V/14. MAPPING OF PROCESS CAPABILITIES IN THE SECONDARY WOOD PROCESSING

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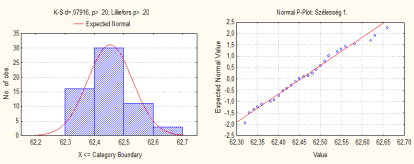
STEP OF RESEARCH PROCESS IN PICTURES

1. MATERIAL AND MACHINE

2. BASIC STATISTICS AND NORMALITY CONTROL

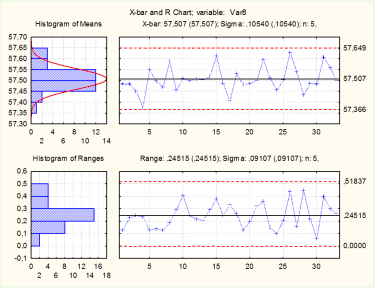


3. SIGNIFICANCE-TEST USING T-TEST

T-test for Independent Samples (u=20 vf=8000)
Note: Variables were treated as independent samples

Group 1 vs. Group 2	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2
Bükk - Szélesség vs. Tölgy - Szélesség	40,09540	40,01522	4,883211	57	0,000009	29	30

4. DETERMINATION OF THE CAPABILITY INDICES



Machine capability index of Spruce (width)	Variable: Var8 (v20u12) -3,000 *Sigma+57, 1770 +3,000 *Sigma+57, 837 6
	Value
Lower Specification Limit	57,30000
Nominal Specification	57,50000
Upper Specification Limit	57,70000
PP (performance index)	0,6655 3
PR (performance ratio)	1,00144
PPK (perf. demonstr. excell.)	0,5835 1
PPL (lower performance index)	0,6275 5
PPU (upper performance index)	0,5835 1

Process capability index of Spruce (width)	Variable: Var8 (v20u12) -3,000 *Sigma+57, 1911 +3,000 *Sigma+57, 8251
	Value
Lower Specification Limit	57,30000
Nominal Specification	57,50000
Upper Specification Limit	57,70000
CP (potential capability)	0,6325 1
CR (capability ratio)	1,58090
CPK (demonstrated excellence)	0,60955
CPL (lower capability index)	0,65552
CPU (upper capability index)	0,60955
K (non-centering correction)	0,03639
CPM (potential capability II)	0,60423

5. RESULTS AND DISCUSSION:

INTRODUCTION

The focus of the present study is to determine to what extent the currently applied speed of feeding on moulding machines (8 to 12 m/min) can be increased without compromising precision of machining as characterised by the process capability indices and central tendency of the machined parts' critical dimensions.

MATERIAL AND METHODS

Machine observed: Weinig Powermat 1000, 8-spindle moulding machine,

Wood species used: Black locust u=8,6% (*Robinia pseudoacacia*), Beech (*Fagus silvatica*) u=8,4%, Poplar (*Populus ssp.*) u=8,2%, Oak (*Quercus robur*) u=9,7%, Spruce (*Picea excelsior*) u=7,7%

- Size of samples: 120 parts per species (total: 600 parts),
- Machine settings: 3 different settings per species (total 15): 1st setting: u= 20 m/min v_f=12000 1/min, 2nd setting: u= 20 m/min v_f= 8000 1/min 3rd setting: u= 10 m/min v_f=12000 1/min.

BASICS STATISTICS AND TEST OF NORMAL DISTRIBUTION

Measured data was evaluated by using the software package STATISTICA. The hypothesis of normal distribution of date sets was checked by histograms and probability plots. It could be established that in 80% of the cases the hypothesis of normality was acceptable.

SIGNIFICANCE TESTS USING T-TEST

Differences between the individual samples' means were tested for significance by using t-tests.at α=0,05 significance level (test results with p<0,05 were taken as significant. Findings:

- Wood species does have an effect on the precision of machining;
- Best uniformity of dimensions was attained in the case of poplar, regardless of machine setting.
- By comparing the machined dimensions of the different species it can be stated that all of the applied machine settings resulted in significant differences between the samples of the individual species. Because of the important differences in the texture of the woods tested it is impossible to find a unique set of machining parameters that is optimal for all species. .
- With extended experimentation it would be possible to establish specifications in tabular form for choosing the most appropriate settings for the position of cutting units, speed of feeding and cutting speed as a function of species in order to attain the best effectiveness of machining.

DETERMINATION OF THE CAPABILITY INDICES

Capability indices were calculated from data sets, after screening of data when applicable. Screening aimed at modelling the in-control state of the process when it was found out-of control. Process performance indices (*CP* and CP_K) were determined based on a number of small-size sub-samples, while machine capability indices (*PP* and PP_K) were derived from large samples taken within short time. These results give us direct indication of the attainable precision of machining.

RESULTS AND DISCUSSION:

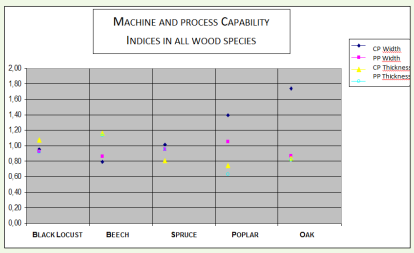
1. Doubled speed of machining (speed of feeding of 20 m/min at 12 000 rot/min of cutting tool shaft) resulted in roughly identical (in a few cases higher higher) capability indices than the use of normal feeding speed.

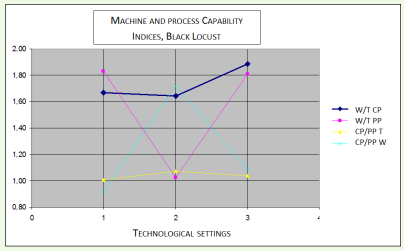
2. Machining to thickness generally resulted in higher precision than machining to width. This tendency remained constant with doubling the speed of feeding.

3. In summary it can be stated that from the point of view of precision the effectiveness of machining on the multiple-spindle moulding machine can be doubled by doubling the feeding speed in the range studied, since the capability indices relating the precision of machined part dimensions are not deteriorated.

v20u12000 versus v10u12000

Wood species	Technological parameter	Width CP	Width PP	Thickness CP	Thickness PP	Total CP	Total PP	Thickness/Width CP	Thickness/Width PP	CP/PP W	CP/PP T	Width CP	Width PP	Thickness CP	Thickness PP
Black Locust	10/12000	1,08	1,07	1,80	1,96	1,43	1,31	1,67	1,83	1,01	0,92	0,95	0,93	1,08	0,91
	20/8000	0,90	0,84	1,48	0,86	1,11	0,92	1,64	1,02	1,07	1,72				
	20/12000	1,03	0,99	1,94	1,79			1,88	1,81	1,04	1,08				
Beech	10/12000	0,88	0,79	0,82	0,75	0,89	0,81	0,93	0,95	1,11	1,09	0,80	0,86	1,16	1,13
	20/8000	0,93	0,90	0,98	0,79	0,92	0,84	1,05	0,88	1,05	1,24				
	20/12000	0,70	0,68	0,95	0,85	0,70	0,64	1,36	1,25	1,05	1,12				
							0,00								
Spruce	10/12000	0,62	0,63	1,50	1,21	0,84	0,77	2,42	1,92	0,98	1,24	1,02	0,95	0,81	0,95
	20/8000	0,72	0,74	1,42	1,31	0,90	0,87	1,97	1,77	0,97	1,08				
	20/12000	0,63	0,60	1,21	1,15			1,92	1,92	1,05	1,05				
Poplar	10/12000	0,71	0,75	2,35	2,29	0,90	0,69	3,05	3,05	0,95	1,03	1,39	1,05	0,74	0,63
	20/8000	0,93	0,82	1,90	1,84	1,29	1,08	2,24	2,24	1,13	1,03				
	20/12000	0,99	0,79	1,75	1,45	1,38	0,99	1,84	1,84	1,25	1,21				
Oak	10/12000	1,12	1,08	1,73	1,81	1,33	1,28	1,68	1,68	1,04	0,96	1,74	0,87	0,84	0,81
	20/8000	0,76	0,72	1,53	1,38	1,00	0,89	1,92	1,92	1,06	1,11				
	20/12000	1,05	0,94	1,45	1,47	1,12	1,09	1,56	1,56	2,07	0,99				





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