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ERGONOMICS AND SECURITY AT IMES SYSTEMS

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Abstract: *The paper presents a brief history of the current situation on the part of ergonomics in automotive companies related IMES systems as well as key points from a process that highlights the importance of ergonomics procedures in a company. The ergonomics part is very important within the IMES systems because in addition to the management of the resources, management of the movements of the operators can be done. The integration of IMES and ergonomics is vital for the following reasons: Safety and Productivity, Quality Control and Sustainability. The integration of ergonomics and IMES enhances human performance and resource efficiency, hence supporting sustainable production practices in the automotive sector. The study also includes the maintenance part of an IMES system from an ergonomic point of view and comes with some recommendations in different maintenance steps.*

Key words: *automotive, IMES systems, security, sustainability*

1. INTRODUCTION

The term “Integrated Management and Engineering System” (IMES) refers to a full system that is used inside a company to manage and optimize different engineering and management processes. This system unifies various functional domains into a single platform, including project management, engineering design, production, quality control, maintenance, and resource management. To put it briefly, an IMES System is a full management tool that combines engineering and management techniques with the goal of improving production, quality, and efficiency across a range of industrial sectors.

Ergonomics, often known as human factors engineering, is the study of designing systems, environments, and goods with people's needs and abilities in mind. In the automotive industry, ergonomics plays a major role in enhancing driver comfort, safety, and overall driving experience. The material here covers the primary areas of ergonomics in automotive design, including visibility, controls, seating, and interior layout. It also includes some

recommendations for ergonomics procedures for IMES systems.

Ergonomic design of workspaces [1, 2] should consider the following aspects:

- Ensuring that workstations are ergonomically designed to reduce worker fatigue and improve operational efficiency;
- Implementation of adjustable and automated equipment to minimize physical exertion and prevent injuries;
- Operator training;
- Offering training programs to educate workers about good energy use practices and energy efficiency measures;
- Promoting an organizational culture that supports the responsible use of energy and the implementation of ergonomic measures.

2. IMES CONCEPT

IMES and their involvement in ergonomics can be analyzed from several perspectives, given that both areas aim to improve efficiency and quality of life in the industrial environment. The

following characteristics highlight this connection in particular:

A. Optimizing energy consumption: IMES have as their main purpose the optimization of energy consumption to reduce costs and minimize environmental impact. A well-designed ergonomic environment can reduce the need for overuse of energy equipment because work processes are more efficient and require less energy. For example, efficient lighting and ergonomic equipment can reduce the need for additional heating or cooling;

B. Improving Working Conditions: IMES provides reducing energy consumption and optimizing the use of equipment, IMES systems can help create a pleasant and safer working environment. An ergonomic working environment reduces fatigue, accident risks, and stress on workers, which can lead to a more efficient use of energy as equipment is used in a more sustainable way.

C. Waste and resource reduction: the implementation of IMES leads to better control of energy resources, reducing waste and unnecessary consumption. The ergonomically optimized design reduces waste by minimizing unnecessary movement and making efficient use of materials and equipment;

D. Productivity and efficiency: IMES systems provide effective energy management and contribute to increased productivity by reducing downtime and energy consumption during production breaks. Ergonomic improvements lead to greater work efficiency, reducing the time required for certain tasks and decreasing errors and accidents at work, which indirectly contributes to energy savings.

E. Innovation and Technology: IMES implementation advanced technologies for energy management can include automation and intelligent control of equipment. The use of advanced ergonomic technologies, such as exoskeletons or adjustable equipment, can contribute to better energy use by reducing physical exertion and the risk of injury;

F. Environmental impact: IMES is reducing energy consumption and using renewable resources to contribute to environmental sustainability. Ergonomic design contributes to a healthier and more sustainable work

environment, which can have a positive impact on the community and the environment.

In the following will be presented some examples of ergonomics procedures in the case of industrial energy management systems (IMES), including some ergonomic procedures that can be integrated into IMES:

- Ergonomic Workplace Assessment (Early identification of ergonomic problems can prevent workplace accidents and improve operational efficiency);
- Equipment and Machinery Optimization (Implement intelligent automation and control systems to optimize energy use);
- Ergonomic Workspace Design (An ergonomic workspace design can reduce the time and energy consumed to complete tasks);
- Efficient lighting (Proper lighting improves visibility and reduces eye strain, which can increase productivity and reduce energy consumption);
- Training of Workers/Operators (Workers trained in the ergonomic use of equipment can work more efficiently and safely, helping to reduce energy consumption);
- Continuous Monitoring and Feedback (Continuous monitoring allows for quick and efficient adjustments, improving both working conditions and energy use);
- Implementation of Relaxation Breaks and Exercises (Regular breaks and relaxation exercises reduce the risk of musculoskeletal injuries and increase workers' energy and concentration);
- Ergonomics of Control and Monitoring Stations (Operators working in optimal ergonomic conditions can monitor and control IMES systems more efficiently, optimizing energy use);
- Integration of Advanced Technologies (advanced technologies can provide innovative solutions to ergonomic problems and improve energy efficiency).

Some examples of using ergonomics procedures in the case of some automotive companies that have IMES are Toyota Company (Auto Assembly Plants) known for implementing Lean Manufacturing principles,

which include both energy efficiency and ergonomics. In addition, Ergonomics Procedures used in communication include:

- Kanban and Just-In-Time - These methodologies reduce unnecessary movements and the waiting time, contributing to the efficiency of processes.
- Adjustable Workstations - The assembly stations are adjustable to accommodate different workers' heights, reducing physical discomfort and preventing fatigue.
- Automation and Robotics - The use of robots for repetitive tasks reduces the physical effort of workers and optimizes the energy consumption of equipment.

In addition, the results obtained using the procedure can refer to:

- Increase productivity and product quality;
- Reduction of work accidents and worker fatigue;
- Optimization of energy consumption thanks to more efficient processes.

One of the best practices in the discussed field is Siemens Company, which implemented a comprehensive energy management and ergonomics program in a turbine plant. The ergonomics procedures used were:

- Workstation Analysis: Detailed evaluation of workstations to identify and eliminate ergonomic hazards;
- Ergonomic Equipment: Introduction of ergonomic tools and equipment for handling heavy components;
- Continuous Training: Training programs for workers on correct posture and efficient use of equipment.

The results achieved by Siemens Company refer to the following improvements:

- Reduce energy costs by optimizing the use of equipment;
- Improving workers' health and morale;
- Increase operational efficiency and reduce downtime.

Another best practice in the discussed field is of Bosch Company – Electronics Products Factory that integrated IMES systems with ergonomic procedures to improve efficiency and safety in its electronics factory. The ergonomics procedures used were:

- Efficient Lighting - Implementing automatically controlled LED lighting systems to ensure optimal lighting while reducing energy consumption;
- Modular Workstations - Creating workstations that can be easily adjusted to suit the individual needs of workers;
- Ergonomics of Movements - Optimization of workflow to minimize unnecessary movements and reduce physical effort.

The results obtained are:

- Decrease energy consumption by up to 20%;
- Reduction of accidents and musculoskeletal problems among employees;
- Increased productivity thanks to a more comfortable and efficient working environment.

Another best practice is by the General Electric Company (GE) - Avio Engine, Production Division - which applied a holistic approach to ergonomics and energy management in its aircraft engine factories. The ergonomics procedures used are:

- Exoskeletons for Workers - The use of exoskeletons to reduce heavy physical loads and prevent injury;
- Vibrating Tools with Dampers - The use of tools with vibration dampers to reduce physical stress on workers;
- Ergonomic Feedback - Continuous collection of feedback from workers to improve the design of workstations.

The results achieved refer to the reduction of physical effort and work accidents and improving the energy efficiency of production processes.

According to the practitioners and the literature, Toyota and Siemens have led to process optimization and 100% IMES (Industrial energy management systems).

3 IDEAL WORKPLACE DESIGN

Creating an atmosphere that increases output, reduces physical strain, and enhances workers' general well-being is the goal of ergonomic workplace design, especially for Integrated Management and Engineering Systems (IMES).

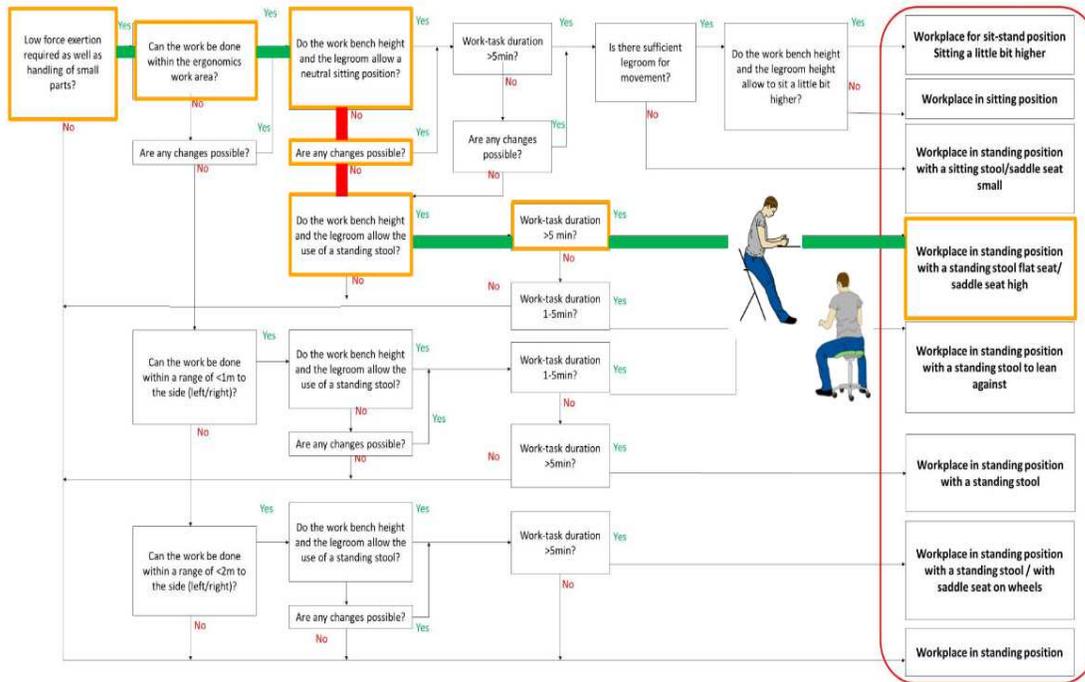


Fig. 1. Outlining an ergonomically ideal workplace.

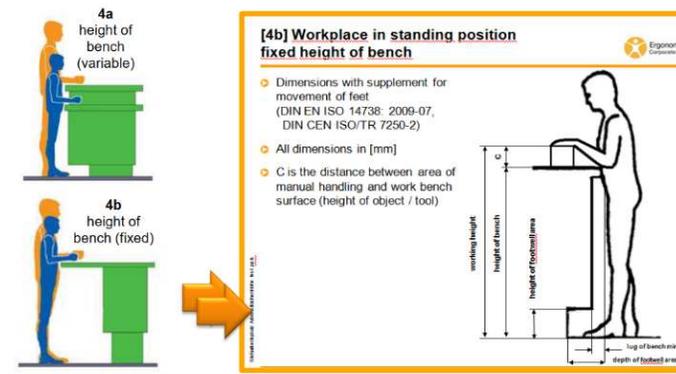


Fig. 2. Workplace standing position [12].

The main aspects are summarized in Fig. 1 with details given in Fig. 2. Designing an ideal workplace, particularly from an ergonomic perspective, is crucial for enhancing employee productivity, health, and overall well-being. In the case of IMES (Integrated Management and Engineering Systems), the focus on ergonomics can lead to a more efficient, safe, and satisfying work environment.

Ergonomics is the science of designing the workplace, keeping in mind the capabilities and limitations of the worker. Good ergonomic design removes compatibility issues between the work and the worker, leading to a safer and more

productive environment. An assessment of the workplace design is:

- Workstation Analysis - Evaluate the design of workstations to ensure they meet ergonomic standards.
- Employee Feedback - Collect feedback from employees regarding their comfort and any physical issues they may be experiencing.

Apply the following ergonomic design principles to create an ideal workplace: (a) adjustable furniture (use adjustable desks and chairs to accommodate different body sizes and shapes); (b) proper chair design (chairs should support the lower back, and the seat height

should be adjustable) and (c) desk layout (desks should have enough space for all necessary equipment and be designed to reduce the need for awkward postures).

3.1 Workplace in Standing Position

Remember the height of objects that are processed and the height of the assembly device. Referring to posture and movement, the following aspects should be considered [6, 7]:

- Neutral Posture - Promote neutral postures to reduce your risk of strain. This entails having your knees approximately hip level, your feet flat on the floor, and your backrest supporting your lumbar curve;
- Frequent Movement - Encourage staff members to move around during brief breaks and to swap positions often.

When typing, the height of the bench should allow the forearms to be parallel to the floor. The elbows should be at a 90–100-degree angle and near to the torso.

Remind staff members on a regular basis to keep proper posture. Ergonomic flooring, sit-stand workstations, and posture-correcting gadgets are examples of useful tools.

3.2 Operating Distances

In the context of Industrial Energy Management Systems (IMES), operating distances denote the geographic separation between various system components, including sensors, controllers, and monitoring units. From the perspective of the operators, efficient management of these distances is essential to guaranteeing data integrity, dependable communication, and overall system performance.

Maintaining data integrity, guaranteeing dependability, and maximizing performance all depend on the efficient management of operating distances in IMES. Operators can create reliable systems that satisfy the requirements of contemporary industrial energy management by considering factors like maintenance requirements, data security, latency, and communication dependability. The utilization of techniques like edge computing, hierarchical networks, and predictive

maintenance can augment the effectiveness and expandability of these systems.

Reaching areas for assembly routines under consideration of min/max body measurements.

1. Reaching area, both hands can be seen, both hands are close to each other, zone for assembling and quality control;

2. Advanced reaching area, both hands can be seen, any point within the zone can be reached with both hands;

3. One-hand reaching area, to place workpieces which can be reached with the right or left hand;

4. Advance one-arm reaching area, beyond other areas and can be used for e.g. drawers.

Operating Distances can be split into the areas of two zones (Fig. 3):

Primary Reach Zone: This is the area that frequently needs to be reached and where controls and tasks should be placed. It encompasses an area of the worker's body of approximately 38-50 cm. To reduce needless movements, controls, often used tools, and keyboards should be positioned inside this area.

Secondary Reach Zone: This zone reaches up to approximately 63–76 cm past the primary reach. It works well for things that are used seldom, such controls or reference materials that are not usually accessible.

The four operating zones/areas are well explained and depicted in Fig. 3 and Fig. 4. The zone includes also recommendations regarding the distances between operators and IMES system (workstations).

3.3 Operating Distances: Horizontal Alignment of Displays/Work Objects/Tools/Actuators

To provide the best possible efficiency, safety, and ergonomics when examining the horizontal alignment of displays in Industrial Energy Management Systems (IMES) from the operator's perspective, several crucial elements need to be considered (Fig. 5):

A. Important and often used actuators;

B. Important displays and rarely used work

objects, storage area for often used tools and material;

- C. Additional displays and rarely used work objects, storage area for occasionally used tools and material;
- D. Rarely required displays and very rarely used work objects, storage area for rarely used tools and materials;
- E. Rarely required displays and very rarely used work objects.

In addition, the following aspects should be considered in the ergonomics design approach [8, 9]. To minimize neck strain and promote comfort, displays should be positioned within the ideal viewing angle, which is normally between 15 and 30 degrees below the horizontal line of sight (ergonomics of viewing angle). The distance between the operator and the display should be small enough to allow for easy reading of the text and images without straining the eyes. This typically ranges from 20 to 50 to 100 cm, depending on the resolution and size of the display.

In optimized movements, an operator should consider the recommendations in figure 5, and the tools used should be positioned according to the importance of their use according to the recommendations of the 3 zones (I, II, III). Vertical Alignment of Displays/Work Objects/Tools/Actuators:

- I. Important displays;
- II. Actuators and additional displays;
- III. Rarely used displays, work objects and actuators.

Employees can sustain longer periods of comfort and productivity by maintaining a more natural posture when displays are ergonomically adjusted.

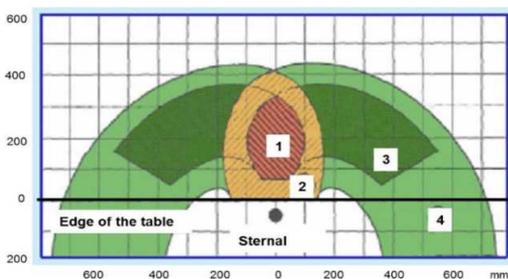


Fig. 3. Operating distances

Fig. 6 and Fig 7 show an example of good practice and bad practice from an ergonomic point of view for an operator handling an IMES system.

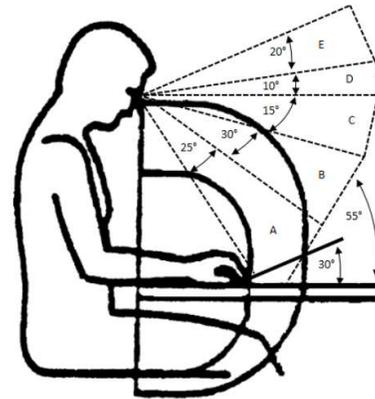


Fig. 4. Operating Distances: Horizontal Alignment of Displays/Workstation.

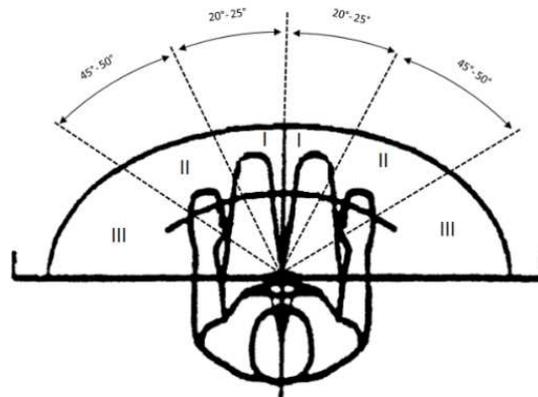


Fig. 5. Vertical Alignment of Displays/Workstation [12].

The displays' user interface (UI) should have a simple, user-friendly design with a distinct visual hierarchy and no clutter. The following aspects should be considered:

- Centralized control - Assign central location to the most important and often used controls and displays;
- Information layered - To ensure clear visibility, use many display layers, if necessary, with primary data on the front layer and supplementary data on the back layer;
- Eye-level placement - To lessen strain, position the center of the primary display at eye level;
- Smooth transitions - Make sure there aren't any gaps or physical obstacles in the way of fast data access while switching between displays.

4. ERGONOMICS OF MAINTENANCE

It is essential for high level performance of the system to do regular maintenance in

accordance with the manufacturer's instructions. This will prevent unplanned downtime.

Table 1 shows the daily maintenance with tasks for each item [11]. The maintenance of an IMES can be adjusted for system efficiency as well as the health and productivity of the human operators who use it by taking certain ergonomic

considerations into account. From an ergonomics standpoint, maintaining an IMES is all about maximizing the way that human operators and the system interact to maximize productivity, decrease error rates, and reduce mental and physical stress.

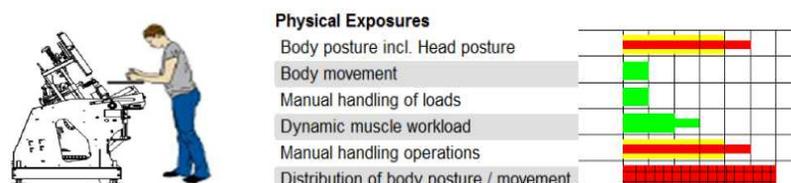


Fig. 6. Bad example of position [12].

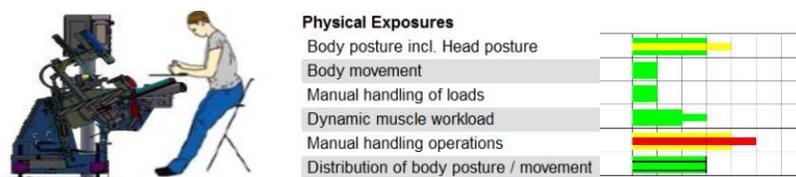


Fig. 7. Good example of position [12].

Table 1

Assignment of maintenance.

Item	Maintenance	Action
Fixture	Clean and remove dust from parts: Check the vacuum holes for tightness	Use damp cloth / vacuum cleaner / No compressed air Push the blocked hole with a needle through
Thermodes	Remove contamination: Check plan parallelism:	Thermode cleaning module 61W0002; Polishing disk 69C0000 / Use pressure paper 67W0003 or use low pressure paper; 67W0023
Control box	Clean and remove dust from parts	Disconnect the system from power supply; Use clean cloth (and tweezers).
Thermode head	Clean and remove dust from parts:	Disconnect the system from power supply; Use damp cloth
Power supply	Clean and remove dust from parts:	Disconnect the system from power supply; Use damp cloth
Emergency control system		Make sure the complete system is connected to the power supply and in standby press every EMO button and check it activated safety. Reset EMO button & initialize (standby). Repeat for all button's
		Press all emergency stops push buttons in sequence.

In Table 1 are presented the item and the type of maintenance of a workstation, the workstation is an IMES system.

The workstation is an IMES one because it is a software-based system used in manufacturing to monitor, track, document, and control the production process in the factory where it is used. It integrates various aspects of production, such as machine performance, inventory management, quality control, and production scheduling [11].

5. CONCLUSION

The points that need to be clarified regarding ergonomic protocols for IMES systems are compiled in this study. The paper briefly presents some examples of procedures implemented in a few automotive companies highlighting ergonomic procedures for IMES systems. The maintenance from an ergonomic point of view of an IMES system is also included in this study, are presented some steps of maintenance in concordance with the items of

the workstation (IMES system). Some examples of the good or bad position of the operators of the IMES systems are presented and operating distances in case of workstations that are Integrated Manufacturing Execution System (IMES).

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Ergonomie și securitate la sistemele IMES

Lucrarea prezintă un scurt istoric al situației actuale în ceea ce privește ergonomia în cadrul companiilor din industria automobilelor în legătură cu sistemele IMES, precum și punctele cheie ale unui proces care evidențiază importanța procedurilor ergonomice într-o companie. Partea de ergonomie este foarte importantă în cadrul sistemelor IMES deoarece, pe lângă gestionarea resurselor, se poate face și gestionarea mișcărilor operatorilor. Integrarea sistemelor IMES și a ergonomiei este vitală din următoarele motive: siguranță și productivitate, controlul calității și durabilitate. Integrarea ergonomiei și a IMES îmbunătățește performanța umană și eficiența resurselor, sprijinind astfel practicile de producție durabile în sectorul automobilelor. Studiul include și partea de mentenanță la un sistem IMES din punct de vedere ergonomic și vine cu câteva recomandări în diferiți pași de mentenanță.

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