

# Editorial

## ISO standards on physical environments for worker performance and productivity

This editorial describes the exciting new initiative to develop a series of international standards on the effects of the physical environment on human performance. The initiative is early in the standards development cycle, however proposals have been made to provide direction. The proposals are described below but much has yet to be decided by international contribution and the reader is requested to consider how such standards might be best formulated to serve their own subject and area of application.

It is the experience of all people that the physical environment (heat, cold, noise, vibration, air quality etc.) can influence their health, comfort and performance at tasks. International standards have been developed to protect workers' health from extreme environments<sup>1,2</sup>) as well as to specify conditions for comfort and predict the degree of discomfort<sup>3</sup>). There is however no comprehensive system of international standards for predicting how a physical environment can affect human performance. That is, despite extensive research<sup>4–13</sup>), much interest and clear economic benefits as well as implications for worker safety.

There are many examples where components of the physical environment can influence human performance. Noise can interfere with signals and auditory communication or cause distraction<sup>14</sup>); people who are cold can have reduced hand skin temperature leading to numbness and reduced ability to pick up small objects<sup>15,6</sup>); poor air quality can influence office work<sup>16</sup>); whole-body vibration can reduce visual acuity as well as the ability to track objects using a control<sup>17,18</sup>); and hand-arm vibration can reduce the threshold for touch on the hands<sup>10</sup>). Some ISO standards have considered human performance in a simple way. ISO 2631 (1985)<sup>19</sup>) considered levels of vibration that produce 'fatigue decreased proficiency' (not included in later versions of the standard); ISO 7731 (2003)<sup>20</sup>) describes levels of noise in relation to auditory signal interference; and ISO 13732-3 (2005)<sup>21</sup>) provides skin temperatures that on

contact with cold surfaces will reduce manual dexterity and cause pain and numbness. These are simple, first order methods. The intension of the new ISO initiative is to provide a more comprehensive and systematic approach to the subject.

The ability to specify physical environments that are optimum for human performance and lead to maximum productivity are of great economic interest. The cost of providing appropriate physical environments may be greatly out-weighed by the benefits of greater productivity<sup>22,13</sup>). It may also lead to greater worker satisfaction and safety (reduced absenteeism and accident rates).

It is of interest therefore to consider why a series of ISO standards on human performance in physical environments has not been produced. One answer is the concentration on health in extreme environments in industrial work, and comfort, to specify conditions required in buildings throughout the world. Another reason is that predicting the effects of the physical environment on human performance involves a number of contextual, social and individual factors that are not easily quantified but are highly influential. It is recognised for example that individual and group motivation to perform is important. This will be greatly affected by personal incentive, management style and leadership, which may be dominant in determining performance even where physiological capacity is reduced and environmental limits have been exceeded (not recommended for safety). Distraction may also be reduced as a motivated person may be less distracted. It should also be remembered that physical environments can also provide pleasure. A pleasant environment may increase motivation. Whether pleasant or not, physical environments may also improve performance, by providing stimulation even in extreme environments.

To take these factors into account, along with the often intricate nature of the physical environment, may be too complex to provide simple guidance in the form of an ISO standard. Additional factors for example will include the level of skill and experience of the person doing the task<sup>23</sup>) and the percentage of their workload capacity a person has

available. If when performing the task a person is close to his or her workload capacity then an additional stressor caused by the physical environment may act as an increase in workload and over-load the person with consequent loss in performance. A final point is that it may be considered that dividing work into simple tasks (the so-called reductionist approach<sup>12)</sup> is never representative of realistic complex and continuous conditions. In other words general guidance will not be possible.

Partly for this reason, and as an often used prudent approach to a new area, the ISO proposal is to produce two Technical Reports in the first instance. If the reports are found useful then they will be converted to full international standards at a future date. The two proposed Technical Reports are intended to be produced by 2020 and are entitled:

*ISO ???–1: Human performance in physical environments: Part 1-A performance framework.*

*ISO ???–2: Human performance in physical environments: Part 2-Measures and methods for assessing the effects of the physical environment on human performance.*

ISO TC159 SC5 is concerned with the development of ISO standards in the area of the ergonomics of the physical environment and its working group 4 (WG4), concerned with integrated environments, has proposed the new initiative on human performance. It has current expertise in the area which should be enhanced when new participating international experts are identified for the new work. An invitation has been sent to ISO member countries but experts should contact their national standards institutes, directly, if they wish to participate or express views. A first meeting to discuss the proposal for the Technical Reports was held in Chongqing in China in November 2017 and with suggestions and modifications made by international experts, a proposal has been made to the ISO for new work items.

A strategy for the production of international standards was agreed where experts concerned with total or integrated environments (ISO TC 159 SC5 WG4) will provide a structure within which to consider human performance in physical environments (Part 1) and how to measure that performance (Part 2). These two documents can then be used as a basis and starting point for the production of international standards in specific areas of the physical environment such as cold environments, noise, lighting etc.

The structure is described in a framework in Part 1. The initial proposal for the framework is to consider three main practical reasons why a physical environment might influence human performance. These are the interference of the physical environment with *human function* or activity, the *distraction* caused by the physical environment, and hence related to time off the task and work, and the time involved in *suspended work* due to physical environments beyond those of environmental limits for health and safety. Three linked concepts are proposed as outcomes. The influence of the physical environment on *capacity* to carry out activities, the influence on *task performance* and the effects the physical environment will have on *productivity*. The following draft definitions are provided which are likely to be modified during the development of the Technical Report.

**Human Function**—The capacity of a person to sense a stimulus, process information or carry out an action.

**Distraction**—The tendency for a person to attend to a stimulus resulting in time away from a task or job.

**Stimulus**—A physical environmental input to a person.

**Human Performance**—The extent to which a person carries out a task or a combination of tasks.

**Productivity**—The amount a person, group or organization produces.

## Human Function

There are many ways in which human function can be described and it must be remembered that the human body acts in harmony with a large number of systems to even complete a simple task. Hence a task taxonomy is never perfect. The proposal in the Technical Report is to divide human performance into four areas of performance – cognitive; Perceptual-motor; Manual; and sensory. With the following sub-divisions.

### *Cognitive performance*

Attention; Vigilance; Signal detection; Learning; Logical reasoning; Memory; Decision making

### *Perceptual-motor performance*

Tracking

### *Manual performance*

Fine dexterity; Gross motor performance; Lifting and handling; Endurance;

### *Performance of sensory organs*

Vision; acoustic; touch; balance; taste; smell.

Part 2 of the series of standards will be a technical report in the first instance. It will be developed after or in parallel with part 1 and will describe how to measure the effects of the physical environment on human function and perfor-

mance and relate it to productivity. Requirements for measurement methods will be provided as well as examples of standard tasks that can be used to measure each of the elements of the framework provided in part 1. When both Technical Reports are complete they will provide guidance and a starting point to standards makers so that they can adapt the information to their own area and context of the physical environment. The final outcome in years to come will be a series of complementary standards that will support the creation of safe and productive industrial and other environments.

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‘Ergonomics of the Physical Environment-Integrated Environments’