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INFLUENCE OF ERGONOMICS ON TRAFFIC SAFETY AND ECONOMY DEVELOPMENT

ABSTRACT

As an interdisciplinary science, ergonomics needs to make the operating of traffic safer, faster and more reliable, for the sake of higher profitability and generally improved economic effects. This is achieved by adapting and shaping the workplace, machines, transport means, equipment, physical environment, working process etc. according to experience about human anatomic physical, sociological, intellectual and other minimal, average or maximal capabilities. Therefore, it is necessary to analyse ergonomics from the standpoint of better productiveness of humans, greater safety (comfort) and security in general.

KEY WORDS

ergonomics, economic effects (productivity), economic efficiency regarding ergonomics, physical characteristics, energy, time and microclimate, traffic-generated noise

1. INTRODUCTION

Apart from alphabet and print, what most contributed the advanced civilisation were the innovations in traffic.

The use of natural and human resources of a country, as well as the development of economy, economic competitiveness, quality of living and the general civilisation level depend on the transport and its development.

One may speak of the final forms of relations and interdependence of transport, economy and ergonomics, but they may be summarised into four basic ones:

1. Transport allows the process of reproduction,
2. Transport branches are big consumers of the production of other sectors,
3. Transport is a significant factor in improving specialisation and social labour division,
4. Transport affects strongly the social and political aspects of development, by strengthening the unity and connectedness of the market, peoples, strengthening of integrity of a country with other countries, upgrading the academic, general culture, civilisation level, etc.

As an interdisciplinary science, ergonomics deals with increasing the harmonisation of the factors in the production process in traffic: people, working means and objects of work, from the micro-aspect. The organisation of work in traffic studies these factors from the macro-aspect.

The ergonomics[1], as an interdisciplinary science has to make work in traffic safer, faster, more reliable, more comfortable and on the whole more efficient. This is achieved by adjusting and shaping the workplace, machines, transport means, equipment, clothes, footwear, physical environment, working process, etc. according to the knowledge about the human anatomic, physical, sociological, intellectual and other capabilities. Ergonomics is increasingly expected, especially in the field of exploiting the transport means, to deal also with the adjustment of people in all the fields in which, for objective reasons, the adjustment will not go the other way round, i. e. according to people.

The basic action of ergonomics in traffic is reduced to finding the optimal relations in the system: driver (engineer) – car (engine) – traffic surface – organisation of the complex influence of the environment.

Regarding the large number of influencing factors which act on the traffic safety from the aspect of ergonomics, this work will be limited to some anthropogenic, energy, physical, gerontological, meteorological and psychological characteristics.

It is namely a fact that good knowledge about the ergonomics in traffic and economy, apart from finding adequate solutions for the overall increase in safety and operation efficiency, is a very important pre-condition for the operation in traffic and economy.

In the simplest terms, it could be said that ergonomics takes into consideration people, their capabilities, as well as the limitations within which a certain requirement can be imposed on a person not endanger-

ing their physical and mental health, provided they are satisfied and that they feel well at work.

2. ANTHROPO-TECHNICAL FEATURES

Adjusting work to man, and thus to traffic and economy can generally be technical or social. Technical adjustment of work is the task of ergonomics, which uses psychology, physiology, gerontology, meteorology and other scientific and economic disciplines in the process.

The social method of adjusting work to man relies on psychology, sociology, law, aesthetics and other sciences.

Therefore, both ergonomics and traffic, and then economy as well are complex interdisciplinary systems. In the research we encounter "double", and often also "triple" interdisciplinary characteristics, which has to be taken into consideration in order to study the interrelations.

The graphical presentation shows that we are constantly moving within the frames of technology, i. e. the production process.

Technology understands the action of natural laws and technical principles in the production process. The narrower field includes the technology which constitutes the machines and equipment in the production process. It includes the events all the way to the final product.

The technological process, on the other hand, considers single phases of production, and it follows the technological procedure which consists of a sequence of changes in the phase (details) and the technological operation and the technological intervention. The man participates in everything as the subject of production.

Therefore, no production process in the sphere of material as well as service production can be realised without the existence of traffic. Traffic is the generator of production, consumption and recycling as the re-conversion of various technological wastes into useful elements.

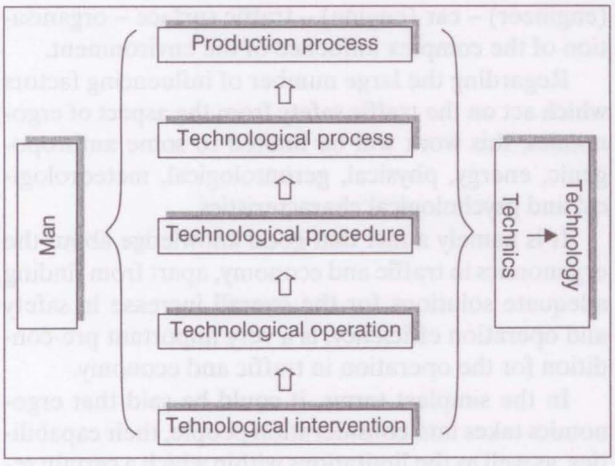

Figure 1

Man spends most part of the workday in the vehicle, cabin-cockpit, and it is his/her workplace. The man uses vehicle, machine, etc. to overcome distances.

Therefore, it is necessary to study ergonomics from the aspect of man's better productivity, greater safety and comfort, and security in the traffic process.

As a science, anthropology studies the physical nature, i. e. constitution of man, their position among organic beings. In the physiological sense, it is the study of the essence of man, his role and position in the world, and the sense of his existence. Anthropo-technical features which take into consideration the physical nature of man are considered the most important factor in the security and safety, as well as of the overall economy in general. It is therefore necessary to consider the position of man in the working space (vehicle, at a machine, etc.) and generally in the production process.

The construction of the workplace – car cabin, its dimensions, layout, form and distance of the instruments on the dashboard, field of sight within and outside the cabin, then dimensions, form and the scope of regulating the seat, backrest, etc. significantly influence the efficiency of work in general, and thus also the safety and productivity.

Difficulties with the spine, for instance, belong without doubt to the illnesses of the modern times, and they are the consequence of the modern way of life and work. Numerous employees, especially in traffic, are forced to spend most of their working time in the sitting position. Therefore, the frequency of incidence of spine problems is of no surprise, nor are the data that at least half of the applications for disability retirement are based on this illness.

The most frequent causes for these difficulties lie in the bad posture while working in the sitting position, which is closely related to the selection of an adequate seat. Therefore, the seat has to be anthropomorphic and anatomically shaped and has to take into consideration the latest anthropological knowledge. Thus, at the workplace and wherever possible, one has to sit upright, the back should be supported in the part of the kidneys and the lumbar part, so that the hip bone stays in the correct posture. Where possible, except in public transport, seats have to be rotatable, since in this way the spine does not turn too many times and it stays upright.

Absolute traffic safety cannot be achieved, but the use of passive security means can significantly alleviate the consequences of traffic accidents.

Apart from the design of the workspace – vehicle cabin etc., passive security means include: seat belts, anatomically designed seats, headrests, and recently also airbags.

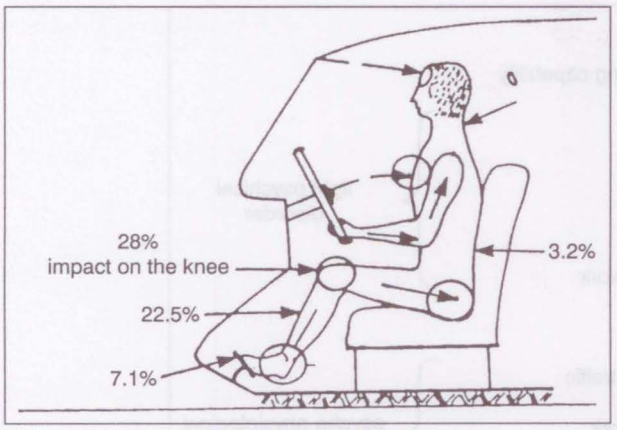

Figure 2

The use of seatbelts and headrests on seats can significantly reduce the very serious consequences of injuries, because during acceleration they prevent direct contact with the vehicle parts.

From the ergonomic aspect, the emphasis is on the headrest which, due to the inertia of the head mass and its sudden movement rearwards when the vehicle turns or suddenly stops, or in case of collision, prevents the very often fatal injuries of the spine.

The most frequent causes of death in the injured in road traffic are the head and neck injuries.

The posture of the body and the movements of the legs can be different, depending on the jobs and work tasks, and they may be different, depending on the way presented in Figure 2: sitting, standing, walking, partly bent down, or, less frequently kneeling down, bent down, squatting, stretched out, etc.

Highly productive work can be achieved only with the right organisation of work and ergonomically designed workplace, including the right distribution of the means of work, equipment and material, control instruments, commands on the dashboard, and a rational distribution of levers and control commands. Good design of the workplace results in better concentration of the worker, prevents fatigue and possibilities of injuries. The man's workspace is full of different threats, which can cause injuries, poisoning and suffocation as well as professional diseases, and on the other hand it can reduce productivity and can harm the economic development in general.

The injuries result from the disturbance in the relations between the man and the working environment.

The conditions that have to be satisfied by the workspace and the working environment have been standardised by the rules that regulate single human factors and the factors of the working environment.

In programming and designing the workspace, attention should be paid to the functionality, technological requirements, safety requirements, security regulations, and ergonomic requirements in general.

From the ergonomic aspect and the description of the workplace, the factors of the working environment are of great importance.

The factors of the working environment include:
- physical factors (microclimate),
- dangerous radiation,
- noise and vibration,
- lighting,
- biological factors.

The physical microclimatic factors include: air humidity, air circulation speed, air pressure, which is very important and it significantly affects the behaviour of the driver. The microclimatic factors include also thermal radiation, etc.

Regarding temperature, one can speak about the body temperature and the ambient temperature. The body temperature results from the heat generated by food burning in the man's organism. Normal temperature is between 36 and 37°C, depending on the place and time of measurement. During the day, the body temperature depends, thus, on the relation between the production (thermal genesis A) and its loss (thermolysis B). As long as this relation is 1 (A/B=1), body temperature is constant and the human organism functions normally.

Every disturbance related to the increase or decrease of the body temperature affects negatively the working capability and threatens the worker (driver in traffic, in his working space).

The ambient temperature depends on a number of factors, most frequently the internal ones (human organism) and the external ones, such as: air temperature, temperature of the solids in the environment, content of humidity, and airflow velocity.

Temperature, humidity and airflow (provided the air is unpolluted) represent interrelated factors of the microclimatic working conditions.

Human organism has the capability of thermal regulation since it tends towards biological maintenance of constant temperature. Thermal regulation has its limits that depend on the temperature of air humidity and airflow velocity. The heat transfer from the environment onto the human body proceeds by conduction (carrying), convection (streaming), radiation (thermal radiation) and evaporation.

Regarding the type of work and the position of the body during work, at relative humidity of 50%, the favourable temperature in working premises (driver's cabin) can amount to:
- 19-20°C for the work in the sitting position,
- 18°C for easy work in the standing position (ticket collector),
- 17°C for difficult work – standing position (workers engaged in loading, unloading and reloading),
- 15-16°C for extremely difficult work – standing position (the same as for the difficult work).

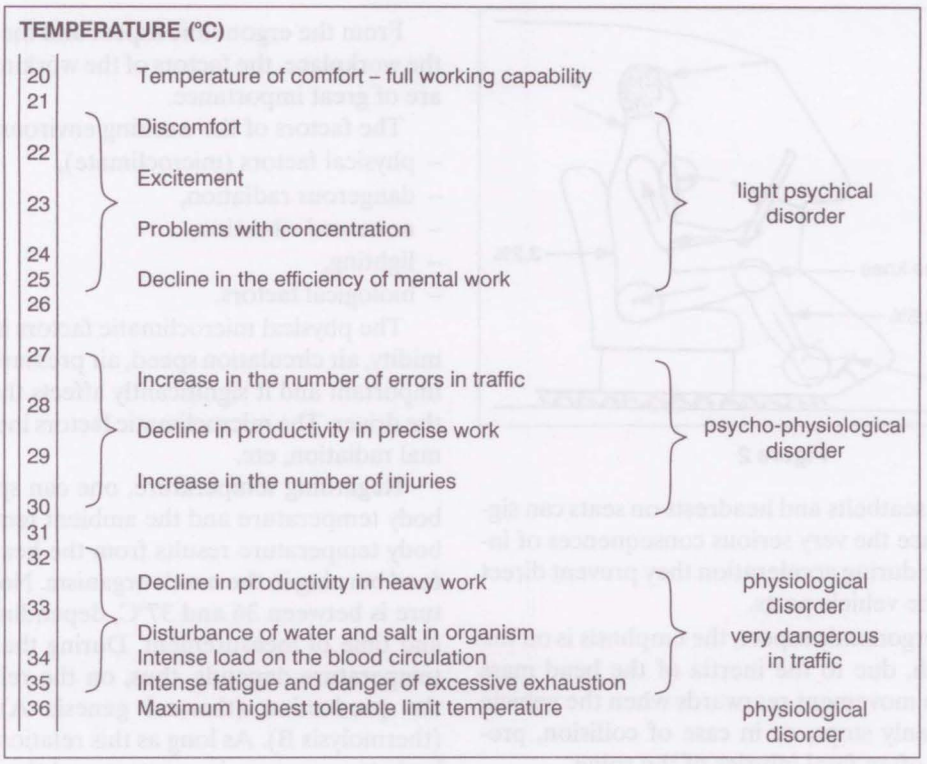

Figure 3

The influence of the increase in air temperature (50% relative humidity) on the feeling of comfort and psychophysical condition of the worker is presented in Figure 3.

Normal movement in traffic favours the airflow velocity of 0.5 m/s, and while working in the premises 0.2-0.4 m/s. In the office premises, 1-3 air exchanges per hour are desirable, and in sanitary premises even up to 8 exchanges per hour.

Air humidity is expressed in absolute humidity, maximal and relative one. Relative humidity is calculated by the expression $R_v = A_v/M_v$, and it ranges from the values 0-1 or in percentages, if the obtained value is multiplied by 100.

Air pressure affects significantly the work of the traffic workers (drivers, engineers, pilots, etc.)

Deviation of air pressure from the mean value upwards or downwards acts on the human compensation mechanism and at the altitude above 4500 m the body cannot be supplied by sufficient quantities of oxygen. The changes in the atmospheric pressure cause various mechanical and chemical reactions in the human organism, and they are reflected in headaches, pain in the muscles, slower and more difficult breathing, thus affecting the safety of all the traffic participants.

Respecting the ergonomic rules, the efficiency of operation and productivity of work in transport and economy are achieved.

The evaluation of economy of transport has to be based on the output, not as the quantity of goods and services, but rather as the output in relation to the benefits, value that is achieved by the completion of the performed operation (the provided transport service). The tendency then is to achieve more efficient results with a lot less input.

The action of the economic laws from the aspect of ergonomic optimality stimulates and forces the transport company to realise the operation goals in such circumstances, i. e. smaller reproduction process elements and lower traffic costs.

The ergonomics in transport tends to achieve safety, comfort, efficiency and speed. The process includes many other sciences as well, so that the vehicle, machine or any other means would adapt to psychical, economic, industrial and somatic characteristics of humans. An important role is played also by a special branch of ergonomics which deals with psychological research – techno-psychophysiology or engineering psychology.

The scientific advancement from the aspect of ergonomics has several phases. Manualisation, i. e. various transport – manipulative activities regarding loading and unloading, which is the first phase, followed by mechanisation where the vehicle as a machine is involved in realisation, whereas the major part of the technological process is still performed by man. In the automation phase, the greater part of the process is performed by vehicle and in the phase of automatics, the greater part of the process is carried out by the vehicle, and in the phase of robotics the man gives the idea, and other activities are carried out by the robot, e. g. in an aircraft.

Phases of scientific development / Flow of technological process	Manualisation	Mechanisation	Automation	Automatics	Robotics
Ideas and their realisation	H	H	H	H	H
Preparation and immediate process programming	H	H	H	M	M
Control	H	H	M	M	M
Realisation	H	M	M	M	M

Figure 4 - Ideogram of the technological process development (H- human, M – machine)

3. ENERGY CHARACTERISTICS

The energy characteristics refer to the consumption of the driver's energy when manipulating the command resistance, depending on the force requirements, direction of action and frequency of its application.

The energy necessary for the operation of muscles is obtained mainly by oxidation of hydrocarbons and fat. For all those jobs that are not difficult, sufficient energy can be obtained in that way. If very heavy work has to be carried out, the energy is obtained by means of anaerobic chemical reactions in the muscle. This results in a certain debt of oxygen, so that in the recovery phase it is prolonged by the oxidation processes until the oxygen debt is settled. Therefore, the main thing is to know the oxygen consumption, since this gives best insight into the energy consumption.

The forces realisable by hands depend substantially on the type of movement and the angle between the time and vertical body axis. Thus, the maximum force, approximately about 600 N, with maximum speed is achieved at an angle of 180°C by pushing the item "away from oneself". The right hand realises 5-10% greater force than the left hand, and the total leg muscle endurance is 1.5-2 times greater than the endurance of arm muscles.

It has been determined that there is linear correlation between the energy and output. Similarly, very difficult jobs, that would represent overload on the organism during full working time, are spontaneously interpolated with breaks which makes it possible to continue with the work.

Along with ventilation (litre per minute), energy consumption is presented per kilogram of body weight in the unit of time (minute). That is per 70 and 75 kg of body weight per minute for male persons. The data for female persons are presented with reduced body weight, 55 and 60 kg.

Thus, if a driver consumes more energy for physical work related to manipulating the car commands, there is less energy left for psychic work, in the process of decision-making, which in complex traffic conditions may be an accidentogeneous parameter.

Humans consume energy even during sleep, which is 66 cal/hour, whereas typewriting e. g. consumes 140

Table 1 - Energy consumption of the employees according to the job in the traffic process (Source: Group of authors: Ergonomija – problemi biološke antropologije)

activity - jobs	ventilation 1/min	kJ kg/min	kJ 70 kg/min	kJ 75 kg/min
Truck with trailer, Fiat, 30 tonnes, driving along a road with curves	13.84	0.130	9.100	9.750
Truck with trailer Fiat, 30 tonnes, driving downhill	12.60	0.126	8.820	9.450
Truck with trailer Fiat, 30 tonnes, driving downhill, with curves	11.76	0.105	7.350	7.875
Truck with trailer Fiat, 30 tonnes, straight driving	11.69	0.109	7.630	8.175
Truck with trailer Fiat, 30 tonnes, undoing and taking off the cover	30.40	0.373	26.110	27.975
Driving done by tram driver in Sarajevo	14.16	0.111	7.780	8.330
Driving done by tram driver in Zagreb	13.74	0.125	8.750	9.380
Driving done by bus driver in Zagreb	17.15	0.189	13.230	14.180
Driving done by bus driver in Sarajevo	14.57	0.172	12.040	12.900
Riding of tram ticket-collector in Zagreb	14.64	0.142	9.940	10.650

cal/hour, fast walking 650 cal/hour and walking upstairs 1100 cal/hour. It may be observed that certain activities require higher and other lower amounts of energy. Similarly occurs with work. Between work and effect there is a correlation with spontaneous interpolation of breaks, because of fatigue.

As elsewhere in economy, performing jobs, thus also in traffic, the workers' energy consumption differs depending on the job. This is presented in Table 1.

In case a detailed research was carried out about the working conditions, its workload and the realised productivity over several years, and if the influence of various ecological conditions were taken into account, the data obtained would be similar to those in Table 1. Such data could be used in studying the workers' energy consumption, as well as for considering the realisation of certain economic effects.

4. WEATHER AND MICROCLIMATIC CHARACTERISTICS

Weather in traffic and traffic economy depends on the weather conditions and environmental factors. The increase in the response time depending on poorer performance due to poor working conditions often results in tragic consequences for people and greater material damage. On the other hand, these are not measurable only in money since they often result in ecological catastrophes and environmental pollution on a smaller scale.

Most of the weather conditions cannot be influenced, but there are those weather conditions that can be influenced in order to provide normal working conditions. Thus, e. g. lighting can be modified, focusing on the colour, type, arrangement, intensity and density. Stronger intensity adjusted to the type of job is preferred, and in traffic headlights e. g. on a car, should be avoided since they may lead to glare, and subsequently to accidents.

Temporal characteristics in the ergonomic sense refer to the period of time spent on managing the vehicle. Such period of time can be defined as the one starting from the moment the information has been obtained up to the moment of activating the commands of the transport means. It includes, thus, identification and receipt of information by the car, route, traffic signalisation, organisation and environmental conditions, as well as their processing and analysis in the human central nervous system. Based on such information decisions are made, and activities on the dashboard undertaken accordingly.

While working with the vehicle commands, the man is exposed to the action of conditions that come from the environment in which the work is being carried out. If these conditions are unfavourable for humans, then their effect is reduced and the energy consumption in doing the respective job is increased.

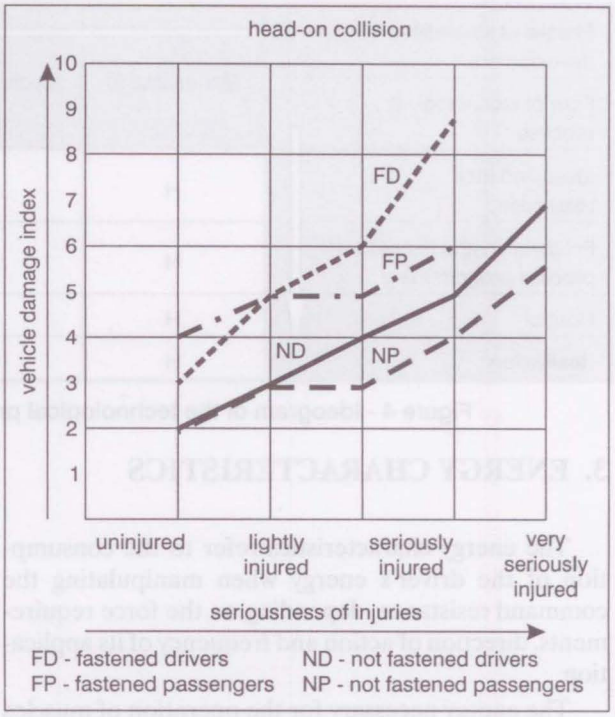

Figure 5

In order to prevent unfavourable influence of the environment on man and in order to provide such working conditions in which man will feel normally while doing the activity, certain principles must be complied with, such as e. g.:

- intensity, distribution and type of lighting have to be such as to avoid excessive eyestrain,
- intensity of lighting should be preferably high, rather than poor, and should be adjusted to the type of work,
- application of several individual lighting bodies near the workplace should be avoided because this could create shadows, and in case of cars with headlights this may result in glaring sight position,
- every direct source of lighting has to have a cover, and should not use uncovered lighting bodies (high-beam headlights on),
- temperature of the working premises has to be adapted to the work performed, since normal activity of human organism is related to the constant inner temperature, and every greater increase or decrease in temperature causes discomfort by the worker. Therefore, the feeling of comfort is achieved at relative humidity of 50%, with the above-mentioned temperatures in the premises.

The psychophysical characteristics of drivers and information application influence their analysis and processing, decision-making and the undertaken activities.

The most important information come from the transport means, path and environment. The carriers of such information can be: vehicle movement dynamics, lateral movement of the car in relation to other moving traffic participants, and atmospheric and other conditions that affect the car, the road, the environment, etc.

Experiences have shown that the driver's response time in driving a car is influenced by: quality of visual perception, car velocity, load, driver's age, knowledge and experience, skills and habits, then alcohol and pharmacological means.

The time necessary for a driver to process information for certain activities measured in seconds is the following: stabilising of car on horizontal route (1.55 s), movement along the horizontal part of the curve (1.79 s), straight movement downhill (2.06 s), movement in curve downhill (2.05 s), overtaking (1.11 s), straight movement in intersection (2.70 s).

The largest part of the driver's response time is accounted for by the decision-making time. The decision-making period increases with the increase in the level of critical state of the traffic situation, and depends mostly on the obtained information and psycho-physical condition of the driver.

5. PHYSICAL AND MICROCLIMATIC CHARACTERISTICS

Physical and microclimatic factors affect the microclimate of the working premises. These include: air humidity, circulation speed, air pressure and the temperature in the cabin, cockpit, engine-room, etc.

If these conditions are within permitted limits, the working conditions will be good, which will be reflected in the productivity and generally in economic effects, and if not, the productivity will be poorer along with the economic effects.

Some researches have shown that the influence of noise, vibrations, lighting, radiation and other phenomena are beyond the limits of tolerance regarding human body.

The problem of noise as an element which negatively affects the capability of the driver, pilot, engineer and which threatens the environment, reduces the productivity and especially harms the health of people, has been recently more and more the topic of discussions.

Some tests have shown that noise occupies the third place on the list of the polluters (following water and air). In the life of the modern man it is present every day and it accompanies all his activities in life, including his work. In industrially developed countries, every third citizen complains because of noise or suffers from it. It is a known fact that the human organism cannot adjust to noise, and every so-called getting used to it results in mental and physical disturbances. There are the so-called non-fractory persons who are immune to noise, but these are very few.

As harmful factor in the traffic system and economy, noise has officially, clinically and terminologically, entered medicine many years ago, when e. g. it was determined that blacksmiths after working long with hammer on the anvil become half-deaf and some of them also completely deaf. As harmful factor, noise appeared much earlier, even in the pre-history time, since forged items of the pre-history culture had been hammered in the same way, with hammer on the anvil, thus automatically producing noise.

With the invention of powder and its indirect factor, explosion, strong detonation, this problem became even greater.

It was found out that soldiers – cannoneers, became deaf very fast and that their hearing impairment was of permanent character.

However, today noise has acquired completely different dimensions. Sometimes, in the life of a modern man it also plays a positive role. Sound enables conversation, listening to music, identification and making a diagnosis (stronger heart activity, louder car valve knocking, screeching of tyres, etc.).

In order to perform the working process without problems, the level of noise should be below 65 dB. Noise above this level (98 dB) is harmful and stressful.

Therefore, the regulations about the permitted noise are very different in Croatia and in the world. The permitted noise in Croatia is 60 dB (A) during the day and 55 dB (A) by night. In Zagreb, for example, it amounts to approximately 40 dB (A) with certain corrections (day or night). Average noise in Zagreb amounts to 70 dB (A), and at many places 85 dB (A).

Noise can be expressed also mathematically. Sound is a stimulus, and it reaches the ear as part of the energy of the audibility field which is transmitted in it as longitudinal vibration. Therefore, in the medium of density p it spreads by phase speed – alleviation and densification determined by the changes in pressure Δp, and the air temperature is expressed in °C.

$$v = 332^{ms^{-1}} \sqrt{1+\frac{t}{273.15}}$$

Phase of vibration speed $c = f \times \lambda$,

λ – vibration wavelength,

f – frequency.

Having expressed the motion of the audibility field in the presented manner, it remains only to explain the ways in which men receive sound as stimulus, i. e. information. It is explained by the Weber-Fechner law of relations between stimulus and sense, which says, in fact, that the change of sense Y is proportional to the

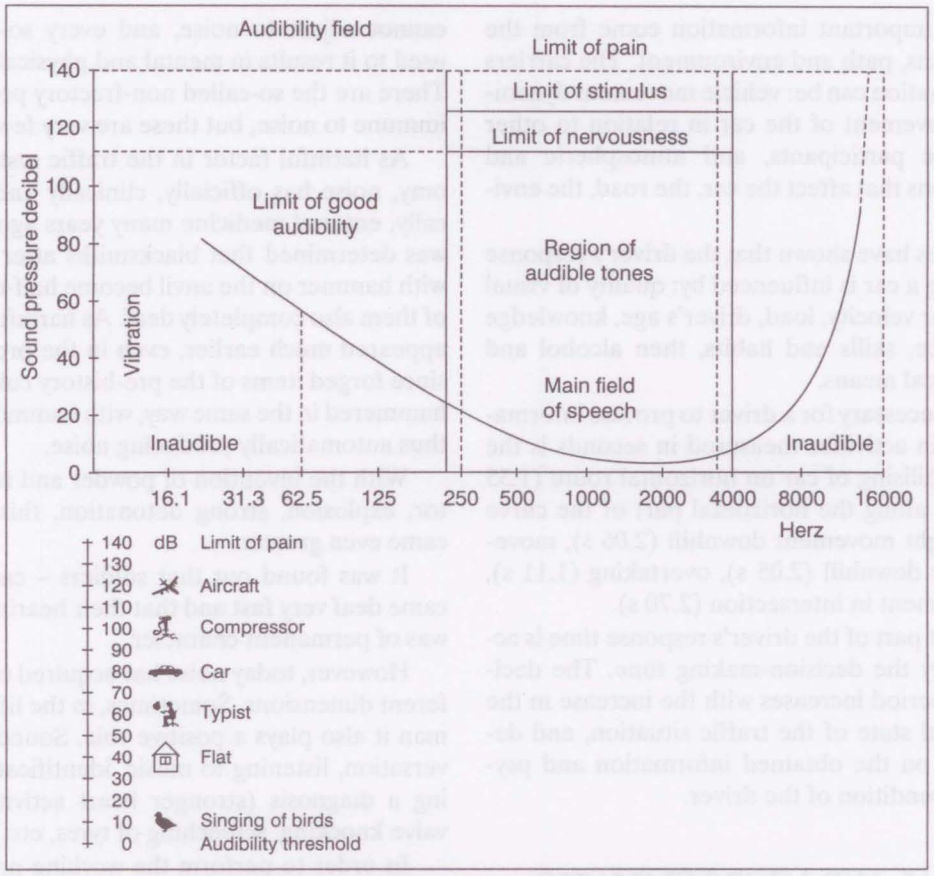

Figure 6 – Graph which shows the audibility field

change in stimulus X, which can again be expressed mathematically:

$$dy = K\,d\,Y / X$$

$$Y = \ln X + C$$

In case of sound, stimulus X is proportional to the density of the power of the audibility field and is measured in [W/m^2]. If we replace in the equation $Y = \ln X + C$ natural logarithm by the decimal one, and if we determine the constant C, so that the sense has the value of 0, and the sensitivity threshold of the ears W_0 is equal to the density of the sound intensity, we obtain:

$$Y = \log\left(\frac{W}{W_0}\right)$$

For the use in practice, where the industrial production has been intensified, and the work productivity is strong, a 10 times reduced unit is used, called dB (decibel), and the sound intensity is:

$$L = 10\log\left(\frac{W}{W_0}\right)\ dB(A)$$

$$W_0 = 10^{-12}\ W/m^2$$

The consideration does not include the frequency. Since it is known that human ear recognises different frequencies, the gauges are fitted with the frequency filter («filter A»).

It should certainly be noted that in case of double multiplication of the noise source, i. e. noise for the new source, the level of noise increases by 3 dB, independent of the level of the first source.

Mathematically:

$$L_1 = 10\log\left(\frac{W_1}{W_0}\right)\ dB(A)$$

$$L_2 = 10\log\left(2\frac{W_1}{W_0}\right) = 10\log\left(\frac{W_1}{W_0}\right) + 10\log 2 = L_1 + 3\,dB(A)$$

Thus, we can calculate that the increase of sound by 10 times increases the initial intensity by 10 dB(A), and by 20 dB(A) for a 100-times increase.

In case of different sources of noise, the intensities of the audibility field have to be added, and the resulting intensity is expressed by the expression:

$$L = 10\log\sum_{i=1}^{n} 10^{Li/10}$$

In alternate noise, adequate level L_{eg} is the constant intensity that would result in energy load on the worker in the production, as if being continuously exposed to noise:

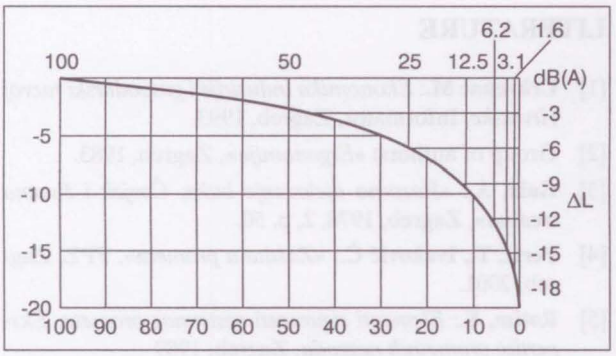

Figure 7

$$L_{eg} = 10 \log \frac{1}{t_0} \int_0^{t_0} *10^{L(t)} * 10^{dt}$$

t_0 – time duration of measuring the intensity,
$L(t)$ – function of time.

From the medical point of view, noise has a very harmful impact. Such activities are of aural[2] and extra-aural[3] character.

6. CONCLUSION

Today, at the age of great changes in production, industry, computers and communication, as well as increasing scope of technology, in the race for profit, men sometimes forget their very selves. Therefore, the study of work, ergonomics and economy in general is very significant, since it is very important to perform this work efficiently, correctly, and fast (productively), without harming the health of people and their existence.

As interdisciplinary science, ergonomics deals with the study of the production process factors in traffic and beyond: men, means of work, items of work, from the microaspect. The work organisation in traffic does this from the macroaspect.

Numerous researches in the world and in Croatia have shown that there is extreme increase in the number of the diseased in material, but also in the non-material (traffic) production (service) with low-back pain, jobs where the spine is exposed to excessive load, especially in case of poor fitness or temporary extremely high loads. Poor fitness is the result of long sitting or inactive resting, often present in the driving staff or in the sphere of production which involves the sitting position.

Therefore, in programming and designing of the workspace attention should be paid to its functionality, technological requirements, safety requirements, security regulations and ergonomic factors in general, because this is the space in which the production takes place, and in which, on the other hand, the worker is exposed to different threats and dangers. If these are not eliminated, the working effects could be reduced because work is an efficient human activity which has as its objective the obtaining of new products or useful services, capable of satisfying human needs, directly or indirectly.

As a factor in traffic and at other working places in the economic flows, man is especially exposed to very strong impact of noise. If conditions in the industrial production, in which man as worker spends more than half of his lifetime, were studied in more detail, we would find the intensity of this problem surprising, not speaking of the little attention that it receives.

From the medical point of view, there are two types of harmful action of noise: aural and extra-aural.

Aural or direct impact of noise on the hearing organ has been known from earlier with the development of advanced traffic means and other technologies, and the number of workplaces exposed to excessive noise is increasing, resulting in the consequences and a greater number of people with impaired hearing (drivers, pilots, engineers, etc.). It has been scientifically proved that about 4% of younger workers who have been working for 3-4 years in the environment exposed to intense noise, suffer from such injuries that cannot be cured any more.

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SAŽETAK

UTJECAJ ERGONOMIJE NA SIGURNOST PROMETA I RAZVOJ GOSPODARSTVA

Ergonomija kao interdisciplinarna znanost treba djelatni proces u prometu, učiniti sigurnijim, bržim i pouzdanijim, radi veće produktivnosti i uopće boljih gospodarskih učinaka. To se postiže prilagođavanjem i oblikovanjem radnog mjesta, strojeva, prometnih sredstava, opreme, fizičke okoline, radnog procesa i dr. prema spoznajama o ljudskim anatomskim, fizičkim, sociološkim, intelektualnim i drugim minimalnim, prosječnim ili maksimalnim sposobnostima. S obzirom na to, potrebno je proučiti ergonomiju sa stajališta čovjekove bolje produktivnosti, veće sigurnosti (komfora), te zaštite, općenito.

KLJUČNE RIJEČI

ergonomija, gospodarski učinci (produktivnost), ekonomičnost glede ergonomskih aspekata, fizikalne karakteristike, energetske, vremenske i mikroklimatske, buka u prometu

NOTES

1. Ergonomics Greek (ergon+nomos - custom, order. law) - a scientific branch which studies the relation between man and machine in contemporary conditions of production which tends to harmonise the production work

and machine with the human psychical and physical capabilities and vice versa.

2. The intensity of sound is expressed in decibels (dB), and it ranges between 0-140 decibels, with 0 expressing the "hearing threshold" and 140 is the "pain threshold". Usually the value of dB is taken as a limit above which aural action occurs, i.e. direct hearing damage occurs, and below this limit there is extra-aural impact.
It is generally estimated that the noise up to 50 dB has no direct damaging effect on the hearing organ, but long-term exposure to this intensity results in hearing fatigue. If the noise is of level greater than 66dB, it comes to the narrowing of the blood vessels, and therefore also to the disturbance in the reaction times, which in case of the driving staff in traffic is of extreme importance. At noise levels of 95 to 100dB and frequency of 50-5000Hz the visual surface and the visual field as well as the capability of colour identification (especially the red colour) are reduced. Therefore for professionally exposed workers during the eight-hour working time, provided they may spend the rest of the day resting free of noise, the limit of the noise level intensity is set at 80dB.
3. Extra-aural impact or action of noise on other organs and the whole organism is such action which influences the neuro-vegetative system, increases the strain, blood pressure. It causes disturbance in the heart activity, lungs, stomach and endocrine system, reduces the imuno-biological resistance, causes feeling of fear, reduces concentration and working productivity (by as much as 25-30%), which in case of the driving staff is very critical and dangerous regarding safety of the traffic participants and the entire environment. Since extra-aural action is manifested in man much earlier than the hearing damage, one may thus say that this action is caused by any sound that harms the man or driver in traffic.

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