Automatic control system - most efficient way of revitalization of older fleet maintenance workshops

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Abstract **-The presented paper concerns revitalization of an older workshop with minimal investing costs. The low costs are main agent of effective operation of every factory or workshop. One of main sources of extra costs are warranty repairing. It is especially seen in communication means, like trams, or metro trains. A failure of this kind of device results in many disturbances in public transport and high cost of transporting of the immobilized vehicle back to the workshop.**
The problem of revitalization is much common, as there are many small factories or workshops in Poland, that are equipped with older, simple type of tools or all production lines. Replacing the tools with new ones is mostly almost impossible from economical point of view.
Authors propose very costs effective, simple method of revitalization of this kind of workshops: to equip them in modern control systems. Relative cost of such a solution is very low, but the results can be really impressive. Below the authors would like to share their experience in this kind of revitalization they have obtained for some last decades.

1. Introduction

Communication system in Gdansk, Sopot, Gdynia agglomeration – called Tri-City bases on fast urban train (SKM). The SKM is the spine of Tri-City, mainly due to the fact the towns lay by the Gdansk Bay one-by-one.

Basic unit of SKM consists of three carriages- middle one has driving electrical motors. The motors work in pairs, which requires precisely matched electrical characteristics [1,2]. Very intensive usage of the train and safety requirements make frequent inspections and period repairs of the train driving units, specially driving motors.

This service has been made since 70' in Gdansk Train and Urban Repair Workshops (Gdańskie Zakłady Remontowe Taboru Kolejowego i Miejskiego (ZNTKiM).

One of the most important problem of economical effectiveness of the Workshops was problem of warranty repairs of the electrical motors. In many trams or metro trains electrical engines work in pairs, due to the way of their speed control. This kind of operation requires precise matching of the motors working in a pair.

The matching can be done manually, but in this case human factor is absolutely the weakest part of the system. There are several reasons of this phenomenon; from the fact the measuring process is long (it can takes a few hours) so the technician caring it can get tired and bored, up

to lack of time and short terms resulting in the pressing from the manager to perform the test as fast as possible and to obtain good results, which is obvious contradiction.

Fully automatic system is free from this kind of disadvantages.

Before automation, electrical characteristics of the motors used to be taken manually, of poor precision, which resulted in damaging of a motor very soon, even after one hour of exploitation. To reduce the resulting losses, the decision was undertaken to make an automatic stand for testing of the motors. Computer aided testing system was designed and made in cooperation of employees from Electrical Faculty of Technical University of Gdansk.

2. Repair technology applied in ZNTK

Driving unit were towed in to a repair stand in the main hall (see Fig.1.). The unit under repair was lifted up, all driving cars were removed, and motors were taken out to repair. After repair the motors had tested insulation, resistance of the windings, maximal voltage and the idle state test was performed. Than the montage process was made in reverse order. After that the train unit was tested on the trails.

Fig. 1. Main hall of ZNTKiM

During the trail tests unmatched motors were just damaged. It resulted in very high extra costs as the all unit had to be towed back to the Workshops, and the repeated repair frequently was more expensive, due to the fact the damages could be larger than the original one. It is cheaper to replace a bearing than windings.

The problem of warranty repairs was really serious, as the warranty toll was approximately 11-12% of the motors. The real costs were much higher than 12% as the secondary repairs were more complex than primary ones and the technology of taking out a single motor was more difficult. The automatic test stand was expected to improve the situation.

3. Testing stand

Existing electrical test station had to be equipped with an additional room for the protection of the electronic devices, both measuring and controlling. The test station with the newly erected small room for the stand is shown in Fig.2. The room was a must, as the environmental conditions on the main hall were really severe, too severe to apply computer equipment even in industrial form. The environmental conditions were severe from both, climate and electrical interferences.

Fig. 2. Room for the automatic test stand

Fig. 3. The control room

Fig.3 presents control room, in which main control consol is situated and all measuring and computer equipment. The consol is the same that it had been used before computerization the stand. The consol was adapted by adding some electrical drives to existing devices, that had been set manually.

The A/D converts and optocoupler insulation barrier was placed into heavy, industrial case to additionally protect the electronic devices from hard environmental conditions. The operator has the interactive interface in the form of keyboard and a monitor. The operator's interface make it possible to type in all necessary data to the program. Results of the matching process were presented on line on the monitor. When the matching procedure finishes, the hard copy of the final protocol is printed on a printer. It is worth mentioning, the all imported data, like date and time of the test is taken from the computer system, so it is impossible to change it.

The block scheme of the computer aided test stand presents Fig.4. The most important factor in industrial application is lack of sensitivity to interferences. It is worth mentioning, the motors are supplied with 1.5kV voltage, and currents are in hundreds of amps. The hall is full of heavy electrical tools, so the main designers problem was to foreseen and apply all available protection barriers.

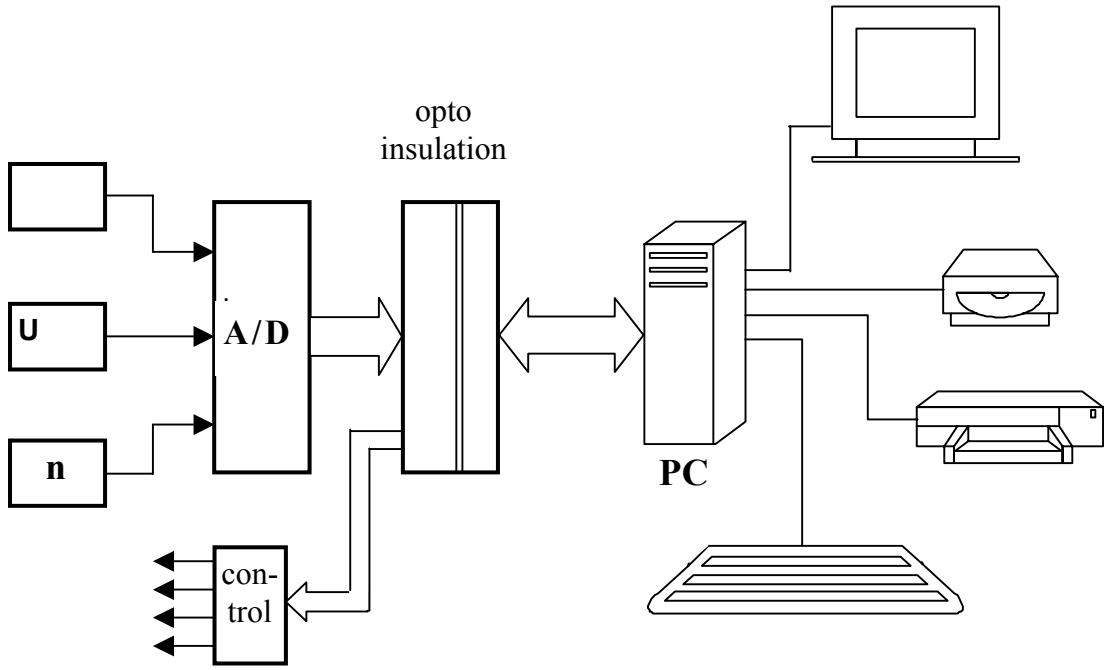
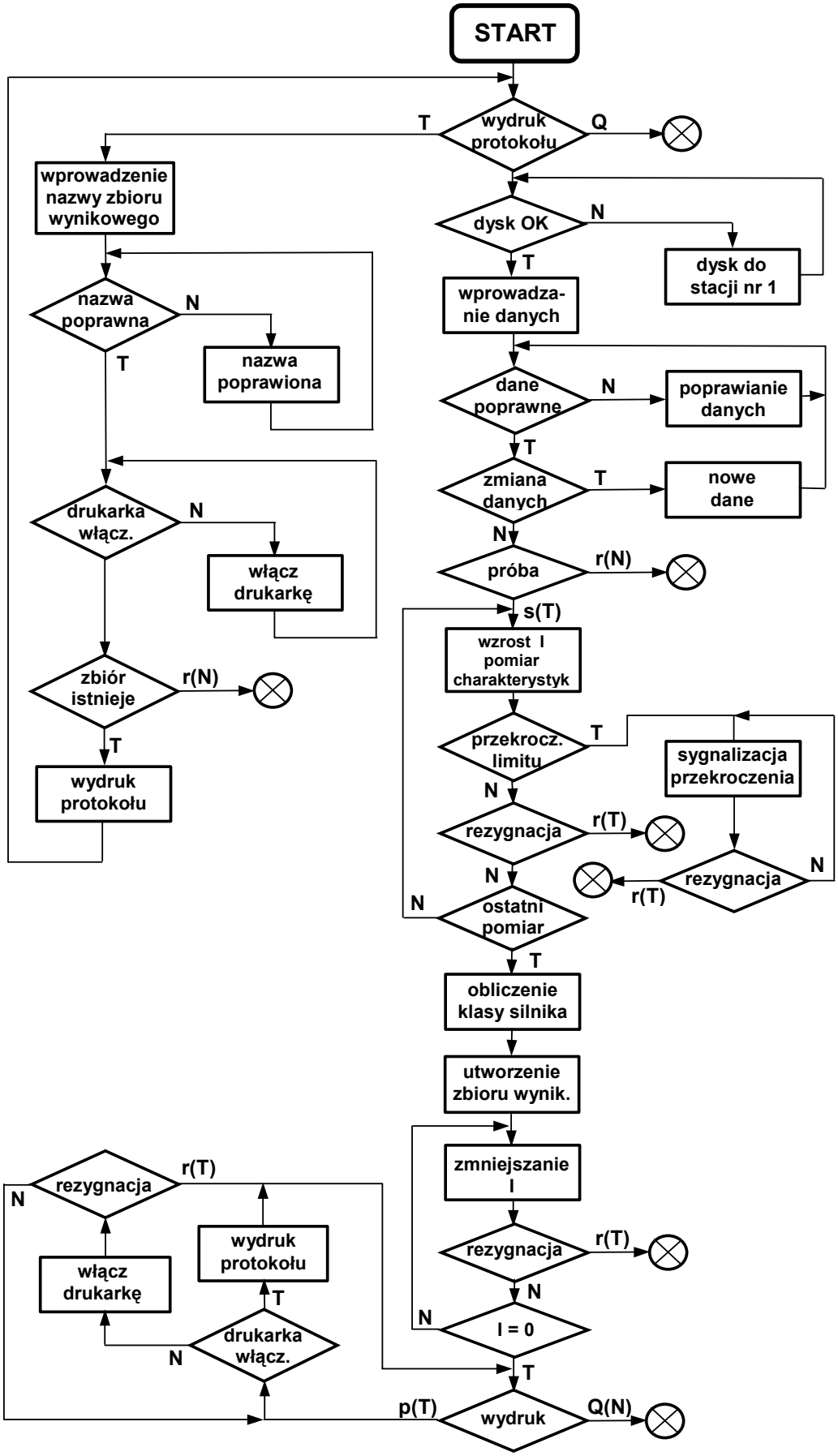


Fig. 4. Block scheme of the computer aided test stand

The aim was achieved by the application of relatively slow dual-slope A/D converters, optocouplers barrier and statistical processing of the measured data.

Another problem – typical in such situation – were the dynamic properties of the controlled mechanic-electrical devices .The power of a motor is about 300kW, so all drives are large and their time constants are very high. The problem of controlling the stand was solved with an adaptive algorithm presented in Fig.5 [3].


START
wydruk protokołu
T
Q
wprowadzenie nazwy zbioru wynikowego
dysk OK
N
T
dysk do stacji nr 1
wprowadza-nie danych
nazwa poprawna
N
T
nazwa poprawiona
dane poprawne
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T
zmiana danych
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nowe dane
N
drukarka włącz.
N
włącz drukarkę
próba
r(N)
s(T)
zbiór istnieje
r(N)
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wzrost I pomiar charakterystyk
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przekrocz. limitu
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sygnalizacja przekroczenia
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T
obliczenie klasy silnika
utworzenie zbioru wynik.
zmniejszanie I
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wydruk protokołu
włącz drukarkę
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rezygnacja
r(T)
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I = 0
drukarka włącz.
N
T
p(T)
wydruk
Q(N)

Fig. 5. Flow chart of the algorithm

All the mentioned questions were successfully managed and it resulted in the stand that has been working for more than 8 years without any problems. Finally, the stand stopped due to the damage of a floppy drive! Since there is no such drives, and the stand after so many years of service deserves retiring, an decision has been undertaken to design and made a new stand, made accordingly to today technology. The stand is being made at the moment.

4. Conclusions

Author's first experience in the field revitalization was really teaching. It was very interesting, that at the beginning the workshop managers were against this 'independent' system, but the authors of it firmly convinced them that it is the only reasonable solution; simply because automatic system dependent from the operator has no sense. First, the managers were not so sure we were right, but quickly they understood that this is good for their firm. From the one hand the inevitability of the performing really objective test led to the necessity of quality improving and from another - to the really precise matching of the engines. The final results were astonishing, the warranty repairs toll decreased to 0%!. During 8 years of service, non motor was repaired twice. Since the annual output of the workshops was approximately 400 motors, it is easy to calculate, that the cost cutting was equal to the equivalent of about 40..45 motors per year. For 8 years of service it makes about 320..400 motors.

Besides, all the customers were sure that the workshop gives them product of really good quality, so the workshop had a lot of demands and low costs-which is a dream of every firm. The test station started its service in 1990, and has been working continuously up to the last year, when a disk drive damaged. Since there is no such a drives and the station after so many years of service deserves retiring, the workshop managers have decided to replace the control system with the today version. There is no need to say the authors of the new one are the same.

Revitalization of older workshops seems to be of really great importance, as it give some extension of tools life of technological lines. In today hard times every help in economic situation of a workshop or small factory is worth consideration.

5. References

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