

## A human quality control system in furniture manufacturing – a pilot study

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**Abstract:** *A human quality control system in furniture manufacturing – a pilot study.* The article presents the results of pilot studies in which an attempt was made to check what the subjectivity of visual inspection looks like during the control of MDF delamination process in the milling process. 100% match of assessors' scores was obtained only with low (VB = 0–0.08mm) and high (VB = 0.3–0.33mm) tool wear. In addition, the impact of gender on the results was significant. Women rated items less restrictively. Based on the results obtained, one can expect a problem with subjectivity when using a single-person human quality control system.

*Keywords:* human visual quality control, melamine-faced MDF, milling

### INTRODUCTION

Quality control of production plants is an extremely important issue at every stage of product manufacturing. As a basic element of the organization's management system (next to planning, organizing and leading), it aims to check the compliance of the process or product with the customer's requirements, by eliminating or minimizing defects and incompatibility (Hamrol et al. 2011, Kang et al. 2018)

Despite the development of measurement methods and the widespread automation along with the technological progress, the dominant method of quality control in many companies is the use of human senses only (organoleptic control). A special example of such control is visual control (visual inspection), which includes: simplicity of carrying out in comparison with other types of control, low costs, speed, low number of samples. This method does not require specialized measuring equipment, the role of which is played by human vision, and is a non-destructive method (Kujawińska and Vogt 2015, Kang et al. 2018). However, visual control does not guarantee an unequivocal, fully correct assessment. The complexity of the problem of credibility of a human visual assessment results from the fact that its effectiveness is influenced by many factors (Kujawińska and Vogt 2015):

- technical (type of defects, defect visibility, quality level, standards (tests), control automation),
- psychophysical (age, sex, observation skills, experience, temperament, creativity),
- organizational (training, scope of decision making, feedback, precise instructions),
- workplace environment (light, noise, temperature, work time, workstation organization),
- social (team communication, pressure, isolation).

It is, therefore, necessary to regularly check the effectiveness of human visual quality control in manufacturing plants. Appearance of conformity assessment errors, in the form of incorrect product classification, may contribute to deterioration of process efficiency. Due to the high degree of subjectivity of visual inspection, human quality control system should set themselves the task of not only focusing on finding and eliminating the root causes of errors, but also monitor the effectiveness of the work of raters. This will allow creating a reliable source of feedback on the production process, which will improve production and reduce manufacturing costs.

The article attempts to determine what the subjectivity of visual control looks like when controlling the MDF delamination process in the milling process.

## MATERIALS AND METHODS

The assessment procedure required special preparation of samples for testing and ensuring appropriate conditions. The experiment uses elements made of a MDF laminated board (one of the basic materials in the furniture industry). A step was milled in each of them, resulting in a k1 edge for evaluation of machining quality. The dimensions and the shape of the object are shown in Fig. 1. In the experiment, one brand new tool was used, which was gradually blunted to obtain the desired state of wear of the VB blades (0mm, 0.08mm, 0.09mm, 0.11mm, 0.20mm, 0.22mm, 0.30mm, 0.31mm and 0.33mm). Dulling of the tool took place in a way that imitated factory conditions, i.e. on various wood-based materials. Five items were made for each tool condition.

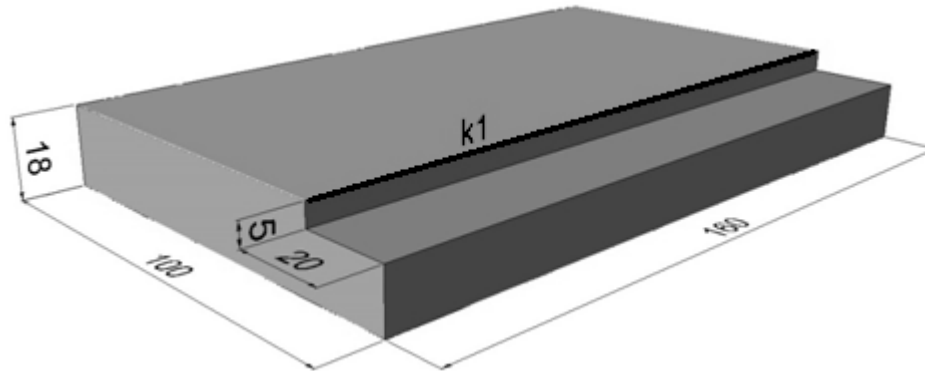


Fig.1. Dimensions and shape of samples (in mm) with a marked edge k1.

Six assessors (3 women – J1, J2, J3; 3 men – J4, J5, J6) took part in the study, furniture engineers, after short-term internships in furniture factories. The results obtained in the study are 45 assessments for each assessor. They were always held in the same room, during one uninterrupted session, with similar lighting and sample presentation (all elements were displayed simultaneously). During the tests, the assessor (under time pressure, which allowed to simulate working conditions in industrial conditions) made a single assessment of the k1 edge of the subject: 1 – high quality, 0.5 – conditionally acceptable quality, 0 – clearly bad quality. The assessor should not try to pretend to be a professional (e.g. factory) quality controller but be guided by his own “intuition” (as if he were an ordinary customer who watches the goods in the store). Possible damages on the first and last 5mm of the edges may be due to non-processing reasons and as such should not affect the quality assessment of the entire edge, so they should be ignored by the assessor.

## RESULTS AND DISCUSSION

The obtained results of assessments by individual assessors are presented in Table 1. On its basis, the agreement table whose rows are the subjects from the rating table where any row with fewer than two ratings are dropped was determined.

Analyzing the received data (Tab.1, Tab.2.), ambiguity of assessors judgments was found in 31% of cases, within which 11% differentiation occurred in a perfectly symmetrical way (three assessors gave the same higher grade, the other lower grade). 100% compliance was observed for VB in the ranges of 0–0.08mm and 0.30–0.33mm. In addition, the impact of gender turned out to be unambiguously significant – women rated subjects less restrictively (giving a higher grade). Also within the same sex, more or more severe assessors were noticed (J6 turned out to be the most radical).

The above conclusions suggest that a human quality control system based on one person would not be an objective tool for assessing manufactured products. Despite the fact that there was no extreme case of divergence of grades (0 and 1 for the same subject),

a definite problem with the subjectivity of grades during the control of the MDF delamination process in the milling process should be stated.

Table 1. Rating table

VB	J1	J2	J3	J4	J5	J6
0 mm	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
0.08 mm	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
0.09 mm	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	0.5	0.5	0.5	0.5	1	0.5
0.11 mm	1	0.5	1	0.5	1	0.5
	1	0.5	1	0.5	1	0.5
	1	0.5	1	0.5	1	0.5
	0.5	0.5	0.5	0.5	0.5	0.5
	0.5	0.5	0.5	0.5	0.5	0.5
0.20 mm	0.5	0	0.5	0	0.5	0
	0.5	0.5	0	0	0.5	0
	0.5	0.5	0.5	0.5	0.5	0
	0.5	0.5	0.5	0.5	0.5	0
	0.5	0.5	0.5	0.5	0.5	0
0.22 mm	0.5	0.5	0.5	0.5	0.5	0
	0.5	0.5	0.5	0	0.5	0
	0.5	0	0	0	0.5	0
	0.5	0.5	0.5	0.5	0.5	0
	0	0	0	0	0.5	0
0.30 mm	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
0.31 mm	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
0.33 mm	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0

Tab. 2. Agreement table

VB	0	0.5	1
0 mm	0	0	6
	0	0	6
	0	0	6
	0	0	6
	0	0	6
0.08 mm	0	0	6
	0	0	6
	0	0	6
	0	0	6
	0	0	6
0.09 mm	0	0	6
	0	0	6
	0	0	6
	0	0	6
	0	4	2
0.11 mm	0	2	4
	0	2	4
	0	3	3
	0	6	0
	0	6	0
0.20 mm	3	3	0
	4	2	0
	2	4	0
	2	4	0
	2	4	0
0.22 mm	2	4	0
	3	3	0
	4	2	0
	2	4	0
	5	1	0
0.30 mm	6	0	0
	6	0	0
	6	0	0
	6	0	0
	6	0	0
0.31 mm	6	0	0
	6	0	0
	6	0	0
	6	0	0
	6	0	0
0.33 mm	6	0	0
	6	0	0
	6	0	0
	6	0	0
	6	0	0

There are many questions that still need to be asked regarding this topic, such as: how would a person evaluate the same samples on a different day or in different working conditions? In this case, one would also expect a lack of repeatability. This problem requires further investigation. The presented article presents only pilot studies.

## CONCLUSIONS

1. 100% match of assessors scores was obtained only with low ( $VB = 0-0.08\text{mm}$ ) and high ( $VB = 0.3-0.33\text{mm}$ ) tool wear.
2. The influence of gender on the results turned out to be significant. Women rated items less restrictively.
3. Based on the results obtained, one can expect a problem with subjectivity when using a single-person human quality control system.

## REFERENCES

1. HAMROL, A., KOWALIK, D., KUJAWIŃSKA, A. 2011: "Impact of selected work condition factors on quality of manual assembly", *Human Factors and Ergonomics in Manufacturing* 21(2), pp. 156–162.
2. KANG C.W., RAMZAN B.M., SARKAR B., IMRAN M., 2018: "Effect of inspection performance in smart manufacturing system based on human quality control system", *The International Journal of Advanced Manufacturing Technology*, February 2018, Volume 94, Issue 9–12, pp. 4351–4364, <https://doi.org/10.1007/s00170-017-1069-4>
3. KUJAWIŃSKA, K., VOGT, K., 2015, "Human factors in visual quality control", *Management and Production Engineering Review*6(2), pp. 25–31.

**Streszczenie:** *Kontrola jakości przez człowieka w produkcji mebli - badanie pilotażowe.* W artykule zaprezentowano wyniki badań pilotażowych, w których podjęto próbę sprawdzenia jak wygląda problem podmiotowości kontroli wzrokowej podczas kontroli procesu delaminacji MDF w procesie frezowania. Stuprocentową zgodność ocen sędziów otrzymano jedynie przy niskim ( $VB=0-0,08\text{mm}$ ) oraz wysokim ( $VB=0,3-0,33\text{ mm}$ ) zużyciu narzędzia. Ponadto wpływ płci na wyniki okazał się istotny. Kobiety oceniały przedmioty mniej restrykcyjnie. Na podstawie otrzymanych wyników można spodziewać się problemu z subiektywnością w przypadku zastosowania jednoosobowego systemu kontroli jakości przez człowieka.

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