

AN EASY-TO-USE PARTICIPATIVE VIDEO-COMPUTER METHOD FOR ERGONOMIC EVALUATION OF COMPLEX WORK

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VIDAR is a participative video-based method for ergonomic assessments. An employee is first video-recorded when performing his/her daily work. He/she then does an assessment of physically and psychologically demanding situations. In this project we have developed a new version of VIDAR, which runs with a (mobile) PC and a digital camcorder (DV). Three different ways of using the method were compared in each of three case studies. In each of the three ways the film is played and the employee(s) identify demanding situations. The three different ways of usage were: a person sees a film of himself/herself in work, a person sees someone else in work, a group sees someone in work. The case studies showed that the new version of VIDAR is useful in various branches. The practitioners agreed that the group analysis was the most time effective, that would also be their own choice of application in an other workplace analysis.

INTRODUCTION

Combinations of physical and psychosocial exposure induce musculoskeletal disorders. The complex associations between exposure and disorders make it hard to define limits. There is a need for easy-to-use systematic methods for assessments of such complex exposure. In e.g. nursing, long cycle time assembly or in production systems involving job rotation, the jobs are complex, involving varieties of tasks and equipments over a working day. The large number of situations and the different exposures to be considered may make ergonomic evaluation extremely difficult.

In IEA '97 in Tampere we presented our first version of a video-based method for ergonomic assessments (VIDAR; Kadefors & Forsman, 1997; 2000). After that a psychosocial part has been added (Johansson Hanse & Forsman, 2001). When using the method an employee is first video-recorded when performing his/her daily work. He/she (could also be someone else or a group) then does an assessment of physically and psychologically demanding situations. The window that opens when a psychologically demanding situation is being saved showed in the old version four demand-control questions, which were based on control and demand theory (Karasek & Teorell, 1990). The situations are saved on the hard-disc and reports are easily printed. The old version of VIDAR has been used in several case studies. A significant disadvantage was the need for large, heavy and expensive hardware.

The use of video in ergonomic data collection is not new; several methods have been developed during the last decades, e.g. ARBAN, HAMA, PEO, OWAS, RULA, VIRI. All of these methods are used by experts and result in time statistics of loads for the whole body or selected parts. These methods are very time consuming. VIDAR is instead based on the knowledge that employee has of his/her own work. It is a participative method where the resulting documentation may be used in interventions.

The aim of this project was to develop and test a new version of VIDAR. The project plan included two phases. In phase one, the program should be developed to run on a (mobile) PC connected to a digital camcorder (DV); the psychosocial part should be changed to better describe a demanding situation, and the program should be designed so that it is easy to learn and to use by practitioners. In phase two three different ways of using the method were to be used in each of three case studies in three different branches.

METHODOLOGICAL PRINCIPLES

The main principle of the method is that the employee should be seen as an expert at his/her own work, and that relevant information of physically and psychosocial information can be assessed when employees see themselves on video doing their ordinary work.

Physically demanding situations

To assess information about a physically demanding situation a body map (Kourinka et al., 1987) is used in combination with Borg's CR-10 scale (Borg, 1982). They are used in the same way as in the old version. Information of a situation's rate of occurrence is now included (also in psychosocially demanding situations).

Psychosocially demanding situations

The section of VIDAR that analyses identified psychological demanding situations has been restructured in the current version. Instead of scales for specific dimensions measuring eg levels of demand, a two-level thierarchy of questions with specified categories have been implemented. The categories aim at classifying the nature of the specific situation stopped for.

The categories of situations have been chosen are mainly based on action theory (e.g. Frese and Zapf, 1994). From this perspective, stressors are circumstances that disturb the goal directed regulation of actions. According to action theory, regulation problems can be classified into *overtaxing regulations* (meaning high speed and intensity of regulation, for example time pressure or high arousal over a long time), *regulation obstacles* (interruptions or other events that make goal attainment difficult or impossible), *regulation uncertainty* (lack of knowledge about the nature of the goals 'also known as role ambiguity', lack of knowledge how to achieve a certain goal, and deficiency of feedback that can give knowledge of the results of work). *Deficiency of feedback* is specified as a separate category.

Besides the action theory based taxonomy, some other categories were incorporated. *Lack of control*, means that the worker does not have autonomy and influence over the current work situation and thus has difficulties in the regulation of goal attainment. This is also a central part in the control-demand theory perspective (Karasek & Theorell, 1990). *Risky situations* include situations that involve danger or risk for health and safety for the focal person, other persons or risk for property and economical damage. *Emotional demands* include social stressors like interpersonal conflicts, and emotional work involving strong feelings or demands for hiding emotions (eg Di Salvo, 1995; Dorman & Zapf, 2002, Söderfeldt et al, 1996). Finally, *deficiency of goals* includes situations where internal goals are not established, like passive work or work situations that is regarded as meaningless. The categories on the first level of the hierarchy are shown in Figure 3.

A common feature for the chosen categories is that they can be tied to the specific critical situation that the video is stopped for. This limitation means that working conditions of more general nature are not incorporated as categories (eg satisfaction with leadership, rewards, social support). Such general working conditions may instead be asked for in a seperate questionnaire.

Data processing

The project aimed at a method that is well suited to be used by practitioners in ergonomic interventions. The software should therefore be user friendly and easy to learn. It should also facilitate integration of several individuals' analyses in a workplace. The software was designed in a co-operation of programmers, researchers (who had used VIDAR), and ergonomists (practitioners).

THE NEW VERSION OF VIDAR

Microsoft's .Net Visual Basic was used to implement the new program version. To enable communication between the computer and a DV, functions from Microsoft's framework Direct-X was encapsulated into a component that could be used from Visual Basic. To make the program easy to learn, the user interface is similar to that of other Windows programs. All text that you see when you run the program is read from a text file, which makes it very easy to change details, and to translate the program to additional languages. So far, the program supports Swedish and English.

VIDAR is meant to be used by practitioners in participative workplace interventions. Before the video recording, the personal is informed about the method and about the intervention project. Initially in a analyse session, the employee is again informed about the method and especially what happens when the buttons "physical" and "psychosocial" is clicked. The employee (could also be someone else than the filmed person, or a group) then sees the film of himself/herself in work, and assesses demanding situation by clicking the appropriate button. The main window of the program is shown in Figure 1.



Figure 1. The main window of VIDAR. When the Play button is pushed, the employee sees himself on video on the computer screen, doing his ordinary work, and can by clicking Physical or Psychosocial pause the film and save a demanding situation of one kind or the other (see Figures 2 and 3, respectively).

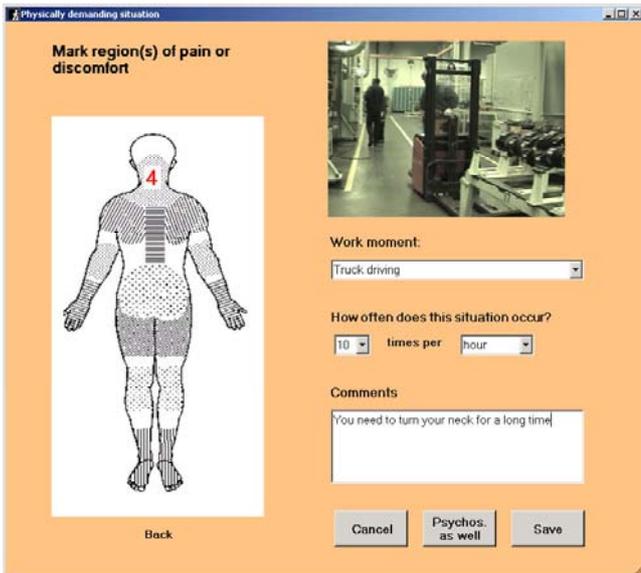


Figure 2. The physically demanding situation window. One or more body regions should be marked, and for each region, a value on the Borg CR-10 scale. Work moment information is required. The picture is saved together with the data.

The window that is opened when the “Physical” button is clicked is shown in Figure 2. You mark one or more body regions where the present situation causes pain or discomfort. For each marked body region an other window is shown where you are requested to mark a value on the Borg CR-10 scale. For each situation a name of the work moment should be given, either written or chosen from already used ones. You should also answer how often this situation occurs in times per minute/hour/day/week.

The window that is opened when the “Psychosocial” button is clicked is shown in Figure 3. In the old version there were four demand-control questions to be answered on a three-grade scale. Those four have now been substituted by one question and several describing terms (e.g. time pressure). One or more terms can be checked. For most terms there are an attendant question again with several alternative terms. In cases where one level is enough, the attendant questions may be hidden as an option in the meny bar of the main window. Work moment and occurrence rate information should be given for each identified situation.

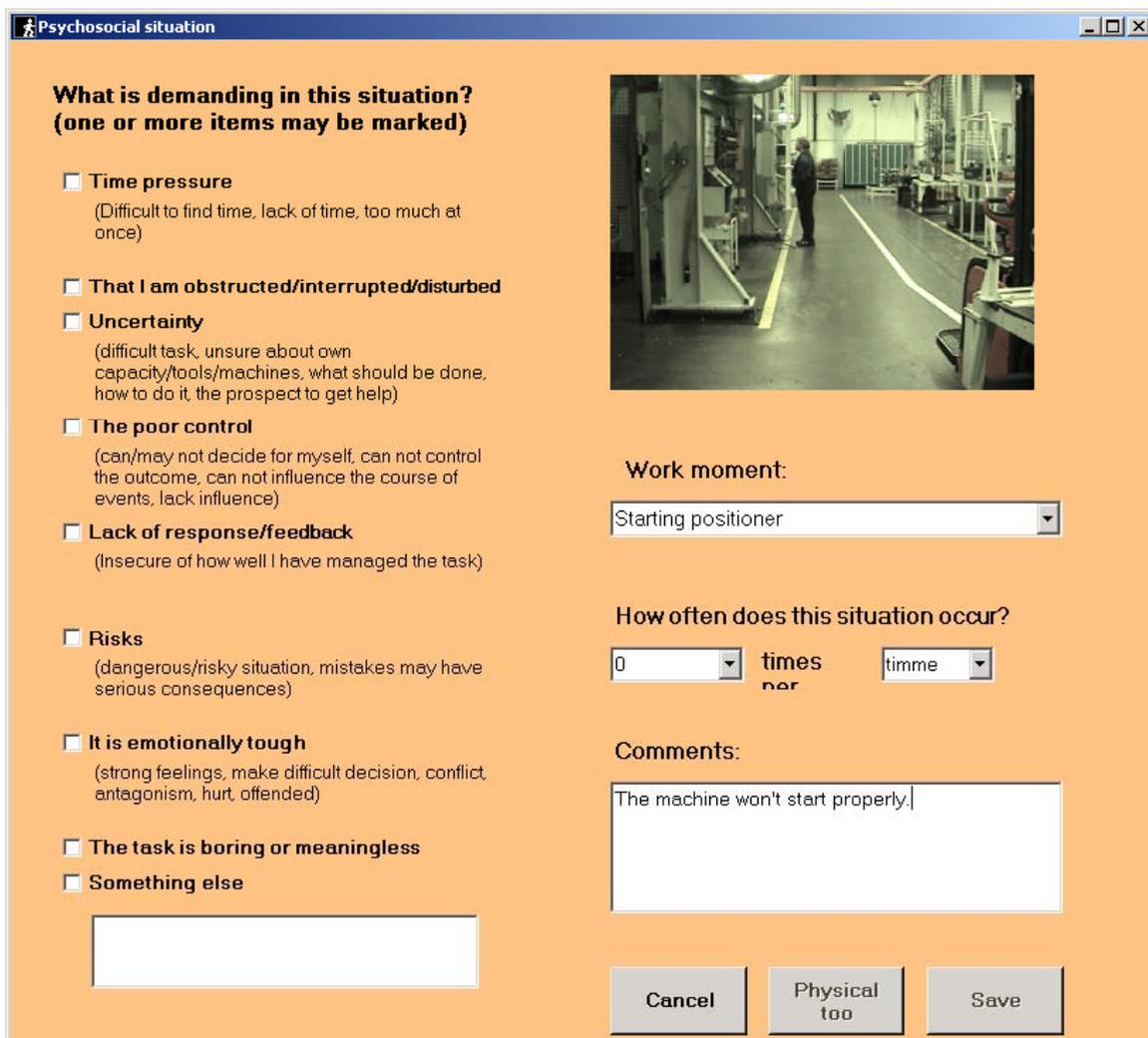


Figure 3. The psychosocial demanding situation window. The situation is described by one or more terms from the list.

Table 1. Summary of all saved situations in the case studies.

	Hospital			Glass			Trucks dept.1			Trucks dept.2		
	Own	Others	Group	Own	Others	Group	Own	Others	Group	Own	Others	Group
Physically demanding situations												
Total number of saved situations (all stops)	97	81	24	32	45	13	30	37	14	14	21	10
Number of different situations	40	37	15	12	15	11	13	12	11	10	14	8
Psychologically demanding situations												
Total number of saved situations (all stops)	10	5	3	2	2	1	2	6	3	8	5	4
Number of different situations	6	3	2	2	2	1	2	4	3	6	4	4

Case studies

To test the new version in the hands of practitioners and to compare different ways of using VIDAR, three different ways were used in each of three case studies. The case studies were carried out in three different branches and three different practitioners. In each of the three ways the film is played and the employee(s) assesses demanding situations. The three different ways of usage were:

- A person sees a film of himself/herself in work.
- A person sees a film of someone else in work.
- A group sees together, on a large screen, someone in work and each person may stop the film when a demanding situation occurs.

The three case studies were:

- a ward for long-stay elderly patients; 12 nurses in 3 groups used VIDAR in each of the three different ways with at least 2 weeks between the analyses, for practical reasons there were difficulties and a few substitutes had to be called for in the last round.
- crankshaft processing in a truck factory; 12 + 12 workers in the individual analyses, and 20 in 4 groups.
- glass workshops, in a glass factory (Orrefors); 15 glass workers were divided into three groups of 5. A total of 5 videos were recorded.

It was expected that “the same” situation would appear in many different analyses, i.e. that many persons would find the same tasks demanding. So was also the case, therefore the ergonomists tabulated all saved situations into groups of similar situations. These tables are summarised in Table 1.

Interviews were performed with the three practitioners based on an interview guide. The three practitioners found VIDAR effective and they all intend to continue to use the method in the future: “The method is easy to use and brings the knowledge of the employees about their own work into the intervention process.” For the third way of using VIDAR, the group analysis, the total number of identified physical situations were lower than for the two other, individual, analyses. In the industrial cases the difference in number of situations was very small but in the Hospital there were considerably less identified situations in the group analyses.

DISCUSSION

The case studies showed that the new version of VIDAR is useful in various branches – practitioners have used the method and demanding situations were identified.

The reports are suitable as a basis for discussions in improvement groups. In one of the cases, group discussions have taken place with good results, while such discussions are planned in the other two.

The three practitioners found VIDAR effective and they all intend to continue to use the method in the future. As shown in Table 1, for the the group analysis, in Hospital the number of identified physical situations were much lower than for the to other, individual, analyses. A probably explanation for this difference is the complex nursing work and that the analysed film time was much lower in the group analysis. In the industrial cases the difference in number of situations was very small. Although the practitioners said that they could find use for all three ways, they agreed that the group analysis was the most time effective, that would also be their own choice of application in an other workplace analysis.

REFERENCES

- Borg, G. Psychophysical bases of perceived exertion. 1982. *Medicine and Science in Sports and Exercise*. 14, 377-381
- Di Salvo, V., Lubbers, C., Rossi, A. M., Lewis, J. 1995. Unstructured perceptions of work-related stress: an exploratory qualitative study. In Crandall & P Perrewé (Eds.), *Occupational stress: a handbook* (39-50). Washington, DC: Taylor & Francis.
- Dormann, C. och Zapf D. 2002. Social stressors at work, irritation, and depressive symptoms: Accounting for unmeasured third variables in a multi-wave study. *Journal of Occupational and Organizational Psychology*, 75, 33-58.
- Frese, M., och Zapf, D. 1994. Action as the core of work psychology: A German approach. In Triandis, Dunnington, Hough, *Handbook of industrial and organizational psychology* (Vol. 4, 271-340). Palo Alto, CA: Consulting Psychologists Press.
- Johansson Hanse J, Forsman M. 2001. Identification and analysis of unsatisfactory psychosocial work situations: a participatory approach employing video-computer interaction. *Appl Ergon* 32:23-9.
- Kadefors R, Forsman M. 1997. Operator based ergonomic assessment of complex video sequences. In IEA '97, Tampere, Finland, Vol 4. 416-418.
- Kadefors R, Forsman M. 2000. Ergonomic evaluation of complex work sequences: a participative approach employing video-computer interaction, exemplified in a study of order picking. *International Journal of Industrial Ergonomics*, 25(4):435-45.
- Karasek, R. och Theorell, T. 1990. Healthy work. *Stress, productivity, and the reconstruction of working life*. Basic Books, Inc., New York
- Kuorinka, I., Jonsson, B., Kilbom, Å., Vinterberg, H., Biering-Sørensen, F., Andersson, G., Jørgensen, K. 1987. Standardised Nordic Questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics* 18, 233-237
- Söderfeldt, B., Söderfeldt, M., Muntaner, C., Ocampo, P., Warg, L. E., och Ohlson, C. G. 1996. Psychosocial work environment in human service organizations. *Social Science & Medicine*, 42(9), 1217-1226.