Development of field and laboratory ergonomic investigations in South Africa

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Introduction
Having been directly involved in ergonomics in industrially developing countries (IDC) for 20 years, initially in South Africa and then at a more global level, it is most encouraging to witness the significant progress that has taken place particularly over the past five years. However, there is still a great deal to be done in order to establish acceptable working conditions, and to enhance worker safety and well-being for the millions of manual labourers who suffer from occupational diseases and injuries as they are pushed to the limits of their capacity on a daily basis. Ergonomics can, and must play a greater role in assisting developing regions to actively rectify these often appalling working conditions and to improve job security and job satisfaction for the workers.

However, before one can amend any situation one needs to have an accurate evaluation of the predicament of industries as a whole, and of the sub-sections within individual industries. These assessments can be conducted on site and/or within a laboratory setting where a problem task is simulated. While the general concepts put forward in this article are relevant to all IDCs (with local modifications), the experiences and examples used to explain the manner in which rigorous and meaningful information can be acquired, are from South Africa.

Awareness into action
Although some exceptionally good work has been carried out in isolated pockets in most IDCs over the last 30 to 40 years, it is only since the nineties that there has been an international drive to establish ergonomics as widely as possible. The result is that there is clearly a more general awareness of ergonomics, but the practical application of ergonomic principles is far less global. More action within the workplace still needs to be promoted and guided by ergonomics ‘experts’, who not only have the scientific knowledge, but are also sensitive to the conditions and needs of the country in which they are working. It is essential that idealistic theories are modified and applied in the field before ergonomics will be of benefit to the local working populace in their specific region.

Field evaluations
If we accept that ergonomics is about the interaction between the human operator and the task requirements, the ‘man-machine’ interface put forward by Grandjean in 1986 (1), and where a discord is so clearly evident in most IDC situations, then it is necessary to investigate any problem area by assessing the actual worksite, and investigate the specific situation in conjunction with the many extraneous local factors which...
may influence this interaction between the two key components in all worksites. In recognizing the need to take cognizance of the in situ realities at the ‘coal-face’, over the last several years in South Africa there has been an increase in field-laboratory investigations conducted in various local and multi-national, small and large industries and mines around the country.

Initially ergonomists tend to be called in to address a specific problem, and in order to demonstrate immediate and obvious improvements, a ‘micro-ergonomics’ approach is taken. Typical examples of this reactive solution to an overt problem are to bring in a platform for short workers to stand on when required to work overhead, or when boxes or any objects are stacked too high, to reduce the stacking height of the column by one or two so eliminating the high overhead stretch, or to bring in a foot rail when workers are standing, or sitting on a high stool, working at a conveyor belt (2). These are all low-cost interventions which Kogi (3), Scott (4) and Scott et al. (5) have advocated over the years. Photos A and B illustrate two basic examples, one in situ, and one where the benefits of a no-cost modification of the task are rigorously assessed in the laboratory.

However, it is essential that ergonomists do not just use this “band-aid” method, rightly criticized by Hendrick (6), and then leave the situation. Too often this ‘patch-up’ approach does simply that it serves to cover up the greater problems which permeate throughout the plant, and while management may feel that they have at least addressed the immediate problem, there are no genuine long-term benefits to the workers or to the company. For any ergonomic input to be beneficial and sustainable it is crucial that a more in-depth analysis of the problem is taken in order to be able to quantify the magnitude of the incompatibility between the workers’ capabilities and the often exorbitant task demands. However, the use of advanced technology (so readily available now) on semi-skilled, semi-literate rural labourers working under horrendous climatic and working conditions, is fraught with difficulties (7) and (8), not least being that it is likely to interfere with the natural working pattern. While the use of sophisticated equipment may be problematic it is nevertheless important to conduct a basic assessment of the workers in the field. This should include such variables as stature, mass, grip strength, ‘resting’ and ‘working’ heart rates, together with a more detailed assessment of the task requirements, work methods and ambient conditions. The use of videos, with a motion analyser programme, allows for a non-invasive recording of the work patterns, enabling ergonomists to assess the ‘working postures’ of the operators as they go about their job as naturally as possible. In addition, there are several useful theoretical models available to conduct a rigorous analysis of the forces in the various joints as the work is being executed.

From a glance at the working postures adopted to execute the tasks illustrated in photos C and D, it is evident that there will be excessive physical stress imposed on the workers, and the likelihood of high incidence of work-related musculoskeletal disorders (WRMDs) is inevitable. Although the emphasis is generally focused on the lower back (often assessed by means of the Lumbar Motion Monitor, as seen in photos B and B1) it is necessary to include evaluations of the forces experienced in the upper and lower limbs, using biomechanically based programmes which enable one to predict the forces imposed on the main joints of the body.

A review of the literature will reveal that much of the research conducted on the assessment of manually executed tasks in the work environment has focused on the musculoskeletal stresses. Far less have been addressed the equally important physiological responses of these workers, where the intensity and duration of physically demanding tasks in extreme climates has a daily and cumulative debilitating effect on the workers. The use of non-invasive heart rate monitors can be used in situ to record “working” heart rates during a work-shift. Without going into detail here [reported elsewhere, see (9) and 10], mean
working heart rates of 124bt.min⁻¹, with a peak response of 181bt.min⁻¹, have been recorded in the field. These heart rates are well in excess of acceptable ranges for a sustained work effort (11, 12). Furthermore, Scott and Christie (9) investigating the energy expenditure of forestry workers in KwaZulu Natal (see photo C), and comparing this with the average daily nutritional intake of these labourers, identified an unacceptable imbalance between energy intake and energy output. Considering the lifestyle of these rural workers and the associated socio-economic poor health status, it is no wonder that these workers, who are not lazy, but rather as a consequence of the interaction of so many compound- ing negative factors have a low work capacity, are therefore unable to retain the required work rate. The inevitable outcome is poor productivity and an increase in the incidence and severity of occupational diseases and injuries.

**Laboratory simulation**

Due to the many extraneous factors which will affect the basic interaction between the operator and the task and the problems associated with the use of expensive equipment in the field, where possible, laboratory investigations of the task should be conducted using the relevant information acquired in situ. The data from these rigorous laboratory experiments will then provide tangible evidence of the excessive musculoskeletal and cardio-respiratory stresses being placed on these manual labourers. The scientific quantification of the extremely high biomechanical and physiological responses not only demonstrates the marked incompatibility between the task requirements and the workers’ capabilities, but should also serve as the basis for bringing in minor to major adjustments to the working conditions.

**Positive commitment**

When reporting back to the company on the theoretical results and practical application of these data, (both field and laboratory results) the investigating ergonomist should use the opportunity to encourage the company to make a greater commitment to establishing an ergonomics ethos within the company. We are encouraged by the number of companies who are now requesting that we follow the field-lab investigations with ergonomics workshops which are attended by a cross-section of employers and employees from the company. The objective of these workshops is to “help others, help themselves”, explaining how to identify potential problem areas and to take preventive steps to minimize high-risk factors.

It is essential that as we show shocked concern for the horrific figures on occupational diseases, injuries and deaths put out by the ILO and WHO annually, we as ergonomists must make a more dynamic, focused-driven effort to demon- strate what a huge contribution ergonomics can play in improving the plight of the millions of workers worldwide who suffer from the most severe musculoskeletal and cardio-respiratory problems. Ergonomics can, and must, reverse the negative spiral so evident in IDCs by improving working conditions, reducing the physical strain being placed on the manual labourers and improving work efficiency, thereby assisting industrially developing countries to fulfill their potential, and to play a more viable role in the global economy. Ergonomics is a “win-win” situation; the benefits are experienced by all.

**References:**

9. Scott PA, Christie CJ. A Preliminary field assessment of the energy expenditure of for- estry workers in South Africa. Proceedings:
Ergonomics in small-scale grain mills in Nigeria

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Introduction
Nigeria, the most populous country in Africa (about 120 million) is essentially agrarian in nature with over 80 per cent of her food needs being produced by peasant farmers cultivating, in many cases, less than 2 hectares of land. Among the major crops produced and consumed in large quantities are sorghum, millet, maize, rice, cassava, and yam. The inhabitants of each region of the country can be identified by having at least one of these crops as their major food. For example, grains are consumed in the far north, while in the southern part of the country, tubers are the main food.

However, the crops are subjected to different processes before they are ready for consumption. One such process is the conversion of the grains or the chips (in the case of cassava and yam) into flour (size reduction). Some decades ago, this operation was done using stones. Today, as a result of mechanization of agriculture and advancement in technology generally, there are tools and machines for performing this operation.

Although the country has a few large-scale industries (flour mills), the size reduction process in most cases is done at the small-scale (sometimes at family) mills using hammer or burr mills (Photo 1). The capacity of such mills can be as low as 20kg/h and as high as 100kg/h. These mills are of different makes and designs. They are equally housed in structures made of different materials and with different sizes and designs. Casual observation of the mills shows that they are noisy and may be hazardous to the operators and clients.