Human Factors Safety Information

Prepared by the Safety Advisory Council

Safety Info HF 12/12

Task - Human Factors in Design

Human Factors Engineering is the application of human factors to the design and development of systems and services.

Ergonomics is about ensuring a good 'fit' between people and the things they use. People vary enormously in height and weight, in physical strength, in ability to handle information and in many other ways. Ergonomics uses information about human abilities, attributes and limitations to ensure that our equipment, work and workplaces allow for such variations.

Learning more about human factors in design

Human Factors Engineering (HFE)

Are any of the following aspects considered in the design of areas where people work or of the systems, services and equipment they use:

- Layout of controls, displays and operating panels?
- User interfaces to computing facilities? e.g. screen designs; provision of functionality to the appropriate users?
- Location and layout of workstations or consoles?
- Workplace layouts (e.g. control rooms; maintenance spaces, plant layout)?
- Design, location and layout of maintained equipment (e.g. maintenance access; ease of maintenance)?

Health Hazards

Has the potential for the following hazards been identified and have measures been included to eliminate or mitigate them and protect personnel from them?

- Chemical hazard
- Electrical hazard
- Mechanical injury
- Musculoskeletal injury (e.g. heavy lifting; repetitive movement)
- Extreme heat or cold
- Optical hazards
- Electro-magnetic radiation

EUROPEAN INDUSTRIAL GASES ASSOCIATION *AISBL*
AVENUE DES ARTS 3 – 5 ♦ B-1210 BRUSSELS
PHONE +32 2 217 70 98 - FAX + 32 2 219 85 14 - E-mail : info@eiga.eu - www.eiga.eu

- Vibration
- Noise
- Thermal comfort
- Radiation
- Stress
- Biological hazard

System Safety

Has human factors input been included in safety management activities?

Have task analyses been provided as input to hazard analyses?

Has the human involvement in safety critical tasks been identified?

Has the potential for human failure been identified?

Has the impact of external factors on human performance been identified (e.g. environment. workload)?

Has the potential for equipment misuse or abuse been identified?

If the answer to any of the above is 'no', then you need to take action!

Human factors in design

The design of control rooms, plant and equipment can have a large impact on human performance. Designing tasks, equipment and work stations to suit the user can reduce human error, accidents and ill-health. Failure to observe ergonomic principles can have serious consequences for individuals and for the whole organisation. Effective use of ergonomics will make work safer, healthier and more productive.

The earlier that consideration is given to human factors and ergonomics in the design process, the better the results are likely to be. However, it is important to use human factors and ergonomics expertise correctly and at the right time. People with knowledge of the working processes and of the end user should be involved. For that reason, user involvement is key to designing operable and maintainable plant and systems.

Poor design contributes to work-related ill-health and has also been found to be a root cause of incidents.

Ergonomics

Knowing that you have an ergonomic problem

If you look at the circumstances surrounding incidents and near misses in your workplace you may find problems such as people being:

- unable to see important displays;
- unable to reach controls;
- unable to work in a comfortable position;
- overloaded with too much information at one time;
- inattentive because there is too little to do.

The people who do a particular job are in a good position to identify especially awkward or difficult tasks, but remember that they may also have become used to a poor design.

Some jobs may be extremely tiring or liable to cause aches and pains. Observation of how

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	people actually use equipment can highlight ergonomic problems. Temporary and imperfect modifications or adaptations to equipment such as lengthened levers, extra labels on switches, blocks of wood or cushions used to alter working positions etc, can be a sign that the design of the equipment or of the job or task needs attention. Medical and sickness absence records may reveal patterns of injury or complaint that could be associated with particular jobs or tasks.
Work environment	The work environment can impact on a person's performance in a number of different ways including: • effects that damage health (heat stress, musculoskeletal disorders); • effects that reduce the individual's ability to perform a task (poor lighting, distraction); • effects that cause dissatisfaction, resistance to change and uncooperative attitudes ("if management think so little of us why should we …").
Lighting	At its simplest, different levels of lighting are required for different types of work – close, accurate work such as soldering a control panel will require higher light levels than walking along a corridor. However, when considering lighting for specific tasks or activities, a number of different factors need to be considered such as colour, contrast, glare etc.
Thermal comfort	Extremes of temperature (very cold or very hot) can put physiological stress on an individual. Lack of control of the temperature of a workplace (e.g. in an open plan office) can lead to job dissatisfaction and increased incidence of stress and long term sickness absence.
Working space	Work rooms or areas should have enough free space to allow people to move about with ease.
Noise	When assessing a task, employers should also consider whether noise might interfere with safety-critical communications. Exposure to high levels of noise can increase individual experience of stress. In addition, even relatively low noise levels significantly above background or ambient level and experienced over long periods may lead to the same effect.
Vibration	Whole body vibration (such as experienced in vehicle cabs) can contribute to lower back pain and fatigue. Some frequencies of vibration can have a negative effect on visual performance. Relatively uncommon effects of low frequency vibration (infrasound ~ 7Hz) can include throbbing in the head and temporary depressed psychological states.

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What should my company do about it?

Management need to act on problems caused by bad ergonomics or workplace conditions and improve working conditions and equipment. But, people working with poorly designed devices do get used to them and 'adapt'. Managers should get specialist advice and decide whether to change such systems or 'leave well alone'.

Workplace risk assessments (including display screen assessment, manual handling assessment, chemicals risk assessment etc.) will help in the design aspects of safer workplaces. A risk assessment is simply a careful examination of what, in your work activities and tasks, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm. Workers and others have a right to be protected from harm caused by a failure to take reasonable control measures.

Users should be involved in the design process. This should include different types of users including operators, maintenance workers and systems support personnel.

Some aspects that need to be considered including musculoskeletal problems; problems with displays; problems with controls; workplace and working environment; problems with hazardous substances are discussed below.

Musculo-skeletal problems

Musculoskeletal problems are aches, pains and other discomfort arising from physical work, often where power tools are used. The terms 'Repetitive Strain Injuries' (RSIs) and 'Work Related Upper Limb Disorders' (WRULDs) are also used.

The company should:

- ensure that equipment is fit for use and does not produce excessive strain or vibration;
- where equipment cannot be changed, provide additional protection or support equipment to reduce the problem;
- review tasks that force or encourage employees into an uncomfortable posture for long periods (stooping, kneeling, crouching, twisting, stretching, bending etc.);
- where heavy or awkward loads need to be lifted and carried, schedule work and rest breaks to minimise any negative health effects caused by equipment operations.

Problems with displays

A display is any device that provides information to the operator. Displays are mainly 'visual' and include status lights; dials; digital readouts; pen recorders; visual display unit screens and mimic boards. 'Audible' displays are pre-recorded messages or tones. *Note that the advice given here is similar to that for controls*.

The company should:

- provide the correct type of display for the information to be passed (e.g. not a 'pointer and dial' if you need to take an exact reading - a numeric display would be better for this);
- ensure displays work as the user expects them to (e.g. a pointer moving

clockwise or to the right means an increase in flow, temperature or pressure etc);

- group displays logically (i.e. put all the displays for one system near to each other and in the order they are to be used);
- put the display devices near to any associated controls (e.g. if a control increases flow, put it adjacent to the flow gauge);
- label each display and use colour or other coding to enhance displays (e.g. show danger zones on dials, but don't rely on this as the only warning of danger).

Problems with controls

A control is anything that is used to operate a system (switches, levers, handles, wheels, knobs, sliders, keyboards, joysticks, etc.).

The company should:

- provide the correct type of control for the job to be done (e.g. a foot pedal if a lot of force needs to be applied, switches or selector knobs for making settings);
- ensure controls work as the user expects them to (e.g. pushing a switch down turns the machine on, turning the wheel on a valve anti-clockwise opens it). Exceptions, e.g. reverse threads, should be made clear;
- group controls logically - put all the controls for one system near to each other and arranged in the order they are to be used and according to frequency of use, if possible;
- put controls where they can be easily reached and operated: protect any that should not be accidentally operated - cover with a flap, put in a recess or make the operation a double action (e.g. release with a key then turn);
- label each control so that it is clear what it does and what the movement is required to operate it (e.g. 'Emergency Shut Down'; 'open flap and push down to operate'). Use appropriate colour coding, e.g. red buttons to stop;
- Consider human factors in alarm handling.

Workplace and working environment problems (physical work space and conditions)

The company should:

- control temperature - not too warm to cause drowsiness and not too cold to affect use of tools or equipment;
- control air movement - to provide fresh air and cooling if needed;
- control vibration - to prevent annoyance, injury or effects on vision;
- control lighting - not too dark to see but not too bright to cause 'glare' (bright spots);
- control noise - to allow good communications and reduce annoyance;
- control workspace - not too cramped to cause discomfort or injury, (e.g. where using PPE or other safety equipment) and position equipment within easy reach and not spread over a large area.

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Problems with hazardous substances

Most businesses use substances, or products that are mixtures of substances. Some processes generate substances. These could cause harm to employees, contractors and other people. Sometimes substances are easily recognised as harmful. Common substances such as paint, bleach or dust from natural materials may also be harmful.

The company should:

- find out what the health hazards are;
- decide how to prevent harm to health by doing risk assessments;
- recommend less hazardous substances or provide control measures to reduce harm to health and make sure they are used;
- keep all control measures in good working order;
- provide information, instruction and training for employees and others;
- provide monitoring and health surveillance in appropriate cases;
- plan for emergencies.

Problems with plant design

The company should:

- design equipment in accordance with key ergonomics standards including EN614 Parts 1 and 2;
- design control rooms in accordance with key ergonomics standards including EN11064, EEMUA 191 and EEMUA 201;
- design plant and processes for operability and maintainability and other elements of the life cycle should not be neglected e.g. decommissioning;
- consider all foreseeable operating conditions including deviations and emergencies;
- consider the interface between the end user and the system.

Useful Reference Information

1. Health and Safety Executive - Safe use of work equipment: Provision and use of work equipment regulations 1998 Approved code of practice
2. Health and Safety Executive, Reducing Error and Influencing Behaviour, HSG48, 2007, HSE Books ISBN 978-0-7176-2452-2
3. Health and Safety Executive - Upper limb disorders in the workplace HSE HSG60
4. Health and Safety Executive - Manual handling: solutions you can handle HSE HSG115 8.
5. Institute of Petroleum, Ergonomics, Human Factors Briefing Note No 8, 2003.
6. EIGA, Task Alarm Handling, Human Factors Safety Information HF 08 –
7. EIGA, Maintenance Error, Human Factors Safety Information HF 05
8. EIGA, Task - "Fatigue from working patterns - Shiftwork and overtime" , Human Factors Safety Information HF 09

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