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INFLUENCE OF PHYSICAL FACTORS OF WORKING ENVIRONMENT ON WORKER'S PERFORMANCE FROM ERGONOMIC POINT OF VIEW

Peter Trebuňa
Technical University of Košice, Faculty of Mechanical Engineering, Institute of Technologies and Management, Department of Industrial Engineering and Management, Němcovej 32, 042 00 Košice,
e-mail: peter.trebuna@tuke.sk
Andrea Petriková
Technical University of Košice, Faculty of Mechanical Engineering, Institute of Technologies and Management, Department of Industrial Engineering and Management, Němcovej 32, 042 00 Košice,
e-mail: andrea.petrikova@tuke.sk
Miriam Pekarčíková
Technical University of Košice, Faculty of Mechanical Engineering, Institute of Technologies and Management, Department of Industrial Engineering and Management, Němcovej 32, 042 00 Košice,
e-mail: miriam.pekarcikova@tuke.sk

Keywords: physical factors, working environment, noise, vibration, lighting, microclimate
Abstract: The article deals with the optimization of logistic flow of selected company in the area of software module Process Simulate. The aim is to design a logistics flow, which will reduce machine downtime, number of workers during the operation of CNC centres or achievement the elimination of redundant manipulation steps of direct staff. Modelling and simulation of workplace in a software module Process Simulate enables to rationalize it in virtual environment, which will contribute to cost savings that are expended in the process of direct implementation of the proposals in practice.

1 Introduction

The aim of company is to maximize quantity and quality of production and remove barriers that defend it. The best example of these barriers are: excessive noise of environment, bad working desk, poor lighting, but also air current or odor. All these factors are called working conditions. It is true that many working conditions are regulated by legislation, but there are also factors which are not regulated by legislation or are difficult to measure.

The aim of this paper is to explain and process work environment in relation to physical factors and ergonomics. These factors that are often overlooked, may be the etiological agens and a source of personal employee disaffection.

1.1 Working environment

Working environment is a set of physical, chemical, biological, socio-psychological and other factors, that affects on employees. Within physical conditions, most authors focus on microclimate of working environment (temperature, humidity and air flow in the workplace), workplace lighting, noise and vibration in the workplace, colorful interior design, and air pollution.

1.1.1 Physical factors of working environment

Work is performed in a specific physical environment. Physical factors consist of following factors: microclimate conditions that affect thermal comfort of humans, noise, vibration and lighting.

Noise:

Noise is defined as all sound in the workplace, either wanted or unwanted and is one of the most common Occupational Health and Safety (OHS) hazards and is found in many different environment. Noise or sound is created by alternate compression and decompression of particles of the air. This causes the air pressure to fall and rise in the form of waves. Frequency (pitch) and intensity (loudness) are the two characteristics of sound [4].

The loudness of sound is measured in units called decibels. Sound pressure level (SPL) is the basic measure of the magnitude of the acoustical vibrations of the air that make up sound. Because the sound pressure range that human listeners can detect is very wide, (10-5 to 102 Pascal (Pa), these levels are measured on a logarithmic scale with units of decibels. For example, usual conversation is approximately 60 decibels, the humming of a refrigerator is 40 decibels and city traffic noise can be 80 decibels [4], [10].

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.

Phase of vibration speed $c = f \times \lambda$,
λ - vibration wavelength,
f- frequency.

$$v = 332^{ns^{-1}} \sqrt{1 + \frac{t}{273{,}15}} \quad (1)$$

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

dy=KdY/X (2)
Y=lnX+C (3)

In case of sound, stimulus X is proportional to the density of the power of the audibility field and is measured in [W/m2]. If we replace in the equation Y = In 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:

$$Y = \log\left(\frac{W}{W_0}\right) \quad (4)$$

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:

$$L = 10\log\left(\frac{W}{W_0}\right) dB(A) \quad (5)$$

$$W_0 = 10^{-12} W / m^2 \quad (6)$$

The consideration does not include the frequency. Since it is known that human ear recognises different 254 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:

$$L_1 = 10\log\left(\frac{W_1}{W_0}\right) dB(A) \quad (7)$$

$$L_2 = 10\log\left(2\frac{W_1}{W_0}\right) = 10\log\left(\frac{W_1}{W_0}\right) + 10\log 2 = L_1 + 3dB(A) \quad (8)$$

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 lOO-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:

$$L = 10\log\sum_{i=1}^{n} 10^{Li/10} \quad (9)$$

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:

$$L_{eg} = 10\log\frac{1}{t_0}\int_0^{t_0} x10^{L(t)}\, x10^{dt} \quad (10)$$

t0 - time duration of measuring the intensity,
L(t) - function of time.

Exposure to noise at work [10]:

The noise is most common negative factor in the work environment, while only in Slovakia in 2008 were more than 88 300 employees of various economic sectors exposed to excessive noise. Despite the generally accepted view, that threaten are only (or especially) employees of industries, there is number of other professions that may be exposed to noise levels exceeding the limits.

Slovakia According to the first candidate countries survey on working conditions in 2001, about 20 % of workers in Slovakia were exposed to noise so loud that they had to raise their voice to talk all of the time or almost all the time. On the whole, approximately 45 % of workers were — to various degrees — exposed to noise at work. According to the data of the Institute of Public Health of the Slovak Republic, the number of workers exposed to noise decreased in 2005–2010 by about 15 %, but after this period there have been no significant changes in the percentage of workers exposed. About 89 000 workers were exposed to noise at work in 2013. The percentage of women exposed to noise decreased from 22 % in 2005 to about 18 % in 2015.

In Slovakia there is a joint legal regulation for both outdoor and indoor noise limits. This regulation is incorporated in the Ordinance of the Ministry of Health No. 549/2007 Coll. on Details of Permissible Values of Noise, Infrasound and Vibrations.

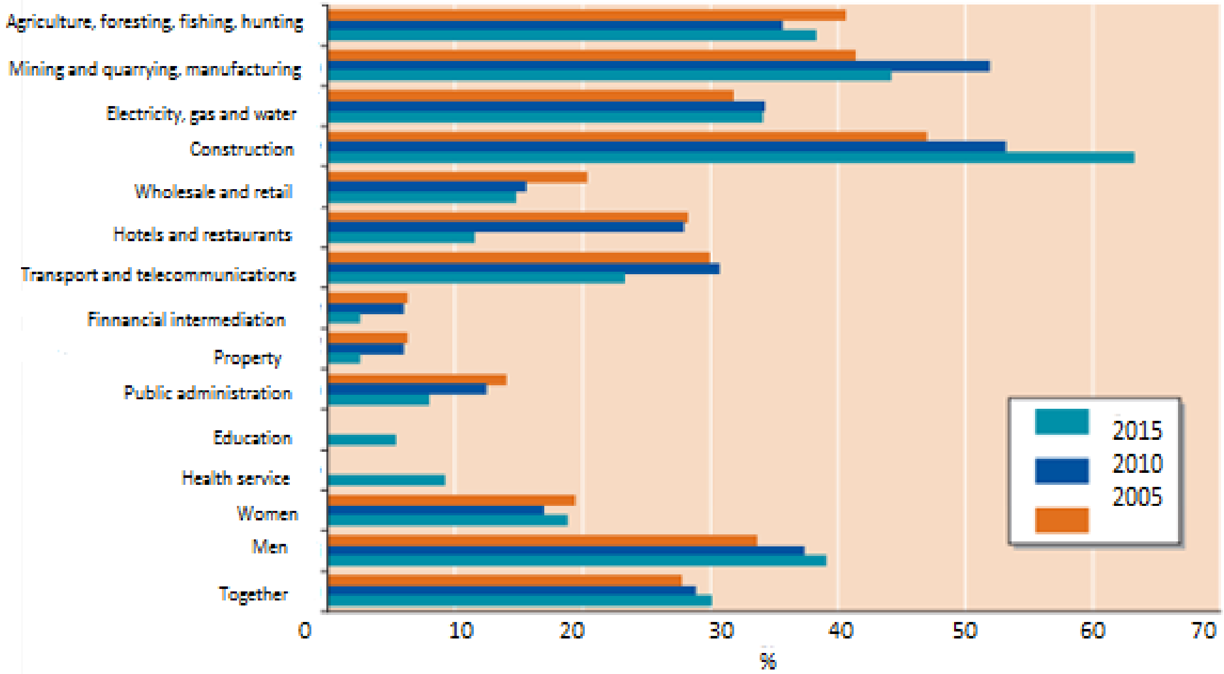

Figure 1 Percentage of workers exposed to noise for at least quarter of working time [10]

Lighting:

The Illuminating Engineering Society of North America (IESNA) defines light as "radiant energy that is capable of exciting the retina and producing a visual sensation." Light, therefore, cannot be separately described in terms of radiant energy or of visual sensation but is a combination of the two [17].

Light is that part of the electromagnetic spectrum that is perceived by our eyes. The wavelength range is between 380 and 780 nm.

Light has a triple effect:

Light for *visual* functions:Illumination of task area in conformity with relevant standards, Glare-free and convenient

Light creating *biological* effects: Supporting people's circadian rhythm, Stimulating or relaxing

Light for *emotional* perception: Lighting enhancing architecture ,Creating scenes and effects.

Basic parameters used in lighting:

Luminous flux , Luminous intensity , Illuminance, Luminance

Luminous flux:

The luminous flux describes the quantity of light emitted by a light source. The luminous efficiency is the ratio of the luminous flux to the electrical power consumed (lm/W). It is a measure of a light source's economic efficiency [2].

Luminous intensity:

The luminous intensity describes the quantity of light that is radiated in a parti - cular direction. This is a useful measurement for directive lighting elements such as reflectors. It is represented by the luminous intensity distribution curve (LDC).

Illuminance:

Illuminance describes the quantity of lumi - nous flux falling on a surface. It decreases by the square of the distance (inverse square law). Relevant standards specify the required illuminance (e.g. EN 12464 "Lighting of indoor workplaces").

$$E(lx) = \frac{lu\min ousflux\ (lm)}{area\ (m^2)} \tag{11}$$

Luminance:

Luminance is the only basic lighting parameter that is perceived by the eye. It specifies the brightness of a surface and is essentially dependent on its reflectance (finish and colour).

All principal Lighting associations and Societies of the world agreed about optimal lighting conditions for various areas, so finally international standards have been made. Standards are collected within European norms, which can be purchased from National Standardization Institutes or from the central European Institution for Standardization [2].

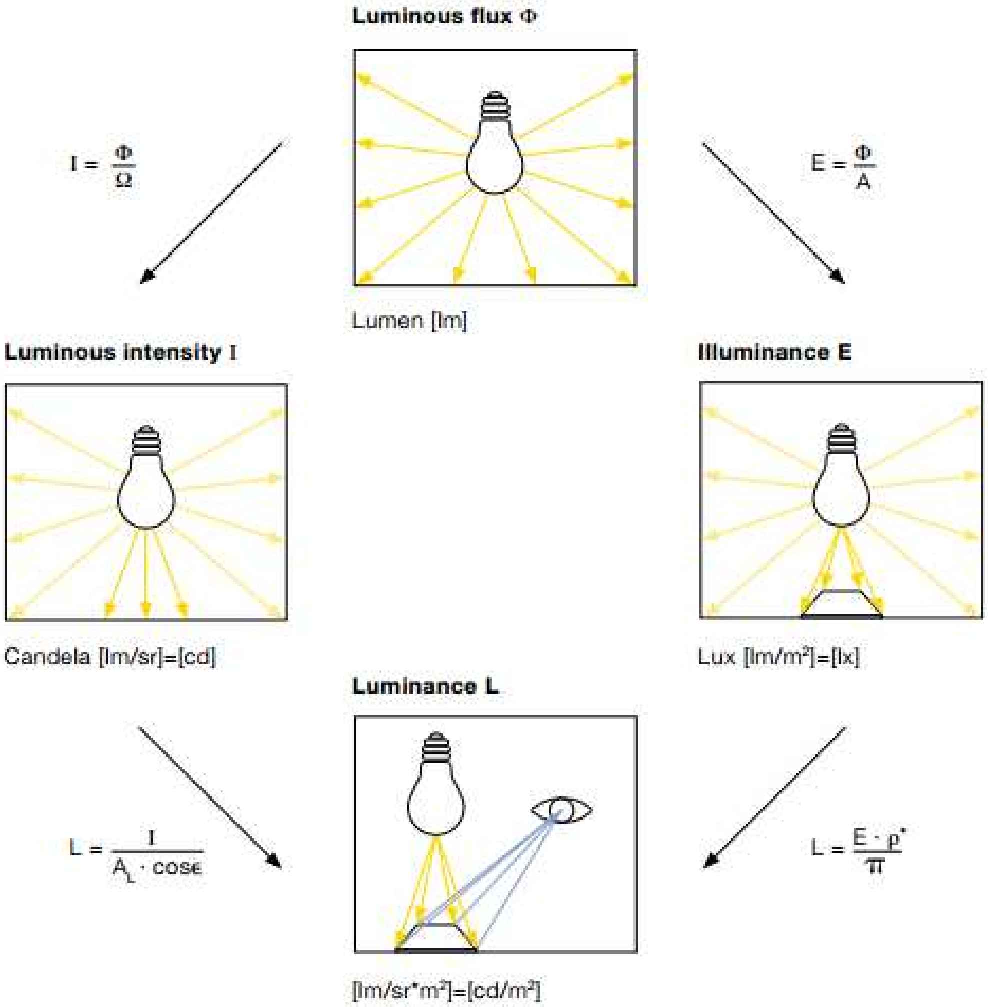

Figure 2 Basic parameters used in lighting [17]

Microclimate:

Microclimatic parameters: Microclimatic parameters (or conditions) of the work environment also known as thermal-moisture parameters are determined by temperature, relative humidity and airflow. These physical quantities define subjective well-being (comfort) or ill-being (discomfort). In extreme cases can be considered as pollutants with adverse effects on human health [1].

Temperature: Particular type of working class has got determined the optimal microclimate conditions, depending on body heat production affected by intensity of employee's activity. The total energy expenditure assigns the individual work activities to the working classes: 1a (sitting at work, administration), 1b (standing at work), 1c (such us mechanics work, work in the steel industry), 2 (such as operating machines, work in the building industry), 3 and 4 (intensive and very intensive work).

Table 1 The optimal and permissible temperature for some working class [1]

Working class	Temperature (°C)			
	Optimal temperature		Permissible temperature	
	Warm season	Cold season	Warm season	Cold season
1a	21-25	20-23	20-28	20-26
1b	20-24	18-21	18-26	17-24
1c	18-22	15-19	16-25	13-22
2	16-19	12-17	12-24	10-20
3	The value does not determine			
4				

Range of optimal values of microclimatic conditions in the working environment is set for a warm period (average daily outdoor temperature 13 °C and more) and winter season (decrease of the average daily temperature for two consecutive days below 13 °C). The optimal and permissible temperatures for warm and cold season of the year are in the Table 1 (Slovak Directive No. 544/2007). In case of the workplace with long-term nature where it is impossible to provide optimal conditions, the employer is required to ensure compliance with permissible microclimatic conditions. Exceptions are in need of special workplaces where the burden of heat or cold is impossible to be removed due to various technological reasons [1].

Humidity: Humidity in the working environment is a specific factor. The specificity of factor is mainly in the fact that unlike the temperature, this can be subjectively very difficult to perceive and then evaluated. The human body can have an adverse effect on the decrease in humidity on the level of 20% mainly in winter (due to heating) and the humidity in excess of the 60% in other seasons [4].

Heat production of man increases with the physical activity. The main resources are mainly muscle groups that produce net metabolic heat. Basal metabolic heat is added to net metabolic heat, which is produces basically on biological processes in the human body. Metabolic heat q_m is given by:

$$q_m = M - W = q_{m,b} + q_{m,\,net} \tag{12}$$

M is the total metabolic heat production in $W.m^{-2}$
W is job performance (mechanical work) in $W.m^{-2}$
$q_{m,b}$ is basal metabolic heat in $W.m^{-2}$
$q_{m,b}$ is net metabolic heat in $W.m^{-2}$

European standard establishes the metabolic heat unit met. *Met* represents thermal output of sitting man. (1 met = 58,2 $W.m^{-2}$)

Energy expenditure is determined by measuring the oxygen consumption according to reference tables or calculation.

Thermoregulatory process of heat exchange between human body and the environment is given by equation of heat balance

$$S = Q_{core} + Q_{sk} \tag{13}$$

S is accumulated heat in body in $W.m^{-2}$

$Q_{core} = (M-W) + (C_{res}+E_{res}) + q_{tr} + q_a$ is heat flow form the core of body through the skin in $W.m^{-2}$

$Q_{sk} = C+R+K+E_{sk}$ is a heat flow from the body surface to the environment in $W.m^{-2}$

where:
$(M - W)$ is the metabolic heat in $W.m^{-2}$
$C_{res}+E_{res}$ is respiratory heat (conventional resp. heat in C_{res}+ *evaporative heat* E_{res} in $W.m^{-2}$
q_{tr} is thermoregulatory heat
q_a is adaptation heat in $W.m^{-2}$
C heat is transferred by convection in $W.m^{-2}$
R heat is transferred by radiation in $W.m^{-2}$
K is heat tranferred by convection in $W.m^{-2}$
E_{sk} is heat transferred by evaporation or condensation in $W.m^{-2}$

Vibration:

Vibrations are mechanical oscillations which pose a hazard to human health when acting continuously on the hand-arm system (hand-arm vibrations) or on the entire body (whole-body vibrations). Vibrations may cause blood circulation problems, bone or joint disorders, neurological or muscular conditions, back pain, or damage to the spinal column.

Vibration is often called a vector quantity, which means that the vibratory motion has both a negative effect in of itself and a magnitude or intensity component [16].

Generally, two forms of exposure may be distinguished: whole-body vibration (WBV), which is transmitted by mobile or fixed machines where the operator is standing or seated, and hand-arm vibration (HAV), which is transmitted by hand-held or guided tools. In simple terms, vibration is defined by its magnitude (traditionally described using acceleration, expressed in m/s^2) and frequency (the number of times per second the vibrating body moves back and forth, expressed in cycles per second, or hertz (Hz)). The risk of damage is not equal at all frequencies; therefore, when calculating exposure, a frequency weighting is used. Furthermore, vibration must be evaluated in three axes (vertical, fore and aft, and lateral axes in the case of WBV). From each vibration axis a frequency-weighted root-mean-square average acceleration is measured. This is referred to as ahw. Since the risk of damage is not equal in all axes, a multiplying factor must be applied to the frequency-weighted vibration values. In the case of WBV, the acceleration values for the two lateral axes (x and y) are multiplied by 1.4, whereas for the vertical (z axis) they are multiplied by 1.0. In the case of HAV no multiplying factors are used. In the case of WBV, the equivalent acceleration is obtained from the highest of three orthogonal axes' values (1.4awx 1.4awy or awz) that are used for the exposure assessment. HAV risk, on the other hand, is based on the frequency-weighted acceleration total value ahv given by the root sum of squares of the frequency-weighted acceleration from the three orthogonal axes, x, y and z [16]:

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2} \tag{14}$$

The vibration directive defines the daily exposure, *A(8)*, as:

HAV: the equivalent continuous acceleration, normalised to an eight-hour day; the *A(8)* value is based on root-mean-square averaging of the acceleration signal and has units of *m/s²*;

$$A(8) = a_{hv}\sqrt{\frac{T}{T_0}} \tag{15}$$

where T is the daily duration of exposure to the vibration magnitude a_{hv} and T_0 is the reference duration of eight hours.

WBV: the equivalent continuous acceleration over an eight-hour period, calculated as the highest (rms) value, or the highest vibration dose value (VDV) of the frequency-weighted accelerations, determined on three orthogonal axes (1.4awx, 1.4awy, awz for a seated or standing worker). The directive sets exposure action values, above which it requires employers to control the vibration risks to their workforce, and exposure limit values, above which workers shall not be exposed:

- a daily exposure action value of 0.5 m/s² (WBV) or 2.5 m/s² (HAV);
- a daily exposure limit value of 1.15 m/s² (WBV) or 5 m/s² (HAV).

Human exposure to WBV should be evaluated using the method defined in International Standard ISO 2631-1:1997, together with the detailed practical guidance on using the method for measurement of vibration at the workplace, which is given in EN 14253:2003. In the case of human exposure to HAV, the method that should be used is defined in European Standard EN ISO 5349-1:2001, together with the detailed practical guidance on using the method for measurement of vibration at the workplace, which is set out in EN ISO 5349-2:2001 [16].

2 Ergonoic analysis in the digital environment

Most companies looking for savings in purchased materials, overheads, energy. They are looking for ways to achieve these savings. One way is to use software products for the creation of virtual reality and optimization of the current state of business processes without the cost of direct implementation of suggestions for improvement.

The principle of modeling in Tx Jack and Process Simulate Human is demanding in terms of modeling machines, equipment, vehicles, etc. To create a working environment, it is appropriate to use other softwares, which creates a working environment easier.

Software Tx Jack is compatible with the software, which can create a virtual environment of a particular workplace or halls such as CAD. Thus created environment can be imported into the working environment of Tx Jack and then place a concrete worker in it with concrete working activities

Main function of Tx Jack and Process Simulate Human are therefore create a human being with accurate anthropometric parameters, simulation of movements (individual body parts) and determine the burden caused by work´s aktivities and work´s environment. If it is not necessary to determine the physical stress on the particular operator, but it is necessary to dimension the workplace in general, it is possible to use the database ANSUR (Survey of U.S.Army) which contains data collected realization of a survey personnel of military of USS in 1988.

Siemens Tecnomatix software package has several modules for each area of usage. For modeling and simulation of the impact of the working environment on staff, creating 3D models of working environment, workers and their activities and detect physical stress through a specific predefined base of ergonomic analysis can be used two modules [3]:

- **Tx Jack/Jill -** it’s a 3D simulation tool for evaluating of physical stress during the manual work activities, this is the instrument through which it is possible design workplace in the virtual environment and simulate various solutions that meet ergonomic standards without investing in equipment and technology. Digital human model in this program is a real biomechanical properties of natural motion and joint rang - taken from NASA studies.
- **Process Simulate Human -** allows users to verify the design of work stations, verify the achievement of the required safety of the individual parts of a product. The module offers powerful features for analyzing and optimizing the ergonomics of human activity, thereby providing an ergonomic and safe production process according to industry standards. Using simulation tool of human activity, the user can perform realistic simulation of the human tasks and optimize process times of the production cycle according to the standards of ergonomic.

In the following figures (Fig. 3 and Fig. 4) there is a short comparison between human operation created in the Process Simulate environment and Jack module. It is shown only a basic operation – walking, where you can see the differences of creating the operation and also the graphical windows displaying the software environment.

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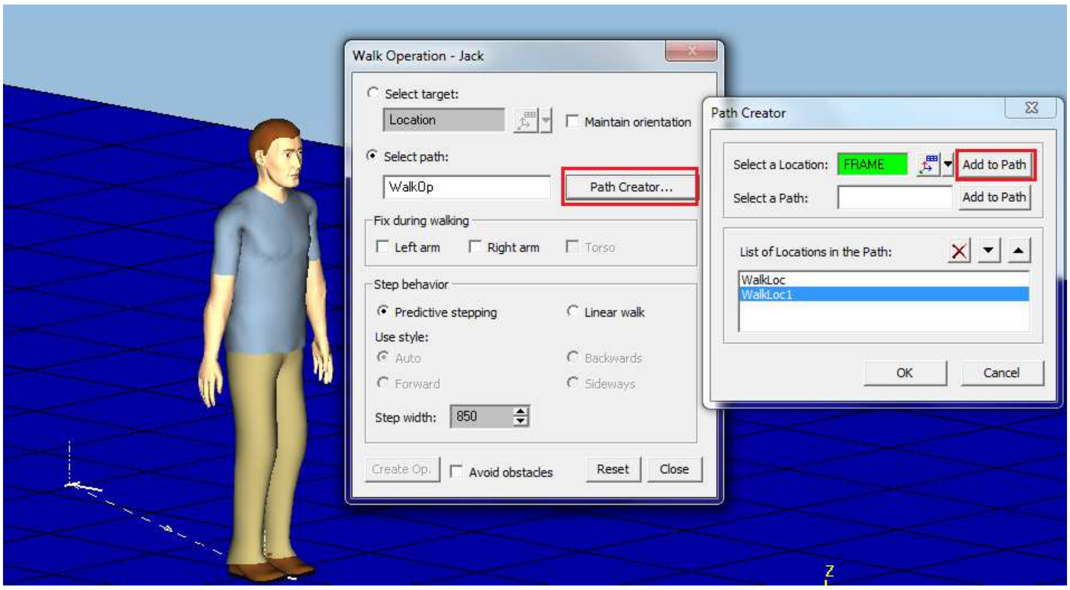

Figure 3 Tecnomatix Process Simulate - Walk creator

In the Process Simulate module, you need to choose the requested human model in the graphics window and selecting Walk Creator - from the main Human menu. In the window Operation Walk - Jack there is a possibility to propose the walk operation by positions - either by entering the human target positions (Select Target), where human has to move, or selecting Path Creator and then entering a path along which go human model to the desired destination.

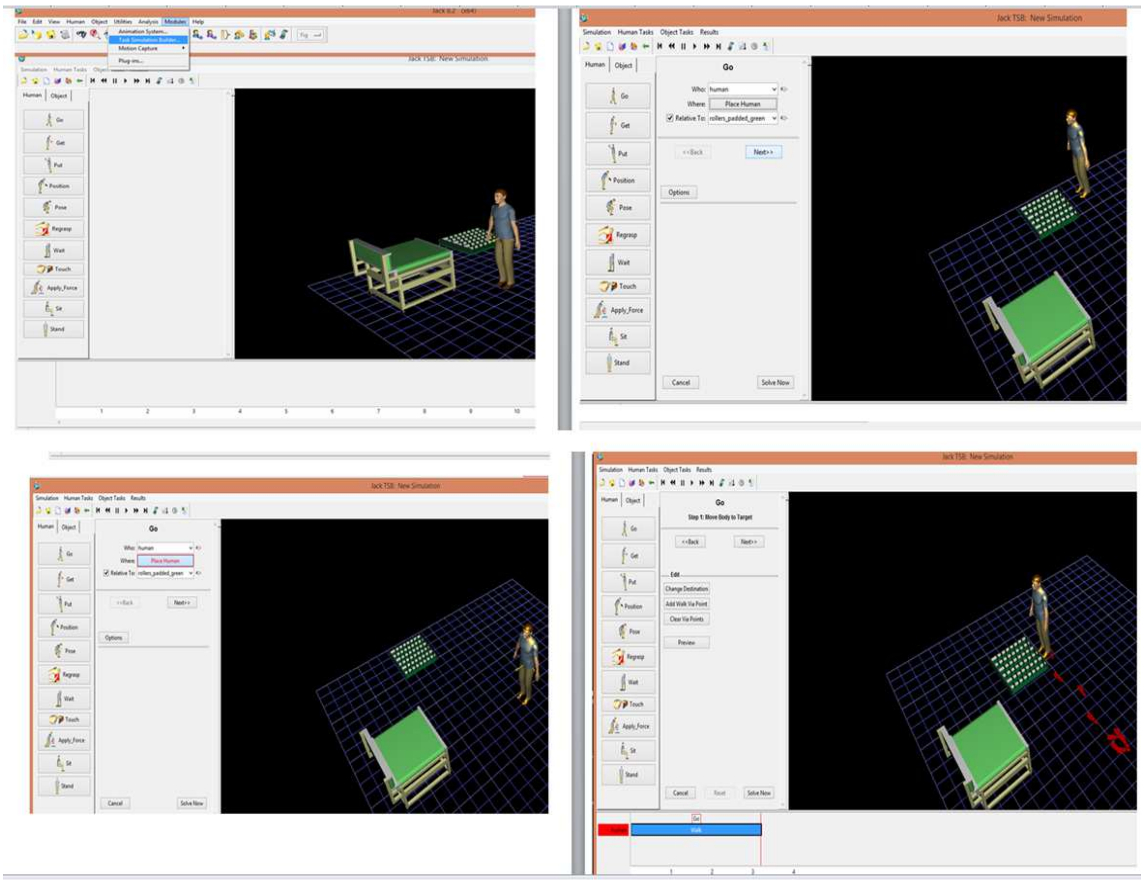
Figure 4 Tecnomatix Jack - Task Animation Builder

It needs to click in the main menu Modules_Task Simulation Builder. It opens a working environment in which it is possible to create human movements that are in the menu - eg. Go, Get, Put, position, pose, touch, regrasp ATC.

2.1 Jack Task Analysis Toolkit

Task Analysis Toolkit (TAT) assessment tools are linked directly to the human figure, minimizing user inputs and standardizing assessment results between users. TAT tools can be run interactively, enabling realtime results during animations and motion capture sessions. TAT tools are based on recognized data sources endorsed by the ergonomics community • Analysis reports are available for TAT tools, enhancing communication of results. TAT includes simplified screening tools, as well as complex quantitative analysis options, facilitating easy use and interpretation. Tecnomatix Jack module has many tools for ergonomic measurement (Fig. 5):

- NIOSH (National Institute for Occupational Safety and Health)
- OWAS (Ovako working posture analysis)
- MTM (Methods-Time Measurement)
- RULA (Rapid upper limb assessment)
- SSP (Static strength prediction)
- And many other...

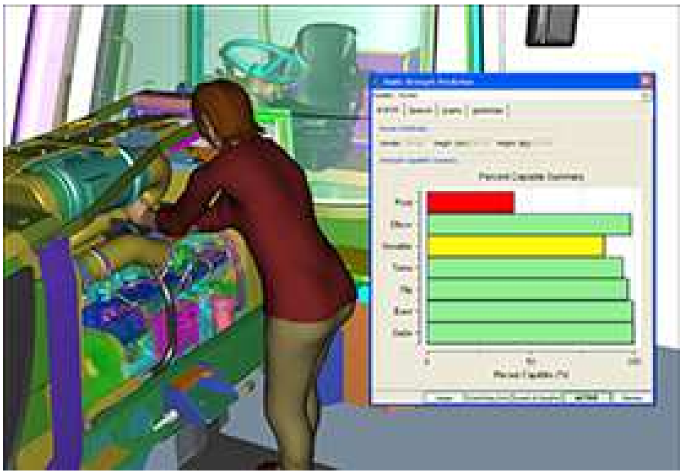

Figure 5 Tecnomatix Jack - Task Analysis Toolkit

Conclusions

Violation of ergonomic principles leads to the health damage of workers. Working in wrong position and performing unnatural movements can lead to incapacity to work what represents financial losses for employer. Legislation provide that the employer must create suitable working conditions for its employees. The attention should be paid to factors affecting the long-term physical and psychological burden on workers, because the workplace is characterized by physical load and work done in unsuitable environments.

Physical factors of working environment must be measured by appropriate methods and measuring devices, that are defined in the relevant laws and regulations. Subsequently, the measured values are compared with the requirements laid down in legislation. Nowadays, this form of evaluation is preferred, but it does not bargain for reciprocal action of parameters in working process.Therefore the scientific discipline called ergonomics was created. The main goal is to bring a systemic view of the relationship created between man and the working environment, including work tools. If the measured value exceeds the value of certain factors that are standardized, it is important to ensure the elimination of the factor applying different measures.

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COMPUTED TOMOGRAPHY – ITS DEVELOPMENT AND PRINCIPLE

Marianna Trebuňová
Technical University of Košice, Faculty of Mechanical Engineering, Department of Biomedical Engineering and Measurement, Letná 9, 042 00 Košice, Slovakia, marianna.trebunova@tuke.sk
Galina Laputková
Pavol Jozef Šafarik University in Košice, Faculty of Medicine, Department of Medical and Clinical Biophysics, Trieda SNP 1, 040 11 Košice, Slovakia, galina.laputkova@upjs.sk
Jozef Živčák
Technical University of Košice, Faculty of Mechanical Engineering, Department of Biomedical Engineering and Measurement, Letná 9, 042 00 Košice, Slovakia, jozef.zivcak@tuke.sk

Keywords: Computed Tomography, principle, machine, modelling
Abstract: CT (Computed Tomography) displaying is non-invasive diagnostic method, which has begun to apply in medicine since the beginning of the 70s and it has progressively become an irrecoverable part of the complex of imaging methods used by modern medicine. CT scanning made a remarkable effect on medical practise and diagnosis. The main principle of CT is based on attenuating of X-ray radiation beam passing object as in conventional X-ray examination. This article briefly describes the development and underlying principles of this non-invasive imaging technique.

1 Development and principle of CT

1971 October 1, CT examination was carried out in 41-year-old female patient and the frontal lobe tumor was discovered. The scanning of the patient lasted 15 hours and the CT machine developed by sir Godfrey Neobold Hounsfield (Nobel Prize laureate) in EMI company (Electrical and Musical Industries) in London was used. The musical industry EMI after the success of the Beatles recordings invested in a new product. For the first time in the history of medical radiology doctors were able to obtain the high quality images of cross section of the internal parts of the body. Since then the explosive technical sophistication has dramatically developed CT scan techniques and with the new research possibilities this development is being in progress even today [1,2].

The first generation of CT scanner used by Hounsfield in his original experiment consisted of parallel beam geometry, in which numerous measuring of permeated X-ray beam were carried out with the help of single suppression narrow pencil X-ray beam and detector. The beam was moved in linear motion over patient in order to obtain the projection profile. Subsequently the source and the detector rotated around the patient by approximately 1° and so another projection profile was taken. This translational-rotational scanning motion was repeated until the source and the detector turned around by 180° (Figure 1) [3].

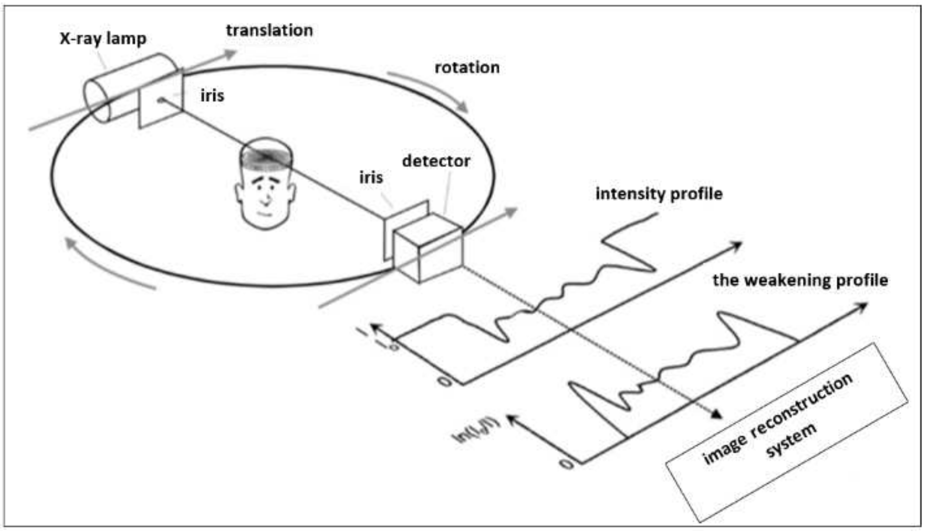

Figure 1 1st generation CT machine principle

The slow speed image data acquisition (approximately 5 min for each image) meant the restriction of scanning for moving artifacts connected with long-lasting scanning only on head. In order to overcome these time restrictions the second generation of CT scans which used a narrow fan-shaped beam and more detectors was developed. Although those scanners also used the translational-rotational moving the scanning time was reduced to 30 seconds because of the narrow fan-shaped X-ray beam and the linear series of detectors which facilitated bigger rotational acquisitions. In 1976 3rd generation of CT scanners which used fan-shaped beam configuration and rotating series of detectors was launched. In this generation fan-shaped X-ray beam together with the curved series of hundreds of detectors rotated by 360° around the patient.

The third generation of CT scanners enabled only 1-second acquisition. Consequently 4th generation of CT scanners used the rotating fan-shaped non-stationary series of detectors consisting of 600-4800 independent detectors arranged in a circular configuration around the patient (Figure 2) was developed. The scanning times of 4th generation were similar to 3rd generation scanning times.

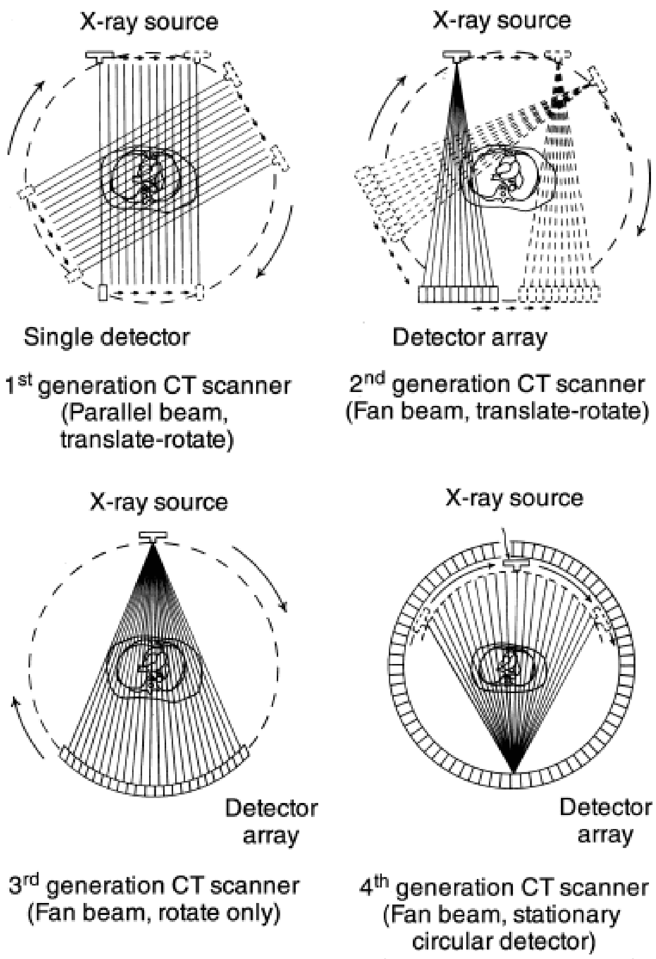

Figure 2 CT machines. The graphical representation of particular generations of CT machines [4].

The requirement for faster scanning heavily influenced the further development of CT technology in order to obtain volumetric data for 3D displaying and multiphase acquisition of images. It was enabled by the revolutionary development of slip-ring technology in 1990 which allowed X-ray source to rotate around the patient without reverse rotation (which was inevitable in conventional CT scanners) [5].

In combination with high-energy X-ray lamp, more efficient computers and more sophisticated displaying algorithm, the slip-ring technique enabled spiral CT scanning. This consists of continually activated X-ray source and continual movement of top board of the table through the gantry (a part of CT machine, a ring composed of a system of detectors and rotating X-ray) which results in volumetric acquisition. SSCT (*SpiralScan* CT) machines enabled faster and continual scan technology to obtain numerous cross cuts and volumetric data (Figure 3). The significant parameter for spiral scan characterization is pitch *p*. According to IEC specification in 2002 *p* is determined: *p* = movement of table in one rotation / total thickness of beam suppression [6].

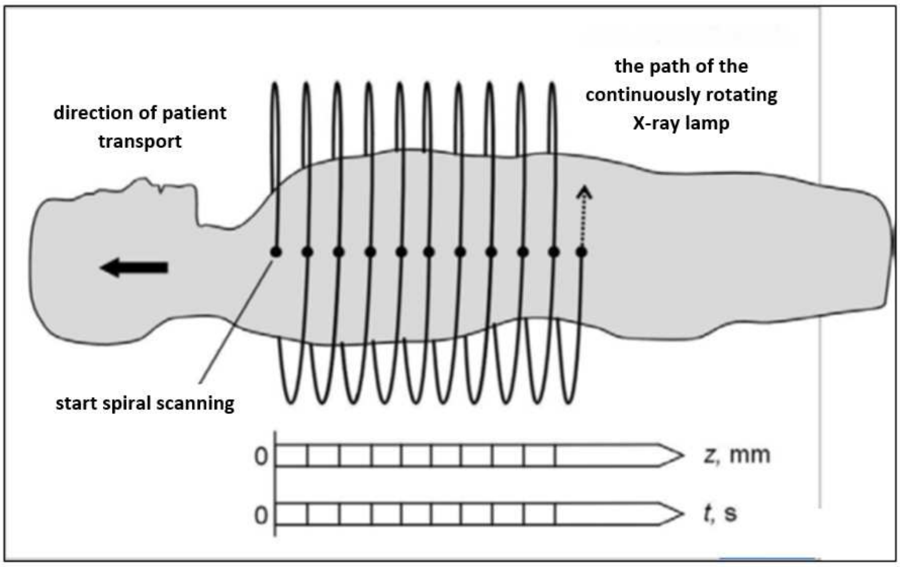

Figure 3 Schematic illustration principle of mono-slice 1st generation CT machine [5].

In 1998, the multi-slice spiral CT technology was set up which enhanced CT applications. Although MSCT (*Multi-sliceSpiralComputeTomography*) made use of the same slip-ring technology as SSCT, it provided a unique advantage in terms of increased movement of the table on rotation resulting in enlarged thickness of fan-shaped beam suppression based on width configuration of series of detectors. It is interesting that CT scanners were considered as mono-slice technique despite the fact that the first CT scanners were de facto two-slice scanners [7]. Fast development of multi-slice technology from 2000 to 2007 brought 2, 4, 8, 16, 40, 64, 256 and 320-slice CT scanners. Looking at the numbers of slices of MSCT and a year of their operation it is obvious that the number of slices exponentially increased as a time parameter roughly twice each year which is in compliance with Moore Laws of Electronics [6].

Further development was different. In 2005 the first dual-source CT scanner was launched (Figure 4). The main benefit of DSCT (*DualSourceComputedTomography*) was the scanning of the heart with improved temporal distinction. It provides the temporal distinction of one quarter of the rotation time of the gantry which is independed of the heart action and it does not need multisegmental reconstruction techniques. Except heart examination this scanner is a contribution also for general radiology. The acquisition of dual energy is the revolutionary benefit. Both X-ray lamps can operate with either various settings kV or various prior filtration. Among potential applications of CT examination with dual energy there is the tissue characterization, calcium quantification and the quantification of local blood volume in contrast images [7].

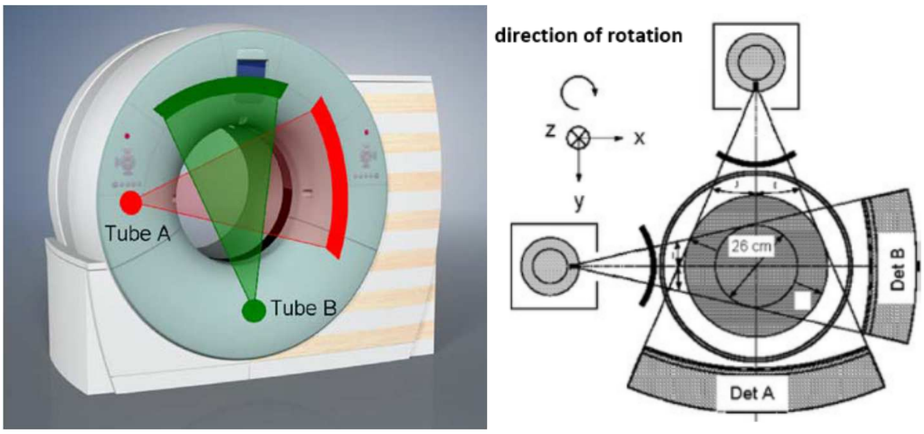

Figure 4 DSCT scanner. A schematic illustration of DSCT machine using two X-ray lamps and two series of detectors mutually placed in 90°. This type of scanner provides the temporal distinction equal to a quarter of rotating time of gantry independent of the heart action. In technical realization, the first detector (a) covers the whole scan FOV (field of view) with average 50 cm and second detector (b) has got smaller FOV [8].

By means of modern MSCT scanners it is possible to display the whole human body during the comfortable breath holding. Improved and faster displaying algorithms, improved capacity of data storage and higher quality of 3D displaying significantly affected hardware development. Obviously usage of MSCT scanners leads to the increased productivity of CT and multi-slice examinations are carried out with more complicated protocols than CT examinations with SSCT scanners [9]. Further development of CT scanning should provide information of 4D scanning, what is the dynamic volume scanning. CT scanners with conical beam have even today the capacity for 3D displaying of larger volumes with isotropic distinction and they have a potential for 4D displaying because they are capable to obtain data from large volumes during one rotation both X-ray lamp – detector [10]. At present Toshiba and Siemens companies are imposing machines focused on this target. Toshiba launched 320-slice scanner which enables to examine all organs during one rotation. Siemens introduced 128-slice scanner with dynamic spiral shuttle mode which enables to gain 4D data from large volumes. Figure 5 demonstrates the example of perfusion scan of the whole brain. Perfusion scan has been possible only in one-slice so far.

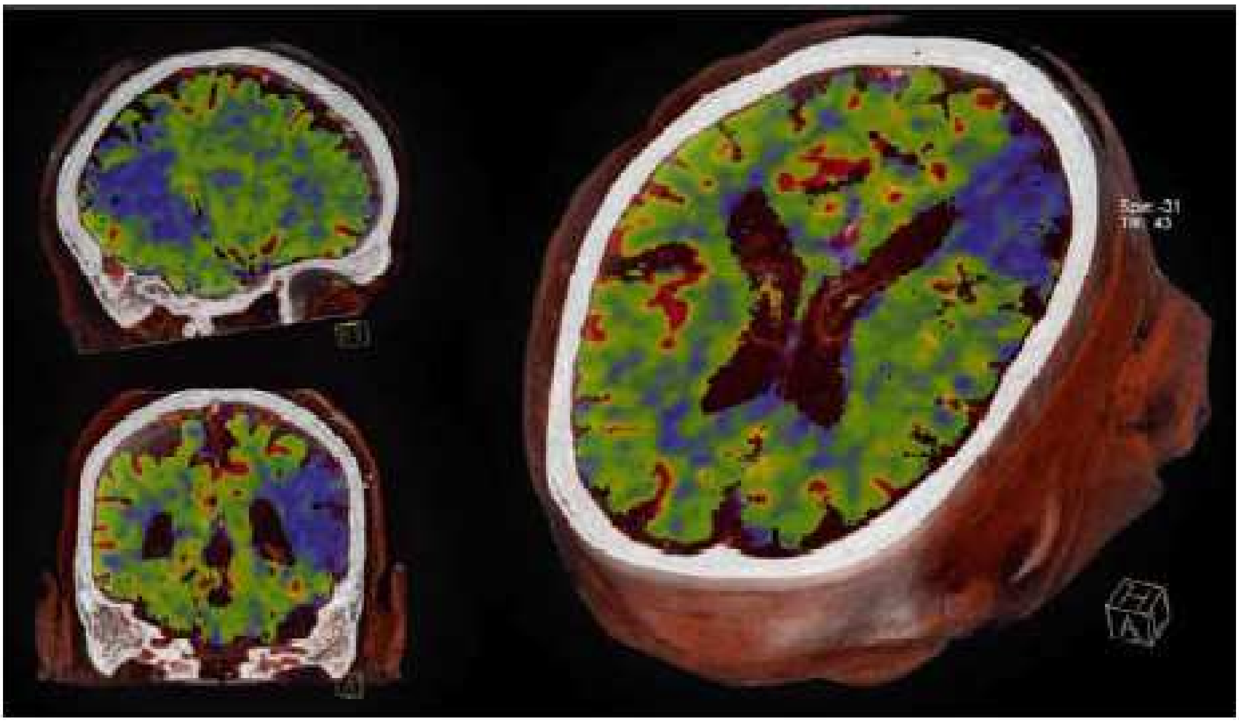

Figure 5 Perfusion scan of the whole brain on the device Siemens SOMATOM Definition AS+:

Configuration of detectors 128 x 0,6 mm and detector coverage 38,4 mm was carried out for perfusion scan of the whole brain in special spiral shuttle mode which uses sinusoidal movement of patient´s bed through the whole brain within 30sec. [6].

Prototype CT scanners use the technology of flat panel detectors originally used for conventional catheterization angiography. Their excellent spatial distinction as a consequence of small size of detector pixels predetermines them for clinical applications from ultra-high distinctive bone displaying through dynamic CT angiography study to functional examinations [11].

Conclusion

For correct interpretation of diagnostic images, it is inevitable to understand the principle of particular diagnostic methods and the principle of formation of their artifacts.

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Review process

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