should be produced and in what machine ratio by machine. Of course it is possible to produce a product in 0%. This means that this product will never be produced in the current simulation context.

Here we have to mention the opportunity to define the optimal product matrix, because every product has a price and a cost of production. If we could define a proper ratio product by product for minimizing the global cost and maximizing the global price, we would get the optimal producing matrix. Backward of this method is the demand of a huge computer capacity. One variation takes 10–15 minutes to play on a mid-range computer, thus if we suppose that the global result takes e.g. 1000 step, we get a huge time as bare computer time, not to mention if the 1000 step is not enough!

– What parts are needed for a product to be assembled

It is a marginal part of simulation, when SIMUL8 defines the parts for a product. There is a built-in script,

Table 3 Product data retrieved directly from SAP
Tablica 3. Podaci o proizvodu preuzeti iz baze SAP

Product ID *ID proizvoda*	**Product description** *Opis proizvoda*	**Quantity** *Količina*
230639	FZ-AXARM N620A06116L	163 773
230640	FZ-AXARM N620A06116R	114 728
263183	FZ-AXARM N620A05116L	34 014
263184	FZ-AXARM N620A05116R	30 842
331513	FZ-AXARM HEBEL L NT	26 347
...	...	...

Table 4 Parts data retrived directly from SAP
Tablica 4. Podaci o dijelovima proizvoda preuzeti iz baze SAP

Product ID *ID proizvoda*	**Part ID** *ID dijela*	**Part description** *Opis ili naziv dijela proizvoda*	**Quantity** *Količina*
230639	208888	BUCHSE AX-BD GEBREMST	1000
230639	242405	AXERBD-K 12/20-13	1000
230639	232011	SENK-NIET AXER	2000
230639	374834	FALZAXERWINKEL	1000
230639	349639	Hebel links	1000
230639	349634	Exzenter	1000
230639	263188	STELLPLATTE	1000
230639	100059	V.KART.29	10
230639	**100066**	TAUSCHPALETTE	0,63
230639	100126	V.KART.	0,63
230639	**100086**	ZWISCHENLAGE	1,25
230639	232815	DIST-HOLZ L320	2,5
230639	232817	QUER-HOLZ L787	1,25
230639	100090	HEFTZWECKE 42/19 NK	12,5
230639	100271	KUNSTSTOFFBANDGIERUNG	3,75
0**230639**	100301	ETIKETT-1 99X105	10
230639	100302	ETIKETT-3 148X105	2,5
230640	208888	BUCHSE AX-BD GEBREMST	1000
230640	242405	AXERBD-K 12/20-13	1000
...	..	...	...

which solves this problem. There are two tables, where in the first table (Table 3) we store products (identified by a ProductID), while in the second table (Table 4) we store the parts (identified by the *PartID*) and of course here we use the *ProductID* as a foreign key to decide which part belongs to which product.

With *local* parametres, you can obtain the following:

– Timing
  This allows you to say how often work will arrive. A variable or label can be entered of course.
– Routing In parametres
  Controls how work is selected by the work center.
– Routing Out parametres
  Controls how work leaves the work center.

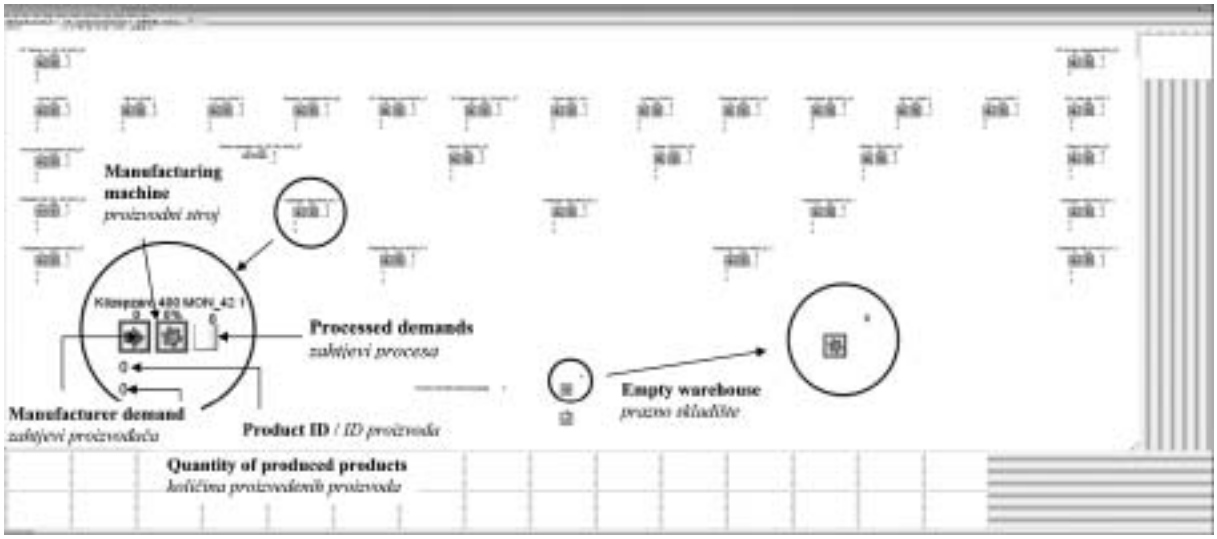


Figure 1 Scheme of simulation processes
Slika 1. Shema procesa simulacije

Table 5 Produced products
Tablica 5. Izrađeni proizvodi

	Machine ID / *ID stroja*												
Product ID *ID proizvoda*	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	...	**Psc.** *Kom.*	**Pal.** *Paleta*	**Mass, kg** *Masa, kg*
...	...	...	...	...	...	...	...	...	...	...	...	...	...
260297	0	0	0	0	0	0	0	0	0	...	0	0	0
260298	0	0	0	0	0	0	0	0	0	...	0	0	0
260299	503	894	984	665	1000	0	728	0	0	...	4774	6	2349
260300	0	0	0	0	0	0	0	969	879	...	1848	1	1214,28
260303	0	0	0	0	0	0	0	0	0	...	0	0	0
260304	0	0	0	0	0	0	0	0	0	...	0	0	0
260305	0	0	0	0	0	0	0	0	0	...	0	0	0
260306	0	0	0	0	0	0	0	0	0	...	0	0	0
260307	0	0	0	0	0	0	0	0	0	...	0	0	0
260308	0	0	0	0	0	1000	0	0	0	...	1000	1	530
260309	0	0	0	0	858	0	0	0	0	...	858	2	514,81
...	....	...	...	...	...	...	...	...	...	...	...	...	...

Product ID – A globally unique product identifier (number) in the ERP system / *ID proizvoda – jedinstveni broj proizvoda u ERP sustavu*; Machine ID – A globally unique machine identifier (number) in the ERP system / *ID stroja – jedinstveni broj stroja u ERP sustavu*; Pcs. – The number of the pieces of the product with the given ID produced within the simulation / *broj izrađenih komada određenog ID proizvoda unutar simulacije;* Pal. – The number of the palettes of the product with the given ID produced within the simulation / *broj paleta gotovih proizvoda*; Mass – The net weight of the produced product of the given ID / *neto masa gotovih proizvoda*

– Tabel actions
  Tells a work center how to change a work item's labels as they come through the work center.
– Resources
  Requires a resource before work can be completed by e.g. a work center.

3 RESULTS AND DISCUSSION
3. REZULTATI I DISKUSIJA

As it can be seen on Figure 1 and Figure 2, finally, the simulation does not look too complicated, but inside there are many intelligent scripts working to satisfy specific needs. When we open the simulation, and fill in tha data in the tables mentioned above, SIMUL8 generates the whole simulation context with all the simulation objects, as required. There is a script for building the part-objects, another that creates the proper connections between the parts and the producer objects, and also another that generates demands according to the set needs as shown in Table 2. So after the simulation is started, every machine shows what kind of product is produced by itself right now, and how many are left from those to be produced from the defined value specified in the demand. As the simulation time passes by, some of the specific properties of the manufacturer

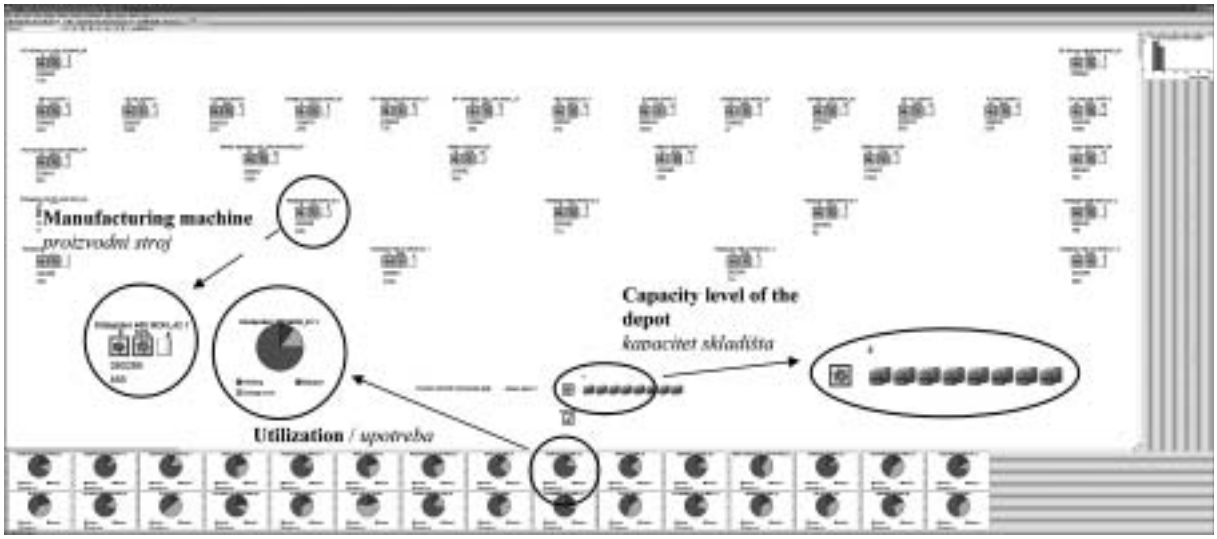


Figure 2 Simulation in 24 hour
Slika 2. Simulacija unutar 24 sata

machines become clearly obvious from the pie chart at the bottom of Figure 2.

Actually, there is no limitation of properties shown. It depends on the imagination of the simulation builder or on the customer needs. Every kind of value can be displayed graphically.

4 CONCLUSION
4. ZAKLJUČAK

It is obvious that evaluating the results always depends on the parametres that have been enetered into the simulation. The primary goal is to collect proper data for the simulatuion. Mostly this is understated, because it is hard to achieve and sometimes it takes a long time, e.g. in a company, where data are not stored in a modern way, or where there are many different kinds of machines with different kinds of parametres. It should be mentioned that collecting data is not cheap at all, and however it is worth it! In this particular case the primary goal has been reached, because we could give our customer accurate and relevant data. Since then the new hall has been built, and the after-sampled data confirmed the results of the simulation and brought satisfaction both for us and our partner.

5 REFERENCES
5. LITERATURA

1. Hauge, J.W.; Paige, K.N. 2004: Learning SIMUL8: The complete guide 2, Bellingham, USA, 715 – 856.
2. Varga, M.; Csanády, E.; Kovács, Z.; Kocsis, Z. 2008: *Simulation in Furniture Industry I. Producing Components*, Sopron.
3. **** 2008: SIMUL8 Corporation, *http://www.simul8.com*.

Corresponding address:

Associate professor ETELE CSANÁDY, PhD

University of West Hungary
Faculty of Wood Sciences
Institute of Machinery
Sopron, Hungary
e-mail: ecsanady@fmk.nyme.hu

Izložba minijaturnog namještaja

Muzej za umjetnost i obrt, Zagreb, 14. svibnja – 31. kolovoza 2009.

U sklopu ciklusa *Događanja u stalnom postavu MUO*, postavljena je izložba autorice Vanje Brdar Mustapić, voditeljice Zbirke namještaja. Zbirka obuhvaća dvadesetak izložaka namještaja malih dimenzija, proizvedenih u Hrvatskoj i ostalim europskim državama. Na prvi pogled taj namještaj podsjeća na namještaj za kuću lutaka i premda je jedan od izložaka upravo kuća za lutke s pripadajućim namještajem, većina izložaka izrađena je za druge namjene. Uz kuću za lutke (sl. 6), najveći je eksponat minijaturni kredenc – sekreter, dimenzija 105 x 50 x 24 cm (sl. 1) i naslonjač za dijete, dimenzija 61 x 35 x 38 cm (sl. 1. i 3).

Povijesni razvoj europskoga minijaturnog namještaja započeo je u srednjem vijeku, a njegova izvedba odgovara stilskim i oblikovnim značajkama pojedinog razdoblja. Tipovi namještaja, materijal izrade i tehnike ukrašavanja uglavnom su identične kao za veliki namještaj. Kraj 17. i, pogotovo, 18. stoljeće karakteristični su po procvatu izrade minijaturnog namještaja.

Slika 2. Minijaturna komoda, Austrija, druga četvrtina 18. st., jelovina, orahov furnir, intarzija, pozlaćena mjed

Jedna od namjena minijaturnog namještaja, oblikovanoga poput škrinjica, komodica i raznih vrsta ormarića, služila je za odlaganje sitnih predmeta kao što su numizmatičke zbirke, pisma, nakit ili pribor za ši-

Slika 1. Dio izložbe mijaturnog namještaja

Slika 3. Naslonjač za dijete, Srednja Europa, 19. st., djelomično izrezbarena orahovina, presvlaka od svilenog damasta, dimenzije 61 x 35 x 38 cm. Minijaturna komoda također potječe iz Srednje Europa, oko 1800. god., jelovina, orahovina, orahov furnir, intarzirane bordure, mjedeni lim, unutrašnjost od papira.

vanje (sl. 2-5). Namještaj poput naslonjača (prijestolja) ili kolijevki služio je za svetačke figure, i to najčešće za dijete Isusa.

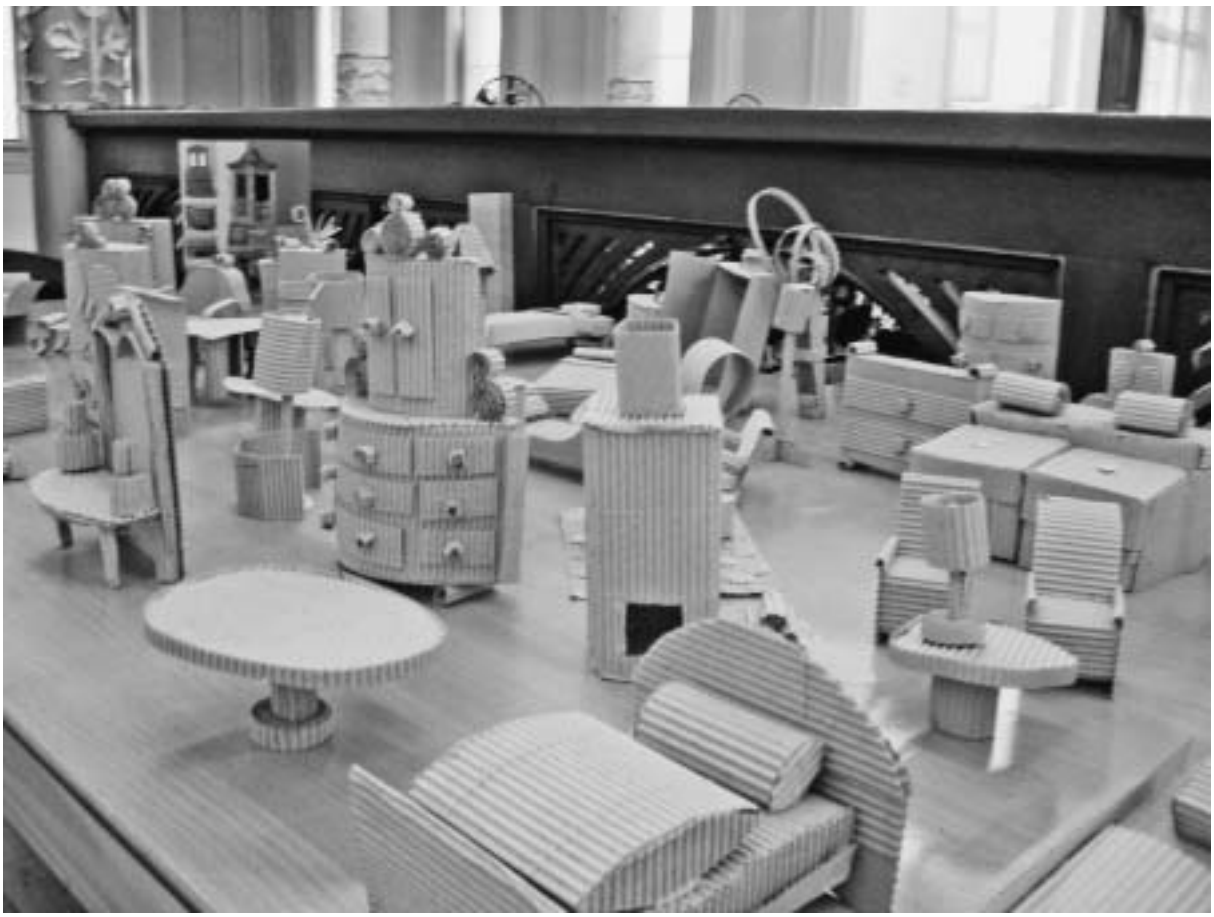
Da su se pri izradi namještaja primjenjivala antropometrijska mjerenja, svjedoči i minijaturni namještaj namijenjen djeci, npr. naslonjač iz 19. st. (sl. 1. i 3). Osim za djecu, minijaturni namještaj za sjedenje izrađivao se i za kućne ljubimce, a najčešće je bio namijenjen mačkama i manjim psima.

Namještaj malih dimenzija pretežito se izrađivao kao model kako bi plemstvo i imućni građani toga doba prije izrade namještaja u pravoj veličini mogli vidjeti izgled i kvalitetu na minijaturnomu modelu. Majstori su izrađivali model namještaja kakav bi trebao biti u prirodnoj veličini, pri čemu su upotrebljavali skupocjene materijale poput bjelokosti, srebra i pozlate. Pri tak-

Slika 4. Minijaturna komoda, Francuska 19. st., 1760. – 1770. god., furnir palisandera i ružina drva, pozlaćena mjed, mramor; dimenzije 30 x 35 x 20 cm

Slika 5. Minijaturni ormar – spreminca, Hrvatska, druga polovica 19. st., orahovina, mjed

Slika 6. Kuća za lutke, Beč, oko 1870. god.



Slika 7. Modeli namještaja od kartona izrađeni u sklopu radionice za djecu

voj izradi bila je potrebna posebna preciznost i velika vještina jer i u umanjenom obliku minucioznom izvedbom majstora, reproduciran je svaki i najmanji detalj, a namještaj je furniran često s intarzijama i inkrustacijama, zbog čega je pravo umjetničko djelo.

U sklopu izložbe održana je i radionica za djecu, a vrlo vjerni modeli namještaja iz 18. i 19. stoljeća od kartona izloženi su također u muzeju (sl. 7).

doc. dr. sc. Silvana Prekrat

Šumarski fakultet Sveučilišta u Zagrebu

u suradnji s

organizira i poziva Vas na

20. MEĐUNARODNO ZNANSTVENO SAVJETOVANJE

"DRVO JE PRVO – NOVI MATERIJALI, KVALITETA I DIZAJN PROIZVODA"

16. listopada 2009. godine, Zagrebački velesajam

Poštovani,

Naše tradicionalno savjetovanje u okviru 36. međunarodnog sajma namještaja, unutarnjeg uređenja i prateće industrije održat će se **16. 10. 2009. na Zagrebačkom velesajmu** pod pokroviteljstvom Ministarstva regionalnog razvoja, šumarstva i vodnoga gospodarstva. Tema ovogodišnjeg savjetovanja je "DRVO JE PRVO – NOVI MATERIJALI, KVALITETA I DIZAJN PROIZVODA".

Pozivamo Vas da nam se pridružite.

Predsjednik Znanstvenog odbora Savjetovanja
Prof.dr.sc. Ivica Grbac

Koordinatorica projekta AMBIENTA 09
Prof. dr. sc. Vlatka Jirouš-Rajković

AKREDITIRANI LABORATORIJ ZA DRVO U GRADITELJSTVU

Predgovor

Važan događaj u stručnom razvoju i suradnji drvnotehnoloških institucija s gospodarstvom jest akreditacija Laboratorija za drvo u graditeljstvu (LDG) Zavoda za namještaj i drvne proizvode Šumarskog fakulteta Sveučilišta u Zagrebu. Od 25. ožujka 2009. godine LDG je akreditiran prema odrednicama norme HRN EN ISO/IEC 17025, koja definira opće zahtjeve za osposobljenost ispitnih i umjernih laboratorija. Međunarodna ocjeniteljska komisija provjerila je način ustroja i rada laboratorija, te je potvrdila da LDG udovoljava europskim kriterijima. Laboratorij je akreditirao izabrane norme za ispitivanje drvenih podnih elemenata - svih vrsta masivnog parketa i podova, višeslojnog parketa, brodskog poda i opločnika, zatim svojstava površinske obrade podova i ljepila za parkete, te za ispitivanje odabranih fizikalnih svojstava drva bitnih za primjenu na podu (sadržaj vode, tvrdoća, gustoća, dimenzijska stabilnost). Laboratorij vodi ispitivanja početnog tipa proizvoda, pomaže pri ustrojavanju unutarnje proizvodne kontrole te koordinira ispitivanja s drugim ovlaštenim i akreditiranim laboratorijima za provedbu CE označivanja podnih elemenata. Osim navedenoga, laboratorij provodi mjerenja uvjeta na zgradama za izvedbu podova, konzultacije, seminare, stručna vještačenja i ima druge savjetodavne funkcije.

Pogled na dio laboratorija vidi se na slici 1, a potvrdu i kompletan popis akreditiranih normi (područje akreditacije) laboratorija moguće je vidjeti na stranici http://www.akreditacija.hr/akreditacija/registri.php?clear=true

Što je akreditacija

Akreditacija je riječ čije je podrijetlo u francuskom glagolu *acrediter*, s korijenom u latinskome *credere*, što znači *vjerovati.* Time se otkriva da *akreditirati* znači iskazati povjerenje, odnosno potvrditi da institucija udovoljava nekim formalnim zahtjevima ili propisima, te da joj se mogu povjeriti određeni zadaci ili poslovi.

Slika 1. Pogled na dio novouređenog Laboratorija za drvo u graditeljstvu na Šumarskom fakultetu u Zagrebu

Slika 2. Sva je mjerna oprema u Laboratoriju umjerena. U prvom je planu praktičan izum Hrvoja Turkulina koji omogućuje brza mjerenja sadržaja vode elektrootpornom metodom, bez mučnoga i bučnog udaranja sondom.

Akreditacija laboratorija jest formalno priznanje mjerodavnog tijela da je laboratorij osposobljen za provedbu određenih ispitivanja. Mjerodavno tijelo je Hrvatska akreditacijska agencija (HAA), članica Europske suradnje za akreditaciju (EA). Od trenutka kad je Hrvatska potpisala međudržavni sporazum (*Multi-lateral agreement, MLA)* s institucijama država Europske zajednice, akreditacija naših laboratorija značit će punopravno i automatsko priznavanje naših ispitnih izvješća u zemljama EZ-a. U postupku akreditacije mjerodavno povjerenstvo provodi kontrolu rada laboratorija s različitih stajališta, primjerice obavlja provjeru dokumentacije, organizacije i djelovanja laboratorija u sklopu svoje institucije i prema komitentima, provjeru točnosti opreme i provođenja metoda, načina rukovanja uzorcima, podacima i pohranom, provjeru osposobljenosti osoblja itd. Grupu za ocjenu LDG-a činili su djelatnici i ocjenjivači HAA-e, a tehnički ocjenjivač bio je voditelj jednoga od najrenomiranijih europskih instituta drvne znanosti i tehnike.

Na što se odnosi akreditacija

Akreditacija se odnosi na instituciju čiji se rad provjerava, a u ovom slučaju to je samostalna organizacijska jedinica – Laboratorij za drvo u graditeljstvu Zavoda za namještaj i drvne proizvode Šumarskoga fakulteta Sveučilišta u Zagrebu. Laboratorij određuju njegov prostor, oprema i osoblje, a njegovi su članovi: prof. dr. sc. Hrvoje Turkulin, voditelj, dr. sc. Goran Mihulja, zamjenik voditelja, Vjekoslav Živković, dipl. ing., voditelj kvalitete, te administrativno i tehničko osoblje: gđa Dubravka Cvetan, g. Danijel Mežnarić i g. Saša Janjuz.

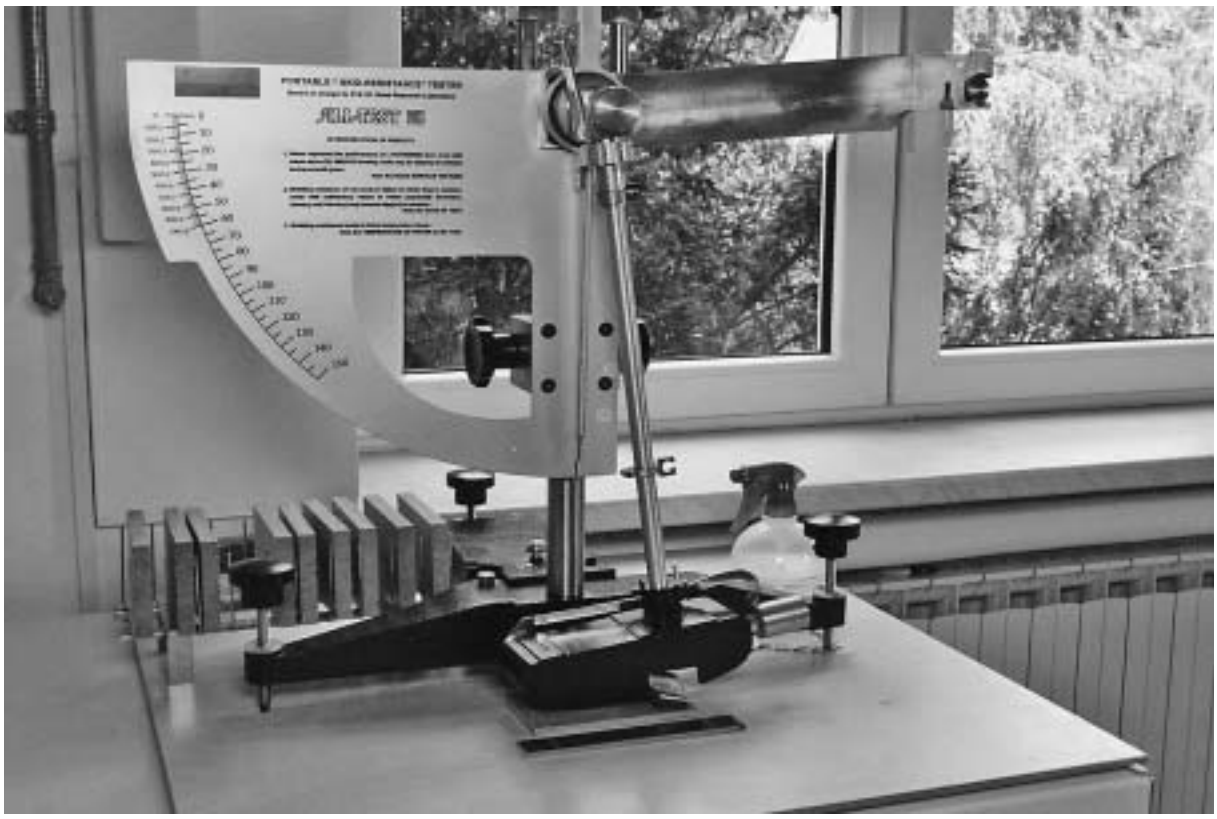
Akreditacija se odnosi i na akreditirana ispitivanja, a definirana je tzv. područjem akreditacije. U LDG-u se sadašnje područje akreditacije odnosi na ispitivanje drvenih podnih obloga, površinske obrade drvenih podova, ljepila za drvene podove i odabranih fizikalnih svojstava drva (*Testing wood flooring, finishes for wood flooring, adhesives for wood flooring and selected physical wood properties*).

Zašto se provodi akreditacija

Akreditacija se provodi radi zahtjeva tržišta, koje nastoji održavati mehanizam kojim se osigurava povjerenje u sigurnost i kvalitetu proizvoda. Norme, kojima se određuje i mjeri kvaliteta nekih proizvoda, nisu obvezne u primjeni. Kakogod, država može zahtijevati dokazivanje usklađenosti proizvoda sa zahtjevima sigurnosti, zdravlja i zaštite okoliša, te tehničkim propisima može obvezati proizvođače na dokazivanje određenih svojstava svojih proizvoda. Naravno, ispitivanje i deklariranje tih svojstava treba se provoditi u laboratorijima čiji je rad kvalitetan, neovisan, povjerljiv, provjerljiv i pouzdan, pa se te značajke rada laboratorija dokazuju postupkom akreditacije. Na taj se način uređuje sustav: uvodi se normizacijski sustav u područje tehnike, poboljšava se tehnička razina države i njezin odnos s međunarodnim asocijacijama, a država stvara sustav ovlaštenih laboratorija za provođenje mjerenja i ispitivanja. Naposljetku, korisnici su sigurni da će rezultati ispitivanja njihovih proizvoda, dobiveni u akreditiranim laboratorijima, vrijediti i na međunarodnom tržištu.

Kome je potrebna akreditacija

Akreditacija je potrebna laboratoriju koji sustavno provodi određena ispitivanja i stručne aktivnosti (mjerenja, ekspertize, vještačenja itd.). Na taj se način



Slika 3. Novi uređaj za ispitivanje klizavosti površine poda

podiže kvaliteta rada laboratorija, poboljšava njegova reputacija, a u konkurenciji to može značiti i opstanak u poslu. Akreditacija laboratorija potrebna je, međutim, i njegovim korisnicima jer suradnjom s takvim laboratorijem podiže se i jamči razina kvalitete njihove proizvodnje i proizvoda. Na taj način proizvođači dokazano boljim proizvodima mogu odrediti i veću cijenu, ili pak, u uvjetima više razine vlastite i vanjske kontrole, smanjiti mogućnost reklamacija.

Što za laboratorij znači akreditacija

Akreditirani je laboratorij prostor s *kontroliranim ulazom*: općenito, u laboratoriju se nastoji osigurati mogućnost da se što više detalja njegovih aktivnosti nadzire, bilježi, kontrolira, umjerava te da se može provjeriti. Okolišni uvjeti (npr. klimatski) strogo su praćeni i održavani, sva je oprema umjerena, provjerena i planski se nadzire. Tko god želi provjeriti neki podatak iz rada laboratorija u proteklom razdoblju, moći će npr. dobiti uvid u podatke o tome koji su uvjeti vladali na dan ispitivanja, kojom je opremom obavljeno mjerenje i je li ona u trenutku mjerenja bila ispravna i umjerena itd. Kontroliran je i postupak rukovanja uzorcima, tako da se osigura pouzdanost mjerenja i ponovljivost rezultata: svaki uzorak i mjerna mjesta na njemu obilježeni su i mogu se provjeriti. Uzorci su šifrirani, tako da ni ispitivači, ni drugi posjetitelji laboratorija ne mogu povezati rezultate s proizvođačem uzorka. U LDG-u je uveden sustav automatskog bilježenja mjernih rezultata i njihove automatske analize i obrade. Na taj način nitko od djelatnika laboratorija ne može utjecati na ispitni rezultat, pa on postaje objektivniji i pouzdaniji.

Takvo stanje uređenosti laboratorij održava redovitim provjerama i ocjenama vlastitih djelatnika među sobom, ocjenama unutar institucije, usporednim ispitivanjima s drugim laboratorijima te godišnjim vanjskim ocjenjivanjem cijelog sustava. Tim se sustavom postiže prepoznavanje i kontrolirano uklanjanje neusklađenosti u radu laboratorija.

Akreditacija za osoblje laboratorija znači dodatne troškove i povećanje obima poslova u usporedbi s onima u neakreditiranom laboratoriju. Svejedno, ti se dodatni troškovi vraćaju kroz povećanje ponude i cijene usluga akreditiranog laboratorija. Osoblje svojim stalnim usavršavanjem i razvojem laboratorija napreduje u radu u tako uređenom sustavu.

Što akreditirani laboratorij nudi korisnicima

Ispitne norme koje je akreditirao Laboratorij za drvo u graditeljstvu svrstavaju se u tri grupe ispitivanja podnih elemenata i svojstava podova. Prvo, to su fizikalna svojstva prirodnoga drva, kao i pregrijanoga drva (prTS CEN 15679) koja su bitna za uporabu na podu, npr. njegova tvrdoća, gustoća, sadržaj vode:

- Drvene podne obloge – Postupci uzorkovanja za ocjenu sukladnosti HRN EN 14762:2008
- Sadržaj vode piljenog drva – prvi dio: Gravimetrijsko određivanje HRN EN 13183-1:2008
- Sadržaj vode piljenog drva – drugi dio: elektrootporno određivanje HRN EN 13183-2:2008
- Drvo – Određivanje gustoće za ispitivanje fizikalnih i mehaničkih svojstava HRN ISO 3131:1999
- Određivanje otpornosti na utiskivanje (Brinell)-metoda ispitivanja HRN EN 1534:2008

Slika 4. Akreditacijska potvrda Laboratorija za drvo u graditeljstvu

Nadalje, akreditirana su svojstva podnih elemenata koja se ispituju u sustavu provjere kvalitete i početnom ispitivanju proizvoda (Initial Type Testing). Ispitivanja obuhvaćaju dimenzijske, oblikovne i estetske značajke sljedećih podnih elemenata:
- HRN EN 13226, masivni parket ("klasični")
- HRN EN 13227, lam parket
- HRN EN 13228, tanke obložne parketne daske
- HRN EN 13488, mozaik (lamel) parket
- HRN EN 13629, masivne (predgotovljene) podne ploče
- HRN EN 13489, višeslojni parket
- HRN EN 14354, furnirane podne obloge
- HRN EN 13990, brodski pod (četinjača)
- Ostale (HRN EN 14761 – "kant", štapići, blokovi; DIN 68702 – prizme ili opločnici)
- HRN EN 13647:2008, drvene i parketne podne obloge i drvene oplate te daščana pročelja – točnost dimenzija i oblika.

Usto se provode i obvezna i dopunska ispitivanja koja su povezana s CE označivanjem podnih elemenata:
- DIN CEN/TS 15676:2008-02, određivanje klizavosti drvenih podova – test njihalom
- HRN EN 1910: 2008, drvene i parketne podne obloge i pročelja - određivanje dimenzijske stabilnosti

Naposljetku, LDG mjerodavno ispituje svojstva površinskih slojeva (osobito lakova) drvenih podova, te ljepila za drvene podne elemente:
- Drvene podne obloge – Određivanje elastičnosti, otpornosti na trošenje i otpornosti na udar, RpHRN ENV 13696:2008
- Drvene i parketne podne obloge i drvene oplate i daščana pročelja – Otpornost na kemijska sredstva, HRN EN 13442:2008
- Ljepila za drvene podove – Fizikalna svojstva i čvrstoća lijepljenja, HRN EN 14293:2007

Tim skupinama ispitivanja LDG nudi našoj drvnoj industriji usluge za primjenu CE znaka (prema HRN EN 14342, Drveni podovi: svojstva, ocjena sukladnosti i označavanje) na njihovim proizvodima:
- tehničke konzultacije i zajedničko uvođenje tvorničke unutarnje kontrole,
- mjerenja kvalitete proizvoda prema „produkt"-normama (akreditirana mjerenja)
- određivanje dijela svojstava iz EN 14342 – mjerenje klizavosti
- suorganiziranje mjerenja u drugim ispitnim laboratorijima (otpornost na požar, kemijska svojstva pregrijanog drva, biološka svojstva, toplinska svojstva itd.), a od suradničkih laboratorija treba istaknuti Euroinspekt-Drvokontrolu, d.o.o. iz Zagreba i Slavonskoga Broda, CATAS iz Udina (Italija) te Holzforschung Austria iz Beča.

Što nije akreditirano

Važna skupina aktivnosti koju LDG još nije akreditirao, a koju već godinama provodi u suradnji s parketarskom, podopolagačkom i građevinskom strukom, jesu mjerenja na zgradama i ekspertize. Pri ocjenjivanju uvjeta za polaganje drvnih podova LDG je razvio sustav usporednog mjerenja svojstava podnih elemenata, podnih podloga te fizikalnih uvjeta na zgradi, kojim se ustanovljuje usklađenost svih parametara u sustavu i podobnost za izradu poda. U situaciji kakvoj smo svjedočili posljednjih godina, u kojoj se gradilo brzo, a često i nekontrolirano, mjerodavna i pouzdana ispitivanja LDG-a pridonijela su izbjegavanju mnogih grešaka i šteta. U sklopu tih aktivnosti LDG će pripremiti i ciklus seminarskih izlaganja u kojima će podopolagače teorijski i praktično usavršavati u postupcima terenskih mjerenja svojstava drva i uvjeta za pravilno izvođenje podova.

Pogovor

Šumarski fakultet Sveučilišta u Zagrebu, točnije njegov Drvnotehnološki odsjek sa svojim laboratorijima, razvijat će, osim nastave, dva osnovna smjera stručne aktivnosti: izvrstan znanstvenoistraživački rad, kao i aktivnu i praktičnu suradnju s gospodarstvom. Posljednje dvije godine poduzete su opsežne aktivnosti da bi se na fakultetu pripremio novi, zaseban prostor za laboratorije. Profesor Turkulin je, uz svoja dva mlađa suradnika, Vjekoslava Živkovića, dipl. ing. i dr. sc. Gorana Mihulju, uredio i opremio Laboratorij tako da može provoditi većinu normiziranih ispitivanja koja se odnose na drvene podove.

Da bi stručnjaci Šumarskog fakulteta mogli pouzdano i na odgovarajući način ispuniti zahtjeve i očekivanja gospodarstvenika, Fakultet će nastaviti razvijati i opremati ispitne laboratorije i poboljšavati njihovu stručnost. Akreditacija LDG-a trebala bi biti samo prva stanica na putu zajedničkog razvoja drvnoindustrijske djelatnosti i Fakulteta, koji će se uskoro, sasvim opravdano, zvati Fakultet šumarstva i drvne tehnologije.

prof. dr. sc. Hrvoje Turkulin

Cinnamomum camphora Nees et Eberm.

NAZIVI I NALAZIŠTE

Cinnamomum camphora Nees et Eberm. vrsta je drveta koja pripada porodici Lauraceae, a poznata je pod trgovačkim nazivima Camphor tree, Kusonoki, Ohez, Kalingag, Dalchini i Kayu. Prirodno je rasprostranjena u Tajvanu, južnom Japanu, jugoistočnoj Kini i Indokini. Uspješno se kultivira i u drugim područjima.

STABLO

Stablo je prosječno visoko od 18 do 30 metara, a samo deblo visoko je do 13 metara, promjera 60 do 120 centimetara. Listovi imaju sjajan voštani izgled i mirišu na kamfor. U proljeće je lišće zeleno, s mnogo malih bijelih cvjetova. Plodovi su u obliku malih grozdova nalik na kupinu, promjera oko 1 centimetar. Kora je blijeda i vrlo gruba, s uzdužnim žljebovima.

Premda je stablo atraktivnog izgleda, a krošnja stvara duboku sjenu, može biti vrlo destruktivno. Vrlo se lako razmnožava, korijenje mu se brzo širi, a kamfor iz listova loše djeluje na okolnu vegetaciju.

DRVO

Makroskopska obilježja

Bjeljika drva vrlo je slične boje kao srž i teško se od nje razlikuje. Srž je svjetložuto-smeđa, svjetloružičasta ili crvenosmeđa, često s tamnim prugama.

Žica drva je ravna, usukana ili valovita, a tekstura srednje fina do fina. Godovi su dobro vidljivi golim okom, a drvni traci nisu vidljivi bez povećala. Drvo je izrazito jakoga, ali ugodnog mirisa na kamfor ili anis.

Mikroskopska obilježja

Drvo je rastresito porozno. Promjer pora je od 50 do 200 mikrometara, a gustoća pora je od 30 do 125 na 10 mm^2. Traheje su radijalno ili difuzno raspoređene i često ispunjene tilama. Perforacije članaka traheja jednostavne su. Intervaskularne su jažice velike. Drvni traci široki su od 4 do 10 stanica. Aksijalni je parenhim paratrahealan, vazicentričan, aliforman ili konfluentan. Ima i uljanica ili sluznica. Libriformska su vlakanca debelostjena.

Fizikalna i mehanička svojstva

Prosušeno drvo srednje je gustoće, oko 450 kg/m^3. Tangentno utezanje iznosi oko 8,0 %, radijalno oko 5,0 %, a volumno oko 10,0 %.

TEHNOLOŠKA SVOJSTVA

Obradivost

Drvo se lako ručno i strojno obrađuje.

Dobro se pili, ljušti, lako se zakiva čavlima, lijepi, brusi, pjeskari i politira standardnim postupcima.

Sušenje

Drvo se lako prirodno suši, obično s malim greškama. Pri sušenju u sušionicama drvo se može izvitoperiti.

Trajnost i zaštita

Drvo *Cinnamomum camphora* prirodno je otporno na napade gljiva uzročnica bijele i smeđe truleži, ali može biti podložno i napadu termita.

Uporaba

Drvo pravilne žice, bez grešaka, upotrebljava se za proizvodnju furnira, stolarije i laganih drvenih konstrukcija. Na Dalekom istoku služi za proizvodnju trupaca, drvenih sanduka i drvenih lijesova. No drvo *Cinnamomum camphora* nekad je bilo poznatije po tome što se od njega dobivao kamfor, koji se rabi u medicini, kao važan sastojak bezdimnog baruta, a upotrebljava se i kao začin jelu. Danas se kamfor dobiva i sintetičkim putem.

Literatura

1. Brazier, J.; Franklin, G.L. 1961: Identification of Hardwoods – A microscope key, FPR Bulletin No. 46, HMSO, London.
2. Rendle, B.J. 1970: World timbers, London: Ernest Benn limited University of Toronto press, vol. 3, str. 14.
3. *** 1970: Identification of Hardwoods – A lens key, FPR Bulletin, No. 25, HMSO, London.
4. *** 1979: The Timber Research and Development Association (TRADA): Timbers of the world, The Construction Press Ltd., Lancaster, England.
5. *** Wikipedia, the free encyclopedia.

izv. prof. dr. sc. Jelena Trajković

dr. sc. Bogoslav Šefc

Portal of scientific journals of Croatia

http://hrcak.srce.hr/

Upute autorima

Sve autore molimo da prije predaje rukopisa pažljivo prouče sljedeća pravila. To će poboljšati suradnju urednika i autora te pridonijeti skraćenju razdoblja od predaje do objavljivanja radova. Rukopisi koji budu odstupali od ovih odredbi i ne budu udovoljavali formalnim zahtjevima bit će vraćeni autorima radi ispravaka, i to prije razmatranja i recenzije.

Opće odredbe

Časopis "Drvna industrija" objavljuje izvorne znanstvene i pregledne radove, prethodna priopćenja, stručne radove, izlaganja sa savjetovanja, stručne obavijesti, bibliografske radove, preglede te ostale priloge s područja iskorištavanja šuma, biologije, kemije, fizike i tehnologije drva, pulpe i papira te drvnih proizvoda, uključivši i proizvodnu, upravljačku i tržišnu problematiku u drvnoj industriji.

Predaja rukopisa razumijeva uvjet da rad nije već predan negdje drugdje radi objavljivanja i da nije već objavljen (osim sažetka, dijelova objavljenih predavanja ili magistarskih radova odnosno disertacija; što mora biti navedeno u napomeni); da su objavljivanje odobrili svi suautori (ako ih ima) i ovlaštene osobe ustanove u kojoj je rad proveden. Kad je rad prihvaćen za objavljivanje, autori pristaju na automatsko prenošenje izdavačkih prava na izdavača te pristaju da rad ne bude objavljen drugdje niti na drugom jeziku bez odobrenja nositelja izdavačkih prava.

Znanstveni i stručni radovi objavljuju se na hrvatskome uz širi sažetak na engleskome ili njemačkome, ili se pak rad objavljuje na engleskome ili njemačkome, s proširenim sažetkom na hrvatskom jeziku. Naslovi i svi važni rezultati trebaju biti dani dvojezično. Ostali se članci uglavnom objavljuju na hrvatskome. Uredništvo osigurava inozemnim autorima prijevod na hrvatski. Znanstveni i stručni radovi podliježu temeljitoj recenziji bar dvaju izabranih recenzenata. Izbor recenzenata i odluku o klasifikaciji i prihvaćanju članka (prema preporukama recenzenata) donosi Urednički odbor.

Svi prilozi podvrgavaju se jezičnoj obradi. Urednici će zahtijevati od autora da prilagode tekst preporukama recenzenata i lektora, a urednici zadržavaju i pravo da predlože skraćivanje i poboljšanje teksta.

Autori su potpuno odgovorni za svoje priloge. Podrazumijeva se da je autor pribavio dozvolu za objavljivanje dijelova teksta što je već negdje drugdje objavljen, te da objavljivanje članka ne ugrožava prava pojedinca ili pravne osobe. Radovi moraju izvještavati o istinitim znanstvenim ili tehničkim postignućima. Autori su odgovorni za terminološku i metrološku usklađenost svojih priloga.

Radovi se, u dva tiskana primjerka i u elektronskom zapisu, šalju na adresu:

Uredništvo časopisa "Drvna industrija"
Šumarski fakultet Sveučilišta u Zagrebu
Svetošimunska 25, HR - 10000 Zagreb
E-mail: drind@sumfak.hr

Rukopisi

Predani rukopisi smiju sadržavati najviše 15 jednostrano pisanih DIN A4 listova s dvostrukim proredom (30 redaka na stranici), uključivši i tablice, slike i popis literature, dodatke i ostale priloge. Dulje članke je preporučljivo podijeliti u dva ili više nastavaka.

Tekst treba biti napisan u MS Wordu, u normalnom stilu bez dodatnog uređenja teksta. Uredništvo prihvaća elektronski zapis na disketi, CD-u ili putem elektronske pošte.

Prva stranica poslanog rada treba sadržavati puni naslov, ime(na) i prezime(na) autora, podatke o zaposlenju (ustanova, grad i država), te sažetak s ključnim riječima (približno 1/2 DIN A4 stranice, u obliku bibliografskog sažetka).

Znanstveni i stručni radovi na sljedećim stranicama trebaju imati i naslov, prošireni sažetak i ključne riječi na jeziku različitom od onoga na kojem je pisan tekst članka (npr. za članak pisan na engleskome ili njemačkome naslov, prošireni sažetak i ključne riječi trebaju biti na hrvatskome, i obratno). Prošireni sažetak (približno 1 1/2 stranice DIN A4), uz rezultate, trebao bi omogućiti čitatelju koji se ne služi jezikom kojim je pisan članak potpuno razumijevanje cilja rada, osnovnih odrednica pokusa, rezultata s bitnim obrazloženjima te autorovih zaključaka.

Posljednja stranica sadrži titule, zanimanje, zvanje i adresu (svakog) autora, s naznakom osobe s kojom će Uredništvo biti u vezi.

Znanstveni i stručni radovi moraju biti sažeti i precizni, uz izbjegavanje dugačkih uvoda. Osnovna poglavlja trebaju biti označena odgovarajućim podnaslovima. Napomene se ispisuju na dnu pripadajuće stranice, a obrojčuju se susljedno. One koje se odnose na naslov označuju se zvjezdicom, a ostale natpisnim (uzdignutim) arapskim brojkama. Napomene koje se odnose na tablice pišu se ispod tablice, a označavaju se uzdignutim malim pisanim slovima abecednim redom.

Latinska imena pisana kosim slovima trebaju biti podcrtana.

U uvodu treba definirati problem i, koliko je moguće, predočiti granice postojećih spoznaja, tako da se čitateljima koji se ne bave područjem o kojemu je riječ omogući razumijevanje namjera autora.

Materijal i metode trebaju biti što preciznije opisane da omoguće drugim znanstvenicima obnavljanje pokusa. Glavni eksperimentalni podaci trebaju biti dvojezično navedeni.

Rezultati trebaju obuhvatiti samo materijal koji se izravno odnosi na predmet. Obvezatna je primjena metričkog sustava. Preporučuju se SI jedinice. Rjeđe rabljene fizikalne vrijednosti, simboli i jedinice trebaju biti objašnjeni pri prvom spominjanju u tekstu. Za pisanje formula koristiti Equation Editor (program za pisanje formula unutar MS Worda). Jedinice se pišu normalnim (uspravnim) slovima, a fizikalni simboli i faktori kosim slovima. Formule se susljedno obrojčavaju arapskim brojkama u zagradama, npr. (1) na kraju retka.

Broj slika mora biti ograničen na samo one koje su prijeko potrebne za pojašnjenje teksta. Isti podaci ne smiju biti navedeni u tablici i na slici. Slike i tablice trebaju biti zasebno obrojčene arapskim brojkama, a u tekstu se na njih upućuje jasnim naznakama ("tablica 1" ili "slika 1"). Naznaka željenog položaja tablice ili slike u tekstu treba biti navedena na margini. Svaka tablica i slika treba biti prikazana na zasebnom listu, a njihovi naslovi moraju biti tiskani na posebnim listovima, i to redoslijedom. Naslovi, zaglavlja, legende i sav ostali tekst u slikama i tablicama treba biti pisan hrvatskim i engleskim ili hrvatskim i njemačkim jezikom.

Slike i tablice trebaju biti potpune i jasno razumljive bez pozivanja na tekst priloga. Naslove slika i crteža ne pisati velikim tiskanim slovima. Uputno je da crteži odgovaraju stilu časopisa i da budu tiskani na laserskom printeru. Tekstu treba priložiti izvorne crteže ili fotografske kopije. Slova i brojke moraju biti dovoljno veliki da budu lako čitljivi nakon smanjenja širine slike ili tablice na 160 ili 75 mm. Fotografije trebaju biti crno-bijele; one u boji tiskaju se samo na poseban zahtjev, a trošak tiskanja u boji podmiruje autor. Fotografije i fotomikrografije moraju biti izvedene na sjajnom papiru s jakim kontrastom. Fotomikrografije trebaju imati naznaku uvećanja, poželjno u mikrometrima. Uvećanje može biti dodatno naznačeno na kraju naslova slike, npr. "uvećanje 7500 : l".

Svaka ilustracija na poleđini treba imati svoj broj i naznaku orijentacije te ime (prvog) autora i skraćeni naslov članka. Originalne se ilustracije ne vraćaju autorima.

Diskusija i zaključak mogu, ako autori tako žele, biti spojeni u jedan odjeljak. U tom tekstu treba objasniti rezultate s obzirom na problem koji je postavljen u uvodu u odnosu prema odgovarajućim zapažanjima autora ili drugih istraživača. Valja izbjegavati ponavljanje podataka već iznesenih u odjeljku "Rezultati". Mogu se razmotriti naznake za dalja istraživanja ili primjenu. Ako su rezultati i diskusija spojeni u isti odjeljak, zaključke je nužno iskazati odvojeno.

Zahvale se navode na kraju rukopisa.

Odgovarajuću **literaturu** treba citirati u tekstu i to prema harvardskom ("ime - godina") sustavu, npr. (Bađun, 1965). Nadalje, bibliografija mora biti navedena na kraju teksta, i to abecednim redom prezimena autora, s naslovima i potpunim navodima bibliografskih referenci. Nazive časopisa treba skratiti prema publikacijama Biological Abstracts, Chemical Abstracts, Forestry Abstracts ili Forestry Products Abstracts. Popis literature mora biti selektivan, osim u preglednim radovima. Primjeri navođenja:

Članci u časopisima: Prezime autora, inicijal(i) osobnog imena, godina: naslov. Skraćeni naziv časopisa, godište (ev. broj): stranice (od - do). Primjer: *Bađun, S. 1965: Fizička i mehanička svojstva hrastovine iz šumskih predjela Ludbrenik, Lipovljani. Drvna ind. 16 (1/2): 2 - 8.*

Knjige: Prezime autora, inicijal(i) osobnog imena, godina: naslov. (ev. izdavačeditor): izdanje (ev. tom). Mjesto izdavanja, izdavač, (ev. stranice od - do).

Primjeri:

Krpan, J. 1970: Tehnologija furnira i ploča. Drugo izdanje. Zagreb: Tehnička knjiga.

Wilson, J.W.; Wellwood, R.W. 1965: Intra-increment chemical properties of certain western canadian coniferous species. U: W. A. Cote, Jr. (Ed.): Cellular Ultrastructure of Woody Plants. Syracuse, N.Y., Syracuse Univ. Press, pp. 551- 559.

Ostale publikacije (brošure, studije itd.):

Müller, D. 1977: Beitrag zür Klassifizierung asiatischer Baumarten. Mitteilung der Bundesforschungsanstalt für Forst- und Holzvvirtschaft Hamburg, Nr. 98. Hamburg: M. Wiederbusch.

Tiskani slog i primjerci

Autoru se prije konačnog tiska šalju po dva primjerka tiskanog sloga. Jedan primjerak treba pažljivo ispraviti upotrebom međunarodno prihvaćenih oznaka. Ispravci su ograničeni samo na tiskarske greške: dodaci ili promjene teksta posebno se naplaćuju. Autori znanstvenih i stručnih radova primaju besplatno po pet primjeraka časopisa. Autoru svakog priloga dostavlja se po jedan primjerak časopisa.

Instructions for authors

The authors are requested to observe carefully the following rules before submitting a manuscript. This will facilitate co-operation between the editors and authors and help to minimise the publication period. Manuscripts that differ from the specifications and do not comply with the formal requirements will be returned to the authors for correction before review.

General

The "Drvna industrija" ("Wood Industry") journal publishes original scientific and review papers, short notes, professional papers, conference papers, reports, professional information, bibliographical and survey articles and general notes relating to the forestry exploitation, biology, chemistry, physics and technology of wood, pulp and paper and wood components, including production, management and marketing aspects in the woodworking industry.

Submission of a manuscript implies that the work has not been submitted for publication elsewhere or published before (except in the form of an abstract or as part of a published lecture, review or thesis, in which case that must be stated in a footnote); that the publication is approved by all co-authors (if any) and by the authorities of the institution where the work has been carried out. When the manuscript is accepted for publication the authors agree to the transfer of the copyright to the publisher and that the manuscript will not be published elsewhere in any language without the consent of the copyright holders.

The scientific and technical papers should be published either in Croatian, with extended summary in English or German, or in English or German with extended summary in Croatian. The titles and all the relevant results should be presented bilingually. Other articles are generally published in Croatian. The Editor's Office provides the translation into Croatian for foreign authors.

The scientific and professional papers are subject to a thorough review by at least two selected referees. The Editorial Board makes the choice of reviewers, as well as the decision about the accepting of the paper and its classification - based on reviewers' recommendations - is made by Editorial Board.

All contributions are subject to linguistic revision. The editors will require authors to modify the text in the light of the recommendations made by reviewers and linguistic advisers. The editors reserve the right to suggest abbreviations and text improvements.

Authors are fully responsible for the contents of their contribution. The Editors assume that the author has obtained the permission for the reproduction of portions of text published elsewhere, and that the publication of the paper in question does not infringe upon any individual or corporate rights. Papers must report on true scientific or technical progress. Authors are responsible for the terminological and metrological consistency of their contribution.

The contributions are to be submitted in duplicate printout and an electronic version to the following address:

Editorial Office "Drvna industrija"
Faculty of Forestry, Zagreb University
Svetošimunska 25, HR - 10000 Zagreb, Croatia
E-mail: drind@sumfak.hr

Manuscripts

Submitted manuscripts must consist of no more than 15 single-sided DIN A-4 sheets of 30 double-spaced lines, including tables, figures and references, appendices and other supplements. It is advised that longer manuscripts be divided into
two or more continuing series.

Manuscripts should be written in MS Word, in normal style. Electronic version on diskettes, CD or sent by e-mail will be accepted with the printout.

The first page of the typescript should present full title, name(s) of author(s) with professional affiliation (institution, city and state), abstract with keywords in the main language of the paper (approx. 1/2 sheet DIN A4, concise in abstract form).

The succeeding pages of scientific and professional papers should present a title and extended summary with keywords in a language other than the main language of the paper (e.g. for a paper written in English or German, the title, extended summary and keywords should be presented in Croatian, and vice versa). The extended summary (approx. 1 1/2 sheet DIN A4), along with the results, should enable the reader who is unfamiliar with the language of the main text, to completely understand the intentions, basic experimental procedure, results with essential interpretation and conclusions of the author.

The last page should provide the full titles, posts and address(es) of (all) the author(s) with indication as to whom of the authors are editors to contact. Scientific and professional papers must be precise and concise and avoid lengthy introductions. The main chapters should be characterised by appropriate headings.

Footnotes should be placed at the bottom of the same page and consecutively numbered. Those relating to the title should be marked by an asterix, others by superscript arabic numerals. Footnotes relating to the tables should be printed below the table and marked by small letters in alphabetical order. Latin names to be printed in italic should be underlined.

Introduction should define the problem and if possible the frame of existing knowledge, to ensure that readers not working in that particular field are able to understand author's intentions.

Materials and methods should be as precise as possible to enable other scientists to repeat the work. Main experimental data should be presented bilingually.

Results: only material pertinent to the subject can be included. The metric system must be used. SI units are recommended. Rarely used physical values, symbols and units should be explained at their first appearance in the text. Formulas should be written by using Equation Editor in MS Word. Units are written in normal (upright) letters, physical symbols and factors are written in italics. Formulas are consecutively numbered with arabic numerals in parenthesis (e.g. (1)) at the end of the line.

The number of figures must be limited to those absolutely necessary for clarification of the text. The same information must not be presented in both a table and a figure. Figures and tables should be numbered separately with arabic numerals, and should be referred to in the text with clear remarks ("Table 1" or "Figure 1"). The position of the figure or a table in the text should be indicated on the margin. Each table and figure should be presented on a single separate sheet. Their titles should be typed on a separate sheet in consecutive order. Captions, headings, legends and all the other text in figures and tables should be written in both Croatian and in English or German.

Figures and tables should be complete and readily understandable without reference to the text. Do not write the captions to figures and drawings in block letters.

Line drawings should, if possible conform to the style of the journal and be printed on the laser printer. Original drawings or photographic copies should be submitted with the manuscript. Letters and numbers must be sufficiently large to be readily legible after reduction of the width of a figure/table to either 160 mm or 75 mm. Photographs should be black/white. Colour photographs will be printed only on special request; the author will be charged for multicolour printing.

Photographs and photomicrographs must be printed on highgloss paper and be rich in contrast. Photomicrographs should have a mark indicating magnification, preferably in micrometers. Magnification can be additionally indicated at the end of the figure title (e.g. Mag. 7500:1). Each illustration should carry on its reverse side its number and indication of its orientation, along with the name of (principal) author and a shortened title of the article. Original illustrations will not be returned to the author.

Discussion and conclusion may, if desired, be combined into one chapter. This should interpret results in relation of the problem as outlined in the introduction and of related observations by the author(s) or others. Avoid repeating the data already presented in the "Results" chapter. Implications for further studies or application may be discussed. Aconclusion should be added if results and discussion are combined.

Acknowledgements are presented at the end of manuscript.

Relevant **literature** must be cited in the text according to the name - year (Harvard-) system. In addition, the bibliography must be listed at the end of the text in alphabetical order of the author' s names, together with the title and full quotation of the bibliographical reference. Names of journals should be abbreviated according to Biological Abstracts, Chemical Abstracts, Forestry Abstracts or Forest Products Abstracts. The list of references should be selective, except in review papers. Examples of the quotation:

Journal articles: Author, initial(s) of the first name, year: Title. Abbreviated journal name, volume (ev. issue): pages (from - to). Example;

Porter, A.W. 1964: On the mechanics of fracture in wood. For. Prod. J. 14 (8):325 - 331.

Books: Author, first name(s), year: Title. (ev. editor): edition, (ev. volume), place of edition, publisher (ev. pages from - to). Examples:

Kollmann, F. 1951: Technologie des Holzes und der Hokwerkstoffe. 2nd edition, Vol. 1. Berlin, Göttingen, Heidelberg: Springer

Wilson, J.W.; Wellwood, R.W. 1965: Intra-increment chemical properties of certain western Canadian coniferous species. In: W.A. Côte, Jr. (Ed.): Cellular Ultrastructure of Woody Plants. Syracuse, N.Y., Syracuse Univ. Press, pp. 551-559.

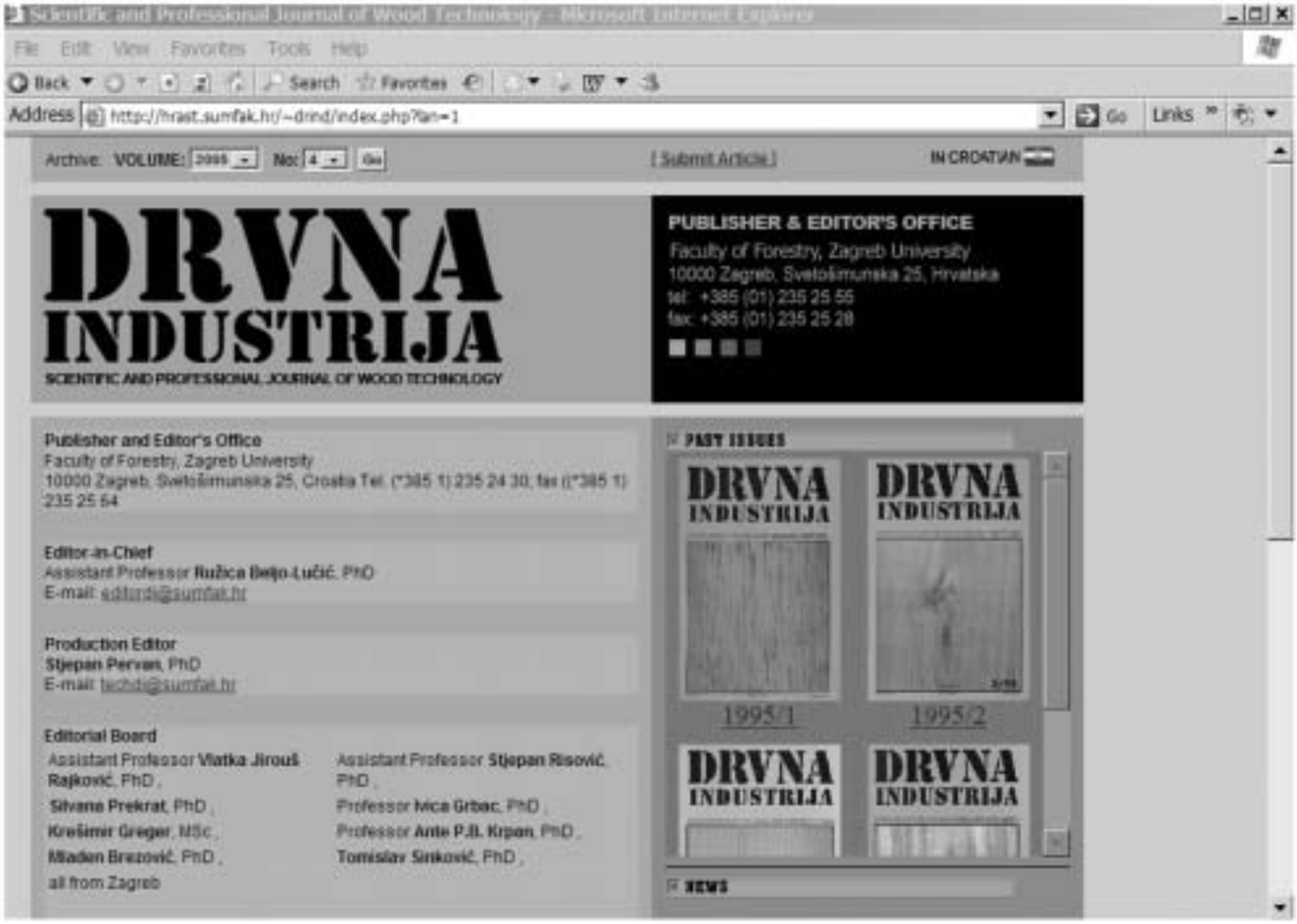
Other publications (brochures, reports etc.):

Müller, D. 1977: Beitrag zur Klassifizierung asiatischer Baumarten. Mitteilung der Bundesforschungsanslalt für Forst- und Holzwirtschaft Hamburg, Nr. 98. Hamburg: M. Wiederbusch.

Proofs and journal copies

Galley proofs are sent to the author in duplicate. One copy should be carefully corrected, using internationally accepted symbols. Corrections should be limited to printing errors; amendments to or changes in the text will be charged.

Authors of scientific and professional papers will receive 5 copies of the journal free of charge. Acopy of a journal will be forwarded to each contributor.



Search wood technology science at

http://drvnaindustrija.sumfak.hr/

LABORATORIJ

ZA HIDROTERMIČKU OBRADU DRVA I DRVNIH MATERIJALA

Ispitivanje procesa hidrotermičke obrade drva i drvnih materijala

Kontrola i određivanje sadržaja vode u drvu standardnim i nestandardnim metodama

Određivanje makro i mikroklimatskih uvjeta za prirodno sušenje, organizacija stovarišta

Projektiranje i razvoj klasičnih i nekonvencionalnih načina sušenja

Projektiranje parionica

Izrada i modifikacija režima sušenja drva

Savjetovanje u odabiru tehnologije sušenja

Provođenje standarda kvalitete sušenja

Odabir parametara savijanja drva

Detekcija pogrešaka u hidrotermičkoj obradi drva i sprečavanje njihovog nastanka

Skraćivanje postupka sušenja drva

Izračun troškova sušenja drva

385 1 235 2509 tel
385 1 235 2544 fax
hidrolab@sumfak.hr
pervan@sumfak.hr
www.sumfak.hr

SVEUČILIŠTE U ZAGREBU
ŠUMARSKI FAKULTET
ZAVOD ZA TEHNOLOGIJE MATERIJALA
Svetošimunska c. 25, p.p. 422
HR-10002 ZAGREB