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The long-term effects of working with computers: the state of the art in the field of computer use and occupational health

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THE CONCEPT OF OCCUPATIONAL HEALTH

The concept covers a wide range of health criteria; in general, this gives rise to a classification involving the following categories: job-related ill-health; job-related discomfort (physical and mental); mental well-being; social well-being; professional and skills development.

To illustrate how all these dimensions are related to health, we can position them on the bipolar continuum that has been accepted within the western world since it was adopted by the World Health Organisation (WHO) after the end of the Second World War.

When confining our attention to a particular occupational sector, the elements of the different health dimensions are specified (as the research progresses) in terms of particular forms of ill-health, types of workload and conditions of well-being; these will depend on the technical equipment, job demands and work organisation that prevail in the occupational sector in question.

(-) Disease or infirmity	(o) absence of disease or infirmity (freedom from disease)	(+) complete well-being (optimal health)
job-related ill-health	physical and mental workload	job-related mental and social well-being professional and skills development

Figure 1. The domain of occupational health in relation to the concept of health in a wider sense (from negative to positive)

One such sector is 'office work' which in fact contains a variety of shifting occupations and professions, but which is still regarded as comprising an occupational sector in itself, just on the grounds of the intensive computer-based automation to which this area of work has been exposed over the last decades. By distinguishing office work from manual manufacturing work, it has been possible to compare different motives for the introduction of computerised systems, as well as to describe their human consequences and draw conclusions on the benefits that computerisation might provide for blue-collar and white-collar workers.

In general, it can be said that computerisation in the industrial and distribution sectors has ameliorated (or eliminated) job-related ill-health and physical strains and, with some exceptions, led to a qualitative improvement in the demands to which blue-collar workers are exposed and the social situation in which they find themselves. The position of blue-collar workers is tending to approach that of white-collar workers in terms of occupational skills and forms of working together, very largely as a result of the introduction of computer technology.

For blue-collar workers, therefore, computer technology (despite the fact that it has been introduced in order to rationalise production and increase productivity) has given rise to better working conditions with respect to both physical and psychological aspects of occupational health.

For white-collar workers, however, although the motives for the introduction of computer technology (rationalisation and increased productivity) have been the same, the human consequences appear to be quite different. This may not be so strange. The same computer technique is employed to promote rationalisation, greater speed in the accomplishment of tasks, and improved efficiency in sectors between which there are radical differences. Industrial jobs are already tightly structured and tasks are planned in detail; by contrast, office jobs tend to involve the provision of

decision-making support and the processing of information, and in most cases demand a consistent capacity to work in a manner which is both adaptable and flexible.

With respect to 'office work', research on the health consequences of the use of computers has been quite intensive during the last 10 to 12 years. Against the background of the bipolar health continuum described above, we can outline the problem of health from a multifactorial perspective (see figure 2).

(-)	(o)	(+)
Disease or infirmity	Absence of disease or infirmity (freedom from disease)	Complete well-being (optimal health)
Negative pregnancy outcomes Serious physical complaints related to electromagnetic fields from VDT equipment	Skin complaints / Sight complaints (rashes) Professional/skills	Musculoskeletal load Stress development

Figure 2. Occupational health dimensions of research on the human consequences of computer use

Before providing a sketch of how occupational health research has developed up to the present day, it should be pointed out that the profession of translator is not to be found among the occupations that have been studied in the field of office work. To judge from a database search that I carried out as a precautionary measure in preparation for this conference, translators have clearly managed to avoid becoming the subjects of investigations – at least as an occupational group that has been specifically identified (see Table 1).

For this reason, we must utilise research findings derived from the study of other occupational groups and see whether these might be applicable to the target group with which we are currently concerned, translators. In this context, it is useful to make a distinction between *the impact of VDT use* and *the impact of computer use* on employees.

Number of references discovered by database searches on the following categories. Main category: translation; subordinated categories: computer use, VDT, word processing, new technology, work environment, ergonomics, occupational health, human factors, psychosocial factors

Database	*Number of references*	*Topics*
Labordoc	2	general
Psychinfo	3	cognition; efficiency
SocSciSea	5	work procedures
SocSciSea	27	computer aid
HSE line	7	programming, computer aid
Total	44	

Table 1. Publications on the working conditions of translators

THE IMPACT OF VDT USE

There are now a number of occupational health studies available concerned with the impact of VDT use on employees. Occupations have been compared across organisational units and sometimes between companies. These studies are designed to provide a *general* picture of how *length of working hours* and *type of VDT tasks* have influenced achievement, efficiency and health. An epidemiological approach has been most common.

There are three aspects to 'time spent' at terminal work. It has been defined in terms *of frequency of use, total amount of time devoted to terminal work (per day or per week)*, and the *average length of the working period.* In the extensive epidemiological literature on terminal work and pregnancy, the only measure used is total amount of time, either per week (Goldhaber, 1988;Westerholm, 1987; McDonald, 1986; Ericsson, 1986b), or per day (Kurppa, 1985; Butler, 1986); sometimes the amount is crudely estimated, on the basis of occupational criteria, as 'small', 'medium' or 'large' (Ericsson, 1986a). Johansson, 1984, and Dainoff, 1981, also use amount of time per day. One study has included three different measures of time spent at terminal work (Knave, 1985). In some studies (Westlander, 1988; Soderberg 1989; Aronsson *et al.,* 1988), frequency of use is also analysed. Only a few investigations focus on length of working periods on VDT work (Evans, 1985; Aronsson *et al.,* 1988).

Reference	Study group N	OCCUPATIONAL SECTORS	TIME SPENT AT VDT WORK . . . . . Frequency of use	Amount of time (per day/week)	Working period	VDU WORK CONTENT
Aronsson G, et al 1989	8414	Telecom-munication	- - -			input, retrieval, interact. programm., CAD/CAM
Söderberg, I., 1989	290	Local govern-ment	daily, twice a week, twice a month, never			shorter /longer scripts
Aronsson G et al 1988	3247	State employees	daily, about once a week, a few times a month, periodically	<1 hours/day,1-2, 2-4,4-6,>6 hours	continuous/ in periods	input, retrieval, input + retrieval, word proc., progr/ system.
Goldhaber, F et al 1988	1583	White collar workers		0 hours/week,<5 , 5-20,>20 /week		
Westerholm, P et al 1987	4117	Social insurance		0 hours/week, little, >10,>15,varying.		
Mc Donald A, et al 1986	56012	Regional popl.		number of hours /week		
Butler, W et al 1986	788	Public admin-istration		>1hour/ day,1-5, 6-20/week,21-40		
Ericsson, A et al 1986	10025	White collar occupations/ comput work		experts rating: small, medium, large amount		
Ericsson, A et al 1986	1498	see above		<5hours/week,5-9, 10-14,15-20		
Kurppa K, et al 1985	2951	Office-, bank-, EDP-occup.		<1hours a day,1-4, >4 hours		
Westlander G, et al 1988	18313	National popl. sample	daily/not daily			
Evans J, 1985	3819	Computer users		1-2 hours/day, 2-4,4-6,6-8,>8	1-2 hours, 2-3,3-4,>4	
Knave, B., et al 1985	650	Insurance newspaper comp. travel agency		n hours/week n hours/day n hours with eyes on screen		retrieval, input, input+ retrieval
Dainoff, M .J. et al 1981	121	Office workers		n hours/day		(word proc; input, retrieval, account.)
Smith, M.J et al 1981	400	Insurance-, newspaper comp.		% time of working day		input, retrieval, wordproc. teleph sell.
Johansson, G. et al 1984	128	Insurance company		% of working day: 0, 1-10,10-50, >50		input, customer service(retrieval)
Westlander, G 1990; 1990	269	Social insurance off. Local government Food distrib. compan	several times daily; several times per week; once per week; once a month; never	1/2 an hour, one hour, 2 hours most, 4 hours most, > 4 hours	<5 min;about 5 *min*; about 10 min; about 20-30 min; about 30-60; about 1-2 hs; > 2 hours; varying length	input, retrieval, inter-active, word processing
Smith et al 1984						input, retrieval, interact word processing

Table 2. VDU research - references where time spent at VDU work and type of VDT tasks are discussed.

In studies where several measures of 'time spent' are included, analyses have either been conducted using each of the measures separately to discover whether some have stronger correlations with certain health variables than others (Knave, 1985; Evans, 1985; Aronsson *et al.,* 1988) or have concentrated on a combination of frequency and amount (Söderberg, 1989). The research as a whole can be characterised as an investigative process starting from a very low level of knowledge of the impact of terminal equipment on the human being. Looking at and comparing the results derived from using a variety of time measures can be seen as an expression of this process of investigation.

Table 2 lists a number of studies which focus on terminal work and mainly concern its consequences for various aspects of physical and psychological health. The selection of studies is confined to those published after 1980.

Parallel on-going research from another perspective, on cause and effect in the work environment, attempts to discover which organisational factors lie behind and initiate a particular division of work with reference to, among other things, time spent and type of activity (Westlander, 1987 and 1989b; Söderberg, 1989); the latter are then considered as dependent variables.

The discussion on time limits which, at least periodically, has been very intense, is mainly based on research results derived from analyses of the relationship between one or two of the 'time spent' variables on the one hand and physical and mental workload on the other. One reason why there are great difficulties in influencing legislative activity may be that the real conditions of VDT work (with the exception, of course, of those that apply to full-time VDT workers) do not exactly correspond to the picture that the research has suggested. For this reason, a multivariate (complex) assessment of amount of time spent at VDT work is of clear value in organisational analyses. The findings of a recent study (Westlander, 1990) provide a picture of characteristic organisational time patterns: the number of people involved in VDT work, the extent of the work, the regularity or variability of time schedules. This assessment, which takes the three time dimensions into account simultaneously, is of great value in cases where the *reorganisation of VDT work appears necessary.*

Moving from the 'time spent' aspect to *type of VDT tasks,* our level of knowledge on what the *nature of computer work tasks* involves for the individual is continuing to increase. The fact that different definitions of the content of VDT work have been employed in different studies can be seen as an expression of a search for the aspects that are of decisive importance. Glancing back at the studies of the last decade, the following trends can detected.

In earlier studies (Dainoff, 1981; Smith *et al.,* 1981), VDT users occupying a variety of types of office jobs were compared. These posts

contained tasks such as data entry, data acquisition, interactive communication, and word and text processing. No detailed attempt, however, was made to classify VDT users by type of task itself. Interest was primarily directed at the determination of the 'pattern of complaints' within various categories of office workers in terms of physical and psychological strain and psychosocially-related stress. Using non-VDT users as control groups, the results suggested that, in the case of office workers at lower levels in an organisation, those with VDT tasks had a worse work environment than other workers in these particular respects.

This early research was followed by studies that were designed to 'control for' the type of VDT work so as to permit comparisons between workers with different types of VDT tasks; these included comparisons between those involved with data entry and interactive (conversational) communication (Johansson *et al.,* 1984) and between office workers specialising in data entry, data acquisition, interactive communication, and word and text processing (Smith, 1984; Evans, 1985). Smith's study of job-related health has been of particular importance as it provides a thorough description of the differences between these types of VDT work with respect to a series of important ergonomic characteristics, such as the amount of time spent with eyes directed at the screen, specific job demands, mental workload, strain on the eyes, musculoskeletal strain, and postural demands. Smith claims that it is possible – taking account of occupational differences to a certain extent – to arrive at a comparatively general characterisation of these VDT tasks on the basis of the *types* of strain that afflict the terminal user. In this way, it has become clearer which preventive measures urgently need to be undertaken.

The taxonomy of VDT tasks employed, inter alia, by Smith and his colleagues was adopted by a number of researchers; studies of personnel were conducted, usually within large companies where the distribution of tasks was clear, and where, as a consequence, employees with VDT tasks related to the categories (data entry, data acquisition, interactive communication, and word and text processing) could be found. The point of the research was to make comparisons between computer jobs involving specific uniform tasks and to draw conclusions with respect to their consequences for the individual. In Sweden, the taxonomy was used as the basis for extensive reviews of the relationship between VDT work and health (Knave *et al.,* 1985; Aronsson *et al.,* 1988; Aronsson *et al.,* 1989). As new areas of activities have come to be computerised, the taxonomy has been extended to cover them (e.g. programming and CAD/CAM).

The findings of the original comparative studies (Smith *et al.,* 1984; Johansson *et al.,* 1984), i.e. that different types of work with computers involve relatively varied job demands, generated a further line of research, the purpose of which was to deepen our knowledge of job demands with

respect to certain specific types of VDT work, such as word and text processing or supervisory control.

It should also be pointed out that the combined effect of time spent and type of VDT work has been investigated in a number of studies (Johansson *et al,* 1984; Aronsson *et al,* 1988; Westlander *et al,* 1988).

The researchers we have mentioned have a strikingly uniform view on what are the relevant objects of study with respect to job-related health. With the exception of pregnancy outcome which has been the object of specific attention (see, for example, a review by Westlander, 1989a), these range from poor ergonomic conditions (VDT health) to work pressure and deterioration in working conditions as a whole. There is also one study that treats absence from work through sickness as a hypothetical effect (Aronsson *et al.,* 1989).

Given that the different research findings reveal similar tendencies in that certain specific VDT tasks, undertaken for large amounts of time, are related to certain specific complaint patterns, it follows, from the perspective of prevention, that we are and should be interested not only in the risk of an extensive amount of time spent at VDT work (= exposure to the screen), but also in the degree of specialisation of this work, i.e. how computer work is distributed between employees (= exposure to job demands).

The impact of VDT use has generally been studied from a long-term perspective, in the sense that the subjects chosen for the epidemiological investigations have been working with the VDT tool sufficiently long for it to be said that they are no longer novices; nor are they going though any particularly sensitive period of training. In order to establish that there is some form of dose-response relationship, a certain 'exposure time' must have elapsed. The lower limit is usually set in terms of two years experience (or more) of VDT work. But, as the techniques are relatively new, we still have only very modest knowledge of long-term effects – of the effects of the work after, let us say, ten years. Some, if only a few, such prospective studies are already in progress in several countries, but findings on sight, skin and musculoskeletal complaints are still not ready for publication. Up to now, what we have is knowledge of effects from a 'short long-term' perspective!

THE IMPACT OF COMPUTER USE

As the concept of occupational health also covers states of well-being in a psychosocial sense, it is important to draw attention to research on computer use that has been conducted from a psychological perspective. One strand consists of 'stress research'. This has generated a considerable body of knowledge on the stressors that threaten employees working in a computerised environment. The findings permit

generalisations as to which working conditions contribute to relatively long-lasting states of stress and tension. Some of these stressors emanate from the organisation of work, which has the implication that they can only be avoided through the application of skilled leadership to organisational change. Other stressors are directly 'machine-related'. They are often conscious components of management styles, and can only be eliminated through a *combination* of technical and organisational change.

Organisational factors	*Machine-related factors*
High workload combined with low autonomy (control)	Machine pacing
Repetitive tasks	Electronic monitoring
Lack of time for training	Computer mediation
Unrealistic expectations in terms of speed.	a. human judgements built into the system
	b. the abstract nature of the work
	c. human-computer dialogue

Table 3. Stressors identified in the context of computer use at work

Still other stressors are more complex and – many would say – rather 'subtle' by nature. Although there are only a few systematic empirical studies of these phenomena, I would like to mention Craig Brod's identification of three psychological states, each of which represents a different kind of emotional discomfort:

*Frustration and worry about being 'overidentified' with computer technology (giving rise to a struggle *not* to glide into 'technostress') - .....
Technoanxiety

*Eager acceptance of the job demands necessary to use the computer in a perfect manner (identification with the machine) - .....
Technostress

*A personality that is unconsciously influenced by information technology; in his/her everyday life, the user has become heavily oriented towards problem-solving, perfectionism and cognitive thinking - .....
Technocentration

While Technoanxiety represents a company management problem that needs to be handled using some form of technique to counteract resistance to change, it is important to note that management attitudes to the two other states of emotional discomfort, Technostress and Technocentration, are quite different. These states are not regarded by employers as 'dangerous'. On the contrary, they are seldom viewed unfavourably, and are even welcomed for the short-term benefits in terms of efficiency they provide! In this way, they can constitute hidden threats to long-term health within the organisation.

To summarise, the chief purpose of stress research in the context of computer use (for which funding has been made available) has been to identify the negative job factors that may exist in the everyday job situation on a *daily* and *concrete* basis. In this way, the findings of this type of research (see table 3) can be related to a further research activity that is widespread in *European* countries; this involves assembling large numbers of behavioural scientists to work intensively on the development of job analyses that can provide the basis for job design, systems development and organisational change. The idea is to be able to offer guidance to production planners, both within the manufacturing and office sectors, so as to optimise job demands and to utilise these so that employees may alternate between intellectually and socially demanding tasks on the one hand and less demanding tasks on the other. This also involves developing the capacity to evaluate the use of computer technology in accordance with this ideal and to adopt a position on how it is to be employed.

A field of study that can also be included within a wide definition of occupational health research is the highly interesting research on skills development and computer use; this is also largely based in Europe and has brought together social scientists, psychologists and systems development specialists from many countries. It gives rise to a "non-medical" evaluation of health and is concerned with what happens to occupations and professions and their practitioners when computer technology is introduced into an occupational field. But, this type of research on how occupational skills are safeguarded and how occupational expertise develops and will develop is very much harder for the business world to digest and understand.

To describe the features of this research, we have to look at computer use as a process starting *before* the planning of and preparations for the implementation of a computer support have taken place, and ending several years later when use has been made of the computer system, and the employees have adapted to it. To facilitate an understanding of the characteristics of the process from the point of view of the user, a phase model has been proposed (Goranzon, 1990). See Figure 3.

			CONSEQUENCES:			
			FIRST ORDER ..	SECOND ORDER		..THIRD ORDER
"Before"	Preparation of computer system	Installation of equipment	Technical adaptation	Ergonomic adaptation	Organisational adaptation	Skills changes
	0-------		1 month	6 months- -	18 months	48 months
Problems to be solved:			x	x	x	???

Figure 3. Human consequences of the introduction of computer technology into the workplace. A long-term perspective

This research is based exclusively on intensive case studies. As a long-term effect problem is involved, the studies are usually conducted for a period of several years. It is not too much to say that such studies demand extraordinary skills from the researcher: he or she must be patient, highly sensitive to qualitative changes in job demands and work behaviour, and willing to return periodically for several years to the occupational field he/she is observing. But most important, the researcher must have a humanistic and critical attitude to how professional changes proceed generally.

With the qualifications in mind it is not surprising there are very few empirical (systematic) studies of this kind published. I will finish by mentioning two examples (Goranzon, 1990) which could have some relevance to the translation profession even if they concern quite different activities. The first is a study which has gone on for about ten years. The aim was to explore how computerisation changes the work procedures in the governmental authorities for valuation and taxation of woodlands. Foresters, forest officers and office workers employed by the authorities were continuously involved in a dialogue about how to develop a computer system which could support and not deprive them of necessary in-depth knowledge about the conditions of forest seeding, silviculture and forestry. Skills were as a matter of fact changed at the end of the study period towards a more superficial and generalised approach to the object in focus: the qualities of forests and woodlands, i.e: towards a deskilling of the professions/occupations involved.

The second study concerns the social insurance system and the work in the local social insurance offices in particular. Here the problem is how skills change when rules and legislation are built into the computer system and the social insurance officer no longer is required to make a decision when treating a single case. From being more of a social worker with a direct, personal contact with the individual client and his/her problems, office automation makes the employee deal automatically with the clients' needs for economic support. Moreover, he gradually loses the knowledge about rules and legislation, since they are so to say hidden in the computer,

the aim being to increase the number of clients handled per day.

This radical change of the work procedures in the local social insurance offices had the purpose of increasing efficiency, but with very little consideration for effectiveness. This can also be said about the first example. As such, these two studies have been and could in future be used as warnings and challenges to be careful in creating computer support, computer aid and computer-substituted human production in every professional field. There is a possibility that the professional skills developed over several decades or even centuries have features which we shall not miss until they have been lost!

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