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Preliminary communication

The Model of Changes in the Psychomotor Performance of the Production Workers

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Abstract: The results of the study indicated a relationship between the worker's psychomotor performance at a certain time of the work shift and the changes in the level of their fatigue. The performance is reflected in the production results, such as the decrease in the productivity and an increase in the number of defects. The results of the study made it possible to define a model (algorithm) of changes in the worker's psychomotor performance. The developed model identifies the direction of the organisational changes in a production plant environment operating in the rotational shift pattern. The organisational changes can relieve staff in the night and minimise the risk of the declining production efficiency during work at night.

Keywords: jet lag; night work; physical and mental fatigue; psychomotor skills of production workers; shift work

1 INTRODUCTION

Production management is a string of decisions that affect the efficiency of the individual links in the production chain, the result of which is the success or failure of the company on the market. The pressure to achieve certain objectives, usually with inadequate resources, in a complex organisation and in the rapidly changing environment imposes different variants of work organisation [1–6]. The role of the management is to monitor progress, set ambitious goals and manage processes [7–9]. The organisation of production, and in particular the need for maximum resource utilisation, the reduction of the time needed to perform tasks, and the technological requirements require work to be performed continuously, which means performing work at night, as well [8, 10–11]. In Europe and North America approx. 15–20% of the working population performs shift work, which includes night shifts [12]. The situation worldwide in the industrialised countries is estimated to be similar – almost 20% of workers perform tasks on rotational shifts, and in the United States alone more than 6 million people work in this way [13–14]. This type of employment applies mostly to sectors, such as healthcare, manufacturing, mining, transportation, communications and hospitality [12].

In the natural cycle of the functioning of the human body, the day is the time of activity – the emission of energy – and the night is for body recovery and rest. As a result, night work is a substantial disturbance of the natural human rhythm [15–16]. Night work requires the worker to make an increased physical and mental effort regardless of his job position [17–18]. Even a sedentary work or work involving surveillance of facilities is very tiring at night time. The night work on a production plant involves additional adverse factors, such as noise, traffic, the need to adjust the worker to the pace at which the production line is operating and the need to focus on a particular task at hand while concentrating on multiple ancillary issues impede the functioning of the worker's body [19]. The events taking place in the changeable environment of the production shift, in conjunction with the natural disturbance of the worker's psychophysical state, are a source of stress. Professional stress is stress experienced in the workplace as a result of the events related to the work. It has an adverse and chronic effect on the worker, who is in contact with various stress-causing factors (stressors) in their working environment. They are a cause of negative health effects including psychological disorders (e.g., depression, anxiety, post-traumatic stress disorder) and other types of emotional strain (e.g., dissatisfaction, fatigue, tension, etc.), maladaptive behaviours (e.g., aggression, substance abuse), and cognitive impairment (e.g., concentration and memory problems). In turn, these conditions may lead to poor work performance, higher absenteeism, less work productivity or even injury [11, 20–23]. Thus, it is also important to monitor, analyse and evaluate the impact of organizational factors on the effectiveness of inspection in the manufacturing process [24–25].

Disruptions of the biological clock cause malaise, trouble falling asleep and the deterioration of the quality of sleep, disturbances in the family relationships and social life of workers [11, 15]. The worker supplements the deficiencies in the natural sleep during the day. The functioning of human body largely depends on the pineal gland (Latin Corpus pineale), the gland producing the sleep hormone – melatonin. The proper functioning of the pineal gland is associated with light stimuli in the daily rhythm of changes in luminance. The disruption in the natural functioning of the human body causes problems in the functioning of the pineal gland and the secretion of melatonin. This adversely affects the rhythm of many of human basic physiological functions [26–27]. The sleep at day in a room that is rarely completely dark is characterised by lower quality than the rest at night and therefore disrupts the functioning of the pineal gland and negatively affects the human being.

Physical or mental activity at night causes an industrial jet lag [28–29], which is a characteristic chronic state that leads to many ailments. The jet lag is the difference between astronomical local time and the indications of the internal biological clock. Depending on a number of different conditions of the worker's working environment and seniority, these may produce symptoms, such as sleep disorders, lack or excess of appetite and problems with excretion of products of metabolism [30–31]. Many years of study in different scientific centres suggests that the populations of workers employed on night shifts suffer from diseases of the circulatory system, gastrointestinal dysfunction, peptic ulcers, diabetes, obesity [32–33], states of chronic fatigue, anxiety, sleep disturbances and depression [21, 27, 34–35] more often than people who

work only during the day. Night work disrupts the eating cycle, as well. The change in eating times, irregular mealtimes or excessive consumption of drinks and meals lead to dangerous conditions. These are usually problems with the digestive system, blood pressure and nervous disorders. Night work is conducive to the consumption of excessive amounts of sweets, coffee and energy drinks. It often leads to metabolism disorders and significant changes in glucose levels, which affects the correct performance of vital functions. An excessive intake of coffee is a cause of the increased loss of trace elements in the body. Workers working at night consume coffee at the beginning of the second phase of the shift, in particular, to improve their comfort, and then also during the day for the apparent balancing of the ailments associated with sleep arrhythmia. Limits which are sometimes organisationally imposed on coffee consumption cause workers' dissatisfaction together with a related stress, as well as demotivation and a sensation of excessive fatigue in workers. Studies confirm that the incidence of diseases of the digestive system is several times greater in workers working on night shifts than in the rest of the staff [14, 21, 27, 32, 35, 36]. This is associated with the impaired intestinal peristalsis and the irregular secretion of digestive juices. The problem is intensified especially in workers over 40, whose natural tendency for this type of disorder is usually greater.

2 MATERIALS AND METHODS

The study was conducted in a production plant where workers worked in three-shift pattern from Monday to Friday, with some workers in certain periods and selected departments also starting work on a Sunday night until the second shift on Saturday. The study used e.g. an observation method structured by means of predefined questions. The survey was carried out throughout 3 months in a group of 70 people working in a three-shift pattern. The group included 38 women aged 19-61 and 32 men aged 21-54. The study was carried out at the night shift, and also – in order to create a control group – at the first shift as part of an analysis of changes of level of psychomotor performance in the production workers. The night time is defined as a working time between 10 PM and 6 AM of the next day.

The goal of the study was:

- To determine the negative effects of the night work. The detailed issues were defined as follows: the functioning and organisation of the worker's professional and personal life, the sensation of fatigue at different times of the night work, the subjective sensation of fatigue in the workers during the week when they were working at night, the worker's priorities after waking up after the night work, the worker's declared duration of sleep after working at night on weekdays and on the first day after a series of days of working at night, the declared time of going to sleep after returning from the night shift;
- The impact of the negative effects of the night work on the level of the production plant worker's psychomotor performance;
- The confirmation of the occurrence of additional risks, including those related to driving on the way back home after the night shift.

The analysis was divided into two parts. The first part of the study consisted of a survey and the second part involved an analysis of selected production data. An analysis was conducted to ascertain the productivity and the average number of defects generated by workers producing plastic details on injection machines. The survey was carried out in direct talks with the workers. The direct talks enabled a better understanding of the problems associated with the functioning of the production team and the correctness of understanding of the questions as well as clarification of the answers by the worker. The questions were asked between 3 and 4 AM. During this period, the worker feels the greatest fatigue. The questions applied to the issues related to the personal and professional life while working on a night shift. The examination of the decrease in productivity and the changes in the actual number of defects was conducted in a group of 21 persons selected from the surveyed team.

3 RESULTS AND DISCUSSION

Many factors determine the degree of discomfort related to shift work. The duration of the shifts, their order, the number of night shifts and days off, the time of starting the shifts and the possibility of taking a rest during the night shift have been examined as part of multiple studies, but their conclusions were not entirely clear. In addition to the above-mentioned factors, there are also interfering factors that are difficult to assess, associated with the relations between the workers, their mood at work, the worker's attitude towards the work and the satisfaction derived from it or the intensity of stress – which sometimes can have a greater impact on sleep than the shift work [37]. Workers assess the impact of the shift work on their lives ambiguously – some point to the numerous family or health problems while others prefer this type of work because of a greater amount of leisure time [36]. The differences in the perception and tolerance of the shift work result in some workers quitting this form of work after some time, e.g. due to the shift work intolerance syndrome. Smith and Colligan [20] reported poorer sleep, greater risk of sickness absence, and a higher alcohol consumption among shift workers compared to the day workers.

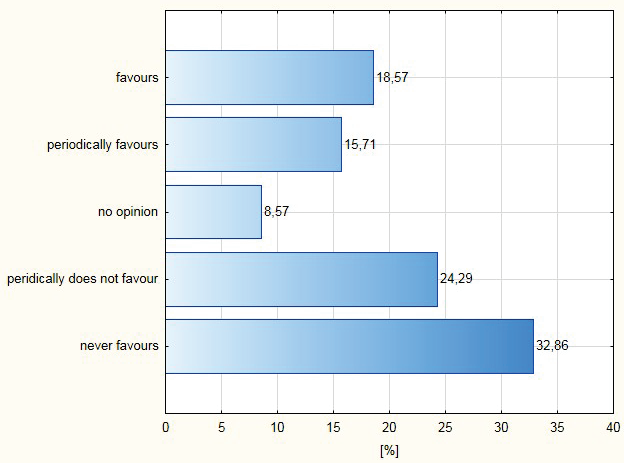

Figure 1 The night shift workers' feelings on the functioning and organisation of the professional and personal life

It is undeniable, however, that resting at other times than those resulting from our biological clock leads to

poorer sleep quality (despite an adequate number of hours) [20, 28] with all the consequences (the risk of accidents, the decline in the psychomotor performance, the chronic fatigue and the previously mentioned health consequences) [24,35]. According to many authors, correct, restorative sleep should not be less than 7 hours and should happen at night [36].

The analysis of the negative effects of night work has started with the attempt to determine whether workers feel that working at night is conducive to the functioning and organisation of their professional and personal life or rather impedes them (Fig. 1).

For almost 33% of the surveyed workers, working at night is always unfavourable. The reason is the larger-than-normal (in the case of the work on one shift, usually between 7 AM – 3 PM, 8 AM – 4 PM or 10 AM – 6 PM) fatigue and difficulty in adapting to the change in the natural rhythm of the day. Almost 25% of the respondents indicate that the night work is periodically felt by them as unfavourable. As an explanation, they mostly point to the period of spring and summer and the associated household work and leisure that happens then. The night work is conducive or periodically conducive to the functioning of the professional and personal life for 18.57% and 15.71% of the respondents, respectively. The reason is the possibility of performing additional work or studying during the day. Almost 9% of the respondents have no opinion on the matter, usually indicating their wont as the reason for this state of things.

Due to the conflict between human activity during the day and the natural regeneration of the body in the night, night work is a significant circadian rhythm disruption. Its intensity also varies at different times of the night. Therefore, the workers were asked which hours of the shift were the time when they felt the strongest fatigue and difficulty in working on the production line. The results of the answers are shown in the form of a graphic in Fig. 2.

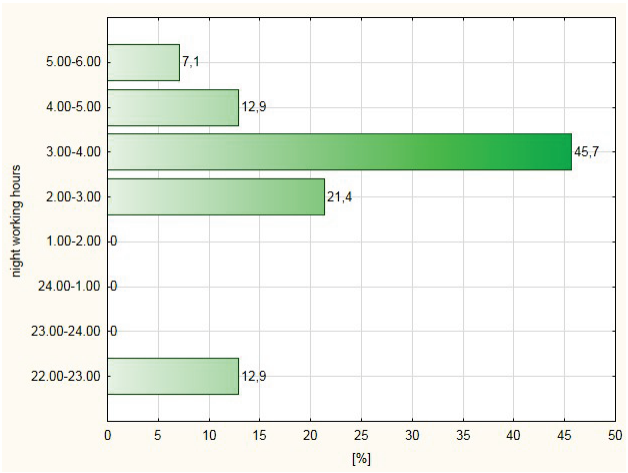

Figure 2 Fatigue at different times of the night work

It turns out that the build-up of fatigue is strongly associated with the duration of the shift. The answers to this question are subjective. The first hour of the work is the time when the greatest difficulties are felt by almost 13% of respondents. This is due to the rest before the start of the work and the body's need to switch to the load associated with the work at night. The next three hours are not perceived by the respondents as a time when excessively great fatigue is felt. At about 2 AM, so at the beginning of the 5th hour of the shift, during the regular break, the fatigue becomes more strongly felt and builds up. Conducive to that is the decrease in the intensity of noise level in the employee welfare area during the break and the relaxation resulting from the sudden stopping of the constant labour. This is confirmed by both the authors' observations carried out during the study and by the employees themselves. More than 21% of workers indicated the time between 2 and 3 AM as the time of the greatest fatigue. This is influenced by the effort of the body associated with the consumption of the meal and digestion. The problem is growing in the 6th hour of the night shift (3-4 AM). Close to 46% of the surveyed workers indicated this time as the most difficult for them. The reason for this is the end of the relaxation time and the effort put into working after returning to the tasks. The period between 3 and 4 AM is a natural period of deep sleep for humans, so the body demands it during the night work. Similar results are confirmed by the studies by Kowal and Dudarski [40] and Knauth et al [41]. They identified that between 4 and 6 AM, the sensation of fatigue declines in the respondents. The reason is the positive emotions associated with thinking about the end of the work. In the summer time, a longer day and more light in the morning also cause apparent decline in the sensation of fatigue.

The severity of fatigue on a night shift accumulates over subsequent days of the week. Therefore, the distribution of the fatigue across different days of the week looks similar (Fig. 3).

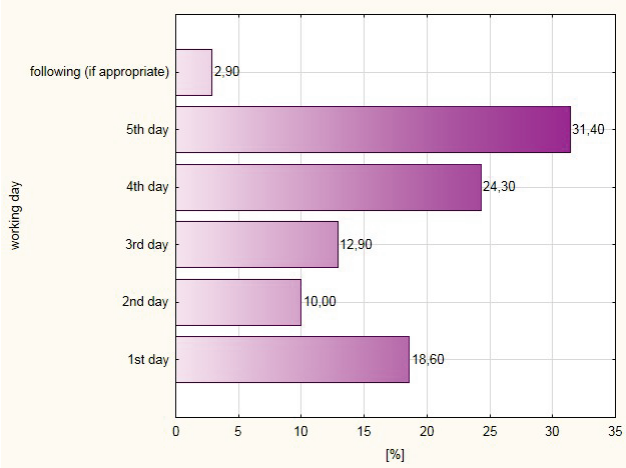

Figure 3 The subjective sensation of fatigue in the workers during the week of working at night

The 4th and 5th night shifts are perceived by the surveyed workers as the most difficult. This is declared by almost 56% of the respondents, who consider this an effect of the accumulation of sleep deficiency and arrhythmia. Every tenth worker being surveyed (mostly women aged 40-55) admits they take pharmaceuticals to balance the sleep deficiency. Close to 19% of the workers indicate the first night at work as the most difficult, the main reason being the difficulty of adjusting to working at night. Only around 3% of the respondents declare that each additional day following the 5 consecutive days worked between 10 PM and 6 AM is the most difficult in the night work. According to Wagstaff et al. [11] work periods more than 8 hours carry an increased risk of accidents that cumulates,

so that the increased risk of accidents at around 12 hours is twice the risk at 8 hours.

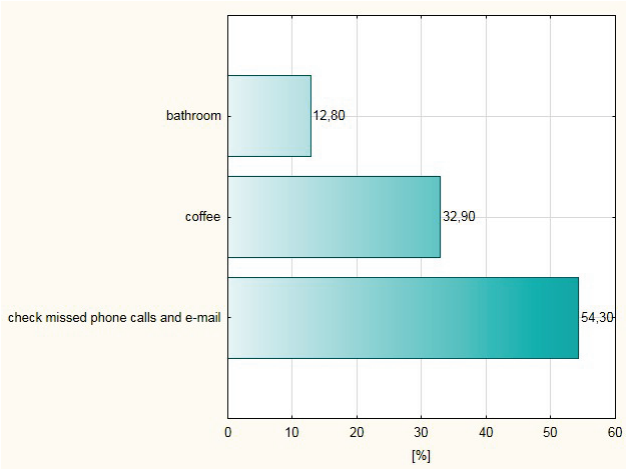

Figure 4 Worker's priorities after waking up after working at night

Circadian rhythm disorders and stress cause sleep to be often shallow, nervous and short-lived, and sometimes intermittent. Åkerstedt [15] reported shift workers practically always report more sleep disturbances than day workers. Circadian rhythm disorders translate into an increase in fatigue and worker's simultaneous difficulties in thinking about thorough task performance in the worker's professional and private life. Therefore, the respondents were asked about the first activity they perform after they wake up (Fig. 4).

More than 54% of the respondents admit that immediately after waking up, they reach for a phone to check any missed calls and e-mail with the professional relations in mind. This is proof that the worker has work-related thoughts in mind at all times. This negatively affects the sleep duration time. For approx. 33% and for less than 13% of the respondents, respectively, the first thing they do is to prepare the coffee or perform toilet activities. It should be stated that the majority of the 2nd and 3rd group declare that reaching for the mobile phone is the second activity. The workers emphasise the difficulty in returning to the natural rhythm after the end of the night work. Every fourth respondent has difficulty sleeping, suffers from excessive fatigue and feels anxieties that cause them to wake up nervously. During the day, on the other hand, especially in the morning, the workers have difficulty concentrating.

After working at night, not everyone falls asleep immediately and the duration of their sleep and its quality are very different. Almost 55% of the respondents sleep far too little compared to the energy expenditure resulting from working at night (Fig. 5). Approx. 25% of the respondents sleep only 3-5 hours. This is confirmed by symptoms, such as fatigue, red eyes and dark circles under the eyes, paleness. Only 13% of the workers declare they sleep for 8 hours or more, 33% of the workers report sleeping for 5 to 8 hours in total. It is worth noting that this is often a sleep consisting of two parts: in the morning and afternoon or evening. According to many authors, correct, restorative sleep should not be less than 7 hours and should happen at night [39]. This can be conducive to the reduction in the overall immunity of the body. On the first day after the end of the cycle of night work, the worker's declared sleeping time is more favourable than during the cycle. This comparison is shown in Fig. 5.

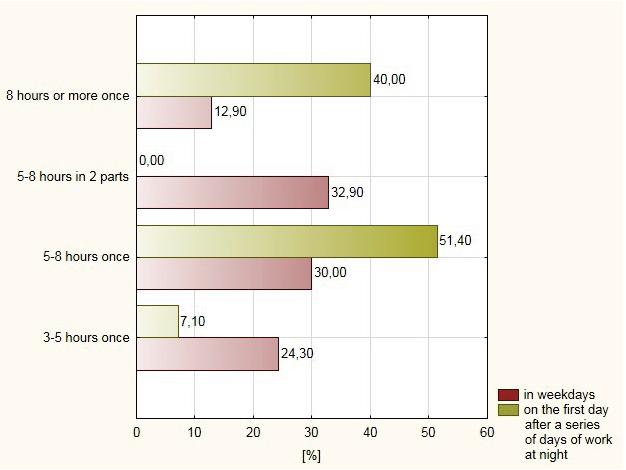

Figure 5 The worker's declared sleeping time after working at night on weekdays and on the first day after a series of days of night work

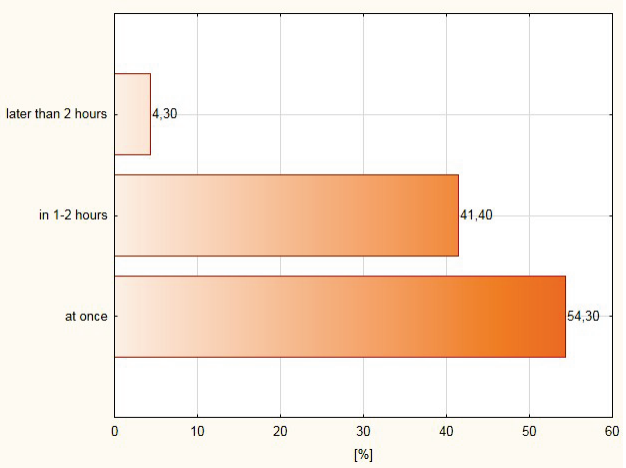

Figure 6 The declared time of going to sleep after returning from a night shift

The share of the workers who sleep too little is declining and the number of workers who sleep longer after the night work-related energy expenditure is increasing. The sleep is calm, deep, stable and without awakening in the meantime. The respondents also declare that the first thing they do when they wake up and make sure that it is a day off is usually to go to the toilet and have coffee (approx. 40%) rather than check the means of communication (less than 20%). The performance of different activities than those during the work week results from the decrease in the level of stress associated with returning to work and the mental relaxation associated with the prospects of having a few days off. It is worth stressing again that restorative sleep should not be less than 7 hours and should occur during the night [39]. This is confirmed by the results [42], where the shift workers declared a higher number of hours spent on sleeping than the non-shift workers, but signs of sleepiness and fatigue were observed in them nevertheless. Another fact is also interesting: it has been shown that people tend to overestimate sleep problems [43]. Akerstedt et al. [44] indicated it usually takes two night sleep periods before normal low sleepiness levels have been achieved after the last night shift. Permanent night workers tend to sleep somewhat less than day workers [45]. The latter study showed that the first day

sleep was reduced by 1.1 h (compared with normal night sleep) and decreased a further 0.8 h over the six night shifts. Also, Wilkinson [45] found in a review that permanent night workers on the whole reported longer sleep (6.7 h) than weekly (6.3 h) or rapidly rotating (5.8 h) shift workers.

The declared time after returning home from a night shift after which the worker goes to sleep is interesting as well (Fig. 6).

More than half of the respondents (54.30%) go to sleep immediately after returning from the work, and close to 42% do that within 2 hours. Less than 5% of the respondents declare that they go to sleep later than two hours after returning from work. The reasons include the organisation of family life and wont. The obtained results comply with the results of the Knauth and Rutenfranz study [46], which are widely known in the literature. They reported the sleep after a night shift is usually initiated 1 h after the termination of the shift, with very little variation (30–60 min SD) between individuals.

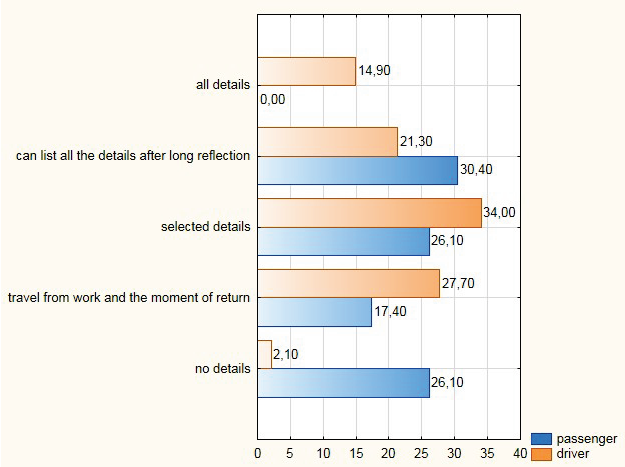

Figure 7 The details of the way back home remembered by the driver (orange) and passengers (blue) after a night shift

The study also raised the issue of fatigue on the way back home after the night shift, including the issue of driving a vehicle. Due to the fatigue of the workers driving vehicles, the problem applies to the safety of both the workers and other road users. 47 workers (67.14%) declared they always drive on their way back home after the night shift. The distanced travelled is usually 8-28 km, and the total number of people in the car is usually 3-4. The return journey leads through rural areas, which reduces the tension and makes the ride more monotonous and tedious compared to driving in the city, which requires continuous changes in driving parameters and driver's behaviour. In combination with the warm air flow, this has a very adverse effect, additionally contributing to the fatigue. When asked about the number of details remembered on the way back home after a night shift, the workers responded after a moment of consideration, always emphasising the significant levels of fatigue (Fig. 7).

All the ride-related details (e.g. the driving speed, the topics of conversations raised by the passengers, the encountered cars, etc.) can be provided only by 14.90% of the worker-drivers and none of the passengers. 21.30% of drivers and 30.40 of passengers are able to provide all the details after a longer moment of consideration. 34.00% of drivers and 26.10% of passengers acknowledge they are able to provide important details, such as the arrival at home, encountering a police patrol, aggressive behaviour of other road users, etc. Almost 28% of drivers and 17.40% of passengers admitted that they often remember only the departure from work and the arrival at home. The group of people who declared they did not remember any details included 1 driver (2.1%). This is a particular reason for reflecting on the issue and studying a far larger group of workers. They often admit that concentrating is extremely difficult, which proves a very serious reduction in psychomotor performance as a result of a fatigue related to working at night. 6 passengers (26.1%) do not remember any details, as they often fall asleep during the ride as a result of the fatigue and monotony in the car. Wagstaff and Lie revealed in their review [11] that both long hours and shift and night work affect accident risk. This is of importance to all organizations and workers, but of particular importance to safety-critical activities.

The change in the production worker's psychomotor performance level is simple to identify. One can see it in the workers' behaviour, as well as in the results of the data collected. For the purposes of this study, a comparative analysis was carried out for the results achieved in the working conditions on the 1st and 3rd shifts. The results confirm the adverse effects of the night work on the work results, which constitutes information on the decline in the workers' psychomotor performance.

Table 1 The average productivity and average number of defects of the production worker on the first shift (working hours: 6 AM – 2 PM)

The days of the series of shift I	**days**	**1**	**2**	**3**	**4**	**5**
The target for detail 1	pcs/person./h	1065	1065	1065	1065	1065
The average number of completed details	pcs/person./h	1069	1092	1067	1099	1097
Productivity	**%**	**100,4**	**102,5**	**100,2**	**103,2**	**103,0**
The allowable number of defects	pcs/h	11	11	11	11	11
The allowable share of defects	%	1,0	1,0	1,0	1,0	1,0
The actual number of defects	pcs/person./h	9	7	6	6	3
The actual share of defects	**%**	**0,8**	**0,6**	**0,6**	**0,5**	**0,3**

Table 2 The average productivity and the average number of defects of the production worker on the third shift (working hours: 10 PM – 6 AM)

The days of the series of shift III	**days**	**1**	**2**	**3**	**4**	**5**
The target for detail 1	pcs/person./h	1065	1065	1065	1065	1065
The average number of completed details	pcs/person./h	1044	1065	1067	1022	1015
Productivity	**%**	**98,0**	**100,0**	**100,2**	**96,0**	**95,3**
The allowable number of defects	pcs/h	11	11	11	11	11
The allowable share of defects	%	1,0	1,0	1,0	1,0	1,0
The actual number of defects	pcs/person./h	14	13	15	21	27
The actual share of defects	**%**	**1,3**	**1,2**	**1,4**	**2,1**	**2,7**

Table 3 The optimisation of the selection of the task difficulty level for production staff working on night shifts in relation to the decline in their psychomotor performance caused by fatigue

		Particular hour of night shifts															
Consecutive hour:		1.		2.		3.		4.		5.		6.		7.		8.	
Time from - to:		10.00-10.30 PM	10.30-11.00 PM	11.00-11.30 PM	11.30-00.00 AM	00.00-00.30 AM	00.30-01.00 AM	01.00-01.30 AM	01.30-02.00 AM	02.00-02.20 AM	02.20-03.00 AM	03.00-03.30 AM	03.30-04.00 AM	04.00-04.30 AM	04.30-05.00 AM	05.00-05.30 AM	05.30-06.00 AM
day of the week	Monday																
	Tuesday																
	Wednesday																
	Thursday																
	Friday																
	- implementation of tasks of high and medium level of difficulty, short series and unit production under individual orders the customer, possible large variability of machinery during production,																
	- implementation tasks of medium difficulty, medium and short series, seasonal variation machine parameters during production,																
	- implementation of tasks with a low degree of difficulty, long and medium series, unchangeable parameters used during production,																
	- Statutory break.																

The study included the analysis of the productivity and the average number of defects generated by the workers who produce plastic details on injection machines. In manufacturing, productivity makes it possible to analyse and assess the degree of resource utilisation, and thus allows realistic planning and formulation of goals and programmes aimed at improving the current state of things. The study analysed the number of items of products undergoing the final processing, which consisted in evaluation and manual or semi-automatic removal of unnecessary elements after machining and gluing, and an assembly of a certain set for packaging. The values of the results are average for the entire 21-person team. Tab. 1 shows the results based on the data from 5 weeks across the period of 9 months when the workers worked on the first shift. The productivity is always above the established target, and the share of defects is below the established threshold. For comparison, the analysis was carried out for an analogous team, group of products and conditions of production but with night work in mind (Tab. 2). The productivity is often below the target, while the number of defects is greatly exceeded in relation to the targets adopted in the planning of production.

It is also recommended to consider the possibility of changing the regular breaks to 3.00–3.20 AM individually for each case. This will extend the period of the effective performance of tasks in the first part of the shift before the break and also move the period indicated by the workers as the most difficult to overlap with the break. This may affect the shortening of the period of lower efficiency during the shift. It should, however, be preceded by analyses that take into account factors, such as the cooperation between departments, the production cycle, the technological capabilities associated with stopping certain production equipment. The extension of the first part of the night shift should, however, take into account the fatigue and the need to drink coffee individually by each worker at an earlier time than during the late regular break without causing an interruption in production.

The proposed organisational changes can positively contribute to relieving night workers and minimise the risk of the reduction in the production efficiency while working at night.

4 CONCLUSIONS

Based on the study, one can draw the following conclusions:

I. According to 32.86% of the workers, working at night always impedes the functioning and organisation of the professional and personal life, and 24.29% of respondents admit that they periodically experience an inconvenience associated with this. However, there is a large group of people for whom night work is conducive to their functioning (18.57% – conducive, 15.71% – periodically conducive). The reason is the possibility of performing additional work or studying during the day.
II. For more than 67% of the workers, the 5th and 6th hours of the night work (2-4 AM) are the period of feeling the greatest fatigue, and for more than 55% of them, the 4th and 5th subsequent night shifts in the week are the period in which fatigue is felt the most.
III. More than 87% of the workers sleep too little after working at night compared to their physiological needs.
IV. Only 54.3% of the workers go to sleep immediately after returning home after night work.
V. As many as 63.8% of the drivers and 69.6% of the passengers returning home after a night shift are able to provide only a few selected details of their way back home.
VI. The results of the study show a link between the worker's psychomotor performance at a given time during the night shift and the changes in the level of fatigue. This adversely affects the production results, causing a decrease in the productivity and an increase in the number of defects. A decrease in productivity was observed in the persons being studied – on average by 2.1% daily, including by 4.35% on average in the second part of the week, along with an increase in the number of defects by 0.74% on average per day, including by 1.4% on average in the second part of the week.

Discomfort related to working at night affects the workers' psychomotor performance in a specific way, especially their behaviour. This impact is reflected in many aspects of their professional and family life. Within the analysed scope, the workers' behaviour and the effects of their activity are associated with adverse changes in the psychomotor performance. This translates into a number of mistakes, attention disorders, a decrease in the activity and commitment. This causes negative effects on the disturbances in the organisation of work, and thus the performance of technological processes.

The fatigue and decline in the psychomotor performance, as a result, affect the worker very strongly, causing an unfavourable general condition. As a consequence, worker-drivers who drive back home after a night shift are often a threat to themselves, the passengers and other road users.

This study is only a measurement sample of the actual state of things, which applies to all workers performing their professional duties at night. An analysis of the issue individually for each organisation can make it easier to learn the degree of impedance in the functioning of the workers caused by night work. It may support the organisation of work in the company by reducing the discomfort for the worker while minimising the risk of disturbances in the production process.

The study suggests considering the possibility of adjusting the speed of the production line or shortening the night shift cycle, since the problem of the changes in the productivity and the actual number of the defects builds up, especially in the second part of the week.

The proposed model can be used as the basis for the development of corrective actions that may favourably affect the production efficiency. In order to be correctly used, the defined model must take into account the nature of the company due to the possible consequences, including e.g. an overhaul of the entire work organisation system and a change of the technological cycles.

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