Ergonomics and Ergonomic Analysis of Driving Education System by Personal Car with Supporting IT

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ABSTRACT---- ***The subject of the car education / training system, with IT support, was selected for research. The hypothesis was set: to analyze the theory and empiricism of the collected data and to determine the characteristics for the elements of the system and the influences among them. The necessary updating and reworking of the sample operation was made. A multidisciplinary and interdisciplinary science called Ergonomics and Ergonomic Analysis have been selected for this very complex research. First, all the individual parts of the system are presented right down to the theoretical facts, then the individual parts in the subsystem are presented, and finally the whole ergonomic system is presented. In the practical part of the article, many analyzes were performed on the basis of the vast amount of data collected, based on six characteristics. From mathematical statistics and probability theory, major analyzes were performed, including two types of different sample sizes, with cumulative and average values. The enormous scope requires multiple content publishing, where each individual article must have both parts, theoretical and practical. Concrete ideas and measures for implementation have been proposed. Practical parts are supported with IT. The article is aknowledgement to late B.Sc.Mech.Eng. Marijan Biščanić and prof. Ph.D. Dragutin Mikšić for their contribution.***

Keywords---- ergonomics, education system, IT, personal car driving

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1. INTRODUCTION

For the research subject of this article a training / education of driving a personal car is chosen. A following hypothesis is set: explore the theory and analyze the collected empirical data, identify the most important characteristics of the system elements and features of their mutual influence and conclude on important influences now, in the future , in the problem in question. A necessary addition and reworking of the basic sample of work was made. Analogous to the approach to the field Operational research (comprehensive, comprehensive, with data, likely enough, verifiable), it is necessary to apply a systematic approach, [1, 2, 3] .As the chosen subject is a very complex research problem, research into the subject should be published in the scope, where each part of the concept must cover theory and application. Selected is multidisciplinary and interdisciplinary science called Ergonomics, a research has been chosen for its particular part - Ergonomic analysis. Therefore, first the theoretical assumptions of Science ergonomics and then, the part of the item in the training / education of driver-ice by car will be presented, while the applied part of the article, including the structure and size of the sample candidates and their characteristics with associated analyzes, for the monitoring and analysis period covered. The basic concepts of man and machine are explained. In further publications, according to the conception of the problem of education / training, for theory part they are proportionally stated: first, the individual characteristics of elements as system elements , then elements within the identified subsystems, and finally, the connection of elements and subsystems, as part of an ergonomic system. An analysis of the content in relation to the instructor-training methods is presented, as well as an analysis of the content of the pedagogical approach to training, and, finally, an analysis of the professional training of the student or candidate for the driver. For each further part, according to the conception of the problem and the results of the research, the applied part is proportionality presented. Previous presented are the most

important conclusions of the research conducted, as well as conclusions-instructions, that can be used in general to improve the system of training rides. Of course, the presentation contains a list of sources and references from which the data were used.

2. THEORETICAL SETTINGS OF ERGONOMICS , THE CHARACTERISTICS OF HUMAN AND SYSTEM DRIVER'S EDUCATION

About the concept of ergonomics. It contains a compound word of two words: greek word **ergon** = work, act and work, and greek word **nomos** = decision, order, justice and law. Ergonomics is a scientific discipline, research that focuses on the interaction between man and technical systems, and which is based on the sciences of man, especially physiology, psychology and anthropology, and, in contrast, physics and engineering. The analysis of ergonomics ranges between defining it as a cross section of individual sciences (with the existence of the term Greek, Phenomenon, missing the opposite term Greek, Noumenon) and an experiential or non-scientific approach with the term technology. Ergonomics includes a series of studies that aim at organizing work in the study of the function of a human work with the aim of optimization. The concept of organization differs from author to author, so for some ergonomics is research that enables, for better effect, the organization of work and the adaptation of machines and the natural environment to man or work, and for others ergonomics is a general concept that implies the scientific organization of work or psychology, or physiology, or occupational hygiene , [2, 4, 5, 6, 7, 8, 9] .

Ergonomics. Today **, it is** absolutely considered a multidisciplinary science, while it is relatively considered an interdisciplinary part of the **science about work** . Simplified, work science deals with the disassembly and design of work systems and work resources, and a man is in the group and individual dynamics of that system. Labor science seeks, on the basis of scientific knowledge, to improve and facilitate the life of man in industry. The system of work science is accounting for: people, machines, the way of organization, with the interaction of man, machine and work environment (workplace). Therefore, the erroneous identification of ergonomics and work science is also a misconception: the difference is that ergonomics must be viewed in principle, from the point of view of its practical dimension, that is, as a technology, which makes it a theoretical field narrower than work science. The task of ergonomics is to harmonize parts of the system with the help of the following components of occupational science: anthropometry, work physiology, work psychology, work sociology, work technology, work pedagogy, work organization. Now, using the above components , which serve ergonomics that with their help serve engineer at solving specific tasks in the life and work in the industry, and can further confirm the relationship of ergonomics and science work using the criteria of a degree of generality. The criteria of individual parts defines the term so that in principle the degree of generality determines the science of work, while the breakdown of degree of generality determines ergonomics.

In the modern way of organizing production, it is absolutely certain that much attention must be paid to the human-workplace-environment system. Finding good solutions to existing problems would make a big contribution to reducing wasted time, making better use of working time, reducing operating costs, and improving business success. It is even more important that the correct solution of these problems and relationships in this system contributes to humanizing the work of man so that he can feel better and can develop all his abilities without hindrance. The optimal solution to the human-workplace-environment relationship, in which work and working conditions must be adapted to man, requires the following elements to be taken into account and then harmonized with each work design: technology (what, how, and with what material), technique (machine or workplace, tool, gadget, performance device), ergonomics (man, his abilities and capabilities and limits of making claims, without harming his health and his satisfaction) and organization of work (connecting the previous elements to the system, with interactions). There are several definitions of ergonomics, and in the aforementioned research, the following was developed: “Ergonomics is a scientific field in which a multidisciplinary approach (exploring the effects of technology, technique and environment on humans) and an interdisciplinary approach to the adoption and application of ergonomic principles seeks to harmonize relationships in the human-workplace system. - environment, for the purpose of more humanized and better and more successful work. " An important difference between this and the previous other definitions is the introduction of a multidisciplinary approach to human action and the interdisciplinary application of principles. In doing so, for a person's successful work and humanization of work, it is necessary to: thoroughly know the person and his / her capabilities in performing the work; design the workplace or machine according his capabilities; ensure normal working conditions and prevent their harmful effects on human being.

Strategic goals of ergonomics. They show that the work, especially industrial work, is even considered exclusively the anthropological provision of the man, although often unpleasant, more exacting, and unhealthy. Given the fact that the work is often not the sole independent choice of the man (or not at all his choice, but was imposed), it is obvious that work is not only an anthropological provision of the man, but can also be a mere means (survival), with the necessary consequence of alienation from work.

Ch Argyris pointed to a fundamental discrepancy between human nature and the formal organization of industrial enterprise. The discrepancy occurs in the following four levels, at: impersonal rational level, strict division of labor, centralized management, unified management, [10] .

Mr. Strauss thinks otherwise : the pursuit of raising levels is unequally distributed, so the pursuit of actualization / achievement requires engagement, and the pursuit of aspiration / achievement of something requires something that is not certain. Many do not want such uncertainty, the opportunities are right for them and they do not resist not because they have no choice but because they are raised that way , [11] .

E. Schein is critical of both previous views, because he believes that they are extreme, one-dimensional and exclusive (either human is being of actualization / realization or not), that is, man is a much more complex and multidimensional flexible being, while workplace and work system has its own characteristics that in turn affect the characteristics of the man , [12] .

The systems, which ergonomics deals with. They contain the interaction of man, machine and environment, and are characterized by the degree of human versus machine control. The human-machine-environment system is an interdependent relationship that aims to purposefully convert an input to a desired output, within the given (restricted) environment. Known interaction can be simplified to be classified into the following types: manual / manual system, flexibly operated machine by operator; a mechanical system, inflexibly controlled by the operator; automatic system, simple, programmable and adaptive. Along with the aforementioned depersonalization, formalization and disintellectualisation of work and many poor ergonomic solutions, several other phenomena and problems present themselves.

With the help of **multiple types of ergonomics** with associated characteristics, in rational behavior, it is possible to design work systems with two goals: to design a new work system with a proper purpose: to rationalize the existing system with defects in purpose. Types of ergonomics and associated features are: **conceptual** ergonomics represents a common way of creating ergonomic measures in the beginning of work system construction , and that is in two areas , in the area of humanity and in the economy; **systematic ergonomics** must take into account the harmonization of human and machine functions in the overall man-machine-environment system (man must not be overloaded or underloaded) in the production system; **corrective** ergonomics usually occurs in a later period of creation or use of a work system; **software** ergonomics (cognitive ergonomics, communication ergonomics, software psychology, organizational ergonomics) is a part of the science of work that deals with the direct or indirect action of software products in a human-machine work system; h**ardware** ergonomics, unlike software ergonomics, in the narrow sense of the word "classic" and does not deal with the contents, but with the technical and physical components of the computer system.

The abilities and limitations of a human . It is good to know them, as well as the machine's abilities, to solve everyday and work problems. Features of the man would be the following: a man in his "input" receives stimuli from the environment and should , for a number of restrictions, his perceptual skills would be limited approximately to the sound frequency between 20 and 20,000 Hz (20 kHz), visual stimuli are in the range of wave lengths from 6 to 10 on the exponential meters of the electromagnetic spectrum, while the time of sensing input does not appear to be faster than 10 consecutive units per second; man also has his "output", so he is a transmitter of information to another person and equipment in the system and other parts of the interactive system. He does this in different ways , by sound / voice or tactile/touching, light signal, etc. Unlike the "inputs" of information from the recipient of information, the "outputs" of information are much slower, which is a consequence of motor responses. Under balanced conditions, the output of musical instruments is limited to 25 bits (6 to 7 notes per second), up to a maximum of 40 bits. For typical tasks, this amounts to about 2 bits per second; man is also a controlling "mechanism", but his value functions in some control system are dependent on the human requirement. The example of comparing manual and pilots using autopilot clearly indicates the important characteristics of both situations, with the notion of an "active operator" playing an important role; man is also a being of motor reactions, so he can act in various ways, influence the shaping of useful movements in the work, but also the elimination of those which are useless; the importance of the great sensory capacity of a person is informed by examples of sensations of sight and hearing. The example of sight sensation suggests that about 90% of information is obtained by sight, so vision is considered one of the most important senses. Under normal lighting conditions, it can differentiate colors, shape and space. The perception, formed by the eye as a visible organ, is the result of the action of electromagnetic radiation at the appropriate range in nm, which makes a certain color. Visual acuity is significant, with visual acuity being the ability to detect and discriminate visually in the field of vision. Under ideal conditions, the eye can perceive an object measuring approximately 1.5 mm from a distance of 5 meters. The example of hearing sensation indicates that $1 * 10$ energy at $\exp^{-17}$ W is sufficient for the appearance of auditory sensation. The loudest sound, heard without pain, contains about 10 billion times more energy. Otherwise, the ear, as the auditory sensory organ of a person, observes tones that range in the frequency range between 16 and 20 000 Hz (20 kHz), while the voice range is in the range from 1 000 to 4 000 Hz (1 to 4 kHz); There are three types of memory in humans: sensory, short-term and long-term. A man has a good and long-lasting memory for principled information, but it is poor for most sensory information, especially for hearing. Comparison of human and computational characteristics shows that the person recalls more slowly than computers, but therefore has the ability to "recall" generalizing patterns. Man is a relatively weak numerical computer, but unlike a computer, a man is capable of deduction but also of solving problems by logical induction; a man is very flexible and very efficient in various jobs, with the assumption that his limitations are not neglected. Because of these characteristics, a man also does those jobs for which the machine / computer is incapable, [13, 14] .

Ergonomics - other fields and branches of research and principles . Research beginnings of ergonomics and ergonomic design methodology of various supplies (tools , equipment, etc.) with various purpose and function in mechanical production can be considered (also) a research by Frank B. Gilbreth and his wife, Ph.D. Lillian Gilbreth by designing studies of (micro- or elemental) movements, developing a classification and systematization of 18 movements (therblig- an anagram of the surname Gilbreth), and developing a set of rules of the motion economy. A scientist, researcher and teacher at UCLA, Los Angeles, USA, R. Barnes developed the classification and systematization of 22 principles of economy of movement or principles into 3 groups , [15, 16] :

I 1) the use of the human body (8 principles),
II 1) workplace arrangements (8 principles), and
III 1) Design of tools and equipment (6 principles)
(22 principles in total).
(also, latin number 1) indicates the first type of principle).

Ergonomic research and ergonomic principles. Taking into account that in practice, in the production, it still exists (except for transport tapes, transfer lines, etc.) a large number of individual jobs, and only manual and machine-manual (those with less labor and workers with a much higher proportion of machine work, up to those with a very high proportion of workers' work and a much smaller proportion of machine work), their characteristics can be determined to a great extent. To this end, it was reported in the period 1981-1985 in Croatia, that a scientific study was conducted with the theme Humanization of the work-place (Application of ergonomic principles in the formation of the work-place), the purpose of the research as reported was: to determine the state of application of ergonomic principles in workplaces in production; identify new, and complement existing, data for future ergonomic databases; apply established data on ergonomic principles in the design and creation of new machines, tools and devices, with the creation of new work places and at improving and upgrading existing, and that in any production process. In addition to multidisciplinary effects, interdisciplinary application in individual fields and branches of work is also important (for example, in the Labor Study, ie in rationalization and measurement of working time, in the design of technological processes and elsewhere).

The results of ergonomic principles from known essential researches conducted in the period 1981 to 1985 were published, whose were checking existing and substantial replenishment of the new (at the same time, latin number 2 indicates other types of principles), 17). Resulting ergonomic principles are classified in the following five groups:

I 2) ergonomic principles in design work jobs machines and tools (23 principles)
II 2) ergonomic principles in designing work in the workplace (15 principles)
III 2) ergonomic principles indetermining (8 principles)
IV 2) ergonomic principles in material and tool handling (8 principles)
V 2) ergonomic principles in shaping the environment in which the work takes place (19 principles).
(73 principles in total)

The comparison shows a simple comparison of Barnes principles and newly established and published ergonomic principles , among others :

- Barnes Principles consist of 3 groups with a total of 22 individual principles, and new 5 groups with a total of 73 individual principles, or 2 groups or almost 3.5 times more individual principles,
- 3 new sets of principles have been added to the new classification with around 37 new individual principles, which is almost double the number of individual principles compared to the previous 2 groups.

Ergonomic research in the Republic of Croatia, former Yugoslavia. Survey data obtained by objective discussions with records gathered in 7 working organizations in the Republic of Croatia, on a sample of 208 work places and workers, of which 161 were men and 47 women. To carry out the research on ergonomic principles in production, the appropriate questionnaire was made (eng., Ergonomic check-list). The recording was analyzed by a computer program. The analyzed data are sorted in 18 ergonomic characteristics (especially for men and especially for women, and the numerical results is a descriptive statement) where some features have up to 4 sub-questions, but most ordinary features had 5 to 10 sub-questions. For example, presented are only a few groups of question and related sub-questions with the overall results for them (without division into male M and female F). **Questions** for the 1st group are: 1.1. Is he satisfied with the work? 1.2. How he feel about the work? 1.3. Does he do the same job all the time? **Answer** : Contains questions that determine the type of workplace and work. The questions related to the feeling of satisfaction at work, so that showed that 75% of people were satisfied with the work, 9.6% were dissatisfied and 15.4% were undetermined. The problem of the dissatisfied and the undetermined ones is psycho-social, so in this part research should be deepened, which is confirmed by the fact that only 50.5% of people feel comfortable at work. A problem that sociologists and psychologists should also investigate is the correlation between (in) job satisfaction and permanence or job change, since it reads from the data that about 50% of people are satisfied with doing the **same job all the time**, but also about 50% are satisfied with constantly **changing jobs** during work shifts. **Question 5** groups are: 5.1. Is the work iperformed either mechanically or

manually? 5.2. What is the workplace like? **Answer** : The most frequent (40%) work is done in a classic workplace, and in 22.1% the situation is on a semi-automatic machine, with the most frequent (41.7%) being machine-manual work and then only (14.9%) machine work. Considering 25.5% of manual labor and 41.7% of machine-manual labor, it is concluded that in 67.2% of situations, man is a basic element in performing work, since ergonomic principles are known to him, those should be applied only, which should lead to easier work for workers, more satisfied workers, and then should increase labor productivity and more humane work. **Questions 11** . the groups are: 11.1. Does he use instruments in his work? 11.2. Can the instruments be well read? 11.3. What is the reach? 11.4. Are the important startup devices specifically marked? 11.5. Is the control signaling device easy to read? **Answer**: Contains questions designed to determine the rational use of instruments and devices. 62.9% of performers use instruments. and since 37.5% of contractors do not use instruments, this is satisfactory. It is also satisfying that in 62.9% of contractors, the control signaling devices are located so that they can be easily read. In contrast, 37.5% of contractors are out of reach and in only 66.9% of contractors the essential startup and control devices are specially marked.

In addition to work [17] , a valuable contribution to the research was given in the paper, where an ergonomic coefficient Ker, instead of Kn*Ko, was defined and calculated for determining additional time in automated production, [18] .

Description of driving education system. A human who wants to learn how to drive and take the exam: must first enroll in an officially registered driving school; in the first phase of training, the candidate must listen to the pedagogically presented theoretical parts of the traffic area (including the Transport Act) and the basic theoretical and practical details of the first aid in traffic, therefore become acquainted with “all the letters of the Law” and pass the first, theoretical, part of training; then perform the second, practical part of the training, where the man / candidate is introduced to the vehicle and operates it independently, under the control of instructor in traffic; when he has mastered the second phase as well, he is ready to take the driving test and pass it immediately, that is, after the practical driving and retaking (not a common occurrence), and not pass it (a rare occurrence). The instructor teaches candidates or future driver "first steps" (according to the law responsible for a candidate), and the two aspects: first, he teaches the "driving culture and behavior" or correctional function, and, secondly, teaches him the skills and habits of mastering driving, that is, carrying out an educational function. It is important to train the candidate to learn correctly their "first driving steps", because they are later more difficult, or very difficult to correct. It is best to initially candidates are being led by just one instructor and that only he / she raise and educates the candidate. Job of the instructor is hard and responsible, he must follow all movements of the candidates and predict possible errors, otherwise it can result in great defects and damage. At the same time,the instructor has to let the candidate drive on their own because otherwise there would be no expected benefits and training would not make sense. Instructor "carries the head in a bag," requires a very large concentration and attention, experience, patience and pedagogical approach to the candidate.

Instructor and methods of education / training rides: The process of professional education requires activity, awareness, focus on the purpose and creativity, and of students, or candidates , and of the teacher , or instructor. For this training, there are the following special professional methods: 1) self-education is at the same time an organizational form and a method of teaching in work, psychologically based on imitation and trial and error, that is, the method of one's own skin. The roots originate historically from the original man, but even today it is a compulsory and important part of every other form of professional, especially individual; 2), the oldest and most widespread method of in-service training, almost as old as the first method, is the method in question. It is used when students are immediately presented with the task of performing the complete driving activity, and this is at the same time the first sub- method of the second method 2): it can also be performed by processing the quality of execution of certain operations, and therefore it can be performed by means of the second sub-method, on special teaching devices, also known as the training apparatus. Psychological benefits of the method 2) are: reality, concreteness and concretized results, interest in students for result of the work, the existence of clarity. The psychological deficiencies methods are: the execution of a series of already well-learned activities in order to perform new actions (uneconomy), poor habits flexibility, often rapidly declining interest because of the monotony of work, the passivity of students, etc .. From a higher principle of education, one would research process and the legality of work in training. Based on the appropriate tests, a procedure must be set: first, the operation must be performed at a comfortable pace, then at a rapid pace, and at the optimum pace achieved, it approaches the maximum pace at which it continues. The analogy for driving expressions shows the following procedure: it starts at an optimum pace (polygon; duration depends on driver performance), continues at a faster pace in sparse city traffic and finally drives at maximum pace in dense city traffic. The pedagogical approach to practicing includes the fact that the instructor transmitted to candidates their knowledge, skills and habits, and this is achieved by practicing driving. One of the more important purposes is to achieve highly automated movements that become habitual.

The main psychological elements of driving education. These are **:** movement and habits , attention, among the various properties of the term attention are: the intensity of attention and the concentration of attention, stability of attention, distribution of attention and speed shift attention to other subjects. Also, one's own attention span is important, since, as in the previous section, the data and literature were mostly presented. In this part the content distribution and switching of attention are presented, as parts of the structure of psychological components, used data from our

own research instructor M.Biščanić . The above mentioned has an important role in switching element of attention, and the element called professional care forming. Of particular importance is the notion of opinion.

Planning your driving activity. A possibility of planning activities is always associated with certain professional experience, because every prediction, as well as a separation from a concrete situation, is possible after overcoming actions sufficiently in practice. Activity planning must be learned. So it is important for a instructor to plan an activity in a driving training class. Before departure, he must determine a teaching unit for the next "lesson" in his mind determine the direction of travel, and lead the driving candidates in certain situations in order to meet the planned school plan contents. It is very important in what kind of mood the candidate is (tired of the hard physical or mental work, thinking prevalently about his personal problems?, etc.), but he can not sufficiently or at all even pay attention to the lessons? The same goes for the instructor. For good and quality reach teaching, and for the educational hour to be justified, both listed participants need to be well rested, calm, focused, and careful.

Professional training of the person / candidate driving. Candidate education is a planned organized activity of some pedagogues and students aimed at mastering professional knowledge, skills and habits, which correspond to the modern level of technical, ie traffic. It encompasses the versatile development of his psychic and physical abilities. When a person encounters a form of work activity that is new to him and he is just beginning to learn, he does not yet have the necessary habits. In the process of training, a person's personality changes, his / her occupations, ideals, the goals of his / her activity as a whole, as well as the goals of individual actions, change. The complex development of habits, which are related to appropriate knowledge and specific skills, are the basis for acquiring professional qualifications. Habits, through automation in the training process, go through a series of stages on which the habit scheme is based. Such a scheme applies to working motor habits, but to a very large extent can be applied to the sensory habits, and to some extent on the mental habits. For work-related motor habits, a 3-stage habit development scheme can be applied: the first stage consists of studying the individual elements of movement and grouping a series of individual partial actions into one complete action; the second phase of training is characterized by the removal of superfluous movements and superfluous muscular stress; the third phase is related to the further refinement of the motor habit, namely the harmonization of the activities of the whole range of afferent systems. Useful automation of habits should not be confused with automatons, which are not subject to conscious control and which are always harmful to work activity. Even highly automated work habits remain under the control of consciousness and are part of conscious activity. By combining in the process of practicing with other actions, a highly automated habit can become an independent activity and a means of performing more complex actions. The psychological criteria for the transition of habit into a means or a way to execute a more complicated habit is the emergence of an awareness of an elemental goal, which was previously conscious. Such an objective is brought to the awareness of a more general goal, which has now become an elemental goal. The task of achieving a high degree of automation of professional habits, if the habit consists of an action formed in the exercise process, is solved in a short time by the proper organization of the exercise. For training to be effective in the training process, it must meet a number of psychological requirements. Education is a psychological-pedagogical term, More precisely, it refers only to a human being, because it is associated with social action on a person. Education is a determined, systematic and purposeful action on the psychology of the person being raised in order to acquire the qualities that the teacher wants to instill. Knowledge, skills and habits can be acquired by a person in the process of self-education, but he cannot do this while learning to drive, because by the law, an instructor must also be present.

3. RESULTS OF THE RESEARCH AND PROPOSAL FOR IMPROVEMENT OF THE EDUCATION SYSTEM

In the first place, because of the necessary analysis and conclusions about the big number of established very valuable data, this last point is directed at the content of a comprehensive determination and to compare them with previous data. Several subunits (research topic) with the essential information are formed: the description of the research, the recording mode, mode analysis and its conclusions, which arise from the analyzes, because this kind of approach allows a complete access to the research process of the driver motor vehicles and the identification of influencing factors in the process. At the same time, based on actual data and analyzes, certain settings from the transitional section of the article are confirmed or denied and supplemented.

Driving Candidate`s Characteristic Data. So far, there have been studies linking characteristics of personal data of candidates (age, number of hours of driving during training, the month in the year of examination, etc.) With the success of the same on the training of driver. One of the more interesting analyzes would be a prediction analysis : what is the probability of successfully passing the driving test based on known personal information of the candidate?

Collecting candidate data for the driving. The quantity and quality of the data collected offers and permits the selection of data, that seek to achieve the set research goals and answer the question "Is there, and what, is the relationship between the collected data and the performance of the exam? Is there any influence of the parameters used on the number of exams? ". an additional question is "What information do I collect to get the answers I ask for?". Taking into account

the existing limitations, the aim of the research was to determine the adequacy of the following candidate data: year of age, gender, duration of school, the month of the year when the exam is taken, number of driving hours during training, which candidate passed the exam (6 parts of personal data). Author of research and mentioned the graduate work, as a graduate of the University of Zagreb, was a member of the AMD university, where they used the above information. A sample of multiple driving years, 1972 to 1975 (larger sample, longer study period , possibility of analysis and individual years of training) was selected for analysis, rather than a minimum sample of 1 year. In the four years covered by the driving the basic data for the 61 candidates are determined, but because of the extensive data, the sample containing 34 candidates is presented, with their data in **Table 1.** . Later, the analysis taken in 1975, with 11 candidates (male 7, female 4). The codes are: M / M -Male sex, f / f - f female sex, age / age - expressed in years (lower limit of majority at 18 years old), school duration expressed by the months of training, a month in the year of examination, for example, mark 4 means the month of April, driving hours during the training (the minimum number is 30 hours of driving, according to the Law), - who passes the exam / ordinal number of exams, for example mark 1 means the candidate takes the exam for the first time (6 personal data or metrics). With data from the documentation / dead memory, useful were the data obtained from the candidate on the basis of the polling for the previously mentioned 11 candidates / men and women, who are just going through the process of the driving training.

Analysis of collected driving data. To examine the correlation of the data collected for candidates used, first, a) to analyze the total and average results for each personal data / measurement for both sample sizes, presented with n = 34 and total with n = 61. Then, 2 statistical analysis methods were performed, namely: b) calculation of linear coefficients of sample correlations, c) testing of the Ho: ρ = 0 hypothesis . Details of the analysis are:

a) analysis of total and average results for each personal data / metric for both sample sizes:

(1) with the number of male and female candidates in the sample, for the sample given with n = 34
the total sample size data were entered for each measurement size and then average values (decimal and rounded to integers) were calculated for each measurement size,

(2) with the number of male and female candidates in the sample, for the sample given with n = 61
the total sample size data were entered for each measurement size and then average values (decimal and rounded to integers) were calculated for each measurement size,

(3) a comparison of the results of both samples shows the following:

(a) some **average** results in both samples **do not differ significantly** (they differ by chance) for each measuring size, as follows: driving time from 37 to 38 hours (the Traffic Law stipulates at least 30 hours); education takes place mostly during the summer, from April to August (employees and candidates use leave before the annual break or vacation?), most notably in June; the sequence number is 2, so the exam is usually passed in the second; the age / age of the candidate is about 28 years ,

(b) some results are **significant** (not coincidental) between samples): duration of education in presented, smaller sample is about 4 months, while for the total sample it is about half of the duration, ie 2 months; the number of male candidates in both samples is bigger three times or more than the number of female candidates;

b) **calculation of linear correlation coefficients of sample r**: linear correlation coefficient calculates binding strength between two independent random variables, each variable may contain a string of values. A review of the recorded data shows that the **law of stochastic correlation of random variables applies (** one value of the first random variable corresponds to more values of the second random variable. The most interesting to explore is the impact of the random variable **number of the examination,** which is thus designated as a **dependent variable**, while the **other five have to be the independent variable.** the available data are first grouped and later analyzed according to two aspects: (a) the aforementioned **sample of 69 candidates**, randomly selected from each year in the period 1972 to 1975, (b) the sample consists of, from the initially selected 50 in the period 1972 to 1975, all candidates who are first access / ed exam and passed it. F**or both views** are performed analysis specifically for males, especially for females. The processing was performed on an electronic computer. The analysis of the samples shows the following and eating:

- over the years, both male and female candidates who come to training all are older, where the age of female candidates increased from age of male candidates,

- the average duration of school / school months is lower for male candidates than for female candidates. Testing the dependence between age and length of school / school months showed that in male candidates there is a significantly larger probability of prediction of the regular number of exam passing than in female candidates (with male candidates that bond is stronger compared to female candidates). Generally, it is increasingly unlikely that predictions of the number of courses in both groups are decreasing (the correlation is decreasing).

Table 1 .: Driving Education Candidates Data in Year 1975.

Ordinal Number of	Candidates/ number	Sex/ M-W	Attained/ Reached age/	Duration of Education/ months	Ordinal number for Month in Year	Duration of Driving/	Ordinal number of Exam-

Candi-dates			years		of Education/ number	hours	Ination/ number
01	7/230	M	18	3	8.	30	1.
02	5/169	W	35	3	7.	36	1.
03	6/232	W	35	3	8.	35	1.
04	5/132	W	26	4	8.	33	1.
05	4/100	M	34	4	8.	41	2.
06	1/19	M	34	8	8.	52	4.
07	6/173	M	19	3	8.	31	1.
08	5/161	W	23	4	6.	38	2.
09	6/177	W	27	2	7.	56	4.
10	1/30	M	25	7	7.	34	2.
11	3/89	M	24	3	7.	36	2.
12	6/200	W	31	2	7.	34	1.
13	1/22	W	30	7	7.	41	2.
14	2/57	M	35	6	7	48	4.
15	6/184	M	39	2	7.	30	1.
16	5/139	M	25	2	7.	33	1.
17	2/41	M	22	5	7.	30	1
18	6/172	M	22	2	7.	31	1.
19	1/4	M	22	4	4.	41	2.
20	1/27	M	22	4	4.	37	2.
21	2/43	M	18	2	4.	30	1.
22	1/5	M	38	4	4.	39	2.
23	I/28	M	38	4	4.	36	2.
24	3/78	M	25	2	4.	30	1.
25	3/85	M	34	3	6.	36	2.
26	8/38	M	36	5	6.	47	2.
27	2/32	M	21	4	6.	36	2.
28	4/98	M	43	3	6.	30	1.
29	3/65	M	21	3	6.	41	1.
30	5/129	M	19	2	6.	41	1.

31	1/6	Ž	23	6	6.	**74**	1.
32	5/183	M	18	4	8.	31	1.
33	1/8	Ž	38	4	6.	46	2.
34	5/105	M	18	2	**60.**	30	2.
n=34	M 25 Cumulative		24	34	34	34	34
	W 9 Average		28,3 (28)	3,6 (4)	**4,8 (5)**	37,4 (37)	1,7 (2)
n=61	M 22 Cumulative		61	61	**61**	61	61
	W 5 Average		27,6 (28)	1,8 (2)	**5,9 (6)**	37,5 (38)	1,8 (2)

- the period of 1972 to 1975, the drop down trend for number of the examination passing of the male and female candidates. The average number of exams is mostly higher for female candidates than of male candidates in the period from 1972 to 1974, except for the year of 1975,

- average number of driving hours is steadily higher in female candidates than in male candidates. At the same time, the age and hours of driving show a stronger bond for men than for women.

- the link between the age and all other variables (duration of school / months of school, driving hours, number of courses) is constantly stronger for male candidates than for female candidates,

- for all male and female candidates, there is a declining trend of correlation among all random variables, with an averagely stronger correlation between the same variables in males than in females,

c) testing the Ho hypothesis: ρ = 0. The linear correlation coefficient is a random variable defined on samples size **n**. It is necessary to examine whether the existing or calculated **r** belongs to the correlation coefficient **ρ of the** two-dimensional normal distribution **N** (μ- expectation, σ^2-variant), to which **r** also belongs. The similarity of the comparison of the arithmetic mean of the sample **x** with μ-expectation of the two-dimensional normal distribution **N**.

Theorem: If the basic two-dimensional set is a normal distribution with ρ = 0, then a random variable in the t-test ,

$$t = r * \{\sqrt{(n-2)} / \sqrt{(1 - r^2)}\} \quad (1).$$

distributed according to the law of the Student's t-distribution with degree of freedom **k = n - 2** (Student's t-distribution exists up to k = 30, and if k is greater than 30, it is replaced by the unit normal distribution N_1(μ = 0, σ = 1) with a random variable **u**).

Application: Only the linear correlation relationship is known about the stochastic relationship of random variables x and y. The following two hypotheses are tested on the basis of the sample with **n** and **r** :

Ho: ρ = 0 (The null or initial hypothesis) (2)

H_1 ρ ≠ 0 first hypothesis) (3).

Conclusion: testing the random variable **t of** Student's t-distribution is performed by t-test and if the random variable **t** lies in the range of random values of the t-distribution, and **r** must not be significantly different from 0, which means that it is true and acceptable Ho.

Example 1. For a sample of n = 50 pairs, r = -0.74. Can we conclude from the above sample that there is a linear correlation between the variables x and y?

Solution: by the known procedure and by including it in the known expression (1), where **t is a** random variable and has value

$$t = (-0{,}74) * \frac{\sqrt{(50-2)}}{\sqrt{(1-(-0{,}74)^2)}} = (-0{,}74) * \frac{6{,}928}{0{,}678} = (-0{,}74) * 10{,}26 = -7{,}5924 \text{ , or } -7{,}6. \quad (4).$$

As SS = n-2 = 50-2 = 48, it is interpreted by using the unit neutral s distribution N_1. Since **t is** very large, so is **r** different from 0 and significantly deviates from 0 and is worth ρ ≠ 0. It is necessary to choose $H_1$and choose a stochastic dependence between x and y.

The data and z of the study were used to test ρ = 0 (choice Ho) and ρ ≠ 0. (choice H_1) and obtained data in **Table 2.**

Table 2 .: Testing of hypothesis for investigation data from Table 1.

Physical Quantity/ Variables	**1973.**		**1974.**		**1975.**		**1972 - 1975 (1st time exam)**	
Sex	M	W	M	W	M	W	M	W
Sample Sizing n	45	45	45	45	45	15	45	41
Degree of Freedom k=n-2	43	43	43	43	43	13	43	39
Parameter t=2 , t^2=4	4	4	4	4	4	4	4	4
Coefficient of Correlation r	0,290	0,290	0,290	0,290	0,290	0,489	0,290	0,303
Selected hypothesis α=0,05	H_1	H_1	H_1	H_1	H_1	H_0	H_1	H_1
Selected hypothesis α=0,01	H_0	H_0	H_0	H_0	H_0	H_0	H_0	H_0

The conclusions of this point are:

- at the beginning, there is no comprehensive proposal of a better process of education, but are given only selected partial components, which could only after further concrete research provide solutions.
- the analysis is conducted of the influence of other factors or random variables to random variable number of the laying, separately for male candidates, separately for women candidates,
- the analysis was carried out for all the candidates from 1972 to 1975 on a sample of certain size **n,** and in particular for the candidates who, for the first time, passed the examination and passed the examination,
- performed analysis was calculated through **r** calculation and testing of ρ ,
- the following results were obtained :
  - with a probability of an error of the first alpha type = 0.05 (5%), Ho (r = ρ = 0) was obtained in 1972, for male candidates and for female candidates, and in 1975 for female candidates,
  - with the probability of an error of the second type alpha = 0, 01 (1%) obtains Ho (r = ρ = 0) for all male candidates and all female candidates, as well as for those who are / will take the exam for the first time, both for male candidates and for women candidates.

4. AKNOWLEDGEMENT

These articles are in memoriam to late B.Sc.Mech.Eng. Marijan Biščanić (during his own making of a thesis he was a graduate, and after that he became a B.Sc.Mech.Eng. at the Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb, Croatia) in reference [1], never after and nowhere published, exhibited and prepared these rich and worthy theoretical hypothesis of investigation given in personal car driver education, in this, probably, unique in this space and wider, but with special approaches. This also was a very good background for elaborating, processing and editing that subject and belonging content. We are thanking to prof. Ph.D. Dragutin Mikšić for multiple years of collaboration with the first author of this article and for using one of his part context / content about ergonomics from his textbook / manual with the title “Introduction to Ergonomics”, reference [2] , too.

5. REFERENCES

[1] Biščanić, M.: Ergonomic Features in the Training of Driving a Car, Graduate Thesis at the Faculty of Mechanical Engineering and Naval Architecture - Zagreb, University of Zagreb , Zagreb, 1975, Croatia
[2] Mikšić, D.: Introduction to Ergonomics, University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture - Zagreb, Zagreb 1997, Croatia
[3] Djurašević, A.: Production Improvement-Part I, Liber University Press, Zagreb, 1970, Croatia
[4] Murell, K.F.N.: Ergonomics, Chapman and Hall, London 1965,
[5] McCormick, E.J.: Human Factors Engineering, McGraw-Hill Cmpany, New York 1970.
[6] Mellerowicz, H.: Ergometric, Urban and Schwarzen Herg, Munich Berlin 1962,
[7] Davies, C.T.M., Barnes, C.: Ergonomics, 1 (1972,), 3 to 14
[8] Schmidtke, H.: Ergonomie I, Carl Hanser Verlag, Munich, 1973, p. 5
[9] Schreuder, S.: Moderne Arbeitwissenschaft fur die Fabrik der Zukunft, in: Hackstein, R. (et al.):

Arbeitorganisation und neue Technologien, Springer Verlag, Berlin, 1986, p. 197

[10] Argyris, Ch .: Personalities and Organization, Harper and Brothers, New York 1958.

[11] Strauss, G.: The Personality versus Organization Hypothesis, in: Nord, V. (ed): Concepts and Controversy of Organization Behavior, Goodyear Publishing Company, 1972.

[12] Schein, E.: Organizational Psychology: Prentice-Hall, New Jersey, 1970.

[13] Woodson, W.E., Coover, D.W.: Human Engineering Guide, University of California Press, Berkeley, 1964, pp. , 24 to 29

[14] Kirchner, J.H., Rohmert, W.: The Ergonomic Leit Regel zur Menschgeretchen Arbeit Gestaltung, Carl Hanser Verlag, Munich, 1974, p. 93 and 94.

[15] Barnes, R.M.: Time and Motion Study, McGraw-Book Hill, New York, 1963

[16] Barnes, R.: The Study of Time and Movement (translation), Panorama, Zagreb, 1964, Croatia

[17] Taboršak, D., Car, M .: "Investigations into the application of ergonomic principles in manufacturing workplaces", MECHANICAL ENGINEERING 27 (1985), 21-26

[18] Car, M., Seuček, I., G. Marić, Kroneisl, F.: Design and development of ergonomic methodologies of shaping aids (device) for machine construction and the selection of (usually) ergonomic aids (device) , 2. Conference of production engineering CIM ' 93, Zagreb 1993 ,. F-57 to F-64, Croatia

[19] Verhovnik, V., Polajnar, A.: Determination of additional time in automated production and using the ergonomic coefficient Ker, Proceedings " Ergonomic Aspects of New Technologies", Croatian Ergonomic Society, Zagreb, 2 001., p. 85 to 90