

SOME PERSPECTIVES ON THE DEVELOPMENT OF ERGONOMICS IN CANADA

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Abstract

Ergonomics has been practiced since a stone tool was first shaped to be held by a human hand. In an explicit manner, however, its practice in Canada dates back no more than forty years. Two main centres of development can be recognised: DCIEM in Toronto and IRSST in Montreal. These reflect the two areas of military procurement and occupational health and safety that were the initial areas of interest for Canadian ergonomics. They also reflect the innovative role of government, which was only latterly matched by university and industrial commitments. These trends will be examined in terms of one person's involvement in them.

Ergonomics has been practised since a stone tool was first shaped to be held by a human hand. However, its explicit practice in Canada dates back not much more than forty years. Two main centres of development can be recognised: the DCIEM in Toronto and the IRSST in Montreal. These reflect the two areas of military procurement and occupational health and safety that were the initial areas of interest for Canadian ergonomics. They also reflect the innovative role of government, which was only latterly matched by university and industrial commitment. The paper describes one person's involvement in this story.

The generally accepted story of ergonomics is that its origin as a scientific discipline and professional activity lies in the Second World War and that it received its name at a meeting of classically-educated scientists, who were yet to be called ergonomists, meeting in 1948 at the Admiralty in London. Our Polish colleagues have pointed out that the term was used in Warsaw as early as the nineteenth century in a way that we would recognise as valid, but the fact remains that use of the term did not take hold until much more recently. However, quite apart from how we might name the activity, designers have always endeavoured, intentionally or unintentionally, to modify their designs in line with human characteristics. This is why, for example, many tools designed by predominantly right-handed European males are adapted for their use and not for the use of left-handed persons, whether male or female. Their aim in so doing was clearly to maximise the effectiveness and accuracy of performance, and thus they were practising ergonomics.

In talking about the development of ergonomics in Canada in the context of this conference, we are talking, therefore, not so much about the activity itself as about the development of institutions and agencies devoted to its practice and application, and of theories that give it conceptual support. To give this subject the attention that it deserves would require the expertise of a historian of science and a philosopher of science. I am neither. The reason for my being asked to present this paper lies, I believe, not in my expertise but in my happening to be present at, and to have observed many of, the events that have occurred in Canada in our discipline during the past thirty years or so. As one such participant - and there are of course many others who no doubt saw things differently to me - I am happy to offer these reflections on the events.

Ergonomics as we know it was born and given its name in the circumstances of a world war. This is significant. For at least a decade before that time, the practitioners of industrial psychology, one of the godparents of ergonomics, had been mesmerised by Hawthorne and all that that implied. Investigators working at the Western Electric plant had decided that group dynamics, and not working conditions, determined productivity (1). If everyone got on well with each other performance improved: never mind the lighting level. (I often wonder if the investigators ever turned off the lights.) This approach fitted well with the then current predilection with motivation (deriving, perhaps, from interest in psychoanalytic theory), but it was clearly inadequate as a theory of operator performance, and the war showed that to be the case. Little else, we may surmise, motivates an operator so much as the possibility of being killed. If, in such danger, an operator is unable to operate a weapon because it has been designed, say, for a right-handed person or one with full colour vision capability, no group dynamic is going to improve the situation. Only a correctly-designed working situation and environment will optimise performance. This is the basic tenet of ergonomics and the war made its validity abundantly evident.

Unfortunately, as in so many other areas, the lesson of the war was soon forgotten, or, at least, not well learned. My own introduction to ergonomics (I had been trained as an experimental psychologist) came about when some unexplained railway accidents in the United Kingdom led to the innovative idea that it might not be the fault of the locomotive engineers (or train drivers as they are known there) but of inadequately designed equipment. Several of us were set to work on the problem and my task was to have a word with the chaps (2). Then, as political pressures eased we were eased out, with the result that the situation remained as it was. Shortly after that experience I emigrated to Canada where events had preceded me in that, to the extent that ergonomics was found in Canada, it was found in military procurement. The scientists at the Defence and Civil Institute of Environmental Medicine (DCIEM), like their British counterparts, recognised the basic tenet of ergonomics and worked accordingly. Founded in 1939, the DCIEM was spawned from research in aviation medicine, another godparent of ergonomics (3).

Given its situation, it was hardly surprising that the DCIEM was the birthplace of one of our two Associations meeting today. The founding meeting of the Association of Canadian Ergonomists (ACE) was held at the DCIEM in June 1968. The ACE was not known by that name at the time, a point to which I shall return. The twenty-nine founding members (those shown in the celebrated photograph (4)) were mostly military or ex-military persons or functionaries of other government departments. A few were academics and only two were women. In its early days the ACE did not make many waves. It met at least once a year for a conference at which papers were presented, but it did not engage seriously in questions of professional status and development. Furthermore, its work, like that of its members, was orientated to application rather than scientific theory. The prevailing mood changed in 1981 when members were persuaded to forsake the Muskoka Lakes in order to hold the annual conference in Toronto. Ergonomists from places outside southern Ontario were now able to find the venue on the map and the ACE began its expansion. At this time too, the ACE first engaged the services of a professional manager (5).

Apart from providing a birthplace for the ACE, it is also perhaps correct to say that the DCIEM provided the name. In establishing the DCIEM, the Department of National Defence had "recognized the importance of human factors", and today the DCIEM claims "the human factors of command systems" as one of its areas of competence. (It does, however, also claim "environmental and applied ergonomics" as an area of competence.) In 1968, prevailing opinion was that the term human factors correctly described the domain of interest

and did so more appropriately than the term ergonomics. The new association was therefore named the Human Factors Association of Canada (6), and there is no question that it thrived for many years with that name. Looking back, one understands the reasoning behind that decision but it remains an unfortunate one, impeding, in certain respects, the development of ergonomics in Canada.

For ergonomics in Canada, the eighties were a time of change and development. In 1980, the Government of Quebec established in Montreal the Institut de recherche en santé et en sécurité de travail (IRSST) to undertake research aimed at promoting occupational health and safety (7). From its inception, ergonomics research constituted a significant part of its activity, but unlike that of DCIEM, this research was wholly directed to industrial objectives as distinct from what were the military (or, in theory at least, the partially military) objectives of the latter. The IRSST was also distinctive in having representatives of employer organisations and worker organisations sitting on its administrative board. In other respects, the two agencies shared similarities: both were (and are) government sponsored and, for the most part, government funded, and both have given considerable support to the professional and scientific activities of the ACE.

The other major initiative in the eighties was the establishment in 1984, this time by the Government of Canada, of the National Research Council Associate Committee for the Occupational Applications of Ergonomics Research (8). This Committee, drawing members from government agencies (including the IRSST(9)), the universities, industry and commerce, and trade unions, was mandated to promote the application of ergonomics to industry on the assumption that this either was not, or was inadequately, being done already. As always, one was faced with the fact that the designs of industrial products, processes and procedures were necessarily based on ergonomic principles however badly formulated they might be. A designer, at the very least, inevitably designed with his or her own skills, requirements and limitations in mind, even though the fact that other operators might differ in skill, requirement or limitation was usually overlooked. How was the Committee to make the process explicit and persuade designers that they needed ergonomic expertise, whether from themselves or from others?

The Committee set out across Canada to bring the message to workers, managers and employers, with some interesting results. In one city two hundred persons might attend a one-day workshop sponsored by the Committee while in another barely a dozen would turn up. In these workshops the speakers endeavoured to stress the broad scope of ergonomics, pointing out that ergonomics was pertinent not only to occupational health and safety but also to efficiency and effectiveness. In the latter respect it achieved questionable success. The Committee sponsored surveys and seminars implicating government occupational health and safety agencies, ergonomics teachers, trade unions and the ACE and successfully raised awareness of the issues. It tried equally to implicate industrialists and engineers but did not really succeed in doing that. It did succeed in co-sponsoring (with the ACE) the appointment of an industry technical advisor (10). As a legacy, it left a series of useful publications, the first of which, at least, still warrants attention (11).

As this was going on, the introduction of information technology into the workplace had begun. We are all aware of the changes in workplace structure and procedures that followed in its train, calling, once more, for the application of ergonomics theory and technique. In this particular case, the need for ergonomics was explicitly recognised, with some divergent results. On the one hand, at this time a leading high technology company employed the biggest single group of ergonomists in Canada working on the design of its consumer

products (12); on the other, ergonomics became associated in the public mind with the single issue of avoiding repetitive strain injuries. In all events, the topic of man-machine interface (MMI) became a hardy perennial to be cultivated and watered at all conferences designed for computer engineers and computer scientists. (As I sit typing at my PC I can see the outcome of this work.) At the same time, MMI took on a life of its own and thus it seems to have remained. What went wrong?

I suggest that two critical issues need to be addressed by those of us who regard ergonomics as our scientific discipline or professional activity: the first a matter of form and the second a matter of content. Regarding form, we must promote the term ergonomics to identify our domain of interest. To do otherwise allows, at best, confusion and, at worst, a usurping of our claims to validity and expertise. You only have to be human to do human factors. We know that that is not true (anymore than that you only have to be old to be wise) but in failing to name our discipline in an unequivocal way we allow confusion to exist. Perhaps we have scope for a study here: is confusion over the subject more prevalent in English Canada than in French Canada? My conjecture is that it is: francophones are not ambiguous in the matter. In all events, the recent resolution of the question concerning the name of the Association is a step in the right direction and I congratulate the officers of the ACE who have been responsible for implementing that change (13). It would be useful, now, to see university departments follow in the same direction.

During the period with which I am primarily concerned, it was not possible to find a university department of ergonomics in Canada, and that appears still to be the case. This is not to say that ergonomics was not taught then, or is not taught now, as a university subject - far from it - but it was taught in a variety of departments ranging through kinesiology, psychology, industrial engineering, biological sciences, and others. This had the benefit of bringing to the teaching of ergonomics the full range of knowledge and techniques that was called for, but it led to some disarray. Ergonomics was compelled, in many cases, to occupy the minor role in a department named for and devoted to some other discipline, and what students received was shaped accordingly. It also made ergonomics a victim of the inevitable interdepartmental rivalries that one finds in universities. For various reasons, it was difficult for the universities themselves to rectify this situation. One hoped for the establishment of a department of ergonomics, but the time of newly established departments had passed with the end of the seventies, and ergonomics had missed out. In like manner, the Associate Committee failed to persuade the Natural Sciences and Engineering Research Council to establish a grants committee for ergonomics. Grant applications in ergonomics continued to be assessed by the Industrial Engineering Committee or the Psychology Committee. Today, new possibilities have arrived with the birth, after a long period of gestation, of the Canadian College for the Certification of Professional Ergonomists (CCCPE). Again, I congratulate the officers of the ACE who have been responsible for bringing this about (14) and I look forward to seeing that body influencing, in an appropriate but effective way, the syllabuses offered to students at Canadian universities.

The question of syllabus moves us from form to content. While it is important for many reasons that our discipline be uniquely named, it is more important that it be based on a unique and readily identifiable theoretical position. The information-processing model of operator performance provides that theoretical position (15). At the time of the birth of ergonomics, experimental psychology was ridding itself of the sterile assumptions of behaviourism and the stimulus-response model of human performance, and was using the information-processing model to restore cognition and mental processes to the focus of

interest, with promising results. However, old ways die hard, and industry still holds fast to the stimulus-response model.

To illustrate my point, I refer again to the topic of railway accidents. Railway engineers and operations managers conceive the task of the locomotive engineer in terms of a stimulus-response model whereby certain prescribe signals and instructions call forth the appropriate responses and actions. In driving their trains along the track, locomotive engineers are trained (that is, conditioned, to use a behaviouristic term) to respond as the rules of the system require. They are not expected to think about what they are doing, at least not in the sense of forming strategic plans of action or making judgements above the level of perceiving the signals immediately present to them(16). Being human, locomotive engineers do not always behave in the manner prescribed for them(17). The problem lies, however, not with the locomotive engineers but with the system designers who adopt (although not consciously) an inappropriate model of operator performance. An ergonomist knows, of course, that this is inappropriate, but in the period in question no railway administration thought fit to ask an ergonomist.

In principle, it is not possible to practice ergonomics without making an information-processing analysis of the task of interest. Whether this is done explicitly or implicitly, as a major or minor part of the investigation, or, if I may put it thus, in English or French does not matter (18). This does not mean that at an ergonomics conference or in an ergonomics journal one should expect to hear or see a task analysis in every presentation - although, that might not be completely amiss. To pursue this point - one sometimes reads reports of experiments where ingeniously-designed tasks are used to elicit intriguing data, but one wonders what the subjects thought they were doing. If they did not understand the task the way that the experimenter had understood it, were they in fact performing the experiment or some other task? However, research papers apart, if every ergonomics investigation presupposes a task analysis, then the universities must clearly teach ergonomics accordingly. Without it, they may be teaching good psychology or good kinesiology or good industrial engineering but they are not teaching good ergonomics.

The information-processing model is psychology's gift to ergonomics. When placed in the proper context of social, organisational and environmental factors, information processing provides a coherent theoretical basis for addressing issues of operator performance, whether they relate to performance speed or performance accuracy. In the period under review, Canadian ergonomists had some success in making this point with regard to performance accuracy, broadly understood. The existence of both the DCIEM and the IRSST was evidence of that. So was the interest in ergonomics shown by trade unions and governments and, to an increasing extent, by employers. Occupational health and safety is very important, especially for those operators who are, as it were, at the sharp end, and the role of ergonomics in promoting health and safety and reducing injury and accident is now accepted. As ergonomists, however, we should advocate a broader approach. Performance speed, as a term, may be unfortunate, having as it does an underlying note of exploitation, but speed (which, of course, is a dimension ranging from slow to fast and as such is value-free) is an accepted and useful way of measuring performance. The point is that the aim of ergonomics is to make performance not only safe and free of hazard but also efficient, effective, elegant and satisfying.

In conclusion, let me reiterate that original innovative idea, that responsibility for occupational success does not lie with the operator alone but with the total system of which he or she is only one component. It is too easy to lose sight of this idea and to regress to the principle of

individual responsibility. Individual responsibility is an important principle but it lies in the domain of the ethicist not the ergonomist. If operators fail, we must find the solution in restructuring the system, not the operators.

This, then, is my perspective on the development of ergonomics in Canada. It is accurate only to the extent that it is a personal perspective: other, perhaps differing, perspectives from other ergonomists would be no less accurate. Ergonomics has been developed in Canada by many individuals working together. I have mentioned a few of these individuals in my notes not only to recognise those particular persons but also to emphasise that it has, in fact, been a collective venture. My perspective has been coloured by the very many ergonomists that I have had the good fortune to meet. For their influence, and their friendship, I express my thanks.

NOTES

- (1) For an account of this research, see Morris Viteles (1953), *Motivation and morale in industry*, Chapters 10 and 11. W.W. Norton, New York.
- (2) This research was sponsored by the British Medical Research Council. For citation of some relevant reports, see Leslie Buck and Fernande Lamonde (1993). *Safety Science*, 16:1-18.
- (3) For a brief history of ergonomics at the DCIEM, see Sharon McFadden (1989). *Communiqué*, 19(6):1-3.
- (4) The photograph was published in *Communiqué* (1982), 12(2):2, together with the minutes of the founding meeting.
- (5) The company was Fletcher Wright Associates.
- (6) For an account of the first meeting, see Leslie Innes (1988), *Communiqué*, 18(3):1-3.
- (7) An account of the early development of ergonomics in Quebec, entitled *L'Ergonomie au Québec*, was presented in 1987 by Denis Giguère and Robert Gilbert at the 20th Annual Conference of the ACE (HFAC/ACE). (Personal communication.)
- (8) The chairperson of the Associate Committee was Robert Webb.
- (9) The appointment of Roger Langlois to the Associate Committee is an example of how the IRSST supported the development of ergonomics in Canada.
- (10) The industry technical advisor was Heather MacDonald.
- (11) The publications of the Associate Committee include *Obstacles to the occupational applications of ergonomics* (1986), *Education for ergonomics* (1986), *Ergonomics at work* (1988), *The role of ergonomics in implementing the provisions of occupational health and safety legislation* (1989), *Proceedings of the national workshop on education and ergonomics* (1989), and *The role of ergonomics in trade union activity* (1990). For a brief history of the Associate Committee, see Robert Webb (1991), *Communiqué*, 22(4):1-4.
- (12) The company was Bell Northern Research, Kanata, Ontario.
- (13) The president of the ACE during the period in question was Pierre Goumain.
- (14) The first chairperson of the Board of the CCCPE was Alison Smiley.
- (15) As I was preparing this paper I read of the death of Claude Shannon. Obituaries appeared in *New York Times* (27 February 2001), *The Times*, (12 March 2001), and *Guardian Weekly*, (15-21 March 2001).
- (16) For example, see the Report of the Commission of Inquiry into the Hinton Train Collision (1986), pp 119-130. Supply and Services Canada, Ottawa. (T22-72/1986E)
- (17) For an ergonomic analysis of railway operation, see Fernande Lamonde (1996). *International Journal of Industrial Ergonomics*, 17:481-497.
- (18) This linguistic distinction refers to the difference of approach sometimes discernible between anglophone and francophone ergonomists: whether one analyses performance in terms of the task (defined perhaps by the designer or engineer) or the activity as perceived and experienced by the operator. In both cases, the constituent factors are the same but they are addressed from differing perspectives determined, perhaps, by other, non-ergonomic, considerations. Both are essentially information-processing analyses and are therefore in principle equivalent. For an English-language account of the activity approach, see Fernande Lamonde and Sylvie Montreuil (1995). *Relations industrielles (Industrial Relations)*, 50(4):719-740.