SCIENTIARUM POLONORUM ACTA *Acta Sci. Pol.*
Silv. Colendar. Rat. Ind. Lignar. 8(4) 2009, 75-89

INVESTIGATIONS ON THE EXECUTION ACCURACY OF SOLID PARQUET ELEMENTS

Wiesław Zakrzewski, Grzegorz Pinkowski, Andrzej Krauss,
Arkadiusz Rentz
Poznań University of Life Sciences

Abstract. Investigations were carried out to determine execution accuracy of length, width and thickness dimensions of solid parquet elements in industrial conditions. The authors employed STAT-9000 computer software to assess the obtained results. It allowed calculation of the process quality capability index and preparation of the Shewhart control cards $\overline{x} - s$.

Key words: solid parquet, quality capability, control cards

INTRODUCTION

One of the more important elements of the processing precision is dimensional accuracy. It is impossible to manufacture a series of elements of ideal accuracy. However, the shape, dimension and surface geometrical structure of the processed element should correspond to the element specified on the working drawing.

Parquet is a traditional product manufactured from solid wood which, after laying, requires finishing working which consists in sanding followed by lacquering or oiling.

In order to consider dimensions of the manufactured element as correct, their values must not exceed accepted tolerance intervals. Assuming that the tolerance interval is a variability enforced by standards running according to the normal distribution, then the centre of tolerance – which not always can remain in conformity with the basic dimension – should be considered as the mean dimension. This conformity exists only in the case of symmetrical tolerance [Zakrzewski and Staniszewska 2002]. The main parameters of the normal distribution comprise the arithmetic mean and mean deviation. Since processes are influenced by various systematic and random factors, they undergo changes which exert impact on the quality level. The basis of the execution quality management is the maintenance of the variability of these parameters during the produc-

---

Corresponding author – Adres do korespondencji: Dr inż. Wiesław Zakrzewski, Department of Woodworking Machinery and Basic of Machine Construction of Poznań University of Life Sciences, Wojska Polskiego 38/42, 60-627 Poznań, Poland, e-mail: wzakrzewski@up.poznan.pl

tion process within boundaries which will guarantee that the assumed quality standard is achieved with satisfactory probability [Iwasiewicz 1999].

At present, automatic quality management in timber industry cannot be achieved because of lack of modern machine tools characterised by sufficient accuracy [Lisičan et al. 2002]. It is only possible to control the process in such a way that we can ascertain if and to what extent the acceptable dimension variability and stability have been fulfilled. However, the technologist needs to know whether the employed machine tools are capable to maintain during processing the dimension accuracy in accordance with the requirements adopted for the products. The method of control of the dimension accuracy maintenance is also appropriate to control other quality features. That is why a general term: ‘process quality capability’ was adopted in literature on the subject [Czyżewski 1993, PN-ISO 3534-2 1994]. Apart from the process quality capability, its stability is equally important. This means that it guarantees the concentration of its values symmetrically in relation to the centre of the tolerance field and in such a way that the variability interval of the controlled dimension value does not exceed boundaries of acceptable variability determined for it. The attainment of this state of the process is the main purpose of application of Shewhart’s control cards [Matuszewski and Šatanowá 1997].

This study deals with issues of statistical execution accuracy of solid parquet elements manufactured at Biadki Parquet Factory Ltd. One of the key problems during parquet laying is the dimensions of length, width and thickness of parquet woodblocks. Tolerance of their dimensions according to PN-EN 13226 [2009] standard is: T = 1.00 mm for the length, T = 0.40 mm for the width and T = 0.40 mm for the thickness.

OBJECTIVE OF THE RESEARCH PROJECT

The aim of this study was to investigate the execution accuracy of length, width and thickness of solid parquet elements manufactured in industrial conditions. The investigations were carried out with the assistance of STAT-9000 computer software and involved the determination of process quality capability and alignment as well as the assessment of dimension stability of manufactured elements using $\bar{x} - s$ control cards.

METHODOLOGICAL ASSUMPTIONS

Measurements of the length, width and thickness dimensions of solid parquet were carried out at a parquet factory in Biadki. The raw material used to manufacture parquet elements was oak and ash wood as well as some exotic wood species such as: Merbau, Iroko, Badi and Doussie. Wood used in this technology should be healthy with no injuries on the top side. Healthy knots are acceptable. Raw material moisture content should fluctuate between 7-8%.

Parquet blocks are made using milling cutters. For example, a woodblock measuring 400 × 70 × 22 mm is manufactured using 410 × 80 × 25 mm cutters. Parquet floor is made up of woodblocks whose sides and heads are equipped in appropriate tongue and groove profiles. Parquet is laid using elements with left and right grooves and tongues.

The objects of experiments were parquet wood blocks measuring 400 × 70 × 22 mm which constituted an appropriately large production batch. Top and bottom surfaces as well as grooves and tongues of woodblocks were made with the assistance of a Weining Company four-side planing machine type U23. The spindle arrangement of the planer is shown in Figure 1.

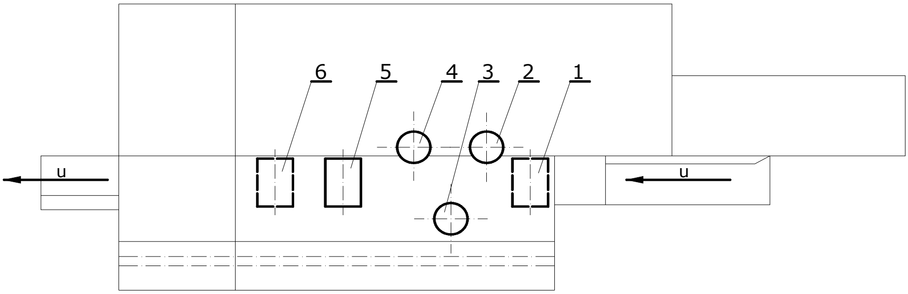


Fig. 1. Spindle setup of the four-side planing machine type U23: 1, 2 – heads forming bases, 3 – tongue-forming cutter, 4 – profile cutter forming the groove, 5 – head forming the bottom part, 6 – head forming the top part

Rys. 1. Układ wrzecion strugarki czterostronnej typu U23: 1, 2 – głowice frezujące bazy, 3 – frez formujący wypust, 4 – frez profilowy formujący wpust, 5 – głowica formująca część dolną, 6 – głowica formująca część górną

Figure 2 presents the processing scheme on the four-side planing machine type U23. The applied tools are designated with the same numbers as in Figure 1.

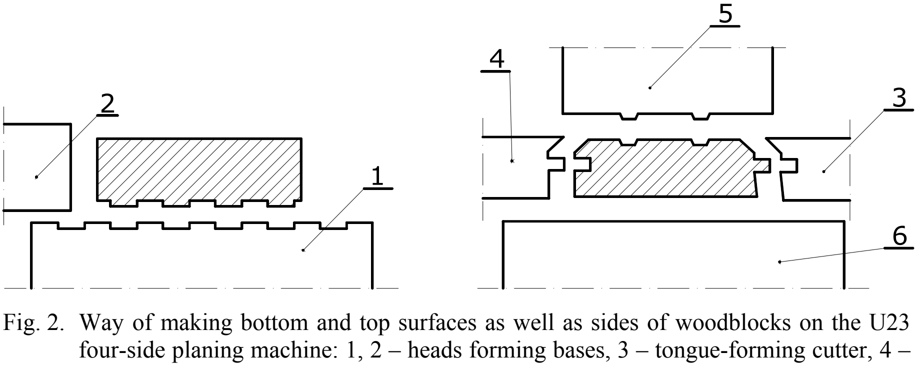


Fig. 2. Way of making bottom and top surfaces as well as sides of woodblocks on the U23 four-side planing machine: 1, 2 – heads forming bases, 3 – tongue-forming cutter, 4 – profile cutter forming the groove, 5 – head forming the bottom part, 6 – head forming the top part

Rys. 2. Sposób formowania powierzchni dolnej i górnej oraz boków na strugarce czterostronnej U23: 1, 2 – głowice frezujące bazy, 3 – frez formujący wypust, 4 – frez profilowy formujący wpust, 5 – głowica formująca część dolną, 6 – głowica formująca część górną

Woodblock heads were processed using a Friulmac Company sizer-tenoner machine, type FN/9. The way of forming grooves and tongues on this planing machine is shown in Figure 3.

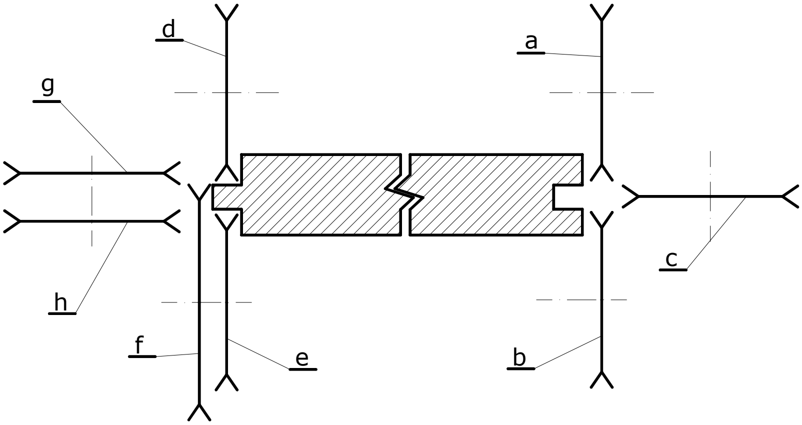


Fig. 3. Way of forming grooves and tongues on heads of woodblocks: a, b, f – forming the length of the woodblock, c – groove, g, h – tongue
Rys. 3. Sposób formowania wpustu I wypustu na czołach deszczułek: a, b, f – formowanie długości deszczułki, c – wpustu, g, h – wypustu

Moisture content of the surface layer was measured in accordance with the EN 13183-2 [2004] standard with 0.1% accuracy using a resistor moisture meter WRD-100 type manufactured by 'Tanel' Company in Gliwice. The mean moisture content of semi-finished products for parquet production was 7.5%, whereas the mean moisture content of finished woodblocks – 7.8%.

Length, width and thickness measurements of woodblocks (Fig. 4) were conducted when they were completely finished using VIS Company (Warsaw) callipers with digital readings. The reading accuracy was ±0.01 mm.

Measurements were taken during 5 consecutive days at the same time of day, systematically every 10 minutes. Five-element samples were collected from the production belt and measurements of length, width and thickness were taken. The total of 25 samples of 5 elements each were taken every day and two length (d_1, d_2), three width (s_1, s_2 and s_3) and three thickness (g_1, g_2 and g_3) measurements were taken which were subsequently averaged so as to obtain one measurement of length (d), width (s) and thickness (g). In other words, the total of 125 elements was examined every measurement day obtaining the sum of 1000 values. After averaging, 375 values were obtained, i.e. 125 measurements of length, width and thickness.

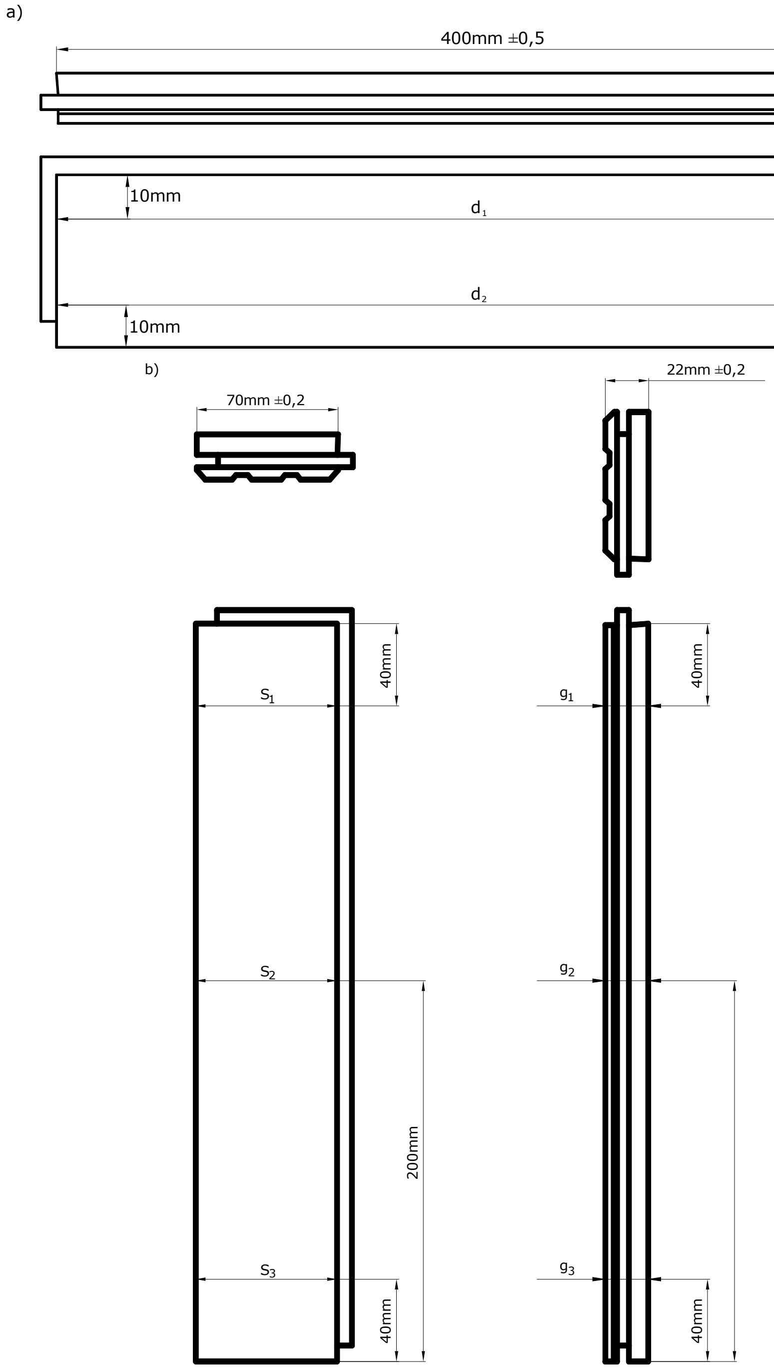


Fig. 4. Measured dimensions: a) length, b) width and thickness
Rys. 4. Mierzone wymiary: a) długość, b) szerokość i grubość

METHOD OF CARRYING OUT CALCULATIONS

Calculations of the process quality capability and stability were conducted using the statistical method. A PC computer equipped in a STAT-9000 software assisting the process quality management was employed as a calculation tool [Marek et al. 1997]. The program makes it possible to feed data in directly from the computer keyboard, from electronic tools (e.g. electronic callipers) or to use the so called data collectors of different companies, e.g. TESA, VIS, OPTOSOFT.

Investigations of the process quality capability involve value calculation and observation of two indices: process quality capability c_p and its alignment c_{pk}. The value of the process quality capability index is calculated from the following dependence:

$$c_p = \frac{T}{6\sigma} \geq 1 \tag{1}$$

where:

T – dimension tolerance,
6σ – dimension spread (observed).

The process aligning index c_{pk}, which is the smaller of the two values, is determined on the basis of the following dependence:

$$c_{pkg} = \left|\frac{B - \overline{\overline{x}}}{3\sigma}\right| \geq 1 \qquad \text{or} \qquad c_{pkd} = \left|\frac{A - \overline{\overline{x}}}{3\sigma}\right| \geq 1 \tag{2}$$

where:

B and A – upper and lower limits (acceptable),
$\overline{\overline{x}}$ – arithmetic mean of values from means $\overline{x}_j$ from 25 five-element samples.

In order to avoid defects, it is sufficient that $c_{pk} \geq 1$. The non-alignment value, also known as dimension setting accuracy [Staniszewska and Zakrzewski 2006], can be written down as:

$$ME = \overline{\overline{x}} - N,$$

where:

N – nominal dimension,
$\overline{\overline{x}}$ – stabilised arithmetic mean from samples.

Properly adjusted process is characterised by the fact that its stability is maintained. This means that it guarantees value concentration of the dimension symmetrically in relation to the centre of the tolerance field in such a way that the variability interval of the examined dimension value does not exceed boundaries established for it. Investigation of stability is the main objective of the application of Shewhart control cards. The best assessment of the process stability is achieved when double-track $\overline{x} - s$ cards are applied. They are very labour-consuming when counted manually, but with the advance of computer technique, they replaced less accurate $\overline{x} - R$ cards used earlier [Andrzejewski et al. 1993]. Each of the two tracks of the control card consists of a central line $\overline{\overline{x}}$ corresponding to the expected value of the controlled parameter from the sample as well as a set of upper (GLO) and lower (DLO) control lines. The control lines limit the allowable variability boundaries of the controlled parameter. The STAT-9000 software employed in this study creates $\overline{x} - s$ control cards using a stabilising method. The description of control cards and ways of calculating their parameters can be found in an article discussing execution accuracy of duo-parquet elements [Zakrzewski et al. 2004].

RESEARCH RESULTS AND THEIR ANALYSIS

The performed measurements and statistical calculations made it possible to evaluate the quality capability and dimension maintenance stability of elements of solid parquet. Calculations of execution accuracy were referred to tolerance intervals contained in the PN-EN 13226 [2009] standard and mentioned in the Introduction to the study. Measurement results were assessed using Shewhart's $\overline{x} - s$ control cards made by stabilisation method with the assistance of the STAT-9000 computer software. Values of the process quality capability c_p and its alignment c_{pk} were derived from control cards and are shown in Table 1. In addition, Table 1 also collates M_E parameters which determine dimensional accuracy of the machine tool setting.

Table 1. Value of the quality capability indices c_p, alignment c_{pk} and dimensional setting of the machine tool M_E, mm

Tabela 1. Wartości wskaźników zdolności jakościowej c_p, wycentrowania c_{pk} i wymiarowego nastawienia obrabiarki M_E, mm

		Day – Dzień				
		1	2	3	4	5
Length Długość	c_p	8.88	7.99	8.21	9.36	8.66
	c_{pk}	7.90	7.05	7.45	8.80	8.04
	M_E	0.055	0.059	0.047	0.030	0.036
Width Szerokość	c_p	3.94	3.69	3.81	4.09	2.82
	c_{pk}	3.64	3.21	3.51	3.90	2.50
	M_E	0.015	0.026	0.016	–0.009	–0.022
Thickness Grubość	c_p	3.69	4.19	4.09	4.63	3.99
	c_{pk}	3.03	3.55	3.24	4.26	3.51
	M_E	0.036	0.030	0.041	0.017	0.024

It is evident from the data collated in Table 1 that the quality capability of the dimensional execution of woodblock length, width and thickness was excellent on each measurement day since the dimensional scatter, in the best case, was smaller than tolerance: by 9.36 times for the length (day 4), by 4.09 times for the width (day 4) and by 4.63 times for the thickness (day 4) and, in the worst case – by 7.99 times for the length (day 2), by 2.82 times for the width (day 5) and by 3.69 times for the thickness (day 1).

The setting accuracy M_E of the machine tool ranged from –0.009 mm for the width (day 4) to 0.059 mm for the length (day 2). This small M_E value exerted a significant influence on the recorded small differences between c_p and c_{pk} indices and guaranteed, at small dimension scatter, production without rejections.

In all cases, the alignment index c_{pk} differed only slightly from c_p values and its smaller value 2.50 (day 5) was determined for the width of woodblocks. Even this worst value exceeded 1 below which production defects would occur.

The stability of the examined process is illustrated by control cards presented in Figures 5-10. Because of restrictions of the text volume, this paper presents only six control cards, i.e. for the length, width and thickness dimensions for the best and worst stabilised process. Figs 5 and 6 show control cards prepared for the length dimension for the best and worst stabilised process.

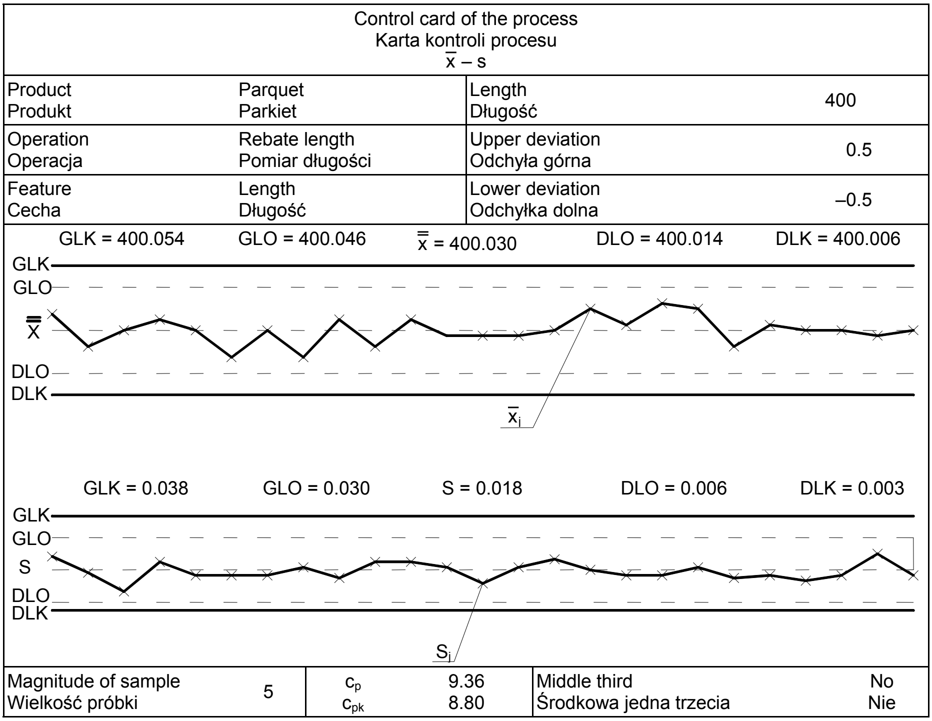
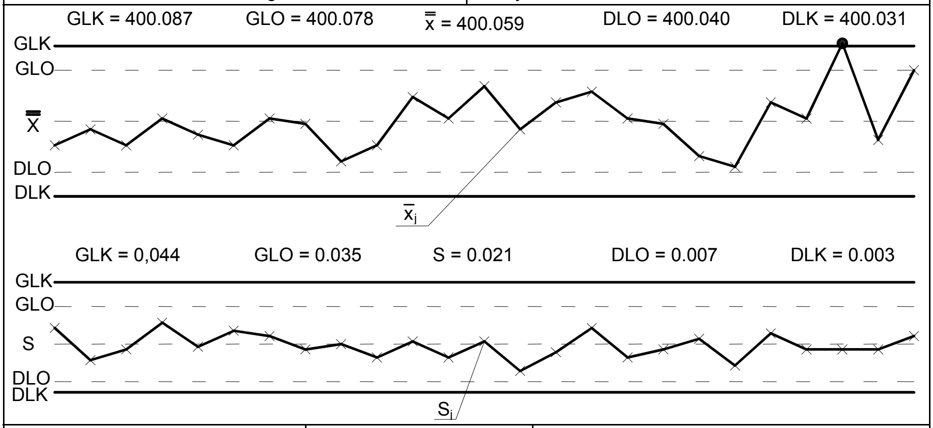


Fig. 5. Control card of the length dimension on day 4 of measurements
Rys. 5. Karta kontrolna wymiaru długości w czwartym dniu pomiarów

The examined process was most stable on the fourth day of measurements (Fig. 5) and the least stable – on the second day (Fig. 6). The central line $\bar{\bar{x}}$ and s as well as GLO and DLO are dashed in Figure 6, while control lines GLK and DLK – continuous. Arithmetic means from individual samples $\bar{x}_j$ and s_j were designated with crosses. In Figure 5, for the track of arithmetic mean $\bar{\bar{x}}$ from individual samples $\bar{x}_j$, the difference between the position of the upper control line GLK and lower control line DLK amounted to 400.054 – 400.006 = 0.048 mm, whereas for the mean deviation of track s

Control card of the process
Karta kontroli procesu
$\bar{x} - s$

Product Produkt	Parquet Parkiet	Length Długość	400
Operation Operacja	Rebate length Pomiar długości	Upper deviation Odchyła górna	0.5
Feature Cecha	Length Długość	Lower deviation Odchyłka dolna	–0.5



Magnitude of sample Wielkość próbki	5	c_p c_{pk}	7.99 7.05	Middle third Środkowa jedna trzecia	No Nie

Fig. 6. Control card of the length dimension on day 2 of measurements
Rys. 6. Karta kontrolna wymiaru długości w drugim dniu pomiarów

GLK – DLK = 0.038 – 0.003 = 0.035 mm. On the other hand, in Figure 6, the stability range on track $\bar{\bar{x}}$ GLK – DLK = 400.087 – 400.031 = 0.056 mm, while the value difference of control lines on track s amounted to GLK – DLK = 0.044 – 0.003 = 0.041 mm. It is evident from Figure 5 that there were no disturbances which would indicate maladjustment of the process. None of the examined 25 samples gave an indication of crossing the control line, either on track $\bar{\bar{x}}$ or s, by a single sample. Also the parameters of two neighbouring samples failed to cross warning lines. In Figure 6, the program marked sample 23 with a black dot which gave a signal of trespassing GLK on track $\bar{\bar{x}}$. This most probable cause of this signal was the occurrence of a knot in element 5. This was the only signal of this type that occurred for the length dimension during all five days. In the case of the length dimension, a signal indicating a systematic error occurred only on the third day of measurements. A run $\bar{x}_j$ type phenomenon occurred below the central line in samples from 5 to 11.

Figure 7 and 8 present control cards for the width dimension for the best and worst stabilised process. The process was most stable on the first day of measurements (Fig. 7) and the least stable – on the second day (Fig. 8). In Figure 7, for the track of arithmetic mean $\bar{\bar{x}}$ from individual samples $\bar{x}_j$, the difference between the position of the upper control line GLK and lower control line DLK amounted to 70.038 – 69.992 = 0.046 mm, whereas for the mean deviation of track s GLK – DLK = 0.036 – 0.003 = 0.033 mm. It is evident from Figure 8 that the stability range for track $\bar{\bar{x}}$ amounted to GLK – DLK = 70.050 – 70.002 = 0.048 mm, while the value difference of control lines

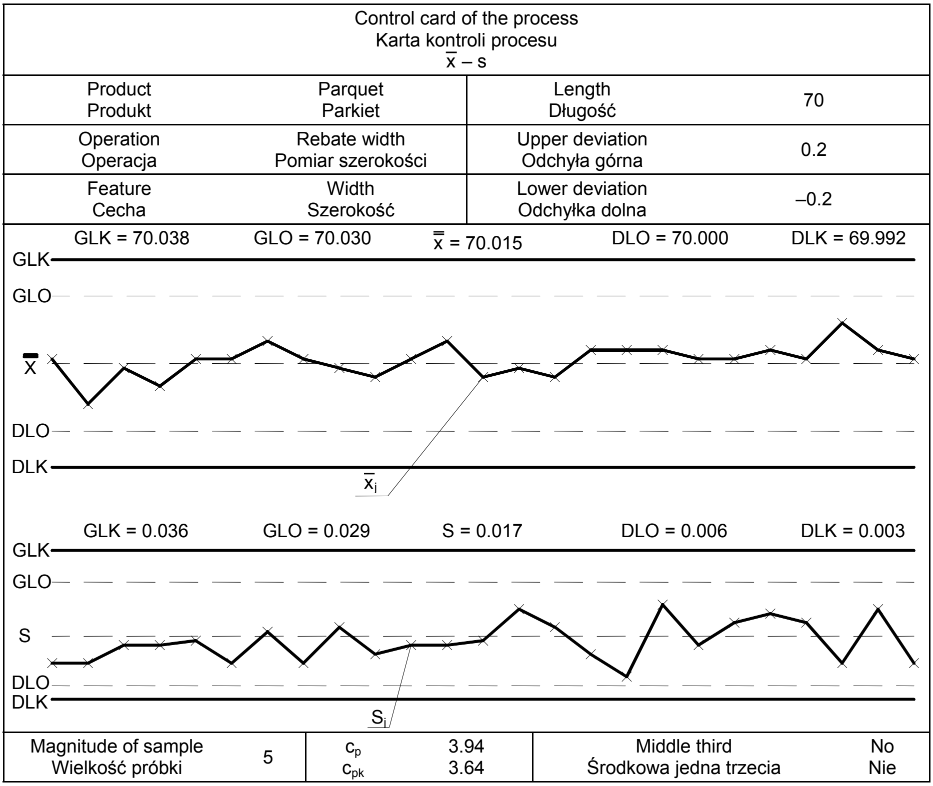


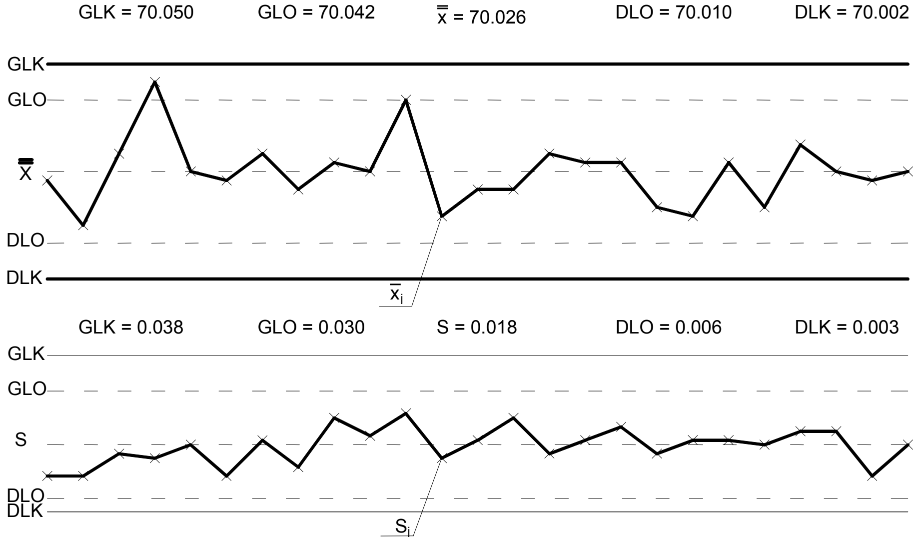
Fig. 7. Control card of the width dimension on day 1 of measurements
Rys. 7. Karta kontrolna wymiaru szerokości w pierwszym dniu pomiarów

on track s amounted to GLK – DLK = 0.038 – 0.003 = 0.035 mm. None of the width measurement series gave an indication of crossing the control line (this refers to tracks $\overline{\overline{x}}$ or s). The warning line GLO was crossed only once on track $\overline{\overline{x}}$ on the second day of measurements (sample 5). However, this did not indicate maladjustment of the process because in order for this to happen, two consecutive samples must cross the warning line. Run type phenomena occurred on days four and five of measurements. On the fourth day, run $\overline{x}_j$ occurred for samples 6-13 under the central line $\overline{\overline{x}}$ and from 14-21 – over the central line. On the fifth day, run $\overline{x}_j$ occurred for samples 7-14 under the central line and run s for samples from 12-18 – over the central line.

Figures 9 and 10 present control cards of the thickness dimensions of woodblocks for the best and worst stabilised process. The best stabilised process occurred on the fourth and the worst – on the third day of measurements.

In Figure 9, for the track of arithmetic mean $\overline{\overline{x}}$ from individual samples $\overline{x}_j$, the difference between the position of the upper control line GLK and lower control line DLK amounted to 22.039 – 21.996 = 0.043 mm, whereas for the mean deviation of track s GLK – DLK = 0.033 – 0.003 = 0.030 mm. It is evident from Figure 10 that the stability

Control card of the process Karta kontroli procesu $\bar{x}-s$			
Product Produkt	Parquet Parkiet	Length Długość	70
Operation Operacja	Rebate width Pomiar szerokości	Upper deviation Odchyła górna	0.2
Feature Cecha	Width Szerokość	Lower deviation Odchyłka dolna	–0.2



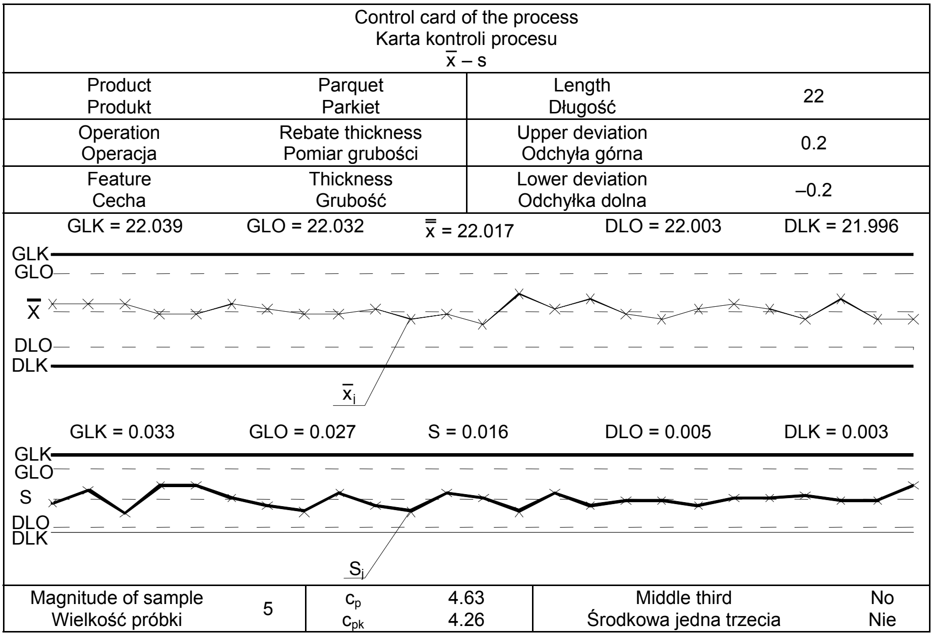
Magnitude of sample Wielkość próbki	5	c_p c_{pk}	3.69 3.21	Middle third Środkowa jedna trzecia	No Nie

Fig. 8. Control card of the width dimension on day 2 of measurements
Rys. 8. Karta kontrolna wymiaru szerokości w drugim dniu pomiarów

range for track $\bar{\bar{x}}$ amounted to GLK – DLK = 22.063 – 22.002 = 0.043 mm, while the value difference of control lines s GLK – DLK = 0.034 – 0.003 = 0.031 mm. The control card on Figure 10 indicated the occurrence of run and trend type phenomena. The run $\bar{x}_j$ occurred below the central line for samples 10-18, while the $\bar{s}_j$ trend was growing and occurred for samples from 18-24. The growing $\bar{s}_j$ trend occurred only one more time on the fifth day of measurements for samples 10-16.

Value variability of the stabilised arithmetic mean $\bar{\bar{x}}$ on individual measurement days are shown in Figure 11, 12 and 13.

For the length dimension (Fig. 11), the stabilised mean $\bar{\bar{x}}$ on all days exceeded the nominal value. The highest value of 400.059 mm was recorded on day 2, while the smallest of 400.030 – on day 4. For the width dimension (Fig. 12), the $\bar{\bar{x}}$ mean exceeded the nominal value on the first three days, while on days 4 and 5, it was smaller than this value. The highest value was observed on the second day and it amounted to 70.026 mm, while the lowest (69.878 mm) – on the fifth day. For the thickness dimension (Fig. 13), the $\bar{\bar{x}}$ mean exceeded the nominal value on all days reaching the highest value of 22.041 mm on the third day, while the lowest (22.017 mm) – on the fourth day.

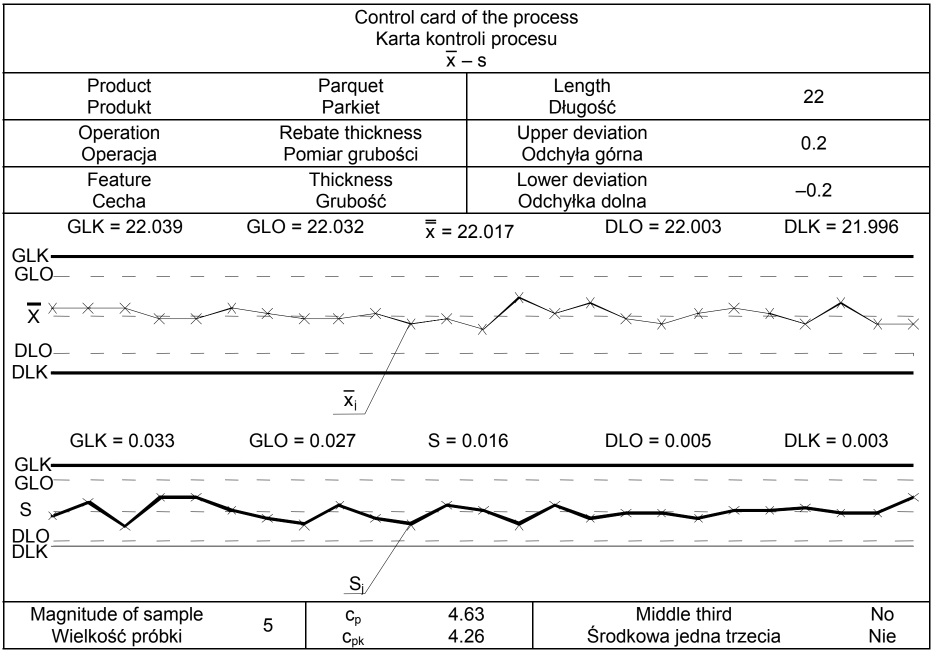


Control card of the process
Karta kontroli procesu
$\bar{x} - s$

Product Produkt	Parquet Parkiet	Length Długość	22
Operation Operacja	Rebate thickness Pomiar grubości	Upper deviation Odchyła górna	0.2
Feature Cecha	Thickness Grubość	Lower deviation Odchyłka dolna	–0.2

Magnitude of sample Wielkość próbki	5	c_p c_{pk}	4.63 4.26	Middle third Środkowa jedna trzecia	No Nie

Fig. 9. Control card of the thickness dimension on day 4 of measurements
Rys. 9. Karta kontrolna wymiaru grubości w czwartym dniu pomiarów



Control card of the process
Karta kontroli procesu
$\bar{x} - s$

Product Produkt	Parquet Parkiet	Length Długość	22
Operation Operacja	Rebate thickness Pomiar grubości	Upper deviation Odchyła górna	0.2
Feature Cecha	Thickness Grubość	Lower deviation Odchyłka dolna	–0.2

Magnitude of sample Wielkość próbki	5	c_p c_{pk}	4.63 4.26	Middle third Środkowa jedna trzecia	No Nie

Fig. 10. Control card of the thickness dimension on day 3 of measurements
Rys. 10. Karta kontrolna wymiaru grubości w trzecim dniu pomiarów

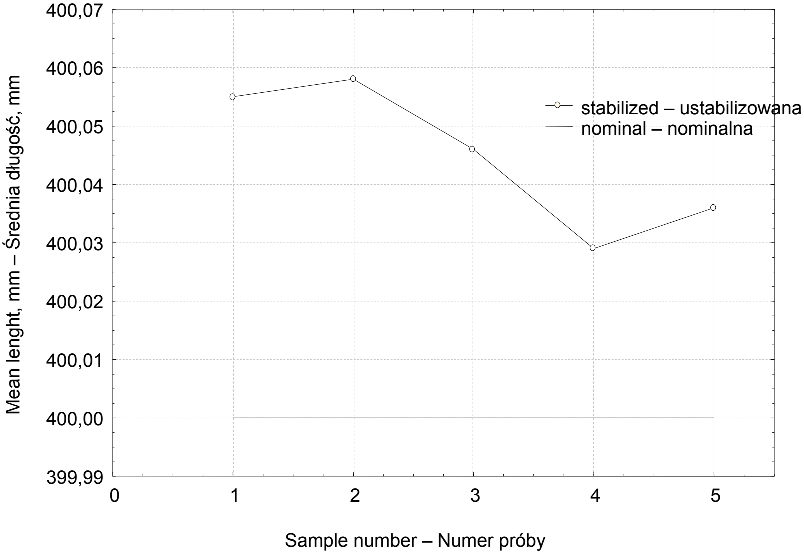


Fig. 11. Value variability of stabilised arithmetic mean of woodblock length dimension on individual measurement days

Rys. 11. Zmienność wartości średniej arytmetycznej ustabilizowanej wymiaru długości deszczułek w poszczególnych dniach pomiarów

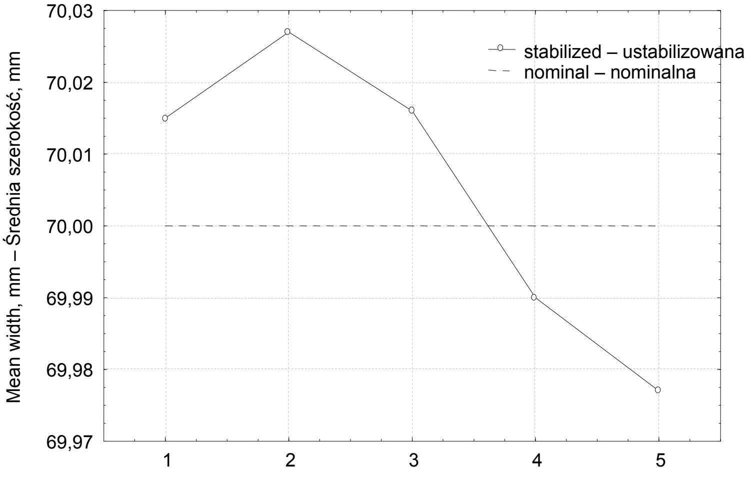


Fig. 12. Value variability of stabilised arithmetic mean of woodblock width dimension on individual measurement days

Rys. 12. Zmienność wartości średniej arytmetycznej ustabilizowanej wymiaru szerokości deszczułek w poszczególnych dniach pomiarów

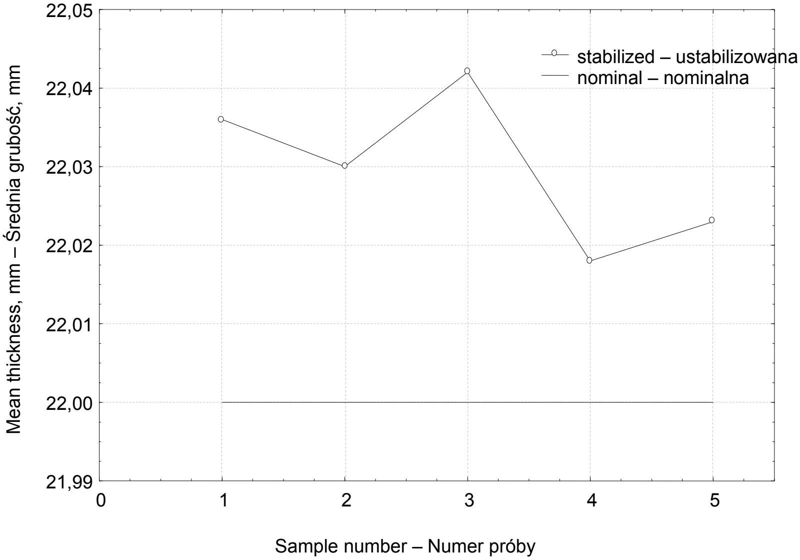


Fig. 13. Value variability of stabilised arithmetic mean of woodblock thickness dimension on individual measurement days

Rys. 13. Zmienność wartości średniej arytmetycznej ustabilizowanej wymiaru grubości deszczułek w poszczególnych dniach pomiarów

CONCLUSIONS

The following conclusions were drawn on the basis of the performed measurements and calculations:

1. On the basis of observations of the quality capability c_p and alignment c_{pk} indices, the entire process was evaluated as qualitatively capable.

2. Only one signal of the process malfunctioning involving transgression of the control line was recorded. Apart from this, phenomena of trend and run types were observed to occur on five control cards.

3. The performed investigations showed that the extent of edge dulling at five-day intervals only slightly affected dimensional scatter of parquet elements.

REFERENCES

Andrzejewski M., Wieczorowski K., Żurek J., 1993. Obróbka skrawaniem – dokładność obróbki [Machine processing – execution accuracy]. WNT Warszawa [in Polish].

Czyżewski B., 1993. Metody statystyczne w sterowaniu jakością procesów technologicznych [Statistical methods in quality management of technological processings]. Pozn. Klub Jakości Poznań [in Polish].

EN 13183-2. 2004. Drewno. Oznaczanie wilgotności [Wood. Moisture content determination]. Warszawa [in Polish].

Iwasiewicz A., 1999. Zarządzanie jakością [Quality management]. PWN Warszawa [in Polish].

Lisičan J., Očkajová A., Staniszewska A., Zakrzewski W., 2002. Statistische Kontrolle der Ausführungsgenauigkeit des Luftspalts am Holzfenster-Aussenschlang. Wood Res. 47(4), 37-48.

Matuszewski A., Šatanowá A., 1997. Metodyczne instrumenty zarządzania jakością w przedsiębiorstwach przemysłu drzewnego [Methodological instruments of quality management in wood industry enterprises]. Przem. Drzewn. 48(11), 3-6 [in Polish].

Marek R., Roleder W., Tokarek M., Wiśniewska M., 1997. STAT 9000. Podręcznik operatora [STAT 9000. Operator's manual]. OPTOSOFT Wrocław [in Polish].

PN-EN 13226. 2009. Podłogi drewniane. Elementy posadzkowe lite z wpustami lub wypustami [Wooden floors. Solid flooring elements with grooves and tongues]. Warszawa [in Polish].

PN-ISO 3534-2. 1994. Statystyczne sterowanie jakością. Terminologia i symbole [Statistical quality management. Terminology and symbols]. Warszawa [in Polish].

Staniszewska A., Zakrzewski W., 2006. Obróbka cięciem [Cutting processings]. Wyd. AR Poznań [in Polish].

Wprowadzenie statystycznej kontroli SPC do procesów produkcyjnych. Monitorowanie procesów. Sprzęt pomiarowy [Introduction of SPC statistical control to production processes. Process monitoring. Measuring equipment]. 1993. Komb. Przem. Narzędz. VIS, Fabr. Wyr. Prec. Warszawa [in Polish].

Zakrzewski W., Staniszewska A., 2002. Dokładność obróbki cięciem [Accuracy of cutting processings]. Wyd. AR Poznań [in Polish].

Zakrzewski W., Pinkowski G., Krauss A., Dryjański T., 2004. On the machining exactness of the "DUO-PARQUET" elements. Folia For. Pol. Ser. B 35, 85-98.

Zakrzewski W., Staniszewska A., Pinkowski G., 2003. Kontrola dokładności luzu na uszczelkę przylgową w elementach stolarki budowlanej [Clearance accuracy control for a cling-type seal in elements of construction woodwork]. Folia For. Pol. Ser. B 34, 67-78 [in Polish].

BADANIE DOKŁADNOŚCI WYKONANIA ELEMENTÓW PARKIETU LITEGO

Streszczenie. Przedmiotem badań była kontrola dokładności wykonania wymiarów długości i szerokości elementów parkietu litego przeprowadzona w warunkach przemysłowych. Pomiary przeprowadzono w fabryce parkietów w Biadkach. Wyniki badań opracowano z użyciem programu komputerowego STAT-9000 służącego do obliczania wskaźników zdolności jakościowej c_p i c_{pk} oraz do tworzenia kart kontrolnych $\overline{x} - s$ Shewharta. Badanie zdolności jakościowej oraz stabilności utrzymania wymiarów w procesie produkcyjnym prowadzono w okresie pięciu tygodni kartami kontrolnymi w odniesieniu do wymagań PN-EN 13226. Na podstawie obserwacji wartości wskaźników c_p i c_{pk} proces oceniono jako zdolny jakościowo, aczkolwiek jeden raz wystąpił sygnał świadczący o jego rozregulowaniu (niestabilności). Poza tym na pięciu kartach kontrolnych powstały zjawiska typu trend i run.

Słowa kluczowe: parkiet lity, zdolność jakościowa, karty kontrolne

Accepted for print – Zaakceptowano do druku: 30.10.2009

For citation – Do cytowania: Zakrzewski W., Pinkowski G., Krauss A., Rentz A., 2009. Investigations on the execution accuracy of solid parquet elements. Acta Sci. Pol., Silv. Colendar. Rat. Ind. Lignar. 8(4), 75-89.