APPEARANCES CONCERNING THE PREDICTABLE RELIABILITY OF THE AUTOMATION SYSTEM ON THE ADVANCES MECHANISM FROM THE LATHES WITH DIGITAL COMMANDING

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Abstract. In the work it's studied the predictable reliability of the automation system from the lathes with digital commanding SPT 32, which is compared with they operational reliability. There are tested two lots of 12 lathes, whereat the automation mechanisms had in structure mechanic and hydraulic elements (the lot 1), respectively mechanics and electric-electronic elements (the lot 2). The observation period was of the precinct 20000 hours, respectively 5 years of work. The mechanic components had the same behavior both constructive variants, conversely the hydraulic components presented much more broke downs comparative with the electric-electronic components.

For both variants is calculated firstly the predictable reliability, through the utilization of constant intensity of the breakdowns λ, recommended from the specialty literature. Abaft effectuation of the operational reliability studies they consisted in sensitive differences between the breakdown intensities between of the two automation systems variants, but also comparative with calculating values to the predictable reliability.

Keywords: lathes with digital commanding, automation mechanisms, predictable reliability

1. Introduction

On the strength of the block scheme of automation equipment of the lathe with digital commanding SPT 32 (figure 1) it can bee followed the part concerning the advances mechanism, respectively the entrainment of the sleds after X and Z axis. In figure 1 the symbols have the next significations: CNC – digital commanding with the computer; TP – position sensor; TH – tahogenerator; P – hydraulic pump; M – electric motor.

The functional structure of the lathe with digital commanding it can bee represented in the likeness of a logical schemes as the one in the figure 2.

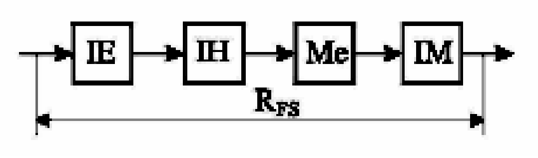

Figure 2. The reliability scheme of the functional lathe structure

In this situation, the total functional reliability of the lathe system is give by the probability of good working of a series system, like in relation (1):

$$R_{FS} = R_{IE}\, R_{IH}\, R_{Me}\, R_{IM} \qquad (1)$$

In the logical scheme presented, the installation succession doesn't always represent the succession of the functional flux. By example, the engine *Me* doesn't receive the statement from the hydraulic installation *IH*, but direct from electric installation *IE*. The inclusion of block *IH* block between IE and *Me* is symbolic, the scheme from the figure 2 presenting the influence of the different blocks in the technical system from reliability viewpoint.

The reliability of the advances training mechanism is give by the product reliabilities of the component elements, because we have to deal from viewpoints of the reliability schemes, with a series system.

2. Material and Method

The predictable reliability of the components results from statistically experiments, for which the results are much better, if the experiments number its much bigger. In this case of its used the extrapolation method for the estimation of the advances mechanism predictable reliability from the lathe with digital commanding SPT 32. The reliability estimation through the extrapolation method is made after the statistical specific model of the analyzed product or equipment, but also on the available databases [1, 2].

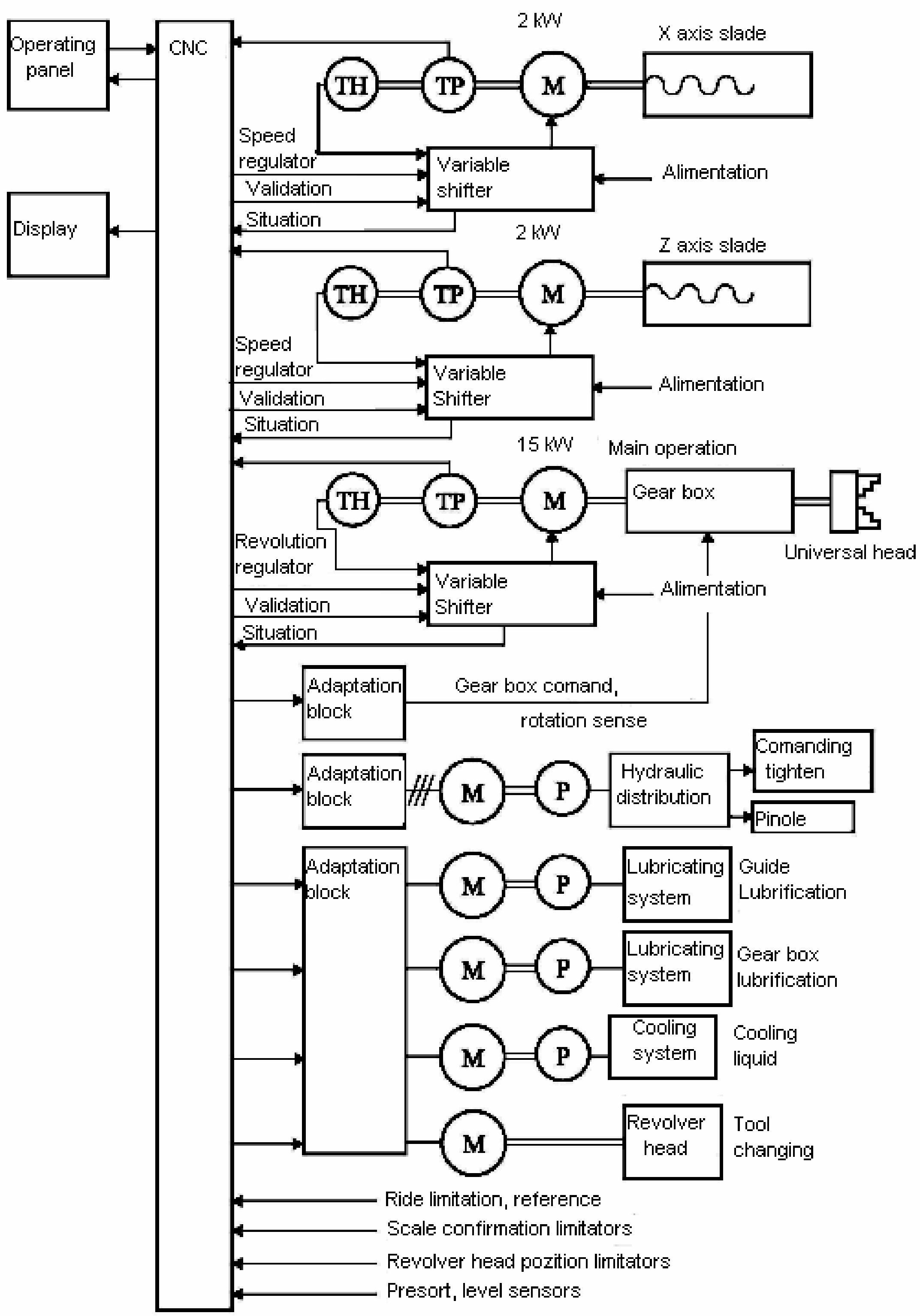

Figure 1. The block scheme of automation equipment for lathes with digital commanding

The predictable reliability is calculated taking particular values of breakdown intensity λ for the component elements, established experimentally and presented in the special literature [3].

Using the exponential repartition law, for which $z(t) = \lambda$ = constantly, the predictable reliability of an component is calculated with the relation (2):

$$R(t) = e^{-\lambda t} \quad (2)$$

The predictable reliability of the advances mechanism is obtained through the multiplication of the component elements reliability.

The study was made on tow groups of 12 lathes itch with digital commanding SPT 32 (the variant 1 and the variant 2), whereat the differences appear to a part from the system of automation of statement of the advances [4, 5].

To first variant the respective equipment were of hydraulic type, and to another of electric type. The lathes were followed on period of approximately 20000 hours of work [6]. For each among one 24 lathes it was drew up a broke down evidential card.

Table 1. The predictable reliability calculus

t(i)	1150	3450	5750	8050	10350	12650	14950	17250	19550
R(ti) for component elements – variant 1									
Pump	0.9840	0.9528	0.9227	0.8934	0.8651	0.8377	0.8112	0.7854	0.7606
Filter	0.9997	0.9990	0.9983	0.9976	0.9969	0.9962	0.9955	0.9948	0.9942
Pressure regulator	0.9975	0.9926	0.9878	0.9829	0.9781	0.9733	0.9685	0.9638	0.9590
Accumulator	0.9929	0.9788	0.9650	0.9513	0.9378	0.9246	0.9115	0.8986	0.8858
Gaskets	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Servo valve	0.9661	0.9017	0.8416	0.7854	0.7331	0.6842	0.6386	0.5960	0.5563
Hydraulic motor	0.9951	0.9853	0.9756	0.9660	0.9565	0.9471	0.9377	0.9285	0.9194
Screw with balls	0.9999	0.9998	0.9997	0.9996	0.9995	0.9994	0.9993	0.9991	0.9990
Intermediate tooth wheels	0.9998	0.9993	0.9988	0.9984	0.9979	0.9974	0.9970	0.9965	0.9960
Guidance	0.9997	0.9992	0.9987	0.9982	0.9977	0.9972	0.9967	0.9962	0.9957
Sensor coupling	1.0000	0.9999	0.9998	0.9997	0.9996	0.9995	0.9994	0.9993	0.9992
Digital commanding	0.9943	0.9829	0.9717	0.9605	0.9496	0.9387	0.9280	0.9174	0.9069
R(ti) total – variant 1	0.9307	0.8062	0.6983	0.6049	0.5239	0.4538	0.3931	0.3405	0.2949
R(ti) for component elements – variant 2									
Screw with balls	0.9999	0.9998	0.9997	0.9996	0.9995	0.9994	0.9993	0.9991	0.9990
Intermediate tooth wheels	0.9998	0.9993	0.9988	0.9984	0.9979	0.9974	0.9970	0.9965	0.9960
Guidance	0.9997	0.9992	0.9987	0.9982	0.9977	0.9972	0.9967	0.9962	0.9957
Sensor coupling	1.0000	0.9999	0.9998	0.9997	0.9996	0.9995	0.9994	0.9993	0.9992
Digital commanding	0.9943	0.9829	0.9717	0.9605	0.9496	0.9387	0.9280	0.9174	0.9069
Electrical engine c.c.	0.9983	0.09948	0.9914	0.9880	0.9846	0.9812	0.9778	0.9745	0.9711
Revolution variator c.c.	0.9894	0.9684	0.9479	0.9279	0.9082	0.8890	0.8702	0.8518	0.8338
R(ti) total – variant 2	0.9814	0.9453	0.9105	0.8769	0.8446	0.8135	0.7836	0.7547	0.7269

3. Results and Discussions

In the table 1 is presented the predictable reliability function calculus *R(t)* for the component elements and for the whole advances mechanism, in both constructive variants, using laps times *t(i)* the same in the case of operational reliability establishing, in order to permit the optimum comparer of those two indicators, with the broke downs rate λ tacked from the special literature.

From the date presented in the table 1 it's consisted that their exist differences between the values of predictable reliability for the two lots of lathes, corresponding to those two constructive variants of advances mechanism. The charts of predictable reliability for those two constructive variants are presented in the figures 3 and 4. Comparer the results for the predictable reliability function estimated for those two constructive variants is presented in the figure 5. The values for *R(t)* are bigger for in the case of the second constructive variant, in which the hydraulic training is replaced by the electric-electronic training.

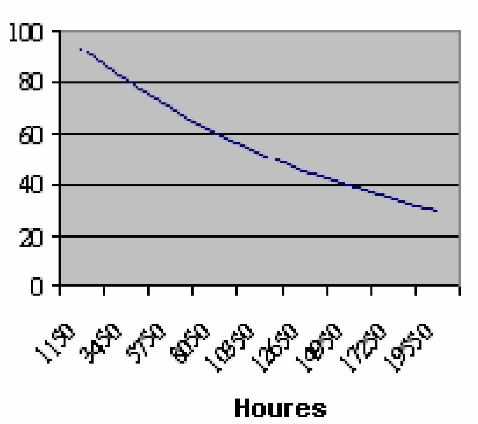

Figure 3. The predictable reliability variant 1

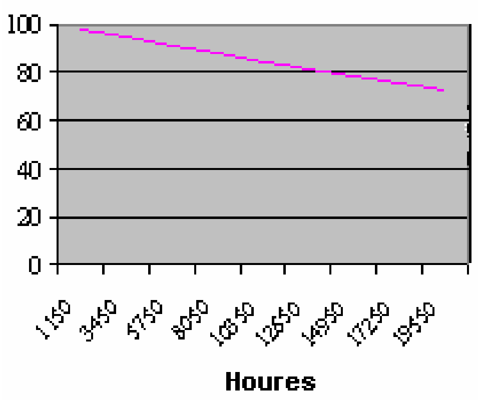

Figure 4. The predictable reliability variant 2

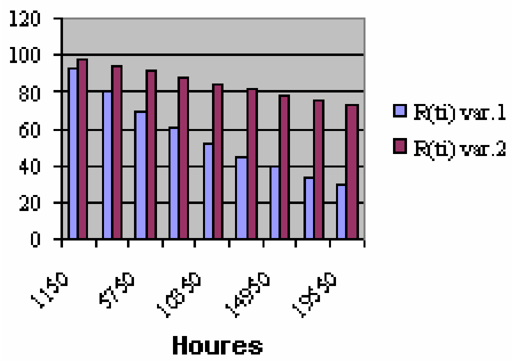

Figure 5. The comparing of predictable reliability function values for those two variants

In the sight of making a later on precise calculus for the predictable reliability, they determinate the values of the advances mechanism broke down intensity rate for those two constructive variants, in the case of operational reliability. The values are presented in the table 2.

Table 2. The broke down rate for automation equipments of the advances mechanisms for digital commanding lathes

Product name	**Broke down rate, $\lambda \cdot 10^{-6}$/h**		
	max.	med.	min.
The hydraulic training advances mechanism	0.0281	0.0221	0.0161
The electronic training advances mechanism	0.0214	0.0172	0.0130

After the effectuation of the reliability indicators calculus it can bee compared the values of predictable and operational reliability function, each constructive variant. The comparative values of predictable and operational reliability function for the variant 1 is presented in the figure 6, and for the variant 2, in the figure 7.

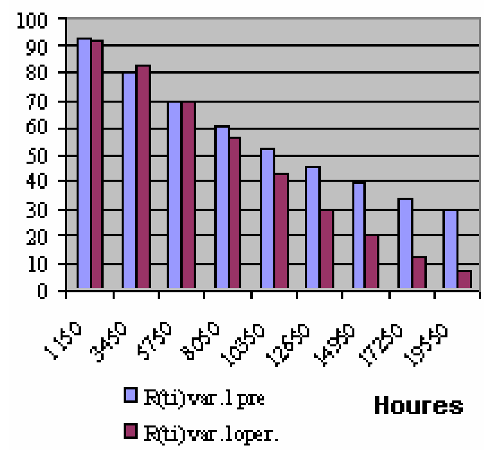

Figure. 6. Compare between the predictable and operational reliability, variant 1

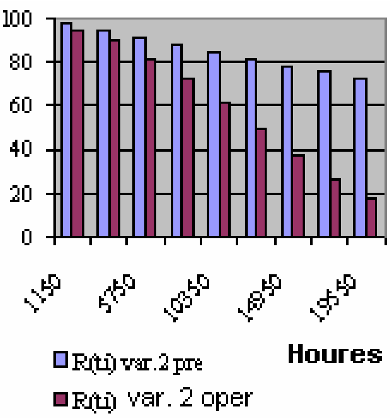

Figure. 7. Compare between the predictable and operational reliability, variant 2

Is noticed that the values of predictable reliability are bigger than the one of the operational reliability. For the effectuation of precise calculus for the predictable reliability from automation advances mechanism is recommended the values of λ from table 2.

4. Conclusions

1. By replacing the automation hydraulic system with an electric-electronic system has led to the decrease of broke downs number and the decrease of the stationing time for service. Is consisted the decrease of the medium number of broke downs from 223 at variant 1, to 20 at variant 2.

2. The reducing of component elements number and the utilization, in the variant 2 of some reliable components (ex. the incremental transcriber), is has as a result the improving of reliability indexes for this technical system.

3. The predictable reliability estimated for those two lots of lathes is bigger with 51.35% in the case of the second constructive variant, comparative with the first variant.

4. In the sight of effectuation of a subsequent precise calculus for predictable reliability from the automation advances system from digital commanding lathes is recommended for the broke downs intensity rate λ the medium values 0.0221 for first constructive variant and 0.0172 for second constructive variant.

5. References

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