European standards and risk assessment for MSD: challenging the future

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The early days of standardisation for MSD

In 1985, CEN[1] set up a specific Technical Committee on Ergonomics (CEN/TC122) with the backing of Technical Committee 114 Safety of Machinery. In 1988, the "Biomechanics" Working Group held its inaugural meeting in Nijmegen in the Netherlands. The EU's Manual Handling of Loads Directive (90/269/EEC) was in the pipeline, and it seemed a good way to use the standardisation process to push through a risk assessment method for manual handling. The Netherlands (Netherlands Standards Institute, NNI) offered to supply the secretariat and convenorship. In 1990, the European Commission's DGIII and CEN/TC122 decided to change the Working Group's remit from "health and safety at work" to "safety of machinery" under the Machinery Directive (89/392/EEC)[2]. In 1993, three parts of prEN 1005 were sent out for first public enquiry. This produced a demand for more emphasis on machinery design and taking account of key A-standards on machinery that had been published in the meantime. The approach and requirements of these standards are now included in the new four parts of prEN 1005. (Comments on the first three parts were canvassed in the second public enquiry in December 1998; the first enquiry on part four opened in November 1998).

Ergonomics experts and work-related musculoskeletal disorders

Experts from thirteen European countries (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Spain, Sweden and United Kingdom) are involved in drafting these standards on manual handling, recommended forces, evaluation of working postures and repetitive handling at high frequencies. They are all ergonomics practitioners, but with different scientific backgrounds and practical experiences: economics, industrial organisation, occupational health, occupational psychology, physiotherapy, biomechanics, applied mechanical engineering, kinetics and industrial design.

The main issues on which we had to harmonise our different approaches to reach a consensus were:

- *ergonomics*: fitting the job to the user or the user to the job?
- *gender*: is it enough for the Machinery Directive's essential safety requirements to envisage only male workers, or should we try and accommodate male and female user equally? Why not combine both sets of gender requirements? Are we protecting women or encouraging discrimination? These issues triggered off an ethical, practical and philosophical discussion about equity, equality and risk assessment;
- *legal status of harmonised standards*: how to accommodate potential discrepancies in the status of standards stemming from differences between national legal systems;
- *state of the art*: how to incorporate different scientific and practical approaches, such as publishing in international literature or the direct application of research findings in guidance and standards.

Although the task of CEN Working Group experts is to work out a consensus document which reflects the state of the art in science and practice, individual experts normally argue the "position" in their own national standards committees which in turn often act as a mirror group for European standardisation. Developing standards for "human physical performance" as part of CEN's machinery safety standards programme remains quite a challenge. Better communication and understanding between ergonomists, machinery safety and machinery designers is still essential.

Machinery Directive and human performance

The Machinery Directive expressly requires safety to be designed into machinery. Machinery manufacturers must take into account the capabilities of operators and incorporate both physical an psychological aspects. Discomfort, fatigue and psychological stress faced by the operator must be reduced to the minimum possible taking ergonomic principles into account[3].

The prEN 1005 series includes methods to enable machinery designers to make a risk assessment. These standards have to present the available information on human physical performance, not just for

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[1] CEN: European Committee for Standardisation, Rue de Stassart, 36, B-1050 Brussels

[2] 89/392/EEC and latest version including several amendments: 98/37/EC

[3] 89/392/EEC, Annex I, 1.1.2.d: "Under the intended conditions of use, the discomfort, fatigue and psychological stress faced by the operator must be reduced to the minimum possible taking ergonomic principles into account."

selected future users, but as much as possible for all occupational and domestic users. It is for designers and manufacturers to make the risk assessment and decide which part of the market their product is intended for. The results of the risk assessment should be clearly described.

Second Enquiry for prEN 1005 Parts 1, 2 and 3

Part 1 presents the relation between physical performance parameters (body dimensions, postures and movements, force requirements) and different ergonomic standards (EN 547-1-2-3, EN 894-3, EN 1005-2-3-4). Terms and Definitions (like *action, general working population, grip of object, manual handling, operator, recovery time, rest, risk assessment, shift*, etc.) used other parts are given.

Part 2 presents a risk assessment approach on manual handling for machinery manufacturers. Eliminating the hazard by excluding the need for manual handling is the first "solution". If there is no alternative to manual handling, a risk assessment must be performed.
The main risk factors for *machinery/objects* (e.g., mass, size, grip/handles, etc.), the *operator-machine interface* (distances from the body, frequency of operation, working postures, etc.) and *environmental hazards* (like vibration, climate, temperature, etc.) are described. Machinery design recommendations to achieve a low level of risk for manual handling are given.
If these ergonomic criteria are not met, a risk assessment must be performed. The standard offers three methods, all with the same basis but differing in complexity of application. Each contains three steps:
- consider the mass constant in relation to the intended user population;
- assess the risk factors;
- identify the action required.

Work sheets are included to facilitate the procedure. The risk assessment methods are an amalgam of existing NIOSH methods, research results, literature and the experts' own experiences. They are to be used by designers and experts and reviewed for feedback to make future improvements. A follow-up study could be very useful.

Part 3. The main recommendation on force application is that the operator should have control of the operating sequences and pace of the machinery. The machinery must also be designed in a way that actions demanding force exertion can be performed optimally with respect to the body and limbs and the direction of force application. Recommendations are given to act on the factors affecting risks, like working posture, acceleration and movement precision, vibration, man/machine interaction, personal protective equipment and external environment (temperature, lighting).

The risk evaluation is based on the assumption that decreasing fatigue during work helps reduce musculoskeletal disorders. A three-step risk assessment model is described. The first step is to establish, for relevant actions, the maximal isometric force generating capacity of intended users (Step A). This force is reduced according the circumstances under which it is generated (velocity, frequency and duration of action) by a set of multipliers, until it may be delivered without substantial fatigue (Step B). The maximal attainable force is then reduced to values associated with the different zones of risk (recommended, not recommended, to be avoided) during the intended use of the machinery (Step C).

First enquiry for part 4 of prEN 1005

A five-step design process flow chart is given (establish the user population, perform a task analysis, identify the ergonomic data required, evaluate at the drawing-table/CAD-screen, evaluate with users). The standard presents figures and tables with working postures and movements divided into three categories (acceptable, conditionally acceptable and not acceptable). The risk evaluation is based "on the U-shaped model" which proposes that health risks increase when the task approaches either end of the curve, i.e. if there is little or no movement, or if movement frequencies are high (i.e. 2 per minute or more).

These standards represent the current state of progress in some areas of ergonomics and prevention of MSD, and could be helpful tools for improving the safety of machinery.
Collecting practical experiences on the use of these standards would be the first step towards their further improvement. ■

Key European MSD standards under development in the framework of the Machinery Directive:

- **prEN 1005-1:**
Safety of Machinery
Human physical performance
Part 1: terms and definitions
- **prEN 1005-2:**
Manual handling of objects associated to machinery
- **prEN 1005-3:**
Recommended force limits for machinery operation
- **prEN 1005-4:**
Evaluation of working postures in relation to machinery
- **prEN 1005-5:**
Risk assessment for repetitive handling at high frequency