
**ORGANISATIONAL AND PSYCHOSOCIAL FACTORS AND THE DEVELOPMENT OF
MUSCULOSKELETAL DISORDERS OF THE UPPER LIMBS**

Addendum: development of training video

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CHAPTER 1: INTRODUCTION

As evoked in the conclusions of the report of the main study, the collective prevention actions must be accompanied by training programs of the workers with the aim of making them able to recognize the risks incurred and to teach them the strategies to implement in order to reduce these risks at the individual level.

The objective of this research action was to develop and validate a training method aimed to:

- provide the workers with information concerning ULDs and good work practices;
- make them conscious of their implication in the management of this problem;
- teach them how to adapt their movements and adopt new behaviours so as to prevent ULDs to occur.

The main training tool is a videocassette specific to the workplace. On the basis of a thorough study of the workplace and of video recordings of various workers, a videocassette is prepared in order to illustrate the good and bad work habits concerning postures, movements and operations. This cassette is integrated in a more comprehensive training program with a theoretical introduction on ULDs and a general discussion of the problems.

In order to assess the effectiveness of the intervention, we carried out a short-term evaluation of the principles, facts and techniques by means of a questionnaire before the training session and one month later.

CHAPTER 2: GUIDING PRINCIPLES

A. INTRODUCTION

More than in the past, the managers regard training of the employees as a "profitable" investment. Two reasons are that

- the company has a permanent need to update competences and knowledge of the personnel in a prospect of improvement of the productivity (Bouteiller, 1997).
- the training sessions, in particular those concerning the ULDs, contribute to the well being of the workers, to the reduction in the absentee rate and thus directly to the productivity (Guilbaut, 1997).

B. DESIGN OF A TRAINING ACTIVITY

According to Parmentier (2003), the design of a training includes several steps:

1. the collection and the analysis of the needs: the aim is here to measure the gap between the existing and desired situations and to list the needs that the training session must fulfil
2. the collection of the resources and the constraints
3. the analysis of the public concerned: the number of people, distribution, gender, age, education, qualification, experience.

Leplat (2002) proposes 4 phases for this design:

1. Initial conditions

The initial conditions are defined by the answers to the questions "training of whom and to do what?", which requires to collect the characteristics of the population to be trained, to determine its learning possibilities and to define the goals and the object of the training.

2. Diagnosis

The qualification to be acquired (and thus the training to provide) depends on the gap between the present qualification and the qualification required to perform the work.

3. Development and implementation of the training programme

The third phase consists in upgrading the qualification. The methods (content and procedure) are numerous and vary as a function of the diagnosis, the objectives, the possibilities and the context.

4. Results and evaluation

The author makes a distinction between two types of evaluation:

- the internal validation that answers the question: "Did the training session fulfil its goals"
- the external validation that answers the questions "is the training preparing for the work for which it was conceived of? Is the information provided indeed necessary to perform the task? "

CHAPTER 3: MATERIAL AND METHODS

A. SELECTION OF THE WORKPLACES AND THE POPULATION

This study was led in appendix of the prospective research entitled "Organisational and psychosocial factors and development of musculoskeletal disorders of the upper limbs". The workplaces were selected at the time of this research. All the workers (and not only those who took part in this research) underwent the training programme. Three workplaces were kept, given the quality of the relations developed during the prospective research, and the interest or even the request of the company. The three workplaces are:

- The inspection and packaging of catalytic converters: 18 operators
- Assembly of electronic parts: 10 operators
- The "shoppers" in a distribution centre for cosmetic products: 9 operators.



The work at these 3 workplaces is essentially repetitive.

B. THE PREVENTION TOOL

1. Collection of the data and information

a. First contacts

Since this study follows the prospective 3-year research, the workplaces had been observed and the workers had been questioned on several occasions. The 3 workplaces were thus quite familiar and the workers knew us.

b. Video recordings

Video recordings supplement direct observations: they can be viewed several times, in slow motion or on fixed frames so that the analysis can be more thorough. Recordings had been made already at the time of the main study. However it was necessary to return to the third company as the workplace had just been modified.

In order to be able to advise good work practices, it was necessary not only to know the workplaces, but also the interindividual differences in performing the tasks.

The recordings covered several operating cycles. They included an overall presentation of the work situation (approximately 5 minutes) and targeted views of the upper limbs and the neck comparing various operating procedures (minimum 10 minutes depending upon the operating cycle).

The whole made it possible to identify extreme postures, repetitive movements or unfavourable work practices, to understand the reasons for these and illustrate better procedures.

c. Biomechanical analyses

During the main study, a quantitative analysis made it possible to determine the percentages of the time during which the operators were in various postures. Our attention had been focused on the quantification rather than on the reasons of these postures so that it was necessary to analyse them again. However, the unfavourable movements and postures were known.

d. Observation

A meeting was organized with some operators, the occupational physician, an occupational health (OH) practitioner, possibly the section head and sometimes a union representative. The **Observation** method of the SOBANE ULDs strategy (Malchaire et al. , 2001) was used. It made it possible to better identify the possible improvements to the workplace and to better know some aspects of the working conditions like the organization, some causes of stress, of bad work postures. . . .

2. Development of the training materials

a. Montage of the cassette "training for good work practice"

The training cassette was edited in 6 stages.

- **1st stage:** all the recordings of each workplace were viewed again, keeping in mind the main risk factors, the results of the biomechanical analyses and the solutions highlighted during the Observation meeting. All the remarks were written down concerning the general work position, the various phases and operations and the good and bad work habits.
- **2^d stage:** A list was prepared with all the relevant and significant remarks concerning the whole group of operators.
- **3^d stage:** The recordings were again viewed in order to locate sequences illustrating the various points of this list.
- **4th stage:** A text was written describing the bad and good work practices.
- **5th stage:** Video sequences were selected to correspond precisely to the text and the montage of the cassette was carried out.
- **6th stage:** Finally the soundtrack was recorded.

b. The written document distributed to the operators

To accompany the oral and visual training using the videocassette, a written document was prepared:

- A first part relates to the ULDs: What are they? What are the risk factors? What concepts are important to know?

- The second part takes again some advices with regard to the general work posture, the movements to avoid on the level of the wrists and the hands and on the level of the shoulders for the 3d workplace (shoppers).

c. The organization of the training

- **Practical organization**

A meeting with the OH practitioner and the section head was organized in order to present the videocassette and discuss the practical organization of the training within the company by group of approximately 10 operators.

- For the inspection of catalytic converters, 3 groups (of 6 workers accompanied by the respective foreman) attended the training session as well as the head of the department, the OH practitioner or the nurse.
- For the assembly of electronic parts, a group of 10 operators attended the session, with the foreman, the OH practitioner and a union representative.
- For the shoppers, 3 groups of 3 people attended the session with the OH practitioner and the occupational physician.

A short individual discussion preceded the training session to evaluate the basic knowledge of the operators concerning ULDs and the good work practices. This interview was repeated approximately 30 days later in order to evaluate the impact of the training on the level of knowledge.

- **The training sessions**

The group meetings were organized in three parts:

- A theoretical introduction concerning:
 - ✧ the aim of the programme and its schedule;
 - ✧ the upper limb disorders: this part was organized in a participative way, with the trainer inviting the participants to define together ULDs, the risk factors, the relevance at their workplace, why? ...
 - ✧ how to view the training cassette.
 This theoretical introduction was the same for the 3 workplaces.
- Vision of the videocassette without interruption.
- Discussion

Everyone gives his opinion. What does come out from it? What struck you? What do you recall? Did you realize certain things? What do you think about it?

This discussion appeared all the more interesting as the operators often paid attention to different aspects.

During this discussion, the trainer ensured that the significant points, the key words were again stated.

- **Some strategies to be considered**

The strategy described above obeys the following principles:

- **Before the training:**

Following Basque (1998), the training session started with an introduction clearly explaining the goal, the significance, the planning of the training so that the participants feel concerned and get involved.

This introduction is a significant stage to integrate the participants and to reinforce the dimensions described by Haccoun (1997): the feeling of personal effectiveness (belief to be able to succeed) and the feeling to be able to control his own behaviours and motivation. This reinforcement must start from the very start but is spread out over the whole duration of the training activity. During or after the training, the trainer must react as soon as a doubt appears among the participants.

It is essential to give information on the result of the efforts (Leplat 2002). In this case of a training relating to good movements at work and ULDs, we insisted from the beginning to the end, on the fact that any effort by the workers, whatever small, will contribute to their well being.

- **During the training:**

In the 3 companies, the managers showed their interest to the training programme. As underlined by Basque (1998), this implication contributed to the good course of the training in a relaxed atmosphere. The author also stresses the importance of the physical environment. We paid attention so that the sessions were held in a comfortable and well adapted room, a conference room with the adequate material to view the cassette.

We also paid attention so that there was no temporal constraint. The training sessions always took place a little more than one hour before the end of the shift, implying that the work was ended.

As shown by Parmentier (2003), the more the adult is in interaction with the trainer and the contents of the training, the more he learns, the interactivity being essential to the training. After viewing the cassette, enough time was allocated so that each participant could express what struck him, could react based on his experience and express his difficulties or doubts.

- **After the training:**

After a training session, it is necessary that the participants be able to turn to a source of information that answers their questions. The support that we chose to provide is a summary document of what we broached together.

3. The evaluation of knowledge: development of a questionnaire

The questionnaire was developed in order to structure the interviews, before and one month after the training session (appendix 1 for the assembly workplace).

The first part dealt with the ULDs, their definition, the way they develop, the risk factors, and how the worker perceives them. It also included some questions about how the operator believes that he works.

The second part related to the best practices and dealt with the main points in the videocassette.

The operators were interviewed at the workplace so that they could illustrate their remarks in the real working conditions. It lasted about ten minutes per person.

CHAPTER 4: PRESENTATION AND ANALYSIS OF THE RESULTS

A. THE TRAINING

1. The videocassette

The durations of the cassette were

- 23 minutes for the inspection of catalytic converters.
- 14 minutes for the assembly of electronic parts.
- 24 minutes for the "shoppers".

Table 4.1. shows the content of each cassette. These cassettes were only passed on the company for obvious reasons of confidentiality.

Table 4. 1: Framework of the content of the training video cassette

Introduction
The introduction describes the context in which the cassette was produced, the expectations, the objectives and the means to reach them. It introduces also the points dealt with. Possible remarks specific to the workplace are made.
I. General work posture
One starts to describe the general work posture (sitting or standing) - and the consequences of a bad posture. Advices are given for a good sitting or upright position as well as on how to rest in this position. The various segments of the body are then considered successively. For each one, pictures illustrate the good and bad postures and their consequences. This section ends with a summary of the good postures specific to the workplace, which is repeated at the end of the cassette.
II. Analysis of various elementary operations
Work is broken up into various tasks, for which the movements are analysed. Again, filmed sequences illustrate the good and bad work habits.
III. Postures and movements to be avoided
This section is centred on the postures and movements to be avoided on the level of the wrists. A theoretical introduction, common to all the cassettes, presents the extreme postures to avoid: flexion, extension, ulnar and radial deviations. These postures are then illustrated by good and bad examples from various tasks at the workplace.
IV. Summary
The cassette ends by a summary. The main ideas are taken up and illustrated by particularly conclusive video sequences.

2. Training

Table 4. 2 shows the framework of the training session. The first two sections are identical for the 3 cassettes.

Table 4. 2: Framework of the training session

<p style="text-align: center;">Introduction</p> <ul style="list-style-type: none">• Why some questions before the training session? So that you notice yourself the state of your "knowledge" about ULDs and the good work practices.• We will define together what we mean by ULDs and will view a cassette edited on the basis of recordings of some of you. This cassette is supposed to show what are the good and bad work habits. It describes the various operations at the workplace and your way of working. We will return in about 30 days to ask you again some questions in order to determine what this training brought to you.
<p style="text-align: center;">ULDs</p> <p>Before viewing the cassette, let us define together what we call ULDs.</p> <ul style="list-style-type: none">• According to you, what are ULDs?<ul style="list-style-type: none">✦ This term concerns a whole set of diseases and symptoms.✦ ULDs can result in discomfort but also in pain.✦ They can have an impact on work, either the person works differently, or is simply not able to work any longer.✦ They develop gradually.✦ At the level of the muscles, articulations, tendons.• The risk factors are found at the workplace but also at home. In view of the place of work in the life in general, 8h/d, 5d/ week, it is absolutely necessary to act on the risk factors present at the workplace.<ul style="list-style-type: none">✦ What can be risk factors related to work? Repetition, forces, awkward postures, vibrations, sharp edges, etc.✦ Apart from work, what factors do you imagine responsible for the appearance of ULDs? <u>Personnel</u>: age, anthropometrics, training, previous accidents or problems (weakening of some body areas).. <u>Leisure</u>: sport, hobbies (knitting), gardening... <u>Psychosocial factors</u>: monotony, job insecurity, social environment, social relationships, time pressure...• Some important concepts:<ul style="list-style-type: none">✦ There are often several origins to ULDs.✦ Each situation is different.✦ Any improvement on the level of the practices will have a positive impact.✦ It is necessary to start by optimising the working conditions and adopting correct work practices.• Do you think you are exposed to some risk factors among those we talked about?• Do you think you can be prone to ULDs?<ul style="list-style-type: none">➔ Make the workers aware of the risk, insist on the fact that all are concerned and insist on the importance of implementing some strategies to avoid or to reduce risk factors.
<p style="text-align: center;">View of the video cassette</p> <p>We will view the video cassette. It lasts approximately ... minutes.</p> <ul style="list-style-type: none">• I ask you<ul style="list-style-type: none">✦ to pay attention to the text which goes with the video sequences,✦ to try to imagine yourself carrying out the operation discussed in the sequence.

- The various operations will be described.
- There are good and bad examples, pay attention to the consequences of the various practices. Attention, bad practices do not mean that the person is not working correctly.
- It is a question to see what movements occur and to recommend good work practices to avoid musculoskeletal discomfort or disorders.

Discussion

- What emerges from this?
- Were you struck by something?
- Did you realize some movements or practices, which you did not know you were doing?
- What do you recall?

Inspection of catalytic converters	Assembly of electronic parts	Shoppers
<ul style="list-style-type: none"> • Upright posture: that must be lighten <ul style="list-style-type: none"> ✦ Don't remain still ✦ Move the feet for a good blood circulation ✦ Move the feet to avoid torsions ✦ Move, stretch the legs to rest • On the level of the arms, to avoid any spreading <ul style="list-style-type: none"> ✦ As much as possible wait the converters at the end of the line ✦ Pay attention at the bright of the piles of paperboards or guides ✦ Move the body • For the wrists <ul style="list-style-type: none"> ✦ Avoid constraining postures and extreme movements ✦ Pay attention to the movements ✦ Alternate the various grips ✦ Favour palmar grips • Concerning the time <ul style="list-style-type: none"> ✦ Make one thing at a time, as the work rates allows it ✦ Rest as soon as possible: to stretch or sit down ✦ Pay attention not to lean on sharp edges 	<ul style="list-style-type: none"> • Sitting posture: it is necessary to pay attention that this position be as adequate as possible, that is: <ul style="list-style-type: none"> ✦ Good dorsal support: backrest straight and symmetrical ✦ Good seat height: avoid bending the neck and spreading the arms ✦ Good position of the legs/feet: use the footrest, feet non crossed, not under the seat, in order to avoid compressions • On the level of the wrists and hands <ul style="list-style-type: none"> ✦ Avoid constraining postures and extreme movements ✦ Pay attention to the movements ✦ For the grips, use the whole hand as frequently as possible, or alternate to the maximum ✦ Avoid pinching with the end of the fingers ✦ Avoid maintaining permanently a tool in the hand: useless effort, permanent contraction ✦ Work with small reserves of parts around the gauge in order to decrease the broad and constraining movements • Resting posture <ul style="list-style-type: none"> ✦ Stretch the legs regularly 	<ul style="list-style-type: none"> • Upright posture: <ul style="list-style-type: none"> ✦ Move the feet to accompany the movements of the trunk and avoid any torsion of the trunk. ✦ Move vis-à-vis the product in order to avoid rotations of the shoulders. ✦ Avoid bending the back by assembling the paperboards at good height. • On the level of the wrists and hands <ul style="list-style-type: none"> ✦ Avoid the constraining postures (in flexion, extension, ulnar and radial deviations) when gripping the products, pushing the shopper or closing the paperboards. • On the level of the arms and more particularly of the shoulders <ul style="list-style-type: none"> ✦ Avoid any extreme movement of extension, spreading or rotation when gripping the products. • When gripping the products. <ul style="list-style-type: none"> ✦ Grip with the whole hand. ✦ Avoid gripping several products or boxes at the same time. ✦ Avoid working with another thing in hand such as a cutter or a piece of plastic.

3. Informative document intended for the operators

The document distributed to the workers at the end of the training session summarizes the contents of the training. It includes a section on ULDs and another one entitled "good work practices".

We tried to dynamize the document (using bold characters, drawings, bullets...) so that it is pleasant to read. The document is identical for the 3 workplaces for the section concerning the ULDs, but it differs regarding the good practices. It is illustrated in appendix 2 for the assembly of electronic parts.

B. THE EVALUATION OF THE TRAINING

1. Definition of the model of evaluation of the intervention

Table 4. 3 shows the classification of the methods of evaluation of a training intervention suggested by Robson (2001). The greyed parts indicate the choices made, given that the duration of our study was only of a few months. It is about an evaluation of short-term knowledge by means of a questionnaire administrated right before and one month after the training session.

Table 4. 3: Model of evaluation implemented: advantages and disadvantages.

Objectives	Short term: to improve the education and qualification		
	Medium term: to bring a behavioural change		
	Long term: to decrease the frequency of industrial accidents		
Methods	Quantitative: measurements of indicators, variables	ADVANTAGES	WEAKNESSES
	Qualitative: Interviews, analyses, observations	<ul style="list-style-type: none"> Determine whether there is an effect or not 	<ul style="list-style-type: none"> More subjective evaluation
Design	NON EXPERIMENTAL (Field survey) Before and After	<ul style="list-style-type: none"> Evaluate the difference in the same group before and after an intervention 	<ul style="list-style-type: none"> Pay attention to events other than the training session that occur during the observation period To use when it is about short-term impact
	Afterwards		
	Afterwards + Control Groups		
	QUASI experimental: lab and field studies		
	Experimental: laboratory studies		
Measure results	Observations of the behaviours and workstations :		
	<ul style="list-style-type: none"> Interview of the person Write, at least, an outline of the interview Quantitative analyses, codify the answers and process results statistically Qualitative analyses, process the interviews individually 	<ul style="list-style-type: none"> Measure what cannot be observed, that is, knowledge, beliefs, perceptions OK if the intervention targets a change on the level of knowledge The qualitative data collected during the talks are useful to supplement other measurements 	<ul style="list-style-type: none"> If the intervention aims at behavioural changes an evaluation by interview can be indicative but the behavioural changes cannot be confirmed The drafting of the questionnaire is difficult, the coding of the answers can be regarded as subjective

2. Results

The first part of the questionnaire, shared by the 3 workplaces, related to the understanding of ULDs. It includes 3 questions (score from 0 to 8) relative to

- the definition of the ULDs (from 1 to 3 points),
- the risk factors (from 1 to 4 points),
- the development of the ULDs (1 point).

The second part related to the knowledge of the good work practices. It was specific to each workplace.

- **Post inspection catalytic converters (table 4.4)**

A total score (from 0 to 18 points) was calculated from the 5 partial scores related to:

- the general work posture (from 0 to 2 points),
- the grip and handling of the parts (from 0 to 6 points),
- the layout of the workstation (from 0 to 3 points),
- the movements to avoid (from 0 to 5 points),
- the resting posture (from 0 to 2 points).

- **Post assembly electronic parts (table 4.5)**

A total score (from 0 to 15 points) was calculated from the 4 partial scores:

- the general work posture (from 0 to 4 points),
- the grip and handling of the parts (from 0 to 4 points),
- the movement to avoid (from 0 to 6 points),
- the resting posture (to 0 point).

- **Post "shoppers" in a distribution of cosmetic products (table 4.6)**

A total score (from 1 to 25 points) was calculated from the 3 partial scores:

- the general work posture (from 0 to 11 points),
- the training on how to close the boxes (from 0 to 4 points),
- the movement to avoid (from 0 to 10 points),

3. Analyses of the results

Tables 4.4., 4.5. and 4.6. give the means and standard deviations of the scores before and after the training sessions as well as the means and standard deviations of the differences of the 2 scores. These scores are reported in absolute values (on their own scale from 1 to 3 or 1 to 8...) and in relative values, expressed as a percentage of the maximum score. The last column gives the statistical degree of significance of the student test bearing on this difference.

The last lines give the total results for the part on "Practices" and for the whole questionnaire.

Table 4. 4: Means and standard deviations of the scores – before, after and difference - of the questionnaire for the operators of the workstation "inspection of catalytic converters"

n=18		m	s	m %	s %	test t
ULD theory (max=8)	before	2,94	2,29	36,8	28,6	
	after	5,72	0,75	71,5	9,4	
	diff	2,78	2,02	34,7	25,2	***
General work posture (max=2)	before	0,75	0,79	37,5	39,5	
	after	1,78	0,43	88,9	21,4	
	diff	1,03	0,83	51,4	41,5	***
Grip and handling of the parts (max=6)	before	2,44	0,98	40,7	16,4	
	after	4,72	1,32	78,7	22,0	
	diff	2,28	1,71	38,0	28,5	***
Layout of the workstation (max=3)	before	1,72	1,13	57,4	37,6	
	after	2,44	0,86	81,5	28,5	
	diff	0,72	1,07	24,1	35,8	*
Movements to avoid (max=5)	before	2,17	1,50	43,3	30,1	
	after	4,17	1,15	83,3	23,0	
	diff	2,00	1,37	40,0	27,4	***
Resting posture (max=2)	before	1,28	0,75	63,9	37,6	
	after	1,64	0,48	81,9	24,0	
	diff	0,36	0,68	18,1	34,1	*
Total "Practices" (max=18)	before	8,36	2,39	44,8	12,3	
	after	14,75	2,57	76,3	14,6	
	diff	6,39	2,27	31,5	12,1	***
Total (max=25)	before	11,31	2,73	40,8	13,8	
	after	20,47	2,60	73,9	8,2	
	diff	9,17	3,13	33,1	14,4	***

Caption: * p< 5% , *** p < 0. 1 %

Table 4.5: Means and standard deviations of the scores – before, after and difference - of the questionnaire for the operators of the workstation "assembly of electronic parts"

n=10		m	s	m %	s %	test t
ULD theory (max=8)	before	3,50	1,58	43,8	19,8	***
	after	6,10	1,45	76,3	18,1	
	diff	2,60	1,65	32,5	20,6	
General work posture (max=4)	before	2,45	1,21	61,3	30,3	**
	after	3,85	0,34	96,3	8,4	
	diff	1,40	1,13	35,0	28,1	
Grip and handling of the parts (max=4)	before	2,50	1,43	62,5	35,8	*
	after	3,90	0,32	97,5	7,9	
	diff	1,40	1,43	35,0	35,7	
Movements to avoid (max=6)	before	1,90	2,02	31,7	33,7	**
	after	4,40	1,90	73,3	31,6	
	diff	2,50	2,37	41,7	39,5	
Resting posture (max=1)	before	0,80	0,42	80,0	42,2	NS
	after	1,00	0,00	100,0	0,0	
	diff	0,20	0,42	20,0	42,2	
Total "Practice" (max=15)	before	7,65	3,51	51,0	23,4	***
	after	13,15	2,24	87,7	14,9	
	diff	5,50	3,21	36,7	21,4	
Total (max=23)	before	11,15	3,40	48,5	14,8	***
	after	19,25	3,21	83,7	13,9	
	diff	8,10	2,90	35,2	12,6	

* p < 5% , ** p < 1%, *** p < 0. 1%

Table 4.6: Means and standard deviations of the scores – before, after and difference - of the questionnaire for the operators of the workstation "shoppers"

n=9		m	s	m %	s %	test t
ULD theory (max=8)	before	1	1,58	12,5	19,8	***
	after	4,56	0,88	56,9	11	
	diff	3,56	1,59	44,4	19,9	
General work posture (max=11)	before	3,44	2,07	31,3	18,8	**
	after	6,22	1,72	56,6	15,6	
	diff	2,78	2,28	25,3	20,7	
Training on how to close the cases (max=4)	before	1,78	0,83	44,4	20,8	***
	after	3,56	0,53	88,9	13,2	
	diff	1,78	0,83	44,4	20,8	
Movements to avoid (max=10)	before	1,56	1,24	15,6	12,4	***
	after	4,11	1,9	41,1	19	
	diff	2,56	1,51	25,6	15,1	
Total "Practice" (max=25)	before	6,78	3,77	27,1	15,1	***
	after	13,9	2,93	55,6	11,7	
	diff	7,11	3,1	28,4	12,4	
Total (max=33)	before	7,78	4,21	23,6	12,7	***
	after	18,4	3,13	55,9	9,48	
	diff	10,7	2,65	32,3	8,02	

** p < 1%, *** p < 0.1%

To supplement our first observations, a variance analysis was carried out in order to see whether a "workstation" or "subject" effect could be highlighted. The following multiple variance analyses were carried out:

- Dependent variables:
 - ✦ Score Theory ULDs (%)
 - ✦ Total score "Practice" (%)
 - ✦ Total score (%)
- Independent variables
 - ✦ Subjects and moments (before and after)
 - ✦ Workstations and moments (before and after)

Table 4.7 summarizes the variance analyses

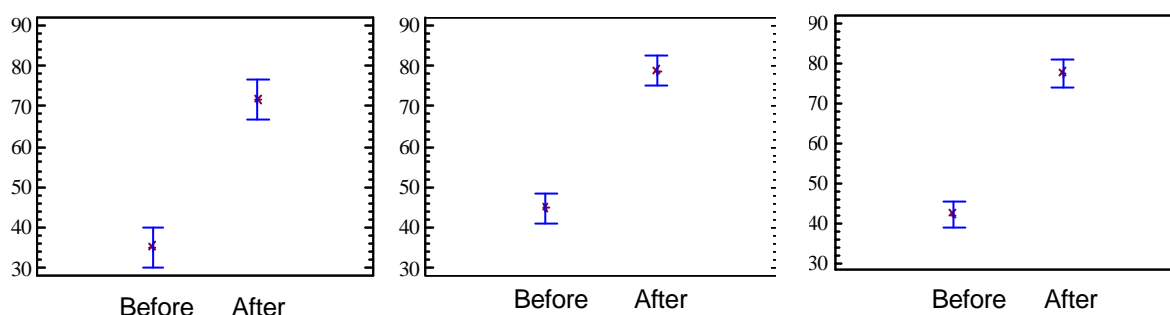
Table 4.7: Variance analyses

Independent variables			Dependent variables		
			ULDs	Practical	Total
1st Analysis	Subjects		NS	*	NS
	Moments		***	***	***
2nd Analysis	Workstations		***	***	***
	Moments		***	***	***

* p < 5% , ** p < 1%, *** p < 0.1%

- A "subject" effect is observed only with regard to the personal practice, some workers learning more than others how to adapt their movements.
- The "moment" effects are all highly significant. Figures 4.1 to 4.3 show the mean and confidence intervals of the group of the 37 subjects before and after the training for the 3 scores:

Figure 4.1: Mean % and confidence intervals for the theory score before and after the training session	Figure 4.2: Mean % and confidence intervals for the score "Practice" before and after the training session	Figure 4.3: Mean % and confidence intervals for the total score before and after the training session
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- A "workstation" effect is observed for the 3 main scores, as table 4.8 summarizes it. This effect comes obviously from the third company where as well the basic knowledge as the way of working were the worse before and remained the worse after the training. However, the induced improvement is approximately of the same order of magnitude, that is, about 30% in all cases.

Table 4.8: Means of the scores "Theory ULDs", "Practice" and "Total" for each workstation and the whole group of subjects

Scores		Item 1		Item 2		Item 3		Total	
Theory ULDs	Before	36,8	28,6	43,8	19,8	12,5	19,8	32. 8	26. 7
	After	71,5	9,4	76,3	18,1	56,9	11	69. 3	14. 3
	Diff	34,7	25,2	32,5	20,6	44,4	19,9	36. 5	22. 7
Practice	Before	44,8	12,3	51,0	23,4	27,1	15,1	43. 0	18. 9
	After	76,3	14,6	87,7	14,9	55,6	11,7	77. 1	18. 5
	Diff	31,5	12,1	36,7	21,4	28,4	12,4	34. 1	15. 3
Total	Before	40,8	13,8	48,5	14,8	23,6	12,7	40. 5	15. 2
	After	73,9	8,2	83,7	13,9	55,9	9,5	75. 6	15. 8
	Diff	33,1	14,4	35,2	12,6	32,3	8,02	35. 1	11. 1

CHAPTER 5: DISCUSSION

A. MONTAGE OF THE VIDEO CASSETTE

1. Collection of the data

The study was carried out at the end of the epidemiological research project on the "Organisational and psychosocial factors and development of ULDs" and thus profited from the information collected in particular during:

- the use of the method of level 2, **Observation** of the SOBANE strategy;
- the quantitative biomechanical analyses of the video recordings concerning the postures and the most demanding grips;
- the revision of the recordings under another angle in order to understand the reasons of these postures or grips.
- the questionnaires giving the prevalence of ULDs in the various groups.

The development of the training video requires a perfect knowledge of the workstation (spatial and temporal organization, definition of the tasks, constraints...) and of the movements and postures to be avoided. For an ergonomist external to the company, work must start with a thorough study of the workstation. A participative method (type SOBANE ULD) with people knowing very well the work situation is essential.

Then, video recordings of a maximum of people must be made to describe the various work practices. These recordings must be carried out within the various working groups (groups of workers or work teams) in making sure that the working conditions (production, absenteeism, operating cycle) are representative of the normal work situation.

It is also essential to record the characteristics of the subjects and their responsibilities in order to adapt the text, the substance and the form, to put them in confidence concerning their capacities and consequently to make them more prepared and open to receive new information. As underlined by Haccoun (1997) "the belief to be able to succeed" and the motivation can be born, shaken or reinforced by the fact that the training is adapted or not to the capacities of the subject.

This collection of data takes time but must be carried out completely and correctly as it determines the quality of the intervention.

2. Recording of the video cassette

The recording of the cassette in itself is a long work that requires a perfect knowledge of the workstation and the operations. The ideal would be that two observers, in order to avoid the omissions and to diversify the ideas carry it out.

The selection of the sequences is also a delicate task

- first, the problem is to choose the sequence illustrating the text as well as possible;
- then, the sequences (overall picture or targeted, with or without fixed frames) must be arranged so as to highlight the ideas;
- finally, it is necessary to note which worker is selected, for which illustration (positive or negative) so that the division between the good and bad examples and the various people is balanced.

B. TRAINING

The training (presentation of the cassette, discussion, documentation) is specific to the workplace so that the workers feel themselves directly concerned.

Three conditions appear essential for the good course of the training session:

- the hierarchy must support the training project, express its importance, define the objectives (Bouteiller, 1997) and grant the time necessary for the session.
- the physical environment plays also a role on the perception of the conditions (Basque 1998). The room must be pleasant, sufficiently large, with the necessary equipment.
- the training must be as much interactive as possible. The interactivity can result in the awakening of the senses (Parmentier, 2003): during the training session, the workers had the opportunity to hear (introduction and cassette), see (cassette) and repeat the information (participative introduction and final discussion).

The purpose of the discussion, after viewing the cassette, is that each one expresses his opinion, his confusion or his difficulties, but also that he formulates his questions (Leplat, 2002). This phase is important because everyone could express himself but also because the objectives, the expected results and the broad outline of the training were reformulated.

C. THE EVALUATION OF THE TRAINING SESSION

1. Objectives and tool of the evaluation

The evaluation is necessary, if only, to justify to the direction the training cost.

Kirkpatrick (Alliger, 1989) proposes a model of evaluation in 4 levels: reactions, learnings, behaviours and results.

The first level (reactions) consists in collecting the first opinion of the person concerning the training session. Several authors as Haccoun (1997) think that this level does not bring valid information about the effectiveness of the training.

We wanted to evaluate the impact on behaviours. Such an evaluation (development of checklists, new video recordings and comparison with the first recordings) needed a lot of time that was not available.

We consequently chose the second level which, according to Alliger (1989), would be indicative of the higher level (behaviours) and although, as Haccoun (1999) underlines it, "the reactions to the training and the learning are not the main causes of the transfer".

According to the model, the evaluation includes the measurement of the principles and technical facts, understood and mastered. Haccoun (1997) distinguishes two possibilities of evaluation: that of declaratory knowledge and that of the conceptual learning. We chose the first, the second approaching an evaluation of the behaviours. The evaluation of declaratory knowledge measures, using a questionnaire, what was actually remembered.

We chose a non-experimental investigation with an evaluation before and after the intervention in order to be able to determine the gaps of knowledge before; and the evolution of the knowledge after the intervention.

2. Analysis of the results

Important and statistically significant improvements of the various scores are clearly observed. The final scores are particularly better given that they were good before the training session.

The time interval between the 2 evaluations was only approximately one month so that these short-term effects could not translate in long-term transformations. A reevaluation after a longer period is necessary. The scores will however be lower than the current scores since, as all the

literature underlines it, it is essential to repeat the training at regular intervals in order to anchor new working practices and replace those contracted since 3 to 25 years.

The results seem interesting in absolute value since the scores increased from 30 – 40% to 70 to 75%.

One can however think that any intervention, whatever insubstantial it is, would have had an effect. Thus, the results must now be studied in relative value, in comparison to those of other more flexible and less expensive types of training.

CHAPTER 6: CONCLUSION

The objectives of the project have been achieved: a methodology for training about ULDs and good work practices was developed and its impact on the knowledge of the participants was evaluated.

The training, as conceived, is strongly personalized using a videocassette prepared from recordings of the workers themselves. The workers liked this personalized training, and declared better realize the problems by the fact of seeing themselves or their colleagues at work. This personalization however is very costly. Its design requires the collection of a great number of data and, consequently, a lot of time. This constitutes a real obstacle in the field. Once the cassette is prepared the time necessary for the training is about the same as with other methods.

The results show that the training is fruitful in the short-term, but do not give any information concerning the changes of behaviours for the reduction in the prevalence of ULDs. The pursue of this work towards a longer-term evaluation would be desirable.

This training cannot be regarded as being the major mean of prevention of the ULDs. It must be complementary to collective prevention measures and be registered rather at the level of **Analysis** of the SOBANE strategy. Thus, it is not use teaching an operator the characteristics of a good sitting posture, if the available seat is in bad shape or uncomfortable. The technical measurements needed and feasible must be taken at the same time, and preferably before, any individual prevention measure.

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APPENDIX 1: QUESTIONNAIRE FOR THE ASSEMBLY WORKSTATION

Workstation:	Date:
Name (number):	Visit: Before – After the training session

1st Part: ULDs

1. In your entourage, your colleagues, your family, has someone already suffered from ULDs? . . .
.....
2. What was it?
.....
3. What was the cause?
.....
4. How did it appear?
.....
5. In general, are you careful about how you hold yourself?
.....
6. In general, are you careful about your movements of the wrists and the hands?
.....

6bis. At work, did you adapt your movements following the training you received?
.....

6ter. At work, did you change certain practices since this training session?
.....

2nd Part: Knowledge of good work practices

General work posture

7. You work seated. What advices would you give a new operator for a good sitting posture?
At the level of the back:
.....
8. At the level of the neck:
.....
9. For a good sitting posture, what advices would you give for the position of the feet to ensure a
good blood circulation?
.....
10. At the level of the arms and elbows, what position would you recommend so that the muscles
of the shoulders remain relaxed?
.....

Grip and handling of the parts

11. A new operator must weld a part. What advices would you give him/her to avoid a significant
flexion of the neck and a stooping of the back?
.....

12. During the assembly, some operators permanently hold the screwdriver in the hand. What do you think of this?

.....

Why?.....

.....

13. For operations requiring some efforts, such as the closing of the cases, some workers use two fingers, others the hand. What is preferable?

.....

Why?.....

.....

Movements to avoid

14. Can you show 3 constraining movements of the wrists?

.....

.....

15. In which operation for example can you find these movements?

1).....

2).....

16. How can you avoid these movements?

.....

.....

Resting posture

17. The sitting posture leads to some tiredness or pain or discomfort. Do you have the possibility of resting and lessening the strain on you? How?

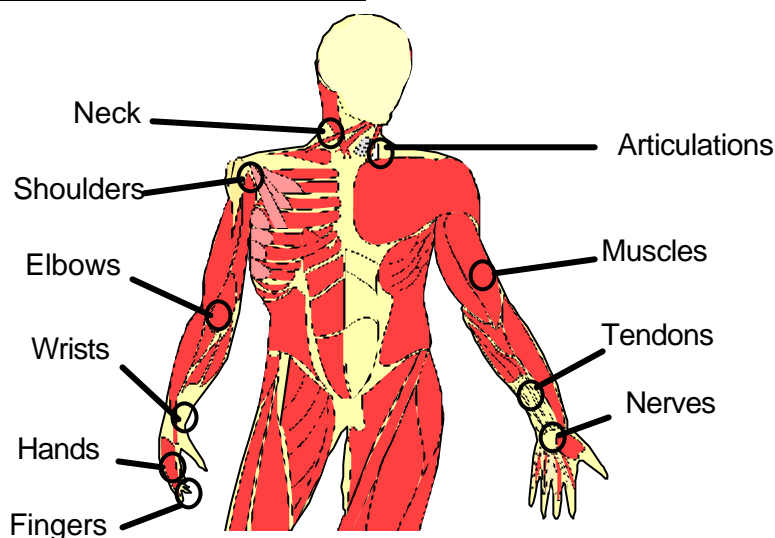
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APPENDIX 2: INFORMATIVE DOCUMENT FOR THE OPERATORS OF THE ASSEMBLY WORKSTATION

Training to good practices at work Assembly of electronic parts

1. Upper limb disorders: ULDs



a. What is it ?

- difficulties, discomfort or pain
 - ✧ at the level of the articulations, muscles, tendons
 - ✧ with a reduction in the capacities (forces, movements...) or even some disability.
- ULDs appear gradually
They do not occur following a shock or an accident, but rather gradually when the worker is exposed to certain risk factors.
- ULDs gather together a whole of diseases or symptoms.
Example: Tendonitis, lumbagos, Carpal tunnel syndrome

b. What are the factors responsible for ULDs?

- At work:
 - ✧ The repetition of the same movements
 - ✧ Significant forces
 - ✧ Unsuitable postures (extreme movements, remaining still a long time ...)
 - ✧ Others: such as
 - vibrations

- sharp edges of working surfaces or tools
- cold surfaces
- Personal factors:
 - ✧ Age
 - ✧ Training (good practices, correct use of the tools, good movements)
 - ✧ Height and weight
 - ✧ Previous accidents or problems (weakening of some parts of the body)
 - ✧ Attitudes toward work
- Leisure:
 - ✧ Sports (racket sports)
 - ✧ Hobbies (bad postures, repetitivity: knitting)
 - ✧ Music (bad posture of the neck and arms)
- Psychosocial factors:
 - ✧ Monotony, job insecurity, time pressure
 - ✧ Environment, relations between colleagues and with superiors, etc.

c. Significant concepts

- ✧ There are often several causes at the origin of ULDs
- ✧ Each situation is different
- ✧ There is no miracle solution
- ✧ Any improvement of any factor will have a positive impact
- ✧ It is necessary to start by improving the working conditions: forces, postures and repetitivity

2. Advices for good work practice

a. General work posture

- If you work mainly seated, you should:
 - have a good back support: use the back of the chair and make sure your back is supported in a symmetrical way,
 - adjust the height of the seat in order to reduce a maximum the neck flexion,
 - use a footrest without crossing the ankles in order to insure a good blood circulation,
 - stretch your legs as soon as possible.
- Avoid the spreading of the arms: In order to keep the arms along the body, it is necessary to pay attention to the good adjustment of the seat height. This posture allows the shoulder muscles to be relaxed.

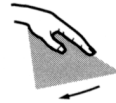
b. Some advices for good work practices: It is advised

- to put down the tools, the screwdriver for example, between uses rather than keeping them continuously in the hand, to avoid permanent contractions of the fingers and the hand muscles,
- to check the condition of the tools so that they remain effective and that the operations require as little efforts as possible,
- to make some small provision of parts around the gauge in order to reduce the frequency of constraining movements to get a part in the bins.

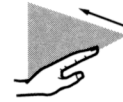
c. Hand and wrist movements

- Pay attention and avoid extreme movements of the wrists, i. e. :

Flexion:



Extension:



External deviation:



Interior deviation:



- Alternate as much as possible between the various movements.
- Where are these constraining movements encountered?
 - ✦ When grasping the parts in the bins (the movement depends on the position of the bin with respect to the operator),
 - ✦ during the assembly itself, especially as the operator is too close to his worktable,
 - ✦ during the closing of the cases when efforts are exerted, etc.

Keep paying attention to make good movements and avoid constraining postures. This will make it possible **to reduce discomfort and fatigue** and, in the long-term, will help **to prevent musculoskeletal problems of the upper limbs**.