Developing an Ergonomics Intervention Technique Model to Support the Participatory Ergonomics Process for Improving Work Systems in Organizations in an Industrially Developing Country and its ‘Meta-Reflection’

Faramarz Helali

Luleå University of Technology
Department of Human Work Sciences
Division of Industrial Work Environment
Developing an Ergonomics Intervention Technique Model to Support the Participatory Ergonomics Process for Improving Work Systems in Organizations in an Industrially Developing Country and its ‘Meta-Reflection’

Faramarz Helali

Luleå University of Technology
Department of Human Work Sciences
Division of Industrial Work Environment

2008: 28 ISSN: 1402-1544 ISRN: LTU-DT – 08/28 -- SE
Developing an Ergonomics Intervention Technique Model to Support the Participatory Ergonomics Process for Improving Work Systems in Organizations in an Industrially Developing Country and its ‘Meta-Reflection’

Faramarz Helali

Luleå University of Technology
Department of Human Work Sciences
Division of Industrial Work Environment
SE – 97187, Luleå, Sweden

June, 2008
This book is dedicated to the memory of my three mentors:
My grandmother (IRAN HELALI), my father (JAFER), and
father of my wife (ALI GHOMI-SARAJKAR)

‘The best and most beautiful things in the world cannot be seen or even
touched. They must be felt with the heart.’ - Helen Keller

‘Keep you face to the sunshine and you cannot see the shadow’-
Helen Keller
Acknowledgements

I first would like to thank the Lord my God who gives me the breath of life every morning, it would have been impossible for me to carry out and finish the work presented in this doctoral thesis without His gift of life every day.

I would like to thank Head of Department of Human Work Sciences, Luleå University of Technology (LTU), Associate Professor Örjan Johansson and former Head of Department, Associate Professor Ylva Fältholm, for his and her faith in my abilities and help during my research work by providing morale support and an inspirational and motivational source. Without his and her supports this thesis would not have been completed.

My pursuance of this doctoral study was made possible by the magnanimity of Professor Jan Johansson who accepted me in his division of Industrial Work Environment.

I sincerely express my gratitude to my thesis supervisor Professor Houshang Shahnavaz, Head of Centre for Ergonomics of Developing Countries (CEDC) - Sweden, for his invaluable and unremitting contribution towards accomplishing my research work. I am grateful to Professor Houshang Shahnavaz, who has also provided me with discourse ergonomics in IDCs and the ergonomics training workshops in Iran. I am also grateful to Associate Professor Emma-Christin Lönnroth for her guidance and support towards partly of my research work.

I sincerely express my gratitude to Professor Ewa Gunnarsson, Head of Division of Gender-Technology and Head of SIRA (Swedish Interactive Research Association), who has provided me with a better organizing structure of my doctoral thesis and whom I held brainstorming sessions with appreciative conversation on my first version of the manuscript. Without her support this thesis would not have been organized and completed.

I sincerely express my gratitude to Professor Tony Ghaye, Director Reflective Learning UK (RL-UK), who has provided me with discourse Participatory and Appreciative Action Research (PAAR) at LTU. Without his contributions and the brainstorming sessions on PAAR issue this thesis would not have been completed to point out some interesting avenues for the future.

I am grateful to Professor Andrew S Imada who has provided me with discourse Participatory Ergonomics (PE) at LTU in 2002.
My grateful thanks to my first Manager of Director, Mr. Sayed Abulqusim Miriyan for his appreciative guidance at work when I was the Plant Manager at Glucosan Factories from 1984 to 1986.

I would express my gratitude to the members of the ‘Council of Industries Protection (CIP)’ in Iran and all the managers, experts, supervisors and workers from Glucosan factories (GC) for their support from ‘learning strategy’ and ergonomics intervention programme at GC, from 1990 to 1997.

I would express my gratitude to Professor Esmail Salehi-Sangari, Head of Division Industrial Marketing at LTU, Dr. Hessameddin Bayan, and Mr. Hossein Farrokhmal from ‘Higher Education Institute of Iranian Industrial Research’ (HEIIIR), for the organizing ‘Contemporary Management’ Course for Iranian managers (20 top managers) at LTU in 1993. I was a participant of the course.

I would express my gratitude to the Board of members Danesh Maal Institute (DMI), Mr. Hossein Farrokhmal, Mr. Mir Javad Azimi, and Dr. Mohammadali Lahmi, the first institute that was established as a support centre for industries interested in ergonomics training and application in Iran, from 1997 to 2001.

I am also thankful to the participants from Iranian industries who participated in the ergonomics training workshops and the ergonomics intervention projects.

I sincerely express my gratitude to Dr. Mohammadali Lahmi, member of Occupational Health Department, Tehran University, and the first president of Iranian Ergonomics Society (IES), for his appreciative guidance and supports.

My grateful thanks to the Board of members Iran Khodro (car) Company (IKCo), Dr. Alireza Alavi, the management of Department PADAR as well as the members of steering committee at IKCo for supporting, the first phase of EIP project at IKCo, from 2001 to 2002.

I am thankful to Dr. Majid Motamedzadeh, who was Ph.D. student at Occupational Health Department, Tarbiat Modarres University and he is Faculty member of Hammedan Medical Sciences University, Dr. Alireza Choobineh, who was Ph.D. student at Occupational Health Department, Tehran University and he is Faculty member of Shiraz Medical Sciences University, as well as MS. Mojgon Hadadian, Faculty member of Rehabilitation and Welfare University, Tehran, for a team working under the auspices of CEDC, Professor Houshang Shahnazav, for the establishing Iranian Ergonomics Society (IES) in Iran.
I am also thankful to the Board of members the three poultry companies, Brothers Rosooli, especially to Mr. Mohammed Rosooli, who support to me for the action research-type intervention.

I wish to acknowledge to support of the administration group who helped me in many diverse ways throughout my work, particularly Marie Boström, Barbro Bladmo, Annika Lidberg, Dagny Granlund, Marianne Andersson, Anita Kero, Stig Karlsson, and Sven-Erik Tiberg and also from my colleagues; the Ph.D. Students of Department of Human Work Sciences, as well as the staff members of the Library Department at Luleå University of Technology.

I am also thankful to all the friends and co-workers who helped me in many diverse ways during the course of my work, particularly Dr. Mohammed-Aminu Sanda was resourceful discussion partner with whom I held brainstorming sessions on issues that appeared illusive to me, and Dr. Rupesh Kumar, Division of Industrial Design, for his help for the first organizing part of my doctoral thesis.

I give my deepest gratitude to my mother Kobra Rajabi-sigari, for her gift (i.e. living with love) to me, and also mother of my wife, Mahsoomeh Hoshdar for her patients and gift (i.e. the lovely wife) to me.

I am also thankful to my seven sisters and also her husbands for all the supports given to me, especially, one of my sisters, Firouzeh. Thanks Firouzeh for supporting part me financially. Another financially supporting part of my research work during my licentiate thesis from 2001 to 2003 (for 15 months, 7500 SEK monthly) was given by the Head of Division of Industrial Ergonomics. I am also thankful to Professor Houshang Shahnavaz.

Last but not the least; I am indebted to my family for letting me do my research work and thesis writing during some of our family evenings and holiday times. My wife, Shekoufeh, my sons, Ashkan and Arash, deserve a lot of credit for accepting my long time schedule requirements. Thanks Shekoufeh for running things smoothly at home while, I was focused on this project, also thanks for supporting me financially till I could finish my thesis writing.
List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Awakening for changing</td>
</tr>
<tr>
<td>AI</td>
<td>Appreciative Inquiry</td>
</tr>
<tr>
<td>AI</td>
<td>Appreciative Intelligence</td>
</tr>
<tr>
<td>AGs</td>
<td>Action Groups</td>
</tr>
<tr>
<td>AR</td>
<td>Action Research</td>
</tr>
<tr>
<td>CAS</td>
<td>Course of Action Study</td>
</tr>
<tr>
<td>CEDC</td>
<td>Center for Ergonomics of Developing Countries</td>
</tr>
<tr>
<td>DMI</td>
<td>Danesh Maal Institute</td>
</tr>
<tr>
<td>E</td>
<td>Evaluation</td>
</tr>
<tr>
<td>EA</td>
<td>Ergonomics Application</td>
</tr>
<tr>
<td>EAB</td>
<td>Ergonomics Awareness Building</td>
</tr>
<tr>
<td>EI</td>
<td>Ergonomics Intervention</td>
</tr>
<tr>
<td>EIP</td>
<td>Ergonomics Intervention Programme</td>
</tr>
<tr>
<td>EIPs</td>
<td>Ergonomics Intervention Programmes</td>
</tr>
<tr>
<td>EIPT</td>
<td>Ergonomics Intervention Programme Technique</td>
</tr>
<tr>
<td>EIPTs</td>
<td>Ergonomics Intervention Programme Techniques</td>
</tr>
<tr>
<td>EIPT Process</td>
<td>Ergonomics Intervention Programme Technique Process</td>
</tr>
<tr>
<td>EIT</td>
<td>Ergonomics Intervention Technique</td>
</tr>
<tr>
<td>EP</td>
<td>Ergonomics Process</td>
</tr>
<tr>
<td>ET</td>
<td>Ergonomics Training</td>
</tr>
<tr>
<td>ETWs</td>
<td>Ergonomics Training Workshops</td>
</tr>
<tr>
<td>EWA</td>
<td>Ergonomics Work Analysis</td>
</tr>
<tr>
<td>FA</td>
<td>Facilitator Activity</td>
</tr>
<tr>
<td>FW</td>
<td>Future Workshop</td>
</tr>
<tr>
<td>GC</td>
<td>Glucosan Factories</td>
</tr>
<tr>
<td>HELLLR</td>
<td>Higher Education Institute of Iranian Industrial Research</td>
</tr>
<tr>
<td>HS</td>
<td>Health and Safety</td>
</tr>
<tr>
<td>I</td>
<td>Integrating</td>
</tr>
<tr>
<td>IDC</td>
<td>Industrially Developing Country</td>
</tr>
<tr>
<td>IDCs</td>
<td>Industrially Developing Countries</td>
</tr>
<tr>
<td>ICs</td>
<td>Industrialised Countries</td>
</tr>
<tr>
<td>IEA</td>
<td>International Ergonomics Association</td>
</tr>
<tr>
<td>IES</td>
<td>Iranian Ergonomics Society</td>
</tr>
<tr>
<td>IKCo</td>
<td>Iran Khodro (Car) Company</td>
</tr>
<tr>
<td>ILO</td>
<td>International Labour Office</td>
</tr>
<tr>
<td>INGO</td>
<td>International non-governmental organization</td>
</tr>
<tr>
<td>L</td>
<td>Learning</td>
</tr>
<tr>
<td>LTU</td>
<td>Luleå University of Technology</td>
</tr>
<tr>
<td>NB</td>
<td>Network Building</td>
</tr>
<tr>
<td>M</td>
<td>Method of the EIPT</td>
</tr>
<tr>
<td>Abbr.</td>
<td>Full Form</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
</tr>
<tr>
<td>MENI</td>
<td>Mehr E Nami Institute</td>
</tr>
<tr>
<td>MSDs</td>
<td>Musculoskeletal Disorders</td>
</tr>
<tr>
<td>NGO</td>
<td>non-governmental organization</td>
</tr>
<tr>
<td>NBOSH</td>
<td>National Board of Occupational Safety and Health</td>
</tr>
<tr>
<td>OB</td>
<td>Organizational Behaviour</td>
</tr>
<tr>
<td>OD</td>
<td>Organizational Development</td>
</tr>
<tr>
<td>ODAM</td>
<td>Organizational Design and Management</td>
</tr>
<tr>
<td>PAAR</td>
<td>Participatory and Appreciative Action Research</td>
</tr>
<tr>
<td>PAR</td>
<td>Participatory Action Research</td>
</tr>
<tr>
<td>PDSA</td>
<td>Plan-Do-Study-Act</td>
</tr>
<tr>
<td>PE</td>
<td>Participatory Ergonomics</td>
</tr>
<tr>
<td>PEP</td>
<td>Participatory Ergonomics Process</td>
</tr>
<tr>
<td>PTW</td>
<td>Prevention, Treatment and Welfare</td>
</tr>
<tr>
<td>RA</td>
<td>Research Activities</td>
</tr>
<tr>
<td>RC</td>
<td>Reference Committee</td>
</tr>
<tr>
<td>RL-UK</td>
<td>Reflective Learning UK</td>
</tr>
<tr>
<td>SC</td>
<td>Steering Committee</td>
</tr>
<tr>
<td>SWOT</td>
<td>Strong points, Weak points, Opportunities, and Threats</td>
</tr>
<tr>
<td>TMU</td>
<td>Tarbiat Modarres University</td>
</tr>
<tr>
<td>V</td>
<td>Vision</td>
</tr>
<tr>
<td>WMSDs</td>
<td>Work-related musculoskeletal disorders</td>
</tr>
</tbody>
</table>
Preface

This doctoral thesis is based on the research work carried out at Luleå University of Technology (LTU), Sweden, between 2001 and 2003 at the Division of Industrial Ergonomics, and from 2004 to May 2008 at the Division of Industrial Work Environment, Department of Human Work Sciences at LTU. In February 1996, under the supervision and encouragement of Professor Houshang Shahnavaz, I began my postgraduate study. The project developed on the Ergonomics Intervention Programme (EIP) by means of the Ergonomics Training Workshops (ETWs) for transferring ergonomics 'know-how' to Iranian industries. This was compatible with the goal of the Centre for Ergonomics of Developing Countries (CEDC), the Division of Industrial Ergonomics, and Department of Human Work Sciences at LTU.

I finally came to Luleå in September 2001 when the Iranian Ergonomics Society (IES) was established in the process of the pre-intervention phase of the EIP. I began to write down the idea for the research proposal that eventually became a project geared towards identifying and describing an Ergonomics Intervention Technique (EIT) in Iranian industries, in 2003. From 2002, for the collection of data and due to the nature of my action research-type intervention, I went to Iran at least twice each year, for periods of, three months at a time until 2006. Unfortunately, the Division of Industrial Ergonomics was closed when Professor Shahnavaz retired in 2003. According to his suggestion, there was only one alternative to me: Associate Professor Emma-Christin Lönnroth became my supervisor. Unfortunately, Associate Professor Emma-Christin Lönnroth left LTU in 2006.

Before I finish this preface I would like to introduce you to a message that has motivated me to continue this research journey; the text sticks in my mind even now. I first read it in a book on 'Appreciative Inquiry' in 2007:

'Be not afraid of life. Believe that life is worth living, and your belief will help you. Create the fact' (William James). ‘But, you know, we can easily forgive a child who is afraid of the dark. The real tragedy of life is when men are afraid of the light' (Plato).

It is my aim, by highlighting the current research, which practitioners both present and future will be equipped to contribute to the number of EIPs, especially the EIPT process model, for improving work systems. Nevertheless, there are examples of poor experiences of the participatory methods or a lack of good experiences of participation at work and, furthermore, there is poor focus on employees’ livelihoods. On the other hand some improvement frustrations; i.e. the ‘islands of improvement effect’ (lack of spread or disseminated) or the ‘improvement evaporation effect’ (lack of sustainability). Therefore, it is natural that after ETWs and EIPs, most people voiced their many fears for the future, such as the fear of change, of mistakes, of loss,
etc. However, the human cost of fear and loss can be a poor democratic metaphor because I feel there is low 'Communication-Knowledge-Action' for a proactive task at work. The main issues may be a lack of ‘building creative workplace culture’, poor supporting social awareness in education and poor interaction research within the IDC industries and universities, as well as between IDCs (Industrially Developing Countries) and ICs (Industrialised Countries).

I feel it is necessary to expand the contributions NGOs (non-governmental organizations) and INGOs (International non-governmental organizations) in the hope that 'communication, knowledge sharing, reflection-learning and action' can together successfully give root to better living in our society.

Faramarz Helali

Luleå, June, 2008
Abstract

The Ergonomics Intervention Programme (EIP) can be a means of guaranteeing the most efficient use of the labour force of an industrially developing country (IDC) by creating safe and appropriate working conditions. Many problems at work can be resolved with ergonomics intervention, but persist due to a lack of ergonomics awareness and ‘know-how’, as well as poor social awareness in education.

This thesis represents an attempt at investigating how the Ergonomics Intervention Programme (EIP) and Ergonomics Intervention Programme Techniques (EIPTs) can be implemented in an organization by using an Ergonomics Intervention Technique (EIT) process (i.e. EIP activities, EIP team, and EIP process). The objective was to develop an action-oriented intervention process for the improvement of health and safety, as well as trying to improve work systems in IDC industries. To respond to these purposes, two main questions and four different sub-questions were formulated in this study as follows:

I. Why are the efforts of these industries to implement and internalise the EIP being constrained?
   a. What are the main causes of these constraints?
   b. Is it that the EIP is difficult to implement?

II. How should the EIPTs be delivered to the Iranian Industries and possibly to other organizations in IDCs, so that they can easily learn how to use them successfully?
   c. How can EIPTs be successfully implemented and internalised by such organizations?
   d. What practical activities are required for the EIPTs’ implementation?

This thesis also describes the development and results of using various methods during the last 10 years and illustrates the challenges of introducing EIP to Iranian industries. In this thesis, two complementary strategies have been used to collect and analyze evidence. Empirical evidence has been collected through case studies from pre-intervention phase of the EIP in Iranian Industries (as archival analysis), and action research in the three subsidiary companies while theoretical evidence has been collected through a literature study.

Put simply, the conception of action research that I used is one of ‘learning by doing; individually and collectively’. One popular action research model is ‘reflecting, planning, acting, and observing’. The main difference between action research and the case study approach is noted in this study. Furthermore, in this study I mention many kinds of action research described as ‘Action Research’ (AR), ‘Participatory Action
Research’ (PAR), and ‘Participatory and Appreciative Action Research’ (PAAR). The purpose was to distinguish between the different kinds of reflections in joining up practice with theory, or ‘knowing-in-action’ (i.e. the context was the EIP), including: ‘reflection-in-action’ (i.e. the EIP was by ETWs), ‘reflection-on-practice’ (i.e. EIP was by EIPTs) and ‘Meta-reflection’ (i.e. this is thinking again about our reflection-on-practice).

Based on data analyses and outcomes, an understanding was derived about factors which impact on the implementation of the EIPT Process Model. The main EIP activities were: Awakening for changing (A), Vision (V), Method of the EIPT (M), Learning (L), and Integrating (I)). Furthermore, the EIPT method in Study H was formulated to include, Participatory Ergonomics (PE) and Ergonomics Awareness Building (EAB). EAB includes; Ergonomics Training (ET), Ergonomics Application (EA), and Evaluation (E). Research Activities (RA) and Network Building (NB). The EIPT team includes: action groups (AGs), a Steering Committee (SC), and Facilitator (s) (FA). The EIP process includes; routine (pre-intervention) tasks, modified (EIP process) tasks, and new EIP (post-intervention) tasks.

Two key research questions emerged in the process of reflecting on the EIP. They were: (1) ‘What is it we want more of here, and how can we amplify this?’ and (2) ‘How does the future unfold from an appreciation of the positive present?’ These new research questions are the other side of this study. The author has discussed trying to get the EIP conversations to ‘Tip’ positively. This opened up the possibility of having new kinds of conversation through EIP studies and for further research. For example, firstly, focusing on the root cause of a ‘problem’ and risk of managing it, is essentially a conversation about what we may want less of here. Secondly, if we use our appreciative intelligence (i.e. the ability to perceive the positive inherent generative potential within the present), we open up the possibility of trying to understand the root cause of success. These conversations are about what we may want more of here.

The main knowledge contribution of this study was the development and evaluation of a generally-applicable EIP and a range of EITs based on macro-ergonomics theory. Thus, the focus was mainly on improving workplace action and using participatory ergonomics processes through, the use of the EIPTs. Implementing and sustaining change were made possible by commitment to continual learning and focus on new improvement in action. The major outcome was a ‘Proposed model for the ergonomics ‘know-how’ transfer at individual, group, and organizational levels in an IDC (at Micro/Macro ergonomics levels)’. The outcomes of this study are also used to provide industrial managers with a set of principles and processes to practically deal with ergonomics ‘know-how’ transfer.
Furthermore, Participatory, and Appreciative Action Research (PAAR) can help to develop an understanding of different ways to apply (research) ergonomics intervention techniques in an IDC. It is therefore a positive outcome and further development of this study. Pursuing the general question of PAAR, ‘what is it we want more of here and how can we amplify this?’ I use an acronym ‘C.R.E.A.T.I.V.E’ to point out some interesting avenues for future research. I hope this will be the next part of the EIP journey in the IDC. It will involve ‘heart, head, and hands’ and especially behaviours that are ‘Human centered, Participatory, and Appreciative’!

Keywords: Ergonomics Intervention, Techniques, Macro-ergonomics, Participatory Ergonomics Process, Work System, ‘Meta-Reflection’, and Industrially Developing Country (IDC)
Thesis (List of Papers)

This thesis based on the following papers:


**PAPER B (Study B):** Helali, F. and Shahnavaz, H. Ergonomics intervention in industries of the industrially developing countries, Case study: Glucosan – Iran. Published in: Human factors in organizational design and management - V: proceedings of the Fifth International Symposium on Human Factors in Organizational Design and Management (ODAM) held in Breckenridge, Co., U.S.A., July 31-August 3, 1996. Amsterdam: North-Holland, 1996. p. 141-146. In this study, Faramarz Helali described and analyzed this unique exercise, regarded as success. Professor Houshang Shahnavaz contributed with useful remarks, comments and editing of the paper.

PAPER D (Study D): Helali, F. and Shahnavaz, H. Experimental Model of Ergonomics Intervention in Industries of the Industrially Developing Countries, Case study: Iran. Published in the Proceedings of the Ergonomics conference Cape Town, South Africa, 9th to 11th September 1998. P. A. Scott, R. S. Bridger, J. Charteris (Eds.) Elsevier Science, 1998, p. 51 – 56: In this study, Faramarz Helali introduced the experimental model of EIP in Iranian Industries. This was also the first major assessment of the workshops participants’ perception (N=97), which was made after 6 months of each ergonomics workshop (see Appendix 1). Professor Houshang Shahnavaz contributed with useful remarks, comments and editing of the paper.


The studies E and F described the first phase of the project, which was planned for 18 months at Iran Khodro Car Company (IKCo). Faramarz Helali was one of the facilitators in the project. He also evaluated the project. This was a co-operative project between PTW (Prevention, Treatment and Welfare) of Iran Khodro Car Company (IKCo) and the CEDC (Professor Houshang Shahnavaz and two of his PhD. Students). Professor Houshang Shahnavaz was manager of the project and contributed with comments and proposed a theoretical model for ergonomics intervention as well as offered help with editorial issues.

questionnaire was sent to 186 participants from industries who have participated in different ETWs during a 4 years period (see Appendix 2). Professor Houshang Shahnavaz contributed with comments and editorial issues.

**PAPER H (Study H):** Helali, F. and Shahnavaz, H. A Model of Implementing Ergonomics Intervention Programme Technique (EIPT) in Industrially Developing Countries (IDCs) – Case Iran. Published in: Human factors in organizational design and management - VII: re-designing work and macroergonomics - future perspectives and challenges: proceedings of the Seventh International Symposium on Human Factors in Organizational Design and Management held in Aachen, Germany, October 1-2, 2003. Aachen: Wissenschaftsverlag Mainz, H. Kuczak and K. J. Zink (Editors) 2003. p. 811-814: Faramarz Helali developed and analyzed an ergonomics intervention technique called an Ergonomics Intervention Programme Technique (EIPT) from a sequenced pre-intervention phase of implantation of the EIP in Iranian industries in the three levels, viz, individual, group, and organization. Professor Houshang Shahnavaz contributed with feedback on the paper regarding content and editorial issues.


**PAPER J (Study J):** Helali, F. Using Ergonomic Checkpoints to Support the Participatory Ergonomic Intervention in an Industrially Developing Country – a Case Study, Submitted to International Journal of Occupational Safety and Ergonomics (JOSE).

The studies I and J were about the participatory ergonomic intervention in three subsidiary companies from one-Industry. They participated in improving their organizational working and organization design by EIPT’s tool (such as ‘Future Workshop (FW)’, ‘Ergonomics Checklist’, and ‘Ergonomic Checkpoints’) using the process of an action research-type intervention. Associate Prof. Lönnroth contributed with critical comments for the first version of papers I and J. Professor Houshang Shahnavaz contributed with useful remarks, comments and editing of the papers I and J.
PART I

1. INTRODUCTION ..............................................................................1

   1.1. Relevance of the research ......................................................5
   1.2. Rationale behind the research ................................................5
   1.3. Research problem ..................................................................6

2. AIMS AND OBJECTIVE OF DOCTORAL THESIS ..............11

   2.1. Research Questions ..............................................................11
   2.2. Delimitation .........................................................................12

3. LITERATURE REVIEW ...............................................................13

   3.1. Ergonomics Intervention and IDC ........................................13
       3.1.1. Different forms of ergonomics intervention and the results of
               intervention .................................................................13
       3.1.2. Objective of an Ergonomics Intervention Programme (EIP) ....13
       3.2. Ergonomics intervention in ICs industries ............................14
       3.3. Ergonomics intervention in IDCs industries and
            Iranian industries ............................................................15
       3.4. IDCs and the ergonomists’ work ........................................16
       3.5. Intervention ......................................................................17
       3.6. Ergonomics Intervention (EI) research ................................18
       3.7. Macro-ergonomic Intervention .............................................19
           3.7.1. A concept of Macro-ergonomics: Human-centered and
                   Participatory ...............................................................21
           3.7.2. Participatory Ergonomics and the role of the ergonomist in the
4. THEORETICAL FRAMEWORK ..............................................25

4.1. Introduction ...............................................................25
4.2. Proposed model of EIPT for an action research .......................26
4.3. Theoretical frame of references in ‘Macro-ergonomics theory’ ........27
4.4. Theories of change .........................................................32
4.4.1. Resistance to change and types of organization change ..........34
4.4.2. Change processes in workplaces and learning organization ........35
4.4.3. Workplace transformation and ‘Tipping point’ ......................39
4.5. The use of the presented theory .........................................41

5. RESEARCH METHODOLOGY ..............................................43

5.1. Introduction ...............................................................43
5.1.1. Introduction to research .................................................43
5.1.2. The accomplishment of the research ..................................44
5.2. Choice of research approach .............................................45
5.2.1. Deduction, induction, and abduction ..................................45
5.2.2. Positivism and Hermeneutics ...........................................47
5.2.3. Quantitative and Qualitative Research ...............................48
5.3. Choice of Research strategy ...............................................49
5.3.1. How to choose a suitable research strategy .........................49
5.3.2. Case Study ...............................................................50
5.3.3. Action Research .........................................................51
5.4. Methodology for research question one (with two sub-questions) ....53
5.4.1. The choice of case study type and the participants for EIP by the ETWs .................................................................54
5.4.2. Data Collection and data analysis of the case studies ..............56
5.5. Methodology for research question two (with two sub-questions) ....62
5.5.1. The co-operation that turned into action research ..................62
5.5.2. The choice of action research and companies ........................64
5.5.3. Data collection and data analysis of the case research ..............65
5.6. Research design quality ....................................................69

PART II

6. SUMMARY OF THE PAPERS AND THE STUDY DESIGN.....75

6.1. Issues and challenges for Ergonomics Intervention Programme (EIP):
PART III

7. RESULT ‘Tips’ OF THE EIP, ANALYSIS, CONCLUSIONS AND FURTHER RESEARCH

7.1. A short summary of the aims and objectives of the research

7.2. Results of ‘Tips’ from an action pathway, the challenges the EIP faces in taking action in the IDC industries

7.2.1. General discussion or Conversation

7.3. Research Question a

7.3.1. Results in relation to theory

7.4. Research Question b

7.4.1. Results in relation to theory

7.5. Research Question c

7.5.1. Development of the EIPT model

7.5.2. Results in relation to theory

7.6. Research Question d

7.6.1. Results in relation to theory

7.7. Reflection on the model

7.7.1. Strengths of the model

7.7.2. Weaknesses of the model

7.8. Final conclusions or recommendations

7.8.1. Development of the original model

7.8.2. A model of applying ‘Ergonomic Checkpoints’; linking Ergonomic Checkpoints of ILO (1996) with integrating ergonomics in Health and Safety as well as the work system

7.9. Scientific contributions

7.10. Further research

PART IV

REFERENCES

APPENDED PAPERS AND OTHER APPENDICES
The disposition of the dissertation

This thesis consists of four different parts, illustrated in Figure 01 below.

Figure 01 shows the disposition of the thesis
Part I – Theoretical foundation

Section 1: Introduction. Here an introduction to the research phenomenon is given. This section also includes the purpose created from that background, including the research problem, the successes and failures of the applied method of EIP by Ergonomics Training Workshops (ETWs) at three levels in Iranian Industries, the relevance and rationale behind the research and the reason for interest in the research issue.

Section 2: This section describes the aims and objectives of the doctoral study. Also included are research questions and the delimitation of the thesis.

Section 3: This section includes a literature review on the keywords as follows: Ergonomics intervention and IDCs, Ergonomics intervention in Industrialised Countries’ (ICs) and IDCs’ industries as well as Iranian Industries, ICs and the ergonomists’ work, intervention, Ergonomics Intervention (EI) research, Macro-ergonomic intervention including, a concept of macro-ergonomics, Participatory Ergonomics (PE) and the role of the ergonomist in the participatory ergonomics design and analysis process.

Section 4: Theoretical framework, based on the choice of ‘Macro-ergonomics Theory’ and describing its root as the concept treated in the thesis, as opposed to other alternative methodology (or concepts), a system perspective is explained. The section also provides definitions of fundamental and important concepts of the thesis and the use of the presented theory in summary.

Section 5: Research methodology: Here the methodologies used in the investigations are described. This section is important for the results of the thesis and contains a discussion about different approaches to research, such as deduction and induction, positivism and hermeneutics, and quantitative and qualitative. Then a discussion follows about the choice of research strategy. Out of this discussion, a choice of methodology is made and the research process is described. The section ends with a discussion about research design quality, reliability and validity.

Part II – Summary of papers and Study design

Section 6: Summary of papers and the study design, in order to achieve the objectives of the research study, ten separate studies were designed. These have been conducted as case studies (Papers A, B, C, D, E, and F), a questionnaire survey (Paper G), an empirical model on the implementation of the pre-intervention phase of the EIP (Paper H), and the action research-type intervention (Papers I and J). In the description of the methodology, results and discussion for studies are presented as
Study A; Study B; Study C; Study D; Study E; Study F; Study G; Study H; Study I; Study J” in Section 6.

Part III – Results ‘Tips’ of the EIP, analysis, conclusions and further research

Section 7: This section describes ‘Tips’ for the EIP as a general conclusion of the action pathway from the challenges that the EIP in action found from 1993 to 2008 in Iran and its discussion. Further discussion based on the research questions, a reflection on the results of the research, conclusions, recommendations, scientific contributions and further research are presented.

Part IV – References, appended papers and other appendices
### List of Figures

<table>
<thead>
<tr>
<th>Figures</th>
<th>Titles of the figures</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 01</td>
<td>Shows the disposition of the thesis</td>
<td>xxi</td>
</tr>
<tr>
<td>Figure 1</td>
<td>The action pathway of the EIP journey in the IDC</td>
<td>5</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Three aspects of a methodology for systemic intervention (Source, Midgley, 2000)</td>
<td>17</td>
</tr>
<tr>
<td>Figure 3</td>
<td>‘The nature of participatory ergonomics cycle’ (Source, Haines &amp; Wilson 1998)</td>
<td>22</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Ergonomics technology supplier and receiver decision making and action on Ergonomics Intervention Programme Technique in the organization in an IDC (Micro/Macro ergonomics levels); Modified by the author; source: Adapted from Shahnavaz 2002b; Helali 2003 and study A)</td>
<td>26</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Proposed model of EIP in one organization in Iranian Industries for an action research (Source, Helali 2003)</td>
<td>27</td>
</tr>
<tr>
<td>Figure 6</td>
<td>PDSA Cycles of Learning</td>
<td>27</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Work System Sub-Systems (source, Kleiner, B.M. 2004)</td>
<td>30</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Three change states, adapted from Balogun and Hailey, (1999)</td>
<td>36</td>
</tr>
<tr>
<td>Figure 9</td>
<td>The figure shows how more power and resources are introduced in the transition state be able to make a change take place (Balogun &amp; Hailey, 1999)</td>
<td>36</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Three phases of transition, modified from Balogun and Hailey, 1999</td>
<td>37</td>
</tr>
<tr>
<td>Figure 11</td>
<td>The figure shows different phases during an organizational change and gives some indications how management should act during the different phases (Modified from Balogun &amp; Hailey, 1999)</td>
<td>38</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Illustration of different strategies for ergonomics change, the arrows describe from where and in what direction ideas and energy concerning change goes in a very simplified and schematic way (Skoglind-Öhman and Shahnavaz, 2004; adapted from Ingelström, 1996)</td>
<td>38</td>
</tr>
<tr>
<td>Figure 13</td>
<td>The research wheel, modified of Burke and Larry (2004)</td>
<td>46</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Deduction – Induction – Abduction: The figure is inspired by Alvesson &amp; Sköldberg (1994)</td>
<td>46</td>
</tr>
<tr>
<td>Figure 15</td>
<td>The research work was accomplished over a rather long time and consisted of continuous EIP by ETWs at three levels</td>
<td>53</td>
</tr>
<tr>
<td>Figure 16</td>
<td>The research work is accomplished after the licentiate thesis</td>
<td>62</td>
</tr>
<tr>
<td>Figure 17</td>
<td>Common participatory steps for developing and using ergonomic checkpoints of the ILO (1996)</td>
<td>69</td>
</tr>
<tr>
<td>Figure 18</td>
<td>Proposed theoretical model for ergonomics intervention (source; paper F; Professor Houshang Shahnavaz 2002)</td>
<td>86</td>
</tr>
<tr>
<td>Figure 19</td>
<td>Noer’s four-level redundancy intervention model Source: Noer (1993) and adapted from Cameron and Green 2004</td>
<td>115</td>
</tr>
<tr>
<td>Figure 20</td>
<td>Bridges: Endings and beginnings; source: Bridges (1991) and adapted from Cameron and Green 2004</td>
<td>116</td>
</tr>
<tr>
<td>Figure 21</td>
<td>Proposed model for Ergonomics Intervention Programme Technique (EIP) Process</td>
<td>124</td>
</tr>
<tr>
<td>Figure 22</td>
<td>A framework for the developing the EIT in the IDC or ‘Proposed model for the ergonomics know-how transfer to individual, group, and organization levels in an IDC (at Micro/Macro ergonomics levels)”</td>
<td>134</td>
</tr>
</tbody>
</table>
List of Tables

<table>
<thead>
<tr>
<th>Tables:</th>
<th>Titles of the tables</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Successes of Ergonomics Awareness Building (EAB) = Ergonomics Training (ET) + Ergonomics Application (EA) + Evaluation (E) at the three levels Viz, individual, group, and organization (source, Helali 2003)</td>
<td>7</td>
</tr>
<tr>
<td>Table 2</td>
<td>Failures of Ergonomics Awareness Building (EAB) = Ergonomics Training (ET) + Ergonomics Application (EA) + Evaluation (E) at the three levels Viz, individual, group, and organization (source, Helali 2003)</td>
<td>8</td>
</tr>
<tr>
<td>Table 3</td>
<td>Successes &amp; failures of Research Activity (RA) at the three levels (source, Helali 2003)</td>
<td>9</td>
</tr>
<tr>
<td>Table 4</td>
<td>Successes &amp; failures of Network Building (NB), (source, Helali 2003)</td>
<td>10</td>
</tr>
<tr>
<td>Table 5</td>
<td>Comparison between the Positivistic and Hermeneutic Paradigms (adapted from Gummesson, 2000, p. 178)</td>
<td>48</td>
</tr>
<tr>
<td>Table 6</td>
<td>Shows criteria for Ergonomics Process (EP) in the three kinds of cases</td>
<td>55</td>
</tr>
<tr>
<td>Table 7</td>
<td>Shows criteria for different activities in the three kinds of cases in pre-intervention phase of the EIP</td>
<td>60</td>
</tr>
<tr>
<td>Table 8</td>
<td>Shows criteria for different role of the EIP team in the three kinds of cases in pre-intervention phase of the EIP</td>
<td>61</td>
</tr>
<tr>
<td>Table 9</td>
<td>Shows how well the different EIP processes fulfilled criteria in the three kinds of cases</td>
<td>61</td>
</tr>
<tr>
<td>Table 10</td>
<td>Specific responses of survey questionnaire by target cases</td>
<td>87</td>
</tr>
<tr>
<td>Table 11</td>
<td>Statistics, ‘Age of participants’ that they have replied to the questionnaire</td>
<td>87</td>
</tr>
<tr>
<td>Table 12</td>
<td>Position of participants that have replied to the questionnaire at three levels</td>
<td>87</td>
</tr>
<tr>
<td>Table 13</td>
<td>Responses to the workshops at individual level</td>
<td>88</td>
</tr>
<tr>
<td>Table 14</td>
<td>Distribution of respondent’s responses regarding problem identification and solutions</td>
<td>88</td>
</tr>
<tr>
<td>Table 15</td>
<td>Responses to the workshops at group level</td>
<td>89</td>
</tr>
<tr>
<td>Table 16</td>
<td>Responses to the workshops at organizational level</td>
<td>89</td>
</tr>
<tr>
<td>Table 17</td>
<td>The training workshops and training courses conducted by CEDC (Professor Shahnavaz and his student (the author of this doctoral thesis))</td>
<td>92</td>
</tr>
<tr>
<td>Table 18</td>
<td>Outcome of the SWOT Analysis for the Organization</td>
<td>96 &amp; 97</td>
</tr>
<tr>
<td>Table 19</td>
<td>The measures selected as the work system’s checkpoints and evidence of improvement of the work systems</td>
<td>100</td>
</tr>
<tr>
<td>Table 20</td>
<td>The kinds of reflection adapted of source; Ghaye, T., 2007</td>
<td>109</td>
</tr>
<tr>
<td>Table 21</td>
<td>Distinguishes the three kinds of the Ergonomics Intervention Programme (EIP) way</td>
<td>127 &amp; 128</td>
</tr>
</tbody>
</table>
PART I

1. INTRODUCTION

This thesis seeks to meet the challenge that, in general, knowledge and understanding of ergonomics and ergonomic interventions, in Industrially Developing Countries (IDCs) is relatively poor. In the thesis an attempt is made to investigate how an Ergonomics Intervention Programme (EIP) and Ergonomics Intervention Programme Techniques (EIPTs) can be implemented in an organization by an Ergonomics Intervention Technique (EIT) process (i.e. EIP activities, EIP team, and EIP process). The objective is to develop an action-oriented intervention process for the improvement of health and safety, as well as trying to improve work systems in IDC industries. This thesis describes the development and results of various methods used during the last 10 years towards the introduction of EIP to Iranian industries. Analysis of the conducted case studies (Studies A, B, C, D, E, F, and H), a questionnaire survey (Study G), and the action research-type intervention (Studies I and J) during these years support the conclusions reached.

In Helali’s licentiate degree study (2003), ergonomics intervention was defined as follows:

‘A well-planned, structured process for thinking and action at three levels, viz, individual, group and organizational, in an organization for instigating change, which is suitable for the work systems in question. It is important that the ergonomists receives a professional evaluation and improvement of the work system through the participation of the workers (end-user) in action.’

Unfortunately, the benefits of ergonomics application are not yet well known by most people in IDCs. Among the reasons are a general lack of knowledge and awareness about ergonomics and its positive contribution to health, safety, productivity and quality of work (Shahnavaz, 2002a). Examples of indigenously and exogenously generated ergonomics research and development projects in IDCs were given by O’Neill (2005). He has concluded that the principles of ergonomics and its potential to deliver benefits have been accepted and practised in a small number of development and technology transfer programmes but not many decision-makers are conversant with the breadth and depth of ergonomics (O’Neill, 2005).

Iranian industries, like most industries in IDCs, are not aware that the application of ergonomics practices can help to remove barriers to development and cause greater industrial efficiency (Studies B and H, Shahnavaz et al., 2000, Choobineh et al., 2002, and Choobineh et al., 2007). Arguably, there is lack of a full commitment by employers and employees’ unions, as well as low interest from government agencies that are responsible for the health and safety of people. Additionally, the ergonomic community at large in the industrialised world shows low interest in ergonomics of industrially developing countries (Shahnavaz, 2002a). The application of ergonomics is, therefore, not widely spread and the subject is in its infancy in most IDCs (Study B; Shahnavaz, 2002a).
One definition of ergonomics is suggested by the International Ergonomics Association (IEA) as follows:

‘Ergonomics is the scientific discipline concerned with the fundamental understanding of interaction among humans and other elements of a system and the application of appropriate methods, theories and data to improve human well-being and overall performance’, (Karwowski 2001, p. 102).

Participatory ergonomics can be described as a concept involving the use of participative techniques and various forms of participation in the workplace (Vink and Wilson, 2003). Wilson defined participation in ergonomics projects as ‘the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes in order to achieve desirable goals’ (Wilson and Corlett, 1995).

Ergonomics can play a key part in efforts to identify the main causes of accidents, injuries, low productivity and low work quality (Shahnavaz, 1995). Rahmany’s (2003) study about the evaluation of health risks and health conditions at two work sites of the Iran Khodro Car Company (IKCo) has indicated that the health problems at the press site were related mostly to work stress and dissatisfaction with work organization. In the store site, health problems were related to working conditions poor posture, manual handling of materials, heavy loads - which contributed to the development of musculoskeletal disorders among workers. Choobineh et al (2007) has mentioned that the workers' level of exposure to work-related musculoskeletal disorders’ (WMSDs') risks was high in an Iranian communication company. Furthermore, WMSDs are a common health problem throughout the world and a major cause of disability in the workplace. Awkward working posture is a main risk factor for developing WMSDs (Choobineh et al., 2007). Assessment of exposure level to WMSDs' risks can be an appropriate base for planning and implementing EIP in the workplace (See, Choobineh et al., 2007, Maul et al., 2003, Kemmlert, 1994, Genaidy et al., 1993, Shahnavaz 1987). Poor working conditions and the absence of an effective work injury prevention program in IDCs has resulted in a very high rate of MSDs (Jafry and O’Neill, 1997). In IDCs, the problems of workplace injuries are also extremely serious (Choobineh et al., 2007). Musculoskeletal disorders (MSDs) represent one of the leading causes of occupational injury and disability in developed and industrially developing countries (Shahnavaz 1987, Genaidy et al., 1993, Kemmlert, 1994, and Maul et al., 2003).

In the case of Iran, ergonomic considerations have not been taken into account yet and no statistics exist, implying ergonomic disorders' prevalence and productivity deficiencies caused by neglecting workplace ergonomics (Choobineh et al., 2002, Shahnavaz et al., 2000).

But Stacey (1992) noted an old joke in his book as follows:

[One night a woman is walking down a dark street. She comes to a pool of light under a streetlamp and sees a man on his knees there, obviously looking for something. She asks, “What are you looking for?”]
“A coin I have lost,” the man replies.
“Well, where did you lose it?” the woman inquires.
“Over there,” he responds, pointing to a dark area between two streetlights.
“Why on earth are you looking here, then?” comes her puzzled question.
“Because the light is better here,” is his exasperated reply.

According to Stacey (1992), this old joke encapsulates the message of his book. He mentioned: ‘Today most of us are trying to explain a messy, opportunistic global competition game using mental models that focus on order, stability, cohesion, consistency, and equilibrium. We are not paying enough attention to the irregular, disorderly, chance nature of the game. We do this because it is easier and more comfortable than feeling about in the dark for explanations that describe the world in terms of disorder, irregularity, unpredictability, and chance.’ [p. 21]

According to Yin (2003), as is mentioned in Sub-section 5.3.2 the case study strategy may also be used to explain the causal links in real-life intervention that are too complex for survey or experimental strategy. On the other hand, put simply, action research is ‘learning by doing’ and a simply action research model is ‘reflecting, planning, acting, and observing’ (Kemmis and McTaggart 2000; McTaggart 1997). But, there are three levels of researcher participation in an action research (Carr and Kemmis, 1986). Furthermore, according to Ghaye and Melander-Wikman1, (a draft paper in 2007; Ghaye, 2008) there are many kinds of action research including Action Research (AR), Participatory Action Research (PAR), and Participatory and Appreciative Action Research (PAAR)2. They have mentioned how to distinguish between AR, PAR and PAAR by the nature of the key questions that guide the research. They have noted example of key questions as follows:

In AR: ‘How can I improve my practice here?’ Or ‘What is the practical problem I need to address in my work?’
In PAR: ‘What can we do together to make a positive difference here?’
In PAAR: ‘What are our successes and how can we amplify them to build and sustain a better future from valued aspects of the positive present?’

1 Ghaye, T and Melander-Wikman, A. Participatory and Appreciative Action Research (PAAR): What promise does it bring for research into aging? (A draft paper in 2007): contact; Anita. Melander-wikman@ltu.se

2 Professor Tony Ghaye (2008) describes ‘The label ‘participatory and appreciative action research’ (PAAR) is new. I use it to describe what I suggest is a necessary development from more conventional forms of action research (AR) and from participatory action research (PAR), to a more explicitly ‘appreciative’ form. PAAR synthesises the best practices of action research (AR) and participatory action research (PAR) and adds a third and new dimension called appreciative intelligence. Like its forebears, PAAR is a systematic and rigorous style of democratic research, concerned with developing practical knowing in the pursuit of worthwhile human purposes. PAAR brings together action and reflection, with the participation of a range of stakeholders, in order to identify and amplify current achievements and to produce practical solutions in mis-alignments between values and actions. I ground PAAR in a view of the generation of knowledge informed by critical-realism, structuration theory, pragmatism and humanism. It is not simply about change. It is more about improvement and sustaining success. PAAR may be regarded as a kind of 3rd generation action research.’ (Source, see http://www.ltu.se/arb/d13942/d17711/d17724/1.36350 ).
This thesis has made reference to the first key questions above when the author did the phase of the EIPTs in practice after his licentiate degree in 2003. It is hoped that this expanded focus will help to improve the EIPTs’ practice at the organizational level. However, the author has been engaged in the process of ergonomics ‘know-how’ transfer to Iran since 1996. This has led to an understanding that embracing AR and PAR could help to fill the knowledge and skill gap between universities and industries. How? ‘Learning by doing; individually and collectively’. Furthermore, I feel that there is a most pressing need to try to better understand ‘common goal and effect’ at workplaces (See studies B, C, I, and J). This may or may not lead to the development of common sense. I have reported that the action research in the three companies was creating some fears among the participants and top manager (see Study J). Maybe this illustrates the issues about the development of common sense?

The author worked for about 18 years for Iranian Industries (from 1979 to 1997) in the positions of Plant Manager and Director. Since then, he has worked for about 10 years at Luleå University of Technology in a research student position since 1996. He organized 20 ergonomics training workshops for Iranian Industries from 1997 to 2002. The Danish Maal Institute (DMI) was established in 1997. Finally, in the pre-intervention phase of the EIP, the Iranian Ergonomics Society (IES) was established in 2001. I feel the IES has not yet been fully successful. This could have many reasons: 1) poor ergonomics resource and material locally, 2) poor ergonomics awareness building in Iranian universities and industries, 3) low teamwork culture, 4) low level of research culture in both universities and industries in Iran, and 5) lack of a macro-ergonomics toolbox for the EIP in IDCs. Furthermore, the author had additional experience in 2003 when he established the Mehr E Nami Institute (MENI) after his licentiate degree. It provided another chance for following up the action research-type intervention in the three companies (Studies I and J). But he could not expand his activities in other industries due to his position as a research student. One key finding in these processes could be the necessity of forming and using non-governmental organizations (NGOs) in the IDC. That means it is necessary to know which researchers come from universities and industries to constitute a community of researchers. Therefore, learning by doing - individually and collectively - becomes crucial. Today is also the first day of the future. An understanding of the process of ‘re-framing’ (i.e. trying to see something different, taking the problem and framing it as positive) opens up new possibilities at the end of this dissertation. A question that arises from this is, ‘What is the Ergonomics Intervention Technique (EIT) you/I want more of here and how can we amplify this?’ Figure 1 illustrates the action pathway of the EIP journey (i.e. own experiences of ‘reflecting, planning, acting, and observing’) in the IDC.
1.1. Relevance of the research

This research is important because the practice of ergonomics, after half a century, remains in its infancy as an identified profession in many IDCs. Almost two thirds of the world’s population has little or no access to the vast knowledge base that makes ergonomics such an important tool for work environment and productivity improvement (Shahnavaz, 1995). There is a lack of awareness regarding the potential benefit of ergonomics (Study B; Shahnavaz, 2000; O’Neill, 2005). While ergonomics has the potential in IDCs to ensure optimum technology utilization of technological development and industrialization, interest and attention paid to the subject is very low among responsible IDC organizations and industrial managers (Shahnavaz, 1995). The focus for ergonomists aiming for work environment improvement is to create ergonomics awareness in IDCs (Scott, 1999; Shahnavaz, 1996).

1.2. Rationale behind the research

According to Karwowski (2005), industrial ergonomics, which investigates the human–system relationships at individual workplace (workstation) level or at the work system level, embraces knowledge that is also of central interest to management. From this point of view, industrial ergonomics in congruence with management is focusing on organization and management at the workplace level (work system level), through the design and assessment (testing and evaluation) of job tasks, tools, machines and work environments, in order to adapt these to the capabilities and needs of workers (Karwowski, 2005).

Imada’s (2000) study has shown that a macro-ergonomic approach for improving safety needs to address more than one set of factors. Imada (2000) suggested that traditional interventions alone (training, awareness, ergonomics, and technical safety programmes) are insufficient to reduce injuries and accidents. Imada (2000) mentioned that safety must be analyzed and treated from a system perspective (i.e.
engineers and designers need to be aware of a human-centred approach that focuses on real, not desirable human qualities. Furthermore, Imada’s study (2000) indicated that there are several dimensions that are directly affected by macro-ergonomic intervention (i.e. psychological dimensions, management dimensions, financial dimension).

According to Robertson (2002), when a macro-ergonomic approach is taken, training is part of a comprehensive, systematic approach to enabling knowledge within an organization. But Deming (1993) describes a system as a network of interdependent components that work together to try to accomplish the aim of the system. The system begins with an awakening (‘an awakening to the crisis’ as Deming (1988) described it). The aim of the awakening could be to stress the importance of the need to change. Without an awakening, the person can, at best, learn many important lessons (For example, different people participated in the Ergonomics Training Workshops (ETWs) between 1996 and 2002, or the ETWs were conducted at group level for the IKCo, between 2001 and 2002. This resulted in people learning many lessons. But, deeply motivated intention occurs after the awakening (see Study C about using the ‘Future Workshop’ at the organizational level).

It must be noted that continuous improvement is not a short-term activity. Rather it requires long-term management commitment to continuously adapting and improving the programme (Robertson, 2002). Feedback provides information to accomplish two key performance improvement goals: 1) improve the training program and identify necessary corrective actions, and 2) reinforce the positive outcomes and benefits of using the learned skills in the workplace (Robertson, 2002).

Based on the definition of ergonomics in Section 1, the concept of ergonomics is also broad, systems and interaction related. The focus is on understanding (Hörte, 2006).

It is therefore, deemed the first essential step to initially understand the scope of the problems as follows:

1.3. Research problem

Based on studies B and D to the effect that there is a prevalence of low ergonomics awareness among managers and workers in Iranian industries, a study was carried out by the author (i.e. licentiate thesis, 2003 and study H) which led to the development of an intervention tool known as Ergonomic Intervention Programme Technique (EIPT). When the author started work on this research project in 1996, the research problem was a lack of ergonomics awareness among managers and workers in Iranian industries. The aim therefore, was to build ergonomics awareness among managers in selected Iranian industries and to answer questions such as:

Is the ‘Ergonomics Training Workshop’ a suitable tool for ergonomics awareness building among managers and workers?
Is the workshop sufficient in its structure for this purpose?

Does the ‘Ergonomics Training Workshop’ start a process of improvement/change, or both, in industries?

But as it became obvious, Helali’s (i.e. licentiate degree, 2003) study did not answer the questions outlined above in their entirety, and as a consequence appeared to have shifted in focus towards the main research problem. It can be argued that the study (i.e. Helali, 2003) has not resulted in a clear conceptualization of ergonomics awareness among managers and workers, but a number of reflections that are based in different ways upon the concept of ergonomics awareness among managers and workers. Furthermore, it was possible to find the successes and failures of pre-intervention phase of the Ergonomics Intervention Programme (EIP) at the three levels, viz, individual, group, and organization in Iranian Industries. Tables 1 to 4 show the successes and failures of the applied methods as follows: This information indicated different EIPs for Iranian industries.

Table 1: Successes of Ergonomics Awareness Building (EAB) = Ergonomics Training (ET) + Ergonomics Application (EA) + Evaluation (E) at the three levels Viz individual, group, and organizational (source, Helali 2003)

<table>
<thead>
<tr>
<th>EAB</th>
<th>Individual level</th>
<th>Group level (At Iran Khodro Car Company (IKCo))</th>
<th>Organizational level (At Glucosan Factories (GC))</th>
</tr>
</thead>
</table>
| Successes of EAB by various ergonomics training workshops conducted in the different areas of Iran | The training of 293 persons at 24 workshops from industries. A questionnaire was sent to 186 participants in industries & 51% responded completely. 16% of respondents belong to the individual level of participants in the workshops. | All participants were very positive about the ET + EA and its benefit. Experts (35 people) have learned and applied EA at their workstations. Evaluation was made regularly. The results of EAB in the first phase (18 months) showed that:
  a) Out of 90 projects were at workstations by AGs, 35 resulted in small wins and were effective.
  b) The management has accepted the promotion of the first phase project. The planning for phase 2 of the project was made by participatory method in November 2002, for another two years starting 2003. | All participants were very positive about the ET + EA and its benefit. All levels have learned. The results of EA for period 1995-1997 were:
  a) Production capacity was raised from 70% to 105% of the nominal capacity.
  b) ‘Utilization’ of starch from corn was improved by 15%, GC has achieved an international index of production.
  c) The quality of the products was improved, reaching international standard, making it possible to be exported.
  d) An increase of up to 600% in all employee wages through profit sharing.
  e) Development of a new organizational system for making full use of worker participation.
  f) This practice was the first sample of systemic EIP in Iranian industries and successful at the organizational level.
  g) After 12 months of macroergonomics intervention at GC, the company’s profit rose by 390% (i.e. from 3980 million Rials to 19500 million Rials). |
Table 2: Failures of Ergonomics Awareness Building (EAB) = Ergonomics Training (ET) + Ergonomics Application (EA) + Evaluation (E) at the three levels viz, individual, group, and organizational (source, Helali 2003)

<table>
<thead>
<tr>
<th>EAB</th>
<th>Individual level</th>
<th>Group level (At Iran Khodro Car Company (IKCo))</th>
<th>Organizational level (At Glucosan Factories (GC))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failures of EAB by various ergonomics training workshops conducted in the different areas of Iran</td>
<td>Not making full use of the acquired. Competence by the participants after the workshops for EA in the organizations. Lack of “development work activity” in most Iranian industries. Lack of evaluation culture at work. Poor educational levels of staff in most Iranian industries. Insufficient income. Lack of a strategic training for industries. Lack of management strategies in industries Lack of R&amp;D in industries.</td>
<td>Lack of formal organizational support. Lack of team-work culture for determining a reward system for the action groups (AGs). Lack of integration of EIP with other levels in organization. Lack of formation of SC completely. Lack of interval evaluation by SC. Lack of economic evaluation of projects Lack of a competitive market. EIP was stopped at IKCo in 2003 due to change in management.</td>
<td>Lack of OHS legislations and a guideline for EIP. Lack of research culture in industries. Lack of competitive market. Lack of job security and safety. EIP was stopped at GC in 1998 due to change in management, omission of personal values during two years, lack of training strategies, and the resistance of new manager towards ergonomics programme. Lack of committed stakeholders. Changing organizational structure without attention to the results of EIP and core R&amp;D at GC by new manager.</td>
</tr>
</tbody>
</table>
Table 3: Successes & failures of Research Activity (RA) at the three levels (source, Helali 2003)

<table>
<thead>
<tr>
<th>EAB Research Activity (RA)</th>
<th>Successes</th>
<th>Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Papers presented:</td>
<td>Lack of RA culture in industries.</td>
</tr>
<tr>
<td></td>
<td>For GC</td>
<td>Low productivity.</td>
</tr>
<tr>
<td></td>
<td>- 3 national papers (1996)</td>
<td>Lack of research activities.</td>
</tr>
<tr>
<td></td>
<td>- 2 international papers (1996 &amp; 1998)</td>
<td>High cost of living and participation in international conferences for postgraduate students at IC universities.</td>
</tr>
<tr>
<td></td>
<td>For IKCo</td>
<td>Lack of documentation on relevant information on ergonomics or related fields at the national level</td>
</tr>
<tr>
<td></td>
<td>- 3 national papers (2001 &amp; 2002)</td>
<td>Insufficient financial support by IC’s university for a Ph.D. student of IDCs.</td>
</tr>
<tr>
<td></td>
<td>- 3 international papers (2002)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For individuals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The first national conference in November 2002, produced 60 national ergonomics papers</td>
<td></td>
</tr>
</tbody>
</table>
Table 4: Successes & failures of Network Building (NB), (source, Helali 2003)

<table>
<thead>
<tr>
<th>EAB</th>
<th>Successes</th>
<th>Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Building (NB)</td>
<td>Establishment of Danesh Maal Institute (DMI).&lt;br&gt;Establishment of Iranian Ergonomics Society (IES).&lt;br&gt;Publication of IES newsletter.&lt;br&gt;IES becoming a member of IEA.&lt;br&gt;Developed IES home page: <a href="http://www.modares.ac.ir/ies">http://www.modares.ac.ir/ies</a>&lt;br&gt;And e-mail address: <a href="mailto:ies@modares.ac.ir">ies@modares.ac.ir</a></td>
<td>Lack of private institutions, such as non-governmental organizations (NGOs).&lt;br&gt;Lack of resources and material.&lt;br&gt;Lack of governmental network for supporting EAB.&lt;br&gt;Lack of positive connection between Ministry of Work and ILO.&lt;br&gt;Poor interest for transfer of know-how from ICs to IDC.</td>
</tr>
</tbody>
</table>

The findings reported by the author were primarily not answers to the question. ‘Does an Ergonomics Training Workshop start the process of improvement/change, or both, in industries?’ The finding was rather an account of the importance of running the EIPT’s tools such as ‘Future Workshop’, ‘Ergonomic Checklist’ and ‘Ergonomic Checkpoints’ with an action learning-oriented approach for development of the EIPT at the organizational level in Iranian industries (note: Iran is an IDC). It therefore, became imperative in this doctoral study that scientific-based answers are sought to the research questions outlined in Section 2.1 relative to the findings of Helali (2003). It is hoped that this expanded focus will help in furthering the development of the Ergonomic Intervention Technique (EIT) and its relative importance as an ergonomics process for enhancing ergonomics interventions in the IDC industries.
2. AIMS AND OBJECTIVE OF DOCTORAL THESIS

The aim of this doctoral study is to investigate how the EIP and Ergonomics Intervention Programme Techniques (EIPTs) can be implemented, in an organization, by using an ergonomics intervention technique (EIT) process (i.e. EIP activities, EIP team, and EIP process). The objective is to develop an action-oriented intervention process for the improvement of health and safety, as well as trying to improve work systems in IDC industries.

2.1. Research Questions

The description of the pre-intervention phase of the EIP indicates that the ideas of the EIP and EIPTs for developing intervention techniques overlap (Studies A and H). But there are few practical examples to illustrate the benefits that can come from the EIP and its use in IDC industries. The reason for these few practices is a lack of awareness and recognition of the potential benefits of ergonomics in IDCs (Studies B, C, and D; Jafry & O’Nell, 1997; Rubenowitz, 1997). On the other hand, the efforts of a few industries to implement and internalize the EIP are being constrained. It would, therefore, be interesting in practice to study the main causes of these constraints.

The interest in an EIP exists because the advantages and positive results of the ergonomics intervention at Glucosan factories (GC), (Studies B, C, and D) indicated financial benefits, the development of the organization and personnel advantages. However, at the Iran Khodro Car manufacturing Company (IKCo) (Studies E and F), it resulted only in the competence development of participants and some small wins, but not full advantage to the organization. However, an EIP with a view of macro-ergonomics in theory and action seems to be a possible foundation for an EIP strategy that builds upon and further develops participatory ergonomic intervention techniques. It would therefore be interesting to see: Is it that the EIP is difficult to implement?

If an organization wants to implement an EIP process and apply EIPTs, it is crucial to get the involvement of managers and workers in the process of participatory ergonomics. It would therefore be valuable to get an answer on how can EIPTs be successfully implemented and internalized by such organizations.

Kogi (1997a) describes action-oriented procedures where participation is especially important in a range of low-cost solutions. It is essential to develop an integrated change strategy emphasizing (i) enabling methods that can lead people to immediate action in multiple aspects of work, (ii) participatory steps with the active participation of local people, and (iii) flexible use of support tools and techniques, and training in how and when to use these tools and group work techniques. Since EIPTs are considered as important parts of an EIP, it would be interesting to find the practical activities that are required for the EIPTs implementation.
Therefore, in order to be able to achieve the aim and objectives of this study as outlined in Section 2 above, it is imperative that the following questions are explored:

I. Why are the efforts of these industries to implement and internalise the EIP being constrained?
   a. What are the main causes of these constraints?
   b. Is it that the EIP is difficult to implement?

II. How should EIPTs be delivered to Iranian Industries, and possibly to other organizations in IDCs, so that they can easily learn how to use them successfully?
   c. How can EIPTs be successfully implemented and internalised by such organizations?
   d. What practical activities are required for the EIPTs’ implementation?

2.2. Delimitation

The research area is limited to few companies in Iran. The main reason is lack of ergonomics awareness among managers and workers in Iranian industries. Delimitation also exists in the area investigated, which mainly includes how to implement EIP and the EIT on the organizational level and what is required from the organization to facilitate this implementation. The research study presented in this thesis is based on the perspective of macro-ergonomics and participatory ergonomics process, with a focus on EIP, EIPTs and change. The literature studies, which have generated the theoretical frame of reference, have to a high extent, been limited to the fields of macro-ergonomics, EIP and change in IDC industries.
3. LITERATURE REVIEW

This literature review is based on the general aspects of ergonomics intervention and IDC; different forms of ergonomics intervention and the results of intervention; the objective of an Ergonomics Intervention Programme (EIP); ergonomics intervention in ICs’ industries; ergonomics intervention in IDCs’ industries, and Iranian industries; IDCs and the ergonomists’ work; intervention; Ergonomics Intervention (EI) research; macro-ergonomics intervention and a concept of macro-ergonomics; the participatory ergonomics process, and the role of ergonomists in the participatory ergonomics design and analysis process.

3.1. Ergonomics Intervention and IDC

3.1.1. Different forms of ergonomics intervention and the results of intervention

There are different ways to classify literature on ergonomics intervention. According to Shahnavaz (1993), different forms of intervention are as follows:

- Workstation improvement for physical changes,
- Operators’ training for qualitative changes of operator’s conception and skill,
- Work organization change for improving person-person interaction,
- Technology change for improving person-machine interaction,
- Work systems improvement for optimizing system interfaces.

In the early 1990s, Hendrick (1994 and 2002a) indicate that instead of the 10%-25% improvements in the system effectiveness that many ergonomists have experienced from successful micro-ergonomics interventions, one can achieve improvements of 60%-90%, or more, from macro-ergonomics interventions. As documented in several cases (Hendrick and Kleiner, 2001), the best EIP is performing both the micro and macro-ergonomics intervention.

3.1.2. Objective of an Ergonomics Intervention Programme (EIP)

The objective is to design jobs that are possible for people to do, worth doing, and give the worker job satisfaction and a sense of identity within the company. The ergonomics intervention should result in the employee’s well-being (health, safety and satisfaction) as well as company well-being and optimal performance, productivity and quality (Shahnavaz, 1993).

Factors affecting ergonomics intervention are worker participation, ergonomics awareness and know-how, legislation and inspection, cost, organization and culture (Shahnavaz, 1993).

Worker participation is important for successful intervention because:

- The employee knows his/her job better than anyone else and possesses valuable information,
- Being familiar with the operation, the employee can help to isolate the problem and find a simple/specific solution that is most cost-effective,
- The employee can and will accept responsibility for his/her work, health and safety,
- Intelligence and creativity exist amongst the workforce at all levels of the organization,
- Workers involvement makes them more amenable to the enterprise’s matters.
- The employee will accept and use the solution when he/she has had input to its development.

3.2. **Ergonomics intervention in ICs industries**

Most of the previous research on EIP has often been based upon intervention techniques at the micro-ergonomics level from which Ergonomics Intervention (EI) models and detailed descriptions of the intervention process have been developed. According to Hägg (2003), different types of programmes are identified, with ambitions ranging from time-limited intervention to continuous processes. Common elements are health surveillance, workstation design and choice of tools, product design, quality aspects, participative aspects and education, training and information. The implementation of ergonomics programmes varies substantially depending on the type of company, company policies and organization. During the 1990s the interest for ergonomic issues in a wide sense grew within enterprises, as a result of an increasing awareness of the importance of those matters for corporate core values such as productivity, quality and an inevitable change process (Wilson, 1999).

Numerous reports in the scientific literature describe such programmes more or less briefly. Those reports often are concerned about interventions made by researchers, addressing some specific hypothesis. However, the programme documentation is often fragmentary, leaving out information on, e.g. degree of company involvement, long-term impact in the organization or training efforts. A critical survey of such company programmes was published by Hägg (2003) under the theme ‘Corporate Initiatives in Ergonomics’ in such corporations as Ford (Joseph and Log, 1991; Joseph, 2003), SAAB (Svensson and Sandström, 1995 and 1997; Stroud, 1999), Chrysler (Oriet and Ewasyshyn, 1998), Volvo (Munck-Ulfström et al., 2003), Volkswagen (Klatte et al., 1997; Brandenburg and Bubser, 1999), Mercedes Benz (Bullinger et al., 1997), BMW (Piotrowski, 2000), Peugeot (Moreau, 2003), and Toyota (Adler et al., 1997; Sugimoto et al., 1998). This mainly addresses physical factors in the workplace and serious involvement of the companies.

Within the food industry numerous adverse ergonomics factors are also found. Especially in slaughterhouses and poultry industries, high rates of repetitive movements, high manual forces, awkward postures, and a cold environment create significant problems. See e.g. NBOSH (1999) reports, showing the highest figures of MSD in official statistics for decades. According to Gjessing et al. (1994), Moore and Garg (1998), the problems in the red meat industry in the USA caused NIOSH to launch three intervention studies at three plants. These studies were all supervised by an external expert in ergonomics or organizational behaviour.
Furthermore, in-depth review finding ergonomic solutions (i.e. participatory approaches) and summary examples from a range of industries, including health care, military, manufacturing, production and processing, services, construction and transport, were given by Hignett et al. (2005). The definition of participatory approaches included interventions at macro (organizational, systems) levels as well as micro (individual), where workers are given the opportunity and power to use their knowledge to address ergonomic problems relating to their own working activities (Hignett, et al., 2005). They also concluded that participatory ergonomics projects were complex (Hignett, et al., 2005).

The summarized conclusions strongly advocate participatory approaches, involving staff members on all levels, i.e. engineers, supervisors, and operators in teams for ergonomic problem-solving. The problem with these reports is that they are all success stories. It is most likely also that some programmes have failed, which may be more interesting, or that some programmes were never started due to resistance from the management or have been abandoned due to changes in the management or economical condition. It would be most valuable to also have such cases reported, so as to be able to learn from the mistakes of others and to learn what hindrances there are to the introduction of ergonomics in working life.

Company programmes in ergonomics are usually involved in a wide range of measures, depending on the type of enterprise, company policies and culture, and also national legislation and cultural traditions. Changes in modern enterprises are increasingly described as continuous processes. ‘Continuous improvements’ is a basic, originally Japanese concept which has inspired large parts of the industrial world (Lillrank and Kano, 1989).

3.3. Ergonomics intervention in IDCs’ industries and Iranian industries

1983 could be regarded as the year that interest in the ergonomics of IDCs flourished. The first international conference on Ergonomics of Developing Countries was organized by Professor Houshang Shahnavaz and was held at the Luleå University of Technology in June of that year. The conference lasted two days (June 16-17) and brought together 60 delegates from 15 IDCs and 6 ICs. This was also the year when the Center for Ergonomics of Developing Countries (CEDC)3 was established.

The idea for establishing a research and education centre for promoting ergonomics awareness, research and education in IDC grew from the fact that ergonomics can be of great help when IDCs strive to achieve an overall improvement in the quality of life through industrialization and economic growth (Shahnavaz 1995).

In Iran, interest in ergonomics started in the early 1970s with a few isolated studies (Kavoussi, 1976; Shahnavaz and Davies, 1977; Shahnavaz and Tuxworth, 1978). In 1977, ergonomics was introduced (by Professor Houshang Shahnavaz) at the Arya

3 The outcome of this conference was the formulation of the initial objectives of the CEDC and its future programmes (See www.cedc.info).
Mehr Technical University (Sharif) as a course within the Industrial Engineering curriculum. Since then, ergonomics has been taught as a supporting subject of one or two credits in some Iranian universities. However, it is important to note that in the case of Iranian industries, it was not until the year 1995 that ergonomics became a familiar subject (this is discussed later in Studies A, B, C, and D).

In Iran, ergonomics has not found its way and proper place yet and is still an unknown discipline (Studies B, C, Choobineh et al., 2002). Shahnavaz et al., (2000) noted that the fact that ergonomics is not more widely used in IDC workplaces is mostly due to the lack of knowledge of people in charge in these countries, but also our failure as professionals to spread the science more widely in IDCs and inform them about its benefits. They noted that as a result ergonomics is in its infancy in many IDCs. There is a long and challenging way ahead of the ergonomic community to make ergonomics a global science, bringing it to places that are in more need of its application (Study D and Shahnavaz et al., 2000). Iran’s managers are not familiar with ergonomics and its productive applications yet. But the study at Glucosan factories (GC; from 1995 to 1997) was the first ergonomics intervention in an Iranian industry which showed that the study and practices of ergonomics can be made possible, because of management interested in ergonomic practices and their general commitment to continuous improvement of work and adjustment to change (Studies B, C, and D).

3.4. IDCs and the ergonomists’ work

Talking about ergonomics in relation to IDCs means that we have to define what is an IDC, not by economic criteria (e.g. GNP\(^4\)) but by population, prevailing forms of work and work ethic (see, North, 1987). The work of the ergonomists who have conducted interventions in IDCs such as H. Shahnavaz, K. Kogi, H.W. Hendrick, P.A. Scott, A. Wisner and others was reviewed by Yewow and Sen (2002). One special and common outcome of the past activities in IDCs, regarding various types of ergonomics interventions and ergonomics awareness building in IDCs was the low involvement of ergonomists, the low degree of industry involvement, the short-term impact of training and the low effect of training on the organization as a whole, mostly due to the fact that individuals have received the training and not the groups or organizations (Studies A and D). On the other hand, working conditions in IDCs have been described by Shahnavaz (1996), Scott (1997) and Scott and Shahnavaz (1997) as ‘suboptimal’, ‘physically demanding’ and a ‘complex array of problems’. Furthermore, industrialised countries (ICs) are suppliers of technology and IDCs are usually the receivers of technology in the technology transfer process (Shahnavaz, 2002a). Thus, in the process of ergonomics know-how transfer, ergonomists of ICs as suppliers of an Ergonomics Intervention Programme (EIP) need a more challenging ‘comprehensive plan and planning’.

---

\(^4\) Gross National Product
3.5. Intervention

To give an initial definition of intervention, it simply means purposeful action by a human agent to create change. It should not be considered a general definition (Midgley 2000).

According to Midgley (2000) ‘If intervention is purposeful action by an agent to create change, then systemic intervention is purposeful action by an agent to create change in relation to reflection on boundaries’ [p.129]. He suggested that an adequate methodology for systemic intervention should be explicit about three things. The first is the need for agents to reflect critically upon, and make choices between, boundaries. The second aspect that should be made explicit is the need for agents to make choices between theories and methods to guide action, which requires a focus on theoretical and methodological pluralism. Finally, an adequate methodology for systemic intervention should be explicit about taking action for improvement.

Midgley (2000) mentioned that this ensures a proper consideration of a minimum set of three ‘angles’ on possible paths for intervention. Making all of them a specific focus of a methodology for systemic intervention guides the reflections of the agent, ensuring that boundaries, theories, methods, and action for improvement all receive explicit consideration. The three activities are diagrammed in relation to one another in Figure 2. Critique specifically means boundary critique (reflection on, and choice between, boundaries); judgment means judgment about which theories and methods might be most appropriate; and action means the implementation of methods to create improvement.

On the other hand, according to Midgley (2000), many writers contrast observation and intervention; it appears that both scientists (who champion observation) and action researchers (who champion intervention) have an interest in maintaining this pair of concepts in opposition to one another. But a key word in the use of observation as intervention is ‘construction’ (Midgley, 2000). He mentioned that scientific observation is not just any observation, but a moment in which the situation is constructed to facilitate observation under controlled conditions. There are two levels at which this kind of observation is dependent on the involvement of agents within the knowledge generating system (Midgley, 2000); firstly, in establishing the goals and parameters of the observation; and secondly, in actually undertaking the observation.
3.6. Ergonomics Intervention (EI) research

The body of literature on macro-ergonomics provides much information on how to design and improve work systems (Hendrick, 1997; Hendrick & Kleiner, 2001; Hendrick & Kleiner, 2002). Hendrick (1997) has defined a number of ‘levels’ of human factors or ergonomics. These include:

- Human-machine: hardware ergonomics: It primarily concerns the study of human physical and perceptual characteristics and the application of these data to the design of controls, displays, seating, workstations and related workspace arrangements.
- Human-environment: environmental ergonomics: It concerns the effects of various physical environmental factors, such as illumination, heat, cold, noise and vibration, on human performance, and the application of these data to the design of physical environments for people.
- Human-software: cognitive ergonomics: It concerns the way people think, conceptualize, and process information, and the application of these data to software design.
- Human-job: work design ergonomics: It concerns the design of jobs to ensure proper workload and characteristics such as task variety or having different meaningful things to do in one’s work identity or sense of job wholeness, significance or perceived job meaningfulness autonomy or control over one’s work, and feedback or knowledge of results.
- Human-organization: macro-ergonomics: It concerns the interfacing of employees with the over-all organizational design of the work system so as to most effectively utilize both the personnel and technology employed in the system in responding to the organization’s external environment.

The term intervention refers to efforts made to effect change and render such change stable and permanent (Westlander, et al., 1995). According to Westlander, et al. (1995), at least two different things can be meant by intervention research:

- Research is conducted into interventions that are taking place;
- Research is conducted according to a study design that includes an intervention.

In the first case, the intervention is initiated and carried out within the organization. Thus the initiative comes somewhere ‘from within’, and the role of the researcher (from the outside) is to examine and analyze the course of events.

In the second case, the intervention is initiated by a researcher – an expert ‘from outside’ – and carried out as part of a prospective research programme, with the consent and, hopefully, the committed involvement of people in the organization (Westlander, G., 1993). Furthermore, other forms of intervention research are mentioned in the literature: Shahnaz, (1991), mentioned another form of intervention as the results of competence building among a company’s employees:
Research is conducted according to an ergonomics awareness building that includes an intervention by workshop.

This kind of intervention, which emphasizes ergonomics awareness building between employee and managers or participants, was what was mostly implemented in Iran and was reported in the study by the author (licentiate thesis and Study H, 2003). According to this method, the author was involved in the preparation of the pre-intervention and creation of needs for ergonomics application and conducting ergonomics research activities. In the modified phase, another form of intervention as macro-ergonomics intervention was performed for creating a problem-solving process, using the results of competence building among the company’s employees at the work system in the organization for improving work systems as follows:

- Research could be conducted according to an ergonomics awareness building that includes a macro-ergonomic intervention by the EIPTs at an organizational level.

A question raised by ergonomists is how to ensure that ergonomic criteria are considered in the early stage of work system design (Clegg, 1988; Luczak, 1995; Slappendel, 1994). Johnson and Wilson (1988) have discussed two approaches for taking into account ergonomics in work system development: 1) provision of guidelines, and 2) ergonomics input within collaborative design. In order to define macro-ergonomic intervention guidelines, we need a better understand the specific work system elements that affect the outcomes of health, safety, and ergonomics and their integration in the work system. We have limited information on this.

According to Clegg (1988), three different stages of work system development can be distinguished. These are:
- Design of work system,
- Implementation of work system,
- Operation of work system.

Das (1999) states three major approaches to work design as follows:
- the technology-centred approach which follows the linear sequence of system development (i.e. requirement analysis, functional specification, design, implementation, and testing),
- the human-centred approach which focuses on personal growth (i.e. the development of professional skills and social competence, and the use of human capabilities and skills as the main sources of productivity); and
- the socio-technical approach in which both technical and human centred approaches are acknowledged and merged together in the social technical approach.

### 3.7. Macro-ergonomic Intervention


Productivity improvement is a key issue in Industrially Developing Countries (IDCs), (Shahnavaz et al. 2000). During the 1990s the interest in ergonomic issues in a wide sense grew within enterprises, as a result of an increasing awareness of the importance of those matters for corporate core values such as productivity, quality and an inevitable change process (Wilson, 1999). Experiences from Industrialised Countries (ICs) show that consideration of macro-ergonomics is a significant contributing factor, for creating the appropriate working environment in which people are motivated to participate and better utilize company resources for increasing system productivity, reliability and availability (Shahnavaz, 1994; Shulz-wild, 1990; Hägg, 2003).

Macro-ergonomic intervention begins with an assessment of the relevant socio-technical variables and their implications for the design of the structure of the work system and processes. Once key characteristics of the overall work system have been determined, micro-ergonomic prescriptions, such as how to optimally allocate functions and tasks to humans and machines or computers, can be accomplished (Hendrick, 1986). According to Hendrick (1995), an important outcome of macro-ergonomic intervention is a culture change, where organizational culture is primarily defined by the organization’s core values, but which also includes traditions and unwritten rules.

As Shahnavaz (2002b) points out, with introduction of new technology, especially through technology transfer, numerous health and safety problems are brought to the IDC workplaces, which are hampering the company’s competitiveness. However, emphases for remedy, if any in a few progressive companies are mostly on micro-ergonomics. This is mainly because of the traditional thinking, cultural issues and the lack of knowledge and skill needed to deal with macro-ergonomics issues. Nevertheless, ergonomics intervention in IDC will be best-achieved through macro-ergonomic input, which will trigger even no-cost/low-cost micro-ergonomics improvements (Studies B, C, D, E, and F).

The success of low-cost improvements actually depends on the careful selection of feasible solutions. It is suggested that one should select, with the help of appropriate support tools, low-cost improvements that can be built into work methods and equipment and are realizable by means of local skills and materials (Kogi 1997b).

Furthermore, Scott and Charteris (2001) emphasized that it is necessary to include both micro-ergonomic (i.e. as a concept of an Ergonomics Stress Index (ESI),
Genaidy et al. (1992), and macro-ergonomic approaches (i.e. the goal of macro-ergonomics is to optimize the work system’s design in terms of its socio-technical system characteristics, and then carry the characteristics of the overall work system design down through to the design of individual jobs and human-machine and human-software interfaces to ensure a fully harmonized work system). Instead of evaluating the relative merits of the two approaches, one needs to acknowledge their complementary interdependence, where the ratio between their inputs will vary according to the situation being addressed (Scott and Charteris, 2001). Furthermore, according to Hendrick (2002b), when the goal of macro-ergonomics is achieved, the result should be dramatic improvements in various aspects of organizational performance and effectiveness. This has been shown (Studies B, C, and D) in the EIP at Glucosan factories (from 1995 to 1997) in Iranian industries.

3.7.1. A concept of Macro-ergonomics: Human-centered and Participatory

According to Hendrick and Kleiner (2001), macro-ergonomics is top-down (i.e. strategic approach to analysis), bottom-up (i.e. participatory) and middle-out (i.e. focus on processes). Central to macro-ergonomics is the expectation that analysis and design of work systems will be participatory in nature (Imada, 1986; Imada and Nagamachi, 1995). To achieve human-centered work system designs, human-centered analytical processes must be used. This constitutes the socio-technical principle of compatibility. Consistent with the emphasis on participation in a number of domains, participatory ergonomics is rapidly emerging as an area of international inquiry in its own right (Brown, 1994) and is seen as a core method in macro-ergonomics. Macro-ergonomics is human-centered (Hendrick, 1986) and participatory ergonomics is a primary methodology of macro-ergonomics involving employee at all organizational levels in the design process (Imada, 1988).

3.7.2. Participatory Ergonomics and the role of the ergonomist in the participatory ergonomics design and analysis process

According to Wilson and Haines (2001), a variety of different tools and methods have been reported as useful within participatory ergonomics initiatives. Some have been borrowed, adapted or developed with participatory ergonomics specifically in mind, whereas others have been taken from more ‘traditional’ ergonomics initiatives and then applied within a participative exercise. The variety of ways in which participatory ergonomics may be applied means that certain techniques will be much better suited to certain situations. For example, if we are looking to instigate and support participatory ergonomics as a macro-ergonomic strategy, we are likely to be interested in tools to sell a participative approach to stakeholders or to facilitate group-working and improve interpersonal skills (Wilson and Haines, 2001). Tools and methods will be employed in various stages of a participatory ergonomics exercise, for instance organization, support, problem analysis, idea generation and concept evaluation (Wilson and Haines, 2001).

According to Ogden Brown (2005), participatory ergonomics as a concept has been defined in differing but complementary ways. Wilson and Haines (2001) point out that participatory ergonomics can be regarded as a philosophy, an approach or strategy, a programme, or a set of techniques and tools. They noted
that of all the advantages of participatory ergonomics, there are two direct benefits that are commonly referred to. Firstly, employees have unique knowledge and experience of work and their involvement should, therefore, provide a clearer understanding of both the types of problems being encountered and the solutions that will be appropriate. Second, involving people in the analysis, development and implementation of a change should generate greater feelings of solution ownership and may generate a greater commitment to the change being implemented. As such, in the participatory ergonomics process, the process of participation itself may provide benefits, with participants developing more self-confidence, competence, independence, personal development, social contact, feedback, influence, challenge and variability, the very characteristics that have been identified as contributing towards ‘good’ work and reducing stress at work (Karasek and Theorell, 1990). The long-term implication of using participatory ergonomics is that individuals will be able to exert some control over their environment. According to Noro and Imada (1991), this would lead to feedback, self-determination, and self-regulation, helping the end-users to improve their work environment and working conditions.

Wilson and Haines (2001) have mentioned that participatory ergonomics is complex and diverse, an umbrella used to cover a fairly broad range of ideas and practice. This means that there is a range of models and ways of carrying out participatory ergonomics, and a multiplicity of tools and methods employed within participatory ergonomics initiatives. But Wilson and Haines (2001) concluded that most commentators see participatory ergonomics as offering a common set of advantages (Figure 3). Firstly, it is seen as exploiting the detailed knowledge and experience of those who inhabit the very workplace under investigation (i.e. getting most from those who, in a sense, should know best). Secondly, it is felt to encourage a sense of ownership among the participants, such that it helps to secure at least some degree of commitment both to the process itself and to any change that may result. A third and related advantage of participatory ergonomics is thought to centre upon psychosocial factors.

![Figure 3: The nature of a participatory ergonomics cycle (Source, Haines & Wilson, 1998)](image_url)

Furthermore, Wilson and Haines (2001) noted against such benefits, there might be some concerns about the time, cost and case of implementing participatory programs, and about inappropriate or poor quality implementations.
Ogden Brown (2005) describes the role of the ergonomist in the participatory ergonomics design and analysis process as being varied and complex. The role of the ergonomist common to all participatory approaches is that of change agent. Furthermore, the ergonomist can be a facilitator of change (Ogden Brown, 2005). The facilitator, in this regard may be the “owner” of a project or the person who wants the intervention and can be someone from inside or outside the organization (Ogden Brown, 2005).
4. THEORETICAL FRAMEWORK

This section contains a description of why macro-ergonomics, as the main ergonomics ‘know-how’ transfer concept, is questioned. The section also contains a description of concepts fundamental for this thesis, such as the theory system, the socio-technical theory and macro-ergonomics theory, and theories of change describes how ‘the linear and non-linear strategies for change’ may reach an organizational goal. At the end of this section, the use of the presented theory is questioned as follows: ‘why did the author select theses theories and not other theories?’, ‘What is important theory in relation to the research questions?’ In addition, generally, ‘what are the advantages and disadvantages of these theories?’

4.1. Introduction

Ergonomic interventions must be a local process that responds to the particular needs of local people (Kogi, 1995). In view of the many constraints, special attention is drawn to participatory ergonomics as an effective means of finding locally workable solutions (Kogi, 1995). According to Shahnavaz (2002b), one of the main problems for IDCs is the lack of scientific, technology infrastructures, and training facilities for improving the workforce’s level of education, skill, and understanding of safe and effective operation, maintenance, and development of the imported technology. Thus, a well-established support and information system for providing and supporting top manager (s) in the beginning of the EIP is important. In the process, it needs the commitment of employees and managers to learning in the organizations to ensure the EIP process (see Studies B and C). Furthermore, ‘the local culture of the technology recipient firm and its similarities with the technology producing firm greatly influence the success of the transferred technology. Cultural values and behavioral patterns have a direct bearing on people’s willingness and ability to adapt and absorb technology’ (Shahnavaz 2002b) [p. 322].

According to Kogi (1997a), it is important that the application of ergonomics principles itself represents a process of technology transfer. According to Meshkati, (1986) and Shahnavaz (1991a), the unique situation and characteristics of each company, the prevailing conditions within the country and the nature of technology demand a specially designed programme in which the ergonomics activities of both technology supplier and technology receiver are described in detail for each phase of the technology transfer life cycle. These phases are the initiation phase, the analysis phase, the selection phase, the implementation phase and finally the utilization phase (Meshkati, 1986; Shahnavaz, 1991a). Furthermore, a successful transfer thus requires that the cultural barriers be overcome and cultural issues be considered in the life cycle of the ergonomics ‘know-how’ transfer process (Shahnavaz, 2002b).

My initial study for the licentiate degree (Helali, 2003) was on the ‘Ergonomics Intervention Programme Technique (EIPT)’. The interaction model which was presented in paper A was used in Iran in order to emphasize the EIP as an essential process for establishing long-term relations between facilitator (supplier) and three levels of users or receivers, viz individual, group and organization. This could
guarantee continuous support for local actors of the EIP. Furthermore, this was a type of ergonomics management like ergonomics know-how transfer that people in IDCs need in order to be successful in macro-ergonomics intervention processes (see figure 4).

To better apply micro and macro-ergonomics at an organizational level, the support and commitment of top managers to learning are needed. In this process, commitment of employees to ergonomics learning (both at micro and macro levels) was attained by the EIPTs at the organizational level. This led to a more appropriate ergonomics ‘know-how’ transfer and awareness building among managers and workers in a long-term relationship (see studies B, C, and D).

4.2. Proposed model of EIPT for an action research-type intervention

According to Helali’s (2003) study, there was a need for the continuation and follow-up of the macro-ergonomic interventions. Action research-type intervention in the area of EIP was also required to complete three processes (routine, modified and new ergonomics intervention programme task) of the feasible method for ergonomic know-how transfer with regard to the goals of ergonomics (see Figure 5).

According to Deming (1988), the role of management is prediction. Prediction without information and knowledge is guessing. Knowledge is obtained through learning. Several authors (Smith and Smith, 1988; Deming, 1993; Senge, 1990; Joiner, 1994) have noted that knowledge for transformation must come from the outside (i.e. external education and coaching).
It should be mentioned that action is the application of new learning (theory of macro-ergonomics knowledge, see Section 4.3). Action, however, must be managed. This can be accomplished through a Plan-Do-Study-Act (PDSA) cycle (Deming 1993); i.e. the PDSA cycle describes a method of continuous improvement. First, the problem is identified and a subsequent solution is found (Plan). Then the solution is applied with the hope that it eliminates the problem (Do). After this, the result of the activities is investigated (Study). The last phase is to establish the result in the organization to see if the result is satisfactory, and give feedback to other interested parties (Act). This cycle is a flow diagram for learning, and for improvement of a product or of a process. As such, learning must be continual. The only way to continue the transformation is to obtain feedback and to reflect (Oden, 1999), and then to repeat the loop (see Figure 6).

4.3. Theoretical frame of references in ‘Macro-ergonomics theory’

Macro-ergonomics is a socio-technical systems approach to work system design (Hendrick and Kleiner, 2001 and Hendrick, 2002a). But, the notion of open system theory has played an important role in the study of organizations, for example the
socio-technical theory is heavily influenced by the systems theory. It is usually also referred to in macro-ergonomics (Hendrick, 1986).

Trist and Bamforth tried to use the open systems theory in their study of the coal mining industry (de Board, 1978). The general systems theory also receives attention from researchers from various fields of science in search of integrating principles. Robbins (1987) defines system as a set of interrelated and interdependent parts arranged in a manner that produces a unified whole. The notion of open system derives from biology but has a large impact on the behavioral sciences. The general systems theory was influenced not only by von Bertalanfly’s (1950) ‘Open systems in physics and biology’ but also by others who themselves tried to describe the nature of systems in general. The general system theory assumes that every system is open, and that all systems are dependent upon interactions with their environment. All systems (it can be a cell, a plant, an animal or a social organization) are characterized by having methods for handling information overload, boundary crossing, and feedback, transactions of input, throughput and output (Katz and Kahn, 1978).

TAVISTOCK INSTITUTE OF HUMAN RELATIONS RESEARCH (1950s to 1960s) developed the framework in an attempt to reflect on and generalize their ideas about the interdependence of technology and work organization, and their commitment to group self-regulation. The key features of the open socio-technical system framework were that work or production operations should be seen as a system with interdependent parts, and open systems adapting to and pursuing goals in external environments, - Open socio-technical systems possessing an internal environment made up of separate but interdependent technical and social subsystems, -Open socio-technical system with equifinality, i.e. in which system goals can be achieved by different means. This recognized the existence of organizational choice in the type of work organization that could complement any given technology -Open socio-technical systems in which performance depends on jointly optimizing the technical and social subsystems are optimized at the expense of the other.5

According to Badham et al. (2001) the classical formulation of socio-technical design principles is by Charns (1987): Compatibility (the process of design should...
be compatible with the design objectives; i.e. ‘processes should be highly participative), minimal critical specification (while objectives should be specified, the means of achieving them should not be), variance control (variances should be controlled at source (and should not be exported across boundaries)), boundary control (boundaries should not be drawn so as to impede sharing of information, knowledge or learning), information flow (information should be provided to those who require it when they require it), power and authority (those who need equipment, materials, or other resources to carry out their responsibilities should have access to them and authority to command them), the multifunctional principle (individuals and teams should take on multiple roles to increase their response repertoires.), support congruence (supporting systems and subsystems need to be congruent. (E.g. planning, payment systems and career systems)), transitional organization (periods of transition require planning from the old and the new systems, and are themselves subject to socio-technical design), incompleteness (re-design is continuous and is the function of self-regulating teams’).

Chern’s principles (1987) provide criteria that can be used to guide the design of individual jobs, group work, technology, work processes, organizational structure and the design process.

A socio-technical system is a bounded, purposeful enterprise comprised of people whose purpose is to transform inputs into outputs (Taylor and Felten, 1993). The system is open in that it exists in and is influenced by an environment (Hendrick, 1991). Mumford (2003) states that socio-technical system design has two important components (i.e. to humanise work and support democracy at work). According to, Trist, (1993) some of the primary principles of socio-technical system are as follows:

- Work organizations consist of two independent yet interdependent systems: the technical system (equipment, machinery, chemical processes, etc.) and the social system (individual workers and groups of workers).
- The work system is the basic unit, comprising a set of activities that make up a functioning whole, rather than single jobs and tasks.
- The work group, rather than the individual jobholder, is central.
- Regulation of the system is performed by the group itself, instead of by supervisors (completely counter to Taylor’s scientific management notions).
- An individual worker is complementary to the machine, rather than an extension of it.

In socio-technical theory, the system is broken into three sub-systems: technological, personnel, and job design (Hendrick, 1986). The technological sub-system contains the tools, technology, work rules, and processes that convert system inputs into outputs (Hendrick, 1986).

As illustrated in Figure 7 below, there are several important sub-systems, the personnel sub-system, technological sub-system, organizational job and task design, and the internal and external environments. The three major principles behind socio-technical system theory (Badham et al. 2001) are 1) joint causation (i.e. a characteristic of socio-technical systems is that they are open systems), 2) joint
optimization (i.e. if the personnel or technological sub-system were to be optimized, the result would be a sub-optimized system), and 3) joint design (i.e. joint optimization is achieved through joint design. According to Kleiner and Drury (1999) these can be factors of a successful macro-ergonomic practice. The requirements of each sub-system are considered along with the influence of the environment in designing the system), (Hendrick, 1986). Hendrick (1997) states that, there are at least three major characteristics of the personnel sub-system these are sensitive to the design of an organization’s work system structure: 1) the degree of professionalism, 2) demographic characteristics, and 3) psychosocial aspects of the workforce.

Figure 7: Work System Sub-Systems (source, Kleiner, B. M., 2004)

Macro-ergonomics is concerned with the optimization of work system design through the consideration of relevant social, technical, and environmental variables and their inter-actions (Kleiner and Drury, 1999). The work system is comprised of personnel interacting with technology, within internal environments, external sub-environments, and the organizational structure (Hendrick and Kleiner, 2001). Furthermore, Macro-ergonomics is human-centred because it considers the worker’s professional and psychosocial characteristics in designing a work system and subsequently carries the work system design through to the ergonomic design of specific jobs and related hardware and software interfaces (Hendrick, 1986).

Integral to this human-centered design process is joint design of the technical and personnel sub-systems, using a humanized task approach in allocating functions and tasks. Participatory ergonomics is a primary methodology of macro-ergonomics involving employee at all organizational levels in the design process (Imada, 1988).

Macro-ergonomics takes a top-down and bottom-up (e.g. participatory ergonomics) socio-technical systems approach to the design of organizations, work systems, jobs, and related interfaces between humans and machines, users and system, and humans and environment. This results in a fully harmonized work system at both the macro- and micro-ergonomic level (Hendrick, 1995b). Furthermore, this approach is ‘a top-down approach to system design based on a socio-technical perspective’ (Brown 1994; Hendrick, 1994; 2002a, Noro & Imada, 1991, and
Kleiner, 1996). In macro-ergonomics, a top-down approach begins by identifying the appropriate socio-technical system variables and determining how these variables will affect the design of the work system and processes. The ultimate goal of macro-ergonomics is to have an optimized work system at the macro- and micro-ergonomic levels. By applying the macro-ergonomic perspective to a tutoring system, socio-technical system variables were identified and tested to determine the effect on the work system and people using the system (Hendrick and Kleiner, 2001; Hendrick 2002a). Furthermore, the organizational structure of a work system can be conceptualized as having three core dimensions (Hendrick, 2001a). Three major components in the running of any organization are its complexity, formalization, and centralization (Robbins, 1986).

- Complexity refers to the degree of differentiation and integration which may exist within an organization. The degree of differentiation is such as vertical, horizontal, and spatial, increasing any one of these three increase a work system’s complexity. Integration refers to the number of mechanisms designed into a work system for ensuring communication, coordination, and control among the differentiated elements. Some of the more common integrating mechanisms that can be designed into a work system are formal rules and procedures, committees, task teams, liaison position, and system integration offices (Hendrick, 2001a).

- Formalization; maintaining standards; refers to the degree to which employee decision discretion is limited by explicit job descriptions, extensive rules, and clearly defined procedures covering processes (Hendrick, 2001a) and,

- Centralization; decision-making and strategic planning; refers to the degree to which formal decision-making is concentrated in a relatively few individuals, group, or level, usually high in the organization (Hendrick, 2001a).

According to Hendrick (2002a), effective macro-ergonomic design drives a number of aspects of the micro-ergonomic design of the work system and thus ensures ergonomic compatibility of the system components with the work system’s overall structure. In socio-technical system terms, this approach enables joint optimization of the technical and personnel subsystems from top to bottom throughout the organization and harmonization of the work system’s elements with its overall design and the external environment. The result is greater assurance of optimal system functioning and effectiveness, including productivity, quality, and employee safety and health, psychosocial comfort, intrinsic motivation, commitment, and perceived quality of work life.

As Hendrick posits, complex systems are synergistic, the implication being that the whole is not equal to the simple sum of its parts. In this respect, therefore, because organizations are complex systems, they too should be synergistic. Theoretically, because of this synergism, certain circumstances should tend to occur in complex work systems. According to Hendrick (1994), when work systems have incompatible designs, then one can expect a) productivity – especially quality of production – to be relatively deficient, b) accident rates and lost-time injuries to be relatively high and adherence to safety standards and procedures poor, and c)
motivation and related aspects of job satisfaction and perceived quality of work life (e.g. psychosocial comfort, stress) to be relatively poor. But, when the work systems have compatible designs, synergistic functioning becomes possible, and the various system effectiveness criteria, such as productivity, safety, employee satisfaction, commitment, and perceived quality of work life, will be much greater than the simple sum of the parts.

For many years now (since the early 1980s), Organizational Design and Management (ODAM) factors have become an accepted field of research for ergonomists (see ‘Historical Development of Macro-ergonomics’ by Hendrick, 2001a). In the literature, macro-ergonomics is defined as a technique of ODAM, (i.e. human factors are taken into account in organizational design and management). The technique of macro-ergonomics is acknowledged to have a great potential for improving organizational functioning. In the beginning, macro-ergonomic methodologies mainly used traditional micro-ergonomic tools that it was possible to also use in macro-ergonomics. The tools came from organizational psychology, organizational design and related disciplines, such as industrial sociology. Examples of such tools are: Participatory Ergonomics, User System Analysis, Work System Design, Systems Analysis Modelling, and Ergonomics Work Analysis (EWA), also called Course of Action Study (CAS) (Hendrick, 1991). Furthermore, macro-ergonomics offers a scientific, theoretically rich, socio-technical framework for studying both the macro and micro-enterprise issues that challenge practitioner and scholar alike, such as organizational performance improvement (Kleiner and Drury, 1999). Performance is viewed as multidimensional, characterized by criteria and measures related to various checkpoints in the system (Kleiner, 1996).

4.4. Theories of change

There are many approaches to managing and understanding change to choose from, none of which appears to tell the whole story, most of which are convincing up to a point (Cameron and Green, 2004). They mentioned the advantages and disadvantages of some models of change; i.e. Lewin ‘three-step model’, Bullock and Batten ‘planned change’, Kotter ‘eight steps’, Beckhard and Harris ‘change formula’, Nadler and Tushman ‘congruence model, William Bridges ‘managing the transition’. Carnall ‘change management model’, Senge ‘systemic model’, and Stacey and Shaw ‘complex responsive processes’. The aim of this thesis was not a model of change’s theory. In the author’s opinion, it is important that changes not only improve existing systems, but also change the system and working conditions within the system. According to the aim of this thesis, it is therefore important to understand some keywords and the different kinds of change; i.e. resistance to change, to make an organization capable of learning, ‘Tip’ and ‘Tipping point’, revolutionary or evolutionary change. In this explanation, theories of change distinguished for mention are linear and non-linear strategies or system and non-system perspectives for reaching the organizational goal. Within the goals and objectives of the system, some may be action-driven (requiring immediate action), while other may be vision-driven (more long term). Furthermore, the ‘Tipping Point’ principles have been described in sub-system 4.4.3 as a magic moment when ideas, trends and social behaviour cross a threshold, tip and spread like wildfire.
Change usually involves a considerable part of the organization’s energy and resources. In the implementation of technical change for example, many very different issues have to be addressed at the same time in the change process. Eason (1990) gives the following list of concurrent events: 1) installing and testing the technical system, 2) designing the local workplace, 3) training and supporting the employees, 4) changing the organization, and 5) ensuring acceptance of change.

According to Ingelgård (1996), several strategies for change have been proposed that emanate from different theoretical views: such as 1) Manufacturing strategies6 (the research of manufacturing strategy can be divided into two fields: the content and process of manufacturing strategy, where the content of the manufacturing strategy includes the objectives for manufacturing, plans and policies for change in the structure). The process of the manufacturing strategy refers to the process of formulating, implementing, and manufacturing strategy (Tunälv, 1991). 2) Organizational Development (OD)7: There is a wide variety of intervention strategies related to learning and change, which is aimed at improving the effectiveness of a given organizational unit. Some of the intervention strategies include as follows (French and Bell, 1990):

- Feedback–learning new data about oneself, others, group process,
- Increased interaction and communication – allow a check of perceptions to determine whether they are socially validated,
- Confrontation – removes obstacles to gain effective-interaction; education – upgrades skills, knowledge and concepts,
- Participation – considered to enhance job satisfaction and to promote employee well-being; and increased accountability,
- Activities with the aim of clarifying who is responsible for what and to promote performance related to responsibility).

As Argyris (1982) stresses, the interventionist (an external consultant) has to create and design a procedure which will teach the clients (participants) to discover problems, invent solutions, produce solutions, and evaluate the effectiveness of the production. In this regard, Robbins (1987) posits that any successful work design must jointly optimize the social and the technological demands of the job. According to Pasmore (1988), the strategy for creating a change structure is comprised of three parts; steering committee, design team and consultant. The steering committee provides resources, sanctions changes and oversees that changes are implemented. The design team makes the analyses of the socio-technical

---

6 Manufacturing strategy has been defined by Tunälv (1991, p. vi) ‘…as an overall manufacturing purpose (manufacturing task), a set of perfectly sounded manufacturing objectives, policies, decision rules, and a rational plan for how the manufacturing objectives, policies, decision rules, and manufacturing resources should be arranged in order to accomplish these objectives and the overall purpose’

7 The term OD was not used until the late 1950s (French and Bell, 1990). OD is defined by French and Bell, 1990 (1990, p. 17) as ‘…a top management supported, long-range effort to improve an organization’s problem-solving and renewal processes, particularly through a more effective and collaborative diagnosis and management of organization culture – with special emphasis on formal work team, temporary team, and inter group culture – with the assistance of a consultant facilitator and the use of the theory and technology of applied behavioral science, including action research.’
system, makes redesign suggestions and tries to involve the members of the organization in the process of change. The consultant is the guide who gives information about the change process, about training and what has been done elsewhere. Thus, each part has a specific role to play in the process. Therefore, ‘considering organization change through a socio-technical lens means that one would gather data about both the social and technical system. However, should also consider and act with the perspective that the two are interdependent. A change in one system will directly affect the other, and this effect must be treated as another leverage in the change process (for example, changing a piece of software in an organization’s information system (the technical) will directly affect how employees who use the software interact with one another in the future)’, (Burke, 2002). Thus, the socio-technical theories are important and very much alive for researchers in the field of engineering. Furthermore, socio-technical and Organizational Development (OD) methods are very much influenced by each other (Ingelgård, 1996).

4.4.1. Resistance to change and types of organization change

According to Kotter and Schlesinger (1979), there are four reasons why certain people resist change; these are:
- Parochial self-interest (some people are concerned with the implication of the change for themselves and how it may affect their own interests, rather than considering the effects for the success of the business).
- Misunderstanding (communication problems; inadequate information).
- Low tolerance to change (certain people are very keen on security and stability in their work).
- Different assessments of the situation (some employees may disagree on the reasons for the change and on the advantages and disadvantages of the change process).

Kotter and Schlesinger (1979) set out the following six approaches to deal with this resistance to change as follows:

**Education and Communication:** ‘Where there is a lack of information or inaccurate information and analysis? One of the best ways to overcome resistance to change is to educate people about the change effort beforehand. Up-front communication and education helps employees see the logic in the change effort. This reduces unfounded and incorrect rumours concerning the effects of change in the organization.’

**Participation and Involvement:** ‘Where the initiators do not have all the information they need to design the change and where others have considerable power to resist? When employees are involved in the change effort they are more likely to buy into change rather than resist it. This approach is likely to lower the resistance of those who merely acquiesce to change.’

**Facilitation and Support:** ‘Where people are resisting changes due to adjustment problems? Managers can head-off potential resistance by being supportive of employees during difficult times. Managerial support helps employees deal with
fear and anxiety during a transition period. The basis of resistance to change is likely to be the perception that there will be some form of detrimental effect occasioned by the change in the organization. This approach is concerned with provision of special training, counselling, time off work.  

*Negotiation and Agreement:* ‘Where someone or some group may lose out in a change and where that individual or group has considerable power to resist. Managers can combat resistance by offering incentives to employees not to resist change. This can be done by allowing change resisters to veto elements of change that are threatening, or change resisters can be offered incentives to leave the company through early buyouts or retirements in order to avoid having to experience the change effort. This approach will be appropriate where those resisting change are in a position of power.’  

*Manipulation and Co-option:* ‘Where other tactics will not work or are too expensive. An effective manipulation technique is to co-opt with resisters. Co-option involves the patronizing gesture in bringing a person into a change management planning group for the sake of appearances rather than their substantive contribution. This often involves selecting leaders of the resisters to participate in the change effort. These leaders can be given a symbolic role in decision making without threatening the change effort. Still, if these leaders feel they are being tricked they are likely to push resistance even further than if they were never included in the change effort leadership.’  

*Explicit and Implicit Coercion:* ‘Where speed is essential and to be used only as last resort. Managers can explicitly or implicitly force employees into accepting change by making clear that resisting changing can lead to losing jobs, firing, transferring or not promoting employees.’  

4.4.2. Change processes in workplaces and learning organization  

According to Karwowski *et al.* (2002), the support for a change process will be established through such actions as: 1) development of skills and training for new forms of team work, 2) implementation of the reward systems for participation in teams, 3) design of a comprehensive communication system that incorporates a knowledge of change, and 4) establishment of procedures that allow for experimentation, creating a culture of change, and providing facilities to support change. The knowledge and tools of the macro-ergonomics discipline can be very useful in this process.  

Lack of employee commitment to an organization and its goals has been identified as a major constraint upon its performance; this includes its ability to change (Mullins, 1996). In the opinion of Burgess and Turner (2000), commitment is particularly important for the successful implementation of projects and strategic programmes. They noted that the introduction of new technology or strategic initiatives represents a period of discomfort and risk. As such, commitment can help to smooth this period of transition by removing the delays, decision constraints, and reversion to the old ways of working associated with non-commitment or mere compliance. Therefore, commitment is an important factor.
both in getting the resources required for a project and in ensuring that it can avoid and/or overcome the barriers to implementation that can arise.

In the opinion of Balogun and Hailey (1999), the notion of change can be described in three states (see Figure 8 below). These are the current state (where the organization is now), the future (where the organization wants to be), and the transition (how to get to the future state). They describe how the concept of a change vision is introduced, and also explained how aspects of the future state needs to be considered before moving on to design the transition. Balogun and Hailey also pointed out that the notion of the transition state is expanded to explain how it encompasses three change phases – unfreeze, move and sustain.

According to Balogun and Hailey (1999), one way of making a transition (i.e. the transition from an old way of working to a new one is an important step in a company’s ambition to improve the work system and continue to make improvements) is by using power field analysis, as illustrated in Figure 9 below.

According to Balogun and Hailey (1999), it is also helpful to subdivide the transition state itself into three other phases – unfreeze, move and sustain. This
model (see figure 10 below) is based on the one devised by Lewin (1958). The original model referred to unfreezing, moving and refreezing:

- **Unfreezing** is about making people within an organization ready for change by making them aware of the need for change and dissatisfied with the existing ways of working. It is about creating the readiness for change among the workforce, at all levels from senior managers downwards. Change is a painful, difficult experience for both organizations and the individuals within them. To undertake change people need to feel that the problems and the pain change will cause are outweighed by the need to change.

- **Moving** is the implementation of the needed changes through the selected range of levers and mechanisms.

- **Refreezing** involves embedding the changes throughout the organization to ensure members do not relapse into old patterns of behaviour.

![Figure 10: Three phases of transition, modified from Balogun and Hailey, 1999](image)

Management support and a democratic climate are other important characteristics for change. Karltn (1997) describes processes of changes by classifying them in two categories. Action driven change occurs within the goals and objectives in the system and it is oriented towards immediate action. Vision driven change is more long-term; a shared vision and a programme for change management (Kotter, 1995), and includes changes not only improving existing systems, but also changing the system and working conditions within the system.

There are different models and methods for building vision and developing a change programme that have been presented in the literature, such as the fifth discipline by Senge (1990), and the future workshop by Jungk and Müller (1987). Figure 8 (shown above) is a representation of linear thinking that Balogun and Hailey described. This figure illustrates different phases in the mindset during a change, or transition state. According to, this curve\(^8\), the process individuals go

---

through during change (i.e. the concept of transition curve) can be combined with the unfreeze, move and sustain model as depicted in Figure 11 below.

![Figure 11: Shows different phases during an organizational change and gives some indications how management should act during the different phases (Modified from Balogun & Hailey, 1999)](image)

The transition curve suggests that individuals undergoing change pass through seven stages. It also shows that resistance to change is a natural phenomenon associated, like grieving, with a reluctance to give up possessions, people, status and expectations. Furthermore, there is the possibility that a non-linear strategy for change may reach organizational goals, as illustrated in Figure 12.

In this perspective, a pure ‘bottom-up approach’ is not suitable as change may start any part and level of an organization. Changes cannot be designed with the linear perspective in mind, as they usually take unexpected turns and therefore can be characterized as a non-liner (Skoglind-Öhman and Shahnavaz, 2004; Ingelgård, 1996).

![Figure 12: Illustration of different strategies for ergonomics change, the arrows describe from where and in what direction ideas and energy concerning change go in a very simplified and schematic way (Skoglind-Öhman and Shahnavaz, 2004; adapted from Ingelgård, 1996)](image)

It is imperative to point out that the changes that were studied in this thesis represented all the three states indicated in Figure 12 above. Learning in organization is complex to achieve and this requires a platform of various
ingredients or poles in order for it to be accomplished and maintained. Senge (1990) has summarized five poles as important ingredients to make an organization capable of learning:

- **System thinking:** System thinking is about being able to see the whole and not only the separate parts. One example of system thinking is about understanding how one’s own actions affect the rest of the organization. For a description of system thinking, see Deming (1993), Senge (1990).

- **Personal mastery:** Personal mastery is to continuously clarify and deepen one’s personal vision, focus one’s energy, develop patience and objectiveness in order to view reality objectively. People with a high level of personal mastery have the ability to thoroughly realize the results that mean the most to them. They focus on life, as an artist would face art, by being committed to their lifelong learning.

- **Mental models:** Mental models are deeply rooted assumptions and generalizations, or pictures and beliefs that affect how we understand the world and how we act.

- **Building of shared visions:** According to Senge (1990), it is difficult to see how an organization can be successful if the actors do not in some way share a common picture of what the organization is there to create.

- **Learning in teams:** Learning in teams starts with a dialogue based on the team members’ ability to clarify roles, obstacles and possibilities within the team and to proceed to a genuine ‘thinking together’ phase later on (Senge, 1990).

4.4.3. **Workplace transformation and ‘Tipping point’**

According to Burke (2002), ‘Tipping Point’ principles represent ways of understanding; (a) organization change more thoroughly, for example, through contagiousness and the fact that small events or activities can have large consequences, and (b) ways of planning the process, that is, how to spread a ‘virus’ and cause an epidemic (see Gladwell, 2000). Thus, the ‘tipping point’ is that magic moment when ideas, trends and social behaviour cross a threshold, tip and spread like wildfire (Gladwell, 2000). In this context, Professor Tony Ghaye (2005 and 2007) explained ‘tipping’ thus. When the goals, values and processes begin to be ‘inhaled’ by workers, the transformation process can spread, just like viruses do. The initiative becomes contagious. Workers are infected, with its spirit and purposes. Gradually and incrementally, year-on-year it takes a hold. It becomes addictive. One success leads to another until something exceptional happens. There are three rules of the ‘Tipping Point’, which offer a way of making sense of the organizational change epidemics. These are the Law of the Few, the Stickiness Factor, and the Power of Context. According to Gladwell (2000), the three rules provide us with direction on how to go about reaching a Tipping Point.

In the opinion of Professor Tony Ghaye (2005), getting a project to ‘tip’ means getting two other things right, 1) **Word-of-mouth process:** What leaders actually say
about the process to others, and 2) The involvement of people: Are those leaders involved knowledgeable, energetic, sociable and/or influential among their co-workers?

The qualities of leaders can be described in terms their being ‘brokers’, ‘connectors’, and ‘sales-persons’. As such, it may not be possible to find these qualities in one person. Nevertheless, transformation at the workplace requires the presence of leaders who are brokers (who provide the right messages), connectors (who provide the social glue) and sales people (who get workers to actively ‘buy-in’ to the process), (Gladwell 2000; Ghaye, 2005).

In relation to what pertains during workplace transformation in the IDCs, Shahnavaz, (2002b) argues that in many IDC companies, narrow, tightly controlled, fragmented jobs and hierarchical organization are still common practice. These are usually the cause of low motivation among workers, having adverse effects on both individual and organizational performance. This is against the background of the observation that advanced technology requires a human-centred organization for its effective operation. But as Professor Shahnavaz further noted, introducing organizational changes and new management systems could easily be achieved in IDCs through a process of training and education, which will bring about awareness and action, adding in the introduction of necessary changes.

Schön (1983) describes problem-solving activities as a process of ‘managing messes’. Instead of relying on highly theoretical and rational processes for decision-making, Schön contends that effective leaders reflect on their practice in terms of their personal experience, previous successes, hopes, preferences, strengths and weaknesses, and desired outcomes. Reflection and action, according to Schön, involves on the spot surfacing, criticising, restructuring, and testing of intuitive understandings of experienced phenomena; often it takes the form of a reflective conversation with the situation (see Dan White, 2002).

Few papers are using the ‘tipping point’ as a metaphor. In a paper by Brandon et al. (2005), it is argued that the construction industry is ready to reap the benefits of using information technologies. But implementation of new methods in industry always results in a change in the way of working for the people that have to use and interact with the methods. New ways of working are frequently opposed in companies. New ways of working also require education, or at least a certain time spent with the new method. Literature within the field of change management has been read to understand the difficulties that a company or organization may encounter in managing change (see Siegal, 1996). The study theories of resistances to change revealed the importance of understanding the current situation (Schaffer and Thomson, 1992; Kotter, 1995; Maurer, 1996; McElroy 1996; Rusaw, 2000; Ford et al., 2002). Furthermore, an important distinction is the difference between revolutionary (later to be referred to as transformational) and evolutionary (later to be referred to as transactional) change (Burke, 2002). According to Bernard and Bass (1999), changes in the marketplace and workforce over the last two decades have resulted in the need for leaders to become more transformational (more related to organization change that is discontinuous) and less transactional (more associated with continuous change). It refers here, therefore, to vision driven more
than action driven change some kinds of which are described in Sub-section 4.3.2. Furthermore, the qualities of leaders have been mentioned above, the changes described in Figure 12 as a non-liner can help us in the process of the re-framing of the EIP as the start of an EIPT process.

4.5. The use of the presented theory

The purpose of this section is to give the reader an overview of the field of research. However, there are some parts of the theory, which are more crucial to the purpose of the thesis, in the author’s opinion. This section therefore describes how the theory presented here is used in the different study designs in Section 6, and in the discussions and conclusions of Section 7.

The research process has been conducted over a long period, meaning that even the theoretical framework has been updated during time that has elapsed. However, it is to be hoped that changes and new contributions which have arisen in the theoretical field of this thesis during the time taken for the research, have been followed and taken into consideration during the research journey. The author has selected macro-ergonomics theory and not the other theories, because the goal of macro-ergonomics is to optimize the work system’s design in terms of its socio-technical system characteristics, as described in Section 4.3. According to this point of view, it is important to have a system perspective. There are three major approaches to work designs, which are described in Section 3.6. Studies B, C, D, E, and F have indicated the ‘human-centred approach’, which focuses on personal growth (i.e. the development of professional skills and social competence by the ETWs). Maybe this could be an action-driven to bring about a linear change. However, it is the need to understand ’organizational metaphors’, which is discussed in Sub-section 7.3.1. While the major approach to the work design, is discussed in Sub-section 7.4.1. The EIPT method was to find and sequence the pre-intervention phase of the EIP (Study H). This perhaps indicates a ‘technology-centred approach’, which follows the linear sequence of the ‘development of a work system’; i.e., fix a problem by means of ‘strategic planning’ (for example, the improvement of workstations or the work system level, or both). Such a linear sequence involves, firstly running ‘ergonomics training workshops’, second the ‘ergonomics application’, thirdly ‘evaluation’, fourthly ‘research’ and finally ‘networking building’. In this method, participatory ergonomics was a key issue and an integrating factor for the EIPTs’ method. However, the degree of participation by managers and workers in the ergonomics intervention programmes was different in the different organizations (Studies B and C at GC, studies E and F at IKCo). The concept of macro-ergonomics is described in Sub-section 3.7.1. This can help us to be vision-driven and further both a linear and non-linear sequence of change.

But, what are the strengths and weaknesses of the EIPT process model as well as final conclusions to be drawn? These will be discussed in Sub-sections 7.5.1, 7.5.2, and Sections 7.7 and 7.8.

According to Hendrick and Kleiner, (2002), ‘both organizational psychology and macro-ergonomics are concerned with the design of organizational structures and processes, but the focus is somewhat different. In the case of organizational
psychology, improving motivation and job satisfaction, developing effective incentive systems, enhancing leadership and organizational climate, and fostering teamwork are common objectives. While these objectives also are important to macro-ergonomics, the primary focus of macro-ergonomics is to design work systems that are compatible with an organization's socio-technical system characteristics; and then to ensure that the micro-ergonomic elements are designed to harmonize with the overall work system structure and processes.

Section 7 contains a discussion about the research questions and how the purpose is fulfilled. This section also shows how the results presented are connected to the theory presented in Section 4 and makes use of the ideas presented in Section 4.3. Furthermore, this thesis concludes that there is a challenging issue for the development of the EIPT at the organizational level and the ergonomics ‘know-how’ transfer associated with the macro-ergonomics intervention system for organizations. One of the answers to this challenging issue could be an EIPT process model to support the participatory ergonomics process for improving systems in organization and also, a general model of an ergonomics know-how transfer to an IDC. Furthermore, in Section 7 ‘joining up practice with theory’ and its results are discussed. This was of significance and important to the study.

All these theories in Section 4 and the sub-sections are related to the advantages of a system perspective. However, the workplace transformation and the ‘Tipping point’, are explained in Sub-section 4.4.3 with the emphasis on ‘how to get a project to ‘tip’.

But, Stacey (1992) states in his book (i.e., Managing the Unknowable: Strategic Boundaries Between Order and Chaos in Organizations): ‘Most Western managers believe that long-term success flows from a state of stability, harmony, predictability, discipline, and consensus – a state that I refer to as stable equilibrium. This belief leads them to demand general prescriptions that they can immediately convert into successful action. The most popular prescriptions are to formulate a vision of an organization’s future state, to prepare long-term plans to realize that vision, to set strategic milestones and monitor achievements against those plans, to write mission statements and persuade people to share the same culture, to encourage widespread participation and consensus in decision making, and to install control systems that allow top executives to set the organization’s direction and stay in command.’[pp. xi]

It is to be hoped that Section 1, Section 1.2, and 7 can help the readers to better distinguish between the two views - the system and non-system perspective - for the transfer ergonomics ‘know-how’ to the IDC.
5. RESEARCH METHODOLOGY

5.1. Introduction

This section introduces a discussion about different approaches to research, such as deduction and induction, positivism and hermeneutics, and quantitative and qualitative. Then a discussion follows about the choice of research strategy. Out of this discussion, a choice of methodology is made and the research process is described. The section ends with a discussion about research design quality; reliability and validity.

5.1.1. Introduction to research

According to Maxwell (2005), design in qualitative research is an ongoing process that involves ‘tacking’ back and forth between the different components of the design, assessing the implications of goals, theory, research questions, methods, and validity threats. Such an interactive model is more compatible with the definition of design as the arrangement of elements governing the functioning of a study than it is with design as a re-established plan for carrying out the study or as a sequence of steps in conducting that study (Maxwell, 2005).

The way to accomplish the research has to be reliable and valid. Maybe the largest challenge for an author writing an academic piece of work is the explanation of the goal. Furthermore, why is the study worth doing? What issues does the author want it to clarify, and what practices and policies does the author want it to influence? Why does the author want to conduct it, and why should the author care about the results? This process of knowledge development could, according to Maxwell (2005), be defined as a conceptual framework; what does the author think is going on with the issues, settings, or people the author plans to study? What theories, beliefs, and prior research findings will guide or inform his research and what literature, preliminary studies, and personal experience will the author draw on for understanding the people or issues he is studying?

There are four main sources for this theory: our own experience, existing theory and research, the results of any pilot studies or preliminary research that we have done, and thorough experiments (Maxwell, 2005). Thus, one’s background is important, and the courses are taken further during Ph.D. study. The author has tried to describe his process of knowledge below and has in that description also included some of his background and Ergonomics Intervention and IDC research background (in Section 1 and 2).

Aagaard Nielsen and Svensson (2006) have mentioned that we find some kind of freedom in methods, which allow the broad values and orientations to come up and become essential elements in dialogues.

However, what the author tries to do is to be as free as possible from those philosophies of science, which are noted below. The author believes, as Kira (2003) does, that it is better to be limited by one’s own intellectual capacity than by a paradigm or school formulated by others. The author adds that scientific paradigms
can be used as support in methodological considerations and choice of quality criteria. Therefore, if it makes it easier to judge the scientific value of this thesis, one can look at the author’s view as being system-oriented with a positivistic way of writing.

Action research can be contrasted with positivistic change (Clark, 1972, Coghlan and Coghlan, 2002). Guba and Lincoln (1994) suggest four underlying ‘paradigms’ for qualitative research: positivism, post-positivism, critical theory, and constructivism. Orlikowski and Baroudi (1991), following Chua (1986), suggest three categories, based on the underlying research epistemology: positivist, interpretive and critical. However, it needs to be said that, while these three research epistemologies are philosophically distinct (as ideal types), in the practice of social research these distinctions are not always so clear-cut (e.g. see Lee, 1989). Hörte (2006) describes styles of research in ergonomics in two ways (i.e. one way is called a positivistic, or post-positivistic way, while the other way is called the way of the hermeneutic or constructivist). There is considerable disagreement as to whether these research ‘paradigms’ or underlying epistemologies are necessarily opposed or can be accommodated within the one study (Lee, 1989).

Furthermore, in the literature the following methodological views are discussed by Guba and Lincoln (1994); the analytical (positivistic), the system view (partly positivistic) and, finally, the actor view which is not positivistic but more hermeneutic. The author believes that action research is one way to understand the system and all its complex relations. Therefore, it is still possible to have a positivistic, or in this case partly positivistic, approach based on a system view while doing action research. The fact that the author comes from an Ergonomics Intervention Programme (EIP) by the ETWs and macro-ergonomics intervention background is also an argument for the system approach, since macro-ergonomics intervention is a management system that views a holistic approach as important (see Hendrick and Kleiner 2001 and 2002, and Study A).

5.1.2. The accomplishment of the research

The steps to fulfil the requirement of research based on scientific premises in the thesis are based on the following structure:

- Section 3 describes how the literature review has been chosen. The literature review was based on the general aspects of ergonomics intervention and IDC. This section is also relevant from the whole research process.
- The choice of research approach and the reasons for this choice. This section is general and is relevant for the whole research process.
- The choice of research strategy and the reason for this choice. This section is general and is relevant for the whole research process.
- A description of the methodology used and an analysis of the data collection process. The methodology and analysis are divided into two sections. The first section describes the methodology to find out how the workshops work with EIP and macro-ergonomic intervention, how to find the main causes, the constraints and describe how the three levels, i.e. individual, group, and organizational have worked to deal with EIP in the three different cases. The second section describes
the methodology used when trying to create a model of EIPT to get around more easily and deal with the macro-ergonomic intervention and how the model is tested, and verified for successful implementation.

- The section ends up with a discussion about research design quality; reliability and validity.

5.2. **Choice of research approach**

There are a number of ways of doing research. The approach used in this thesis is not the result of a one-way solution. It is the result of conscious choices and is one way to reach the purpose of the thesis. The reason why just these choices are made is described in this section in terms of keywords such as deduction, induction or abduction, positivism or hermeneutics, and quantitative or qualitative approaches. The different approaches available are often closely related to one another and to the formulated purpose of the study. Some examples of questions that should be asked are, whether the study is performed according to induction, deduction, or abduction; is it qualitative or quantitative, or both?

5.2.1. **Deduction, induction, and abduction**

The field of the Ergonomics Intervention Programme (EIP) and its connection to ergonomics ‘know-how’ transfer and macro-ergonomic intervention at an individual, group, and organizational level in an IDC, was quite new at the beginning of the 1990s when the author started his research work. At that time, there were no established methodologies and theories to use to find out the interesting parts of the field. Therefore, a deductive attempt was not possible at the time, since the theory to build hypotheses on and see if they were satisfying according to reality, was not established. Deduction could be described as taking an explanation of specific empirical material from an established theoretical base. Induction, on the other hand, means that the theoretical base is built, or enriched anyway, from an empirical base. Therefore, a more inductive than deductive attempt was made to find the general ideas about ergonomics ‘know-how’ transfer and the EIP that could result in a theory from which a deductive attempt can be made. Thus, in discussions concerning methodological choices, there is often a differentiation between ‘induction and deduction’\(^9\). Induction means that generalizations are made from the conclusions derived from a specific case. Deduction departs from a general rule in order to explain a specific case (Molander, 1988; Alvesson and Sköldberg, 1994). In practice researchers use both of these methods, and often in a cyclical manner as shown in the research wheel (Figure 13) (Alvesson and Sköldberg, 2000; Burke and Larry, 2004).

\(^9\) The two forms or styles are the inductive form and the deductive form.

(a) The inductive scientific method follows three steps: observe the world, search for a pattern in what is observed, and make a generalization about what is occurring. This is a ‘bottom-up’ approach to research. It is especially useful for generating and constructing new ideas and theories.

(b) The deductive scientific method also follows three steps: state the hypothesis (based on theory or research literature), collect data to test the hypothesis, and make a decision to accept or reject the hypothesis. This is a ‘top-down’ approach to research. It is especially useful for testing ideas and theories (Burke and Larry, 2004).
Induction and deduction are not the only alternatives (Alvesson and Sköldberg, 1994; 2000; Kovacs and Spens, 2005). There are others, such as abduction, which in simple terms means the ability to see patterns, to reveal deep structures (Hanson, 1958). Thus, the way the author has tried to avoid the disadvantages of deduction and induction is by using a research approach based on a kind of logical argument called abduction.

Figure 13: The research wheel, modified from Burke and Larry (2004)

According to Alvesson and Sköldberg (1994; 2000), abduction begins with rising from empirical regularities to meet theory. Abduction can be distinguished from induction and deduction through the idea that it goes further than just condensing facts based on theory-charged empirical material (Alvesson and Sköldberg, 1994). Thus, if the theory were established, it would be tested in an empirical frame and if the empirical frame were established, it would create or build new theory. Figure 14 shows how the research process can be connected to deduction, induction and abduction.

Figure 14: Deduction - Induction – Abduction; on the left are depictions of the meaning of deduction, induction and abduction, and on the right is the author’s interpretation of his research process in terms of deduction, induction and abduction. The figure is inspired by Alvesson & Sköldberg (1994).

10 Hanson uses the less common term ‘Retroduction’ instead of ‘Abduction’; sources: Alvesson and Sköldberg, 2000; p 50.
To the right is the author’s research ‘Journey’ illustrated in relation to the two main research questions (I and II), and the four sub-questions, here-in named as Research Questions a, b, c, and d. In this order, the study for answering Research Question a starts from an empirical base that tries to contribute to theory building about running Ergonomics Training Workshops (ETWs) at the individual, group, and organizational level with an Ergonomics Intervention Programme (EIP) for an ergonomics know-how transfer to Iranian industries. Thus, there was a pre-design stage of the EIP by the ETWs. The study for Research Question b starts from this theory and ends up in empirical regularities, which need support from other research to contribute to theory. This is done in the study to answer Research Question c which in turn does not fully reach empirical material reliable enough to build theory to fulfil the purpose of the thesis.

Therefore, another study related to Research Question d was performed that ends up contributing to the theory of how development of the EIPT by an EIPT process model to support the participatory ergonomics process for improving systems in organization answers main question (II); how should the EIPTs be delivered to Iranian Industries and possibly to other organizations in IDCs so that they can easily learn how to use them successfully.

5.2.2.  Positivism and Hermeneutics

Positivism is associated with natural science (i.e. objective observation, explanation and prediction, generalized knowledge, hypothesis testing, and Physicalism). Hermeneutics is associated with the interpretation of texts (i.e. development of shared understanding, interpretation, and participation in social process, unique situations, dialectic interaction, and hermeneutic circle). Gummesson (2000) describes more major differences between what might be roughly termed positivistic and hermeneutic research (as shown in Table 5).

The author has chosen a more positivistic-oriented approach over a more hermeneutic approach in this thesis, because of the characteristics presented above as important as well as the fact that the purpose of this thesis could not be investigated thoroughly by a hermeneutic approach. A positivistic approach is relevant to the purpose of how the EIP and the EIPTs can be implemented at an organizational level since they represents clearly explained knowledge that assumes that the reality is objective. The hermeneutic approach assumes, on the other hand, that reality is a social construction, which makes it harder to find, for example, pillars in the EIPTs modularly asked for in research questions c and d. The hermeneutic approach is therefore not expressed clearly in this thesis, but has been more of a hidden agenda for the researcher in meetings with different people. A way to describe this mix between positivistic and hermeneutic knowledge could be to use what Fishman (1999) calls a pragmatic approach that is focused on contextualized knowledge and is positioned between the positivistic and hermeneutic approaches. Furthermore, the action-oriented researcher needs to make use of both positivistic and hermeneutic knowledge (Gummesson, 2000).
## Table 5: Comparison between the Positivistic and Hermeneutic Paradigms (adapted from Gummesson, 2000, p. 178)

<table>
<thead>
<tr>
<th>Positivistic Paradigm</th>
<th>Hermeneutic Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research concentrates on description and explanation.</td>
<td>Research concentrates on understanding and interpretation.</td>
</tr>
<tr>
<td>Well-defined, narrow studies.</td>
<td>Narrow as well as total studies (holistic view).</td>
</tr>
<tr>
<td>The vantage point is primarily deductive; though it is governed by explicitly stated theories and hypotheses.</td>
<td>The vantage point is primarily inductive; research’ attention is less focused and is allowed to ‘float’ more widely.</td>
</tr>
<tr>
<td>Research concentrates on generalization and abstraction.</td>
<td>Research concentrates on the specific and concrete ('local theory') but also tempts generalizations.</td>
</tr>
<tr>
<td>Researchers seek to maintain a clear distinction between facts and value judgments; search for objectivity.</td>
<td>Distinction between facts and value judgments is less clear; recognition of subjectivity.</td>
</tr>
<tr>
<td>Researchers strive to use a consistently rational, verbal, and logical approach to their object of research.</td>
<td>Pre-understanding that often cannot be articulated in words or is not entirely conscious – tacit knowledge – takes on an important role.</td>
</tr>
<tr>
<td>Statistical and mathematical techniques for quantitative processing of data are central.</td>
<td>Data are primarily nonquantitative.</td>
</tr>
<tr>
<td>Researchers are detached – i.e. they maintain a distance between themselves and the object of research; take on the role of external observer.</td>
<td>Both distance and involvement; researchers are actors who also want to experience what they are studying from the inside.</td>
</tr>
<tr>
<td>Distinction between science and personal experience.</td>
<td>Researchers accept influence from both science and personal experience; they use their personality as an instrument.</td>
</tr>
<tr>
<td>Researchers try to be emotionally neutral and make a clear distinction between reason and feeling.</td>
<td>Researchers allow both feelings and reason to govern their actions.</td>
</tr>
<tr>
<td>Researchers discover an object of research external to themselves rather than ‘creating’, the actual object of study.</td>
<td>Researchers partially create what they study, for example, the meaning of a process or a document.</td>
</tr>
</tbody>
</table>

### 5.2.3. Quantitative and Qualitative Research

Information that is conveyed by words is called ‘qualitative’ while information that is conveyed by numbers is called ‘quantitative’ (Merriam, 1988). Quantitative research emphasizes the measurement and analysis of variables and relations, and also the identification of causal relations between variables (Denzin and Lincoln, 2000). In qualitative research, one is interested in the meaning and understanding of a studied phenomenon (Merriam, 1988). The use of pictures and words is often more useful, and therefore more common than the use of numbers to describe what the researcher has found during the study of a certain phenomenon. Qualitative research may therefore be seen as descriptive and holistic (Taylor and Bogdan, 1984). Marshall and Rossman (1999) state that many qualitative studies are exploratory and descriptive. However, also other qualitative studies are explicitly explanatory, showing relationships between events and the meanings these events have (Marshall and Rossman, 1999). Alvesson and Sköldberg (2000) state that an important distinguishing feature is that a qualitative approach starts from the perspective and actions of the studied subjects, whereas quantitative studies proceed from the researcher’s ideas about the dimensions and categories that should be focused on. The purpose of this research is not to show relationships between events and the meaning of these events, but to try to explore and describe a phenomenon that is seldom, or incompletely, and described in the literature. This
research aims not at drawing any statistical generalizations, but at gaining a deeper understanding of how the phenomenon may be characterized.

Furthermore, the issue of how the EIPTs should be delivered to the Iranian industries, and possibly to other organizations in IDCs, so that they can easily learn how to use them successfully, which is crucial in this thesis, can be satisfactorily understood with a qualitative study. One reason for this is that a complex social phenomenon is possible to contemplate in some ways but not to control. A qualitative method strives to obtain extensive information from a small number of investigated units, and this seemed to be a fruitful way to look at the general and specific aims and research questions presented in Section 2.

According to Creswell (2002), quantitative methods are of two types. The first one is experiments, which includes true experiment with assignments of subjects and treatment conditions. The second one is surveys, including cross-sectional and longitudinal studies with the help of questionnaires for data collection. The purpose of the latter is to generalize from a sample to a population (Creswell, 2002). On the other hand, there are several important reasons why a quantitative study could be of interest, according to Remenyi et al. (1998). They describe the advantages of a quantitative approach:

- The potential for presenting figures connected to the research area. In this thesis it would concern figures/tables that describe the result of the implementation of the Ergonomics Training workshops (ETWs) at the three levels, viz individual, group, and organizational in the pre-intervention phase of ergonomics know-how transfer in Iranian industries (Studies D and G).
- The ability to measure in numbers and in terms the prerequisites, the results of the EIP for Iranian industries at the individual, group, and organizational level (Study G).
- The possibility of getting comprehensive knowledge. In this thesis it would concern the different implementations of EIP (Studies A, B, C, E and F) and the development of the EIT (Studies I and J).

The data that has been collected is mainly of a qualitative nature but for the process of running the ETWs and implementing the EIP, quantitative data has also been collected in the pre-intervention phase of the Ergonomics Training Workshops (ETWs) study (Studies D and G). In the research work, it seems that the reasons for a quantitative and a qualitative approach are both strong if one looks at the aims and research questions of the thesis. The author’s choice is therefore to combine these two, even if the qualitative parts predominate.

5.3. Choice of research strategy

5.3.1. How to choose a suitable research strategy

As shown in the discussion above, the author has chosen an abduction-oriented approach to his research that should be based on both qualitative and quantitative data. The question now is how the research should be carried out based on these choices. According to Yin (2003), there are five major research strategies in the
social sciences: experiments, surveys, archival analysis, histories and case studies. Yin (2003) explains that the choice of research strategy can be made by studying:

- The extent of control an investigator has over actual behavioral events
- The degree of focus on contemporary, as opposed to historical events.

Yin (2003) states that research questions including ‘Why’ and ‘How’ are more explanatory and likely to lead to the use of case studies, histories and experiments. This is because such questions deal with operational links needing to be traced over time, rather than only by frequencies or incidence. According to Pettigrew (1987), it is important to study in real time to catch the dynamic in a change process. This means that case studies and experiments, here performed by action research-type intervention, suit this thesis better. This is because one out of four research question is purely formulated in ‘How’ form and change processes studied in real time are of interest. The questions, ‘What are the main causes of these constrains?’ and ‘What practical activities are required for the EIPTs implementation?’ ask ‘What’. This is answered by comparing and concluding from different processes and ergonomics interventions ideas and could therefore be said to suit Yin’s (2003) opinion that question in ‘What’ form would be answered by archival analysis. The second part of the question is in ‘How’ form and is answered by action research.

Thus, in this research two complementary strategies have been used to collect and analyze evidence. Empirical evidence has been collected through case studies from the pre-intervention phase of the EIP in Iranian industries (as archival analysis), and action research-type intervention in the three private companies while theoretical evidence has been collected through a literature study.

Furthermore, according to Aagaard Nielsen and Svensson (2006) in action research, theory is an element in the research process in line with processes of Abductive reflections between theory and the empirical field, in the same way as in other areas of qualitative social sciences.

5.3.2. Case study

A case study can be considered as an intensive and holistic description and analysis of a restricted phenomenon (Merriam, 1988). The case study strategy may also be used to explain the causal links in real-life interventions that are too complex for survey or experimental strategy (Yin, 2003). In general, a case study methodology is preferred when solving research questions including ‘how’ and ‘why’, when the investigator has little control over events and when the focus is on a contemporary phenomenon within some real-life context. For example, a case study is suitable when studying introduction processes, managerial processes (for the EIP) and organizational changes (Yin, 2003). Yin (2003) describes four basic types of design for case studies; single-case (embedded), single-case (holistic), multiple-case (embedded) and multiple-case (holistic). One reason for using single case is, when it represents the critical case in testing a well-formulated theory. A second reason for a single case is when it represents an extreme or unique case. A third reason is when the case is revelatory. Multiple-case occurs when the same study may contain
several cases. Every case should serve a specific purpose within the overall scope of inquiry. Multiple-case is often seen as more compelling and robust, according to Yin (2003). On the other hand, a multiple-case study can be more resource demanding.

According to Yin (2003), using case studies for research purposes remains one of the most challenging of all social science endeavors. Thus, the case study is but one of several ways of doing social science research (Yin 2003). Other ways include experiments, surveys, histories, and the analysis of archival information (Yin 2003). Furthermore, case studies can be used for four different research purposes: Exploration, theory building, theory testing and theory extension or refinement (used in Sub-section 5.1.2). These points to the multi-site case study as a suitable method to build theory, which, according to the discussion in Sub-section 5.2.1 about deduction, induction, and abduction, was desired from the beginning of the research process.

For the author’s choice regarding the type of case study chosen, see Section 5.4.

5.3.3. Action research

The main difference between action research\footnote{According to Willander and Styhre (2006), ‘The notion of action research was coined by Kurt Lewin in the 1930s. Ever since, Lewin has played the role of an emblematic figure for action research-minded scholars’ (Chein \textit{et al.}, 1948).} and a case study is that action research is an approach to research which aims at both taking action and creating knowledge or theory about that action. The outcomes are both an action and a research outcome, unlike traditional research approaches, which aim at creating knowledge only.

Action research works through a cyclical process of consciously and deliberately: (a) planning; (b) taking action; and (c) evaluating the action, leading to further planning and so on. The second dimension of action research is that it is participative, in that the members of the system, which is being studied, participate actively in the cyclical process (Coghlan and Brannick, 2001).

According to Coghlan and Brannick (2001), action research is appropriate when the research topic is an unfolding series of actions over time in a given group, community or organization, and the members wish to study their own action in order to change or improve the working of some aspects of the system, and study the process in order to learn from it. Hence, action research is akin to experiential learning (Kolb, 1984) and reflective practice (Schön, 1983).

Doing action research means being engaged in a more rigorous series of diagnosing situations, planning and taking action and evaluating, than is perhaps the norm (Coghlan and Brannick, 2001). Another reason for using action research is when the researcher has a vision or idea he or she wants to test or verify, suggests Wallen
There are three levels of researcher participation in an action research project: technical, practical and emancipatory (Carr and Kemmis, 1986). Furthermore, action research is especially suited to organization change projects. Since new knowledge and insights are likely to produce action, there is a close relationship between the joint constitution of practical knowledge and organization change. According to Shani et al., (2004), ‘action research is viewed as an emergent inquiry process embedded in the partnership between researchers and organizational members for the purpose of addressing an organizational issue (or problem) and simultaneously generating scientific knowledge. Action research is a philosophical view that encompasses the need for the generation of new knowledge in organizational settings and the desire for ongoing organizational renewal.’ However, in the field of management study, there is still only a limited number of cases of collaborative research projects serving as role models for how academic researchers and practising managers may join hands and conduct joint collaborative research (Williander and Styhre, 2006). One issue that could be accomplished by action research, viewed as important by Pettigrew (1987) when studying change processes, is the possibility of catching the dynamics of a change process by studying it in real time. A deeper knowledge about the process and the factors affecting the outcome can be the foundation for discussions. These discussions can in their turn concern, for example, generalization.

To be able to do this, combine the role of the researcher and the role of an active participant Coughlan and Coghlan (2002) mention that action research requires confident and experienced researchers to cope with the uncertainty of the unfolding story and to be able to work as researchers while exposed to the reality of organizational change in real time.

Aagaard Nielsen and Svensson (2006) mention that action research history was said to be moving from an experimental design towards a learning design.

12 In more detail, in the first, technical level of participation the action researcher is merely a technical ‘expert’, a consultant who tells other people what to do. This is the normal form of a consultant’s project; for example, a technical agribusiness consultant is working in a grain development project in a developed country and simply transfers the technology across (Perry and Gummesson, 2004). The second practical level of participation by a researcher is like the starting point of a ‘process consultant’ (Schein, 1990), where the researcher has a Socratic role, encouraging participation and reflection about processes so that others can learn about learning about doing, and not just learn about doing. The researcher helps the client understand how he or she fits into a system (Perry and Gummesson, 2004). The third emancipatory level of researcher participation is the ideal according to some action researchers (Carr and Kemmis, 1986). Here the researcher becomes a co-researcher with the other people, for responsibility for the project is shared equally among everyone. In emancipatory action research, the researchers aim to change the whole context of the problem and thus liberate themselves from its causes, including their mental context. That is, this type of participation (Perry and Gummesson, 2004).

‘… aims not only at technical and practical improvement [technical] and the participants’ better understanding [practical] … but also at changing the system itself and/or those conditions which impede desired improvement in the system or organization. It also aims at the participants’ empowerment and self confidence’ (Zuber-Skerritt, 2002).
Today, action research serves as an umbrella term, comprising a series of different concepts and methodological orientations: participative or co-operative inquiry (Reason, 1999), action inquiry (Ellis and Kiely, 2000), insider/outsider research (Bartunek and Louis, 1996), appreciative inquiry (Johnson and Leavitt, 2001), collaborative research (Adler et al., 2004), insider action research (Coghlan, 2001), action research and interactive research (Aagaard Nielsen and Svensson, 2006) are some examples of the conceptual bewilderment that can be observed in the field. For a more thorough description of what characterizes action research, See also, Gummesson (2000), Coghlan and Brannick (2001), Williander and Styhre (2006), and Aagaard Nielsen and Svensson (2006).

For the author’s choice regarding the type of case research chosen, see Section 5.5.

5.4. Methodology for research questions one (with two sub-questions)

The methodology discussed here describes the research done to answer the following research questions:

The main research question:
I. Why are the efforts of these industries to implement and internalise the EIP being constrained?

Two sub-questions;
   a. What are the main causes of these constraints?
   b. Is it that the EIP is difficult to implement?

The methodology consists of two major parts:
- The choice of type of case study and the kind of EIP for Iranian industries,
- The actual collecting and analysis of facts.

Figure 15 shows the time orders when the different parts were done, during the thesis work.

Figure 15: The research work was accomplished over a rather long time and consisted of continuous Ergonomics Intervention Programme (EIP) by Ergonomics Training Workshops (ETWs) at three levels, viz individual, group and organizational level for Iranian industries, a documentation process that ended in the first half of 2003.
5.4.1. The choice of case study types and the participants for EIP by the ETWs

Based on the description in Section 5.3 about different research strategies, the case study was chosen to answer research question I with two sub-Research Questions (a and b). For Research Question a, a multi-site case study was chosen to identify and describe the EIP in practice. For research question ‘b’, a macro-ergonomics survey, which contains workshops and intervention projects in some Iranian industries, was conducted during the period from 1995 to 2002. There were the three kinds of case studies to indicate the implementation of the EIP at the three levels (i.e. individual, group, and organizational). The result of the pre-intervention phase of the EIP was the EIPT, which it needed to follow up the model of EIPT by an action research-type intervention. Thus, a theory base was built up in the study for main research question I (see Section 4.2. Figure 5). The increased knowledge about the micro and macro-ergonomic intervention made it possible to ensure that every case should serve a specific purpose within the overall scope of inquiry.

Contacting suitable companies occurred as a pre-study to the main research project. More than one of the following aspects selected the case studies involved in the pre-intervention phase of study.

- Efforts to implement EIP at an individual level,
- Efforts to implement EIP at group level,
- Efforts to implement EIP at organizational level,
- Well-documented EIP.

The main reasons for the choice of those aspects were:

Describing how individual, group, and organizational level work with the Ergonomic Process (see the proposed theoretical model for an ergonomics intervention described by Professor Houshang Shahnavaz in 2002; Study F). It is also interesting to look at the different kind of people participation and a management support for Ergonomic Process (EP) by the ETWs. This also gives an indication about the main causes of these constraints, when the EIP is difficult to implement in organizations.

In order to follow the implementing model for an EIP where target cases were worked by the ETWs it was necessary to find what type of activities were required for implementation of an EIP.

**Research Question a**

How the participants work with the EIP in the target cases: Different ways of working with Ergonomics Process (EP) as shown in Table 6. Sub-section 5.5.2 describes the fact collection process that provided the information to classify the case researches. The guidance model of the EP (see study F, Figure 18) was criteria for EIP differentiation at the three levels. Furthermore, Sections 1.2, 1.3, and 2, as well as Sub-sections 5.5.1 to 5.5.3 offer a better understanding, which makes it possible to get deeper into the EIP.
Research Question b

To be able to answer Research Question b it was important to get more knowledge about the macro-ergonomic intervention and the changing process. The outcome of the pre-intervention phase was the EIPT (Study H). The choice of the three separate case studies was made by the ETWs, each having a different intervention approach (Studies B, C, D, E, and F). In the first case study carried out at Glucosan factories (GC, a food industry), all three levels (individual, group and organizational) were trained (Studies B and C). In the second case study, individual people from different industries were trained (Studies D and G). In the third case study, carried out at Iran Khodro car Company (IKCo), a group of people from different worksites was trained (Studies E and F). They were interested in the ETWs. Furthermore, this interest was judged by the researcher according to the results of the fact collection process described in Sub-section 5.4.2.

The reason for choosing these case researches was mainly that the other organizations or companies were involved in ETWs.

The short description above about the target cases shows their special purpose in the study and also explains that they can all serve a specific purpose within the overall scope of inquiry, which is important in conducting a multiple-case study according to Yin (2003).
5.4.2. **Data collection and data analysis of the case studies**

For data collecting, there are two types of data. Primary data is gathered by the researcher himself, while so-called secondary data already existed. It is common to start by studying data that already exists, such as literature studies. For data collecting methods, see, for example, Yin (2003), Lofland & Lofland (1995), and Creswell (2002).


**Interviews:** Yin (2003) notes that interviews are one of the most important sources of information in a case study. The interviews can be planned and performed in several forms. According to Bryman (2001), they can be semi-structured or unstructured. The most common in case studies is an ‘open-ended’ interview, which means that key persons can be asked both about facts (interventions) and about their opinions in one and the same interview. One type of interview is ‘face-to-face’, which means that the interviewer talks to a respondent in person, in contrast to, for instance a telephone interview. A group interview is when the researcher interviews one group of respondents at a time (Creswell 2002).

According to Yin (2003) and Creswell (2002), there are advantages and limitations of the different types of interviews, when used for collecting data.

**Advantages:** According to Creswell (2002), interviews are useful above all when the researcher cannot directly observe the respondents. They are also of value for obtaining historical information from the informants. Another advantage is that the researcher has more control over the questioning, since the interviews can focus directly on the case-study topic, and also provide perceived causal inferences (Yin, 2003).

**Limitations:** Interviews also have their limitations. According to Creswell (2002), an interview provides information filtered through the eyes and memory of the respondent, maybe also affected by the presence of the researcher. Interviews may also be biased if they take place in a designated place and not in the natural field setting. In addition, they can suffer from poorly constructed questions, which can confuse the respondent, see Yin (2003).

**Observations:** Observations are based on visits to the ‘field’ of the case study. Yin (2003) notes that there are two types of observations: ‘direct’ and
‘participant’ ones. The difference between the two is that in a participant observation, the researcher is not only a passive observer. Creswell (2002) distinguishes between four different ‘participants’ observations. A ‘complete participant’ is a participating researcher, who completely conceals her/his role as an observer, while with an ‘observer as participant’ the observing role of the researcher is known to those observed. When the researcher is a ‘participant as observer’, the participation is primary while observation is secondary. Finally, a ‘complete observer’ means that the researcher observes openly, but without participating.

**Advantages:** Observations cover events and their context in real time, and the researcher gets first-hand experience of the studied entity. The researcher can record information as it occurs, and notice unusual aspects. Observations can also give an insight into the behaviour and motives of individuals and their relations, which might be uncomfortable to discuss in interviews (see, Creswell, 2002, and Yin 2003).

**Limitations:** Observations are time and cost consuming. The researcher might introduce some selectivity when observing, and the events might proceed differently because they are observed. There is hence a risk of manipulation of the events by the researcher (Yin, 2003). Creswell (2002) also states that the researcher might limit the observations, if being seen as intrusive, or if lacking necessary skills as an observer. There might also be situations where sensitive information, for instance private, is not suitable for being reported.

**Literature study:** Literature studies may include several categories of ‘literature’, for instance, ‘documentation’, ‘archival records’, ‘audiovisual material’, and ‘books’. According to Yin (2003) and Creswell (2002), ‘documents’ can be minutes of meetings and agendas, newspapers, journals, diaries, other written reports and letters.

**Advantages:** The advantages of using documents as sources of information are, according to Yin (2003) that these are stable and can be reviewed repeatedly. They are not created because of the case study and normally not by the researcher. Documents can be exact and contain exact names, references and details of an event, as well as having a long span of time, many events and many contexts. Creswell (2002), notes also that documents enable the researcher to obtain the language and words used by the informants, and to study the documents in due time.

**Limitations:** Documents might be incomplete, for instance if the information is biased by the author. They might also contain protected information, for instance of a private or military nature, and therefore be of restricted access. Documents of value for new research findings might be hard to find, or to transcribe copy or scan. The information in complicated or old documents might be difficult to interpret (Yin, 2003 and Creswell, 2002).
**Questionnaires:** According to Creswell (2002), surveys are one of the two types of quantitative method for data collection, see Section 5.2.3. A survey can be based on questionnaires.

**Advantages:** The advantages of mail questionnaires are that they are an inexpensive data collection method, and that it is possible to send them too many respondents at the same time. Many different questions can be posed and the respondents can answer them when appropriate and during as much time as it takes. While answering a questionnaire it is also possible for the respondent to check documents or notes. Another advantage is that the interviewer does not directly affect the respondent (Bryman, 2001).

**Limitations:** There is a risk of a serious loss of responses, which may influence the reliability of the study, and raises questions about why so many did not answer. The questionnaire cannot be too extensive or complicated, especially as the respondent has no one to ask if a question is difficult to understand. There is also some uncertainty for the researcher about who really answered the questionnaire, the intended respondent, or someone else. It is also difficult to get answers to open questions, in contrast to those where the respondent is asked to select some alternative, or grade some statement (Bryman, 2001).

**Field study:** The field study method also is variously referred to as systematic or naturalistic observation and as real-life research. These terms, taken together, provide a good description of this approach. It involves going out into the field to systematically observe events as they occur naturally in real life (Hendrick, 2002b).

**Advantages:** The field study method’s primary advantage is realism. By observing things as they occur naturally, the researcher avoids the sterility and artificiality of the laboratory. However, a caution is in order here: It is important for the researcher to recognize that his or her very presence changes the situation, and thus can affect what happens. The researcher has to take great care to be as unobtrusive as possible. But because of this method’s realism, when the researcher is able to establish cause and effect relationships we can have high confidence in the practical usefulness of the results (Hendrick, 2002b).

**Limitations:** Firstly, the researcher has to wait for things to occur naturally. There may be considerable expense before any cause and effect relationship can be established. Secondly, the researcher may have to observe things occurring naturally many times under various conditions before extraneous variables can be eliminated as causal factors, the true causal variables teased out, and their interactions identified (Hendrick, 2002b).

**Field experiment:** Perhaps the most widely used of the classical methods in macro-ergonomic interventions is the field experiment. The field experiment differs from the field study in that, instead of passively observing events as they occur naturally, the macro-ergonomist acts as a change agent: Selected variables
are deliberately and systematically manipulated and the effect on the outcome or performance variables of interest are observed (Hendrick, 2002b).

**Advantages:** The researcher deliberately manipulates the dependent variable(s) of interest, thus overcoming the field study’s problem of having to wait for things to occur naturally. In comparison with the field study, the field experiment is more efficient in terms of time and related costs (Hendrick, 2002b).

**Limitations:** By ‘artificially’ causing a desired change to occur, the researcher or change agent may be introducing extraneous variables that influence the effects of the change. In macroergonomic field experiments, one such problem can be the employees’ perceptions of the purpose of the change. How employees perceive the intervention can alter how they respond to it and their related motivation. In addition, how changes are implemented can sometimes determine the success or failure of the intervention.

Sometimes, the cost of using workers in field experiments or quasi-experiments may be seen by organizations as too prohibitive (Hendrick, 2002b).

**Combining Methods:** Very often, two or more of the classic technique methods are used together in carrying out a macro-ergonomic analysis, intervention, and/or evaluation (see Hendrick, 2002).

To gather data relevant to the EIP in Iran related to many ergonomics training workshops conducted in Iran, the ‘questionnaire survey’ and ‘opinion poll’ methods were used to collect information regarding the ‘usefulness of the Ergonomics Training Workshops (ETWs)’ for the participants at the three levels viz ‘individual, group, and organizational’ (see study G). The usefulness of the EIP by ETWs indicated that to implement is not difficult but, as noted in Section 4, employees are far more likely to accept and support changes where they are actively involved in the change process.

Based on the above questionnaire, additional queries were developed during the project at IKCo as follows:
- What positive or negative effects had the ergonomics training and participation in ergonomic action group on you and your duties?
- What negative points had the ergonomics project for you and for the company?
- In comparison with your other training and activities in the company, how do you evaluate your activity in the ergonomics group?

Furthermore, an opinion poll was conducted and, 25 participants from action groups submitted their answers to the project leader at IKCo in a sealed envelope.

Ergonomics interventions, informal observations and informal interviews, negotiations with participants during the ETWs and the workshop evaluations as well as meetings by the author and co-workers were planned and conducted. Thus, interviews were not systematically taped, but they were documented in notebooks.
by the author and his colleagues. Over the time of the projects at GC and IKCo, as well as the ETWs for different people from areas of Iran, the author acted as an assistant at the workshops. The results of the observations and interviews, as well as comparison of the EIP at the three levels, had the purpose of finding the main cause of constrains and how the EIP could be implemented at the organizational level.

How the participants work with the EIP facts in the target cases: Different ways of working with the EIP are indicated as shown in Table 7 to 9. Sub-section 5.4.1 describes the facts collection for EIP activities that provided the information to classify the case studies at the three levels. This information was then used to see how three case studies had used different ways to implement the model of EIPT. Sub-section 3.7 helped us gain a better understanding to how to implement the macro-ergonomic intervention for the participants at the group and organizational level.

<table>
<thead>
<tr>
<th>Case researches</th>
<th>ET</th>
<th>EA</th>
<th>E</th>
<th>RA</th>
<th>NB</th>
<th>PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucosan Factories (GC)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Iran Khodro Car Co (IKCo)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>ETWs at individual level; the participants were from different industries</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Table 7: Shows criteria for different activities in the three kinds of cases in the pre-intervention phase of the EIP

General participants’ perceptions at GC and IKCo after the training workshops regarding the causes of problems of ergonomics training were: An informal structural, Insufficient time, Unsuitable interval evaluation, Lack of management rationalization, No job security, Negative view of ‘improvement in industries’, such as ‘an improvement is infeasible in the workplaces’ (Study A).
This was interpreted that at the individual level, commitment of participants to learning starts with ergonomics training by the ETWs and must receive top management support to ensure an EIP. At the group level of the EIP by the ETWs, management support and the commitment of the group and management to learning ensure an EIP. At the organizational level of the EIP, the support and commitment of employees and employer to learning ensures the EIP.

Table 8: Shows criteria for different role of the EIP team in the three kinds of cases in the pre-intervention phase of the EIP

<table>
<thead>
<tr>
<th>EIP Teams Case researches</th>
<th>RC</th>
<th>SC</th>
<th>AGs</th>
<th>FA</th>
<th>Interpretation of the EIP Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucosan Factories (GC) ‘Individual, group, &amp; organizational’ level</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Iran Khodro Car Co (IKCo) Group level</td>
<td>○</td>
<td>○</td>
<td>❂</td>
<td>❂</td>
<td>❂</td>
</tr>
<tr>
<td>ETWs at individual level; the participants were from different industries</td>
<td>–</td>
<td>–</td>
<td>❂</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

● = Strong  ❂ = Medium  ○ = Weak
RC= Reference Committee  SC= Steering Committee  AGs =Action Groups  F= Facilitator (s) Activity

Table 9: Shows how well the different EIP processes fulfilled criteria in the three kinds of cases

<table>
<thead>
<tr>
<th>EIP Processes Case researches</th>
<th>R(EIP)</th>
<th>M(EIP) T</th>
<th>N (EIP) T</th>
<th>***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucosan Factories (GC) ‘Individual, group, &amp; organizational’ level</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>1995 to 1997 (during three years) 4 workshops (15 to 57 people participated). 8 top managers trained for three weeks during the EIP. SC &amp; AGs were active. They had a R&amp;D division.</td>
</tr>
<tr>
<td>Iran Khodro Car Co (IKCo) Group level</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>2001 and 2002 (18 months) 7 workshops for 35 people AGs were active alone.</td>
</tr>
<tr>
<td>ETWs at individual level; the participants were from different industries</td>
<td>Yes</td>
<td>Yes*</td>
<td>No</td>
<td>1996 to 2002 Individual people from different industries were trained by the workshop. Some people participated in the second workshops.</td>
</tr>
</tbody>
</table>

R (EIP) = Routine Ergonomics Intervention Programme  M (EIP) T = Modified Ergonomics Intervention Programme Task  N (EIP) T = New Ergonomics Intervention Programme Task

61
5.5. Methodology for research questions two (with two sub-questions)

The methodology discussed here aims at fulfilling the following research questions:

The main question:
II. How should the EIPTs be delivered to the Iranian industries and possibly other organizations in the IDCs so that they can easily learn how to use them successfully?

Two sub-questions:
  c. How can the EIPTs be successfully implemented and internalized by such organizations?
  d. What practical activities are required for the EIPTs’ implementation?

The methodology is based on four main parts:

- A theoretical framework based on a continuous support guarantee for local actors of the EIP in the Section 4.1.
- A description of how the development of the EIPT is done by applying ‘Future Workshop’, Ergonomics Checklist, and Ergonomic Checkpoints.
- The choice of action research-type intervention in the three companies, to develop a model of the EIPT process for the organizational level from collecting and analyzing the data.
- The process of the participatory ergonomic intervention (Studies I and J); how the EIP are used smoothly way while co-operating with three companies. Thus, the EIPTs were in practice.

Figure 16 shows the time orders when the different parts were done during the thesis work.

```
          Licence Thesis
          Co-operation
          Theoretical framework
          Data collection
          Documentation, Doctoral thesis
```

Figure 16: The research work is accomplished after the licentiate thesis

5.5.1. The co-operation that turned into action research

The author worked and supported the three companies for improving ‘Work Organizational and Organization Design’. By using the EIT in a practical and theoretical way, he decided to work with the three companies on an action research
based approach. In 2004, the companies were selected. This was for development and promotion of the EIPTs in practice.

How and why did I select the case research in the ‘Poultry Industry’?

After my licentiate thesis in the year 2003, I negotiated with four different Iranian industries, persuading them to do an EIP. I negotiated face to face with their top managers. My goal was to get agreements from the top managers to conduct a problem-solving process in their organization using EIPTs. The main problem, I observed, was again lack of ergonomics awareness among managers in Iranian industries. One of the Iranian industries, which finally became interested in enhancing its organizational work and organization design by using ergonomics in the year 2004, was a private poultry company. This industry consisting of three private companies was located in State Gilan in different areas with more than 300 employees in one ‘organization’. I have focused my study on these three private companies using an action research method. During the planned period, all the engineers in animal husbandry, specialists and veterinarian from the poultry company (44 people; 14 women and 30 men) participated in ergonomics practice at the workshops and meetings. The emphasis of the project was to take advantage of local skills and resource as well as local solution for improving ‘Work organizational and Organization Design’.

The managing director of the Mehr E Nami Institute (MENI) received a request from the top management of the poultry company for the assessment of their organizational design in March 2004. When I went to Iran in April of the same year, a meeting was arranged with one of owners of the three companies who was the top manager. At the meeting, he told us that the main problems faced by the companies are:

‘1) Physical development of work during last three years, and 2) we have not any proper work organization. We have about 40 experts, most of them working as engineers in animal husbandry and they have experienced only in our companies. They are young in our company. I need a mother company and designing work organization for the three companies’.

I requested to visit the work sites and he accepted. We went to Rasht city in state Gilan for three days. I negotiated with managers of eight divisions of the three subsidiary companies, and this was the subsequent starting point for my research activity. After that, a second meeting was held with two top managers, two owners (three companies have three owners) for a half day. My suggestion was to apply ergonomics for improving ‘Work organizational and Organization Design’.

13 (MENI): In November 2003, the Mehr E Nami Institute was established by a few Iranian industrial managers, with the aim of supporting Iranian industries that are interested in ergonomics application, training, consulting and research. Furthermore, MENI is a research supporter for the implementation of ‘Development of Ergonomics Intervention Programme Technique (EIPT)’ in Iranian industries.
Design. The third meeting was with three owners who were also top managers of the companies. I gave them a pre-proposal, describing the goal and purpose of my project as well as some information about micro and macro-ergonomics and the checklist of the ILO (1996).

My first work experience after receiving a Bachelor of Science in the field of Industrial Management, 28 years ago (i.e. in the year 1981) in Iran, was working in a ‘Poultry Industry’ for four years in Tehran. I recognized and understood the whole tasks of engineers in ‘Animal husbandry’, especially, as it concerns factors such as ‘light, heat, noise, dust, mist, air condition, variation, weight, age, sex’ and the improvement of workstation for ‘Chicks and hens’ in the salons. All those factors are important, as the ‘Utilization’ of chicks and hens is a key productivity issue for the poultry industrial. Thus, it was of interest to find out how a manager/owner from poultry industry would be attending to ergonomics learning in their organization.

When I received the agreement of the top managers for the project, I started my work for the three companies with the intention of applying the three main EIPTs (i.e. ‘Future Workshop’, the ergonomics checklist and Ergonomics Checkpoints) step by step. Furthermore, I designed a Logical Framework Approach (LFA), (NORAD, 1992) for the project.

5.5.2. The choice of action research and companies

Getting in contact with interested companies to prepare and develop a model occurred as a business opportunity for the author. In following up the research programme (i.e. the development of the EIPT), I acted as ‘consultant’ (see subsections 5.3.3 and 5.5.1).

The companies chosen for involvement in the research work had the following similarities:

- The three companies with nine divisions wanted to find ways for improving their work organizational and organization design as well as better using human resources and productivity in a changeable environment.
- They become interested to an EIP after running ‘Future Workshop’ and applying an action checklist in one division. Due to a shared vision and an awakening to change, they became interested in improving their work system.
- They all established an intervention team and a participatory ergonomics process.
- The combination of micro and macro-ergonomics intervention makes it possible for the personnel to understand the work demands more clearly and at the same time, to be able to act to manage the demands.

A key point is that an action researcher and his or her clients differ in knowledge. Clients are the 'problem owners' and they have experience-based knowledge from their actual context. In contrast, the researcher has her or his theory-based knowledge, but such knowledge can be crucial to more precisely identifying actual problems, clarifying implicit assumptions, and through interaction and training changing a client’s perspective on the need to undertake actions for improvements (Arvyris, 1983).
Furthermore, I became involved in two companies in 2004; 1) a food company, and 2) at IKCo but because of the lack of management support and a change of management we could not follow-up the EIP.

1) In the food company; the research work started with a meeting with the managing director and an interview with the plant manager and after that a meeting with seven managers. In this meeting, the ergonomics checklist (ILO 1996) was introduced. The author had the opportunity to take many pictures of the production lines of the company. These pictures were used in the ergonomics training meetings with managers and the head division of occupational health and safety. But over five months the results showed a limited improvement in the workstation. The main problem was the company owner’s fear of the participatory method at work. The author focused on the programme in the division but the managing director changed it. The main problem of the occupational health and safety division was that they were responding to some forms from the governmental hygiene office. The running of the checklist and the ergonomic checkpoints did not receive any support from the other division.

2) At the IKCo; the author had 16 meetings for following up the project (the average length of each meeting was one hour), with the manager of the industrial hygiene division from the department of PTW (Prevention, Treatment and Welfare) during 2004. The result was the development of an ergonomics-training plan for PTW and an agreement for running the checklist at the plants. The author also had three meetings with one manager of the production salons. At the same time, the departmental manager was changed and the research work was stopped.

5.5.3. Data collection and data analysis of the case research

The author conducted an evaluation workshop after six months in the poultry company. All action groups presented their past activities, and this was discussed by all the groups. Furthermore, each member of the action groups answered and discussed in the group the following questions. The questions were presented to them one week before the workshop by the author:

- What are your aims for continuation of working in this group and ‘what are the aims of the group?’
- What are you proud of and what is the group proud of?
- Where are we standing at the process of ergonomics’ improvement and real organizing of work in our company?
- Where is the group unsuccessful? Where has the group failed?
- What do you need to continue your work?
- What do you want to achieve and where are we going?
- Please describe a success story of the group.

Furthermore, after ‘Applying the Checklist’ then ‘Applying the Checkpoints’, at the end of the checkpoints application process (i.e. one year into the study), each head of divisions (N=8) and members of the AGs answered the following questions:
- What positive or negative effects the ergonomics training have on your duties and job?
- What positive or negative effects did the project have on your company?
- How did your activities in the action group compare with your other training and activities in your company?
- How are your organizational and managerial duties in the company in comparison with the past?

Management Support

In the new project, the author introduced macro-ergonomics to the three top managers of the three companies in three meetings. In one occasion the author was participated in the meeting of the division heads (eight people), which was formed during the project. This provided the opportunity for training them in team working. On other occasions, I participated in the AGs’ meetings of the divisions separately. This look places without informing them in advance. This gave the opportunity to visit the workplace and observe the action plans that were implemented by the AGs.

These occasions also provided the opportunity to speak to top managers and division heads and also action groups separately, which did not always give the same output as when speaking to each one of them individually. Other occasions occurred during the workshop evaluation, which provided opportunities for discussion with members of AGs and the steering committee for promotion of their activities and reflections to top managers.

EIP team

After, applying the checklist in one division, the result as feedback of the meeting was the building of an intervention team with the 44 people: They responded to the question; ‘How can the checklist be used in all divisions?’ Then the intervention team was formed for applying the checklist in all the divisions. Nine action groups were formed, together with a steering committee for the three companies, with all 44 people involved. One of the top managers became the head of the steering committee.

The steering committee, consisting of 10 members was formed to supervise the action groups’ activities. The members of the steering committee were selected in participatory process by the participants at the second workshop. The members of the steering committee were mostly the head of divisions.

The action groups of each division were responsible for spreading the checklist information to the employees at their division and creating a participatory environment for employees’ involvement. An interval evaluation committee was also established after the workshop to assist the action groups in matters of their activity and of the steering committee. One of the facilitators (a co-worker from MENI) participated in the meetings of the action groups and the steering committee to help the management of the project and the forming of an external evaluation. The responsibilities of the steering committee and action groups were discussed with the group and the following were suggested:
The responsibilities of the SC were formulated as:

- Setting policies and administrative procedures for their activities.
- Interacting with action groups and documenting project progress.
- Promoting the action groups’ activities.
- Reviewing and approving action groups’ plans for ergonomics implementation.
- Supporting and confirming an action group activity plan (time, place and budget).
- Evaluating action groups’ activities on a regular basis.
- Designing rewards and systems of motivation for action groups.

Furthermore, the AGs were responsible for training employees at their workplaces on the usage of the checklist and ergonomic checkpoints as well as in creating a good condition for employees’ involvement in workplace improvement. They were further responsible as follows:

- Evaluating each section at their workplace using an ‘ergonomics index’; adapted from the Finnish Institute; the ELMERI safety index (ELMERI, 2000). The ergonomics index is calculated as a percentage of all provided items in the checklist (seven topics and 128 items). An index can be calculated for each part of the checklist to identify the major sources of problems and ergonomic bottleneck in the workplace (ELMERI, 2000).
- Implement the project proposal after the steering committee has approved it.
- Evaluating the progress of their own activities (i.e. both group members’ activity as well as group activity) on a regular basis.
- Spreading ergonomics knowledge at their worksites by applying the ergonomic checklist and creating ergonomics awareness as well as participation.

Process of forming SC and AGs

The responsibilities of the facilitator were: Ergonomics Awareness Building (EAB), project monitoring, evaluation and assessment of the activities performed, providing support, developing research plans and assisting in network building.

Participatory Ergonomics Process Using

According to Imada, (1986), participatory ergonomics involves contributions from several levels within an organization to identify, analyze and solve ergonomics problems.

Different ways were used to find out the results of the project. However, six main indicators were primarily used to find out if the model was implemented and if the goals of the project were achieved:

The first indicator, the Future Workshop (FW) showed an awakening to the revision of the organization and also to building a new vision for the organization. According to Aagaard Nielsen and Svensson (2006), the future workshop is a
participatory process. The awakening begins with a challenge, a question as the ‘preparation phase’ of the Future Workshop (FW). The aim of this phase was to define a clear, short and challenging ‘theme’ for the workshop, acceptable to all the participants. It brings question (s) – not answer (s). Furthermore, conducting the FW, applying the checklist in one division, taking pictures of the workstation before and after improvement and presenting this in the workshop evaluation, showed the current suggestions and how well the checklist was applied. See the indicators below.

The second indicator was an overview of how well the self-running of the different action groups was working in eight division with the nine AGs. This overview was divided into a two level scale in two steps:

- The first step involved those who had no access to the ergonomic checkpoints book. They had only the checklist. The items (i.e. problematic work areas) marked PRIORITY based on the application of the checklist (as highlighted in Study J) were then selected as the most important working areas (i.e. whose improvement was likely to be beneficial).
- The second steps involved those working with the support of the ergonomic checkpoints book (ILO 1996) via the AGs, self-running for each division. Self-running means that the AGs had meetings and accomplished improvements themselves by the participatory ergonomics process.

The third indicator was a SWOT (Strong points, Weak points, Opportunities, and Threats) analysis. The SWOT analysis of the organization by participants helped them to gain a better understanding of the situation of the work system and determine which of the areas needed problem-solving activities and which of the areas need promotional activities. Furthermore, it was necessary to build a suitable vision for the organizations after the FW and during the implementation of the project (Study I).

The fourth indicator was the results from forming the ‘Planning Committee’ of division heads. The plans and their planning were presented after nine months by the committee. The division heads went through a participatory ergonomics process and they have developed and accomplished new checkpoints for their organization (Study I).

The fifth indicator was the selected measures for the work system’s checkpoints and improvement of the work system by the activities of the SC and the AGs. In the development of the checklist, issues for improvement of the work system such as; ‘work schedules’ (i.e. planning, organizing, and control), ‘work tasks’ (i.e. improving of the work environment and work system), ‘a healthy work organization’ (i.e. leadership and management practice and continuous improvement), ‘learning’ (i.e. technical and social skills) have been found of particular importance as criteria for evaluation (Study J).

The sixth indicator was linking the Ergonomic Checkpoints of ILO (1996) with integrating ergonomics in Health and Safety (HS). These processes were done systematically by taking participatory steps which followed the Deming process
(Plan, Do, Check and Act). The participatory steps taken in improving HS and integrating ergonomics in health and safety are shown in Figure 17 (Study J).

1) Developing Health & Safety (HS) at organizational level by the checklist

- Identify problems due to improvement of health and safety
- Check locally feasible operational activities by AGs
- Select options for improving health and safety

2) Improving conditions of HS by the ergonomic checkpoints

- Identity problems and potential measures by AGs
- Check practicable workplace actions by AGs
- Organize group work for selecting or implementing actions

3) Integrating Ergonomics in HS at organizational level by the organizational intervention team

- Initial review of any existing Health & Safety by intervention team
- SC & AGs' assessment of the need for actions
- AGs' work for selecting or implementing improvements

**Figure 17: Common participatory steps for developing and using Ergonomic Checkpoints of the ILO (1996)**

5.6. **Research design quality**

This section contains a description of the reliability and validity of the research methodology. Two tests are commonly used to establish the quality of empirical social research. These are validity and reliability.

According to Yin (2003), validity can be divided into three different meanings:

- External validity means to what extent the result from the current study can be suitable even for occasions other than those studied.
- Internal validity means to what extent the achieved results correspond with ‘reality’.
- Construct validity means whether one actually studies the context or issue one wants to study.

Reliability means to what extent a methodology of investigation or fact collection method gives the same results under the same conditions at different occasions (Yin, 2003).

How these issues are treated decides the quality and credibility of the study (see Yin, 2003).
Validity

Construct validity: Dane (1990) argues that construct validity involves determining the extent to which a measure represents and does not represent the concepts that it should not represent. Moreover, construct validity deals with establishing correct operational measurements for the concept being studied (see Yin, 2003).

The practice of delivering the EIP by means of the ETWs was studied by using a case study strategy. This is a suitable strategy, according to Yin (2003), when trying to increase the construct validity.

The constraints of the EIP discussed for implementing development of the EIPT are supported by both theory and practice, which increases the construct validity. The case studies, the action research and the author’s fairly long experiences as industrial manager and consultant should also be considered as a good basis for construct validity.

It is important for research with a case study approach to describe the studied phenomena as correctly as possible. That implies the researcher’s comprehension and interpretation of the studied phenomena. Phenomena should be in accordance with the real phenomenon. According to Merriam (1988), construct validity is increased by the use of multiple sources of information such as questionnaires, interviews, literature, reviews and observations used in a complementary way, together making up a so-called triangular approach. The author has tried to follow this advice as much as possible. Some actions are described below.

Internal validity: Internal validity deals with establishing causal relations between facts (see Yin, 2003). Herzog (1996) states that internal validity refers to the validity of inferences about cause based on research findings. Internal validity is only a concern for explanatory case studies, where causal relationships between variables are studied. In explanatory and descriptive studies, where the causal relationships are not considered, the internal validity is not applicable (Yin, 2003).

Furthermore, the author tried to use different ways to collect similar data, and in that way obtain a form of triangulation. For instance, during the EIP at the GC, comments during different meetings were written down, and information from observations was added to the questionnaire. For the EIP at the IKCo, information collected from different meetings was written down. Additional queries were developed after the questionnaire for participants, and an opinion poll was added on. Furthermore, the different persons were also asked mainly the same questions in order to study the differences between different levels of the EIP (individual, group, and organizational levels) and EIP facts after the questionnaire.

The concluding descriptions of the involved companies (GC and IKCo) and different participants in the ETWs at the individual level, were also sent to a certain contact person at each company who read through the material and gave feedback. Complementing and verifying discussions were carried out over the phone with the participants in the ETWs, and the meetings with top and middle managers involved people and companies, to create as good descriptions as possible. The questions
after the questionnaire survey and the EIP, regarding specific topics about the EIP facts were addressed directly to the persons involved in the topic, not to the contact person. Thus, this way of handling an informal interview after the questionnaire survey and the EIP situation, was thought to increase the internal validity of the results.

Direct observations mean to visit the ‘site’, as Yin (2003) calls it. Just the responses of participants from the ETWs by means of a questionnaire, and after that, informal interviewing of the respondents in a conference room and the meetings do not provide the same chance to get a picture of the environment where the change is going to take place. The action plans for the divisions’ improvements were made by the action groups. The documentation of the meetings and the workshops added new dimensions for understanding either the context or the phenomenon being studied. The observations and also taking photographs at the workplaces were also valuable.

Dabbs (1982), states that at a minimum, the photographs will help to convey important case characteristics to outside observers. The author was engaged during the EIP in different roles at GC, and at IKCo. This gave opportunities for direct observations at the organizations.

There were some documents such as an album of the pictures before and after improvements. These were taken of the tools and the machines, as well as of the workstation by the action groups at GC and IKCo, and have been used as support in discussions and as a way to compare the different view of the EIP. The handling of documents strengthens the internal validity, but also, to some extent, the construct validity. Furthermore, activities and the results of the EIP were presented in the national and international conferences.

During all the work with the thesis, the ETWs by Professor Shahnavaz and the project design, as well as the thesis itself, were discussed with colleagues, who also commented on different occasions on the work and the research design in order to increase construct validity.

Furthermore, during the completion of the projects, different forms of reference groups were formed, which continuously made comments and helped the author to improve the design of the study.

Pattern matching was also used in the analysis of data; particularly data from the EIP, in order to try to increase the internal validity (see Yin, 2003).

**External validity:** External validity refers to the validity of inferences about the generality of the research findings, according to Herzog (1996). The external validity for case studies deals with analytical generalization. This means that some of the results of the case study are generalized to some broader theory (Yin 2003).

The ability to generalize from the investigations could, to some extent, be limited to Iran, an IDC. On the other hand, the theory studied and used for the theoretical framework is not limited to Iranian conditions, which might make it possible to use
the results even in other IDCs with a similar culture. The fact that the empirical facts are supported by and compared with theory increases the external validity of the results of the thesis. This is what Yin (2003) calls analytic generalization.

The analytic generalization demands that the theory is tested though replications of the findings in other cases, where the theory has stated that something will occur. This logic of replication is the same as for experiments, where the scientist can generalize from one experiment to another (Yin, 2003). This is partly obtained by using multiple case studies in the process of the research journey. Direct observations, documentation and even archival records, participant observation and how these have been handled, are described in Sections 5.5 and 5.6.

Reliability

Bell (1993) states that the reliability of an investigation is satisfying if another researcher can conduct the same research and draw the same conclusions, or in other words, if the data collection procedures can be repeated with the same result, Yin (2003). It might be valuable to compare reliability with precision. Precision in measurement is defined as having small measurement errors.

Yin (2003) recommends that a case study protocol and a case study database be constructed. A case study database can be constructed with the aid of a software program, ordinary folders with indexes, or a combination of both. However, due to some data being classified as confidential, due to organizational interest, the reliability of the study is affected negatively. This is because those outside the studied organization may have difficulties in getting access to some of the documents. In order to reduce the negative influence on the reliability, it may be valuable to use sources of evidence that are not classified, but that have information corresponding to the sources that are classified. In order to affect the reliability positively a case study protocol is valuable. To strengthen the reliability of this study, the thesis is written to achieve transparency and inter-subjectivity.

Reason and Bradbury (2001) point to what they consider to be of importance regarding quality in action research. The action research and its description should:

Reflect the co-operation between the researcher and the members of the organization. The author has tried to describe this in both Section 5.5 and 5.6. Even if it is hard to describe the dynamics and all the chit chat in between meetings and on the shop floor with different people, such conversation is important in order to form the whole picture of a change process. This is even harder to describe in a thesis based on a positivistic view and with only small hermeneutic elements. From the author’s point of view, the main criticism of research might be that the dynamics and active participation by the people as an EIP team involved in the change do not really find their place in the thesis because this was a reflection-learning of team-working.

Be governed by iterative reflection. The reflection consisted in meetings with the EIP team at the ‘organization’, and collection of quantitative data, in informal interviews and participants’ observations from different personnel categories as
members of the AGs and SC as well as division heads and top managers. Feedback was collected from running the EIPTs descriptions and the reports concerning the EIP, implementation and evaluating process at the ‘organization’ and, finally, also from the meetings and division visits at the companies during the each phase of the project (running the EIPTs’ tools). This point also increases the internal validity and to some extent the reliability.

Be based on an appropriate methodology for furthering knowledge. The theoretical framework, the action research and the creation of a model for the EIPT by the action research and the Ergonomic Process (EP) facilitate, binding up knowledge and developing it a bit further. This will hopefully make it possible for other organizations and researchers to follow the process; learn and create enough knowledge to be able to study or start their work towards improving work systems in organizations by an EIPT model on the EIT at the organizational level. This point strengthens both the internal validity and the external validity.

Engage in significant work. In the ergonomics intervention programmes in Iranian industries, GC (1995 to 1997) became ‘unique EIP’ for introducing ergonomics to Iranian industries, IKCo (2001 and 2002) was the biggest concentration in the automobile industry. The results of this significant work were introduced in national and international conferences by the participants too. Furthermore, the new case research in the poultry industry (2004 to 2006) which was the start of the development of the EIPT in the participatory ergonomic intervention process was a major work for creating ergonomics awareness and the implementation of basic ergonomics at the three private companies. Personnel of the organizations said ‘this is our pride that a scientific work is happening in our organization’. These points mainly strengthen the internal validity, but also the construct validity.

Result in new and enduring infrastructures. This has truly come through the three case researches in the pre-intervention phase, where the ideas presented in this thesis are run according to its original ideas. Furthermore, at the poultry company the ideas remains but are now included in the new way of technical and social redesigning by the EIPTs. This point also mostly strengthens the internal validity, but also the external validity and the reliability.

Thus, the main research strategies used in the thesis are the case study and action research, as a way to describe complex social phenomena requires a structured way of working to give reliable results. A systematic approach can be important in a case study in order to achieve high reliability.
PART II

6. SUMMARY OF THE PAPERS AND THE STUDY DESIGN

In order to achieve the objectives of the research study, ten separate studies were designed. In the following description the methodology, results and discussion for these studies are presented as ‘Study A to J’. As part of the research journey Papers B, C, E, F, and H are the peripheral papers, which supported the main core Paper A. Study A concerned applying ergonomics knowledge and practice. This was done by using a macro-ergonomics approach in the IDC. Furthermore, this was needed by an action research-type intervention at organizational level for developing the EIPT in the IDC industries. Study D was the first major assessment of reflection on the ergonomics training workshops by means of the questionnaire survey (Appendix 1) and Study G the second major assessment of the Ergonomics Training Workshops (ETWs) by means of a macro-ergonomic survey questionnaire (Appendix 2). These papers are concerned with Research Questions a and b. Papers I and J are other core papers which detail with the EIPTs in the three subsidiary companies. These Studies I and J are concerned with Research Questions c and d in this study.

This section presents a summary of the appended papers. It is intended to help the reader to understand the research even though he or she not read the appended papers. The results will be categorised under the headings of the four kinds of studies as follows:

1) Issues and challenges for the Ergonomics Intervention Programme (EIP), Study A,
2) Pre-design stage: Studies B, C, D, E, F, and G,
3) Design and development stage, Paper H,
4) Implementation stage: EIPTs in practice; Papers I and J.

6.1. Issues and challenges for an Ergonomics Intervention Programme (EIP):

Study A: A Macro-ergonomics Approach, a journey into system thinking, Ergonomics Intervention Programme (EIP) in IDCs, Case-IRAN. 1993-2003

Aim of the study

The aim of this study was to use about 10 year’s experience of the Ergonomics Intervention Programme (EIP) in Iran for the purpose of identifying a macro-ergonomics approach, for optimal ergonomics intervention in an IDC. The main question of the paper that is related to this thesis is:

What was the focus on a ‘Proposed model for developing an intervention process and an EIP situation’ in the ergonomics ‘know-how’ transfer to Iranian industries?
Methodology

This study as a case study anthology\(^{15}\) (see Yin, 2004), based on an Ergonomics ‘Know-how’ transfer to Iran, reflects on and describes activities as well as the results of the Ergonomics Intervention Programme (EIP) in Iran for the purpose of identifying a macro-ergonomics approach, for optimal ergonomics intervention in an IDC, case -IRAN.

The journey of system thinking and system practices for ergonomics intervention in the case-Iran, with the phases that followed and their results are described in this study as follows:

**Phase 1:** Preparation: In 1993, a two-week training course, entitled ‘Contemporary Management’ was organized at the Luleå University of Technology, Sweden, for a group of Iranian industrial managers. One of the subjects discussed in the course for one day was ergonomics and its application in the IDCs.

**Phase 2:** Presentation of the theoretical model in 1995 by Professor Houshang Shahnavaz, (i.e. students coming from IDCs to the different educational programmes can be encouraged to do their thesis work in their home countries).

**Phase 3:** Applying ergonomics in a medium sized industry (GC), 1995-1997 (see Studies B and C).

**Phase 4:** Conducting training workshops for ergonomics awareness building in different parts of Iran and doing a macroergonomics survey in the Iranian industries 1996 till 2002, and the first evaluation of the ETWs in Iranian industries (see, Study D).

**Phase 5:** Assessment of the workshops participants’ perception regarding the ergonomics training for awareness building, 1998 till 2002 (see, Study G).

**Phase 6:** Review of the ergonomics intervention model in IDCs, case-Iran (Shahnavaz et al., 2000). The review of the two case studies conducted by Ph.D. and M.Sc. students under supervision of Professor Houshang Shahnavaz. They mentioned that ‘we need to be patient’. Starting with training, and the creation of ergonomics awareness and convincing industrial top managers about the benefits of ergonomics and how it can improve the productivity and workers’ commitment.

**Phase 7:** Ergonomics intervention at an Iranian car manufacturing company (IKCo), 2001 and 2002 (Studies E and F).

**Phase 8:** Introducing ergonomics at universities in Iran, from 1996 to 2002, and developing Ph.D. studies in ergonomics, between 1999 and 2000.

**Phase 9:** Establishment of the Iranian Ergonomics Society (IES) in connection with the EIP in 2001.

**Phase 10:** Design of research questions for further study for ergonomists interested an EIP in IDCs ((Helali’s study, in 2003 (licentiate degree); Study A).

**Phase 11:** More activities for the promotion of EIP in IDC; one of the IES plans was to organize an international conference in 2005 in Iran\(^{16}\). The IES Board’s

\(^{15}\) According to Yin (2004), ‘a case study anthology takes us on two tours. The first tour is substantive: to experience the panorama of topics covered by some of the best case studies that may ever have been, including a case study that is now 75 years old and still in print. The second tour is methodological: to see how case study research has been practiced – by some of the best social scientists (here the ergonomist), past and present, in the country.’

members were hoping and counting on the support and assistance of Iranian scholars living outside of Iran.

In summary, three separate case studies were conducted for Iranian industries from 1995 till 2002, each with a different intervention approach. The first case study was carried out at Glucosan factories (GC, a food industry) from 1995 to 1997, all three levels (individual, groups and organizational) were trained. In the second case study, individual people from different Industries were trained from 1996 till 2002. The third case study was carried out at Iran Khodro car company (IKCo), a group of people from different worksite was trained during 2001 and 2002.

Furthermore, empirical evidence was collected through case studies from the pre-intervention phase of the EIP in Iranian industries (as archival analysis). For a further description of the methodology, see Section 5.4.

Results and discussion

Analysis of the case studies (EIP) in Iran and the activities during these years led to 1) - training and ergonomics (ET) awareness building (BA), ergonomics application (EA) and evaluation (E): 2) – research activities (RA) and 3) – network building (NB), a model for ergonomics intervention in IDC. The facilitators were an ergonomist and his Ph.D. students. System thinking and system practice of ergonomics intervention had resulted as a consequent by Helali’s study in 2003 (see also Study H). The emphasis of the EIP was on no cost/low cost intervention in the workplaces by using different project methodology.

The researcher was in the situation of the pre-intervention phase of the EIP, from the implementation of a ‘proposed intervention model’ in Iran that was distinguished by the roles, responsibilities, authorities and activities of the people involved and how they could be affected by the process design and conduct. For the results of ‘Tips’ from an ‘action pathway’, the challenges the EIP faces in taking actions in the IDC industries see also Section 7.2.

The main conclusions drawn from the study were as follows:

A Theoretical Framework: The interaction model, which has been presented in Section 4: Figure 5.

EIP Situation: There were three main concepts for EIP situations, which had to be conceptualized and operationalised as part of Helali’s study in 2003. These were routine task (pre-intervention), modified task (EIP process), new task (post-intervention). The conceptualization of the three EIP situations was simply the definition in this study.

EIP Process: The experimental model of ergonomics intervention in Iran was viewed as a process and action. The EIP was categorized into three levels or three tasks as ‘pre-intervention or routine task’, ‘process intervention or modified task’, and ‘post-intervention or new task’ of EIP and its feedback.
The outcome of this study resulted in a recommendation for research in IDC. Applying ergonomics knowledge and practice needed a macro-ergonomics approach in the IDC, including ergonomics management, system thinking and EIP situation as well as the new EIP task by means of an action research-type intervention (see Studies I and J). Studies I and J are concerned with the second main question (i.e. ‘How should the EIPTs be delivered to the Iranian industries and possibly to other organizations in IDCs so that they can easily learn how to use them successfully?’) and two sub research questions which are outlined in Section 2.1.

6.2. Pre-design stage: Studies B, C, D, E, F, and G:

Study B: Ergonomics intervention in industries of the industrially developing countries, Case study: Glucosan – Iran

Aim of the Study

The ergonomic expert (EE) from CEDC (Professor Houshang Shahnavaz), who conducted the 1995 workshop, was invited to Iran in January 1996 to initiate an ergonomic intervention program at Glucosan factories (GC). Over an intensive three-week period, a holistic participative and multidisciplinary ergonomic program was designed and implemented. Emphasis in the program design was to take advantage of local skills and resources within an ergonomic framework with goals of improving working conditions, productivity and employee satisfaction.

Method

- A meeting with the ergonomic expert (EE) and eight top managers of GC; a comprehensive presentation of the GC’s 18-year history by GC’s Managing Director (MD).
- After the presentation, the EE toured the factory. The MD invited the EE to a training class for managers and foremen that ran one day each week.
- Visiting of workplace at GC by the EE.
- Ergonomics training of top managers: This programme started with general ergonomic training of eight top managers (TM).
- Ergonomics workshop: In the 3rd phase, all 57 of GC’s top, medium and shop floor managers participated in a two-day workshop at a Caspian Sea conference site.
- Follow-up workshop: Few days later, in a whole day workshop, attended by the TM and EE, evaluation forms and participant comments from the two days workshop were discussed.

Results and discussion

Almost all workshop participants (98%) regarded the workshop as both very much/much useful and satisfactory. Considering the high motivation amongst the entire work force for ergonomic intervention, the TM decided to form an ergonomics R&D core group. A model for R&D group activities was developed. The main focus was to use appropriate procedures to utilize the results of the previous workshop and sustain the level of commitment and high motivation of the
work force for ergonomic intervention. It was decided that a regular weekly meeting should, in the future, work entirely on ergonomic intervention issues at GC.

After workshop activities: The top management decided, based upon the workshops’ recommendations, to implement two major activities:

   a. Establishment of an ergonomic R&D core group and ergonomic intervention team. The TM defined the R&D core objectives and its structure,
   b. The results of the second day workshop were been distributed to different sections of the company and identified as being supported by management.

Furthermore, the structure of the GC Ergonomic R&D Group and the intervention teams were a direct synergistic effect of the ergonomic workshop. By using the macroergonomics approach, both management and employees discovered new potential and developed ideas for improving working conditions as well as company effectiveness.

The participative management approach for better utilization of human resources and increasing employee motivation was appreciated by all personnel. The overall morale of all GC employees increased. Through this communication-building and problem-solving process, management saw the value of and accepted ergonomics as an effective tool for identifying problems and developing solutions. Employees of the company became closer to each other through the workshop and related activities. A cohesive workforce with the common goals of improving working conditions and productivity was established.

The Glucosan exercise clearly showed that if an opportunity is provided for ergonomics to be implemented at a work place in an IDC it will not only achieve its ergonomics objectives but, moreover, its synergistic effect will have influence beyond the field of ergonomics.

The manager of the GC said and it was noted in the paper: ‘The ergonomics programme has led the workers in a clear, common goal to develop objectives and improvements. We are moving now like swans, who when flying together in the same direction are 70% more effective compared to when flying individually’.

Study C: Adopting a macro-ergonomic approach for the identification of workplace problems and development of low-cost/no-cost solutions in industrially developing countries, Case study: Glucosan – Iran

Aim of the Study

This study presents the result of a macro-ergonomics approach at Glucosan factories. It utilized the ‘Future Workshop (FW)’ by Jungk (Denvall and Salonen, 1995) to identify various management problems and to develop vision, ideas and an action plan for improvement.
Method and procedure

A total of 31 top and middle managers of the Glucosan factories participated in a three-day FW. It was held in the conference facilities of a large hotel in Teheran, where all participants stayed for the whole workshop period. The group was very much motivated because of their previous experiences and involvement in ergonomics.

‘Future Workshop’ is a well-structured process with five phases:

1) Preparation phase (i.e. the aim of this phase is to define a clear, short and challenging ‘theme’ for the workshop, acceptable to all participants).
2) Experience phase: Also called ‘critic phase’ (i.e. this phase aimed to highlight all problems, experienced by participants with regards to the workshop’s theme. A complete ‘problem catalogue’ is developed).
3) Fantasy phase (i.e. the aim of this phase is to come out of the daily limitations that usually lead to restraint, traditional thinking and acting. People have many ideas that have never been expressed or formulated because they are framed in what they believe is right and possible. In the fantasy phase, everything is possible. There are no barriers, no economic, personal, technical or organizational limitations. The idea is to develop future visions).
4) Strategy phase (i.e. the aim of this phase is to go through all the written fantasies with the aim of finding all the barriers regarding the realization of the fantasies). Participants have learned to use the different techniques, such as desirability and possibility assessment, the circle model or development model activity, the triangular model, and cause and effect diagram, in order to develop a feasible strategy and solution to the problem on hand at the workshop.
5) Action phase (i.e. after the workshop, a complete report is prepared containing all the critical problems, and fantasies, as well as the programme/plan proposed by the participants. The report is an idea catalogue for future actions).

Results and discussion

The results of the workshop are presented for each day as follows.

- Day 1- Training in macro-ergonomics for 31 top and middle managers: The objective was to enhance participants’ knowledge on macro-ergonomics for the purpose of the fully utilizing potential resources of the company, especially human resources for a step-by-step improvement of efficiency and productivity of the whole organization.
- Day 2- Compiling a problem catalogue and developing feasible solutions: A problem catalogue concerning problems related to the theme of FW ‘organizational behavior for development’ was prepared by the participants.
- Day 3- Work continued: Participants continued their work in the fantasy and strategy phases by applying various techniques, such as the circle model or development model activity, triangular model, various brainstorming techniques, cause and effect diagram and analysis diagram. The participants
were divided into six groups. Each of the six groups developed a detailed plan for improvement. The main outcome of the six groups work and follow-up activities are summarized as follows:

- Identification of the optimum conditions for proper decision making and providing clear responsibilities for worker participation
- Proposal of a suitable organizational design and structure for the factory
- Development of a list of needed guidelines and compilation of employees’ loan regulations
- Revision of the contract procedure for employees’ welfare insurance
- More efficient transfer of information among different departments and better utilization of existing communication facilities
- Several low cost/no cost ergonomic interventions at various workplaces, and improvement of the machinery.

Activities following the FW: A full report of the FW was prepared by the R&D core. It contained all the problems as well as solutions. Management decided on an organizational redesign, since most of the documented problems were related to the organizational design, which was also emphasized by R&D. A month later, the R&D core developed a new counseling organizational structure with job specifications, rules and regulations. A committee (board) of six full time managers (Factory Counselling Board, FCB), was selected within the company by R&D, based on their competence. All other company managers were also part time members of the committee and were called to meeting according to the subject discussed and their competence.

It was discovered that the main obstacle for implementing the new plan was the position of the plant manager on top of a hierarchical structure. The problem was solved by changing it to a supervisor (one level lower) and making it a rotating one. The new plan was proposed in a meeting to the FW participants and was approved by 80 percent. Soon after, the plan was implemented. The plant manager position was eliminated and for the first time by common agreement, the supervision of the factory was given to a female manager with two years’ experience at the company.

The committee met every 15 days. Several expert sub-committees were also formed to take care of specific issues such as quality improvement, technology and new design, welfare and administration, work environment, etc. They were responsible in assessing all incoming suggestions and developing proposals for improvement.

In the case of Glucosan factories, the matrix structure of the organization, existing for seven years, was changed. It provided possibilities for better utilization of company resources. For example through employees’ efforts, the company prepared the institutionalization of the whole production system towards obtaining ISO 9002 certificates.

Furthermore, by making the best use of human resources (experts and non-experts), management was in a much better position to deal with rapid changes and consider local culture for smoother readjustments. It was generally accepted that ‘Today is the first day of future’.
But the EIP was stopped at GC in 1998 due to a change of management. For failures of the EIP, see also, Table 2 in Section 1.3. This will be discussed with the research question in Sub-section 7.4.

**Paper D: Experimental Model of Ergonomics Intervention in Industries of the Industrially Developing Countries, Case study: Iran**

**Aim of the Study**

This study describes the methods and procedure used during the four years (from 1995 to 1998) to introduce ergonomics in the Iranian industries. Study D shows the first evaluation the pre-intervention phase of the EIP. This study indicates the main cause of some general constraints. It suggests that the EIP, with a view of macro-ergonomics in theory and action, seems to be a possible foundation for an EIP strategy that builds upon and further develops participatory ergonomic intervention for a working development.

**Method**

Based on the positive effects experienced by Studies B and C, several other ergonomic workshops for providing training and ergonomic awareness were organized for a wide range of industrial and commercial firms in Iran during 1996 and 1997. Methods and material used in the workshops were ‘Future Workshop’ and introduction to ergonomic checkpoint (ILO, 1996).

In order to identify the participants’ opinions about the workshops and to assess the perceived strengths/weaknesses, an evaluation form was handed out at the end of each workshop. As a follow-up study (six months later) a questionnaire (Appendix 1) was designed and distributed to the workshops’ participants to find out the effect, if any, of these workshops. It was considered necessary to evaluate the success/failure of the workshop from two perspectives, i.e. that of the participants themselves as well as their perception of the receptiveness of management and colleagues within their organization.

**Results and discussion**

Most participants (N=79) from the four ergonomics workshops replied to the questionnaire. The following are some of the results:

- All respondents assessed the exercise as very beneficial and useful.
- Most workshop participants (95%) were much satisfied with the programme and implementation of the action(s) agreed upon during the ‘Future Workshop’.
- All participants felt there should be a follow-up workshop.
- 60% of the participants indicated that they were much more capable of dealing with problems at the worksite.
The experimental model of ergonomic intervention in Iran resulted from different specific attempts, and from conducting ergonomic workshops for different groups of participants from 1995 till 1997:

1) Ergonomic training workshop and implementation at Glucosan factories (see Studies B and C).

2) Introducing ergonomics to an industrial corporation: Twenty-four top managers of an industrial corporation (consisting of 20 different production and service firms) participated in a three-day ‘Future Workshop (FW)’ conducted by Professor Shahnavaz and his Ph.D. student in the northern province of Iran in August 1996.

3) Ergonomic training workshops: Two groups of top and middle managers (12 and 19) from various production and service companies participated in two separate three-day workshops organized in Teheran during August 1996 and January 1997. In the first workshop, the ‘FW’ method was used and for the second group ergonomic checkpoint was introduced and practised.

4) After the workshops, an evaluation from was completed by the participants and again after six months a questionnaire survey was conducted to find out if any ergonomic improvement had been made by participants as a result of the training programmes.

In general, the results and discussion of the evaluation are summarised as follows:

The lack of both a well-motivated and proactive top management and an active education and training centre at the industrial corporation could be mentioned as the main reasons for not having applied any of the learned knowledge in practice.

The results of the workshop evaluations show that the majority of participants (over 60%) assessed the workshop as good and very good. However, only 50% of the participants completed the follow-up questionnaire after six months. They all considered the workshop as very useful and wanted their bosses to participate in such training programmes. They also wanted more ergonomics support in order to implement the acquired knowledge. The establishment of a national ergonomic organization or center that could provide regular up-to-date information and support was also recommended.

In the case of Glucosan, the success of the intervention programme was mostly due to the establishment of an R&D group with the full support of the top management. In this case, both the individual as well as the whole organization went through an intensive learning process. The managers became learning managers and the top manager provided a condition that facilitated the process of self-development through motivation, support and competence. All activities at the factory become a sort of ‘development work activity’ a prerequisite for changing from a bureaucratic organization to a learning organization.

Furthermore, in the case of the industrial corporation, although all 24 top managers of the industrial corporation (consisting of 20 different production and service firms) participated in a training programme and evaluated the programme as very useful at the end of the training, they did not implement the learned material in their
firms. The reasons for this, which they mentioned in the questionnaire survey, were the bulk of daily routine work and that they did not have the necessary motivation and confidence to make any changes at their firms. The organization of the whole corporation was considered as not adaptive, but rather bureaucratic, and therefore not a learning organization.

In the case of the other industries, the participants who took part in the ergonomic training workshop could not implement their learned knowledge to a greater extent at the local workplaces. This was mostly because individual learning was achieved, but the dynamic process of organizational learning was missing. This was a hindrance for the individual to implement their newly achieved competence in their work environment, which was not receptive to changes.

In March 1997, the Ergonomic Checkpoints (ILO, 1996) was translated to Farsi (including also a translation of Paper B) and published 5000 copies of the book were distributed by GC, including 150 copies free of charge to top government and private decision makers. In July 1997, Danesh Maal Institute (DMI), was established by Iranian shareholders. The aim of DMI was to act as a supporting organization for the Iranian industries that are interested in ergonomics training and application.

Studies E and F: Ergonomics intervention in Iran Khodro Car Company (IKCo)

Aim of the Study

Ergonomics awareness efforts started gradually over four years, since 1996, at Iran Khodro Car Company (IKCo) with a few isolated activities, such as seminars lasting from a few hours to one day, and later a workshop lasting a few days. In May 2001 after almost one year of negotiations with the management of the department of PTW (Prevention, Treatment and Welfare) on a comprehensive programme for applying ergonomics and creating an ergonomic process at IKCo, a project proposal developed by CEDC and was approved for implementation. The project was designed in three phases as a co-operative activity between PTW and CEDC. The main emphasis in the project design was to take advantage of local skills and resources using a participatory approach with the objectives of improving working conditions, working systems, productivity and employee’s satisfaction.

The three phases of project were as follows:

Phase 1 – Improving workstations,
Phase 2 – Improving work systems and organizational procedures,
Phase 3 – Improving products (outputs).

The first phase of the project was planned to last for 18 months. The objective of this phase was to develop ergonomic awareness and knowledge, train a selected group (N=32) of IKCo employees in ergonomics theories and practice and assist them in implementing the new knowledge for improving the company’s workstations and creating better working conditions. An ergonomics expert from CEDC (the project manager) and two of his Ph.D. students acted as facilitators,
who conducted training and co-operated in the follow-up, evaluation and documentation of the ergonomics intervention project.

Methodology

This study, based on one case study at one company, was conducted to get data to analyse phase one and the experiences gained from the 18 months ergonomics intervention process in a large Iranian industry. The methodology applied was action learning, on the job training and team working. A holistic, participative and multidisciplinary approach was conducted throughout the project. A special organization was designed for this project. Proposed ergonomic activities were divided into three categories: 1) Training, ergonomics intervention (or ergonomics application), evaluation, 2) research and 3) network building.

Results and discussion

After 18 months and at the end of the first phase of the project, the results were as follows:

The action groups (AGs) were in more need of an acceptable evaluation and assessment method, which can create motivation and satisfaction, considering the culture and the environmental conditions of the company.

In the first phase and during the 18 months duration of the project, all together seven training workshops were conducted within the project. The total training time was estimated at 151 hours and 5285 total man-hours. In addition, 109 hours and 2913 total man-hours were spent on forming the AGs and developing their working procedure. For successes of the EIP, see also, Table 1 in Section 1.3.

A ‘proposed theoretical model’ for ergonomics intervention was introduced to IKCo management. The model was based on three major factors: top management support for EIP, employees’ participation and knowledge support from facilitators (CEDC). Further, the process starts with employees’ training, team working and feedback system. For the success of EIP, there should also be a functional and acceptable progress assessment system, recognition and reward system as well as an appropriate communication network system. The proposed theoretical model, was accepted by the IKCo management for phase 2 of the ergonomics project (Figure 18).

In the case of IKCo, most participants were experts from various worksites. The success of the EIP was mostly due to a better role of local experts at the group level because of their participation in various training workshops. The project organization of the EIP consisted of three main groups: SC, AGs and the facilitators (EIP team). Some of the groups had both plan and planning for carrying out the task and some just one of these two (Study F).
After 18 months a Reference Committee (RC) consisting of top management was considered necessary for supporting the SC in their tasks of promoting Occupational Health, Safety, Environment, and Ergonomics (OHSE&E) at IKCo. But, the EIP was stopped at IKCo in 2003 due to a change in management and the second phase did not take place (see also, the Table 2 in the Section 1.3). This will be discussed in Research Question a in Section 7.3.

**Study G: Assessment of Implementing Ergonomic Training Workshops (ETWs) at three Levels, the Success of Individual, Group and Organization during Years 1995 to 2002 in Iranian Industries**

**Aim of the Study**

Study G was the second evaluation of the pre-intervention phase of the EIP by investigation of the participants’ perspective regarding the Ergonomics Training Workshops (ETWs).

A questionnaire survey (Appendix 2) and opinion poll information were collected regarding the ‘usefulness of the ergonomics training’ for the participants of industries at the three levels viz, individual, group and organizational:

The aims of this questionnaire study were:
- To identify Organizational Behaviour (OB) of the participants after they had undergone training and its effects on the different levels viz, ‘individual, group and organizational’;
- To analyze and investigate the participants’ perception after the workshops.

The second purpose of study was to find how implementing Ergonomic Training Workshops (ETWs) stood at the three levels, viz, individual, group and organizational.
Methodology

The questionnaires were sent to 186 participants from industries who had participated in different workshops during a four-year period. Overall, 94 completed questionnaire (i.e. 51%) was received. The breakdown of the specific number of questionnaire sent and the response received for each target case are shown in Table 10 below.

Table 10: Specific responses of survey questionnaire by target cases

<table>
<thead>
<tr>
<th>Case</th>
<th>Target number of participants</th>
<th>Number responding to questionnaire</th>
<th>% of response per case</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC</td>
<td>57</td>
<td>37</td>
<td>65</td>
</tr>
<tr>
<td>IKCo</td>
<td>32</td>
<td>25</td>
<td>71</td>
</tr>
<tr>
<td>Others</td>
<td>97</td>
<td>32</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>186</td>
<td>94*</td>
<td></td>
</tr>
</tbody>
</table>

Information regarding the age of the participants that replied to the questionnaire is shown in Table 11 below.

Table 11: Statistics, ‘Age of participants’ who they replied to the questionnaire

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Valid</th>
<th>Mean</th>
<th>Std. Error of Mean</th>
<th>Median</th>
<th>Mode</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>94</td>
<td>94</td>
<td>38.14</td>
<td>0.74</td>
<td>37.00</td>
<td>41</td>
<td>24</td>
<td>52</td>
<td>3585</td>
</tr>
</tbody>
</table>

The position of participants (Top, Intermediate Manager, Expert and Supervisor) is shown in Table 12 below. The workshop’s participants had between 2 to 30 years of work experience in different factories.

Table 12: Position of participants that have replied to the questionnaire at three levels

<table>
<thead>
<tr>
<th>Subject/Position of participants</th>
<th>N = 94</th>
<th>Glucosan (GC)</th>
<th>IKCo</th>
<th>Others participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
<td>%</td>
</tr>
<tr>
<td>Top &amp; Intermediate Managers</td>
<td>12</td>
<td>32.4%</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>Expert</td>
<td>9</td>
<td>24.3%</td>
<td>21</td>
<td>84%**</td>
</tr>
<tr>
<td>Supervisor</td>
<td>16</td>
<td>43.2%*</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>100%</td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>
Results and discussion

The first purpose was to describe how people at the three levels worked with the EIP and ergonomics ‘know-how’ transfer. The results of the participants’ perception are presented in Tables 13, 14, 15, and 16.

Table 13: Responses to the workshops at the individual level

<table>
<thead>
<tr>
<th>Usefulness of training workshop at individual level</th>
<th>Percent Responses (N=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was useful for me</td>
<td>Not at all</td>
</tr>
<tr>
<td></td>
<td>9.6%</td>
</tr>
<tr>
<td>I know now how to improve working condition</td>
<td>7.4%</td>
</tr>
<tr>
<td>I have the ability now to improve my work at workplace</td>
<td>25.5%</td>
</tr>
<tr>
<td>I have implemented some practical measures</td>
<td>6.4%</td>
</tr>
<tr>
<td>I now understand workplace related problems</td>
<td>0%</td>
</tr>
<tr>
<td>I used the knowledge in problem-solving at home</td>
<td>5.3%</td>
</tr>
<tr>
<td>My behaviour is more positive now</td>
<td>38.3%</td>
</tr>
</tbody>
</table>

Table 14: Distribution of respondents’ responses regarding problem identification and solutions

<table>
<thead>
<tr>
<th>Problem identified after workshop</th>
<th>Percent Responses (N=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Identification of problems at the workplace</td>
</tr>
<tr>
<td>Physical</td>
<td>45.7%</td>
</tr>
<tr>
<td>Combination</td>
<td>43.6%</td>
</tr>
<tr>
<td>Such as physical agents, organizational factors, problems of machinery design and tools, and cultural factors</td>
<td>43.6%</td>
</tr>
<tr>
<td>Other factors</td>
<td>10.7%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 15: Responses to the workshops at the group level

<table>
<thead>
<tr>
<th>Usefulness of training workshop at group level</th>
<th>Percent Responses (N=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>It was useful for my group</td>
<td>8.5%</td>
</tr>
<tr>
<td>The power and influence of my work group has changed</td>
<td>48.9%</td>
</tr>
<tr>
<td>My job and position in my group has changed</td>
<td>31.9%</td>
</tr>
<tr>
<td>My work group has changed</td>
<td>55.3%</td>
</tr>
<tr>
<td>I evaluate the changes as positive</td>
<td>6.4%</td>
</tr>
<tr>
<td>I observed conflicts in my group</td>
<td>87.2%</td>
</tr>
<tr>
<td>My work group has done better at improving working condition</td>
<td>31.9%</td>
</tr>
</tbody>
</table>

Table 16: Responses to the workshops at organizational level

<table>
<thead>
<tr>
<th>Usefulness of training workshop at organizational level</th>
<th>Percent Responses (N=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>My organizational top manager has participated</td>
<td>47.9%</td>
</tr>
<tr>
<td>It was useful for my organization</td>
<td>4.3%</td>
</tr>
<tr>
<td>It was useful in practice</td>
<td>53.2%**</td>
</tr>
<tr>
<td>My organization has used the ergonomics knowledge that I have gained from participation in the workshop</td>
<td>61.7%**</td>
</tr>
<tr>
<td>My organization has changed</td>
<td>47.9%</td>
</tr>
<tr>
<td>The organizational changes are positive</td>
<td>4.3%</td>
</tr>
</tbody>
</table>

In Table 16, the participants’ responses indicated that 61.7 % of them perceived that their organizations had not used the ergonomics knowledge that they have gained from participation in the workshop. On the other hand, 53.2% of the participants responded that it was not useful in practice.

It was inferred in this study that ergonomics training workshops, which were conducted at an industrial site were most productive and effective for improving conditions at workplaces. This was because the participants coming from the same industry could exchange ideas, make interventions at the workplace, see and evaluate the results, and get involved in a process of change. This creates a positive atmosphere at work as well as continuous action and learning and an intervention team.
6.3. Design and development stage: Study H

Study H: A Model of Implementing Ergonomics Intervention Programme Technique (EIPT) in Industrially Developing Countries (IDCs) – Case Iran

Aim of the Study

The purposes of this study were:

- To describe a model for implementation of EIPT and the results that it indicated as regards technical factors for ergonomics know-how transfer to an IDC
- To evaluate how the model deals with macro-ergonomic intervention.

Methodology

The methodology consists of two parts. The first was an empirical model on the implementation of the pre-intervention phase of the EIP. The second part was made up of case studies of the EIP by the ETWs.

Results and discussion

The EIPT model: This study describes the materials and methods of the EIPT as a consequence of system thinking and system practice of ergonomic intervention in Iran as follows:

Ergonomics Training (ET) method

The overall goals of ergonomic training were:

1- To provide relevant knowledge (theoretical, practical and communicative),
2- To develop and stimulate human aptitude, talent and creativity for problem identification and problem solving-solutions,
3- To provide the necessary motivation for making optimum use of the learned knowledge and resources for making improvement through ergonomic intervention.

In each training method for EIP, many tools and methods were used. These were referred to as ‘tools of EIPT’ in the study survey by the authors (see also Helali, 2003). These tools help to adopt an action learning approach.

Ergonomics Application (EA): The training programme was concentrated on providing the necessary knowledge and skills to participants in the workshops (individual level) as well as training a whole group of employees from single industry (group level) and ultimately preparing the whole organization for making ergonomics intervention and improving the working condition as well as productivity in a participative, systematic and holistic approach.

Evaluation (E): Evaluation or Feedback of EIP is a control tool for effective performance, learning and development in chronological order. Thus, a systematic
EIP evaluation was conducted for most of the workshops. One of the methods for assessing the effectiveness of the workshop was the pre-testing and post-testing of participants’ ‘know-how’ by the facilitators. Participants’ knowledge was tested before and after they had participated in a workshop. Another method was evaluation of the action groups’ activities by themselves.

**Research activities (RA):** ‘The main objective of ergonomic research viz, improving the health, safety, and satisfaction of employees as well as improving productivity and product quality of the organization is the same globally. However, the research results drawn from studies conducted in the industrialized world could not always be used to solve problems in IDC. This is because the major components of the ‘Human at Work System’, i.e. the human, organization, technology, information, external and internal environmental factors which are influencing the system performance are different in IDCs compared to ICs. As the nature of problems and the causal factors are mostly different and resource availability is limited, the methods of investigation and proposed solutions must be also different. It is therefore necessary to promote ergonomics research in IDC to develop local autonomous capacity and appropriate solutions to the existing problems. Copying results that are developed in IC has been shown not to be the best way of solving problems in IDC workplaces. IDC have to develop their own potential capacity for assessing and solving their own ergonomics related problems.’ (Shahnavaz, 1995)

**Network Building (NB):** Network building is regarded as an important support factor for IDC. National networks building like Iranian Ergonomics Society (IES) which is an attempt toward Globalization of Ergonomics is a support organization for local people who are interested in ergonomics issues. The aim of this networking intervention was to build a strong network of people, companies and the groups of people involved in the ergonomic project, which could provide opportunities for exchange of ideas and visit other manufacturing sites and institutes in Iran and outside of Iran. Another aim of the ergonomics intervention processes in Iran has been to establish academic programmes leading to university degrees and to prepare the necessary infrastructures for conducting research projects in the Iranian industries.

The EIPT model attempt: The first purpose of the study was to describe a model of implementation of the EIPT in Iran for implementation of the EIP.

EIPT was defined as the activities performed by the facilitators (ergonomics expert and his Ph.D. students) for the purpose of doing; 1) - Ergonomics Training (ET) Building Awareness (BA), Ergonomics Application (EA) and Evaluation (E), 2) - Research Activities (RA) and 3) -Network Building (NB) in industries of the Industrially Developing Countries (IDC), case - Iran. Employees and management participation in the ergonomics activities was a key issue and integrating factor in the EIPT.

The results of ergonomics training and awareness building were as Table 17).
Table 17: The training workshops and training courses conducted by CEDC (Professor Shahnavaz and his Ph.D. student (the author))

<table>
<thead>
<tr>
<th>Training workshops (W) &amp; Training courses (TC)</th>
<th>Date</th>
<th>Numbers of participants</th>
<th>Numbers of W &amp; TC</th>
<th>Time (hours)</th>
<th>Total man hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industries</td>
<td>July 1993 to Nov 2002</td>
<td>293</td>
<td>24</td>
<td>681</td>
<td>16838</td>
</tr>
<tr>
<td>Universities</td>
<td>Dec 1996 to Nov 2002</td>
<td>94</td>
<td>7</td>
<td>453</td>
<td>3375</td>
</tr>
<tr>
<td>Total</td>
<td>During 9 years</td>
<td>387</td>
<td>31</td>
<td>1134</td>
<td>20213</td>
</tr>
</tbody>
</table>

This study has concerned itself with Research Question b (i.e. ‘Is it that the EIP is difficult to implement?’) in this thesis. This will be discussed in Section 7.4.

6.4. Implementation stage: Studies I and J:

Study I: Participatory Ergonomic Intervention in an Industrially Developing Country – a Case Study

Aim of the Study

The study aims were to create ergonomics awareness that can lead to finding problems at the work system, as well as the development of feasible and acceptable solutions for improvements.

The study purposes were to develop vision, ideas and action plans for improving the work system.

The underlying question for this study was: Can ergonomics awareness be created inside an organization from a participatory ergonomic intervention by the EIPTs?

Methodology

The research methodology was based on the action research-type intervention was made at the three subsidiary companies from one industry in the state of Gilan as in the following steps. For a further description of the methodology, see Section 5.5.

Three subsidiary companies from one industry were one company (i.e. the Mother Stock Farm) with four divisions. The second company has three divisions (i.e. The Parent Stock Farm, Chicken Factory, and After Sales Service). The third company deals with machinery and equipment. More than 300 people participated in this project. All managers (three top managers and eight heads of divisions), supervisors (28 people) and experts (five people) of three private poultry companies participated in the training workshops, learning different methods for creating ergonomics awareness among managers and employees (44 people; 14 female and
30 male: The average age was 26 (22-30) years for females and 40 (25-55) years for males).

The first processes of the participatory ergonomic intervention in the three companies included as follows:

Meeting with top management: A meeting was held with the three top managers (owners) of the three companies. In the second meetings, the benefit of ergonomics and the experiences to be gained from applying ergonomics in Iranian industries was discussed with the top managers over two hours.

Visiting workplaces, negotiating with head of divisions: With the agreement of the top manager, a visit to the work sites was planned. The author visited eight divisions over three days. During the visits, the head of the divisions introduced the working situation and explained the positive and negative aspects of their work system.

Meeting with top managers: The three top managers participated in the third and fourth meetings. The results of the visits to the work sites were discussed in two sessions during two four-hour meetings. Top managers added information about the companies. Furthermore, in these meetings more general ergonomics information was given. It was agreed to have the last meeting for four hours, during which the project underlined by this study was discussed and planned. The duration of the project was agreed to be 12 months after the first workshop.

‘Future Workshop’ conducted with all 44 subjects for three days: The ‘Future Workshop’ was introduced and conducted with all 44 subjects for three days at the end of May 2004. It was held in one of the offices of the companies in Rasht City. The process was video recorded. The ‘Future Workshop’ was a well structured process with five phases (i.e. ‘Preparation Phase’, ‘Experience phase’, ‘Fantasy phase’, ‘Strategy phase’ and Action phase (See also Study C). 44 Participants have learned to use the different techniques, such as the desirability and possibility assessment, the circle model or development model activity, the triangular model, and cause and effect diagram, to develop a feasible strategy and solution to the problem in hand at the workshop. Furthermore, after the workshop, a complete report was prepared containing all the critical problems and fantasies as well as the programme/plan proposed by the participants. The report was an idea catalogue for future actions.

‘Workshop’ conducted for one day and ergonomics checklist was introduced in one of the divisions: The ‘Ergonomic checklist’ (ILO 1996) was introduced for one of divisions (machinery and equipment division). The workshop was conducted with all 44 people by the facilitator. They were divided into six groups (one of the groups had nine people). The results of the checklist’s activity were presented by the groups as action plans to the heads of the division.

Evaluation workshop after two weeks and forming an intervention team: The group visited and discussed the implementation of the action plan, which was developed by using the ‘Ergonomics Checklist’ at one of the divisions, during one day.
Videotape and pictures of the workplaces at the division were taken during this workshop. Furthermore, the group agreed to work according to a ‘work and morale charter’ which should be developed through participation in the first session of the ‘strategy committee’. Then, they discussed the following question: ‘How can the checklist be used at all worksites of the divisions?’ It was planned that special questions should be discussed within separate groups consisting of the eight heads of divisions. Division’s heads decided to work in two separate groups with different problems. In the first session the group replied to the following two questions: 1) ‘Why should we change?’ 2) ‘How should we change?’

Meeting with divisions heads: Every 15 days, for half a day over three months, all together 10 people (heads of divisions (eight people) and one of the top managers as well as one of the facilitators) had a collective meeting at one of the divisions. In these meetings, they discussed the progress of the groups and coordination of the activities of the various divisions and better supporting the steering committee (SC), which was established after the second workshops. In these meetings, the project facilitator informed them about ‘organizational and managerial’ functions, project monitoring, and evaluation for better conducting the project. In the first meeting, the division heads discussed the following questions: ‘Why meetings of division heads should be held?’ In addition, ‘How should such meetings be held?’

A SWOT (i.e. strengths, weaknesses, opportunities and threats) analysis for the organization by the 44 people: The other activity after the Future Workshop (FW) was a SWOT analysis of the organization by the participants (44 people), which started after two months. This was to develop a vision for the poultry company.

Forming a ‘Planning Committee’ of division heads, after three months of the ‘FW’: After three months, one of top managers and the head of divisions formed a planning committee for better running of ‘organizational and managerial’ functions at the three subsidiary companies as well as for a better follow-up phase of the Future Workshop.

The role of the author was as a coordinator in applying the EIPTs forming an EIP team and implementing the processes of the model presented in Section 4.2. Figures 5 and 6. Thus, he was an interventionist, interacting with an intervention team (i.e. a steering committee, and action groups (AGs)), with single individuals such as workers, divisions heads, and top managers over 14 months, from May 2004 till September 2005. This study describes the first phase of conducting the project.

Furthermore, the author conducted an evaluation workshop after six months. All action groups presented their activities; which were discussed by all the groups. Each member of the action groups answered and discussed in the group seven questions (see the questions in Sub-section 5.5.3. The seven questions were presented by the facilitator, one week before the workshop.

Results and discussion

A high degree of involvement of the 44 people was indicated during all days of the workshops and meetings as well as sessions with the heads divisions. The results of
each method used are presented. This paper shows the results of the different methods towards a social redesigning for the divisions and whole organization by the EIT process (i.e. EIP activities, EIP team, and EIP process). These as main indicators were primarily used to find out how ergonomics awareness could be created inside the organization participatory ergonomics process using, management and employee support, and knowledge support (see also Section 5.5.3).

The result from visiting and negotiating with the eight managers in their divisions indicated the following issues: Lack of (or unsuitable) planning, organizing and control, Isolated work, stress, lack of a balance between work and private life, lack of managers meetings. For example; when the head of divisions introduced their work, they mostly talked about crisis at work and their successful handling of it. Good qualification for a division head was, in their opinion how he or she could solve crises at farms and worksites. They complained of the physical enlargement of the worksites during the last three years. They did not have any suitable work organization. They mostly feared what would happen in the future and the lack of control by the top management.

A full report of the Future Workshop was prepared by the facilitator. It contained all the problems as well as solutions. Most of the documented problems were related to ‘work organization’ which was also emphasized by managers of the three companies. The managers observed how a proper participative procedure would help with the recognition of various problems at work and the development of an acceptable solution.

The observations’ results from the workstation based on the videos and pictures taken indicated improvements due to a better arrangement of the production line and the paying of more attention to health, safety and work environment. The workers indicated that the importance of these activities was demonstrated by the management’s attention to their suggestion for improvements. After two months, the division head reported that the ‘no-cost/low-cost’ changing of the workstation had positively affected productivity and, as a result, they could easily increase the capacity of their production. They had received more orders than in the past. The personnel of this division (three foremen and 32 workers) had received two months extra salary as a reward from the top management.

Furthermore, there was a meeting with the 44 people who participated in the second workshops. The trainers were divided into nine action group, consisting of four to eight members from different sites. The reason for nine action groups was due to the situation of different areas of working and farms: Area 1 (Mother Stock’s Farms); six people, Area 2 (Mother Stock’s Farms), four people, Area 3 (After Sales Service) four people, Area 4 (Making a Chick Factory), eight people, Area 5 (Mother Stock’s Farms), four people, Area 6 (Office Rasht) five people, Area 7 (Mother Stock’s Farms), four people Area 8 (machinery and equipment built for the poultry farms), four people, and Area 9 (Parent Stock’s Farms), five people).

In the results from the responses to the question ‘How should the meetings of division heads be held?’ by division heads, ten different paths were discussed such
as: the responsibility and authority of each individual in the session should be defined, importance should be given to training, and a proper reward and punishment system should be considered.

Then, the division heads considered two questions: Why and how should we change? (see Table 1 from Paper I).

Furthermore, it was important to know the strengths and weaknesses of the organization, as well as the opportunities available and the dangers that threaten it. In other words, which aspects should be safeguarded from change? Which aspects can be changed for the better? With these considerations in mind, they conducted a SWOT analysis. The outcome is presented in Table 18.

Table 18: Outcome of the SWOT Analysis for the Organization

<table>
<thead>
<tr>
<th>Strong points (capabilities)</th>
<th>Weak points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taking a greater share of the market</td>
<td><strong>Lack of Planning</strong></td>
</tr>
<tr>
<td>Much strong, young and specialized manpower</td>
<td>Lack of established (written) program</td>
</tr>
<tr>
<td>Variety of work</td>
<td>Lack of work system</td>
</tr>
<tr>
<td>Changeability</td>
<td>There is no training system</td>
</tr>
<tr>
<td>Forward-looking</td>
<td>Lack of strong marketing</td>
</tr>
<tr>
<td>Introducing new chicken race in Iran</td>
<td>Non – separation of project management and production management</td>
</tr>
<tr>
<td>Exports of chicken</td>
<td><strong>Lack of Organizing</strong></td>
</tr>
<tr>
<td>The organization Employment of native people &amp; using non – native specialized forces</td>
<td>Centralization method</td>
</tr>
<tr>
<td>Positive view toward the company</td>
<td>Lack of organizational chart</td>
</tr>
<tr>
<td>Humanitarian view toward the individual</td>
<td>Lack of distribution of work and giving the authority</td>
</tr>
<tr>
<td>Supporting services (machinery and equipment built for the poultry) by one of companies</td>
<td>Non – separation of work possession and capital possession</td>
</tr>
<tr>
<td></td>
<td><strong>Lack of Controlling</strong></td>
</tr>
<tr>
<td></td>
<td>Lack of evaluation system</td>
</tr>
<tr>
<td></td>
<td>Concealment of mistakes (errors)</td>
</tr>
<tr>
<td></td>
<td><strong>Lack of Planning &amp; Organizing</strong></td>
</tr>
<tr>
<td></td>
<td>Added pressure of work, in speed and execution</td>
</tr>
<tr>
<td></td>
<td>There is no description of duties and jobs</td>
</tr>
<tr>
<td></td>
<td>Lack of research activities</td>
</tr>
<tr>
<td></td>
<td>Lack of supporting staff</td>
</tr>
<tr>
<td></td>
<td>There is no admittance of criticism</td>
</tr>
<tr>
<td>Opportunities</td>
<td>Threats</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Creation of R&amp;D (Research and Development)</td>
<td>Waste and not use of all the positive thoughts of the company</td>
</tr>
<tr>
<td>Produce competitive high – quality products (standard)</td>
<td>Lack of qualification of technical specialized forces</td>
</tr>
<tr>
<td>Use of foreign training possibilities</td>
<td>Reduction in motivations and productivity</td>
</tr>
<tr>
<td>Improvement of the personnel welfare</td>
<td>Increase of unhappiness</td>
</tr>
<tr>
<td>Participation for people in the companies</td>
<td>Creation of informal groups, they are not adjustable to the goal the organization</td>
</tr>
<tr>
<td>Reduction of risk coefficient of executive works by participation of employees</td>
<td>Reduction of job security</td>
</tr>
<tr>
<td>Holding strong sale/purchase agency in/out of the country</td>
<td>Waste of useful work hours</td>
</tr>
<tr>
<td>More speed and higher – quality services due to use of the technical services to companies</td>
<td>Endangering physiological and psychological health of the personnel</td>
</tr>
<tr>
<td>Extension and improvement of after – sale services due to use of facilities of the technical services to companies</td>
<td>Lack of organizational progress</td>
</tr>
<tr>
<td></td>
<td>Deviation from main policy</td>
</tr>
<tr>
<td></td>
<td>Prolongation of goal achievement</td>
</tr>
<tr>
<td></td>
<td>Lack of optimal use of personnel capability</td>
</tr>
</tbody>
</table>

Furthermore, based on the result of the first six months of the project, this study argues for a shared vision, awakening for changing, learning, role of senior management (division heads), a new vision, and respect for each other as follows:

1) A shared vision: Role running ‘FW’ as a useful tool for creating ergonomics awareness and developing change, because of ‘a shared vision and a programme for change developed jointly by employees and management, which were vital for successful change management’ (Karltun 1997). Furthermore, the ‘FW’ technique was used as a point of entry into participation.

2) Awakening for changing: Planning for change was the most important issue indicating dissatisfaction with the present state and articulating a desired future. Involving people from all divisions of the organization occurred in the planning process rather than relying on a single entity or group.

3) Learning: the second workshop indicated that participants could learn from each other by using a holistic learning method. They managed to create ergonomics awareness at their workplaces and conducted many small projects by using the checklist, such as: the improvement of production line, materials handling (clearly marked transport routes), lighting, machine safety, and improvement of workstation design. There were small wins that also provided ways to learn new skills and learn more about their jobs as well as thinking systematically about other ways of creating good ideas and improvement of the workplace by teamwork and using the checklist. These small wins and learning by practices and observations created a good motivation for them. They were interested, and established the ergonomic intervention team, including the steering committee, action groups and the facilitator team.

4) Role of senior management (division heads): The use of transitions management teams and senior management helped to move forward and engage in activity planning. The role of the division heads for forming and contacting the action
groups and intervention team was important for, planning effective change in the organization.

5) A new vision: This was needed to build a suitable vision for the organizations. The SWOT analysis of the organization by participants helped them to gain a better understanding of the situation of the work system and determine which of the areas needed problem-solving activities and which of the areas need promotion activities.

6) Respect for each other: the attention to the ‘work and moral charter’ was a key point for support and a good guideline. Furthermore, workers were more in touch with each other, had more respect for each other and had suggestion for each upcoming problems or criticism. They found that co-workers are not problem but supporting resources, understood that not all problems belong to management, and are not all managerial problems.

Furthermore, in order to achieve the project goal and achieve a continuous learning process in the whole company, it is necessary to conduct the EIPTs (i.e. applying the Ergonomic Checklist and Ergonomic Checkpoints (ILO, 1996)) through workers’ participation at different workplaces.

Study J: Using ‘Ergonomic Checkpoints’ to support the participatory ergonomic intervention in an Industrially Developing Country (IDC) – a Case Study

Aim of the Study

The study aims were: To implement basic ergonomics through participatory ergonomic intervention process that can support a continuous learning process and lead to improving health and safety as well as the work systems in the organization.

The study purposes were: To develop action plans for improving health and safety as well as the work systems.

The underlying question for this study was: Can the ergonomic checkpoints support the ergonomics awareness building inside the organization for participatory ergonomic intervention?

Methodology

The research methodology was based on the action research-type intervention for a continuous learning process were the goal of the second phase of the study; Thus, the second loops of the action research-type intervention were made at the three subsidiary companies from one industry in the State of Gilan as shown in the following steps. For a further description of the methodology, see Section 5.5. The following specific methods were used in assessing (i.e. data generation and collection approach) awareness building as it relates to the issue of health and safety and the work system in the organization for the second process of the participatory ergonomic intervention:
a) Applying the Checklist,
b) Applying the Checkpoints, and
c) Evaluation of the project.

The second major assessment of the project was conducted after one year; each division (N=8) with members of AGs responded to the questions.

Furthermore, two top managers (two owners) and the division heads evaluated the project separately.

Finally, the author discussed the questions with most participants (N=22) in the last meeting and measures for improvement were taken by the action groups (AGs).

Results and discussion

AGs were involved in the first step of running the manual. Direct observation and documents indicated that the AGs were interested in factors such as industrial hygiene (i.e. lighting, air quality, thermal conditions, chemicals, and noise), improving workstations (i.e. sufficient work space, adjustability of work height and seat, tools and materials properly located) and organizing work (i.e. involving workers in planning their day-to-day work, solving work problems by involving workers in AGs, improving jobs that are difficult and disliked, learning about and sharing with each other ways to improve their workplace combining tasks to make the work more interesting and varied). The division heads were interested in the meetings problems as problem concerned ‘managerial and organizational’ issues. Furthermore, the participatory steps taken in improving Health and Safety (HS) and integrating ergonomics in HS are shown in this paper and Figure 17 in Sub-section 5.5.3.

The total time spend in hours by the AGs on conducting the ergonomics intervention was estimated to 13940 total man hours, including: a) the total time in hours spend on applying the checklist 2420 total man hours, b) applying the ergonomic checkpoints 5720 total man hours, and c) the method for forming the AGs during one year 5800 total man hours. The comparison of various AGs activities with the project were a) applying the ergonomic checklist individually 10.36%; b) applying the ergonomic checkpoints individually 24.48%; and c) the method for forming AGs during one year 65.16%.

During 12 months of action groups’ activities, 269 ergonomic improvement projects were identified. 191 of those were planned according to the designed timetable as well as 118 completed (see Table 1: Improvement undertaken by AGs in divisions and Table 2 about examples of no-cost/low-cost improvement frequently by AGs in Paper J of this study).

The four issues of the checkpoints (i.e. ‘work schedules’, ‘work tasks’, ‘a healthy work organization’, and ‘learning’) for assessing the work system were found suitable for the joint change of work schedules and improvement of the work system (see Table 19).
Furthermore, Table 19 summarizes the link between the selected measures for work system’s checkpoints and evidence the improvement of the work system described.

<table>
<thead>
<tr>
<th>Area*</th>
<th>Problem met in plant work</th>
<th>Developing main checkpoints</th>
<th>Improvement of main checkpoints</th>
<th>Toward Improvement of work systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work schedules*</td>
<td>Lack of or unsuitable planning, organizing and control</td>
<td>Planning; production, technical, standards, Quality Control (QC), After Sales Service, Financial and official, developing health &amp; safety, reorganization, developing Organizational Behaviour (OB) and developing Human Resources</td>
<td>Ergonomic worksite, Communication aids ergonomic checkpoints, Avoiding isolation</td>
<td>Standards, QC, After sales Service, Improving health and safety, Improving OB, design organization, Improving Human Resources and work system</td>
</tr>
<tr>
<td>Work tasks*</td>
<td>Excessive, unsafe work load, Poor communication, Improved working environment, Isolated work</td>
<td>Development of competence and the health of employees Changes at all levels in organization</td>
<td>Safer practice, Joint help, Efficient work, Organizational Intervention</td>
<td>Safer practice, Joint help, Efficient work, Organizational Intervention</td>
</tr>
<tr>
<td>A healthy work organization*</td>
<td>Lack of leadership and management practices, Poor change management practice, Stress</td>
<td>High job demands and low control at work</td>
<td>Managerial practice, Participation of people and the utilization of their ideas, Job stress</td>
<td>Managerial practice, Participation of people and the utilization of their ideas, Job stress</td>
</tr>
<tr>
<td>Learning*</td>
<td>Lack of a balancing of work and private life</td>
<td>A balancing of work working hours and work arrangement</td>
<td>The flexibility of working hours and work arrangement</td>
<td>The flexibility of working hours and work arrangement</td>
</tr>
<tr>
<td>Learning*</td>
<td>Lack of an innovative climate promote the idea of lifelong learning</td>
<td>A continuous improvement</td>
<td>Development of ideas &amp; personnel competence</td>
<td>Development of ideas &amp; personnel competence</td>
</tr>
<tr>
<td>Learning*</td>
<td>Poor learning, Poor career building and unsystematic managers meetings</td>
<td>Applied ‘Future Workshop’, ‘ergonomics checklist’ and ‘Ergonomic Checkpoints’</td>
<td>‘A shared vision’, ‘awakening for change’, learning, and ‘common participatory steps for developing and using the ergonomic checkpoints’ participation of employees at the work (plan &amp; planning) by the intervention team activities</td>
<td>‘A shared vision’, ‘awakening for change’, learning, and ‘common participatory steps for developing and using the ergonomic checkpoints’ participation of employees at the work (plan &amp; planning) by the intervention team activities</td>
</tr>
</tbody>
</table>

The work system in the three companies was characterized by a lack of or unsuitable planning, organizing and control at their organizational levels, in the development of the checklist issues of improvement of work system such as:
‘Work schedules’ (i.e. planning, organizing, and control), ‘work tasks’ (i.e. improving of work environment and work system), ‘a healthy work organization’ (i.e. leadership and management practice and continuous improvement), ‘Learning’ (i.e. technical and social skills) were considered. These have been found to be criteria of particular importance for evaluation.

The AGs were very much/much satisfied with the programme and implementation of the actions agreed upon during their activities at the divisions.

Most division heads (i.e. seven people from eight divisions) accepted the process of the development and improvement of the work system and activities at their divisions.

Inferences from the questions (the seven questions) from the AGs indicated the success of the project and a better implementation of ‘managerial and organizational’ issues in the three companies. There were however, some resistances to the course of changing (i.e. ‘limited attitudes of the people’, ‘positive and negative view of personnel and owners’, ‘weaknesses of company’) which had to be attended to by the AGs.

The ergonomics awareness building were included, ergonomics training, ergonomics application, and evaluation in the process of the participatory ergonomic intervention and internal network building from the top manager, interim/senior managers (heads of divisions), and the experts from the three companies. Furthermore, the actions groups managed to create ergonomics awareness at their divisions and conduct many projects.

The opinion of some heads of divisions was that they believed the method was new and the first six months was very difficult for them. They had not had any prior experience of working with people in a group or a team and could now solve the problem of the company by teamwork so that everyone accepted it.

There was a signification difference between top managers (the three owners). This could be due to the increased knowledge of ‘managerial and organizational’ issues for the top manager who was engaged and participated from the beginning in the project. He said the start of the project was difficult but there is no end and no limitation for learning and improving the work system in the company now. Furthermore, the head of the steering committee, one of top manager, said:

‘Before that, I was a manager of crisis for the divisions in the three companies. Now that I can see, the good suggestions of the action groups for improving the workplaces. I am more motivated. Now, I am in a better situation in my role as a facilitator at the work system.’

Generally, the result of this project indicated that the intervention in the three companies was creating some ‘fears’ among the participants and top manager; i.e. most participants said that there were many fears in their views for the future, such as, the fear of change, of making mistakes, of loss, of the unknown, of failure, of low support from top management, etc. On the other hand, the top manager’s evaluation of the project indicated that he has had fear about the change and personnel making mistakes.
However, this study found that the main key issues for making participatory ergonomic intervention successful were method continuous learning, and integrating.

The studies I and J are concerned with Research Question c and d in this thesis. This will be discussed in Sections 7.6 and 7.7.
PART III

7. RESULTS OF ‘Tips’ OF THE EIP, ANALYSIS, CONCLUSIONS AND FURTHER RESEARCH

This section describes the ‘Tips’ for the EIP journey from 1993 to 2008 in the IDC; general discussion or conversation based on reflection of ‘Tips’, as well as discussion based on the research questions and relation to theory, final conclusions or recommendations, scientific contributions, and finally, further research from the result of a ‘Meta-reflection’.

7.1. A short summary of the aims and objectives of the research

The purpose of this thesis was formulated as follows:

‘To investigate how the EIP and EIPTs can be implemented in an organization by using an EIT process (i.e. EIP activities, EIP team, and EIP process). The objective was to develop an action-oriented intervention process for the improvement of health and safety, as well as trying to improve work systems in IDC industries.’

To answer this purpose the following two main questions (I and II) and four different sub-questions were formulated in Part I, Section 2:

I. Why are the efforts of these industries to implement and internalise the EIP being constrained?
   a. What are the main causes of these constraints?
   b. Is it that the EIP is difficult to implement?

II. How should the EIPTs be delivered to Iranian Industries and possibly to other organizations in IDCs so that they can easily learn how to use them successfully?
   c. How can EIPTs be successfully implemented and internalised by such organizations?
   d. What practical activities are required for the EIPTs’ implementation?

7.2. Results of ‘Tips’ from an ‘action pathway’, the challenges the EIP faces in taking actions in the IDC industries

Redwood et al. (1999) argue that the key to successful action is to follow the right path (see also Ghaye, 2007). The following actions have been carried out. Finding and distinguishing between these involved different kinds of reflections. They have mentioned and discussed in the sub-section 7.2.1.

1993: The author participated in the first workshop for industrial managers from Iran, at Luleå University of Technology, Sweden: In 1993 a 2-week training course, entitled ‘Contemporary Management’ was organized at the Luleå University for a group of Iranian industrial managers. One of the subjects discussed in the course for one day was ergonomics and its application in the IDCs. The author a participant of
the course, anticipated the benefit of ergonomics application in his industry and invited a scholar, from the Center for Ergonomics Developing Countries (CEDC) (Professor Houshang Shahnavaz) to help in applying ergonomics training workshops at the Glucosan factories (GC).

1995 to 1997: Applying ergonomics at Glucosan factories (a medium size industry): This was a pioneer ergonomics intervention attempt in an Iranian industry. The result of this unique exercise, regarded by the factory as success, was analyzed and presented at ODAM – V (Paper B) and a complete up-dated report presented at ODAM – VI (Paper C).

1996: A formal postgraduate education: In 1996, having observed the significant benefit of ergonomics, the author who was the Glucosan manager from 1990 to 1998, became interested in the subject and started a formal postgraduate education in the field of Industrial Ergonomics at Luleå University of Technology (LTU) in February 1996. Professor Houshang Shahnavaz became his supervisor at LTU.

1996: The National Conference of Industrial Engineering, December, 1996 (29th - 30th ): Based on the result of the improvement and activities related to applying ergonomics in the Glucosan medium sized industry, three papers were prepared and presented at the National Conference of Industrial Engineering on 29th - 30th December 1996, at the Azad University in Ghazvin, Iran. At the same time, an exhibition of GC’s activities was organized by the ‘Ergonomic Working Committees’ (EWCs) at the university. During the two-day conference, 14 conference participants participated in a ‘Future Workshop (FW)’ conducted by the author at the conference site under the theme ‘How can we make connections between industries and universities effective’.

All together, 95 conference participants visited Glucosan factories, talked to managers and supervisors about ergonomics application, and observed ergonomics intervention activities. The conference had about 600 participants and one of the papers presented was on ‘ergonomics and the role of industrial engineering’ by the author. Two year later, in 1998, another Industrial Engineering Conference was held at Sharife University in Tehran, in which a separate session was held for ergonomics. Six of the papers presented at this session were from participants who had taken part in the Ghazvin Conference in 1996.

1997: Established an Institute: In July 1997; ‘Danesh Maal Institute (DMI)’, was established by Iranian shareholders as an ergonomics-supporting centre. The aim of DMI was to act as a supporting organization for the Iranian industries that were interested in ergonomics training and application (Papers C and D). This Institute was active in the field of ergonomics till the end of 2001. Furthermore, the Chairman and Vice Chairman of the DMI became the Chairman and Vice Chairman of the Iranian Ergonomics Society (IES) in 2001. The author was Vice Chairman of both.

1995 to 2002: Organizing and participating in Ergonomics Training Workshops (ETWs) from July 1995 to November 2002: During these years 24 training workshops for 293 participants from various industries in different places were
organized by the author with co-operation from the Manager Director of the Danish Maal Institute (DMI). The results are training time of 681 hours, which makes 16838 total man-hours training for Iranian industries by Professor Houshang Shahnavaz (see Helali 2003; Paper A).

1996 to 2002: Introducing ergonomics at universities in Iran and developing Ph.D. studies in ergonomics: In general ergonomics training workshops and ergonomics training courses were implemented by Professor Shahnavaz and his Ph.D. Student under the auspices of the CEDC from December 1996 to November 2002. A total of eight training workshops and training courses were conducted for 94 participants from various universities in different places. The results were training time of 453 hours and a total of 3375 man-hours. Furthermore, in 2000 and 2001, two Ph.D. students from the Occupational Health Departments of Tarbiat Modarres University (TMU) and Tehran University become interested in Ph.D. studies in ergonomics. Two research projects were designed. In the first study, an ergonomics intervention project was designed in co-operation between TMU in Tehran and Professor Shahnavaz. A Ph.D. student from TMU was engaged for 2 years in the project, which was conducted at a hospital furniture factory (Sco). The results of this intervention project were presented in a doctoral thesis at TMU in March 2003. The second study was designed as a co-operation project between Tehran University in Tehran and Professor Shahnavaz. The result of this project (Ergonomic Workstation Design for the Iranian Hand-woven Carpet Industry) was presented in a doctoral thesis at Tehran University in year 2004. Furthermore, two of the M.Sc. students from Luleå University of Technology conducted their thesis research work at two Iranian Industries (Hojjati Emami, K., 1999; Rahmany, K. 2003). Furthermore, during 2000 the author presented two ‘Future Workshop’ one in September, (three days for 15 University lectures) and the other in November, (three days for 13 University lectures from the University of Social Welfare & Rehabilitation of Science in Teheran and Mashhad). Furthermore, the author presented two macro-ergonomics course lectures in Tarbiate Modares University for nine M.Sc. Students of Occupational Health and Safety in 1999 and 2000.

In this process, other opportunities in networking in the ergonomics field in Iran have resulted in:

2000: Organizing and conducting a workshop for 22 university teachers from 20 universities, (April 23rd to May 4th 2000) by Professor Houshang Shahnavaz and his two Ph.D. Students. Two historical decisions were made:
1) One day in the Iranian national calendar was named as ‘Ergonomic Day’ by Iranian Ergonomics Society (IES), and
2) Six workshop participants were elected to form a committee for preparing the establishment of the IES. This committee of six was later expanded to 25 full members. The author was one of the organizers of the workshop. He participated in this workshop, which resulted in the historical decisions of trying to establishing the IES as well as to fellow-up the decided issue. A videotape exists from this process.

2001: Forming Ergonomics intervention at an Iranian car manufacturing company (IKCo) (May 2001 to Oct 2002): DMI had arranged a half-day lecture for R&D
personnel at Iran Khodro Car Company in 1998. This was appreciated by R&D personnel. After that, the DMI was in the process of introducing an ergonomics diploma for Iranian Industries in 2000 (this course did not take place). One of IKCo managers became interested in continuing ergonomics training that they had received from one of the M.Sc. student from Luleå University of Technology (Mr. K. Hojjati Emami) for one week in 1998. The author had a meeting with one of the IKCo’s manager in 2000. He stated that they did not only need ergonomics training in the workplaces. They needed to solve their problem by applying ergonomics. The author suggested a meeting with managers and engineering staff from several divisions, i.e. 15 people for a half-day. In the meeting, he applied a method that it was called the ‘aquarium model’. In this process, they presented about 40 good suggestions for improvements of the divisions by a participatory process. After that the author told him that the EIP has many techniques and introduced him to Professor Houshang Shahnavaz. Finally after one year of negotiation, a project was formed. The author participated in this project under the auspices and management of the CEDC (Professor Houshang Shahnavaz). The objectives of the project were to develop ergonomics awareness and knowledge, train a selected group of 32 IKCo employees (engineers, occupational health specialists and safety engineers from IKCo) in ergonomics theories and practice, and assist them in implementing the newly acquired knowledge for improving the company’s workstations and creating better working conditions. (See, Alipour, et al., 2002; Papers E and F.)

2000 and 2001: Another challenging activity was the establishment of the Iranian Ergonomics Society (IES) in connection with the Ergonomics Intervention Programme (EIP) and team working activity in 2001: Society celebrated the ‘Ergonomics Day’ in 2000. A seminar was held in the University of Social Welfare & Rehabilitation Science. Over 60 guests participated in a one-day seminar. The author was one of the organizers. He was also one of the key speakers in the seminar (the seminar had two key speakers; the other key speaker was a University lecture of Tehran University). At the end of the seminar, it was arranged that every participant should introduce him/herself and tell about their interest in ergonomics (there is a videotape). The main results were to inform interested people about forming the IES.

The IES was established on 10th May 2001 based on a teamwork activity. After one year, most of the short-term goals of the IES had been achieved. The society started its own library with 100 donated books. ‘Ergonomics Day’ was celebrated on 7th September 2001 at Iran Khodro Company (IKCo) for the second time. Over 400 guests participated in a one-day seminar. The first issue of IES newsletter ‘Payame Ergonomi’ was published in 24 pages and distributed at the IES seminar. This was managed as a team working and networking building process under the auspices of the CEDC.

Finally, since 29th September 2001, the author has been at Luleå University of Technology to peruse his Ph.D. education and when needed he went to Iran for his data collection. This was his first pathway of research journey about the Ergonomics Intervention Programme (EIP).
1999 to 2002: Assessment of implementing Ergonomic Training Workshops (ETWs) at three levels during the last four years: Ergonomic Training Workshops (ETWs) have been implemented since 1995 under the guidance of professor Shahnavaz in Iran. The workshops were aimed at creating an ergonomics learning and implementation process at three levels, viz, ‘Individual, group and organizational’ among participants of Iranian industries. It was inferred that workshops, which were conducted at an industrial site, were most productive and effective for improving conditions at workplaces (Papers D and G).

2003: ‘Ergonomics Intervention Programme Technique (EIPT) in IDC – Case Studies in Iranian Industries’: The author was registered as an Industrial Ergonomics Ph.D. Student at the Department of Human Work Sciences, Luleå University of Technology, Sweden, in 1996. The theme of his licentiate thesis, defended in May 2003 was ‘Ergonomics Intervention Programme Technique (EIPT) in IDC – Case Studies Iranian Industries’. His study plan for a Ph.D. degree in Industrial Ergonomics (research project) was ‘Development of the EIPT’ and a general model of an ‘ergonomics know-how transfer to IDC’ – case in Iran has been in progress since May 2003.

Unfortunately, in March 2003, the Division of Industrial Ergonomics (and the Masters Programme) was closed down after Professor Houshang Shahnavaz retired.

2003; Establishment of Mehr E Nami Institute in November 2003: The main reasons for doing this were 1) to continue my study plans officially in the new form at Luleå University of Technology (LTU) and forming a sponsor from Iran to support my research activities.

2004 and 2006: The EIPTs in practice: One of the Iranian industries, which became interested in using ergonomics in 2004, was a private poultry company, comprised of three companies, located at State Gilan in different areas with more than 300 employees in one ‘organization’. They became interested in improving organizational working and organization design. The author has participated in this project (Papers I & J) which was a co-operative project between the Poultry Company and MENI.


Sub-section 4.4.3 mentioned that the qualities of leaders are as ‘brokers’, ‘connectors’, and ‘sales-persons’ (Gladwell, 2000 and Ghaye, 2005). The results of ‘Tips’ have indicated the different roles and tasks for the EIP in Iran. Thus, in this study, the point was that the workplace transformation requires brokers (who provide the right messages for the EIP), connectors (who provide the social glue) and salespeople (who get workers to actively ‘buy-in’ to the process).

Therefore, there were different roles for the author in the process of ergonomics ‘know-how’ transfer to the IDC- Case Iran. At first, he participated in the course
‘Contemporary Management’ at LTU in 1993 and received and understood a message (i.e., ‘applied ergonomics for IDCs’). He took GC to activity (i.e. buying in to the process of applied ergonomics). Then, he became interested in the field of ergonomics completely. After that, he was interested and did the introduction and running of the ETWs for others in the IDC industries. He established first the DMI with a few interested people for the social glue and then brought in other co-workers from Iranian industries’ managers as well as universities lectures in applied ergonomics to the IDC. In this process a teamwork and networking was formed. After his licentiate degree in 2003, the task was the EIPTs in the practice and its development, in Iranian industries. However, access to an organization was very difficult due to the lack of ergonomics awareness. It was necessary to establish, the MENI, i.e. another NGO (non-governmental organization) activity again because the Iranian Ergonomics Society (IES) was the first process of team working. Tuckman, 1965, has mentioned that any team appears to go through four stages; i.e., forming, storming, norming, and performing. Therefore, the MENI became the social glue for the action research-type intervention and an official supporter of the activities since 2004. Of course, in this step, the intention and my task were as a research student.

7.2.1. General discussion or Conversation

In the author’s opinion, we can only learn if we keep learning. Practice may not necessarily make perfect, but it does form the basis for future informed practice. But the central question is ‘how can we use the reflections learnt from the EIP to enable us to sustain useful ergonomics awareness building in organizations in an IDC?’ The first step is to find something significant to reflect on (Ghaye, 2006). I feel the concept of macro-ergonomics (i.e. human-centered and participatory) helped us develop a democratic way and ensure productivity in the IDC industries (see, Studies B, C, D, I and J). We have also to ask, ‘Why are reflective practices important?’ Ghaye (2007) has mentioned at least three answers to this question, i.e. 1) Personal importance (reflection helps develop our self-awareness, self-knowledge and self-belief), 2) professional importance (reflection can help us develop our competence. In other words, it is important because it helps us continuously improve what we do and for whom), and 3) political importance (reflection helps us understand who gets on with whom, who has power and influence, who gets things done, who needs persuading if you want something, and so on).

Furthermore, Ghaye and Lillyman (2000) have described ‘joining up practice with theory’. They noted that there are three elements in Schön’s idea of practical knowledge; i.e. ‘knowing-in-action’, ‘reflection-in-action’ and ‘reflection-on-practice, in addition, they have added ‘meta-reflection’ or thinking again about all our previous reflections. Table 20 shows four of the different kinds of reflection in this study.
Table 20: The kinds of reflection adapted from source; Ghaye, T., 2007

<table>
<thead>
<tr>
<th>Reflection</th>
<th>Meanings</th>
<th>In this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Reflection-in-action</td>
<td>1. In a particular workplace</td>
<td>-The context was the EIP,</td>
</tr>
<tr>
<td></td>
<td>2. Thinking on your feet, improvisation</td>
<td>-The workplace was in the IDC – Case Iran,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-The EIP was by the ETWs.</td>
</tr>
<tr>
<td>b) Reflection-on-practice</td>
<td>1. Before or after the event</td>
<td>-The EIP was by the ETWs events at three levels, after that a sequence was the EIPT that it was significant for the ergonomics awareness building, research, and networking.</td>
</tr>
<tr>
<td></td>
<td>2. On something significant</td>
<td></td>
</tr>
<tr>
<td>c) Reflection-for-action</td>
<td>1. For a reason or particular purpose</td>
<td>-for a better understanding from the running the EIPTs tools</td>
</tr>
<tr>
<td></td>
<td>2. Planning what you are going to do</td>
<td>-For the planning, the EIPTs was in practice.</td>
</tr>
<tr>
<td>d) Reflection-with-action</td>
<td>1. Conscious future action</td>
<td>After finding an EIPT process, and observing and learning different EIP ways as well as understanding the pathway of the EIP journey. I am conscious of action to develop my understanding and skills with others.</td>
</tr>
<tr>
<td></td>
<td>2. Action alone or with others</td>
<td></td>
</tr>
</tbody>
</table>

In general, the results of the reflections regarding the ergonomics ‘know-how’ transfer to, and ergonomics awareness building in the industries of the IDC since 1995 were as follows:

1) There was ‘knowing-in-action’ linked to theories-of-action, because, the EIP leaned toward knowledge-based ergonomics, and learning-orientation as well as towards the implementation or facilitation of ‘team-working’ and ‘networking’ for interested participants by means of the ETWs from 1995 to 2002 in the IDC. In this process, the root cause of ‘Problem’ was found. That was the scientific-based answer that was sought to Research Question a in Sub-sections 7.3;

2) There was ‘reflection-in-action’ from the pre-intervention phase of the EIP in the IDC. A consequence of running the ETWs was that EIPTs were found providing an answer to Research Question b in Sub-sections 7.4;

3) There was ‘reflection-on-practice’. This could be reflection learning, to improve and promote existing ways to function, from 2004 to 2006 by means of the EIPTs in practice. Scientific-based answers are sought to Research Questions c and d in Sections 7.5 and 7.6; in the third steps the reflection-learning could be the EIPT process model that calls for a participatory way of implementing the EIP at the organizational level; or ‘How can we make an EIPT process together in order to make a positive difference here?’;
4) ‘Meta-reflection’; i.e. ‘This is thinking again about our reflection-on-practice. It is stepping back and checking out what we thought and said earlier. It is further removed from the action than reflection-on-practice’ (Ghaye and Lillyman, 2000, p. 48). They have mentioned skilled facilitators, or critical friends, are usually a very important part of encouraging the meta-reflection. Furthermore, reflection involves respecting and working with evidence (Ghaye and Lillyman, 2000).

For future research, ongoing questions are, ‘What is it we want more of here and how can we amplify this?’ Also, ‘How will the future unfold from an appreciation of the positive present?’ Thatchenkey (2005), has used the term ‘future-present’ to describe the mindset in which a person is able to see the future in the present, as if bringing the concrete experience anticipated in the future to the domain of the present. Maybe these questions can help us early on to predict major changes in the future with an ‘Appreciative Inquiry’ and in an ‘Appreciative Intelligence’ way. According to Whitney and Trosten-Bloom (2003) ‘Appreciative Inquiry works because it treats people like people, and not like machines. People are social. We create our identities and our knowledge in relation to one another. We are curious. We like to tell stories and listen to stories. We pass on our values, beliefs and wisdom in stories. We like to learn and to use what we learn to be our best. And we delight in doing well in the eyes of those we care about and respect. Appreciative Inquiry enables leaders to create natural human organizations - knowledge rich, strength based adaptable, learning organizations.’ (See http://www.positivechange.org/appreciative-inquiry.html and also p. 233-252) Appreciative inquiry is a methodology and an approach.

Appreciative intelligence is ability (Thatchenkey and Metzker, 2006). Appreciative inquiry and appreciative intelligence are looking at something that is looking toward a better future, not necessarily, what is wrong so that we have an intervention

17 According to Whitney and Trosten-Bloom (2003), ‘Appreciative Inquiry is the study and exploration of what gives life to human systems when they are at their best. It is an organization development methodology, based on the assumption that inquiry into and dialogue about strengths, successes, values, hopes and dreams is it transformational.’ The Appreciative Inquiry has a 4-D cycle; i.e. Discovery; (‘Appreciative interviews and more’), Dream; (‘Vision and voices of the future’), Design; (‘giving from to values and ideals’) and Destiny; (‘Inspired action and improvisation’) unleashes the energy of the positive core for transformation and sustainable success (see also Whitney and Trosten-Bloom, 2003).

18 According to, Thatchenkerry and Metzker (2006) ‘Appreciative Intelligence is the ability to perceive the positive inherent generative potential within the present. Put in a simple way, Appreciative Intelligence is the ability to see the mighty oak in the acorn. Metaphorically, it is the ability to see more than the present existence of a small capped nut. It is the capacity to see a strong trunk and countless leaves as emerging from the nut as time unfolds. It is the ability to see a breakthrough product, top talent, or valuable solution of the future that is currently hidden in the present situation. There are three components of Appreciative Intelligence:
• Reframing
• Appreciating the positive
• Seeing how the future unfolds from the present
Like a three-legged stool that cannot stand if a leg is missing, Appreciative Intelligence is not present without all its components. Each part is essential to the construct.’
(Thatchenkey and Metzker, 2006). According to Thatchenkey and Metzker (2006), people with high ‘Appreciative Intelligence’ are able to visualize and create the sequential small steps that build on one another. Thus creating the momentum for change in individuals and their environments that lead to a positive outcome. i.e., in this study; in each of the phases of the EIP by the ETWs, EIPT, or the EIPT process, those with appreciative intelligence reframed the present – the current state – such that a positive future state could be reached through resources, tools, and concepts that already existed. In the EIPT process, we are looking at the following questions; how do we get participants working together? How do we grow leaders and senior managers and employees in all levels of an organization? What do we do to change what we have now to a better way to see something a little bit different? However, nobody is without ‘Appreciative intelligence’. Look at all the successful things (see Studies B, C, I, J) we do – and everyone around us does – to make it to the end of any process successfully. We solve a huge number of problems. We are always doing little creative things.

Imada (2003) suggests that macro-ergonomists must anticipate rather than react to oncoming technology changes. According to Imada (2003), the lessons that we were taught by industrial-age ergonomists will have less value for us in the future. Identifying trends early can predict major changes in the future (Gladwell, 2000; Gleick, 1987; Stacey, 1992).

As was mentioned in Sub-section 4.4.3 Schön contends that effective leaders reflect on their practice in terms of their personal experience, previous successes, hopes, preferences, strengths and weaknesses, and desired outcomes. Reflection and action, according to Schön (1995), involves on the spot surfacing, criticising, restructuring, and testing of intuitive understandings of experienced phenomena; often this takes the form of a reflective conversation about the situation.

Furthermore, Ghaye (2007) describes the spectrum of conversation within a reflective organization. This can help us to understand how to get the EIP conversation to tip.

In the author’s opinion, getting the EIP conversations to the ‘Tips’ has indicated and opened the different kinds of conversations for this study and a further research: Firstly, focusing on the root cause of a ‘problem’ and risk managing it, is essentially a conversation about what we may want less of. Secondly, if we use our appreciative intelligence we open up the possibility of trying to understand the root cause of success. These conversations are about what we may want more of here. According to, Ghaye (2007), ‘A tip to the right means that an amplification of a particular success is appropriate.’

Exploring these questions is likely to generate different kinds of conversation because we know that deficit-based questions lead to deficit-based conversations, which in turn lead to deficit-based patterns of action (Anderson et al., 2006; Cooperrider and Whitney 2005; and Ghaye, 2007). This was how the author was able to open and shift the balance of the EIP conversations in different ways. Ghaye (2007) describes this process as ‘journeying’.
According to Meshkati and Robertment (1986), culture and traditional variables are major determinants of the applicability and effectiveness of technological endeavors in the IDC. Kogi (1985) reported that certain aspects of local traditional culture or habits represent obstacles to the promotion of technological advances. Furthermore, managerial and organizational theories and methods are also subject to culture; ‘Management is a social function and is embedded in a culture – a society, a tradition of values, customs and beliefs and in government and political systems’ (Drucker, 2007). In my opinion, the social function was ignored in the ergonomics ‘know-how’ transfer in the IDC.

So what helps us to deepen our understanding of this? ‘Critical-thinking’ seeks to understand the underlying causes of the problematic situation and to determine high leverage solutions. This strategy assumes a system model of change, where we recognize that the apparent problem may just be a symptom of some deeper issue, and we seek to understand what is really happening. ‘Professionals Practicing Systems Thinking’ (Midgley, 2000), i.e. taking holistic approaches, breaking traditional boundaries and enhancing interdisciplinary sciences, use this strategy. But, ‘Transformational-thinking’ is important when big issues are addressed creatively, with open minds and hearts. Win/win breakthroughs are the natural result as well as a spirit of community. Here critical and intuitive-thinking will be combined with the empowerment of the group and the spirit of self-organization to contribute to the development of a community in practice. This is ‘Radical Thinking’ (see Valqui Vidal, 2005).

I feel these systems of thinking (i.e., ‘Critical-thinking’, ‘Professionals Practicing Systems Thinking’, ‘Transformational-thinking’, and ‘Radical Thinking’) may and may not lead to problem solutions. Ghaye (2007) has mentioned two levels of conversation within a reflective organization i.e. 1) Recognising when an amplification of the problem is necessary (including root cause of the ‘problem’, risk management, and critical reflective learning), and 2) Recognising when an amplification of the success is necessary (including appreciative reflective learning, appreciative inquiry, and root cause of success). Advocates of appreciate enquiry (Cooperrider and Whitney 1999; Cooperrider et al. 2003; 2005; Srivastva et al. 1990; Whitney and Trosten-Bloom 2002; Whitney et al. 2002; 2005) talk a lot about the power of the positive question. i.e. ‘positive questions guides agendas and focuses organizational attention in the direction of the aspects of organizational existence – latent or explicit, historic or contemporary – that are most life-giving and life-sustaining for employees’ (Ghaye, 2007).

Sections 7.3 to 7.6 are discussions on the research questions and their results relating to the theory as follows.

7.3. Research Question a

What are the main causes of these constrains?

Studies A, B, C, D, E and F, presented in Sections 6.1 and 6.2 show that three kinds of organization levels (i.e., individual, group, and organizational) worked with Ergonomics Training Workshops (ETWs) to develop an EIP. In Studies D and G,
three strategies were identified and evaluated that describe how the participants and companies tried to work with an EIP. ‘Three kinds of working situations’ for the EIP and their constraints, have also been identified as follows:

At Glucosan factories (GC), (Studies B and C): In 1980 (after the Islamic Revolution) the company was nationalized and foreign advisor left the country without having started the work proposed in a signed agreement to increase the factory’s daily grinding capacity from 50 to 150 tons. After that, the GC was under the control of the ‘Council of Industries Protection’ (CIP). Thus, the philosophy of GC because survival. This was the main reason for a learning strategy at GC because the main issue for management was to respond to crises. The first challenge, to increase the daily grinding capacity was completed in 1986 by using reversed engineering. The second challenge to improve quality and utilize total capacity, was achieved in 1990 through job rotation, the consultation management method and the formation of several work committees. These experiences and the learning strategy helped to achieve an acceptance of a step by step application of the EIP at GC from 1993 to 1997. The result of the EIP was successful and was a unique experience. However, at the beginning of 1998, the management of GC and the CIP were changed. The EIP was stopped at GC and most managers left GC during 1998.

At GC, an ergonomics process was initiated and supported by the top manager. Through a systematic process of macro and micro-ergonomics between 1993 and 1997, significant results were achieved. In the case of GC, the success of the intervention programme was mostly due to the establishment of an R&D group with the full support of the top management. In the process of the EIP, the commitment of employees and management to learning was important factors. According to, Studies B and C for the ‘development work activity’, managers and employees learned and worked according to a new common goal and effort in the ergonomics field.

The working situation of participants trained individually from different industries at the ETWs (Study D): The participants who took part in the ergonomic training workshop could not implement their learned knowledge to a greater extent at the local workplaces. This was mostly due to the fact that individual learning was achieved but the dynamic process of organizational learning was missing (Study G). This hindered the individual in his or her attempt to implement their newly achieved competence in their work environment which was not receptive to changes. The results of the workshop evaluations at three levels has shown that the majority of participants (over 60%) assessed the workshop as good and very good. After six months about 51% of the participants completed a questionnaire. They all considered the workshop as very useful and wanted their bosses to participate in such training programmes. They also wanted more ergonomic support in order to implement the acquired knowledge. The establishment of a national ergonomic organization or centre that could provide regular up-to-date information and support was also recommended (Study D).

The key findings of the questionnaire survey revealed the following (Study G):
Almost 95.7% of the participants assessed the workshops as very useful to their organizations.

53.2% of the participants indicated that they had neither used all the acquired information nor applied it in their organization at all.

92.6% of the participants indicated that they were in better positions to suggest improvements in working conditions after the workshops.

Regarding implemented changes, 84% of participants evaluated them as positive in the group level, whilst 95.7% of participants evaluated them as positive at the organization level.

At IKCo (Studies E and F): Most participants were experts at their various worksites. The success of the EIP was mostly due to a better role of local experts at the group level in an organization having a better role as a result of participation in various training workshops. Action groups (AGs) had an informal situation in the worksite at IKCo. Thus a contingency situation, in terms of cooperation between workstations managers and action groups was observed and reported. Hence, there was more improvement in staff relationship by the formation of the action groups (Helali, 2003). The project organization of an EIP consisted of three main groups; the SC, the AGs and the facilitators (the EIP team). Some of the group had both a plan and planning for carrying out the task and some just one of these two (Study F).

Furthermore, delegates from different organizations participated in different numbers and different kinds of workshops. For example at GC employees participated in one to four workshops, at IKCo in 1 to 10 workshops (seven training workshops and three evaluation workshops) and other participants in one to two workshops (Helali, 2003).

Generally, the constraints of the working situation were as follows:
Limited time, lack of vision and lack of learning strategy; the management and employees did not supported their activities; knowledge support was not enough for the EIP at the individual and group level by means of the ETWs; change of manager and lack of continuous learning; lack of employees’ commitment to the organization, and lack of a democratic climate were other constrains.

7.3.1. Results in relation to theory

The study presented in Section 6.2 shows three levels of interventions in general and how the EIP worked in practice by means of the ETWs. Sections 3 and 4 show a better understanding of the EIP with a macroergonomics approach.

Furthermore, Noer (1993) sees intervention at four different levels when dealing with redundancy in an organizational context. Most managers only progress to level one (Cameron and Green, 2004), whereas Noer suggests that managers need to work with their people at all four levels (see Figure 19).
Cameron and Green (2004) describe the key lessons of dealing with redundancy according to Noer’s model as follows:

- To address change on both the task and people level,
- To pay attention, not only to what individuals and groups are going through now, but also the tasks necessary to move the organization along; to use these tasks to engage people as they come out of the more negative aspects of the change curve,
- To take the opportunity of the turbulence of the situation to embed into the organization those structures, systems and processes that will be necessary to sustain change in the longer term.

Furthermore, Bridges’ ideas (1991) on transition lead to a deeper understanding of what is going on when an organizational change takes place. While focusing on the importance of understanding what is going on emotionally at each stage in the change process (see Figure 20). Bridges (1991) says that what often stops people from making new beginnings in a change process is that they have not yet let go of the past.

‘Ending’: ‘Before you can begin something new, you have to end what used to be. You need to identify who is losing what, expect a reaction and acknowledge the losses openly. Repeat information about what is changing – it will take time to sink in. Mark the endings.’
‘Neutral zone’: ‘In the neutral zone, people feel disoriented. Motivation falls and anxiety rises. Consensus may break down as attitudes become polarized. It can also be quite a creative time. The manager’s job is to ensure that people recognize the neutral zone and treat it as part of the process. Temporary structures may be needed – possibly task forces and smaller teams. The manager needs to find a way of taking the pulse of the organization on a regular basis.’

‘New beginning’: ‘Beginnings should be nurtured carefully. They cannot be planned and predicted, but they can be encouraged, supported and reinforced’. Bridges suggests that people need four keys elements to help them make a new beginning:
- The purpose behind the change,
- A picture of how this organization will look and feel,
- A step by step plan to get there,
- A part to play in the outcome.

According to Cameron and Green (2004), the beginning is reached when people feel they can make the emotional commitment to doing something in a new way. Bridges makes the point that the neutral zone is longer and the endings are more protracted for those further down the management hierarchy. This can lead to impatience from managers who have emotionally stepped into a new beginning, while their people seem to lag behind, seemingly stuck in an ending (Cameron and Green, 2004).

In the author’s opinion, this model is important because in the processes of EIP in IDC at the three levels viz, individual, group, and organizational, all trying was at level one of the intervention model, Figure 19; i.e. ‘getting the implementations process right’. But, in the Neutral zone, ‘the manager’s job is to ensure that people recognize the neutral zone and treat it as part of the process. Temporary structures may be needed – possibly task forces and smaller teams. The manager needs to find a way of taking the pulse of the organization on a regular basis (Cameron and Green, 2004)’. Furthermore, according to Cameron and Green (2004), ‘Bridge’s model of endings, neutral zone and beginnings is good for tackling inevitable changes such as redundancy, merger or acquisition. It is less good for understanding change grown from within, where ending and beginning are less distinct’.

In the EIP process at GC, it was accepted after the ‘Future Workshop’ that ‘today is the first day of the future’ (Study D) because they were ready to act with the task ahead. In the participatory ergonomics process, the R&D team and a new
organizational structure (to change people level) were established. This became a new beginning phase. After the positive results, the EIP was stopped at GC due to a change of management, and there was an omission of personal values during two year after 1998. The main constraints could be the decreased motivation due to lack of trust in the organization and the fact that the organization metaphor was changed.

Morgan’s (1986) work on organizational metaphors is a good starting point for understanding the different beliefs and assumptions about change that could exit, about how organizational change works (Cameron and Green, 2004). Four of the Morgan’s organizational metaphors are described by Cameron and Green (2004) as follows:

Organization as machines; i.e. ‘senior managers define targets and timescale. Consultants advise on techniques. Change programme is rolled out from the top down. Training is given to bridge behaviour gap.’

Organization as political system; i.e. ‘A powerful group of individual builds a new coalition with new guiding principle. There are debates, maneuverings and negotiations that eventually lead to the new coalition or losing. Change then ensues as new people are in power with new views and new ways of allocating scarce resources. Those around them position themselves to be winners rather than losers’ (Cameron and Green, 2004).

Organizations as organisms; i.e. ‘There is first a research phase where data is gathered on the relevant issue. Next, the data is presented to those responsible for making changes. There is discussion about what the data means, and then what needs to be done. A solution is collaboratively designed and moved towards, with maximum participation. Training and support are given to those who need to make significant changes’ (Cameron and Green, 2004).

Flux and transformation; i.e. ‘the initial spark of change is an emerging topic. This is a topic that is starting to appear on everyone’s agenda, or is being talked about over coffee. Someone with authority takes the initiative to create a discussion forum. The discussion is initially fairly unstructured, but well facilitated. Questions asked might be ‘Why have you come?’, ‘What is the real issue?’, ‘How would we like things to be?’ The discussion involves anyone who has the energy to be interested. A plan for how to handle the issue emerges from a series of discussions. More people are brought into the net’ (Cameron and Green, 2004).

Furthermore, Cameron and Green have given guiding principles that could be distinguished in the three kinks of the EIP at the three levels.

In the ‘Machine metaphor’, ‘change must be driven. Resistance can be managed. Targets set at the start of the process define the direction. In this process, senior management has responsibility.’

In the ‘Political system metaphor’, ‘there will be winners and losers. Change requires new coalitions and new negotiations. In this process, those with power have responsibility.’

117
In the ‘Organisms metaphor’, ‘there must be participation and involvement, and awareness of the need for change. The change is collaboratively designed as a response to changes in the environment. People need to be supported through change. In this process, there is business improvement and HR/OD managers have responsibility.’

In the ‘Flux and transformation metaphor’, ‘change cannot be managed; it emerges. Conflict and tension give rise to change. Managers are part of the process. Their job is to highlight gaps and contradictions. Who is responsible? Someone with the authority to act responsibility.’

Thus, it could be that individual knowledge can not be utilized unless the required environment is provided for a ‘development work activity’. Furthermore, macroergonomics is concerned with the optimization of the work system design through consideration of relevant social, technical, and environmental variables and their interactions (Kleiner and Drury, 1999). Participatory ergonomics is a primary methodology of macro-ergonomics involving employee at all organizational levels in the design process (Imada, 1988). Furthermore, Senge (1990) challenges the notion of top-down, large-scale organizational change. He provides a hefty does of realism for those facing organizational change; start small, grow steadily, don’t plan the whole thing. But Cameron and Green, (2004) have noted this advice is hard to follow in today’s climate of fast pace, quick results and maximum effectiveness.

Karwowski et al, (2002) describe that the support for a change process can be established through several actions. But, in the study F was described the first action of knowledge support for a group without attention to the work system and a comprehensive communication system at IKCo is described.

A lack of employee commitment to an organization and its goals has been identified as a major constraint upon its performance; this includes its ability to change (see Mullins, 1996, and Burgess and Turner, 2000). Commitment is particularly important for the successful implementation of projects and strategic programmes (Burgess and Turner, 2000).

In addition, management support and democratic climate were other important characteristics. For example, the missing motivation of personnel at GC after 1998 was due to the factors mentioned above. Top management was changed after three years (i.e. in 2001) again. The senior managers and personnel formed several technical committees and held meeting with managers at GC. After seven years, the author was invited to GC. He participated in a technical committee. Direct observation of few improvements has shown that at least a democratic climate, the personnel could find their motivation for the technical committee activity again. GC’s employees complained that the new management had not attended to the personnel’s needs.

In Studies E and F, the second phase did not happen due to the change of manager and lack of interest of top managers at IKCo. However, visiting some worksites at IKCo during 2004 showed that a few members of the AGs who were trained in the
pre-intervention phase had conducted some ergonomics activities under self-management and self-interested.

How to contribute to overcoming some pre-intervention phases of the EIP is presented in Section 6.2. The next Research Question b deals with how the EIPT was implemented.

7.4. Research Question b

Is it that the EIP is difficult to implement?

The Ergonomics Intervention Programme Technique (EIPT) in Study H (see also Helali 2003) was formulated as follows:

2. Ergonomics Intervention Programme Technique (EIPT) = Ergonomics Awareness Building (EAB) + Research Activities (RA) + Network Building (NB)

In addition, participatory ergonomics (PE) will improve the intervention success thus:

3. EIPT = PE + EAB + RA + NB

Furthermore, in Study F the Ergonomic Process (EP) model was presented. But, Sub-section 1.2 indicated that it could fail when there is a lack of leadership with macro-ergonomics knowledge, vision and courage.

In Section 3.6 and Study H, it was argued that there are different ways to classify literature on ergonomics intervention, according to different forms of intervention and the results of interventions. According to Hendrick and Kleiner (2000), the best EIP involve, carrying out both the micro and macro-ergonomics intervention. Thus, this is a difficult as to whether it is not enough to implement an EIP for organizations when there is not a macro-ergonomic approach (i.e. thinking or actions, from middle-out (i.e. focus on processes), top-down (i.e. a strategic approach to analysis), and bottom-up (i.e. participatory ergonomics)). If starting an EIP with micro-ergonomic intervention (for example, improvement of workstation or training for task improvement); three kinds of support were needed (i.e. knowledge, management and employees, and using participatory ergonomics) in order to achieve an improvement of the work system and improvement at the people level in the organization. An example is at GC compared to IKCo.

For the pre-intervention phase of the EIP, there was a need to see issues and challenges for the EIP as part of the journey of system thinking and system practices for ergonomics intervention. In the case of Iran, the several phases and their results were described in Section 6.1 and in Study A.

7.4.1. Results in relation to theory

In Section 4.2, it was stated that action must be managed. This can be accomplished through PDSA Cycle (s). The studies in Section 6.2 and 6.3 that studied the EIP by the ETWs in general do not work according to the definitions of the macro-
ergonomics approach presented in Section 4. On the other hand, three major approaches to work design (Das, 1999) have mentioned in Section 3.6. The socio-technical approach in which both technical and human centred approaches are acknowledged and merged together in the social technical approach.

According to Wilson and Haines (2001), if we are looking to instigate and support participatory ergonomics as a macro-ergonomic strategy, we are likely to be interested in tools to sell a participative approach to stakeholders or to facilitate group-working and improving interpersonal skills. Tools and methods will be employed at various stages of a participatory ergonomics exercise.

At GC (between 1984 and 1986, and from 1990 till 1995), the first technology development and Organizational Development (OD) was done with top management support. Long-range effort was made to improve an organization’s problem-solving (using reversed engineering), and renewal processes (see, Paper B). This was particularly through a more effective and collaborative diagnosis and management of organization culture, combined with special emphasis on the formal technical committees, and temporary technical team and with the assistance of a consultant (facilitator) and the use of the theory and technology of applied behavioural science. In this situation, Professor Hou Shang Shahnavaz was invited to initiate an ergonomic intervention programme at GC in 1995. Then, the EIP by means of the ergonomics training workshop, the ergonomic checkpoints, and the future workshop, helped them achieve more promotion of the organization and improvement of the work systems between 1995 and 1997 (see Studies B, C, and D).

At IKCo, the success was due to a better role of local experts at the group level in an organization due to participation in various ergonomic training workshops (Studies E and F). Thus, there was promotion of the participants’ tasks and improvement of the workstation, which was the goal of the first phase of the project. However, promotion at people level was missing. The manager was interested in the project but he did not managed to find a way of taking the pulse of the organization on a regular basis. The activities of the action groups were not fully supervised.

Haines and McAtamney (1995) emphasized an approach for undertaking ergonomics studies in industry. They highlight the need for careful planning, good communication and, most importantly, commitment from both top management and those on the shop floor. Furthermore, Schein (1985) suggests that there are three levels of culture; artifacts such as buildings, documents and policies; values such as what people agree should be the case, e.g. that safety and welfare should take precedence over profit and efficiency; and basic assumptions, the often unquestioned guesses and hunches about how thing work and how problems should be dealt with. Artifacts are surface symbols, while assumptions and values lie at a deeper level (Shipley, 1995). Handy (1985) says which organizational types are differentiated as distinct cultures. He introduced four organizational cultures; power, role, task and person.
According to Shipley (1995), when an ergonomist enters an organization, absorption into its culture is hard to resist. The older the institution the stronger and more entrenched the culture and consequently its resistance to change.

The social-technical perspective behind macro-ergonomics theory described in Section 4, has inspired me and led me to my stating point for the EIPTs in practice, with running the EIPTs’ tool and forming the intervention team. Then, for the EIPTs in practice, it seems that it is important to be able to implement it in an effective way, see Section 4.2.

The next research question deals with EIPT implemented by the action research-type intervention.

**7.5. Research Question c**

How can EIPTs be successfully implemented and internalized by such organizations?

To facilitate carrying out the implementation process of the EIP at the organizational level in order to support a participatory ergonomic intervention, a model is proposed to handle the EIPT process in Sub-section 7.6.1. It takes into account the requirement for speeding up learning by doing collectively of the EIP in organizations.

Companies that have not worked before with the EIPTs in a structured way could use the model. Considering the EP model in the study F and the EIPT by action research-type intervention in Section 4.2 as well as based on the results of the project in Sub-section 6.4. This EIP in the organizational level can be illustrated by an EIPT process as that is shown in Sub-section 7.5.1 as Figure 21.

**7.5.1. Development of the EIPT model**

The results of the project in Sub-section 6.4 Studies I and J as well as experiences from GC have shown that using a participatory ergonomics approach has discovered new capabilities and created new checkpoints at the work system in the workplace by the EIPTs’ tool. As Sub-section 5.5.3 and the study has indicated, the requirements were: 1) organization support (i.e. management and employees support), 2) knowledge support (i.e. micro and macro-ergonomics), and 3) participatory ergonomics process (i.e., to engage all three levels by the EIPT’s tool support).

The results of the EIPTs in practice have indicated that the EIPT process in this study was:

1) **The main EIP activities were including**: ‘Awakening for changing (A), Vision (V), Method of the EIPT (M), Learning (L), and Integrating (I)’. These factors have contributed to the success of the participatory ergonomic intervention at the organizational level as follows:
**Awakening for changing (A):** The EIP activities in Study I and J began with a shared vision. When the top manager had a crisis or a promotion for the organization at the three companies (Studies I and J), and the EIP at Glucosan Factories (Studies B and C, and D), they requested outside help as at the beginning they had some limited answers to the questions. This has shown a new way to develop thinking about applying ergonomics issues, which through time has become better and better by means of the EIPTs in practice. This is mentioned in Section 6.4 ‘A shared vision’: the Future Workshop (FW) is a useful tool for creating ergonomics awareness and developing change because ‘a shared vision and a programme for change that was developed jointly by employees and management were vital for a successful change of management’ (Karltun 1997). Furthermore, the ‘FW’ technique was used as a point of entry into participation. Öhman and Shahnavaz (2004) have mentioned that the ‘Future Workshop’ can be used with good confidence at the beginning of a change process, in terms of action-driven change or vision-driven change described by Karltun (1997). The ‘Future Workshop’ was a useful tool for creating ergonomics awareness (or new ideas) and developing a process for change (Öhman and Shahnavaz, 2004; Study C). In Section 6.4, awakening for changing has shown that the awakening will be motivated by dissatisfaction with the current state and/or the vision of the future state should the current approach to management and leadership remain (Oden, 1999). If one is comfortable and perceive no threats then there will be little intrinsic motivation to do thing differently. The dissatisfaction has to be substantial. When the organization needs to do things differently, it is often implied that it is because it has been doing things wrong (see the fifth discipline from Senge, 1990). Leaders of an organization begin to lose control of their organization and do not understand why (Oden, 1999). Thus, the system begins with an awakening - an awakening to crisis as Deming (1988) described it. The aim of the awakening is described in Section 1.2. Planning for change was the most important issue indicating dissatisfaction with the present state and articulating a desired future. The planning process involved people from all levels of the organization (for example, at GC and at the poultry company) rather than relying on a single entity or group.

**Vision (V):** Vision was an ever-evolving picture of the future (Deming, 1993). At the beginning of the EIP activities vision can include an exciting sense of the ‘better way’. The vision must be collaborative because one person will not be able to articulate everything. The journey was difficult. See Study J: ‘Most participants said; there are many fears in their views for the future, such as, the fear of change, of making mistakes, of loss, of the unknown, of failure, of low support from top management, etc.’. Thus, in the process, fears were abounded: the fear of change, of loss, of the unknown, of making mistakes, of failure. On the other hand, as others became awaken and joined the transformation process, the collaboration and synergy was incredible like the case at GC. This was mentioned in Study J, ‘There was a signification different between top managers (three owners). It was due to increase knowledge of ‘managerial and organizational’ issues for the top manager who was engaged and participated from the beginning of the project. He said the starting of the project was difficult but there is no end- no limitation for learning and improving the work system in the company now.
Method of the EIPT (M): The method for the EIPT is discussed in Sub-section 6.3 and Study H. The participatory ergonomics process improved the success of intervention. Unfortunately, the path of transformation was not predictable by the EIPT; it was iterative and predicated on learning. This indicates the requirements for thinking through the process about the employee’s feelings, data, process, creativity, caution and optimism. As mentioned in Section 4, the aim of the ‘journey’ of the EIPTs in practice is to create the journey using the system of macro-ergonomics as guidance. It mentions that macro-ergonomics is human-centered and also participatory ergonomics is a primary methodology of macro-ergonomics involving the employee at all organizational levels in the design process and in the improvements of the work system in the organization. It also mentions that action is the application of new learning (the theory of macro-ergonomics knowledge). The degree of change could be ‘incremental improvements’ by the ETWs, or ‘transition from old to new, A to B’, by the EIPT, or ‘necessary’ by an EIPT process (learning by participating). An EIP, needs to show concern for the degree of engaging employees and employers. An example, presented in Sub-section 5.5.3 and Study J, shows how linking Ergonomic Checkpoints of ILO (1996) with integrating ergonomics in Health and Safety was done systematically by taking common participatory steps, as in Figure 17.

Learning (L): Sub-section 6.4 discusses learning. Results from the EIP (the case studies) indicate that small wins and learning by practices and observations has created good motivation for the participants. Deming (1988) once said ‘the role of management is prediction’. Prediction without information and knowledge is guessing. Knowledge is obtained through learning. Several authors (Deming, 1988; Senge, 1990; and Joiner, 1994) have noted that knowledge for transformation must come from the outside (i.e., external education and coaching). They argue that a system cannot see itself. If the knowledge to solve a problem was at hand, then it would have been employed to avoid the problem. The dilemma for managers could be finding qualified outside help especially in an IDC. There is still a low awareness in many IDCs regarding ergonomics and its application (O’Neill, 2005; Shahnavaz, 2000) and few ergonomists. The profession is not well recognized by name in IDCs (O’Neill, 2005). New learning occurs when the PDSA cycle is rigorously adopted and multiple cycles (Figure 6 Section 4.2) bring new learning. Leadership requires action. Action, however, must be managed. This can be accomplished through Plan-Do-Study-Act (PDSA) cycles.

Integrating (I): According to Oden (1999), integration means to form, coordinate, or blend all components into a smooth function or unified whole, thus causing all the parts to work together in a manner that made the whole process most productive (Studies I and J).

EIP team including: action groups (AGs), steering committee (SC), and facilitator(s) (FA). Pasmore (1988) argues in relation to change strategies, a perspective concerned with creating a change structure comprising of three parts; steering committee, design team and consultant. “The steering committee provides resources, sanctions changes and oversees that changes are implemented. The design team makes the analyses of the socio-technical system, makes redesign suggestions and tries to involve the members of the organization in the process of change. The
consultant is the guide who gives information about the change process, about training and what has been done elsewhere.’ Thus, each part has a specific role to play in the process.

2) **EIP process**, discussed at the three different EIP situations called routine (pre-intervention), modified (EIP process), new (post-intervention) EIP tasks in Sub-section 6.1, Study A.

As mentioned in Study F, for the success of Ergonomics Process (EP) and here the EIP process, there should also be a functional and acceptable progress assessment system, a recognition and reward system as well as an appropriate communication net-work system.

Thus, the EIP model in practice was described as the proposed model of EIP in Section 4.2. The guidance model, the EP in Study F, as well as the factors above mentioned, can therefore be concluded in the EIP process model as shown in Figure 21.

![Figure 21: Proposed model for Ergonomics Intervention Programme Technique (EIPT) Process](image)

### 7.5.2. Results in relation to theory

In Section 4.3 it was mentioned that in the literature, macro-ergonomics is defined as a technique of Organizational Design and Management (ODAM), (i.e. human factors are taken into account in organizational design and management). The technique of macro-ergonomics is acknowledged to have a great potential for improving organizational functioning. Vink *et al.* (1998a) describes in the proceedings of ODAM-VI Conference the factors for an ‘Organizational Design’ as: ‘Networks of organizations (i.e. the objectives of such networks can be various, for instance sharing experiences and expertise, setting up a common structure to deal with other organizations, working in supply chains or even to selling applied sciences), Teamwork (i.e., most companies are dealing with kind of teamwork and
try to optimize it) Quality management (i.e. TQM; total quality management has proven its potential to improve the quality of products and services.) Organizational learning (i.e. knowledge and experience is becoming important in the competition between enterprises and therefore the learning possibilities in the organization) Management issues (i.e. in improving the organizational, technological and human factors different management and leadership questions should be tackled) Healthy work (i.e. a healthy working organization), and Management of human settlements (i.e. concern human development and management of human settlements).

Furthermore, Chern’s principles (1987) provide criteria that can be used to guide the design of individual jobs, group work, technology, work processes, organizational structure and the design process. In socio-technical theory, the system is broken into three subsystems: technological, personnel, and job design (Hendrick, 1986). Hendrick describes (see Figure 7) at least three major characteristics of the personnel subsystem that are sensitive to the design of an organization’s work system structure: 1) the degree of professionalism, 2) demographic characteristics, and 3) psychosocial aspects of the workforce (Hendrick, 1997).

Ives and Olson (1984) divide the degrees of user involvement into six sets of categories, viz, No involvement, Symbolic involvement, Involvement by advice, Involvement by work control, Involvement by doing, and Involvement by strong control. Lawler (2006) suggests some reasons why employee participation is important in today’s world. One reason is that individuals are becoming more specialized in their work activities and are acting more as problem-solvers. Lawler (2006) pointed out the fact that most people want control over their work. Participation moves information, knowledge, rewards, or power downwards in the organization, which allows people to have more control over their work. Thorsrud (1976) says that employees at the lower level of the hierarchy are initially quite skeptical or passive, and in some cases negative to participation in change. The reason for this was not because they were not interested, but because they had had bad experiences from previous change processes.

But Mankin, et al. (1997) argue, that people with lateral skills should be picked for project teams, since they are able to work effectively with team members of different backgrounds, perspectives, and agendas, and are willing to limit their personal autonomy to achieve the main objectives that link everyone on the team.

In Section 3, it is argued that workers participation is important for a successful intervention. The reputation of a company for producing high-quality products plays an important role in customer satisfaction, and can be badly damaged if the company is not concerned for the health and safety of the workers (Noro and Imada, 1991). It is mentioned in Section 4.3, as previously characterized, macro-ergonomics is top-down (i.e. strategic approach to analysis), bottom-up (i.e. participatory) and middle-out (i.e. focus on the processes) (Hendrick and Kleiner, 2001). It is highlighted within the open system theory how technical tasks and people interact with each other (Hanna, 1988). The goal of a socio-technical intervention is the principle of joint optimization, as mentioned before (Pastmore et al. 1982, Emery and Trist, 1969). In Sub-section 4.4.2, Figure 11 shows different phases during an organizational change and gives some indications of how
management should act during the different phases. Figure 12 is an illustration of different strategies for ergonomics change, the arrows describe from where and in what direction ideas and energy concerning change goes in a very simplified and schematic way. Senge (1990) has summarized five poles as important ingredients to make an organization capable of learning. Furthermore, in Section 4.4 it was mentioned that it is important that changes not only improve existing systems, but also change the working conditions in the system. Therefore, the work system of the EIPT process can be learning by doing collectively.

7.6. Research Question d

What practical activities are required for the EIPTs’ implementation?

The studies presented in Studies I and J and before that at GC illustrate that the three main EIPT’s tools (Future Workshop, the checklist, and the Ergonomic Checkpoints, ILO 1996) were helpful in adopting an ‘action learning’ approach in the EIP activities. Furthermore, this was important for running these tools in an effective way in the studies (Study I and J). This was an illustration of the practical activities, which were needed for the EIPTs’ implementation in the organization. The main steps in Studies I and J were as follows:

- Meeting with top managers,
- Visiting workplaces, negotiating with division heads,
- Meeting with top managers, after visiting the worksites,
- ‘Future Workshop’ conducted with all 44 subjects for three days,
- ‘Workshop’ conducted for one day and ergonomies checklist introduced and implemented in one of the divisions,
- Evaluation workshop after two weeks and forming an intervention team,
- Meeting with division heads,
- A SWOT analysis of the organization by the 44 people,
- Applying the checklist in all the divisions,
- Applying ‘Ergonomic Checkpoints’ in all the divisions, and,
- Qualitative evaluation of the ergonomics awareness building process.

7.6.1. Results in relation to theory

Hendrick describes; ‘although conceptually, macro-ergonomics is a top-down approach, in actual practice, it is a top-down, bottom-up, and middle-out analysis, design, and evaluation process. Top-down, an overall general work system structure may be prescribed to match the organization’s socio-technical characteristics. Middle-out, an analysis of subsystems and work processes can be assessed both up and down the hierarchy from intermediate levels, and changes made to ensure a harmonized work system design. Bottom-up most often involves identification of problems by employees and lower-level supervisors that result from higher-level work system structural or processes design” (Hendrick, 2002a).’

Hendrick (2002a) has mentioned the ergonomicist or ergonomic team has to begin by making micro-ergonomic improvement that yield positive results within a relatively short period of time (often called ‘picking the low hanging fruit’ strategy). When
managers see these positive results, they become interested in supporting further ergonomic interventions (Hendrick, 2002a). Hendrick has mentioned that over time, senior management comes to support progressively larger ergonomic projects that actually change the nature of the work system as a whole.

Furthermore, there are main concepts for the EIP situation, which have to be conceptualized and operationalised. These were routine task (pre-intervention), modified task (EIP process), new task (post-intervention). The conceptualization of the EIP situations is simply the definition of these situations, in Section 4.2, Study H.

7.7. Reflection on the model

An action learning approach is used for the improvement and changing of the workplaces and is a proactive task. The positive view of engaging people is important for this work process.

The case for a learning organization has been widely canvassed, most notably in Senge’s The Fifth Discipline (Senge, 1990). The wider context was established by Argyris and Schön (1983), emphasizing the importance of double-loop learning and writers such as Checkland and Schöles (1990), Flood and Jackson (1991), and Argyris (1994) discussed methodologies for establishing learning in organizations.

EIP and EIPTs in practice can be stated as in Table 21.

Table 21: Distinguishes the three kinds of the Ergonomics Intervention Programme (EIP) way

<table>
<thead>
<tr>
<th></th>
<th>By the ETW (s)</th>
<th>By the EIPT</th>
<th>By the EIPT process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>Faster &amp; Cheaper</td>
<td>Fix a problem</td>
<td>Survival, Environment, Work systems Change needed</td>
</tr>
<tr>
<td>Thinking</td>
<td>Improve</td>
<td></td>
<td>Thinking or actions, from middle-out (i.e. focus on processes), top-down (i.e. strategic approach to analysis), &amp; bottom-up (i.e. participatory ergonomics)</td>
</tr>
<tr>
<td>Degree of Change</td>
<td>Incremental improvement</td>
<td>Transition from old to new; A to B</td>
<td>Necessary</td>
</tr>
<tr>
<td>Actions</td>
<td>Manage and control processes</td>
<td>Design the plan; implement the plan</td>
<td>Whole system change, complete overhaul of culture, communications, strategy, structure, actions, systems and processes, use of data, macro and micro ergonomics, cycles of PDSA</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Destination</td>
<td>Improvement can be limited to improving the wrong things</td>
<td>Projects completed</td>
<td>Continually transforming; no end state</td>
</tr>
<tr>
<td>Requires</td>
<td>Improvement of skills, practices and performance; often limited to focusing on individual performance rather than the whole system to make significant differences</td>
<td>Controlled process or projects managed</td>
<td>Senior leadership committed to new thinking, learning and actions; coaching from outside, courage</td>
</tr>
<tr>
<td>Approach to work design</td>
<td>Task without focus on people level</td>
<td>Task &amp; could be for people level: Human-centred approach which focuses on personal growth (i.e. the development of professional skills and social competence, and the use of human capabilities and skills as the main sources of productivity)</td>
<td>Task &amp; people level: Socio-technical approach which both technical and human-centred approaches are acknowledged and merged together in the social &amp; technical approach.</td>
</tr>
<tr>
<td>Role of ergonomists</td>
<td>Scientific support of the ergonomics training workshop; Trains</td>
<td>Scientific support of the Project, coach, give the report from the reflections the stages of project</td>
<td>Management &amp; Leadership for the transformation become as a change agent (Macro-ergonomics)</td>
</tr>
<tr>
<td>Role of top managers</td>
<td>Management support</td>
<td>Engage in the project in a reference Committee and a Steering Committee</td>
<td>Commitment to learning, change</td>
</tr>
<tr>
<td>Role of employees</td>
<td>Engage in the ETW (s) &amp; Commitment to learning</td>
<td>Engage in the Action Groups (AGs) and a commitment to learning</td>
<td>Commitment to learning, organization and change, Engage employees and employer</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Improvements limited</td>
<td>Changes limited</td>
<td>Sustainable change (with leadership and continual learning and new actions) New system; adaptable, flexible, involved, creative, moving forward, ability to sense and respond</td>
</tr>
</tbody>
</table>
If we want to hold on EIP by ETWs, we will make incremental process improvement. If we want to move to the next level of EIP by EIPT, yet be safe, we make transitions and change from old State (A) to new State (B). We know where we are going. In transition, we can plan the change and work according to the plan. But if we want to create a better EIP, we have to let go and reach for the unknown. We need the EIPT process for sustainable change with leadership and continual learning and new actions. We adopt the most difficult and challenging strategy because all levels of the organization will be engaged.

Cameron and Green (2004) have mentioned that it is hard to get the first step right in the implementation process. However, the model in Figure 20 still has weaknesses as well as strengths.

7.7.1. Strengths of the model

In Section 6.4 and Study J the four issues of the checkpoints (i.e. ‘Work schedules’ (i.e. planning, organizing, and control), ‘Work tasks’ (i.e. improving of work environment and work system), ‘A healthy work organization’ (i.e. leadership and management practice and continuous improvement), ‘Learning’ (i.e. technical and social skills) for assessing the work system were found suitable for the change of work schedules and improvement of the work system. The facilitator (s) could obtain the required EIP momentum for organizations with the three kinds of supports. The validity of the model showed that the three companies can use the participatory ergonomic intervention for improvement of the work system. Furthermore, Table 21 shows some distinctions in the kinds of the EIP way, which could be obtained from the ETWs, the EIPT, and the EIPT process.

According to Haines, et al. (2002), validating a framework for participatory ergonomics has nine different dimensions, each with two or more associated categories that define a feature of a participatory ergonomics initiative. They argue that depending on their complexity, participatory ergonomics projects may consist of more than one type of participatory group or mechanism (e.g. task forces, department level teams, Steering Committees), so for multilevel projects, a framework should be applied separately to each different type or participatory group within the project (Haines, et al., 2002).

As a conclusion of this study, Table 21 can be a framework for the implementation of the EIP and the ergonomics know-how transfer in the IDC. The author suggests after an increasing number of case studies, the framework could be tested in future for more detailed validation. In the author’s opinion, this thesis provides clarity and organization in the field of EIP and EIPT in practice. The framework could be developed for a definition of a range of different EIPs, establishing a number of operational levels.

Balogun and Hailey (1999) suggest that change can be thought of as occurring within organizations – individual, climate, and structures and system. According to Cameron and Green (2004), ‘there are many approaches to managing and understanding change to choose from, none of which appears to tell the whole story, most of which are convincing up to a point’. Cameron and Green (2004) have
suggested a ‘cycle of change’. Kotter (1995) has mentioned ‘eight steps’ (i.e. 1. Establish a sense of urgency, 2. Form a powerful guiding coalition, 3. Create a vision, 4. Communicate the vision, 5. Empower others to act on the vision, 6. Plan for and create short-term wins, 7. Consolidate improvements and produce still more change, and 8. Instutionalize new approach), for transforming organization, which goes a little further than the basic machine metaphor).

However, the learning organization is complex to achieve and it requires a platform of various ingredients or poles to be able to accomplish and maintain. Senge (1990) describes five poles (i.e. system thinking, personal mastery, mental models, building of shared visions, and learning in teams) as important ingredients to make an organization capable of learning. The author mentioned in Sub-section 4.4.2 that a non-linear strategy for change may reach organizational goal as shown in Figure 12. In this perspective, a pure ‘bottom-up approach’ was not suitable as change may start at any part and level of organization. According to Balogun and Hailey (1999), the change starting point options include not just top-down or bottom-up change, but also prototyping, pockets of good practices, or some combination of these options. In the author’s opinion, the strength of the model is that the EIPT process starts with ‘Middle-out’ (i.e., focus on processes), ‘Top-down’ (i.e. strategic approach to analysis), and ‘Bottom-up’ (i.e. participatory ergonomics) together for improving and changing of the work system. According to Oden (1999), the difference is analytic versus systems thinking: ‘Analytic thinking is, so to speak, outside-in thinking; system thinking is inside-out.’ Neither negates the value of the other, but by systems thinking we can gain understanding that we cannot obtain through analysis, particularly of collective phenomena (Oden, 1999). He argues that classical analysis assumes that the whole is equal to the sum of its parts and can be explained in terms of its parts (Oden, 1999).

Another strength of the model is what Hendrick (1986) describes in socio-technical theory. The system is broken into three subsystems: Technological, personnel, and job design. The technological subsystem contains the tools, technology, work rules, and processes that convert system inputs into outputs (Hendrick, 1986). Furthermore, several authors (Smith and Smith, 1988; Deming 1993; Senge 1990; Joiner 1994) have noted that knowledge for transformation must come from the outside (i.e. external education and coaching).

7.7.2. Weaknesses of the model

I feel that it is not yet clear that what happens after getting the implementation process right, as Noer’s model mentioned. The second level of intervention is dealing with emotions. For example, a top manager (one the of owners) evaluated the project in Study J and told us as follows;

‘The ergonomics is a good scientific method but, I have a problem with direct orders from division heads and other top managers in the line now. I have not time to reply when they ask me ‘why that and why this?’ Before that, I replied to them that they have alternative of problem’s solutions and their action group activity is supporting them.’
The top manager has accepted that the capacities and the manner of personnel have changed. They are in a better situation for suggestions. Further, they have the ability to sense and respond.

But the top manager told us that:

‘I understood that I did not put time in on the project. Most of my activities are about solving monetary and marketing problems for our company. More productivity for the company is good for us, but managing the people is more important. I am going to put more time in on the divisions.’

It could be interpreted that the top manager also has a fear of the change and of the personnel making mistakes. However, it is concerned with cultural issues and leadership style. On the other hand, after the solution of one problem another - the bigger problem is raised.

There are various concepts of organizational learning and learning organization (see Sunassee and Haumant, 2004). Bridges (1991) suggests a part to play in the outcome.

There are different roles of facilitator (s), top manager (s), employees’ supports, and different motivations for the ETWs, the EIPT, or the EIPT process that affect the outcomes of the three kinds of the ergonomics ‘know-how’ transfers.

It is important to understand that people need to feel they can make the emotional commitment to doing something in a new way (Cameron and Green, 2004). Beer (2001) has mentioned motivating managers in the whole organization to monitor and support a change. Top management needs to present a coherent story about why and what type of change is needed. Cameron and Green (2004) mentioned that Senge et al. (1999) observe that many change initiatives fail to achieve the hoped results. They reflect on why this might be so, commenting, ‘to understand why sustaining significant change is so elusive, we need to think less like managers and more like biologists’ (Senge et al., 1999). They talk about the myriad of ‘balancing processes’ or forces of homeostasis, which act to preserve the status quo in any organization.

Senge et al. (1999) have mentioned that the people involved in organizational transformation have not reached that level of authenticity all at once. Most of us seem to develop it over time, through an ongoing, three-stage, cycle of learning, including intellectual understanding, emotional engagement, and sustained action. A cycle never ends. If we really want to sustain a profound organizational change, then we do not simply take actions that fly off in an unconnected fashion. The actions must be integrated with the development of new theory. ‘That’s why I see this chain of activity, from intellectual learning to emotional learning to action, as a never-ending process’ (Senge, et al., 1999).

According to Ghaye (2007), ‘the possibility of sudden change is at the heart of the idea of the tipping point’. We might wish to ask the following question as Ghaye (2007) is mentioned:
Why is it that some ideas and processes start epidemics (in Gladwell’s sense) and others don’t?

What can we do to deliberately start and sustain positive social epidemics such as reflection learning?

Is there more than one way to tip something?

According to Sub-section 7.2.1 and Table 21 we have the ongoing question namely, ‘What is the EIT you/I want more of here and how can we amplify this?’ The EIPT process model has not responded to this question yet. PAAR is a recent style of research (3rd generation of action research) that emphasizes the power of asking the positive question and is a strength-based rather that deficit-based approach to improving the work and working life of individuals and group/teams within organizations (Ghaye, 2007). Ghaye and Melander-Wikman (2007) have noted that ‘in our conception of PAAR there is a focus on the ‘we’ and on the idea upon their social intelligence (Goleman, 2006). PAAR is an expanded view of PAR. Central to it are the processes of collective working and appreciative knowledge sharing (Thatchenkery, 2005). These have at least two significant associated processes. For those involved it is sensing how others feel, or knowing what they might think. Some call this empathy, or social awareness. The second associated process helps make the most of this awareness’. In my opinion, this provides opportunities for EIP and for further research. Thus, the model is not the full-stop on the pathway of the EIP journey in the IDC yet.

In this thesis, the EIP and the EIPTs in practice, seeks to help those who care deeply about ergonomics ‘know-how’ transfer and creating and building ergonomics awareness at three levels, viz individual, group, and organization in the IDC see Section 7.8.

7.8. Final conclusions or recommendations

Based on the discussions and analysis above, conclusions can be drawn to summarize the important parts of the model of the EIPT process for an ergonomics ‘know-how’ transfer to organizations in a sustainable way.

The goal of this study distinguishes three kinds of EIP way. The exercise suggests that the EIPT process as a model can be used as a first basis to support the participatory ergonomics process for improving work systems in organizations:

- Make sure what kinds of degrees of change are needed,
- Make sure what action is needed,
- Make sure of destinations of the EIP (i.e. project (s) completed or continually transforming, or no-end state),
- Make sure that the management is committed to the idea of learning and change; learning by doing collectively,
- Make sure that the management has clear ‘managerial and organizational’ issues,
- The most important pillars for EIPT process are ‘EIP activities, EIP team, and EIP processes,
- A clear implementation structure in the EIPT process is needed. Feedback is needed for improving or changing the work systems by the PDSA cycle (s).
is a model for process analysis and improvement and serves as a symbol for continuous improvements and leanings (Deming, 1993),

- Make sure the approach to the work design includes both task and people level (i.e. socio-technical approach in which both technical and human-centred approaches are acknowledged and merged together in the social and technical approach).

7.8.1. Development of the original model:

The interaction model presented in Section 4.1, Figure 4 could be the ‘Proposed model for the ergonomics ‘know-how’ transfer to individual, group, and organization levels in an IDC (at Micro/Macro ergonomics levels)’. This describes the short-term exchange of ergonomics ‘know-how’ transfer by the ETWs (Studies B, C, D, E, and F). The ETWs for an organizational level, as at GC, was a process of organizational development (OD) with full management support as well as the commitment of employees to learning. This has shown that applying ETWs had positively affected the organization (see Studies B, C, and D). The sequences of the ETWs at the three levels were the EIPT (see Studies, G and H). The EIPT in practice (see Studies A, I and J) has indicated that the model of the EIPT process is supportive of the improvement of ‘organizational and managerial’ issues having a participatory ergonomics support. The EIPT process (Figure 21) can help the implementation of the process of an EIP at organizational level; more learning by doing collectively.

A synthesis of learning from this research is presented below in Figure 2. It is a framework for developing the EIPT in the IDC or ‘Proposed model for the ergonomics know-how transfer to individual, group, and organizational levels in an IDC (at Micro/Macro ergonomics levels)’. It distinguishes three kinds of ergonomics ‘know-how’ transfer. In Figure 22, a significantly new research question is shown. This is, ‘What is the Ergonomics Intervention Technique (EIT) you/I want more of here and how can we amplify this?’
7.8.2. A model of applying ‘Ergonomic Checkpoints’; linking Ergonomic Checkpoints of ILO (1996) with integrating ergonomics in Health and Safety as well as the work system

It was recommended by the Helali study (i.e. licentiate degree, 2003) that application of methodology ergonomic checkpoints (ILO, 1996) ‘Why, how and some more hints’ could be used as a continuous programme for EIP tasks at all three phases (pre, process and post intervention) of the EIP. Example, for a tailored ergonomic checkpoint at the organizational level, at GC application of methodology ‘Ergonomic Checkpoint’ was created some new checkpoints by the R&D team at the internal workshops. The manager director of GC was presented 128 checkpoints in the categories like clusters of grapes at the workshop that could be different forms and sizes of each cluster of checkpoints for various workplaces or organizations (source, Helali, 2003).

Opportunely, this was another chance for the author, i.e. the using of checklist at the organizational level and the ergonomic checkpoints (ILO, 1996) in the three...
subsidiary companies (Studies I and J), (for 128 checkpoints see, Appendix 3). A method was formulated for the common participatory steps for using and developing the ergonomic checkpoints (see Figure 17 in Sub-section 5.5.3). These processes can run systematically by taking the participatory steps which followed the Deming process (Plan, Do, Check and Act). The exercises of the participatory ergonomics process (see Figure 3, in sub-section 3.7.2) and Deming process (see also Figure 6) taken in the areas, of developing and improving Health and Safety (HS) as well as integrating ergonomics in HS (see Study J). Furthermore, this can be a recommendation for development of the checklist, issues for improvement of the work system such as ‘Work schedules’ (i.e. planning, organizing, and control), ‘Work tasks’ (i.e. improving of work environment and work system), ‘A healthy work organization’ (i.e. leadership and management practice and continuous improvement), ‘Learning’ (i.e. technical and social skills) that are the challenges for an intervention team using a participatory ergonomic intervention at the organizational level.

7.9. Scientific contributions

As mentioned in the introduction, it is possible to find research concerning the implementation of the EIP in general. But it is harder to find description about implementation matters specifically connected to the main idea of this thesis, ‘how the EIP and the EIPTs in practice can be implemented in an organization’. For a well-planned, structured process of ergonomics intervention process, one needs systematic intervention, which identifies various contributing factors and process model for the EIPT and its development. Hopefully, this thesis will provide industrial managers and others with some directions on how to practically deal with ergonomics know-how transfer and highlights the outputs in Table 21 in Section 7.7 for the implementation of the EIP in different ways (i.e. by ETWs, by EIPT, and EIPT process).

The combination of the EIT process (i.e. EIP activities; ‘Awakening for change (A), Vision (V), Method of the EIPT (M), Learning (L), and Integrating (I)’, EIP team (action groups, steering committee, and facilitator (s)), EIP process and Feedback in a model is not so common in ergonomics ‘know-how’ transfer to individuals, groups, and organizations. But, Socio-technical approach to work design, both ‘Task and people level’, which consider technical and human-centred approaches are acknowledged by Hanna (1988), Anderson (1994), Hendrick (1986 and 1997), Oden (1999), Badham et al. (2001), Wilson and Haines (2001), Hendrick and Kleiner 2001), Haines et al. (2001), Kleiner (2004).

The contribution of this thesis is to the EIP and the EIPTs in the practice by using macro-ergonomics theory as guidance for the development of the EIPT. Thus, the focus was mainly on action and using participatory ergonomics by the EIPTs. Continual learning and new actions or improvement of action can achieve implementing and sustaining change.

There is a debate about the importance of organizational metaphors (Morgans, 1996; Cameron and Green, 2004). This debate is sometimes in terms of how organizational change works. The guiding principles of Cameron and Green help us
to distinguish three kinds of EIP. Participatory ergonomics is a primary methodology of macro-ergonomics, involving the employee at all organizational levels in the design process (Imada, 1988). See, for example, the advantages of participatory ergonomics described by Wilson and Haines (2001), Noro and Imada (1991), and Karasek and Theorell (1990). The material presented in the thesis shows a way to implement EIP in an organization by combining three kinds of supports (i.e. participatory ergonomics, knowledge, management and employees) and by EIT process (i.e., EIP activities, EIP team, and EIP process), which can make the creation and implementation of the EIPT process easier.

This model balances for - organizational, technological and human factor – whose support is needed to arrive at a successful organization. The changing of each factor could affect the other factors as at GC before 1995 and after 1998. For an OTH-model balancing ‘Organizational, Technology and Human factors’ mentioned by Vink et al. (1998b). They stated if a balance can be found between these factors, production (or product) performance will be improved. However, they argued ‘the model does not generate the approaches and solutions. You still need a toolbox with methods and you still need your own creativity/art’ (Vink et al., 1998c). In this study, I use the EIPTs at the organizational level that helped me find the factors of the EIPT process (see Figure 21). For data collection and data analysis see Subsection 5.5.3 and Studies I and J). This became a developing ergonomics intervention model to support the participatory ergonomics process for improving work systems in organizations in the IDC.

There is a debate about the importance of intervention at four different levels (Figure. 19) and what often stops people from making new beginnings in a change process (Figure 20). Figure 20 has indicated how one can get the implementation process right in an organization. But another challenge could be dealing with emotions. Leavitt (1996) argues. ‘Meaning and feeling in the anthropology of emotions’, these are the distinctions between nature and culture, body and mind, which seemed to pervade all the human sciences (see Milton, 2005).

Finally, the case studies ‘hopefully’ give a scientific contribution to the body of literature. There is a need for case studies if one is interested in following how it can be implemented at the three levels and how to keep improvements sustainable by means of limited change, changes in leadership, continual learning and new actions. Yin (2003) also mentions the contribution from different case studies. He believes that case studies should be performed on organizations that contribute the most to knowledge. See, for example, the author’s choice of the EIP at the three levels of organizations, which was implemented by ETWs. They are described in Section 5.4 and the EIPT by action research-type intervention in Section 5.5.
7.10. Further research

The design of the research questions for ergonomists’ interests in EIP in IDCs were formulated as follows (Helali, 2003 and Paper A):

Research Questions:

i) ‘What are the characteristics of different Ergonomics Intervention Programme (EIP) activities performed by industries?’
In the EIP literature, several authors have noted that EIP activities often involve more than one activity, which is also the result of this thesis. The question is ‘What about EIP activities in IDC?’, ‘Which individual (s) performing EIP activities in IDC in the different EIP situations, and what are their roles?’, ‘Are the owner/manager and other employees involved in EIP activities?’ Thus, the second research question was:

ii) ‘What is the role (s) of the facilitator(s) involved in EIP activities in industries of IDC in different Ergonomics Intervention Programme (EIP) situations?’
Since the researchers do not know which EIP activities are performed in IDCs and by whom the activities are performed, the process of EIP in IDCs is unknown and unclear. Accordingly, the third research question can be formulated as:

iii) ‘What are the characteristics of the Ergonomics Intervention Programme (EIP) Process(es) in IDCs, in different EIP situations?’
An interesting aspect here would be how to implement new ideas connected to promoting ergonomics in IDCs. In IDCs, ergonomics is needed and it has to be transferred by comprehensive research, promotion of ideas and continuous learning.

The framework for developing the EIPT in the IDC or ‘Proposed model for the ergonomics ‘know-how’ transfer to individual, group, and organization levels in an IDC (at Micro/Macro ergonomics levels)’ has been used and tested in some organizations in the IDC that were involved in applied ergonomics in different EIP ways. What happens, for example, if the model will be to implement in other organizations of the IDC? There have been opportunities for the author to choose the organizations (Poultry industries, including three companies) under the same conditions as mentioned in Section 5.5.

Another interesting issue would be to discuss whether the problems and ideas behind the EIPT process (Figure 21) are the same in other cultures. Is the model valid for example in other IDCs or ICs?

The roles of the facilitator and the intervention team have been described as important. Another important role is to coach others after getting the implementation process of the EIP right and dealing with emotions at the organizational level. The author believes that the role of senior managers in changing an organization is important. Good leadership will have a part to play in the outcome, in ensuring sustainable changes and continual learning as well as new actions. Furthermore, the new action pathway of the EIP journey in the IDC and the
ongoing questions were described in Section 1 and Section 7.2. This is another side
and continues the reflection on learning for the future.

In this way, we need ‘tipping-point leadership’ (see, Kim and Mauborgne, 2003;
and Ghaye, 2007) and ‘leading through appreciation’ (see Ghaye, 2007) can be
learned. An understanding of ‘tipping point’ is crucial if we are to see how the
future unfolds from the present (see Sub-section 7.2.1). What Ghaye (2007) calls
‘leading through appreciation’ is an important part of reflection–learning because,
fundamentally, it requires both reflection and action. Ghaye (2007) has mentioned
some suggestions for what leading through appreciation requires. Furthermore,
Stavros and Torres (2005) present some important reflective questions that help
orient us to the notion of leading through appreciation. The questions mentioned by
Ghaye (2007) are:

- How are we responding or reacting to one another?
- What are we aware of (assumptions, beliefs, thoughts, feelings, etc.)?
- What are we working to create, and how are we creating meaning together?

Ghaye (2007) mentioned finally, ‘By asking positive questions, we give ourselves a
chance to create powerful vocabularies of possibility, in particular thinking about
the possibility of positively re-experiencing past successes and doing more of what
satisfies and achieves agreed goals.’ [p. 170]

Generally, the question is ‘what is it you/I want more of here and how we can
amplify this?’ I use the acronym C.R.E.A.T.I.V.E. to point out some interesting
avenues for future research.

C=Core positive question:    ‘Amplifying’
R=Reflecting (Reflection on your successful stories)
E=Energising
A=Appreciating     ‘Appreciative Inquiry’ (i.e. the 4-D Cycle;
See Whitney and Trosten-Bloom, 2003)
(Team-working)
I=Intelligence
V=Vision driven
E=End Not or
‘No-end and no limit’
‘C.R.E.A.T.I.V.E’

Figure 1, in the Section 1, point to continuing reflection-learning in the action
pathway of the EIP journey in the IDC. I know we are going to ‘amplify’ the EIPT
process for the last steps of the action pathway with ‘appreciative eyes’ and ‘no-end
and no limit’. According to Ghaye (2007), it is important that we do not take our eye off the vision (i.e. the journeying along action pathways-to-scale with their useful factors (see, Ghaye, 2007)), namely building a reflective organization. It is also important to know how far co-workers or managers and staff of an organization will ‘buy in’ and support the vision. From Figure 22 in Sub-section 7.8.1 the meta-reflection of the different EIP became the ongoing research question of this thesis. Furthermore, it is possible to see in Box 1, some of the points that have already been raised in this dissertation.

**Box 1. ‘What is the Ergonomics Intervention Technique (EIT) I want more of here and how can we amplify this?’**

| Knowing-in-action: Ergonomics Intervention Programmes (EIPs) and its EIT |
|---|---|
| **EIP by ETWs or EP model** | Training Methodology | knowledge |
| To be happy and competence individually! But… |
| **EIP by EIPT Method** | Action research-type intervention | Knowledge-Action |
| To be professional and good at ergonomics (individually/collectively)! But… |
| **EIP by the EIPT Process Model** | Participatory Action Research-type intervention | Knowledge-Action |
| To be professional at work system, moving like Swans! But… |
| **Appreciative EIP can be by the using the acronym ‘C.R.E.A.T.I.V.E.’** to point out some interesting avenues for future research. |
| In order to brings ‘Communication, Knowledge Sharing, Reflection-Learning, and Action’ Or ‘Action, Reflection-Learning, Knowledge Sharing, and Communication’ together! |
| Participatory and Appreciative Action Research (PAAR) |
| To be … | To be … | To be … |

In this study, C.R.E.A.T.I.V.E. can be a force for change with two meanings. Firstly, it is a word in its own right with a clear action orientation. Secondly, C.R.E.A.T.I.V.E. is an acronym. Here we have synergy between the word itself and the words within it. Its parts describe the particular forces needed to operate in order to ensure the action pathway for reflective learning is continuous with ‘no-end and no-limit’. I hope this will be the next part of the EIP journey in the IDC. It will involve ‘heart, head, and hands’ and especially behaviors that are ‘Human centered, Participatory, and Appreciative’!

I hope you have found something useful in this dissertation as you contemplate building a reflection of the EIP at the three levels of an organization that benefits and supports managers, employees and staff in organizations in IDC industries, so that they can conduct the EIP in the best way they can.
Part IV

REFERENCES


Bell, J. (1993). Introduktion till forskningsmetodik; Studentlitteratur: Lund


Denzin, NK and Lincoln, YS. (2000). Handbook of qualitative research: California; Sage.


Hendrick, H. W., and Kleiner, B. M. (Eds.) 2001. Macroergonomics, an introduction to work system design, Published by the Human Factors and Ergonomics Society, USA.


Imada, A.S. (2002). Department of Human Work Sciences; Division of Industrial Ergonomics: Course code PARTICIPATORY ERGONOMICS. Luleå University, Luleå, Sweden (2002 year, a feedback’s letter of the assessment; professor to his student).


148


Milton, K. (2005). Emotion (or Life, the Universe, Everything) Anthropology, Queen’s University, Belfast, the Australian Journal of Anthropology, 2005; 16:2, pp. 198-211.


Appendices

Papers A - J
Paper A

A Macroergonomics Approach, a journey into system thinking Ergonomics Intervention Programme (EIP) in industrially developing countries (IDC), Case-IRAN, 1993-2003

Helali, F and Shahnavaz, H
Faramarz.helali@arb.luth.se
Center for Ergonomics of Developing Countries (CEDC), Department of Human Work Sciences, Luleå University of Technology, 971-87 Luleå – Sweden

Keywords: Ergonomics, Intervention, System Thinking, Macroergonomics, Ergonomics management, Industrially Developing Countries

Abstract
This case study research involved about 10 years activities of Ergonomics Intervention Programme (EIP) in Iran for the purpose of identifying, a macroergonomics approach, for optimal ergonomics intervention in IDC case IRAN. Analysis of the case studies (EIP) in Iran, the activities during these years led to 1) - training and ergonomics (ET) awareness building (BA), ergonomics application (EA) and evaluation (E) 2) – research activities (RA) and 3) – network building (NB), a model for ergonomics intervention in IDC. The facilitators were an ergonomist and his PhD students. System thinking and system practice of ergonomics intervention had resulted in a consequent; Ergonomics Intervention Programme Technique (EIPT) in Iranian industries. The emphasis of EIP was on no cost/low cost intervention in the workplaces by using different project methodology. The outcome of this study has resulted in a recommendation for research in IDC. Applying ergonomics knowledge and practice need a macro ergonomics approach in IDC including, an ergonomics management, system thinking and EIP situation as well as the new EIP task by action research.

1. A journey of system thinking and system practices for ergonomics intervention in IDC Case-Iran:

In Iran, ergonomics started during early 70’s with a few isolated studies (Kavoussi, 1976, Shahnavaz, 1977, 1978). In 1977, ergonomics was introduced (by H. Shahnavaz) at the Tehran Technical University (Sharif /Arya Mehr) within the Industrial Engineering curriculum. Since then, ergonomics has been taught as a supporting subject of one or two credits in a few universities. However, for Iranian industries, ergonomics was until recently an unfamiliar subject. The comprehensive attempt of introducing ergonomics to Iran and making use of its benefits in Iranian industries started systematically by the Center for Ergonomics of Developing Countries (CEDC) from 1993 in several phases as follows:

Phase 1 Preparation: In 1993 a 2-week training course, entitled “Contemporary Management” was organized at the Luleå University, Sweden for a group of Iranian industrial managers. One of the subjects discussed in the course for one day was ergonomics and its application in the industrially developing countries. The first author, a participant of the course, anticipated the benefit of ergonomics application in his industry and invited a scholar, from CEDC, (the second author) to help in applying ergonomic at the Glucosan factories. A few years later, having observed the significant benefit of ergonomics, Mr. Helali, the Glucosan manager, became so much interested in the subject that he started a formal post graduate education in the field of ergonomics at Luleå University in February 1996.

Phase 2 Presentation of the theoretical model in 1995: According to activities of CEDC, the main objectives of CEDC was to create ergonomics awareness in IDCs, promote ergonomics education, facilitate post-graduate studies in ergonomics at Luleå University of Technology and conduct collaborative research and ergonomics intervention in IDCs. Students coming from IDCs to the different educational programmes were encouraged to do their thesis work in their home countries. This policy, which was adapted for both Ph.D. and MSc. students, was very successful in terms of making student familiar with their own local problems, needs and solutions (Shahnavaz, H, 1995).

Phase 3 Applying ergonomics in a medium size industry, 1995-1998: This was a pioneer ergonomics intervention attempt in an Iranian industry. The result of this unique exercise, regarded by the factory as success, was analyzed and presented at the ODAM – V, (Helali, F and Shahnavaz, H 1996) and a complete up-dated report presented at ODAM – VI, (Helali, F and Shahnavaz, H 1998a). Ergonomic application resulted in developments of a new organizational...
...system for making full use of worker participation. A macroergonomics survey conducted seven months after the implementation of the new plan, showed that the company profit increased by 85% (i.e. from 3980 million Rials to 7360 million Rials). After 12 months, the company’s profit rose by 390% (i.e. from 3980 million Rials to 19500 million Rials). All factory employees (380) received equal access to welfare facilities, and have purchased their individual homes through a company loan scheme. The quality of the products improved, reaching international standard making it possible for the company to export its products.

Phase 4 Conducting training workshops for ergonomics awareness building in different part of Iran and doing a macroergonomics survey in the Iranian industries: In general the training workshops were conducted by CEDC from July 1993 to November 2002. During these years 24 training workshops for 293 participants from various industries in different places were established. The results are training time of 681 hours which makes 16838 total man hours training. The general conclusion of the training workshop activities at the individual level is that, all participants perceived training as very positive and useful (see Helali, F and Shahnavaz, H 1998b and Helali, F 2003).

Phase 5 Assessment of the workshops participants’ perception regarding the ergonomics training for awareness building. A ‘Questionnaire survey’ and ‘opinion poll’ information were collected regarding ‘usefulness of the ergonomics training’ for the participants of industries at the three levels viz; ‘individual, group and organization’.

- The aims of this questionnaire study were:
  - To identify Organizational Behaviour (OB) of the participants after they have undergone training and its effects on different levels viz; ‘individual, group and organization’.
  - To analyse and investigate participants’ perception after the workshops. The questionnaires were sent to 186 participants from industries who have participated in different workshops during a 4 years period. In total, 94 have completed the questionnaire (Helali F, 2003).

Phase 6 Review of the ergonomics intervention model in IDC, case-Iran: The review of the two case studies conducted by Ph.D. and MSc. students under supervision of the second author showed that in order to implement ergonomics in IDC, we need to be patient. Starting with training and creation of ergonomics awareness and convincing industrial top managers about the benefits of ergonomics and how it can improve the productivity and workers commitment. However, it also showed that if an opportunity is provided in IDC to implement ergonomics, it will not only achieve its ergonomics objectives, but moreover, its synergistic effects will have positive influences beyond the filed of ergonomics (Shahnavaz, et al, 2000).

Phase 7 Ergonomics intervention at an Iranian car manufacturing company (IKCo), 2001: In this case a well-defined scientific method of organizational intervention was designed in 3 phases through a co-operative project between PTW (Prevention, Treatment and Welfare) of IKCo and the CEDC. The first phase of the project was planned for a period of 18 months (May 2001 to Oct 2002). The objectives of this phase of the project were to develop ergonomics awareness and knowledge, train a selected group of 32 IKCo employees (engineers, occupational heath specialists and safety engineers from IKCo) in ergonomics theories and practice, and assist them in implementing the newly acquired knowledge for improving the company’s workstations and creating better working conditions (Helali F, and Shahnavaz H, 2002). During the first phase, 90 different projects were designed, approved and implemented by the action groups.

Phase 8 Introducing ergonomics at Universities in Iran, 1996-2002 and developing Ph.D. studies in ergonomics: In general training workshops and training courses were conducted by CEDC from December 1996 to November 2002. A total of 7 training workshops and training courses were conducted for 94 participants from various universities in different places. The results are training time of 453 hours and a total of 3375 man hours. Since 2000, two Ph.D. students from Occupational Health Departments of Tarbiat Modares University (TMU) and Tehran University become interested in PhD studies in ergonomics. Two research projects were designed. In first study, an ergonomics intervention project was designed in cooperation between TMU in Tehran and CEDC. A Ph.D. student from TMU was engaged during 2 years in the project which was conducted at a hospital furniture (SCo). The results of this intervention project have been presented in a doctoral thesis at TMU in March 2003. The second study is designed as a co-operation project between Tehran University in Tehran and CEDC. The results of this project (Ergonomic workstation design for Iranian Hand-woven Carpet Industry) will be presented in a doctoral thesis at Tehran University in 2004. Two of MSc students from Luleå University of Technology conducted their thesis research work at two Iranian Industries (Hojjati Emami, K., 1999, and Rahmany, K. 2003).
After formulating the research problem for the study, three research questions are formulated:

**Research Questions:**

1. **“What are the characteristics of different Ergonomics Intervention Programme (EIP) activities performed by industries?”**

   In the EIP literature, several authors have noted that EIP activities often involve more than one activity. Thus: What about EIP activities in IDC? Who is/are the individual(s) performing EIP activities in IDC in the different EIP situations, and what are their roles? Are the owner/manager and other employees involved in EIP activities? Thus, the second research question will be:

2. **“What is the role(s) of the facilitator(s) involved in EIP activities in industries of IDC in different Ergonomics Intervention Programme (EIP) situation?”**

   Since the researchers do not know which EIP activities IDCs perform and by whom the activities are performed, the process of EIP in IDCs is unknown and unclear. Accordingly, the third research question can be formulated as:

3. **“What are the characteristics of the Ergonomics Intervention Programme (EIP) Process(es) in IDC, in different EIP situation?”**

**Phase 11** - More activities for promotion EIP in IDC, during 2003 till 2005: The IES has plans to organize an international conference in 2005 in Iran. IES Board’s members are hoping and counting on the support and assistance of Iranian scholars living outside of Iran.

2. **Discussion and conclusion**

   The conclusion of the journey into system thinking and action research of ergonomics intervention programme technique (EIPT) was defined as the activities performed by the facilitators (ergonomics expert and his Ph.D. students) for the purpose of doing the 3 different indicated activities, i.e.,

   1. ET BA, EA and E, 2. RA and 3. NB in industries in the Industrially Developing Countries (IDCs), case – Iran. System thinking and system practices of a macroergonomic approach help us in passing of the pre-intervention phase and applying the EIPT in IDCs.

   2.1. The perceptions of people involved in the EIP processes, regarding success of the programme and its benefits. The questionnaire results, regarding perceptions of participants after finishing the training workshops have been indicated; friendly communications, Participation, Team working, Systematic Approach, A new scientific discipline, Good training and applying, Promoting ergonomics culture, Interested personal, Supporting management, Creation of facilities for learning at workplace.

   2.2. ‘Proposed model for developing an intervention process and an EIP situation’

   The interaction model which is presented in Fig.1 was used in Iran in order to emphasize the EIPT as an essential process for establishing long term relations between facilitators (supplier) and three levels of users or receivers, viz. individual, group and organization. This to guarantee continuous support for local actors of the EIP. Furthermore, this is type of ergonomics management like ergonomics know-how transfer that people in IDC need to be successful in ergonomics intervention processes. Also, according to Smith, Smith (1988); ‘Behavioural cybernetics considers human behaviour as a self-governed, closed-loop feedback control process. It asserts that humans need to govern their own actions (i.e., self-regulation) and do so through feedback control of the environment’.

   According to behavioural cybernetic principles, individual closed-loop feedback control is necessary for effective performance, learning and development.

---

**Figure 1**: Ergonomics Intervention Programme in IDCs (Micro/Macro ergonomics levels)

---

3
2.3. The factors included in the model EIP in IDC: The experimental model of ergonomics intervention in Iran was viewed as a process and action, (Fig. 2). According to Huczynski and Buchanan (1991), “action is the term given to the things that people do and the reasons that they have for doing them. Action can thus also be defined as meaningful behaviour”. Process is the series of actions, operations, or motions involved in the accomplishment of an end. Process could be thus also defined as meaningful systematic behaviour. Ergonomics intervention programme is categorized into three levels or three tasks as “Pre-intervention or routine task”, “Process intervention or modified task” and “Post-intervention or new task” of EIP and its feedback.

Fig. 2 EIP process

2.4. EIP situation
Routine EIP tasks are characterized by routine problem solving. Participants of the ergonomics awareness building’s workshop could receive many tools and techniques (such as: “Future Workshop”, “Ergonomics Checkpoint”, Ergonomics Checklist, Team-working procedure, “Role playing information and Aquarium model”, “Cause- and effect diagram technique”, “Logical Framework Approach (LFA)”, Brain storming, “Circle model”, “Triangle model” and “Problem Solving Process”) for ergonomics assessment and improvement of EIPT. (E.g. the participants can easily find the cues of workstation or worksite problems by using “Ergonomics Checkpoint” (ILO, 1996)). In each training method for EIP, the tools and methods mentioned above were used. These tools help to adopt ‘action learning’ approach.

Modified EIP tasks are limited to problem solving situation. The EIP is the result of a problem solving process, which could be achieved through workers and manager’s participation and utilization of human resources and increasing employee motivation. Thus, EIP is complex and need organizational intervention (Steering Committee, Action groups and Facilitators like CEDC (www.cedc.info)) to achieve the goals of EIP.

New EIP tasks as post-intervention and are characterized by extensive problem solving, requiring research activities and organization intervention with network building. There is a need for coordination, evaluation and control for starting the intervention process, which is more difficult and highly uncertain. Thus, EIP is complex and need follow up evaluation of organization intervention for achieving promotion. The goals of EIP could be reached by more Research Activities (RA) and Network Building (NB).

Feedbacks of EIP: It is important to distinguish between time-limited actions or continuous processes of an EIP for ergonomists and participations in EIP in the three levels of EIP situation. Feedback method of EIP is a control tool for effective performance, learning and development in chronological order. Thus, it is important to have a systematic EIP evaluation and a feedback system. Training and transfer of ergonomics know-how requires a dynamic process, where the external expertise meets the recipients’ individual experience and talents in a fruitful interplay (Helali, F. and Shahnavaz, H., 1998). When a research project is managed systemically, the facilitators have very precise responsibilities. Using a well defined scientific method, monitoring and documenting the process are important activities. In the case of Iran, we are now in a much better position to deal and make best recommendations for new EIP task. Also, from implementation the ‘Proposed intervention model’ in Iran, it became clear that several factors influence EIP situations, such as distinguished roles, responsibilities, authorities and activities of people involved and how they can be affected by the process design and conduct.

REFERENCES
Helali, F. and Shahnavaz, H., 1996, Ergonomics intervention in industries of the
industrially developing countries, Case study: Glucosan – Iran. Published in the Proceedings of Human factors in Organizational Design and Management (ODAM) V, North-Holland, 1996, pp. 141-146.


Shahnavaz, H. and Davies, B. T., 1977, Anthropometry of Iranian steel workers, Ergonomics, Vol. 20, 6, 651-658


www.cedc.info

www.modares.ac.ir/ies
Paper B

Ergonomics intervention in industries of the industrially developing countries,  
Case study: Glucosan – Iran

F. Helali and H. Shahnavaz

Center for Ergonomics of Developing Countries (CEDC), Department of Human Work Sciences,  
Luleå University, 971-87 Luleå-Sweden

Management of the Glucosan factory in Iran decided to apply ergonomics practices to fully utilize the company’s human and material resources. An ergonomic expert was invited to initiate ergonomic intervention program. Over an intensive 3 weeks period a holistic, participative and multidisciplinary ergonomic program was designed and implemented. The emphasis of the Program was to take advantage of local skills and resources. The result of the exercise were; formation of a core ergonomics R&D and an intervention team, which has developed long and short terms concrete plans and implemented ergonomic measures at all levels of the company. The participative management approach for better utilization of human resources and increasing employee motivation was appreciated by all participants and overall morale was increased. Through this communication-building and problem solving process, management saw the value of and accepted ergonomics as an effective tool for identifying problems and developing solutions.

Key words: Ergonomics, Intervention, Industrially Developing Countries

1. INTRODUCTION

Ergonomics, after half a century as an identified profession, remains in its infancy in many Industrially Developing Countries (IDC). Almost two-third of the world’s population has little or no access to the vast knowledge base that makes ergonomics such an important tool. While ergonomics has the potential in IDCs to cause optimum technology utilization through technological development and industrialisation, interest and attention paid to the subject is very low amongst responsible IDC organisations and industrial managers. Lack of awareness of the potential benefit is the primary cause for the under utilization of ergonomic principals. There is, however, no doubt that application of micro and macro ergonomics is essential for improving working conditions, system efficiency and promotion of the quality of working life in IDCs (1).

Iranian industries, like most industries in IDCs, are not aware that application of ergonomic practices can help to remove barriers to development and cause greater industrial efficiency. Beginning in 1993, one of the authors of this paper, from the ‘Center for Ergonomics of Developing Countries (CEDC)’, in cooperation with the ‘Iranian Industries ergonomics to Iranian industries. One industry that showed much interest and decided to make full use of ergonomic science and practice was Glucosan Company. Glucosan Company (GC) was established in 1970 with the investment of Iranian shareholders, and cooperation of Alfa-Laval, Sweden and D.D.S. - Kroyer Denmark.

The company’s plant started with the capacity to grind 50 tons corn per day for the production of glucose, starch and related products.

In the year 1975, GC signed a contract with C.P.C. - Belgium Branch for the transfer of up-to-date knowledge to increase the factory’s daily grinding capacity to 150 tons. However, in 1980 (after the Islamic Revolution) the company was nationalized and foreign advisors left the country without having started the agreed upon project. In the last quarter of 1984, the management at that the time, under the control of the ‘Council of Industries
Protection’, decided to give priority to planning, design and development for the 150 tons per day grinding capacity project. The project was to take place in two phases as follows:

1. Maximize production and product yield for the 50 tons per day operation by employing professional people, placing them in key positions, making full use of available personnel and improving the company’s organizational structure. Efficiencies and improvements to be realized in this first phase were seen as those needed to achieve increased grinding capacity and production using internal resources with minimal use of resources outside of the company.

2. Executive planning for completion of the 150 tons per day grinding capacity project, with the goal of implementing increased production in 1985. The work on the project was structured to take place in two stages:
   - Work carried out without stopping existing production.
   - Work requiring stoppage of machinery being used in production for transfer to the new project. Servicing and connecting of transferred and new machinery.

During 1985, the existing 50 ton per day operation achieved a higher rate of yield of extraction of starch compared with the year 1977.

As part of the 150 ton per day grinding project, GC managers signed a contract with an Iranian contracting company for technical assistance and movement of machinery. The contract emphasized utilization of GC employees, along side those of the contractor. While the effort of the contractor in transferring some machinery from the old to the new operation and in servicing new machines can not be ignored, information and knowledge about corn grinding and processing was inadequate. The service of contractor was terminated in July 1986. Thereafter, through the intensive and motivated work of experienced GC employees and by using reversed engineering, the project to increase daily grinding was completed and production started in 1986.

The plant manager and staff of experts, responsible for project design and implementation, left before completion of the project. In 1990, following changes in factory policy, they were invited to return. New employees with additional expertise were added to the team at the same time. The new management team focused on quality improvement and utilisation of total plant capacity. This was achieved through job rotation, the consultation management method and formation of several work committees.

Since 1990, Glucosan starch yield has improved by 10%. The number of specialist and technical personnel has increased from 28 to 60 people. Benefits divided among personnel have risen by 530%. These increases have been achieved through a common goal approach and joint effort of all employees within a flexible matrix organization.

2. OBJECTIVES

In March 1995, a 3 day introductory workshop on basic ergonomics was arranged for GC managers at Kish Island, Iran. The programme was a joint effort of IITRC and CEDC. A year later, to fully utilize the company’s human and material resources, the GC management decided to apply ergonomic practices to plant operation and organization. The ergonomic expert (EE) from CEDC, who conducted the 1995 workshop, was invited to Iran in January 1996 to initiate an ergonomic intervention program at company. Over an intensive 3 week period, a holistic participative and multidisciplinary ergonomic program was designed and implemented. Emphasis in program design was to take advantage of local skills and resources within an ergonomic framework with goals of improving working conditions, productivity and employee satisfaction.

3. METHODS

3.1. Starting of Ergonomics Intervention Program in GC: The Program started with a comprehensive presentation of the GC’s 18 year history by GC’s Managing Director
Following the presentation, the EE toured the factory. The MD invited the EE to a training class for managers and foremen that ran one day each week. This provided the opportunity for the EE to develop a working relationship with all GC personnel.

5.2. Ergonomics training of top managers: This program started with general ergonomic training of 8 top managers. In preparation for the training, material about ergonomics had been sent to GC for distribution among TM. Three of the papers containing basic ergonomic information, written by the EE, were translated into Farsi (the language of Iran) by some of the TM before distribution.

A holistic educational method was applied. In action learning workshops ‘Ergonomics Checkpoints (2)’, various check lists, cause-and-effect diagrams or Fishbone chart (3), and various brain storming techniques were taught and used as the main ergonomic tools.

In the second phase, using the Logical Framework Approach (4), the group developed a hierarchical list of immediate and development objectives for the ergonomics intervention program; elements regarded as essential for GC. Ergonomics awareness, training of the GC personnel and improvement of working conditions by applying micro and macro ergonomics were identified as the main short and long term objectives.

Thereafter, the TM met for two days to discuss the jointly developed objectives. The time was used to clarify issues and settle questions on planning and structure. The group had a later all day session with the EE. In that session, a general ergonomic education and training program for the GC employees were discussed and agreed upon.

3.3. Ergonomics workshop: In the 3rd phase, all 57 of GC’s top, medium and shop floor managers participated in a 2-day workshop at a Caspian Sea conference site. Before leaving for the workshop, each of the GC top managers selected a main topic (according to interest and background) from the cluster of check point topics. All check points for each selected topic were carefully studied by TM. Questions from the TM were discussed and clarified by the EE before start of the workshop. The informational material on ergonomics that had been translated into Farsi for the TM was distributed to all workshop participants.

For the first day, participants were divided into seven mixed groups. A TM acted as a facilitator for each group and discussed the topic they had previously selected. Using brain storming and participative approaches, each group went on to develop a list of ergonomic actions (considering both desirability and probability of each action) considered necessary to achieve the objectives previously developed by the TM. At the end of the first day, each group presented their results during a meeting attended by all participants. Later on, the EE and TM had a session to develop practical methods, plans and means for implementing the action identified from the first day’s workshops. The groups met about the following actions.

1. Organising work- clearing responsibilities.
2. Improving machinery – maintaining machines
3. Improving work stations – improving the physical condition of the barrel cleaning division
4. Work place environment – reducing level of sulphur dioxide in the air and preventing release of SO2 gas in starch and steep sections
5. Materials handling – weight standardization of GC products
6. Personal protective equipment – preparation and maintenance of equipment,
7. Improving office work stations – Better utilisation of the computer system

At the end of second day, in a general session, speakers from each group presented the group result. A Panel consisting of group facilitators answered questions, explained the whys and hows for implementing the decided actions and, discussed the benefits each would bring to GC. On the second night, the TM and the EE met to discuss workshop results and decide upon actions for the future.

3.4. Follow up workshop: Few days later. In a whole day workshop attended by the TM and EE, evaluation forms and participant comments from the 2 day workshop were discussed. Almost all workshop participants (98%) regarded the workshop as both very
much/much useful and satisfactory. Considering the high motivation amongst the entire work force for ergonomic intervention, the TM decided to form an ergonomics R&D core group. A model for R&D group activities was developed. The main focus was to use appropriate procedures to utilize the results of the previous workshop and sustain the level of commitment and high motivation of the work force for ergonomic intervention. It was decided that a regular weekly meeting should in the future work entirely on ergonomic intervention issues at GC.

4. RESULTS

4.1. Ergonomics training of top managers: TM has recognised the ergonomic approach as very innovative and challenging. Before, TM exercised a contingency management technique and leadership style. Through the training they learned a holistic, participative and multidisciplinary ergonomic approach, which helped them to be more effective in problem identification and solving. Few months after the workshop, they reported numerous synergistic effects of the training they had, such as better understanding of conditions at GC, recognizing the abilities and exclusive characteristics of individual personnel, being better understood, and using a participatory style.

4.2. First day workshops: The main objective was to create an interest, awareness and basic knowledge about ergonomics amongst participants. Further, each group developed several specific checkpoints for ergonomics intervention at GC. Each checkpoint contained information on ‘why’ the action was needed and ‘how’ it should be implemented. Even though this session had mostly a training focus, TM found these check points very valuable information for the ergonomics R&D group.

4.3. Second day workshops: In the second day, seven groups had been formed according to skills required for working with previously identified ergonomics actions. Each group developed practical methods, plan and solutions for implementing the proposed action by considering the required resources and its availability at GC.

Using ‘cause-and-effect’ diagram technique, each group examined the various factors that needed change to achieve the desired effects. Seven detailed action plans, methods and means of executing the desired ergonomics intervention activities were prepared.

For example, Group 3 (improving work stations) developed a solution to reduce the level of physical demand for some tasks in the barred cleaning division. This division was regarded as containing the most strenuous tasks at GC, because the barrels were cleaned manually in a partially enclosed area. The group developed a more effective semi-automatic cleaning system that is free of hard manual labour. The new system was put in to operation and is regarded as a successful action by GC personnel.

Group 5, working on materials handling issues, have developed standard weight system for GC products. Products have been packed in different types of packages of approximate weight. This was a source of much extra work for packaging personnel and product loss. Under the existing system, when personnel in the packaging section deliver to customers, each package is weighed to determine weight or weight of packages is estimated. Time spent weighing or product weight under-estimation is a loss to the company. The group developed a semi automatic weighing and packaging system which is now under construction. Similarly, other group’ proposals are gradually coming in to action by the ergonomics R&D group and the effort of the intervention team.

4.4. After workshop activities: The top management decided, based upon workshop’s recommendations, to implement two major activities:

a - Establishment of an ergonomic R&D core group and ergonomic intervention team. The TM defined the R&D core objectives and its structure.

b – The results of the second day workshop has been distributed to different sections of the company and identified as being supported by management.
5. DISCUSSION

This study at GC was the first ergonomics intervention case in an Iranian industry. The study was made possible, because of management interest in ergonomic practices and their general commitment to continuous improvement of work and adjustment to change. The whole exercise was very successful. All participants have assessed the exercise as very beneficial and useful. Most workshop participants (98%) were very much/much satisfied with the program and implementation of the actions agreed upon during the workshop.

5.1- Ergonomics Checkpoints: Ergonomic checkpoints are developed through joint effort of ‘International Labour Office (ILO)’ and the ‘International Ergonomics Association (IEA)’ and will be available after April 1996.

It is a collection of 128 practical and easy-to-use ergonomic solutions for improving working conditions and productivity; particularly for use in IDCs. It covers 8 main subject areas and is a valuable tool for identifying simple, practical and inexpensive solutions to ergonomic problems, especially in small and medium-sized companies (5).

The material has been tested in a few ‘Roving Seminars’ in South East Asia and later improved. This case study was the first application of the material in Iran. Actual use demonstrated that it can be an important tool for introducing ergonomic concepts and solutions, training people in basic ergonomic concepts and finding realistic solutions and practical methods for various kinds of ergonomic problems at workplaces. Further, it has the potential to be customized and teaches users how to develop further checkpoints that are relevant and specific to a company. In the case of GC, having the checkpoints as a formal model and making use of other ergonomics tools such as a cause-and-effect diagram and brain storming techniques, several company specific checkpoints have been developed by workshop participants and since implemented.

5.2- Synergistic effect of an ergonomics approach: The structure of the GC Ergonomic R&D Group and the intervention teams were a direct synergistic effect of the ergonomic workshop. By using the macro ergonomics approach, both management and employees discovered new potential and developed ideas for improving working conditions as well as company effectiveness.

The synergistic effect of a macro ergonomics approach at workplaces is reported earlier in the literature (6). Through the participatory approach that was used in the workshop, TM discovered new capabilities in the workforce. Further, employees reported more satisfaction and higher commitment to the change that were proposed. The old fear that it would lead to more demand by the workforce has changed to greater commitment given gladly by the workforce. The recommendation from one workshop group to eliminate shared responsibilities and overlapping authority among supervisors resulted in the duties of managers and supervisors being clearly defined. Managers and supervisors responded positively by becoming more considerate in their attitude towards and supervision of subordinates.

5.3- General benefits: The participative management approach for better utilisation of human resources and increasing employee motivation was appreciated by all personnel. The overall moral of all GC employees increased. Through this communication-building and problem solving process, management saw the value of and accepted ergonomics as an effective tool for identifying problems and developing solutions. Employees of the company became closer to each other through the workshop and related activities. A cohesive workforce with the common goals of improving working conditions and productivity has been established.

A continuously active process aimed towards acquiring up-to-date knows how and to cause improvement at all levels of the company was designed and put into action. The management described the overall result of the exercise as “The ergonomics programme has leaded the workers in a clear, common goal to develop objectives and improvements.

145
We are moving now like swans, that when flying together in the same direction is 70% more effective compared to when flying individually”.

As the result of this first exercise, management decided to continue with further ergonomics education of its TM. A week training course for the 8 TM is planned in June 1996 at Luleå University in Sweden. Management also plans to offer, during a national seminar, a 2 day workshop to inform other Iranian industries about their achieved benefits from the ergonomics exercise. It is hoped that more industries would follow the example of Glucosan. It is felt that sharing the results of a practical case study is the best way to promote the introduction of ergonomics into Iranian industries.

6. CONCLUSION

Ergonomics can be a key part in efforts to identify main causes of accidents, injuries, low productivity and low work quality. Then, ergonomic principals can identify appropriate measures to cause improvement by considering specific characteristics of the company in question and also the socio-cultural and political conditions that can influence outcome.

Industrially developing countries that have relatively more problem in workplaces are those most in need of ergonomics knowledge and applications. The key issue in overcoming IDC work place problems can be best tackled by appropriate training and education programmes that consider specific conditions in countries as well as the industries.

The 50 years of ergonomics literature provides ample evidence and many examples of successful case studies of ergonomics interventions that have resulted in improved working conditions, increased productivity and improved work quality.

Why ergonomics hasn’t been widely known and used in the industrially developing countries is primarily because of our failure as a professional body to globalize the subject. Up to now, ergonomics has been a discipline of interest in the industrialized world, where most research and education is concentrated. Fortunately, in recent years we are witnessing a growing interest about the subject in most IDCs, especially those who have reached a certain level of industrial development.

The Glucosan exercise clearly showed that if an opportunity is provided for ergonomics to be implemented at a work place in an IDC it will not only achieve its ergonomics objectives but moreover, its synergistic effect will have influence beyond the field of ergonomics.

REFERENCES

2. Ergonomic checkpoints, 1996, ILO publication, CH-1211 Geneva 22, Switzerland.
Adopting macroergonomic approach for identification of workplace problems and development of low-cost/no-cost solutions in industrially developing countries, Case study: Glucosan - Iran

F. Helali and H. Shahnavaz

Center for Ergonomics of Developing Countries (CEDC), Department of Human Work Sciences, Luleå University, 971-87 Luleå-Sweden

Following the positive experiences of the Glucosan factories in using ergonomics, the management decided in 1997 to apply macroergonomics for improving organizational structure. A three day ‘Future workshop, (FW)’ was conducted for all top, middle managers and factory advisors. The aim was to identify problems/obstacles regarding the current organization and the possible alternative solutions for improvement. A new organizational form was planned and implemented. After six months, both management and employees evaluated FW and its outcomes. The results of the macroergonomic intervention at Glucosan factories showed a high increase in company profits and several positive side effects. Although the development of the factories was the main priority, the better utilization of local peoples’ knowledge and abilities that were enhanced through intensive training was the more important gain.

Key words: Ergonomics. Intervention, Industrially Developing Countries

1. Introduction

Organization is a social structure wherein employees play a decisive role in improving its performance. Traditionally performance improvement is based on single top-down actions, usually making employees unwilling to comply. Organizational changes are difficult, time-consuming and expensive process (1). Cultural factors and the way people interact with each other in an organization and commit themselves to organizational goals are complex matters that have significant bearings on the success of an organizational change. Macroergonomics is concerned with joint optimization of the technical and personnel sub systems. It contributes to organizational readjustment for improved competitiveness and good working environment. Combining bottom-up and top-down approaches, macroergonomics, takes full advantages of a broad participation within an organization (2). A shared vision and a programme for change developed jointly by employees and management are vital for successful change management (3). Different models and methods for building vision and developing a change programme have been presented in the literature, such as the fifth discipline by Seng, (4), and the future workshop by Jungk. (5)

This paper presents the result of a macroergonomics approach at Glucosan factories. It utilized future workshop to identify various management problems, and to develop vision, ideas and action plan for improvement. Following the initial
attempt of the Glucosan management to implement ergonomics (6), the company decided to take a further step and make use of macroergonomics for organizational readjustment. In January 1997, the management once again invited the ergonomist (the second author) from Sweden to assist them in their endeavour. It was decided to integrate a learning strategy into the macroergonomics process for enhancing ergonomic changes at the organization.

2. Methods and procedure

Future workshop: ‘Future workshop, (FW)’ is a well developed method for identification of problems at work and for developing feasible and acceptable solutions for improvement. The method was introduced by the scientist Robert Junk in 1984. Later it was spread to other countries and used mostly for optimum utilisation of human and material resources at work in order to make companies more competitive in this world of rapid changes.

The practical prerequisite for running a successful FW is a well motivated participating group, a flexible and informal condition and two experienced and neutral workshop leaders.

A total of 31 top and middle managers of the Glucosan factories participated in a 3 day FW. It was held in the conference facilities of a large hotel in Teheran, where all participants stayed for the whole workshop period. The group was very much motivated because of their previous experiences and involvement in ergonomics. The authors were the two workshop leaders.

Future Workshop is a well structured process with five defined phases that was conducted at the workshop as follows:

1- Preparation phase: The aim of this phase was to define a clear, short and challenging ‘theme’ for the workshop, acceptable to all participants.

At our FW the theme selected by the company management was “Organizational behaviour for development”.

2- Experience phase: Also called ‘critic phase’. This phase aimed to highlight all problems (small or large); experienced by participants with regards to the concentrated only on the negative side of the theme, with the view that what is good doesn’t need to be changed.

One after the other each participant, briefly, described a concrete problem that she/he has experienced. All statements were written (exactly as they were expressed) on a block of large paper by the workshop’s leaders with a running number. This continued until no one had any more critical problems.

Thereafter, the FW leaders distributed ‘voting papers’ to participants. Each participant had 7 votes, which he/she gave to the most serious problems. Each participant selected three main problems, of which two received 3 votes and one only 1 vote. The workshop leaders calculated the voting and wrote problem in order of their received votes. Thereafter, they defined and wrote the main topics that covered all the problems that have received high ranking on separate large papers, followed by a list of problems that did belong to each specific topic.

After a rest period, participants were asked to verify the selected topics and certify if their expressed problem is under the correct topic. The workshop leaders invited participants to select a topic that they liked to work with and formed different voluntary working groups of 3 to 7 members accordingly.
3-**Fantasy phase:** The aim of this phase was to come out of the daily limitations that usually lead to restraint, traditional thinking and acting. People have many ideas that have never been expressed or formulated because they were framed in what they believe was right and possible. In Fantasia Phase, everything was possible. There were no barriers, no economic, personal, technical or organisational limitations. The idea was to develop future visions that had enough power to solve all the critical problems that the group was working with. Each expressed fantasy was discussed in the group with regards to if it could solve one or more of the problems that the group was working on. Disagreement within the group was allowed and accepted. Each individual’s fantasy was written clearly under the proper topic with a running number.

After, every group member had expressed his/her fantasy in concrete terms and was written down in a block of large paper, all participants came together again and each group presented its fantasy solutions to the other groups. In this meeting the participants also decided which part of the fantasy solutions they liked to work in the next phase, the Strategy phase.

4-**Strategy phase:** The aim of this phase was to go through all the written fantasies with the aim of finding all the barriers regarding the realization of the fantasies. The group considered economics, technical and organisational realities of the company as well as the society as a whole. Participants discussed whether any of the barriers could be removed, if yes, how and when? The group prepared a plan/programme for change in order to realize the fantasies that it has decided should be realized.

The discussed plans and programmes have been written down on large blocks of papers. The groups met and discussed various plans and programmes that were developed under the strategy phase and decided upon their hierarchical order.

5-**Action phase:** After the workshop, a complete report was prepared containing all the critical problems, fantasies as well as programme/plans proposed by the participants. The report became an idea catalogue for future actions, and an acknowledgement (feedback) for participants to see how hard, intensive and creative they have worked.

### 3. Results

The results of the workshop are presented for each day:

**Day 1- Training in macroergonomics:** The objective was to enhance participants’ knowledge on macroergonomics for the purpose of fully utilizing the potential resources of the company, especially human resources for a step-by-step improvement of efficiency and productivity of the whole organization. 31 top and middle managers were introduced to topics such as; changing world, work environment, productivity and quality at work, role of macroergonomics, basic research procedure and future workshop technique.

**Day 2- Compiling problem catalogue and developing feasible solutions:** A problem catalogue concerning problems related to the theme of FW “organizational behaviour for development” was prepared by the participants. From a list of 201 different problems 75 of them were considered worthy of thought and action by participants’ votes. They were categorized under 6 main topics. Participants were voluntarily divided into 6 groups in order to work with the selected topics (in the fantasy and strategy phases), to develop the best possible solutions for each recorded problem.
Day 3- Work continued: Participants continued their work in the fantasy and strategy phases by applying various techniques such as circle model or development model activity (7), triangular model (8), various brainstorming techniques, cause & effect diagram and analysis diagram (9).

Each of the six groups developed a detailed plan for improvement. Some examples of their activity results are presented as follows:

**Group 1- Management and Organization:** A counseling plan based on participative principles was prepared for different levels of administration. The plan had 3 phases, each of six months duration as follows:

- Formation of factory counseling management and compiling the related rules and regulations
- Applying counseling administration up to the supervisory level at the factory
- Running the factory by participation

**Group 2- Group work:** Solutions were proposed to prevent dilution of group activities, continuation of expert committees gathering and the planned regular weekly and monthly meetings.

**Group 3- Communication and Information:** Obstacles/weaknesses in information distribution (top-down and bottom-up) were analysed and a better communication and information structure were proposed.

**Group 5- Welfare and individual problems:** The group evaluated the current welfare system and various problems expressed by workshop participants.

**Group 6- Rules and regulations:** The group went through factory rules and regulation, assessed them, and prepared a list of needed rules, regulations and procedure.

**Activities following the FW-** A full report of the FW was prepared by the R&D core. It contained all the problems as well as solutions. Management decided for an organizational redesign, since most of the documented problems were related to the organizational design which was also emphasized by R&D. A month later, the R&D core developed a new counseling organizational structure with job specifications, rules and regulations. A committee (board) of 6 full time managers (Factory Counseling Board, FCB) was selected within the company by R&D, based on their competence. All other company managers were also part time members of the committee and were called to meeting according to the subject discussed and their competence. The committee met every 15 days. Several expert subcommittees were also formed to take care of specific issues such as; quality improvement, technology and new design, welfare and administration, work environment, etc. They were responsible in assessing all incoming suggestions and developing proposals for improvement.

It was discovered that the main obstacle for implementing the new plan was the position of the plant manager on top of a hierarchical structure. The problem was solved by changing it to a supervisor (one level lower) and making it a rotating one.

The new plan was proposed in a meeting to the FW participants and was approved by 80 percent. Soon after, the plan was implemented. Plant manager position was eliminated and for the first time by common agreement the supervision of the factory was given to a female manager with two years experience at the company.

After 3 months, in a large meeting with all top and middle managers, supervisors and floor managers (57 persons), the new organization was evaluated in order to find out its strengths and weaknesses. The group was positive to the new plan, but
emphasized the lack of an on the job training scheme, that became necessary due to their job enlargement as a result of the new organization. Soon after, all personnel were called to a general informal meeting to inform them about the changes. A panel of FCB answered questions and explained the new system. After 6 months of execution, in a general meeting, 57 participants assessed the positive and negative aspects of the plan. They concluded that due to participation, people were working more responsively, and that responsibilities and authorities were much clearer. A questionnaire was also handed out to evaluate the FW from participants’ perspective, their perception of the receptiveness of managers and colleagues within the organization and the overall effects of the FW. All (100%) requested continuation of workshop and wanted that other employees also participate such training sessions. 63% evaluated FW more positively than previous courses. 60% experienced no resentment with regards to improvement and believed they are now more capable of dealing with problems than before.

Due to socio-cultural consideration it was decided that in order to move towards a full participative organization, the factory needs to go through a preparatory phase of counseling organization. The new plan was hoped to become the cornerstone of participative organizational structure of Glucosan factory in future. The main outcome of the 6 groups work and follow up activities are summarized as follows;

* Identification of the optimum conditions for proper decision making and providing clear responsibilities for worker participation.
* Proposal of a suitable organizational design and structure for the factory.
* Development of a list of needed guide-lines and compilation of employees’ loan regulations.
* Revision of the contract procedure for employees’ welfare insurance.
* More efficient transfer of information among different departments and better utilization of existing communication facilities.
* Several low cost/no cost ergonomic intervention at various workplaces and improvement of the machinery.

4. Discussion

The workshop was a training session, geared mostly to train participants in; participative ergonomics, procedures for problem identification, and making optimum use of employees’ potentials for proposing and implementing improvements. It was a continuation of the ergonomics intervention programme which has been started in 1995 with full management support towards a policy of learning and change for improvement. Since the project start, it has a positive and progressive trend in many aspects, especially in general productivity. During the seven months after implementation of the new plan, the company profit increased by 85% compared to the previous period (from 3980 mil Rial to 7360 mil Rial). Looking at the relation of training costs and general profit, it is evident that before 1993, the share of training was less than 0.5% of the company profit (total of 67 mil Rial), compared to about 2% of the profit in recent years (137 mil Rial) also an increase of over 104%. The total cost of ergonomic training was 41 mil Rial, in the last year, which was approximately 30%
of the total training cost. The increase in productivity and better profit was only due to better utilization of both human and material resources which was achieved through training, increasing employees’ competence, participation and organizational readjustment.

FW technique was used as a point of entry into participation. This made management and employees to recognize the benefits of involvement, participation as well as moving information, knowledge and power to all levels of organization.

A future workshop is sometimes the direct and immediate solution to a problem. However, most of the times it also prepares the foundation for new perspectives, future vision and new ideas. In the case of Glucosan factories, the matrix structure of organization, existing for seven years, was changed. It provided possibilities for better utilization of company resources. For example through employees’ efforts, the company prepared the institutionalization of the whole production system towards obtaining ISO 9002 certificates.

While participating in the FW, management observed how a proper participative procedure will help with recognition of causes and effects of various problems at work. Furthermore, problem dimensions were highlighted and feasible solutions, which were not previously perceivable, were proposed. Employees’ fantasies have been put into practical realities. It was generally accepted that “today is the first day of the future”.

5. Conclusion

Industries in the industrially developing countries are in need of proper diagnosis of their work-environment and productivity problems. FW is a helpful tool. It uses employees’ participation for better identification of problems and their priorities. By organizing relevant working groups, problems will be analysed and proper solutions will be proposed. As a result, employees’ knowledge and capacities will be optimally utilized, leading to more job satisfaction and less tension at work. By making the best use of human resources (experts and nonexperts), management is in a much better position to deal with rapid changes and consider local culture for smoother readjustments.

References

Helali, F. and Shahnaz, H. Experimental Model of Ergonomics Intervention in Industries of the Industrially Developing Countries,
Experimental Model of Ergonomics Intervention in Industries of the Industrially Developing Countries, Case study: Iran.

F. Helali and H. Shahnavaz

Center for Ergonomics of Developing Countries (CEDC), Department of Human Work Sciences, Luleå University, 971-87 Luleå-Sweden

A pioneering ergonomic study in Iranian industries was conducted at Glucosan factories in 1995. Because of the successful results of this unique exercise, management decided to incorporate ergonomics in their general training and implement an ergonomics intervention program at the factory. The factory later became a good example among Iranian industries. This created the ground for further ergonomic activities in the country, mostly in the form of training and increasing awareness. Several ergonomic workshops were organized for participants from a wide range of Iranian industries. As a follow-up study (six months later) a questionnaire was designed and distributed to the participants to find our effect, if any, of these workshops. With the rise in the number of seminars and workshops, the “Ergonomic Checkpoints (ILO, 1996)” was translated to Farsi and 5000 copies were distributed. Further activities are planned to promote awareness and application of ergonomics in the Iranian industries. Theses are publishing a quarterly magazine (Man-Work-Environment) with the help of Iranian scholars who are active around the world, introducing a graduate programme in ergonomics and organizing more awareness activities. It is believed that the best alternative is still the scientific approach led by a group of motivated scholars speeding up the process of ergonomics development in Iran.

1. INTRODUCTION

In most industrially developing countries (IDC), application of ergonomics is not widely spread and the subject as a whole is in its infancy. This is due to the shortage of well-trained ergonomists and scarcity of resources. On the other hand, for these countries striving to acquire advanced technology and achieve better productivity and product quality, knowledge and application of ergonomics is of vital importance. Most firms in IDC, having many problems at their workplaces are practically in urgent need of ergonomics. Through incorporation of ergonomics in their skill development programme, they can overcome numerous existing problems and improve their competitiveness.

Training and transfer of ergonomic know-how requires a dynamic process, where the external expertise meets the recipients’ individual experiences and talents in a fruitful interplay. The process must be built upon trust, competence, relevance and a strong tie to the practical reality. It should also be adjusted to the local needs and requirements.
The overall goal of an ergonomic training should be firstly to provide relevant knowledge, (theoretical, practical and communicative). Secondly to develop and stimulate human aptitude, talent and creativity for problem identification and problem solving solutions. Thirdly it aims to provide the needed motivation for making optimum use of the learned knowledge and resources for making improvement through ergonomic intervention.

There is unfortunately very little information available regarding ergonomic intervention in IDC and how best one can promote the subject and apply it in the workplaces of these countries, (1). Each country is unique with regards to its infrastructure, socio-cultural and political conditions as well as development requirements. However, information about the success and failure of various attempts to introduce ergonomics in one or another country/company can be of help to others in their endeavour to make use of ergonomic knowledge.

In Iran, ergonomics started during early 70’s with a few isolated studies (2, 3 and 4). In 1977, ergonomics was introduced (by H. Shahnavaz) at the Teheran Technical University (Sharif) within the Industrial Engineering curriculum. Since then, ergonomics has been taught as a supporting subject of one or two credits in a few universities. However, for Iranian industries, ergonomics was until recently an unfamiliar subject. The first systematic attempt to introduce ergonomics in the Iranian industries started with a cooperative project between Center for Ergonomics of Developing Countries, (CEDC) and the Glucosan factories in Iran. This paper describes the methods and procedure used during the past 4 years to introduce ergonomics in the Iranian industries.

2. METHOD

In 1993 a 2-week training course, entitled “Contemporary Management” was organized at the Luleå University, Sweden for a group of Iranian industrial managers. One of the subjects discussed in the course for one day was ergonomics and its application in the industrially developing countries. The first author, a participant of the course, anticipated the benefit of ergonomics application in his industry and invited a scholar, from CEDC, (the second author) to help in applying ergonomic at the Glucosan factories. This was a pioneer ergonomics intervention attempt in an Iranian industry. The result of this unique exercise, regarded by the factory as success, was analyzed and presented at the ODAM – V, (5) and a complete up-dated report presented at ODAM – VI, (6).

A few years later, having observed the significant benefit of ergonomics, Mr. Helali, the Glucosan manager, became so much interested in the subject that he started a formal post graduate education in the field of ergonomics at Luleå University in February 1996. Since then, through a well established network among Iranian industries, better access to ergonomics knowledge, and close cooperation with CEDC, ergonomic intervention programme at Glucosan achieved more momentum and became an example of good ergonomic practice among Iranian industries.

At the Industrial Engineering conference of the Iranian Universities in December 1996, the factory organized a two-day ergonomics workshop and presented the ergonomics activities of Glucosan. Based on the positive effects experienced by this case, several other ergonomic workshops for providing training and ergonomic awareness were organized for a wide range of industrial and commercial firms in
Iran during 1996 and 1997. Methods and material used in the workshops were “Future Workshop” (7) and introduction to ergonomic checkpoint, 1996. (8).

In order to identify the participants’ opinions about the workshops and to assess the perceived strengths/weaknesses, an evaluation form was handed out at end of each workshop. As a follow up study (six months later) a questionnaire was designed and distributed to the workshops’ participants to find out the effect, it any, of these workshops. It was considered necessary to evaluate the success/failure of the workshop from two perspectives, i.e. of participants themselves as well as their perception of the receptiveness of management and colleagues within their organization.

Because the number of seminars and workshops were on the rise in Iran, by March 1997, Glucosan factories have translated and distributed 5000 copies of the “Ergonomic Checkpoints, 1996” mostly to the Iranian industries.

3. RESULTS

The experimental model of ergonomic intervention in Iran resulted from different specific attempts, and conducting ergonomic workshops for different groups of participants during 1995, 1996 and 1997:

I-Ergonomic training and implementation at Glucosan factories: An ergonomics process was initiated and supported by the factory management (5, 6). Through a systematic process of macro and micro ergonomics during 1993-1997, the following results have been achieved. The production capacity has risen from 70% to 105% of the nominal capacity. Utilization of starch from corn has improved by 11%. The quality of the products has improved, reaching international standard making it possible for the company to export its products. Further, all factory employees (380) received equal access to welfare facilities, and have purchased their individual homes through a company loan system. An increase of up to 600% in all employee wage surplus through profit sharing, institutionalization of the whole production system towards obtaining ISO 9002 certificates, and development of a new organization system for making full use of worker participation were the other achievements.

II-Introducing ergonomics to an industrial corporation: Twenty-four top managers of an industrial corporation (consisting of 20 different production and service firms) participated in a 3-day ‘Future Workshop (FW)’ conducted by the authors in the northern province of Iran in August 1996. One result of the FW was a complete catalogue of problems related to the development issue (theme of the FW). It highlighted 156 different problems within 5 categories in the following hierarchical order: management, government control, technology and production management, financial management and cultural and social issues.

Thirty-two of the identified problems were further analyzed and feasible solutions were proposed by the workshop participants. However, a questionnaire study conducted after 6 months showed that no effort were made by the workshop participants to implement any of the recommendation developed during FW nor were there any changes. The reasons mentioned in the questionnaire were: too much of daily routine work, lack of belief in the modern
theoretical knowledge, fear for change and no confidence in their ability to implement the learned knowledge, and lack of an independent supporting organization to provide the required know-how. In general, lack of a well-motivated and proactive top management plus a shortage of an active education and training center at the corporation could be mentioned as the main reasons for not having applied any of the learned knowledge in practice.

III-Ergonomic workshops: Tow groups of top and middle managers (12, and 19) from various production and service companies participated in two separate 3-day workshops organized in Teheran during August 96 and January 97. In the first workshop, FW method was used and for the second group ergonomic checkpoint was introduced and practiced. After the workshop, an evaluation form was filled by the participants and again after 6 months a questionnaire survey was conducted to find out if any ergonomic improvement has been made by participants as a result of the training programs.

The results of the workshop evaluations show that majority of participants (over 60%) assessed the workshop as good and very good. However, only 50% of the participants have filled the after 6 month questionnaire. They all considered the workshop as very useful and wanted their bosses to participate in such training programs. They also wanted more ergonomic support in order to implement the acquired knowledge. Establishment of a national ergonomic organization or center that can provide regular up-to-date information and support was also recommended.

The general conclusion from this type of ergonomic intervention through workshops’ training is that also all participants were very positive about the ergonomic training and its benefit, only one was able to implement the knowledge afterwards in his workplace. This was probably due to the fact that individuals of the organization went through a learning process but not the organization as a whole and therefore the organization could not make full use of the acquired competence. Individual knowledge cannot be utilized unless the required environment is provided for a ‘development work activity’.

IV- Other activities: Managers of the Glucosan factories have presented papers and organized a workshop at the National Industrial Engineering Conference 96, presenting their ergonomic activities. In March 97 the ‘Ergonomics checkpoint, ILO, 1996’ was published and distributed free of charge to 150 top government and private decision makers. In July 1997 ‘Danesh Maal Institute DMI’, was established by Iranian shareholders. The aim of DMI is to act as a supporting organization for the Iranian industries that are interested in ergonomics training and application. Further, it will be a contact center, linking Iranian scholars living outside of Iran with the Iranian industries. It is also planned to publish a regular journal ‘Human, Work and Environment’ in cooperation with the Center for Ergonomics of Developing Countries, CEDC of the Luleå University of Technology-Sweden. Further, it is planned to introduce a graduate programme in ergonomics in cooperation with CEDC and organizing more awareness activities, such seminars and workshop.
4. DISCUSSION

In the experimental model of ergonomic intervention in Iran, ergonomic training as the major tool has yielded different results in different attempts. The main reason for such diverse effects was the degree of organizational learning process. Since individual learning was mostly the focus of the training programme, the learned material could not be equally implemented by the individuals who participated in the learning process because of the important role of organization and the environment in the learning process. According to Singelton (9), learning organization must be free from organizational, procedural, communications and interaction barriers that increase.

Physical and mental effort required of the employee to achieve their goals. Further, according to Sylwester (10) neurons flourish only in an environment that stimulates people to receive, store and transmit information. According to Paul, (11) ergonomically sound and supportive environment, motivation and emotion can stimulate learning. It is a dynamic process influenced by group dynamics, role, flexibility, group relationship, communication, power to carry-through, control and authority and participation etc., (12, 13).

In the case of Glucosan, the success of the intervention programme was mostly due to the establishment of a R&D group with full support of the top management, participation of all top, middle and floor managers in the ergonomics training. Furthermore, the involvement of all managers in the ergonomic intervention teams which cooperated closely with the R&D group. In this case, both individual as well as whole organization went through an intensive learning process. The managers became learning managers and the top manager provided a condition that facilitated the process of self-development through motivation, support and agility. All activities at the factory become a sort of 'development work activity' a prerequisite for changing from a bureaucratic organization to a learning organization.

In the case of the industrial corporation, although all twenty-four top managers of the industrial corporation (consisting of 20 different production and service firms) participated in a training programme and evaluated the programme as very useful at the end of the training, they did not implement the learned material in their firms. The reasons they mentioned in the questionnaire survey were the bulk of daily routine work and that they did not have the needed motivation and confidence to do any changes at their firms. The organization of the whole corporation was considered as not adaptive, but rather bureaucratic and therefore not a learning organization.

In the case of the other industries, the participants who took part in the ergonomic training workshop could not implement their learned knowledge to a greater extent at the local workplaces. This was mostly due to the fact that the individual learning was achieved but the dynamic process of organizational learning was missing. This was a hindrance for the individual to implement their newly achieved competence in their work environment which was not receptive to changes.

It is believed that no other alternative than the systematic scientific approach led by a group of scholars could have speeded up the process of ergonomics.
development in Iran. This was the fundamental reason for establishing the ‘Danesh Maal Institute DMI’ that would provide the needed theoretical and practical support to the Iranian firms in their endeavor to implement ergonomics and benefit from it.

REFERENCES

Paper E

Ergonomics intervention in industries of the industrially developing Countries, Case study - Iran Khodro (car) Company-IRAN

Faramarz HELALI, Houshang SHAHNAVAZ
Center for Ergonomics of Developing Countries (CEDC), Department of Human Work Sciences, Luleå University of Technology, 971-87 Luleå – Sweden
faramarz.helali@arb.luth.se, Houshang.shahnavaz@arb.luth.se

Abstract

In the process of introducing ergonomics to IRAN (Helali and Shahnavaz, 1996 and 1998, Shahnavaz 2000, 2001) and the objective of Center for Ergonomics of Developing Countries (CEDC), the management of PTW (Prevention, Treatment and Welfare) of Iran Khodro Car Company in Iran (IKCo) has decided to apply ergonomics for improving IKCo’s work stations. This was a co-operative project between PTW and the CEDC. The first phase of the project was planned to last for 18 months, during which 32 engineers, occupational heath specialists and safety engineers from IKCo have been trained in ergonomics theories and practice at varies workshops. The emphasis of the project was employees participation and to taking advantage of local skills and resource. A special organization was designed for this project. Proposed ergonomic activities were divided into three categories, 1)- ergonomics training, ergonomics application and evaluation, 2)- research activities and 3)- network building. Thanks to conduct of phase 1 of the ergonomics intervention project at IKCo, the management is now in a much better position to deal and make best use of human resources.

Keywords: Ergonomics, Intervention, Evaluation, Industrially Developing Countries

1. Introduction

Ergonomics, after half a century that exist as an identified profession, remains in its infancy in many Industrially Developing Countries (IDC). Almost two-thirds of the world’s population has little or no access to the vast knowledge that makes ergonomics application so important for improving health, safety and productivity at work.

Ergonomics has the potential to create harmony between technology, the technology users and the operating environment and contributes to optimum utilization of technology and sustainable development in IDCs.

Lack of awareness about the potential benefit of ergonomics is the primary cause for under utilization of ergonomics principals. There is, however, no doubt that application of micro and macro ergonomics is essential for improving working conditions, system efficiency and promotion of the quality of working life in IDCs (Shahnavaz, 1995).
The Center for Ergonomics of Developing Countries (CEDC) has started various programs for introducing ergonomics to Iranian industries and universities since 1993.
CEDC have conducted more than 20 workshops for 541 participants in Iran. As a result of these training and awareness building activities, many Iranian industries, government and training organization have become interested in ergonomics.
Further, the Iranian Ergonomics Society (IES) was established in 2001 with the support of CEDC and had its first annual meeting in 2001.
One of Iranian industries, which became interested in using ergonomics, was the largest car manufacturing company, Iran Khodro (IKCo), located at outskirts of Tehran.
“IKCo was founded with registered capital of 100,000,000 Rls On 18th Aug 1962. It is the largest vehicle manufacturer company in Iran, having an average share of 65 to 70 percent of domestic vehicle production (and about 18000 employers). Registered Capital of IKCo by the end of Iranian fiscal year 1379(20th March, 2001) was Rls. 1,282,500,000.000 for 1282.5 million shares, each 1000 Rls. In 1997, IKCo broke the record in the 35 years history of production of the company by producing 111,111 units of various passenger cars and vans.” (www.ikco.com/history/)

2. OBJECTIVES

Ergonomics awareness effort started gradually during 4 years, since 1996, at IKCo with few isolated activities, such as one day to few hours seminars and later a few days workshop. During the year 2000, after almost one year of negotiations, with the management of PTW on a comprehensive programme for applying ergonomics and creating an ergonomic process at IKCo, in May 2001, a project proposal developed by CEDC was approved for implementation. The project was designed in 3 phases as a cooperative activity between PTW and CEDC. The main emphasis in the project design was to take advantage of local skills and resources using a participatory approach with the objectives of improving working conditions, working systems, productivity and employee’s satisfaction. The project is designed in 3 phases as follows:
Phase 1 – Improving work stations
Phase 2 – Improving work systems and organizational procedures
Phase 3 – Improving products (outputs)
The first phase of the project was planned to last for 18 months. The objective of this phase was to develop ergonomic awareness, and knowledge, train a selected group of IKCo employees in ergonomics theories and practice and assist them in implementing the learned knowledge for improving the company’s workstations and creating better working conditions. An ergonomics expert from CEDC (the project manager) and two of his PhD student acted as facilitators, who have conducted training and co-operated in the follow-up, evaluation and documentation of the ergonomics project.
3. Project Method

3.1. The company has appointed 32 engineers, occupational health specialists and physicians from different working sites of the company to participate in the ergonomic project. These people have been divided into 6 “Action Group (AG)” consisting of 4 to 6 members from different workstation, as follows: Casting group (1), Press group (2), Motor group (3), Paint group (4), Bodywork group (5), Assembly, Supplemental & Ornamental group (6). After one month, the Assembly, Supplemental & Ornamental group was divided into two groups Supplemental & Ornamental group (6) and Assembly group (7). A steering committee consisting of 5 members from PTW have also been developed to supervise and support the ergonomics activities under the director of PTW (See figure 1). A member of PTW was appointed as the steering committee secretary (SCS), and the contact person between AG, CEDC and the SC.

Figure 1- Proposed organization for the ergonomic project at IKCo

AGs were responsible for training employees at their workshop on basic ergonomics and creating a good condition for employee’s involvement in workplace improvement. They were further responsible to:
- Evaluate each workplace at their worksites and develop feasible and cost effective improvement project proposal according to a standard procedure, called “Logical Frame Work Approach (LFA)”.
- Implement the project proposal after the SC has approved it.
- Evaluate their activity progress. Both group members’ activity as well as group activity on a regular basis.
- Spread ergonomics knowledge to their worksites and create ergonomics awareness and participation.

The responsibilities of the SC were described as:
- Setting policies and administrative procedures for their activities
- Interacting with AGs and documenting of project progress
- Promoting AGs’s activities
- Reviewing and approbating AGs plans for ergonomics implementation
- Supporting and confirming AGs activity plan (time, place and budget)
- Evaluating AG’s activities on regular basis
- Designing rewards and systems of motivation for AGs

The responsibilities of the Supporting Team (CEDC Facilities) were:
- Training and awareness building, scientific Leadership, project monitoring, evaluation, developing research plans and assisting in network building

3.2. Training and awareness building:

Various training programs have been conducted to create the needed ergonomics awareness, develop basic ergonomics knowledge and skill for change and improvement activities as follows:

3.2.1. The first training workshop was held by project manager in May 2001. In this workshop, 32 engineers, occupational health specialists and physicians appointed by IKCo have participated in a 5-day workshop at the company’s country club conference site. A holistic and participative educational method was applied. The topics covered were; basic ergonomics, ergonomics of workplace assessment, methods of ergonomics application and ergonomics activity development process.

Further, LFA method, various checklist, ILO ergonomics checkpoints and participative problem solving procedure were introduced and trained.

3.2.2. Workshop for middle management in basic ergonomics for 3 days at IKCo training center by the project manager.

3.2.3. Training workshop for AGs on ergonomics in design for 5 days at IKCo by one of Ph.D. student.

3.2.4. On the job training on team work techniques, such as aquarium model and role playing for AGs at IKCo, by one of Ph.D. student.

3.2.5. Training in Macro-Ergonomics for top management for one day at a conference site in Tehran, outside IKCo by project manager.

3.2.6. Workshop in manual material handling for five days at IIT, Bombay, India by IIT academic staff and project manager.

3.2.7. Workshop for training AGs and SC on participatory ergonomics and Posture analysis for one day at IKCo training site by the project manager.

3.2.8. On the job training on LFA and team working separately at each AG, by one of Ph.D. student.

3.3. Methods used for forming the AGs:

3.3.1. On the job training: Every 15 days, action groups had a collective meeting, at PTW conference room. The seven AGs were divided into 2 large groups of 3 and 4 AGs. The first group met for 4 hours in the morning and the second in the afternoon for another 4 hours. In these meetings, AGs’ progress was discussed. The groups exchanged ideas and information and assisted each other in learning techniques for evaluating their progress. In these meeting the project facilitator informed them also about new technique, for better working and conducting their duties as efficient teams.
3.3.2. Evaluation of AGs’s activities: Each month all AGs met at a conference site outside of IKCo to exchange idea and discuss their progress. The seven AGs were gathered together for one day from 8 t0 16 in a workshop. The workshop leader was one of PhD student. After each AG has presented their activities, they were asked to evaluate their progress and give score to themselves.

3.3.3. Monitoring of AGs activities and providing support: Every second week one AG was selected randomly and one of the fascinator (Ph.D. student) participated without previous announcement in their weekly meetings. This was done to monitor AG’s activity and support the group if necessary.

3.3.4. Evaluation of SC: Each second week, SC had a meeting at IKCo. Some of the members of SC have also participated in the meetings and training workshops of AGs. In these SC meeting, they informed SC about project progress and other issues that needed SC input. One Ph.D. student was always present at these meetings.

3.3.5. Introducing the project for the managers of worksites in separate meetings: The managers of worksites were informed about the project progress in a formal meeting by the worksite AG. This has helped to introduce project activities and get support for AGs activity.

3.3.6. Major evaluation of the ergonomics intervention project: Every 6 months the project manager conducted a major evaluation workshop. All AGs have presented there past activities, this was discussed by the whole group. Further, the project participants have developed lists of problems that they have faced in their work, what they need and require for more efficient work which was later discussed with SC.

3.3.7. Evaluation of the team work training: After seven months the states of the team working within the AGs was evaluation by one Ph.D. student. The results are presented in a paper for CybErg2002.

3.3.8. Evaluation of AGs after one year: During 4 days, each individual AG has attended a separate workshop for half a day with the project manager.

3.3.9. Meeting with top management: AGs have presented their success stories that were achieved after a year effort for top the management in a 4 hours seminar. The top management discussed the implemented projects and gave feedback to the AGs.

3.4. **Ergonomics application:**

The training program was concentrated on providing the needed knowledge and skill to AGs for doing workplace improvement. Each AG after surveying workplaces in their worksite have developed standard project proposals (LFA) for workplace improvement and have send it for approval to the SC. The approved projects were implemented by the AGs, using local resources.

3.5. **Research and Network building:**

Other objectives of the first phase of the project were research and network development.

The purpose of research is to identify research questions that are specific to IKCo and develop ergonomics research projects that deal with specific issues such as
employee’s health, environmental conditions, cultural issues, customer’s requirements and expectation. Few research projects such as following have been discussed and are under development.
- Association between health risks, health conditions and organizational issues at different workshops, and
- Musculoskeletal problem at various workstation, absenteeism and quality of working life.

Network building was regarded as an important support factor for IKCo. The aim is to build a strong network of people and companies with expertise in ergonomics of car manufacturing, workplace design, occupational health, safety and work organization. Along this line a week workshop was organized at Indian Institute of Technology (IIT) in Bombay, during January 2002. In connection to this, the groups had also the opportunity to visit TATA Car Company in Puna and establish contact and working relationship. Further, it is planned for the group to visit Volvo Car Company in Sweden during October 2002.

4. Result

4.1. Result of Methods applied:

4.1.1. AGs assessment: After one year of forming the AGs, they are in more need of an acceptable evaluation and assessment method, which can create motivation and satisfaction, considering culture and the environmental conditions of the company. During the Bombay workshop the “ProMES” method (a method for measuring and improving organizational productivity, Prichard, 1995) was introduced by the project manager. It was decided that AGs should discussed the method within their group and modify it. During the latest workshop, which was held at IKCo by the project manager in April 2002, the method was finalized and accepted as the major evaluation method of AG’s activities by SC.

4.1.2. Change of organization:

4.1.2.1. The SC after the second months has decided to appoint one of its members as the executive officer responsible for AG’s activities. This decision was taken for making SC more involved in the AG’s activity and for providing the AGs with needed support. In April 2002, it was observed that the SC in its current form could not perform its duties effectively and was in need of radical improvement. During a whole day workshop with all members of the SC, the project manager and one of the facilitators reviewed the activities of SC and the organizational structure. The group (using the ‘Circle Model’) has developed a new vision a set of objectives and decided on various activities and strategies for more effective work, according to a planned timetable. In this workshop the project executive officer was changed and one of the members of AGs which was considered as very active, motivated and knowledgeable by both project management and AGs members were selected as the new executive officer.

4.1.2.2. After six months, a Technical Committee (TC) has also established for better utilization of available human resources and for better conduct of the project. This committee consists of individual experts from AGs, SC and their job is to support both the AGs in their activities as well as the SC.

6
### 4.2. Training and awareness:

<table>
<thead>
<tr>
<th>No</th>
<th>Name of workshops</th>
<th>Numbers of participants</th>
<th>Time (hours)</th>
<th>Total man hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Ergonomics</td>
<td>35</td>
<td>40</td>
<td>1400</td>
</tr>
<tr>
<td>2</td>
<td>Design of tools</td>
<td>35</td>
<td>30</td>
<td>1050</td>
</tr>
<tr>
<td>3</td>
<td>On the job training:</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aquarium model and role playing for team work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Workshops in India:</td>
<td>35</td>
<td>18</td>
<td>630</td>
</tr>
<tr>
<td>5</td>
<td>On the job training on LFA and team working at each AGs separately</td>
<td>35</td>
<td>48</td>
<td>1680</td>
</tr>
<tr>
<td>6</td>
<td>Work posture &amp; participatory ergonomics</td>
<td>35</td>
<td>8</td>
<td>280</td>
</tr>
</tbody>
</table>

Total: 1

### 4.3. Methods used for forming the AGs:

<table>
<thead>
<tr>
<th>No</th>
<th>Kind of activities</th>
<th>Form of conduct</th>
<th>Numbers of participants</th>
<th>Time (hours)</th>
<th>Total man hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>method 3.3.1</td>
<td>session</td>
<td>35</td>
<td>18</td>
<td>630</td>
</tr>
<tr>
<td>2</td>
<td>method 3.3.2</td>
<td>workshop</td>
<td>35</td>
<td>29</td>
<td>1015</td>
</tr>
<tr>
<td>3</td>
<td>method 3.3.3</td>
<td>session</td>
<td>32</td>
<td>16</td>
<td>512</td>
</tr>
<tr>
<td>4</td>
<td>method 3.3.4</td>
<td>session</td>
<td>4</td>
<td>28</td>
<td>112</td>
</tr>
<tr>
<td>5</td>
<td>method 3.3.5</td>
<td>session &amp; negotiation</td>
<td>30</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>methods 3.3.6</td>
<td>(The first step after six month) Workshop</td>
<td>35</td>
<td>8</td>
<td>280</td>
</tr>
<tr>
<td>7</td>
<td>method 3.3.8</td>
<td>(The second step after one year) Workshop</td>
<td>35</td>
<td>4</td>
<td>140</td>
</tr>
<tr>
<td>8</td>
<td>method 3.3.9</td>
<td>Meeting with top management</td>
<td>41</td>
<td>4</td>
<td>164</td>
</tr>
</tbody>
</table>

Total: 109

### Table 4: Comparison of various AGs activities with the project (Time hours)

<table>
<thead>
<tr>
<th>Topic</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time hours</td>
<td>151</td>
<td>110</td>
<td>109</td>
<td>370</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>40.81%</td>
<td>29.73%</td>
<td>29.46%</td>
<td>100%</td>
</tr>
</tbody>
</table>
4.4. Result of ergonomics application:

4.4.1. The first major assessment of the project that was conducted after 6 months showed many positive results. All AGs were involved actively in much improvement Projects at their workshops. Over 20 small and medium to large-size ergonomic improvement projects have been proposed by AGs and were mostly completed according to the planned timetable.

4.4.2. The second major assessment of the project conducted after one year: More than 60 projects have been developed by AGs and sent to SC and 35 of them were implemented by AGs. In an evaluation workshop during one week, every member of AGs has answered and discussed in the group the following questions:

1- What are my objectives to continue in this group and what are the goals of my group?
2- Where are we in our ergonomic process at IKCo?
3- What is my glory in this project and what are we proud of?
4- Where was I unsuccessful and were we have failed?
5- What do we need for our future work?
6- Where do we want to go and what do I like to achieve?

This information was collected to assess the attitude and level of motivations among AGs’ participants as well as their vision, needs and expectations for future activities.

After visiting ergonomics implementations conducted at each AGs’ worksites, and discussing with other workshop employees, the project manager observed several shortcoming and some improper conducts. The maters were discussed both with individual AGs as well as the SC and measures for improvement were taken. It is obvious that introducing a new concept and changing the habits and working cultures of people are not an easy and straightforward task. We need more time for establishing good ergonomics conduct by AGs and for forming an efficient SC.

4.5. Research and Network building:

Iranian Ergonomics Society (IES’) has celebrated the “Ergonomics Day” on September 7, 2001 at IKCo. The first issue of “Payame Ergonomy dar Sanaat” (Ergonomics message from industry) was published by IKCo in 31 pages and the first issue of IES journal called “Payame Ergonomics, IES” in 24 pages was published and distributed at the Ergonomic Day. Further activities of three AGs were presented at this seminar.

The progress of team working effort at IKCo was studied through questionnaire study and is presented at CybErg2002. In addition, the AGs have prepared a written paper on their achievements, which is also presented at CybErg2002.

The first national ergonomics conference is planned by IES on 29-30 October 2002. All seven AGs will be active participant and IKCo will publish the second “Payame Ergonomy in sanaat” for this occasion.
6. **Discussion:**

<table>
<thead>
<tr>
<th>Topic</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total man hours</td>
<td>5285</td>
<td>3850</td>
<td>2913</td>
<td>12048</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>43.87%</td>
<td>31.95%</td>
<td>24.18%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The synergistic effect of a macro ergonomics approach at workplaces is reported earlier in the literature (Hendrick, 1994). The ergonomics intervention programme at IKCo, using a participatory approach has discovered new capabilities in the workforce.

Industrially developing countries (IDC) that have relatively more problems in workplaces are those most in need of ergonomics applications. The results of this project show that it is possible to carry out much workplace improvement by utilizing employee's potentials.

The first phase of project has created many small wins. AGs have managed to create ergonomics awareness at their worksites and conduct many small projects. This small wins create psychological dynamic that has been described by weick (1984). Small wins may also provide ways for people to learn new skills and learn more about their jobs.

Small wins that are achieved by AGs with very low or no cost are preferable over large wins, because they are more structurally sound. They are more stable if they are built one on the other. (Noro & Imada, 1991). On the other hand, a challenging job for the AGs and the SC will be to find a common language and methodology for problems solving and introducing change at IKCo. The project organization was consisting of 3 main groups (SC, AGs and the facilities). Some of the group had both plan and planning for carrying out the task and some just one of these two. During one year activities it has been shown that “Plan is nothing and planning is every thing”.

7. **Conclusion**

The outcome of this the first phase of project at IKCo clearly show that by using a well defined scientific method and by motivating employers, employees and having good monitoring system, it is possible to develop an improve process at work and do many ergonomics intervention activities.

The key issue for improving the existing conditions at the workplaces is to improve the people competent for making use of ergonomics knowledge and practice. The other challenge is to fit the evaluation methods into the culture of the country as well as company. This was only achieved through management support, employee’s participation and building proper intervention teams.

Through the first phase of ergonomics intervention at IKCo, top management is in a much better position to deal and make best use of human resources.
References:


Shahnavaz, H., Helali, F. and K.H. Hojjati Emami 2000, Macroergonomics in Industrially Developing Countries – Case Study Iran, proceedings of the IEA, San Diego. USA.

Shahnavaz, H, 1995, Making ergonomics a world –wide concept, Ergonomics Society Lecture, the University of Kent at Canterbury, UK. www.ikco.com/history/


Paper F

Ergonomics intervention in Iran Khodro Car Company (IKCo)

Helali, F., Motamedzadeh, M. and Shahnavaz, H

Center for Ergonomics of Developing Countries (CEDC), Department of Human Work Sciences, Luleå University of Technology, 971-87 Luleå – Sweden

Abstract

Management of the largest car manufacturing industries in Iran, Iran Khodro (IKCo) has decided in February 2000 to initiate an ergonomics intervention project in cooperation with the Center for Ergonomics of Developing Countries (CEDC). The project was designed in 3 phases and the department of PTW (Prevention, Treatment and Welfare) of IKCo was the project collaborating partner. The main objective of the project was to establish an ergonomics intervention process (EIP) at the company for improving employees’ health, safety and productivity.

The first phase of the project did last for 18 months, and aimed at developing ergonomic competent at IKCo for dealing with micro ergonomics issues such as improving the workstations and working conditions. During the first phase, 32 engineers, occupational health specialists and safety engineers from IKCo have been trained in ergonomics theories and practice at different workshops. The emphasis of the project was to develop an ergonomic process at IKCo and take advantage of local skills and resource. An especial organization was designed and established at IKCo to carry out the project. An ergonomics expert and two of his PhD students from CEDC have co-operated in the training, consulting, follow-up, evaluation and documentation of the project. The methodology applied was action learning, on the job training and team working. A holistic, participative and multidisciplinary approach was conducted throughout the project. Ergonomic activities were divided into: Training, ergonomics intervention, evaluation, research and network building.

This paper will discuss the result of phase one and the experiences gained from the 18 months ergonomics intervention process in a large Iranian industry. Further, a theoretical model has been proposed and the activity plans for phase 2 which will take another 2 years have been presented.

Keywords: Ergonomics, Intervention, Industrially Developing Countries

1. Introduction

One of the Iranian industries, which became interested in using ergonomics, was the largest car manufacturing company, Iran Khodro (IKCo), located on the outskirts of Tehran.

“IKCo was founded with registered capital of 100,000,000 Rls on 18th Aug 1962. It is the largest vehicle manufacturer company in Iran, having an average share of 65 to 70 percent of domestic vehicle production and about 18000 employers. Registered Capital of IKCo by the end of Iranian fiscal year 1379 (20th March, 2001) was Rls. 1,282,500,000,000 for 1282.5 million shares, each 1000 Rls (www.ikco.com/history/).

2. OBJECTIVES

Ergonomics awareness efforts started gradually over 4 years, since 1996, at IKCo with a few isolated activities, such as one day to few hours seminars and later a few days workshop. During the year 2000, after almost one year of negotiations, with the management of PTW on a comprehensive programme for applying ergonomics and creating an ergonomic process at IKCo, in May 2001, a project proposal developed by CEDC was approved for implementation. The project was designed in 3 phases as a co-operative activity between PTW and CEDC. The main emphasis in the project design was to take advantage of local skills and resources using a participatory approach with the objectives of improving working conditions, working systems, productivity and employee’s satisfaction. The project is designed in 3 phases as follows:
Phase 1 – Improving workstations
Phase 2 – Improving work systems and organizational procedures
Phase 3 – Improving products (outputs)

The first phase of the project was planned to last for 18 months. The objective of this phase was to develop ergonomic awareness and knowledge, train a selected group of IKCo employees in ergonomics theories and practice and assist them in implementing the new knowledge for improving the company’s workstations and creating better working conditions. An ergonomics expert from CEDC (the project manager) and two of his PhD students acted as facilitators, who have conducted training and co-operated in the follow-up, evaluation and documentation of the ergonomics intervention project.

3. Project Method

3.1. The company appointed 32 engineers, occupational health specialists and physicians from different working sites of the company to participate in the ergonomic project. These people were divided into 6 “Action Groups (AG)” consisting of 4 to 6 members from different workstations (work sites), as follows: Casting group (1), Press group (2), Motor group (3), Paint group (4), Bodywork group (5), Assembly, Supplemental & Ornamental group (6). After one month, the Assembly, Supplemental and Ornamental group was divided into two groups Supplemental and Ornamental group (6) and Assembly group (7). A steering committee consisting of 5 members from PTW was also developed to supervise and support the ergonomics activities under the director of PTW. A member of PTW was appointed as the steering committee secretary (SCS), and the contact person between AG, CEDC and the SC (Helali. F and Shahnavaz, H., 2002).

3.2. Training and awareness building: Various training programs have been conducted to create the needed ergonomics awareness, develop basic ergonomics knowledge and skills for change and work station improvement activities as follows:

3.2.1. The first training workshop was held by the project manager in May 2001. In this workshop, the 32 engineers, occupational health specialists and physicians appointed by IKCo participated in a 5-day workshop at the company’s country club conference site. A holistic and participative educational method was applied. The topics covered were: basic ergonomics, ergonomics of workplace assessment, methods of ergonomics application and ergonomics activity development process. Further, the Logical Framework Approach (LFA) method, various checklists, ILO ergonomics checkpoints and participative problem solving procedures were introduced and trained.

3.2.2. Workshop for middle management in basic ergonomics for 3 days at IKCo training center by the project manager.

3.2.3. Training workshop for AGs on ergonomics in design for 5 days at IKCo by a Ph.D. student.

3.2.4. On the job training on team-work techniques, such as the aquarium model and role playing for AGs at IKCo, by a Ph.D. student.

3.2.5. Training in Macro-Ergonomics for top management for one day at a conference site in Tehran, outside IKCo by the project manager.

3.2.6. Workshop in manual material handling for five days at IIT, Bombay, India by IIT academic staff and the project manager.

3.2.7. Workshop for training AGs and SC on participatory ergonomics and posture analysis for one day at IKCo training site by the project manager.

3.2.8. On the job training on LFA and team working separately at each AG, by a Ph.D. student.

3.2.9. Workshop for training AGs on office ergonomics for two days at IKCo by the project manager.

3.3. Methods used for forming the AGs:

3.3.1. On the job training: Every 15 days, action groups had a collective meeting, at the PTW conference room. The seven AGs were divided into 2 large groups of 3 and 4 AGs. The first group met for 4 hours in the morning and the second in the afternoon for another 4 hours. In these meetings AGs’ progress was discussed. The groups exchanged ideas and information and assisted each other in learning techniques for evaluating their progress. In these meetings the project facilitator informed them about new techniques for better working and conducting their duties as efficient teams.

3.3.2. Evaluation of AGs’s activities: Each month all AGs met at a conference site outside of IKCo to exchange idea and discuss their progress. The seven AGs were gathered together for one day from 8 to 16 in a workshop. The workshop leader was a PhD student. After each AG presented their activities, they were asked to evaluate their
progress and give self-score their progress.

3.3.3. Monitoring of AGs' activities and providing support: Every second week one AG as selected randomly and one of the facilitator (Ph.D. student) participated without previous announcement in their weekly meetings. This was done to monitor AG’s activity and support the group if necessary.

3.3.4. Evaluation of SC: Each second week, SC had a meeting at IKCo. Some of the members of SC have also participated in the meetings and training workshops of AGs. In these meetings, they informed SC about project progress and other issues that needed SC input. One Ph.D. student was always present at these meetings.

3.3.5. Introducing the project for the managers of worksites in separate meetings: The managers of worksites were informed about the project progress in a formal meeting by the worksite AG. This has helped to introduce project activities and support for AGs activity.

3.3.6. Major evaluation of the ergonomics intervention project: Every 6 months the project manager conducted a major evaluation workshop. All AGs presented their past activities; this was discussed by the whole group. Further, the project participants have developed lists of problems that they have faced in their work, what they needed and required for more efficient work that was later discussed with SC.

3.3.7. Evaluation of the team-work training: After seven months the state of the team-working within the AGs was evaluated by a Ph.D. student. The results are presented for CybErg2002 (Motamedzadeh, M, et al, 2002).

3.3.8. Evaluation of AGs after one year: During 4 days, each individual AG attended a separate workshop for half a day with the project manager.

3.3.9. Meeting with top management: AGs presented their success stories that were achieved after a year’s effort for top management in a 4 hour seminar. The top management discussed the implemented projects and gave feedback to the AGs.

3.4. Ergonomics application:

The training program was concentrated on providing the needed knowledge and skills to AGs for doing workplace improvement. Each AG after surveying workplaces in their worksite developed standard project proposals (LFA) for workplace improvement and sent it for approval to the SC. The approved projects were implemented by the AGs, using local resources.

3.5. Research and Network building:

Other objectives of the first phase of the project were research and network development. The purpose of research was to identify research questions that are specific to IKCo and develop ergonomics research projects that deal with specific issues such as employee’s health, environmental conditions, cultural issues, customer’s requirements and expectation. Some research projects such as the following were discussed few have been conducted and few other are under development.

Association between health risks, health conditions and organizational issues at different workshops, was conducted as a MSc. thesis project by one student at Luleå University of Technology (Rahmany, K. 2003). A project under development is on musculoskeletal problems at various workstations, absenteeism and quality of working life.

Network building was regarded as an important support factor for IKCo. The aim was to build a strong network of people and companies with expertise in ergonomics of car manufacturing, workplace design, occupational health, safety and work organization. Along this line a week workshop was organized at the Indian Institute of Technology (IIT) in Bombay, during January 2002. In connection with this, the groups had also the opportunity to visit TATA Car Company in Puna and establish contact and working relationship.

4. Result of methods applied

After 18 months and at the end of the first phase of the project, the action groups (AGs) were in more need of an acceptable evaluation and assessment method which can create motivation and satisfaction, considering the culture and the environmental conditions of the company. In the first phase and during the 18 months duration of the project, all together 7 training workshops were conducted within the project. The total training time was estimated to 151 hours and 5285 total man hours. In addition, 109 hours and 2913 total man hours were spent for forming the AGs and developing their working procedure. In total 90 projects were designed and carried out by AGs. Out of these, 55 projects were implemented completely at worksite by AGs. The
management has accepted the first phase of the project as a successful attempt and approved its continuation.

4.1. General participants' perception at IKCo after the first phase of intervention project (Helali F, 2003):

<table>
<thead>
<tr>
<th>Factors considered as positive and contributing to project success</th>
<th>Factors which were negative and caused problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friendly communications</td>
<td>· An informal structural</td>
</tr>
<tr>
<td>Participation</td>
<td>· Insufficient time</td>
</tr>
<tr>
<td>Team working</td>
<td>· Unsuitable interval evaluation</td>
</tr>
<tr>
<td>Systematic approach</td>
<td>· Lack of management rationalization</td>
</tr>
<tr>
<td>A new scientific discipline</td>
<td>· No job security</td>
</tr>
<tr>
<td>Good training and applying</td>
<td>· Negative view of “improvement in their industry”, such as ‘improvement is not feasible in the workplaces”</td>
</tr>
<tr>
<td>Promoting ergonomics culture</td>
<td></td>
</tr>
<tr>
<td>Interested personal</td>
<td></td>
</tr>
<tr>
<td>Supporting management</td>
<td></td>
</tr>
<tr>
<td>Creation of facilities for learning at workplace</td>
<td></td>
</tr>
</tbody>
</table>

4.2. Change of organization:

The Steering Committee (SC) in a participatory process with the facilitators (CEDC) decided to promote AGs activity. As a result, it was decided to develop integrated management system by integrating Occupational Health, Safety, Environment and Ergonomics (OHSE&E) to a single working group at each Salon (Worksites), under the leadership of worksite management. This phase was planned for two years starting in January 2003.

This decision was taken for making SC more involved in the AG’s activity and for providing the AGs with needed support. For better utilisation of the available resources and based on the experiences of the first phase, management of PTW (which was called PADAR) has decided to be more involved. As a result, in November 2002, it was decided to change PADAR organization toward ErgoPADAR. The goal was to bring ergonomics to all levels of the department and promote the application of macroergonomics intervention programme. After two weeks activities, the facilitators (CEDC) and Steering Committee (SC) have developed a functional organization for ErgoPADAR. More responsibility and authority have been placed for people dealing with ergonomics and a separate unit for research and development (R&D) was establishing at PADAR.

- After six months from the start of the phase one, a Technical Committee (TC) was also established for better utilization of available human resources and for better conduct of AGs project. This committee consisted of individual experts from AGs, SC and their job was to support both the AGs in their activities as well as the SC.

- After 18 months a Reference Committee (RC) consisting of top management was considered necessary for supporting SC in their tasks of promoting OHSE&E at IKCo, which is now established.

- Further, it was the facilitators of CEDC should become more involved in the second phase of the project.

5. Discussion and conclusion

In the case of IKCo, most participants were experts from various worksites. The success of the EIP was mostly due to a better role of local experts at the group level due to the participation in various training workshops. The top management was in a much better position to deal and make best use of human resources. AGs had an informal status in the worksite. Thus a contingency situation, in terms of cooperation between workstations managers and action groups was observed and reported. Hence, there was more improvement in staff relationship by formation of the action groups. The project organization of the EIP consisted of 3 main groups; SC, AGs and the facilitators (EIP team). Some of the group had both plan and planning for carrying out the task and some just one of these two (Helali. F and Shahnaz, H., 2002). Although, Tuckman (1965) mentioned that any team appears to go through stages of forming, storming, norming and performing. Only in the last stage is productive work done on the task itself. The earlier stages are important in establishing team identity and preparing for further work (Denton, 1997).

The outcome of this project clearly show that by using a well defined scientific method and motivating employers and employees and involving them actively in the three processes, it is possible to develop an improvement process at work and do many good ergonomics intervention activities.

Organization is a social structure wherein employees play a decisive role in improving its performance. Traditionally performance improvement is based on single top-down
actions, usually making employees unwilling to comply. It should also be noted that organizational changes are difficult, time-consuming and expensive process (Hammer and Champy, 1993).

A ‘Proposed of theoretical model for ergonomics intervention was introduced to IKCo management. The model is based on 3 major factors: Top management support for EIP, employee’s participation and knowledge support from facilitators (CEDC). Further the process starts with employee’s training, team working and feedback system. For the success of EIP, they should also be a functional and acceptable progress assessment system, recognition & reward system as well as appropriate communication net-work system. The proposed theoretical model was accepted by the IKCo management for phase 2 of the ergonomics project (see fig 1).

Reference

Assessment of implementing Ergonomic Training Workshops (ETWs) at three levels, the success of individual, group and organization during years 1995 to 2002 in Iranian Industries

Faramarz HELALI and Houshang SHAHNAVAZ
Center for Ergonomics of Developing Countries (CEDC) and Department of Human Work Sciences, Luleå University of Technology, 971-87 Luleå – Sweden

Abstract. The Ergonomics Intervention Programmes (EIP) can be a means of guaranteeing the most efficient use of the labour force of an industrially developing country (IDC) by creating safe and appropriate working condition. Many problems at work can be resolved with ergonomics intervention, but persist due to lack of awareness and know-how. Unfortunately ergonomics is in its infancy in many IDCs due to lack of knowledge and resources. This study attempts to investigate participants’ perception and their actions after finishing ergonomics training. Further, it investigates the effectiveness of ergonomics intervention programme technique in Iran, an IDC, for the purpose of improving working condition and productivity.

Ergonomic Training Workshops (ETWs) have been conducted since 1995 by the Center for Ergonomics of Developing Countries (CEDC) in Iran. The workshops were aimed to create ergonomics learning and implementation process at three levels, viz; ‘Individual, group and organization’ among participants of Iranian industries. It can be inferred that workshops, which were conducted at an industrial sight were most productive and effective for improving conditions at workplaces.

Keywords: Assessment, Macroergonomics, Ergonomics Intervention, Industrially Developing Countries

1. Introduction

Iranian industries, like most industries in IDCs, are not aware that application of ergonomics practices can help to remove barriers to development and cause greater industrial efficiency.

In recent years it has become clear that the training workshop with active trainees participation is the best method of conducting ergonomics training, especially for training people for Ergonomics Intervention Programme (EIP). A participative workshop with a holistic and multidisciplinary ergonomics-training program is an effective way for building competence among employees for designing and implementing improvement changes at work. Based on many ergonomics training workshops conducted in Iran, ‘Questionnaire survey’ and ‘opinion poll’ methods were used to collect information regarding ‘usefulness of the ergonomics training’ for the participants of industries at the three levels.

Three separate case studies were conducted, each with different intervention approach. In the first case study carried out at Glucosan factories (GC, a food industry), all three levels (individual, groups and organization) were trained. In the second case study, individual people from different Industries were trained. In the third case study carried out at Iran Khodro car company (IKCo), a group of people from different worksite were trained.

2. Investigation of participants’ perspective regarding the training workshops

Subjects

After about 18-24 months past each workshop, for each case, workshop’s participants were approached by an especial questionnaire, with the goals of assessing; “ergonomics application conducted at individual, group and organization level”. Questionnaires were sent to 186 participants from industries who have participated in different workshops during a 4 years period. Overall, 94 completed questionnaire (i.e. 51%) was received. The breakdown of the specific number of questionnaire sent and the response received for each target case is shown in table 1 below.

<table>
<thead>
<tr>
<th>Case</th>
<th>Target of number participants</th>
<th>Number of responded questionnaire</th>
<th>% of response per case</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC</td>
<td>57</td>
<td>37</td>
<td>65</td>
</tr>
<tr>
<td>IKCo</td>
<td>32</td>
<td>25</td>
<td>71</td>
</tr>
<tr>
<td>Others</td>
<td>97</td>
<td>32</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>186</td>
<td>94*</td>
<td>51%</td>
</tr>
</tbody>
</table>
Information regarding age of the participants that have replied to the questionnaire is shown in table 2. The position of participants (Top, Intermediate manager, Expert and Supervisor) is shown in table 3. Workshop’s participants had between 2 to 30 years of work experience in different factories.

Table 2: Statistics, ‘Age of participants’ that they have replied to the questionnaire

<table>
<thead>
<tr>
<th>N</th>
<th>Valid</th>
<th>94</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>38.14</td>
<td></td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>37.00</td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>3585</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Position of participants that have replied to the questionnaire at three levels

<table>
<thead>
<tr>
<th>Subject</th>
<th>Glucosan (GC)</th>
<th>BOCO</th>
<th>Others participants</th>
<th>N = 94</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top &amp; intermediate managers</td>
<td>Count</td>
<td>%</td>
<td>Count</td>
<td>%</td>
</tr>
<tr>
<td>Top &amp; intermediate managers</td>
<td>12</td>
<td>32.4%</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>Expert</td>
<td>9</td>
<td>24.3%</td>
<td>21</td>
<td>64%**</td>
</tr>
<tr>
<td>Supervisor</td>
<td>16</td>
<td>43.2%*</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>100%</td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>

3. Result

3.1. The results of the participant’s perception have presented in the following;

‘Summary of results from the questionnaire’: Results from the analysis of the completed questionnaire (N=94) are summarized in the tables shown below.

Table 4: Responses to the workshops at individual level

<table>
<thead>
<tr>
<th>Usefulness of training workshop at individual level</th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was useful for me</td>
<td>9.6%</td>
<td>40.8%</td>
<td>46.8%***</td>
</tr>
<tr>
<td>I know now how to improve working conditions</td>
<td>7.4%</td>
<td>43.6%*</td>
<td>49.0%</td>
</tr>
<tr>
<td>I have the ability now to improve my work at work</td>
<td>25.5%</td>
<td>45.7%*</td>
<td>28.8%</td>
</tr>
<tr>
<td>I have implemented some practical measures</td>
<td>6.4%</td>
<td>0%</td>
<td>93.6%*</td>
</tr>
<tr>
<td>I have understood workplace related problems</td>
<td>9%</td>
<td>12.8%</td>
<td>87.2%*</td>
</tr>
<tr>
<td>I used the knowledge in problem solving at home</td>
<td>5.3%</td>
<td>22.3%</td>
<td>72.4%*</td>
</tr>
<tr>
<td>My behavior is more positive now</td>
<td>38.3%</td>
<td>21.3%</td>
<td>40.4%*</td>
</tr>
</tbody>
</table>

Table 5: Distribution of respondent’s responses regarding problem identification and solutions

<table>
<thead>
<tr>
<th>Problem identified after workshop</th>
<th>Identification of problems at the workplace</th>
<th>Solving identified problems by ergonomics solutions</th>
<th>Personally solved identified problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>45.7%</td>
<td>45.6%</td>
<td>44.7%</td>
</tr>
<tr>
<td>Combination</td>
<td>43.0%</td>
<td>48.9%</td>
<td>42.6%</td>
</tr>
<tr>
<td>Physical agents, occupational factors, problems of machinery design and tools, and ambient factors</td>
<td>43.0%</td>
<td>48.9%</td>
<td>42.6%</td>
</tr>
<tr>
<td>Other factors</td>
<td>10.7%</td>
<td>7.9%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 6: Responses to the workshops at group level

<table>
<thead>
<tr>
<th>Usefulness of training workshop at group level</th>
<th>Percent Responses (N=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>It was useful for my group</td>
<td>8.5%</td>
</tr>
<tr>
<td>The power and influence of my work group has changed</td>
<td>4.9%</td>
</tr>
<tr>
<td>My job and position in my work group has changed</td>
<td>31.9%</td>
</tr>
<tr>
<td>I evaluated the changes as positive</td>
<td>6.4%</td>
</tr>
<tr>
<td>I observed conflicts in my group</td>
<td>87.2%</td>
</tr>
<tr>
<td>My work group is done better in improving working conditions</td>
<td>31.9%</td>
</tr>
</tbody>
</table>

Table 7: Responses to the workshops at organizational level

<table>
<thead>
<tr>
<th>Usefulness of training workshop at organizational level</th>
<th>Percent Responses (N=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>My organizational top manager has participated</td>
<td>47.9%</td>
</tr>
<tr>
<td>It was useful for my organization</td>
<td>4.3%</td>
</tr>
<tr>
<td>It was useful in practice</td>
<td>53.2%**</td>
</tr>
<tr>
<td>My organization has used the ergonomics knowledge that I have gained from participation in the workshop</td>
<td>61.7%**</td>
</tr>
<tr>
<td>My organization has changed</td>
<td>47.9%</td>
</tr>
<tr>
<td>The organizational changes are positive</td>
<td>4.3%</td>
</tr>
</tbody>
</table>

3.2. The results of implementing Ergonomic Training Workshops (ETWs) at three levels, viz; individual, group and organization:

3.2.1. At Glucosan factories (GC); the participants were trained at the three levels, viz; individual, group and organization

An ergonomics process was initiated and supported by the factory management (See papers I, II. Helali, F. 2003). Through a systematic process of macro and micro ergonomics intervention between 1995 and 1997 and ‘learning strategy’, the following results have been achieved.

- The production capacity has risen from 70% to 105% of the nominal capacity.
- ‘Utilization’ of starch from corn has improved by 11% (Starch percentage of corn). This was achieved through participatory ergonomics approach by the R&D team and several special Work Committee Groups (WCGs) comprising middle managers, technical personnel and workers.
- The quality of the products improved, reaching international standard making it possible for the company to export its products. The export of liquid Glucose was from 1995 to 1997 and Starch in 1997.
- All factory employees (380) received equal access to welfare facilities, and have purchased their individual homes through a company loan scheme.
- An increase of up to 600% in all employee wages through profit sharing.
- Developments of new organizational system for making full use of worker participation. Seven months after implementation of the new plan, the company profit increased by 85% (i.e. from 3980 million Rials to 7360 million Rials). After 12 months, the company’s profit rose by 390% (i.e. from 3980 million Rials to 19500 million Rials).

The increase in both productivity and profit was due to better utilization of both human and material resources which was achieved through training, increasing employees’ competence, participation and organizational readjustment.
3.2.2. Ergonomics workshops at individual level: the participants were trained from different industries, individually at ergonomics workshops

The general conclusion at the individual level is that, as a result of the ergonomic intervention through workshops’ training, all participants were very positive about the ergonomic training and its benefit (See paper III. Helali, F. 2003). The most of reports referred to physical ergonomic improvements by participants at workplace after attending ETWs. Due to the fact that individuals from the organization went through a learning process, but not the organization as a whole, the organization could not make full use of the acquired competence of the individuals.

3.2.3. At Iran Khodro (car) company (IKCo); the participants were trained at the group level

The first ergonomics process was initiated and supported by the management of PTW (Prevention, Treatment and Welfare) of Iran Khodro Car Company in Iran (IKCo) (paper V. Helali, F. 2003). In the first phase and during the 18 months duration of the project, 60 projects were designed by Action Groups (AGs) and were carried out. Out of these, 35 projects were implemented completely at worksite by AGs. The management has accepted the first phase project as a successful attempt. The Steering Committee (SC) at IKCo in a participatory process with the facilitators (CEDC) decided to promote AGs activity. As a result, it was decided to integrate Occupational Health, Safety, Environment and Ergonomics (OHSE&E) in each Salon (Workshop), under the leadership of workshop management.

4. Conclusion

It can be inferred that workshops, which were conducted at an industrial sight were most productive and effective for improving conditions at workplaces. This was because the participants coming from the same industry could exchange ideas, make interventions at workplace, see and evaluate the results, and get involved in a process of change. This creates a positive atmosphere at work as well as continuous action and learning and an intervention team.

General participants’ perception at GC & IKCo after the training workshops regarding the benefits of ergonomics training were: Friendly communications, Participation, Team working, Systematic approach, A new scientific discipline, Good training and applying, Promoting ergonomics culture, Interested personal, Supporting management and Creation of facilities for learning at workplace.

References
Paper H

A Model of Implementing Ergonomics Intervention Programme Technique (EIPT) in Industrially Developing Countries (IDCs) – Case Iran

Faramarz HELALI and Houshang SHAHNAVAZ

Center for Ergonomics of Developing Countries (CEDC) and Department of Human Work Sciences, Luleå University of Technology, 971-87 Luleå – Sweden

Abstract. Ergonomics intervention programme technique (EIPT) was defined as the activities performed by the facilitators (ergonomics expert and his Ph.D. students) for the purpose of doing: 1)- Ergonomics Training (ET), 2)- Building Awareness (BA), Ergonomics Application (EA) and Evaluation (E), 2)-Research Activities (RA) and 3)- Network Building (NB) in industries of the Industrially Developing Countries (IDC), case - Iran. Employees and management participation in the ergonomics activities was a key issue and integrating factor in this EIPT.

The EIPT was essential for establishing long term relationship between facilitators, the supplier of ergonomics know-how and users or receivers of know-how at three levels, viz. ‘individual, group and organization’ for a successful transfer of ergonomics technology.

Keywords: Macroergonomics, Intervention technique, Industrially Developing Countries

1. Introduction

A survey of the state of the art of ergonomics research and education in IDCs, gives a picture of the current problems, and help shed some light on appropriate actions for the future (Shahnavaz, 1995). This information highlights lack of systematic method and application in ergonomics activities in IDCs.

In recent years it has become clear that the training workshop with active trainee’s participation is the best method of conducting ergonomics training, especially for training people for Ergonomics Intervention Programme (EIP). A participative workshop with a holistic and multidisciplinary ergonomics-training programme is an effective way for building competence among employees for designing and implementing improvement changes at work. Based on the past 9 years experiences from ergonomics activities in Iran, an interaction model was developed and implemented for EIP process in Iran. In this case close cooperation of the Center for Ergonomics of Developing Countries (CEDC) with Iranian industries and universities, utilizing the local resources, participation of all people involved and emphasizing on low-costs solutions were the main reasons for success (Helali and Shahnavaz, 2003).

2. Materials and Methods of EIPT

2.1. Ergonomics Training (ET) method

The overall goals of an ergonomic training were:

1) To provide relevant knowledge (theoretical, practical and communicative),

2) To develop and stimulate human aptitude, talent and creativity for problem identification and problem solving solutions,

3) To provide the needed motivation for making optimum use of the learned knowledge and resources for making improvement through ergonomic intervention.

In each training method for EIP, the following tools and methods were used. These were referred to as ‘tools of EIPT’ in the study. These tools help to adopt ‘action learning’ approach (Helali, F., 2003): Workshop, ‘Future Workshop’, ‘Ergonomics Checkpoint’, Team-working, Role playing and Aquarium model, ‘Cause- and- effect diagram technique’, ‘Logical Framework Approach (LFA)’, Brain storming, ‘Circle model’, ‘Triangle model’.

A survey by F. Helali (2003), described the results of various methods conducted during the last 9 years for introducing ergonomics to Iranian industries and universities by CEDC. Information regarding various methods that had been used to promote ergonomics intervention in Iran was presented in the three cases (three steps): 1- Glucosan factories (GC) at organizational level, 2- Group of individuals from different industries at individual
level and 3- Iran Khodro car company (IKCo) at group level, which received ergonomics training at various workshops.

2.2. Ergonomics Application (EA)

The training program was concentrated on providing the needed knowledge and skills to participants in the workshops (individual level) as well as training a whole group of employees from single industry (group level) and ultimately the whole organization for making ergonomics intervention and improving the working condition as well as productivity in a participative, systematic and holistic approach.

2.3. Evaluation (E)

Evaluation or Feedback of EIP is a control tool for effective performance, learning and development in chronological order. Thus, a systematic EIP evaluation was conducted for most of the workshops. One of the methods for assessing the effectiveness of the workshop was the pre-testing and post-testing of participant’s “know-how” by the facilitators. Participants’ knowledge was tested before and after they have participated in a workshop. Another method was evaluation of the action groups’ activities by themselves.

2.4. Research activities (RA)

The main objective of ergonomic research viz., improving health, safety, and satisfaction of employees as well as improving productivity and product quality of the organization is the same globally. However, the research results drawn from studies conducted in industrialized world could not always be used to solve problems in IDC. This is because the major components of the ‘Human at Work System’, i.e., the human, organization, technology, information, external and internal environmental factors which are influencing the system performance are different in IDCs compared to ICs. As the nature of problems and the causal factors are mostly different and resource availability is limited, the methods of investigation and proposed solutions must be also different. It is therefore necessary to promote ergonomics research in IDC to develop local autonomous capacity and appropriate solutions to the existing problems. Copying results that are developed in IC has been shown not to be the best way of solving problems in IDC workplaces. IDC have to develop their own potential capacity for assessing and solving their own ergonomics related problems.

2.5. Network Building (NB)

Network building is regarded as an important support factor for IDC. National networks building like Iranian Ergonomics Society (IES) which is an attempt toward Globalization of Ergonomics is a support organization for local people who are interested in ergonomics issues. The aim of this networking intervention was to build a strong network of people, companies and the groups of people involved in the ergonomic project, which could provide opportunities for exchange of ideas and visit other manufacturing and institutes in Iran and outside of Iran. Another aims of the ergonomics intervention processes in Iran has been to establish academic programmes leading to university degrees and to prepare the necessary infrastructures for conducting research projects in the Iranian industries.

3. Result

3.1. Ergonomics Training (ET) and Awareness Building (BA): Both for the participants of industries and universities

The training workshops and training courses conducted by CEDC are shown in ‘table 3.1’:

<table>
<thead>
<tr>
<th>Training workshops (W) &amp; Training courses (TC)</th>
<th>Date</th>
<th>Numbers of participants</th>
<th>Numbers of W &amp; TC</th>
<th>Time (hours)</th>
<th>Total man hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industries</td>
<td>July 1993 to Nov 2002</td>
<td>293</td>
<td>24</td>
<td>481</td>
<td>16838</td>
</tr>
<tr>
<td>Universities</td>
<td>Dec 1996 to Nov 2002</td>
<td>94</td>
<td>7</td>
<td>413</td>
<td>3375</td>
</tr>
<tr>
<td>Total</td>
<td>During 9 years</td>
<td>387</td>
<td>31</td>
<td>1134</td>
<td>20213</td>
</tr>
</tbody>
</table>
3.1.1. Result of methods applied at comparing of three cases

Comparing the 3 cases studied (i.e. GC, IKCo, and Other participants), it can be inferred that workshops, which were conducted at an industrial site were most productive and effective for improving conditions at workplaces. This was because the participants coming from the same industry could exchange ideas, make interventions at workplace, see and evaluate the results, and get involved in a process of change. This has further created a positive atmosphere at work as well as continuous action and learning of the intervention teams (Helali, F., 2003).

3.2. Result of ergonomics application:

3.2.1. The first major assessment of the workshops participants’ perception was made after 6 months of each workshop. A questionnaire was designed and sent to all participants of the Future Workshops (FW) in Iranian industries from 1996 to 1998 (Helali and Shahnavaz 1998).

3.2.2. The second major assessment of the participant’s perception was conducted after a period of 18 to 24 months for each organizational intervention or the conducted workshops by a specially designed questionnaire (see the second paper has presented for ODAM VII 2003).

3.3. Result of research activities

The first author was registered as ergonomics Ph.D. student at the Department Human Work Sciences, Luleå University of Technology, Sweden in 1996. The theme of his licentiate thesis, defended in May 2003 was “Ergonomics Intervention Programme Technique (EIPT) in IDC – Case Studies in Iranian Industries”. His study plan for Ph.D. degree in Ergonomics (Research project) is “Development EIPT and ‘a general model of an ergonomics know-how transfer to IDC’ – case in Iran”. Further more in two Ph.D. students from Occupational Health Departments of Tarbiat Modarres University (TMU) and Tehran University (TU) become interested in PhD studies in ergonomics. Two research projects were designed as a co-operation project between the two universities of Iran and CEDC in 2000. In first ergonomics study, a Ph.D. student from TMU was engaged in a research project. The project aimed to assess the benefits of participative ergonomic process at a small scale industry for ergonomics process. This project was conducted at a hospital furniture manufacturing company (SCo). The results of this intervention project have been presented in a doctoral thesis at TMU in March 2003 and a paper for IEA 2003 (Motamedzadeh, M. et al, 2003). The results of the second project (Ergonomic workstation design for Iranian Hand-woven Carpet Industry) will be presented in another doctoral thesis at Tehran University in 2004. In addition, two of MSc students from Luleå University of Technology conducted their thesis research work at two Iranian Industries (The research topics were: Macroergonomics survey in the production and assembling department of an Iranian manufacturing company in 1999, and Evaluation of Health Risks and Health Conditions at Two Work Sites of Iran Khodro Car Company in 2003).

3.4. Result of network building:

Establishment of the Iranian Ergonomics Society (IES) in connection with the EIP in 2001: At the end of a workshop for 22 university teachers from 20 universities on 23rd April to 4th May 2000, two historical decision were made; 1- One day in the Iranian national calendar was named as ‘ergonomic day’ and 2- Six workshop participants were elected to form a committee for preparing the establishment of the Iranian Ergonomics Society (IES). This Committee of 6 was later expanded to 25 members. The IES was established on 10th May 2001 as a registered scientific society in Iran. In the 2003 conference 50 scientific papers were presented and over 1500 have participated. The society has started its own library with 100 donated books. IES membership, as at march 2003, stands at 150 scholars.

4. Discussion and Conclusion

One efficient form of intervention is competence building among company’s employees (Shahnavaz, H., 1991). This kind of intervention, which emphasizes ergonomics awareness building between employee and managers, is what is mostly implemented in Iran and has been reported (Helali, F., 2003). According to this method the researcher was in the situation for preparation of pre-intervention and creation of needs for ergonomics application and conducting ergonomics research activities.

Secondly, most of the previous research on EIP has often been based upon intervention technique at microergonomics level from which Ergonomics Intervention (EI) models and detailed description of the intervention process have been developed. There are different ways to classify literature on ergonomics intervention, according to different forms of intervention (Helali, F. 2003) and the results of interventions. In the early 1990s, Hendrick indicate that instead of the 10%-25% improvements in the system effectiveness that many ergonomists have experienced from successful microergonomics interventions, one can achieve improvements of 60%-90%, or more from macroergonomics interventions. As documented in several cases (Hendrick and Kleiner, 2000), the best EIP is doing both the micro and macro ergonomics intervention.

Thirdly, it is believed that the best alternative is still the scientific approach led by a group of motivated scholars and PhD. students, who can speed up the process of ergonomics development in IDC’s, as Iran.
Thus, the action research has conducted according to a macroergonomics and qualitative methods for the purpose of doing the 3 different indicated activities; 1- ET BA, EA and E; 2- RA and 3- NB in the case of Iran. The intervention included a macro intervention by workshop at three level viz: individual, group and organization as well as development of EIPT in Iranian industries and universities. The major goal was to develop ‘a general model of an ergonomics know-how transfer to IDC’ – case in Iran”. Following research problem and the research questions were designed for future studies (Helali, F.; 2003, Helali and Shahnavaz, 2003).

**Research Problem:** “What are the characteristics of different Ergonomics Intervention Programme Techniques (EIPT) in IDCs?”

**Research Questions:**
1. “What are the characteristics of different Ergonomics Intervention Programme (EIP) activities performed by industries?”
2. “What is the role(s) of the facilitator(s) involved in EIP activities in industries of IDC in different Ergonomics Intervention Programme (EIP) situation?”
3. “What are the characteristics of the Ergonomics Intervention Programme (EIP) Process(es) in IDC, in different EIP situation?”

**References**


Hendrick, H. W., and Brian M. Kleiner, B. M. (ed.) 2000, Macro- ergonomics, an introduction to work system design. Published by the Human Factors and Ergonomics Society, USA.


Paper I

Participatory Ergonomic Intervention in an Industrially Developing Country - a Case Study

Faramarz Helali
Emma-Christin Lönnroth
Housshang Shahnavaz

Department of Human Work Sciences, Luleå University of Technology, Luleå, Sweden, And
Center for Ergonomics of Developing Countries (CEDC), Sweden

1. INTRODUCTION

Since Oostebeck Forum, in the year 1972 scientists have emphasized the importance of ergonomics application in Industrially Developing Countries (IDCs) as a measure for improving the working condition and productivity [1]. The considerable effort by International Labour Office (ILO) under the International programme for the improvement of working conditions (programme for the improvement of working conditions and environment; PIAC programme 1982, and the ergonomic checkpoints material [2] which can assist industries to find practical solutions for improving working condition) are the world wide comprehensive attempt in this area. But, there is still low awareness in
many IDCs regarding ergonomics and its application [3, 4, and 5]. The profession is not well recognized by name in IDCs [3]. The main attempt of ergonomists for work environment improvement is creating ergonomic awareness in industrially developing countries [6 and 7]. On the one hand, different models and methods for building vision and developing a change programme have been presented in the literature, such as the fifth discipline by Seng 1990 [8], and the future workshop by Jungk and Müller [9].

In Iran, ergonomics started in the early 70’s with a few isolated studies [10, 11, and 12]. In the 1977, ergonomics was introduced (by H. Shahnavaz) at the Tehran Arya Mehr University (Sharif) within the Industrial Engineering curriculum. Since then, ergonomics has been taught as a supporting subject of one or two credits in few universities. However, for Iranian industries, ergonomics was until recently an unfamiliar subject. The first systematic attempt to introduce ergonomics in the Iranian industries started at the Glucosan factories, Iran [13]. The comprehensive attempt of introducing ergonomics to Iran and making use of its benefits in Iranian industries was started systematically under the auspices of the Center for Ergonomics of Developing Countries (CEDC) in several phases [14]. The use of system thinking and system practice of ergonomics intervention has resulted in definition of Ergonomics Intervention Programme Technique (EIPT) in Iranian industries [15]. It has been shown that man can contribute positively to solving work environment and productivity problem by increasing ergonomics awareness [16, 17, 18, and 19]. According to, Yeow and Sen [18], the works of the ergonomists in Industrially Developing Countries (IDCs) had one thing in common, i.e., with the appropriate type of ergonomic interventions, there would be improvements in quality, productivity, working conditions, Occupational Health and Safety (OHS), reduction of rejects and rejection costs, and increase in profit. Local solutions have been shown to be effective and acceptable by both management and employees [20, 21, 22, and 23]. Participation of people involved in the program for identifying problem and developing feasible solution is shown to be effective [24, 25, 26, 27, 28, and 29]. For successful application of developed solution, management commitment and employee’s motivation is important [30, 31, and 32]. A lack of employee commitment to an organization and its goals has been identified as a major constraint upon its performance; this includes its ability to change [33]. “Commitment is particularly important for the successful implementation of projects and strategic programmes. The introduction of new technology or strategic initiatives represents a period of discomfort and risk. Commitment can help to smooth this period of transition by removing the
delays, decision constraints, and reversion to the old ways of working associated with non-commitment or mere compliance. Therefore commitment is an important factor both in getting the resources required for a project and ensuring that it can avoid and/or overcome the barriers to implementation that can arise" [30, pp. 227].

2. AIM

The study aims were: To create ergonomics awareness that can lead finding problems at the work system, as well as the development of feasible and acceptable solutions for improvements.

2.1. PURPOSE

To develop vision, ideas and action plans for improving the work system.

3. SUBJECTS

One Industrial establishment in Iran which became interested in using ergonomics in 2004 is a large firm which is made up of 3 subsidiary companies in the State of Gilan. One company (i.e. the Mother Stock Farm) has four divisions. The second company has three divisions (i.e. The Parent Stock Farm, Chicken Factory, and Services after sales). The third company deals with Machinery & equipment. More than 300 people participated in this project. All managers (3 Top Manager and 8 Heads of Divisions), supervisors (28 people) and experts (5 people) of three private poultry companies participated in training workshop of different methods for creating ergonomics awareness among managers and employees (44 people; 14 female and 30 male: The average age was 26 (22-30) years for female and 40 (25-55) years for male).

4. METHODS

A request was received in March 2004 from top management of a Poultry company indicating a desire for improvement of their companies’ activities by Mehr E Nami Institute (MENI). A meeting was held with the three top managers (owners) of the three companies. In the second meetings, the benefit of ergonomics and the experiences to be gained from applying ergonomics in Iranian Industries was discussed for top managers during two hours. After this session, a visit to the work sites was planned. Eight ‘Divisions’ were visited during three days. During the visits the head of the ‘Divisions’ introduced the working situation and explained the positive and negative aspects of their work system.

---

1 (MENI): In November 2003, Mehr E Nami Institute was established by few Iranian industrial managers, with the aim of supporting Iranian industries that are interested in ergonomics application, training, consulting and research. Furthermore, MENI is a supporter research for implementation of “Development of Ergonomics Intervention Programme Technique (EIPT)” in Iranian industries.
Then, the three top managers participated in the third and the fourth meetings. The results of the visits to the work sites were discussed in two sessions during two four hours meetings. Top managers added information about the companies. Furthermore, in these meetings more general ergonomics information was given. It was agreed to have the last meeting for four hours, during which the project underlined by this study was discussed and planned. The duration of the project was agreed to be 12 months after the first workshop.

The first workshop: Future Workshop was introduced and conducted with all 44 subjects for three days in the end May 2004. It was held in one of the offices of the companies in Rasht City. The process was video recorded.

‘Future Workshop’ (FW) method is a well developed method for identification of problems at work and for developing feasible and acceptable solutions for improvement. The method was introduced by Junk and Müller [9]. Later it was spread to other countries and used mostly for optimum utilization of human and material resources at work in order to make companies more competitive in this world of rapid changes [34 and 35].

Future Workshop is a well structured process with five defined phases that was conducted at the workshop and was guided by two facilitators. The workshop phases are as follows:

1 – Preparation Phase: The aim of this phase is to define a clear, short and challenging “theme” for the workshop, acceptable to all participants.

2 - Experience phase: Also called “critic phase”. This phase aimed to highlight all problems, experienced by participants with regards to the workshop’s theme. A complete “problem catalogue” is developed.

3 - Fantasy phase: The aim of this phase is to come out of the daily limitations that usually lead to restrain, traditional thinking and acting. People have many ideas that have never been expressed or formulated because they are framed in what they believe is right and possible. In Fantasia phase, everything is possible. There are no barriers, no economic, personal, technical or organizational limitations. The idea is to develop future visions.

4 – Strategy phase: The aim of this phase is to go through all the written fantasies with the aim of finding all the barriers regarding the realization of the fantasies.

Furthermore, Groups can use the different techniques as listed below to develop feasible strategy and solution to the problem on hand at the workshop.
Various brainstorming techniques
Desirability and possibility assessment
Circle model or development model activity [36]
Triangular model [37]
Cause and Effect diagram [38].

5 – Action phase: After the workshop, a complete report is prepared containing all the critical problems, fantasies as well as programme/plan proposed by the participants. The report is an idea catalogue for future actions.

After one week, a second workshop was conducted for one day: ‘Ergonomic checklist’ [2] was introduced in one of divisions (Machinery & equipment’s division). The workshop was conducted with all 44 people by the facilitator. They were divided into six groups (one of groups had 9 people). The results of the checklist’s activity were presented by the groups as action plans to the head of Division.

Evaluation workshop after two weeks: Meeting with the 44 people who have participated in the second workshops. The group visited and discussed implementation of the action plan which was developed from using the ‘Ergonomics Checklist’ at one of the divisions, during one day. Videotape and pictures of the workplaces at the division were taken during this workshop. Furthermore, the group agreed to work according to a ‘work and moral charter’ which should be developed through participation in the first session of the ‘strategy committee’. Then, they discussed the following question: ‘How the checklist can be used at all worksites of divisions?’ It was planned that special questions should be discussed within separate groups consisting of the eight heads of divisions. Divisions’ Heads decided to work in two separate groups with different problems. In the first session, the group replied to the following two questions: 1) “Why should we change?” 2) “How should we change?”

Meeting with the heads of ‘Divisions’: Every 15 days, for half a day during three months, all together 10 people (heads of divisions (8 people) and one of top managers as well as one of the facilitators) had a collective meeting at one of the divisions. In these meetings they were discussing about progress of the groups and coordination of the activities of the various ‘Divisions’ and better supporting an ‘Steering Committee’, which was established after second workshops. In these meeting the project facilitator informed them about ‘Organizational and managerial’ functions, project monitoring, and evaluation for better conducting the project. In the first meeting the head of divisions
discussed the following questions: Why should meetings of heads Divisions be held? How should such meetings be held?

Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis for the organization: The other activity after the Future Workshop (FW) was a SWOT analysis of the organization by the participants (44 people), which started after two months. This was to develop a vision for the poultry company.

Forming a ‘Planning Committee’ of division’s heads, after three months of the FW: After three months one of top managers and head of divisions formed a planning committee for a better running of ‘organizational and managerial’ functions at three companies as well as for a better follow-up phase of the future workshop.

Workshop’s evaluation of the participants after six month for one day: We (facilitators) conducted an evaluation workshop after six months. All action groups presented their past activities which, was discussed by the whole groups. Furthermore, each member of action groups has answered and discussed in the group the following questions. The questions were presented one week before the workshop by the facilitator:

1) What are your aims of continuation of working in this group and what are the aims of the group?
2) What are you proud of and what is the group proud of?
3) Where are we standing at the process of ergonomics’ improvement and real organizing of work in our company?
4) Where is the group unsuccessful? Where has the group failed?
5) What do you need to continue your work?
6) What do you want to achieve and where are we going?
7) Please describe a successful story of the group.

Meeting with top managers: The head of divisions and action groups have presented their success stories that were achieved after a year effort in a four hours seminar. Top management discussed the implemented projects and gave feedback to the action groups.

5. RESULTS

High degree of involvement of 44 people was indicated during all days of the workshops and meetings as well as sessions with the heads of Divisions. The results of each method used, are presented as follows:
The top manager informed us (facilitators) in the first meeting that general problems of their companies are: “Physical enlargement of work activity during last three years. No proper work organization. Have about 40 experts, who mostly work as engineers in animal cherisher and 40 experts have only experience from this company and are young in our company. Our company needs to have a mother company”. Finally, a visit was made to the eight divisions of the three companies. The result from the visiting and negotiating with the 8 managers (Division’s Heads) in their divisions indicated the following issues: Lack of (or unsuitable) Planning, Organizing and Control, Isolated work, Stress, Lack of a balance between work and Private life, Lack of managers meetings. For example; when the head of divisions introduced their work, they mostly talked about crisis at work and their successful handling of it. Good qualification of a head division was for them how he or she could solve crisis at farms and worksites. They complained of the physical enlargement of the work sites during the last three years. They have not had any suitable work organization. They mostly feared what will happen in future and the lack of control by the top management.

After the results of visit from the divisions were introduced and the planning for change was discussed, the top managers have discussed how to build a vision and design a suitable organization. The involvement of people in planning and controlling their own work activities was emphasized. Furthermore, the benefit of sufficient ergonomics knowledge and power to influence processes outcomes in order to achieve desirable and feasible goals were discussed. They agreed that the following proposal should be included in their program: Training all 44 people from the different divisions in the use of the Future Workshop (FW) and the checklist.

*The results of ‘Future Workshop’*: A full report of the future workshop was prepared by the facilitator. It contained all the problems as well as solutions. Most of the documented problems were related to ‘Work Organization’ which was also emphasized by managers of the three companies. The managers observed how a proper participative procedure will help with recognition of various problems at work and development of acceptable solution.

The results of the three days FW were as follows:

*At the morning of first day*- Lectures in macroergonomics: The objective was to enhance participants’ knowledge on macroergonomics for the purpose of fully utilizing the potential resources of the three companies, especially human resources for improvement of efficiency and productivity of the whole organization. Topics such as; Introduction to macro and micro ergonomics, changing world, work
environment, productivity and quality at work, role of participatory ergonomics process, and future workshop technique were discussed.

At the afternoon - Compiling problem catalogue and developing feasible solutions: A problem catalogue concerning problems related to the theme of FW “organizational behaviour” was prepared by the participants. From a list of 150 different problems 67 of them were considered worthy of thought and action by participants’ votes. They were categorized under 5 main topics. Participants were voluntarily divided into 8 groups in order to work with the selected topics: One group with 8 people worked on the first topic ‘Work Organization’. Another group with 7 people worked on the second topic ‘Culture and Training’. The third topic ‘Welfare’ was worked on by another group with 6 people. Three different groups with 5 people each also worked differently on the fourth topic ‘Management’. Two different groups with 4 people each also worked differently on the fifth topic, i.e. ‘Planning’. Each group analyzed the indicated problems and developed the best possible solutions for each recorded problem.

Day 2 and 3- The participants continued with their work in the fantasy and strategy phases. Each of the eight groups developed a detailed plan for improvement in the third days. Some examples of their activity results are presented as follows:

- **Groups on ‘Management’**: The group evaluated a strategic view for the future of the companies (i.e. one year ahead) as well as running the divisions by participation. Furthermore, the group formed a technical committee on services.
- **Group on ‘Work Organization’**: The group evaluated the distribution of work among people and set up meeting among divisions’ head. The group evaluated the ‘volume of the work’ and solution for improvement. They considered lack of responsibility and authority of people at work. Furthermore, the group evaluated the problem of ‘non- coordination between staff and arrangement’.
- **Groups on ‘Planning’**: They worked with planning of salary payment, planning for a reward system, and planning for implementation of team working.
- **Group on ‘Culture and Training’**: The group evaluated strategy for training of experts and managers. They evaluated problem regarding ‘Non – reliance’ on knowledge of each other to make progress in ultimate goal of the company’.
- **Group on ‘Welfare’**: The group evaluated the new welfare system and various problems expressed by workshop participants, they worked with complementary insurance for whole personnel.
The result of the second workshop (conducted for one day; ‘ergonomics checklist’ in one worksite): In second workshop the group became aware of how to apply the checklist, a useful tool for the workstation improvement. The result was that manager (head) of the division accepted the most of suggestions that the action groups suggested from the workshop. Several members of different action groups indicated that when they worked in the workstation together with the workers, they received better information and suggestion for solutions.

Evaluation workshop: The result of visiting and meeting with the workers of the division and 44 people who have conducted second workshop: They observed the results of action plans and activities of the action group after two weeks. Some pictures have shown and described (Before and after improvements) in the one worksite as following:

Figure 1: Condition of the worksite before improvement. There is a poor posture. There is air pollution in the worksite because of welding in the worksite. There is not also general ventilation.

Figure 2: Condition of worksite before improvement. There are not any store for the materials and also misused materials in the worksite.
Figure 3: Lack of marked escape routes and keep them clear of obstacles. There is also air pollution in the worksite.

Figure 4: The fan is working without a cover. There is lack of table for working creating a poor posture.

Figure 5: Lack of personal protective equipment for welder and his co-workers as well as a poor posture.
Figure 6: Present Situation after improvement: Draw lines to separate transport areas from working areas and keep the areas clear.

Figure 7: Present situation after improvement: There is a working table for a laminator but the height of the table is not suitable yet.

Figure 8: Present situation after improvement: The worksite is cleaned of the materials and misused materials. Area of the working is also clear.
Figure 9: Present Situation after improvement: Light colors for walls and improve lighting conditions and the workplace atmosphere. Clean windows and well-maintained light sources help to increase lighting.

Figure 10: Present situation: There is no chair or stools for occasional sitting at different part of worksite for resting the workers. Workers are not allowed to seat during working hours.

Figure 11: Present situation of the area of the painter is clear but lack of a suitable space & light, and personal protective equipment for the painter.
Figure 12: Improvement of the fan.

The observations’ results from the workstation based on the videos and pictures taken as well as action plans indicated improvements (See Pictures 7 till 15) and recommendations for the worksite were as following:

- Improve work place air condition
- Provide suitable lighting and clean windows and well-maintained light sources help to increase lighting.
- Provide chairs, stools for occasional sitting at different part of the worksite
- Provide condition for workers participated at the worksite for improving working condition and welfare facilities
- Minimize manual material handling for the load which is heavier than 10 kg
- A better arrangement of the production line after the first improvements
- Provide training programme and encourage workers to participation at the programme

After two months, the division’s head reported that the “no-cost/low-cost” changing of the workstation has positively affected the productivity and as a result they could easy increase the capacity of their production. This increased of capacity and more order than in the past has been confirmed by other head divisions. They were increased satisfaction because of more machinery and equipment was built for the poultry Farms. The personnel of this division (three foremen and 32 workers) have received two month extra salary as a reward by the top management.

Furthermore, the group (44 people) agreed to work according to a ‘work and moral charter’ which consisted of 15 topics that were developed by the participants. Then, the result from the meeting and response to the question (‘how the checklist can be used at all divisions?’) was formation of one
intervention team for applying the checklist in the whole divisions. Nine action groups were formed together with a steering committee for the three companies, with all 44 people involved. One of the top managers becomes the head of Steering Committee (SC). Thus, the trainers were divided into 9 ‘Action Group’ consisting of 4 to 8 members from different sites. The reason for 9 action group was due to the situation of different areas of working and farms: Area 1 (Mother Stock’s Farms); 6 people, Area 2 (Mother Stock’s Farms), 4 people, Area 3 (Services after sales) 4 people, Area 4 (Making a Chick Factory); 8 people, Area 5 (Mother Stock’s Farms); 4 people, Area 6 (Office Rasht); 5 people, Area 7 (Mother Stock’s Farms); 4 people, Area 8 (Machinery & equipment built for the poultry farms); 4 people, and Area 9 (Parent Stock’s Farms); 5 people).

A Steering Committee (SC) consisting of 10 members have also been formed to supervise the Action Groups (AGs) activities. The members of the SC have been selected in participatory process by the participants at the second workshop. The members of the SC were mostly consisting from the head of divisions.

The Action Groups (AGs) of each division were responsible for spreading the checklist information to the employees at their division and creating a participatory environment for employee’s involvement. An interval evaluation committee was also established after the workshop to assist the action groups in matters of their activity and of the steering committee. One of the facilitators has participated in some meetings of the AGs and the SC to help management of the project and a forming of an external evaluation. The responsibilities of steering committee and action groups were discussed with the group and the following were suggested:

*The responsibilities of the Steering Committee (SC) were formulated as:*

- Setting policies and administrative procedures for their activities.
- Interacting with action groups and documenting of project progress.
- Promoting action group’s activities.
- Reviewing and approving action groups’ plans for ergonomics implementation.
- Supporting and confirming action group activity plan (time, place and budget).
- Evaluating action group’s activities on regular basis.
- Designing rewards and systems of motivation for action groups.
Furthermore, the Action Groups (AGs) are responsible for training employees at their workplaces on the usage of the checklist and ergonomic checkpoint [2] as well as in creating a good condition for employee’s involvement in workplace improvement. They are further responsible for:

- Evaluating each workplace at their workplaces using an ‘ergonomics index’; adapted from the Finish Institute; the ELMERI safety index [39]; the ergonomics index is calculated as a percentage of all provided items in the checklist (seven topics and total 128 items). An index can be calculated for each part of the checklist to identify the major sources of problems and ergonomic bottleneck in the workplace [39].
- Implement the project proposal after the steering committee has approved it.
- Evaluate the progress of their own activities (i.e. both group members’ activity as well as group activity) on regular basis.
- Spreading ergonomics knowledge at their worksites by applying ergonomic checklist and a creating ergonomics awareness as well as participation.

**Process of forming SC and AGs:** The responsibilities of the Facilitator was: Ergonomics Awareness Building (EAB), project monitoring, evaluation and assessment of the activities performed, providing support, developing research plans and assisting in network building.

It was stated by the participants that three issues were needed to be discussed: ‘Planning’, ‘Organizing’, and ‘Control’. It was also uttered that the set of activities of the company and related problems depend on one another. Therefore, it was decided that the problems should be surveyed in two separate but related groups, so that it can be surveyed and understood better. The head of divisions followed the suggestion of the participants.

*The results of the meetings of the division’s head:* In the first meeting the heads of divisions to reply to the questions: *Why should these meetings be held by the head of divisions?* 31 good reasons were expressed by participants such as: Analysis of the problems related to market, use of experiences of individuals and units, group support to promote capability of each other through close interaction.

Some criticism was made against the company. It was said that there is no intermediate positions of managers in the company (production management – financial management – technical management and etc). At the same time, organizational tasks are not distinct because the company has been getting bigger. Furthermore, the heads of divisions replied to the question: *How should the meetings of division’s head be held?* Ten different paths were discussed such as: Responsibility and authority of
each individual in the session should be defined, importance should be given to training, and proper reward and punishment system should be considered. Then, these questions were considered by the division’s head in table 1.

**INSERT TABLE 1 HERE**

*The result of the workshop with all 44 people to develop vision for the companies after two months:* It was important to know the strengths and weaknesses of the organization, as well as the opportunities available and the dangers that threaten it. In other words: Which aspects should be safeguarded from change? Which aspects can be changed for the better? With these considerations in mind, they idea conducted a SWOT analysis. The outcome is presented in table 2.

**INSERT TABLE 2 HERE**

*The result of evaluation workshop after 6 months:* In all divisions, FW participants developed action plans for carrying out the proposed improvements and changes. There were many action plans for improvements in the Company. Regularly, the action plans were followed-up after FW. Most divisions have also started weekly meetings. Job rotation and job enrichment were other part of their activities. Factors considered as positive and contributing to the FW success were: Interested personal, friendly communications, participation, team working, systematic approach and finding cause & effects problems at the work system, a new scientific discipline ergonomics, and facilities for learning at workplace. ‘Future Workshop’ participants’ perspective with regards to the receptiveness of managers and experts within the three companies and the overall effects of the future workshop was considered very positive. All requested for the continuation of workshop and recommended that other employees should also participate in such training sessions another question discussed was:

*How many percentages of the problems are solved by the meetings of division’s heads?*

Different answers were given in two different responses by each of the division’s head: (100%-80%)-(90%-60%)-(50%-60%) – (55%-60%) – (50%-50%)-(90%-50%) - (50%-50%). The average response was (69.28% - 58.57%).
Different answers were also given in the two different occasions (after FW and six months after) by each of the top managers (three Owners): (80%-50%), (50%– 50%), and (60%-90%). The average respond was (63, 33% - 63, 33%).

The participants’ responses to the following the seven questions and their evaluation of their groups’ activity after six months were as follows:

1. “What is my aim for continuing work in this group and what are the aims of the group? For reduction of work pressure, for problems solving by participation, learning from each other, engaging personnel in decision-making, innovation, a suitable atmosphere for improvement of production, to solve easier daily work problem, better communication with colleagues in workplace.

2. What am I proud of and what is the group proud of? Variety of work, production, friendly environment, satisfaction of performance, feeling responsible, low and no cost action plans, democratic mentality, offer better workable solution, successful group decisions.

3. What is our position regarding the process of ergonomics intervention in our company? Evaluations of organization, potentialities, capabilities, weak/strong points of organization, a built vision for our organizations, set up good suggestions, positive changing at work, timetable for action plans, and participation at work.

4. Where was the group unsuccessful? Where has the group failed? Giving authority to personnel, a little literacy & traditionalist of workers, no failure for us or in group but lack of time, financial problems perspectives of employees, low security level for the workers, lack of appropriate level of working for old and new workers.

5. What do we need to continue our work? Time, reward system, correct work division, calmness of the work environment, follow-up the decision, providing security and clearing the work environment, training, more supporting senior management from group, use of new individuals and their partnership, executive guarantee for decision making, creation of particular checklist for our worksites, and, continuous evaluation.

6. What do I want to achieve and where are we going? An open environment for presentation of ideas, job security, quality and quantity production, more accountability, revenue increase, satisfaction of work, more skill for workers.

7. Please describe a successful story of the group. The stories were about; Low-cost and no-cost implemented activities such as, painting, applying a computer networking system, self evaluation of
the positive atmosphere of the group activities, election a foreman by voting, the result was interested and very desirable for the workers, we have saved time and money in the production process for egg laying in farms, forming a friendly environment (the former enemies became friends), we could do the works by participation that we were not able to do it before, positive respond to our request and our proposed solution.

This information indicated that in order to be able to assess the attitude and level of motivation among the participants as well as their vision, there is the needs and the expectations for future activities. The facilitator discussed the information with both individual and the top managers face to face and measures for improvement were taken.

It is obvious that the improvements based on a new concept results in the changing of the work system. Furthermore, some covert’s resistances to change found and revealed the importance of understanding the current situation. Such as, political and economical factors (Lack of stablenesses), culture factors (Strong stableness), habits and working cultures of people are not an easy and straightforward task. More time is needed for establishing “ergonomics tools – oriented” conduct at the workplaces by the action groups as well as, at least, a certain time spent with the new method and ergonomics tools.

The results from forming the ‘Planning Committee’ of division’s heads; the plans and their planning were presented after nine months by the committee, which included:

- Conclusion and policy based on the data from production; analysis and evaluation of the results of preparing annual program and standards.
- Educational programming; periodic trainings to increase productivity for all personnel.
- Preparation of annual production program; prediction of different needs, quantities and supply strategies for production, separately and per month.
- Production standards; definition of basic criteria for evaluation of production factors.
- Quality control; creating a managerial system to avoid inaccuracies and problems in performance of the organization and the divisions.
- Programming for construction unit: List of half – finished plans; Performance of the projects; Priorities of half – finished plans of all the production units.
- Expansion of activity; expansion of activity scope of company and doing new economic & production activities by using potentialities, Programming for financial, administration and support (Including definition and standards).
- Programming and financial organizing; preparation and analysis of financial operations of the company.
- Programming and administration organizing; set up a unit for services/legal personnel organizing.
- Programming and organizing support; preparation and supply of all the services and facilities for all the units of company.
- Programming and organizing internal audit; purveyance, assessment, preparation of accounting report and other controls related to activities of one economic unit by auditing unit personnel.
- Programming the sale & support services unit.
- Creation of moving services of technical team.

Furthermore, the emphasis of the programs was to take advantage of local skills and resources as well as appointing intermediate managers for the company in the future. Most divisions have designed and formed top charts for their actual organizations. This process became a promotion for the role of experts and foreman/forewomen in the Farms and a better communication-building in the companies by the participation. They had formed interval network and better distribution of information for the companies.

The results of the meeting with top managers: Head of divisions presented their success stories and their planning that were achieved after a year’s effort for top managers in a 4 hour seminar. The top management discussed the implemented projects and gave feedback to them.

6. DISCUSSION AND CONCLUSION

Based on the results of this project, it can be argued that:

Firstly, a shared vision and a programme for change developed jointly by employees and management were vital for successful change management [40]. FW can be used with good confidence in the beginning of a change process, in terms of action driven change or vision driven change described by Karltn [41]. FW is a usefulness tool for creating ergonomics awareness and developing a process for change [34]. Furthermore, it is a useful tool for Ergonomics Intervention Programme Technique
(EIPT) [15] for the improvement of changes at workplaces, when management needs to plan change at the organizational level. In this study, the FW technique was used as a point of entry into participation. This made both management and employees to recognize the benefits of employee’s active and direct participation as well as sharing information, knowledge and power to all levels of organization. Theme of FW was formulated according to existing needs of the areas of work system, which was determined by participation as “organizational behavior”. The results of improvements were better running and changing of ‘organizational and managerial’ functions (including; planning, organizing, and control) and designing new top charts for the organization and the divisions. It provided possibilities for better utilization of the companies’ resources. For example through a matrix structure of the ‘planning committee’, and participation of the action groups, the division’s heads prepared and presented the “plans and their planning”, after nine months.

Secondly, Top managers informed the facilitators in the first meeting about general problems of their companies. In that content, issues such as planning for change was the most important issue indicating dissatisfaction with the present state and articulating a desired future. Involving people from all divisions of the organization was in the planning process rather than relying on a single entity or group. But, how long the top managers were ready to put time and effort on this project was the other changeling issue for the facilitators. It was considered that the project needed more time allocation from the top managers for meeting and discussing both with project facilitator and with the employees participating in the project. Subordinates of some divisions were also more powerful in terms of decision making than the others.

Thirdly, after six months of the project continuation, it was shown that the problems which were solved by the division’s heads within their regular meetings were improved by 10.71% (from 58.57% to 69.28%). This was the results of improved responsibility and authority throughout the organization from division’s head to division’s personnel. However, between the divisions there were marked differences. Some emphasized participation more than the others, showing significant managerial change. In other cases, the division’s head acted as a powerful leader which was accepted by his subordinates. After six months of the FW, the top managers’ responses to the situation have not been changed in average (63.33% and 63.33%). Furthermore, the responds between top managers were different to the FW. One of the top managers who were more engaged since the start of the project expressed more satisfaction on the current organizational situation and improvement of employees’
competence. Furthermore, the participants of various divisions did not observed any conflict of interests in the workplaces.

Fourthly, practical support for applying the checklist was also important. The results of the second workshop indicated that participants could learn from each other by using a holistic learning method. They have managed to create ergonomics awareness at their workplaces and conducted many small projects by using the checklist, such as: the improvement of production line, materials handling (clear and mark transport routes), Lighting, machine safety, and improvement of workstation design. There were small wins that also provide ways to learn new skills and learn more about their jobs as well as thinking systematically about other ways for creating good ideas and improvement of the workplace by team working and using the checklist. This small wins and learning by practices and observations created a good motivation for them. They were interested and established the ergonomic intervention team, including; steering committee, action groups and facilitator team.

Fifthly, the role of the divisions’ heads and forming of the intervention team: The process of ergonomics intervention is complex and needs organizational intervention to achieve the goal [14]. According to, Wes Siegal et al [42] focuses on management of the transition state, use of transitions management teams and senior management to help move forward and engage in activity planning. Furthermore, importance of communication, leadership and emotional components for successful change is highlighted [43 and 44]. Thus, the role of division’s heads for forming and contacting action groups and intervention team were important for planning effective change in the organization.

Sixthly, the SWOT analysis of the organization by participants helped them to gain a better understanding of the situation of the work system and determining which of the areas needed problem-solving activities and which of the areas need promotion activities. The modified Ergonomics Intervention Programme (EIP) tasks were limited. The EIP was the results of a problem solving process, which could be achieved through workers and manager’s participation and utilization of human resources and increasing employee motivation [14]. Furthermore, this was needed to build a suitable vision for the organizations.

Seventhly, for successful application of developed solution, management commitment and employee’s motivation was important. One of the top managers had participated and was engaged in the project from the start. He was more committed to the project than other top managers who were not participating in the whole project. At the start of the project the top managers have promised to
participate with the facilitators once every two week or each month (depending on their time) in a reference committee. But that was not done regularly.

Eighthly, the attention to the ‘work and moral charter’ was a key point for support and a good guideline. Furthermore, workers were more in touch with each other, had more respect for each other and had suggestion for each upcoming problems or critics. They found that co-workers are not problem but supporting resources and understood that all problems do not belong to management and are not all managerial problems.

Ninthly, the planning for change; on the one hand, considered “the causes of change in organizations, articulation of the vision, how to get from the present to the future desired state and remove the barriers for effective transitions [42, pp. 58].” On the other hand, an ergonomics awareness building needed ergonomics training, ergonomics application, and evaluation [15]. Furthermore, the best way to use ergonomics checklist is to use it in the action groups. The results of the checklist application were discussed by participants. According to, Kogi, it is better to plan the use of a checklist jointly and then apply it in the form of a joint inspection or joint walk-through round [45].

Finally, the present study was an attempt to create ergonomics awareness among managers and workers of the three subsidiary companies in Iran. It showed that the commitment from one of top managers was particularly important for the successful implementation of the project. The outcomes of the strategic programmes have indicated and showed planning change and improvements in the company. The key issue for improving the existing conditions at the workplace was to improve the people competent for making use of ergonomics knowledge and practice [46]. Thus, for achieving an ergonomics awareness building and a continuous learning process at the whole company, it is required to conduct more Ergonomics Intervention Programme Technique (EIPT)’s tool [15] or ergonomics’ tools through workers’ participants at different workplaces.
REFERENCES


8. **Senge, P. M.,** The fifth discipline, the art and discipline of the learning organization, Publisher: New York: Doubleday/Currency, cop; 1990.


16. Helali, F. and Shahnavaz, H., A Model of Implementing Ergonomics Intervention Programme Technique (EIPT) in Industrially Developing Countries (IDCs) – Case Iran Published in the Proceedings of Human factors in Organizational Design and Management (ODAM) VII, 2003; 811-816.


22. Helali, F. and Shahnavaz, H., Ergonomics intervention in industries of the industrially developing countries, Case study: Glucosan – Iran. Published in the Proceedings of Human factors in Organizational Design and Management (ODAM) V, North-Holland, 1996; 141-146.


36. Helali, F. and Shahnavaz, H., Adopting macroergonomic approach for identification of workplace problems and development of low-cost/no-cost solutions in industrially developing countries, Case study: Glucosan – Iran, Published in the Proceedings of Human factors in Organizational Design and Management (ODAM) VI, North-Holland, 1998; 585-590.


Table 1: Why & how should we change? (Responded from the Divisions’ Heads)

<table>
<thead>
<tr>
<th>Why should we change?</th>
<th>How should we change?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• For progress</td>
<td>• Change of intermediate managers</td>
</tr>
<tr>
<td>• Be able to compete</td>
<td>• Proper organizing</td>
</tr>
<tr>
<td>• Optimal employment of personnel (more efficiency of the personnel)</td>
<td>• Recognition of the change points</td>
</tr>
<tr>
<td>• Not to be set aback in the changing world</td>
<td>• Admit criticism</td>
</tr>
<tr>
<td>• Growth of the complex</td>
<td>• Create atmosphere of talk &amp; understanding</td>
</tr>
<tr>
<td>• Optimal use of facilities</td>
<td>• Giving authority</td>
</tr>
<tr>
<td>• Survival of the complex depends on change</td>
<td>• Definition of suitable style of management in the complex</td>
</tr>
<tr>
<td>• Without change in production and sale, we may be destructed</td>
<td>• Application of technology</td>
</tr>
<tr>
<td></td>
<td>• We should not speak ceaselessly or admire ourselves</td>
</tr>
<tr>
<td>Strong points (capabilities)</td>
<td>Weak points</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| • Taking more part of market | ➢ **Lack of Planning**  
• Lack of established (written) program  
• Lack of work system  
• There is no training system  
• Lack of strong marketing  
• Non-separation of project management and production management |
| • Many strong, young and specialized man powers | ➢ **Lack of Organizing**  
• Centralization method  
• Lack of organizational chart  
• Lack of distribution of work and giving the authority  
• Non-separation of work possession and capital possession |
| • Variety of work | ➢ **Lack of Controlling**  
• Lack of evaluation system  
• Concealment of mistakes (errors)  
• Lack of Planning & Organizing  
• Added pressure of work, in speed and execution  
• There is no description of duties and jobs  
• Lack of research activities  
• Lack of supporting staff  
• There is no admittance of criticism |
| • Changeability | | |
| • Forward-looking | | |
| • Introducing new chicken race in Iran | | |
| • Exports of 'chicken' | | |
| • the organization Employment of native people & Using non–native specialized forces | | |
| • Positive view toward the company | | |
| • Humanitarian view toward individual | | |
| • Supporting services (machinery and equipment built for the poultry) by one of Companies | | |

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Creation of R&amp;D (Research and Development)</td>
<td>• Waste and not use of all the positive thoughts of the company</td>
</tr>
<tr>
<td>• Produce competitive high – quality products (standard)</td>
<td>• Lack of qualification of technical specialized forces</td>
</tr>
<tr>
<td>• Use of foreign training possibilities</td>
<td>• Reduction of motivations and productivity</td>
</tr>
<tr>
<td>• Improvement of the personnel welfare</td>
<td>• Increase of unhappiness</td>
</tr>
<tr>
<td>Participation for people in the companies</td>
<td>• Creation of informal groups, they are not adjustable to the goal the organization</td>
</tr>
<tr>
<td>• Reduction of risk coefficient of executive works by participation of employees</td>
<td>• Reduction of job security</td>
</tr>
<tr>
<td>• Holding strong sale / purchase agency in/out of the country</td>
<td>• Waste of useful work hours</td>
</tr>
<tr>
<td>• More speed and higher – quality services due to use of the technical services to companies</td>
<td>• Endangering physiological and psychological health of the personnel</td>
</tr>
<tr>
<td>• Extensibility and improvement of after – sale services due to use of facilities of the technical services to companies</td>
<td>• Lack of organizational progress</td>
</tr>
<tr>
<td></td>
<td>• Deviation from main policy</td>
</tr>
<tr>
<td></td>
<td>• Prolongation of goal achievement</td>
</tr>
<tr>
<td></td>
<td>• Lack of optimal use of personnel capability</td>
</tr>
</tbody>
</table>
Paper J

Using ‘Ergonomic Checkpoints’ to Support the Participatory Ergonomic Intervention in an Industrially Developing Country (IDC) – a Case Study

Short form of title: “To Support Participatory Ergonomic Intervention”

Authors:
Faramarz Helali
Division of Industrial Work Sciences,
Department of Human Work Sciences, Luleå University of Technology - Sweden

Corresponding address
Faramarz Helali,
Department of Human Work Sciences,
Luleå University of Technology, SE – 971 87
Luleå – Sweden
E-mail: Faramarz.Faramarz@ltu.se ;
Fax number: +46920491030.
ABSTRACT

In a previous study, the main key issues for the participatory ergonomic intervention in the three subsidiary companies was discussed. For achieving an ergonomics awareness building at all ‘Divisions’, an intervention team was formed; consisting of a Steering Committee (SC), 9 Action Groups (AGs) by a Supporting Team Facilitator (STF). Specific methods were used for assessing (i.e. data generation and collection approach) awareness building.

The aims were: To implement basic ergonomics through a participatory ergonomic intervention process that can support a continuous learning process and lead to improving health and safety as well as the work systems in the organization.

The purpose was: To develop action plans for improving health and safety as well as the work systems.

Findings were main key issues for making participatory ergonomic intervention (i.e., method, continuous learning, and integrating) successful.

Keywords: Ergonomics’ tools, Intervention team, Participatory Ergonomics, Industrially Developing Country

1. INTRODUCTION

Examples of indigenously and exogenously generated ergonomics research and development projects in Industrially Developing Countries (IDCs) were given by O’Neill [1]. He has concluded that; the principles of ergonomics and its potential to deliver benefits have been accepted and practiced in a small number of Development and Technology Transfer Programmes but not many decision-makers are conversant with the breadth and depth of ergonomics [1]. O’Neill, from analysis of his projects has also shown a considerable overlap between ergonomics and occupational health [1]. The lack of occupational safety and health activities in small and medium-sized enterprises has been pointed out and counter measures have been discussed worldwide in the last decade [2].

Furthermore, at the CybErg Conference in 2002 on promoting ergonomics in Industrially Developing Countries (IDCs), three major discussion points were highlighted in a paper presented by Thatcher [3]:

The first one the transfer of knowledge to IDCs. Another on promoting ergonomics works in IDCs and the third one, on online journal of ergonomics for IDCs. These points were representative of the types of issues discussed by the participants at the conference. Talking about ergonomics in relation to IDCs means that we have to define what an IDC is not by economic criteria (e.g. Gross National Product (GNP)), but rather in terms of population, prevailing forms of work and work ethic [4]. Industrialized Countries (ICs) are suppliers of technology and IDCs are usually the receivers of technology in the technology transfer process.

At present there are few practical examples to illustrate the benefits that can come from an Ergonomics Intervention Programme (EIP) in IDCs. The reason for these few practices is a lack of awareness and recognition in IDCs for ergonomics potential benefits [5, 6, and 7].

According to Kogi [8], ergonomics checklists could be used as a guide to improve the existing designs or conditions of workplaces. Examples of such checklist is presented in the book “Ergonomic Checkpoints: Practical and Easy-to-implement Solutions for Improving Safety, Health and Working Conditions” [9]. Ergonomic checklists are widely used to evaluate ergonomics related conditions of
plans, designs, systems, equipment, facilities, and existing conditions of work and life [8]. Various checklists have been developed for different purposes, usually as tools for prioritizing action plans in ergonomic design or redesign, comparative studies, and training [8]. Action checklists have been developed aiming at active participation of both workers and employers (9 and 10) and in many countries have proved to be effective in facilitating concrete action for improvement, especially in small and medium-sized enterprises in Asia [11, 12, 13, 14, 15, and 16]. Furthermore, method used for Problem-solving could be commonly, but not always proceeded by analysis and diagnostics [17]. Problem-solving itself emphasizes innovation and creativity instead of meticulous fact-finding [17]. Some recent approaches in occupational safety and health minimize the prior analysis and go directly to problem-solving, integrating analytic components into the problem-solving [9]. The term intervention refers to efforts made to effect change and render such change stable and permanent [18 and 19].

For a “Participatory Ergonomics Process”, the beginning premise of the thinking system and system practice on the macroergonomic approach is that learning organization and ‘the nature of participatory ergonomics cycle’ [20 and 21] enhances organizational performance by action learning [22]. Thus, it is needed to adjust the participatory ergonomics cycle of involvement (See Fig 1).

**FIGURE 1 HERE**

Haines and Wilson [20] have mentioned that participatory ergonomics is complex and diverse, an umbrella used to cover a fairly broad range of ideas and practice. This means that there is a range of models and ways of doing participatory ergonomics, and a multiplicity of tools and methods employed within participatory ergonomics initiatives. But, this is concluded by Haines and Wilson [20] that most commentators see participatory ergonomics as offering a common set of advantages: First, it is seen as exploiting the detailed knowledge and experience of those who inhabit the very workplace under investigation (i.e., getting most from those who, in a sense, should know best). Second, it is felt to encourage a sense of ownership among the participants, such that it helps to secure at least some degree
of commitment both to the process itself and to any change that may result. A third and related advantage of participatory ergonomics is thought to centre upon psychosocial factors.

Ives and Olson [23] divide the degrees of user involvement into six sets of categories, viz; No involvement, Symbolic involvement, Involvement by advice, Involvement by work control, Involvement by doing, and Involvement by strong control. Lawler [24] suggests some reasons why employee participation is important in today’s world. One reason is that individuals are becoming more specialized in their work activities and are acting more as problem-solvers.

Mankin, et al [25] argue, that people with lateral skills should be picked for project teams, since they are able to work effectively with team members of different backgrounds, perspectives, and agendas, and are willing to limit their personal autonomy to achieve the main objectives that link everyone on the team.

Hendrick [26] suggests the ergonomist or ergonomic team has to begin by making microergonomic improvement that yield positive results within a relatively short period of time (often called the “picking the low hanging fruit” strategy). When managers see these positive results, they become interested in supporting further ergonomic interventions [26]. He mentioned that over time, senior management comes to support progressively larger ergonomic projects that actually change the nature of the work system as a whole [26].

A number of methods frequently used in various kinds of organizational studies have been adopted for use in macroergonomics analysis, intervention, and evaluation [27]. It is believed that; working condition and ergonomics problems is best identified and solved in co-operation with those who are mostly involved in the process [28]. Thus, ergonomics intervention programme through workers participation is assumed to be one of the useful methods in combination with other methods of macroergonomics for analyzing a change process [see 27, 29 and 30]. According to Wilson and Haines [31] participatory ergonomics has been defined as ‘the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes to achieve desirable goals’.

5
“Ergonomic interventions must be a local process that responds to the particular needs of local people. In view of the many constraints, a special attention is drawn to participatory ergonomics as an effective means of finding locally workable solutions” [32]. Previous study [33], has found the main key issues for the participatory ergonomic intervention (i.e. a shared vision, awakening for changing, and learning). This present study looks at whether the ergonomics awareness can be built upon and be sustained inside an organization by the Ergonomic Checkpoints [9] and the ergonomics intervention team.

2. AIM

The aims of this study were: To implement basic ergonomics through a participatory ergonomic intervention process, which support a continuous learning process and lead to improving health and safety as well as the work systems in the organization.

2.1. PURPOSE

To develop action plans for improving health and safety as well as the work systems.

3. SUBJECTS

The Industrial establishment in Iran which became interested in using ergonomic checkpoints in 2004 is a large firm which is made up of 3 subsidiary companies in the State of Gilan. One company (i.e. the Mother Stock Farm) has four divisions. The second company has three divisions (i.e. The Parent Stock Farm, Chicken Factory, and Services after sales). The third company deals with Machinery & equipment. All managers (3 Top Managers and 8 Heads of Divisions), supervisors (28 people) and experts (5 people) of the three subsidiary companies with more than 300 employees in the State of Gilan participated in this study for applying the checklist and the ergonomic checkpoints [9] in all ‘Divisions’ (eight divisions). According to, the result of
the first study [33], the participants (All together 44 people; 14 female and 30 male: The average age was 26 (22-30) years for female and 35 (25-58) years for male) were divided into 9 ‘Action Group’ consisting of 4 to 8 members from different sites. The reason for the 9 action group was due to the situation of different areas of working and farms: Area 1 (Mother Stock’s Farms); 6 people, Area 2 (Mother Stock’s Farms), 4 people, Area 3 (Services after sales), 4 people, Area 4 (Making a Chick Factory), 8 people, Area 5 (Mother Stock’s Farms), 4 people, Area 6 (Office Rasht) 5 people, Area 7 (Mother Stock’s Farms), 4 people Area 8 (Machinery and equipment built for the poultry farms), 4 people, and Area 9 (Parent Stock’s Farms), 5 people).

The action groups became responsible for using the manual in their workplaces (i.e. training co-workers at their workplaces by using the checkpoints as guides and creating a good condition for employee’s involvement in workplace improvement). These action groups were supervised by a Steering Committee (SC). The SC consisted of 10 members (i.e. Eight Divisional Heads, one top manager and one Divisional Supervisor) and was formed by a Supporting Team Facilitator (STF).

4. METHODOLOGY

In order to be able to attain the aim of the study, the Ergonomic Checkpoints manual was used as a tool for data collection during a one year period. This manual is a compilation of “ergonomic checklist” that can be used to identify problems and also “ergonomic checkpoints” that can be used to find practical solutions for improving working conditions from an ergonomic point of view. Its aim was to provide a useful tool for all those who intend to improve their working conditions for better safety, health and efficiency [9]. The manual entails checklists for assessing the workplace relative to material handling, hand tools, improving machinery, improving workstations, workplace environment, personal protection equipment, and organizing work. The manual includes 128 ergonomic checkpoints covering the following areas:

- **Material Handling: 21 checkpoints**
• Using Hand tools: 15 checkpoints
• Improving Machinery: 20 checkpoints
• Improving Workstations: 15 checkpoints
• Workplace Environment: 27 checkpoints
• Personal Protection Equipment: 8 checkpoints
• Organizing Work: 22 checkpoints

The following specific methods (i.e., applying the checklist, applying the checkpoints, and method used for forming the AGs) were used and assessing awareness building as it relates to the issue of health and safety and work systems in the organization.

d) Applying the Checklist

In this process which covered the first 6 months of the study, the participants were firstly, observed on how they applied the checklists of the ergonomics manual in the workplace regarding the problems identification process. They assessed items at their workplaces, and marked them with a Yes (i.e. problematic) or NO (i.e. not problematic). For items marked Yes, but for which urgent action is perceived, such item is also marked PRIORITY in addition to the YES mark. In order for the Action Groups (AGs) to be able to make propositions for improving the conditions of the workplace they assessed, they evaluated each problematic work area by using the ELMERI safety index [34]. The ergonomics index is calculated as a percentage of all items in the checklist (seven topics and total 128 items). An index can be calculated for each part of the checklist to identify the major sources of problems and ergonomic bottleneck in the workplace [See, 34 and 35].

e) Applying the Checkpoints

After six months, the Ergonomic Checkpoints’ book was introduced to head of divisions. They studied it. Then, each head of division agreed about presenting one of the topics to AGs during one day workshop. In the end of the workshop, the AGs discuss about the manual and how to applying it at the divisions.
The items (i.e. problematic work areas) marked PRIORITY based on the application of the checklist (as highlighted above) were then selected as the most important working areas (i.e. whose improvement was likely to be beneficial) and these were observed using the checkpoints. In this approach, the table shown in figure 2 below was used by the participants as a guide in their selection of the working areas.

FIGURE 2 HERE

It was also recommended to participants that they observe smaller rather than larger kinds of problematic work areas, which will require no-cost/low-cost interventions. The participants then drew action plans for improving the selected areas. They decided also on the desirability and feasibility of their action plans. Based on this, the participants did outline the action plans that are desirable, but not yet feasible (i.e. plans for the future). Using the ‘cause-and-effect’ diagram technique [36], each group examined the various factors that needed to be changed in order to achieve the desired effects.

f) Methods used for forming the AGs:

i. On the job training: Every of the 15, AGs had a collective meeting, at one of divisions for 4 hours in the evening. In these meetings AGs exchanged idea and information and assisted each other in learning techniques for evaluating their progress. In these meetings the project facilitator informed them about new techniques for better working and conducting their duties as efficient teams.

ii. Evaluation of SC: Each second week, SC had a meeting at one of divisions. Most of the members of SC were head of divisions and the head of SC was one of top managers. In these meetings, they informed each other about the activities of AGs and other issues that needed SC input. One of facilitators (One of co-workers of Mehr E Nami Institute (MENI)) was always present at these meetings.

iii. AGs’ meetings: All head of divisions and their action groups had a meeting, every week at their divisions separately. In these meetings the AGs discussed the checklist and their action plans at the division.
iv. Monitoring of AGs activities and providing support: Every second week the project facilitator participated without previous announcement in the AGs weekly meetings (randomly selected). This was done to monitor AG’s activity and support the group if necessary.

v. Evaluation of AGs’ activities: Each month all AGs met at one division to exchange ideas and discuss their progress on the checklist. The AGs from eight divisions were gathered together for one day from 14 to 17 in a workshop. The workshop leader was a facilitator. After each AG presented their activities, they were asked to evaluate their progress and give self score for their progress.

6) Evaluation of the project

At the end of the checkpoints application process (i.e. one year into the study) each of the 8 division’s AGs members answered the following questions. This was the second major assessment of the project conducted after one year.

1) What positive or negative effects the ergonomics training had on your duties and job?
2) What positive or negative effects had the project on your company?
3) In comparison with your other training and activities in your company, how were your activities in the action group?
4) How are your organizational and managerial duties in companies in comparison with the past?

Furthermore, during the process the facilitator (the author) also gained access to other data sources. The most important of these were written accounts by participants and what they had learned from their experience in the action groups. To complement this, the facilitator was also able to attend a one-day workshop at which each of the AGs gave a presentation on their action plans.

Records of the meetings at the divisions, between divisions, top managers and the facilitators, as well as assessing activities were other documents.

The facilitator used these kinds of information to refine the interpretations based on individual and group negotiations. Furthermore, two top managers (two Owners) and head of divisions have evaluated the project in the meetings with the facilitator, separately.
Each six months, a formal report was written; i.e., the procedure of work (using the checklist, and using the checkpoints) and the results, and some ergonomics information which was then presented to top managers. Here intention was to make it as easy as possible to absorb and understand the procedure and the participatory ergonomics process for top managers.

Finally, the facilitator discussed the information regarding the evaluation of the project with most participants (N=22) in a meeting and measures for improvement were taken by the Action Groups (AGs) and the Steering Committee (SC).

5. RESULTS AND INFERENCES

The results and inferences of the specific methods are described as follows:

5.1. Application of the checklist

All AGs worked on the checklist at the divisions separately. They have not had any previous experiences of basic ergonomics training. In the first step of running the manual, direct observation and documents indicated that the AGs were interested to industrial hygiene factors (i.e., lighting, air quality, thermal conditions, chemicals, and noise), improving workstations (i.e., sufficient work space, adjustability of work height and seat, tools and materials properly located), organizing work (i.e., involve workers in planning their day-to-day work, solve work problems by involving workers in AGs, improve jobs that are difficult and disliked, learn about and share ways to improve their workplace for each other, combine tasks to make the work more interesting and varied). The head divisions were more interested in the meetings, which discussed problems concerned to ‘managerial and organizational issues’. Some problems met in the plant were: Lack of or unsuitable Planning, Organizing and Control, Excessive and unsafe work load, Poor communication, Improved working environment, Isolated work, Lack of leadership and management practices, Poor change management practice, Stress, Lack of a balancing of work and private life, lack of a continuous improvement, Poor learning, Poor career building and unsystematic managers meetings.
5.2. Application of the ergonomic checkpoints

During 12 months of Action Groups’ activities, 269 ergonomic improvement projects have been identified by AGs and 191 of those were planned according to the designed timetable as well as 118 project have been completed (see tables 1 and 2).

Furthermore, a method of the common participatory steps for using and developing new ergonomics checkpoints within the process was formulated (See fig. 3).

The work systems in three companies were characterized by lack of or unsuitable planning, organizing and control at their organizational levels, based on the development of the checklist for issues regarding improvement of work system such as; ‘Work schedules’ (i.e. planning, organizing, and control), ‘Work tasks’ (i.e. improving of work environment and work system), ‘A healthy work organization’ (i.e. leadership and management practice and continues improvement), ‘Learning’ (i.e. technical and social skills). These have been found as criteria of particular importance for evaluation. Table 3 summarizes the link between the selected measures for work system’s checkpoints and improvement of work system by the Action Groups.

Furthermore, the AGs were very much/much satisfied with the programme and implementation of the actions agreed upon during their activities at the divisions.

In the process of using the ergonomic checkpoints, they agreed on participation of the division’s employees for better learning, for work designing and organizing, for accessing to more detail...
information, for final design of their action plans, for evaluation of workings and their improvements and for easier accepting change at work.

5.3. Results of the methods used:
The results of the methods used for ergonomics awareness building and forming the AGs are showed in tables 4, 5, 6 and 7.

INSERT TABLES 4, 5 AND 6 HERE

In addition 346 hours and 5800 total man hours were spent for forming the AGs and developing their working procedure.

5.4. Results of the project’s evaluation

Inferences of the questions:
It can be inferred about the first question; the positive effects of the ergonomics training on their duties and job as following:

- Better doing their duties and classification of work (Because of, setting up work groups, each of which collectively carries out work and was responsible for its results. They combined tasks to make the work more interesting and varied in their divisions. They considered also the workers’ skills and preferences in assigning personnel to jobs in divisions).

- Finding the problems in their company and better analyzing problems of the company (Because of the application of ergonomic checkpoints methodology “Why, how and some more hints” used by the AGs for the problem solving in their company).

- Better designing of the plans and better running the problems solving (i.e., the AGs could select to develop a list of ergonomic action; considering both desirability and feasibility of each action).

- Better survey about the problems of work system (Because they solved work problems by involving workers from the divisions in the AGs).
- Team working (Because of the most effective team synergy. Synergy means that the team members interact in such a way that they achieve more than they could possibly achieve individually).

- Creating a systematic thinking at the work (Because there was a continuous learning at work).

Then, it can be inferred about the second question that because of activity in ergonomic group it happens improvements and the positive changing such as creating learning process at individual/group level, developing suggesting process, creativity among the working group, Joint problem – finding by the group, and exchange of different information and ideas of experts from different unit with one another. There are some resistances on the course of change (i.e. limits attitudes of the people, positive and negative view of personnel and owners, weaknesses of company) which have to be paid attention to them.

It can be inferred the third questions that in comparison with other training programs and activities in the company this was new method for them and needed clear support of top managers.

Furthermore, it can be inferred the fourth questions that in relation to their organizational and managerial duties in the past, following was observed:

- Clear role of interim / senior manager from planning and organizing for the company.

- Improved organizational and managerial duties such as more allocation of authority for experts, more promotion for the company. Designing a real organization because they have a sense of belonging now.

Most heads of divisions (i.e. 7 people from 8 divisions) have accepted process of the development and improvement of the work system and activities at their divisions.

The Heads of Divisions have evaluated the project and told us the following:

"The project has helped the other colleagues to get more familiar with his/her job and cooperate to solve the problems concerning their divisions. The plan and planning has been clearer and we have found better our path in doing our duties. Instructing ergonomics and forming the planning committee has caused us to have wider view about the problems of the company, specially 'managerial and
organizational’ issues in our company. In ergonomics training and learning, we learnt a good method for our company (i.e., involve employees in planning of work and solve work problem by involving employees in AGs and SC). In other words, the strong points, opportunities, weak points and threats became more apparent for them from the participatory ergonomics process.”

The head of Steering Committee, one of top manager (One of owners) said;

“Before that, I was a manager of crisis for divisions in the three companies. Now there is more motivation for me when I could see the good suggestions of the action groups for improving workplaces. Now, I am in a better situation of my role at the work system as a facilitator.”

Furthermore, he (the head of Steering Committee) has evaluated the project and has informed us as follows;

“The participants during this project were very positive and we took new techniques and skills for improvement and change in our company. The company could be also better but the top managers (the other Owners) need taking time to think about what they are doing and the impact of their actions. The monetary problem and marketing problems as well as leadership style have not allowed top managers (Owners) much attention to inside of divisions and company.”

Top manager (One of owners) has evaluated the project and told us the following;

“The ergonomics is a good scientific method but, I have problem with direct orders from head of divisions and other top managers in the line now. I have not time to reply when they asked for me ‘why that and why that?’ Before that, I replied to them, they have alternative of problem’s solutions and their action group activity is supporting is them.”

Top manager has accepted that the capacities and the manner of personnel have changed. They are in a better situation for providing suggestions. Furthermore, they have the ability to sense and respond.

But, the top manager told us that:

“I understood that I did not put time in on the project. Most of my activities are about solving the monetary and marketing problems for our company. More productivity for the company is good for us, but managing the people is more important. I am going to put more time on the divisions.”
It could be interpreted that the top manager also has had fear for the change and of the personnel making mistakes. However, this is more related to cultural issues and leadership style.

6. DISCUSSION AND CONCLUSION

The table 8 has shown total man hour time which was spent for conducting ergonomics intervention by AGs. The figure 3 indicates the collective learning which the intervention team drew from a collective experience (i.e., the method of the common participatory steps for using and developing new ergonomics checkpoints within the process which was formulated by the different divisions).

Based on the results of this study, it can be argued and concluded that:

In this project, using a participatory approach has discovered new capabilities among participants and new checkpoints at work system have been developed. Actions Groups have managed to create ergonomics awareness at their divisions and conducted many improvement projects. Senge [37] describes a learning organization as one where: “People continuously expand their capacity to create the result they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together.”

The ‘Action Groups’ could act to develop a list of ergonomic actions (considering both desirability and feasibility of each action. Firstly, there was a kind of an immediately Programme for Action Groups (AGs). The AGs prepared a list of ergonomic action considering desirable but no feasible action at the work. Thus, they have had a challenging task of ‘developing programme’. They have developed an ergonomics intervention programme at the work areas for improvement by the intervention team. It was recommended that attention should be on small rather than large. In the first step AGs took first heading of the seven topics of the checklist [9] and after that the questions of the ergonomic checkpoints step by step.
They did the checklist in the action for finding an ‘immediately programme’; considering both ‘desirability and feasibility’ as well as ‘developing programme’; for action that were desirable but no feasible yet. In the second steps the ‘Action Groups’ have had to fix their problems. The head of divisions, in this step was leading the managerial practice and the strategic planning (See the results forming the ‘Planning Committee’ of division’s heads [33]). The outcomes were (tables 1 and 2) toward improvement of work systems with limited changes (table 3).

According to, Imada and Nagamachi “introduction to Participatory Ergonomics; ergonomics alone cannot solve all the contemporary issues they are asked to address. Without improved organizational support, team processes, team building, role definition, role clarity, communication, management commitment and a supportive culture, our successes will be limited [38]”. Furthermore, the ergonomics knowledge for the participants were obtained through action-oriented learning by the participatory ergonomics process and applying three main tools of Ergonomics Intervention Programme Technique (EIPT) (i.e., (i) Future Workshop as a shard vision or a way of system thinking by personnel from using participatory ergonomics process (See also, the first study [33]) ; (ii) applying an action checklist for improving health and safety; and (iii) the ergonomic checkpoints [9] for improving health and safety as well as the work system in an ‘organization’. The process of implementation were integration, toward built a ‘tailored ergonomic checkpoints’ in the workplaces in a continuous process. According to Oden [39], “integration means to form, coordinate, or blends all components into a smooth function or unified whole, thus causing all the parts to work together in a manner that will make the whole process most productive.”

The ‘improvement of the work system’ has indicated improvement toward Productivity, Organizational Behaviour, Job rotation, Job Enrichment, Team working, Challenging tasks together with good leadership practices, Job satisfaction and Job involvement, Decreased Stress, More degree of freedom at work, A continuous learning, and ‘Integrating Ergonomics in health and safety’ process (See table 3).
The information collected from most participants in the last meeting regarding the questions about the evaluation from the members of AGs and head divisions was discussed. Then, the measures for improvement were taken. There are the needs and the expectations for future activities. It needs more support and commitment from top manager for ‘improvement of the work system’, so the journey will be more difficult. Some head divisions views were: They believed the method was new and the first phase of six months was very difficult for them. They had not any experienced before that. People in a group or a team could assess the company problems by a team working so that everyone accepted it. Action groups followed their action plans. They had no experience of participatory method before that. They need to have a new leadership style in their company now. Most participants said; there are many fears in their views for future, such as; the fear of change, of making mistakes, of loss, of the unknown, of failure, of low support top management, etc.

Furthermore, it is demanded and needed high energy and positive feeling as well as a deep commitment to learning and significant change among top managers, managers and employees in the three companies now. There was signification different between top managers (three owners), which could be due to increase knowledge of “managerial and organizational” issues for the top manager who was engaged and participated from the beginning of the project. He said the starting of the project was difficult but there is no end- no limitation for learning and improving work system in the company now. After the project, he has followed meeting of the intermediate managers by the head of divisions each two week regularly and meetings of the board of managers as well as follows-up the strategic plans.

This present study was an attempt to implement basic ergonomics through ‘participatory ergonomic intervention process’ that could support a continuous learning and led to improving health and safety as well as the work systems in the three subsidiary companies in Iran. This study showed the main key issues for making participatory ergonomic intervention successful.
ACKNOWLEDGEMENTS

The author gratefully acknowledges Professor Houshang Shahnavaz: Head of Center for Ergonomics of Developing Countries (CEDC) for useful remarks, comments, and correcting English grammar in this paper. A special thanks to associate Professor Lönnroth, E. C., for her critical comments on the first version of the paper.
REFERENCES


12. **Conferido RD.** Low cost solution to improving Philippine working conditions; is it wise? Environ Management and Health, 1997; 8: pp. 171-172.


37. **Senge, P. M.** The fifth discipline, the art and discipline of the learning organization, Publisher: New York: Doubleday/Currency, cop; 1990.


Figure 1 ‘The nature of participatory ergonomics cycle’
Source: Haines and Wilson, 1998; [20]
Figure 2 - Guide for the selection of problematic working areas checklist:
Adapted from Sources: [34] and [35]

<table>
<thead>
<tr>
<th>Ergonomics Index</th>
<th>Action Category*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>5</td>
</tr>
<tr>
<td>21-40</td>
<td>4</td>
</tr>
<tr>
<td>41-60</td>
<td>3</td>
</tr>
<tr>
<td>61-80</td>
<td>2</td>
</tr>
<tr>
<td>81-100</td>
<td>1</td>
</tr>
</tbody>
</table>

*Action categories:
1) Working conditions are acceptable (Very good). Also, attention should be focused on priorities.
2) Working conditions are acceptable (good) and corrected measures may be needed. Attention should be focused on priorities.
3) Further investigation and intervention is needed by Intervention team. Corrective measures are required. Attention should be focused on priorities.
4) Further investigation and intervention are needed by group work. Corrective measures are required soon. Attention should be focused on priorities.
5) Further investigation and intervention are needed by group work. They must take corrective action. Corrective measures are required soon. Attention should be focused on priorities.
Table 1 - Improvement undertaken by Action Groups (AGs) in ‘Divisions’

<table>
<thead>
<tr>
<th>Technical Area</th>
<th>Problems met at workplaces (Identification)</th>
<th>Planned</th>
<th>Completed by the action groups (AGs)</th>
<th>To be implemented by AGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials storage and handling</td>
<td>42</td>
<td>38</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>Hand tools</td>
<td>13</td>
<td>10</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Productive machine safety</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Improving workstation design</td>
<td>39</td>
<td>36</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Lighting</td>
<td>18</td>
<td>13</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Premises</td>
<td>35</td>
<td>29</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>Control of hazardous substances and agents</td>
<td>15</td>
<td>9</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Welfare facilities:</td>
<td>29</td>
<td>19</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Work organization</td>
<td>58</td>
<td>22</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>269</strong></td>
<td><strong>191</strong></td>
<td><strong>118</strong></td>
<td><strong>73</strong></td>
</tr>
</tbody>
</table>
Table 2 - Examples of no-cost/low-cost improvement frequently by AGs from ‘Divisions’

<table>
<thead>
<tr>
<th>Materials handling</th>
<th>Use carts, hand-trucks and other wheeled devices or rollers when moving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workstation design</td>
<td>Easy reach, work height, fixtures and good chairs.</td>
</tr>
<tr>
<td>Isolating hazards</td>
<td>Covers, guards and isolating hazard sources</td>
</tr>
<tr>
<td>Lighting</td>
<td>Skylights, light-colored walls and avoiding glare</td>
</tr>
<tr>
<td>Premises</td>
<td>Natural ventilation, smooth floors, and heat insulation</td>
</tr>
<tr>
<td>Welfare facilities</td>
<td>Drinking water, eating and rest place, to ensure good, and provide a place for workers’ meetings and training</td>
</tr>
<tr>
<td>Work organization</td>
<td>Combining tasks, group and team work, job rotation, Job enrichment, and break</td>
</tr>
</tbody>
</table>
1) Developing Health & Safety at organization level by the checklist

- Identity problems due to improvement of health and safety
- Check locally feasible operational by AGs
- Select options for improving health and safety

2) Improving conditions of Health & Safety by the ergonomic checkpoints

- Identity problems and potential measures by AGs
- Check practicable workplace actions by AGs
- Organize group work for selecting or implementing actions

3) Integrating Ergonomics in Health & Safety at organization level by the organizational intervention team

- Initial review of any existing Health & Safety by intervention team
- SC & AGs assessment of the need for actions
- AGs work for selecting or implementing improvements

Figure 3 - Common participatory steps for developing and using the ergonomic checkpoints
<table>
<thead>
<tr>
<th>Area*</th>
<th>Problem met in plant work</th>
<th>Developing main checkpoints</th>
<th>Improvement of main checkpoints</th>
<th>Toward Improvement of work systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work schedules</strong>*</td>
<td>Lack of or unsuitable Planning, Organizing and Control</td>
<td>Planning: Production, technical, standards, Quality Control (QC), services after selling,</td>
<td>standards, QC, services after selling, improving health and safety, improving OB, design</td>
<td>Productivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial and Official, developing health &amp; safety, reorganization, developing Organizational</td>
<td>organization, Improving Human resources and work system</td>
<td>OB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Behaviour (OB) and developing Human resources</td>
<td></td>
<td>Job rotation</td>
</tr>
<tr>
<td></td>
<td>Excessive, unsafe work load</td>
<td>Ergonomic worksite</td>
<td>Safer practice</td>
<td>Team working</td>
</tr>
<tr>
<td>Work tasks*</td>
<td>Poor communication, Improved working environment</td>
<td>Communication aids ergonomic checkpoints</td>
<td>Joint help</td>
<td>Challenging tasks together with good leadership practices</td>
</tr>
<tr>
<td></td>
<td>Isolated work</td>
<td>Avoiding isolation</td>
<td>Efficient work</td>
<td></td>
</tr>
<tr>
<td>A healthy work organization*</td>
<td>Lack of leadership and management practices, Poor change management practice,</td>
<td>Development of competence and the health of employees Changes at all levels in organization</td>
<td>Managerial practice &amp; Participation of people and the utilization of their ideas</td>
<td>Job satisfaction</td>
</tr>
<tr>
<td></td>
<td>Stress</td>
<td>High job demands and low control at work</td>
<td>Job stress</td>
<td>Job involvement</td>
</tr>
<tr>
<td></td>
<td>Lack of a balancing of work and private life,</td>
<td>A balancing of work working hours and work arrangement</td>
<td>The flexibility of working hours and work arrangement</td>
<td>Decreased Stress</td>
</tr>
<tr>
<td></td>
<td>Lack of an innovative climate promote the idea of lifelong learning</td>
<td>A continuous improvement</td>
<td>Development of ideas &amp; personnel competence</td>
<td>More degree of freedom at work</td>
</tr>
<tr>
<td>Learning*</td>
<td>Poor learning</td>
<td>Applied ‘Future Workshop’, ‘ergonomics checklist’ and ‘Ergonomic Checkpoints’</td>
<td>‘A shared vision’, ‘awakening for change’, learning, and ‘common participatory steps for developing and using the ergonomic checkpoints’</td>
<td>A continuous learning</td>
</tr>
<tr>
<td></td>
<td>Poor career building and unsystematic managers meetings</td>
<td>Upgrading work skills and systematic managers meetings</td>
<td>participation of employees at the work (plan &amp; planning) by the intervention team activities</td>
<td>Common effort and goal for ‘Integrating Ergonomics in health and safety’ process</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Participatory Ergonomics</td>
</tr>
</tbody>
</table>
Table 4- AGs members worked on the applying the checklist individually (a)

<table>
<thead>
<tr>
<th>a) Numbers of participants</th>
<th>Time (hours)</th>
<th>Total man hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>55</td>
<td>2420</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>2420</td>
</tr>
</tbody>
</table>
Table 5- AGs members worked on the applying the checkpoints individually (b)

<table>
<thead>
<tr>
<th></th>
<th>Numbers of participants</th>
<th>Time (hours)</th>
<th>Total man hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td></td>
<td>44</td>
<td>130</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>130</td>
<td>5720</td>
</tr>
</tbody>
</table>
Table 6 – Methods for forming AGs during one year (c)

<table>
<thead>
<tr>
<th>No</th>
<th>Kind of activities</th>
<th>Form of conduct</th>
<th>Numbers of participants</th>
<th>Time (hours)</th>
<th>Total man hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>method (i)</td>
<td>session</td>
<td>44</td>
<td>60</td>
<td>2640</td>
</tr>
<tr>
<td>2.</td>
<td>method (ii)</td>
<td>session</td>
<td>10</td>
<td>42</td>
<td>420</td>
</tr>
<tr>
<td>3.</td>
<td>method (iii)</td>
<td>session</td>
<td>4 to 8</td>
<td>182</td>
<td>1092</td>
</tr>
<tr>
<td>4.</td>
<td>method (iv)</td>
<td>session</td>
<td>44</td>
<td>32</td>
<td>1408</td>
</tr>
<tr>
<td>5.</td>
<td>method (v)</td>
<td>workshop</td>
<td>8</td>
<td>30</td>
<td>240</td>
</tr>
</tbody>
</table>

Total                                                                                       346                  5800
Table 7 – Comparison of various AGs activities with the project (Time hour)

<table>
<thead>
<tr>
<th>Topic</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-hours</td>
<td>55</td>
<td>130</td>
<td>346</td>
<td>531</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>10.36%</td>
<td>24.48%</td>
<td>65.16%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 8 – Total time hour spend for conducting the ergonomics intervention by AGs

<table>
<thead>
<tr>
<th>Topic</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total man hours</td>
<td>2420</td>
<td>5720</td>
<td>5800</td>
<td>13940</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>17.3%</td>
<td>41.1%</td>
<td>41.6%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Appendix 1
REFLECTIONS ON ERGONOMICS WORKSHOP

Follow up questionnaire on the ‘Workshop’ attended in … you co-operation and suggestions will be greatly appreciated.

Please boldly circle the appropriate response.

1. Looking back on the Ergonomics workshop held 6 months ago, what is your present view as to the general benefit of the future workshop?

   [ ] Highly Beneficial  [ ] Beneficial  [ ] Average  [ ] Not worth the time

2. What was your main reason for participating in the Ergonomic workshop?

   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………

3. Would you advise others to attend a similar Ergonomics workshop?

   Yes  No

4. Do you think there should be a follow-up workshop?

   Yes  No

5. Do you feel the workshop improved your awareness of Ergonomic issues in your industry?

   [ ] A great deal  [ ] Moderately  [ ] A little  [ ] Not at all

6. Do you feel more knowledgeable about the various factors which affect the working conditions within your industry?

   [ ] Very much more  [ ] Much more  [ ] A little more  [ ] Not at all

7. Do you feel are more capable of dealing with problems on the work-site?

   [ ] Very much more  [ ] Much more  [ ] A little more  [ ] Not at all

8. Do your co-workers listen more readily to your suggestions because of your participation in the workshop?

   Yes  No
9. Have you experienced any opposition or resentment to any recommendations you have made? 

Yes  No

10. Were there any particular benefits to you in your position? (Give a brief outline)

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

11. Were there any practical benefits to your work-site? (Give practical examples).

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

12. Does top management show any interest or concern for your working environments?

<table>
<thead>
<tr>
<th>Great concern</th>
<th>Moderate concern</th>
<th>Little interest</th>
<th>No interest</th>
</tr>
</thead>
</table>

13. Was management interested in what you learnt from the Ergonomic workshop?

Yes  No

14. Have management been more receptive to requests/suggestions for changes to improve the working environment since you went to the Ergonomics workshop?

Yes  No

15. Have you implemented any specific changes in your work place as a result of what you learned at the workshop? If so please describe bellow and give example.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

16. If you compare the Ergonomics workshop to other short courses that you have attended, how would you assess its consequences in your work?

More  less

<table>
<thead>
<tr>
<th>Future workshop</th>
<th>influence</th>
</tr>
</thead>
</table>

17. If after attended the Ergonomics workshop, you have not implemented any changes in your work-site what do you think were the reasons?

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
18. What would you recommend to establish better implementation of ergonomics in industry generally?


19. Which phase of the future workshop did you find useful (please explain)?


20. Which tools in the strategy phase did you find useful (please explain)?


21. Have you any other comments or suggestions on the last workshop or for future Ergonomics workshops?


Thank you for your effort

****
Appendix 2
Questionnaire (2)

As researcher, we undertake to keep the information will give in the questionnaire secret and send the overall evaluation results to the respondents. In case of tendency, write your name and if you’d like to be interviewed later on, please write your telephone number.
First name: ………………… Surname:…………………….Tel. Number:…………..

**Questionnaire**

Please, tick appropriate answer and for descriptive questions write your answer. If necessary, you can use the blank side of the pages.

**Part I: Participants’ general information**

1. In which ergonomic workshops have you participated so far? How often?
   1.1. ( ) Introduction to ergonomics principle …… Times
   1.2. ( ) Workshop & Future workshop …… Times
   1.3. ( ) Ergonomics Core R&D …… Times
   1.4. ( ) Ergonomics intervention team …… Times

2. How did you participate in ergonomic workshops?
   ( ) Alone
   ( ) With 1 to at most 5 colleagues
   ( ) With top and middle managers, experts and supervisors
   ( ) With top manager of related company
   ( ) With top and middle managers and experts of your organization
   ( ) Other

3. In the organization where I worked my position was:
   ( ) Top manager
   ( ) Intermediate manager
   ( ) Expert
   ( ) Supervisor

4. The organization in which I am working or I worked has the following activity:
   ( ) Productive
   ( ) Service delivering
   ( ) Administrative
   ( ) Technical
   ( ) Financial

5. How old are you? …… years

**Part II: Ergonomics application at the individual level (Workplace, home and society)**

1. How useful did you find ergonomics workshop?
   ( ) Not at all ( ) Somehow ( ) yes, very much

2. After having finished the workshop, did you think that you understood workplace problems better?
   ( ) Yes ( ) No ( ) the same as before
3. After having finished the workshop, did you feel that you could offer better corrective suggestion for working condition improvement?
( ) Not at all ( ) Somehow ( ) yes, very much

4. After having finished the workshop, did you feel that you had an ability to improve your workplace?
( ) Not at all ( ) Somehow ( ) yes, very much
If ‘Not at all’, what did you need to be able to suggest for workplace improvement (please explain)?

5. After having finished the workshop, did you implement any practical measure for workplace improvement?
( ) yes, much ( ) yes, a little ( ) No
If no, Why (please explain)?

6. After having finished the workshop, what kind of problem did you identify?
( ) physical agents
( ) Combination of factors (e.g. organizational factors, problems of machinery design and tools and cultural problems)
( ) other factor
Which problem (s) could be solved by ergonomics application?
( ) physical agents
( ) combination of factors (e.g. organizational factors, problems of machinery design and tools and cultural problems)
( ) Other factor
Which problem (s) was/were relatively solved by you?
( ) physical agents
( ) Combination of factors (e.g. organizational factors, problems of machinery design and tools and cultural problems)
( ) Other factor

7. After having finished the workshop, did you feel that you could play a better role in problem solving or improvement at home?
( ) Yes ( ) No ( ) the same as before

8. After having finished the workshop, did your family recognize any positive aspect (s) in your behaviour?
( ) yes behavioral
( ) yes combination of factors (e.g. managerial, social and cultural)
( ) Other
Part III: Ergonomics application in work group level in organizations

1. After having finished the workshop, did you feel that your power and influence on your organizational work group increased?
   ( ) Yes ( ) No ( ) the same as before

2. After having finished the workshop, did your work group power and influence change?
   ( ) Not at all ( ) Somehow ( ) yes, very much

3. After having finished the workshop, did your job or position in your work group change?
   ( ) Yes, it became less monotonous and repetitive, but nobody had anything to do with me.
   ( ) Yes, it was not monotonous or repetitive any more and I participated in work committees.
   ( ) Yes, it contained various tasks and I participated in organizational decisionmaking.
   ( ) Other

Please explain the reason for your choice.

……………………………………………………………………………………
……………………………………………………………………………………

4. After the ergonomics workshop, were there any changes in your work group?
   Note: Work group changes, here, means any changes in group integration, group criteria, group members’ roles, leadership pattern, interaction effectiveness, challenge, basic skills in communication, group decision – making, power and influence.

   ( ) Not at all ( ) Somehow ( ) yes, very much

4.1. Do you evaluate these changes as positive?
   ( ) Yes ( ) No ( ) the same as before

Please explain the reason for your choice and evaluate it.

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

5. After having finished the workshop, did you observe any difference or conflict in your work group activity?

   ( ) Not at all ( ) Somehow ( ) yes, very much

In case of any resistance or conflict in the work group, what was the reason (please explain)?

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

6. After the workshop, how was the performance of your work group to improve environmental conditions?

   ( ) Not at all ( ) Somehow ( ) yes, very much

In any case, please explain performances and evaluate the reasons.

……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
Part IV: Ergonomics application in organization level

1. Did your organization top manager participate in the ergonomics workshop?
   ( ) Yes                                ( ) No

   Was the ergonomics workshop useful (for your organization)?
   ( ) Yes                                ( ) No

   If yes, how much has your organization used applied information?
   ( ) Not at all                         ( ) Somehow               ( ) yes, very much

   If you participated in the ergonomics workshop alone to what extent has your
   organization used your ergonomics knowledge?
   ( ) Not at all                          ( ) Somehow               ( ) yes, very much

   Please explain your choice and evaluate it.

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

2. After the ergonomics workshop, what kind of organizational changes has your
   organization experienced?

   Note: Organizational changes, here, means any changes in responsibility, authority,
   organizational culture, organizational structure, organizational behaviour
   improvement, organizational strategy and tactic, productivity (including
   organizational and personnel), performance motivation and job satisfaction.
   ( ) Not at all                       ( ) Somehow                  ( ) yes, very much

   Do you evaluate the changes as positive?
   ( ) Yes                                ( ) No

   If yes, what are the reasons of changes (Please explain)?

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

   If no, what organizational issue do you mean? Explain please and evaluate your
   reasons.

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

3. After having finished the ergonomics workshop, which of the following sentence
   is correct about your relation to the organization?
   ( ) I have more responsibility
   ( ) I have more responsibility and authority
   ( ) Other

   3.1. Please explain about your choice.

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

   ………………………………………………………………………………………………

4. How useful and applicable did you find the ergonomics workshop in three levels
   (individual, group and organizational)?

   Note: Score 3 = very useful, score 2 = useful and score 1 = useful but a little
   ( ) work group level
   ( ) individual level
   ( ) organizational level
Part V: Questions regarding to what should be done if we want to make a better use of ergonomics know-how in industries? For example:

1. Who should be trained in ergonomics?
   ( ) top & intermediate managers
   ( ) supervisors
   ( ) workers
   ( ) all levels (e.g. top manager, intermediate manager, experts, supervisors and workers)

2. What kind of training programme do you suggest?
   ( ) short time training by workshop
   ( ) Training in organizational by an ergonomics intervention programme
   ( ) others (e.g. long term M.Sc. and Ph.D. educational programme)

3. What kind of support do you think is needed after training?
   ( ) scientific support
   ( ) organizational and top management support
   ( ) combination of factors (e.g. scientific, organizational and top management, financial supports)
   ( ) Other

4. Which organization can be effective to spread out ergonomics intervention programmes in Iran?
   ( ) governmental organizations
   ( ) private institutes
   ( ) combination of factors (e.g. governmental organizations, private institutes, network national and network international)
   ( ) Other

5. What do you suggest to apply ergonomics know-how better and more effective in Iranian industries?

In the end, we appreciate your cooperation. Please write down any suggestions which you think are necessary for continuing this research work.

Thank you for your effort
Appendix 3

(The full checklist (source, ILO, 1999)
Checkpoints 1 – 128)

According to the manager director of GC (1996), ‘the 128 ergonomic checkpoints in
the categories like clusters of grapes that could be different forms and sizes of each
cluster of checkpoints for various workplaces or organizations’ (source, Helali,
2003).

Source this Photo and the Photo on the book cover are: http://search.yahoo.com/
Checkpoints 1 - 128

Materials storage and handling:

1. Clear and mark transport routes.
2. Keep aisles and corridors wide enough to allow two-way transport.
3. Make the surface of transport routes even, not slippery and without obstacles.
4. Provide ramps with a small inclination of up to 5 to 8 per cent instead of small stairways or sudden height differences within the workplace.
5. Improve the layout of the work area so that the need to move materials is minimized.
6. Use carts, hand-trucks and other wheeled devices, or rollers, when moving materials.
7. Use mobile storage racks to avoid unnecessary loading and unloading.
8. Use multi-level shelves or racks near the work area in order to minimize manual transport of material.
9. Use mechanical devices for lifting, lowering and moving heavy materials.
10. Reduce manual handling of materials by using conveyers, hoists and other mechanical means of transport.
11. Instead of carrying heavy weights, divide them into smaller lightweight packages, containers or trays.
12. Provide handholds, grips or good holding points for all packages and containers.
13. Eliminate or minimize height differences when materials are moved manually.
14. Feed and remove heavy materials horizontally by pushing and pulling them instead of raising and lowering them.
15. Eliminate tasks that require bending or twisting while handling materials.
16. Keep objects close to the body when carrying.
17. Raise and lower materials slowly in front of the body without twisting or deep bending.
18. When carrying a load for more than a short distance, spread the load evenly across the shoulders to provide balance and reduce effort.
19. Combine heavy lifting with physically lighter tasks to avoid injury and fatigue and to increase efficiency.
20. Provide conveniently placed waste containers.
21. Mark escape routes and keep them clear of obstacles.

Hand tools:

22. Use special-purpose tools for repeated tasks.
23. Provide safe power tools and make sure that safety guards are used.
24. Use hanging tools for operation repeated in the same place.
25. Use vices and clamps to hold materials or work item.
26. Provide hand support when using precision tools.
27. Minimize the weight of tools (except for striking tools).
28. Choose tools that can be operated with minimum force.
29. For hand tools, provide the tool with a grip of the proper thickness, length and shape for easy handling.
30. Provide hand tools with grips that have adequate friction or with guards or stoppers to avoid slips and pinches.
31. Provide tools with proper insulation to avoid burns and electric shocks.
32. Minimize vibration and noise of hand tools.
33. Provide a “home” for each tool.
34. Inspect and maintain hand tools regularly.
35. Train workers before allowing them to use power tools.
36. Provide for enough space and stable footing for power tool operation.

**Productive machine safety:**

37. Protect controls to prevent accidental activation.
38. Make emergency controls clearly visible and easily accessible from the natural position of the operator.
39. Make different controls easy to distinguish from each other.
40. Make sure that the worker can see and reach all controls comfortably.
41. Locate controls in sequence of operation.
42. Use natural expectations for control movements.
43. Limit the number of foot pedals and, if used, make them easy to operate.
44. Make displays and signals easy to distinguish from each other and easy to read.
45. Use markings or colours on displays to help workers understand what to do.
46. Remove or cover all unused displays.
47. Use symbols only if they are easily understood by local people.
48. Make labels and signs easy to see, easy to read and easy to understand.
49. Use warning signs that workers understand easily and correctly.
50. Use jigs and fixtures to make machine operation stable, safe and efficient.
51. Purchase safe machines.
52. Use feeding and ejection devices to keep the hands away from dangerous parts of machinery.
53. Use properly fixed guards or barriers to prevent contact with moving parts of machines.
54. Use interlock barriers to make it impossible for workers to reach dangerous points when the machine is in operation.
55. Inspect, clean and maintain machines regularly, including electric wiring.
56. Train workers for safe and efficient operation.

**Improving workstation design:**

57. Adjust the working height for each worker at elbow level or slightly below it.
58. Make sure that small workers can reach controls and materials in a natural posture.
59. Make sure that the largest worker has enough space for moving the legs and body easily.
60. Place frequently used materials, tools and controls within easy reach.
61. Provide a stable multi-purpose work surface at each workstation.
62. Provide sitting workplaces for workers performing tasks requiring precision or detailed inspection of work items, and standing workplaces for workers performing tasks requiring body movements and greater force.
63. Make sure that the workers can stand naturally, with weight on both feet, and perform work close to and in front of the body.
64. Allow workers to alternate standing and sitting at work as much as possible.
65. Provide standing workers with chairs or stools for occasional sitting.
66. Provide sitting workers with good adjustable chairs with a backrest.
67. Provide adjustable work surfaces for workers who alternate work between small and large objects.
68. Use a display-and-keyboard workstation, such as a visual display unit (VDU), that workers can adjust.
69. Provide eye examinations and proper glasses for workers using a visual display unit (VDU) regularly.
70. Provide up-to-date training for visual display unit (VDU) workers.
71. Involve workers in the improved design of their own workstation.

**Lighting:**

72. Increase the use of daylight.
73. Use light colours for walls and ceilings when more light is needed.
74. Light up corridors, staircases, ramps and other areas where people may be.
75. Light up the work area evenly to minimize changes in brightness.
76. Provide sufficient lighting for workers so that they can work efficiently and comfortably at all times.
77. Provide local lights for precision or inspection work.
78. Relocate light sources or provide shields to eliminate direct glare.
79. Remove shiny surfaces from the worker’s field of vision to eliminate indirect glare.
80. Choose an appropriate visual task background for tasks requiring close, continuous attention.
81. Clean windows and maintain light sources.

**Premises:**

82. Protect the worker from excessive heat.
83. Protect the workplace from excessive outside heat and cold.
84. Isolate or insulate sources of heat or cold.
85. Install effective local exhaust systems which allow efficient and safe work.
86. Increase the use of natural ventilation when needed to improve the indoor climate.
87. Improve and maintain ventilation systems to ensure good workplace air quality.
Control of hazardous substances and agents:

88. Isolate or cover noisy machines or parts of machines.
89. Maintain tools and machines regularly in order to reduce noise.
90. Make sure that noise does not interfere with communication, safety and work efficiency.
91. Reduce vibration affecting workers in order to improve safety, health and work efficiency.
92. Choose electric hand lamps that are well insulated against electric shock and heat.
93. Ensure safe wiring connections for equipment and lights.
94. Protect workers from chemical risks so that they can perform their work safely and efficiently.

Welfare facilities:

95. Provide and maintain good changing, washing and sanitary facilities to ensure good hygiene and tidiness.
96. Provide drinking facilities, eating areas and rest rooms to ensure good performance and well-being.
97. Improve welfare facilities and services together with workers.
98. Provide a place for workers’ meetings and training.
99. Clearly mark areas requiring the use of personal protective equipment.
100. Provide personal protective equipment that gives adequate protection.
101. Choose well-fitted and easy-to-maintain personal protective equipment when risks cannot be eliminated by other means.
102. Ensure regular use of personal protective equipment by proper instructions, adaptation trials and training.
103. Make sure that everyone uses personal protective equipment where it is needed.
104. Make sure that personal protective equipment is acceptable to the workers.
105. Provide support for cleaning and maintaining personal protective equipment regularly.
106. Provide proper storage for personal protective equipment.
107. Assign responsibility for day-to-day cleaning and housekeeping.

Work organization:

108. Involve workers in planning their day-to-day work.
109. Consult workers on improving working-time arrangements.
110. Solve work problems by involving workers in groups.
111. Consult workers when there are changes in production and when improvements are needed for safer, easier and more efficient work.
112. Reward workers for their help in improving productivity and the workplace.
113. Inform workers frequently about the results of their work.
114. Train workers to take responsibility and give them the means for making improvements in their jobs.
115. Provide opportunities for easy communication and mutual support at the workplace.
116. Provide opportunities for workers to learn new skills.
117. Set up work groups, each of which collectively carries out work and is responsible for its results.
118. Improve jobs that are difficult and disliked in order to increase productivity in the long run.
119. Combine tasks to make the work more interesting and varied.
120. Set up a small stock of unfinished products (buffer stock) between different workstations.
121. Combine visual display work with other tasks to increase productivity and reduce fatigue.
122. Provide short and frequent pauses during continuous visual display work.
123. Consider workers’ skills and preferences in assigning people to jobs.
124. Adapt facilities and equipment to disabled workers so that they can do their jobs safely and efficiently.
125. Give due attention to safety and health of pregnant women.
126. Take measures so that older workers can perform work safely and efficiently.
127. Establish emergency plans to ensure correct emergency operations, easy access to facilities and rapid evacuation.
128. Learn about and share ways to improve your workplace from good examples in your own enterprise or in other enterprises.