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SUMMARY OF DOCTORAL THESIS

National University of
Public Service
Doctoral Committee

EUR. ERG. DR. GYULA SZABÓ

Methodology of Military Service Related Ergonomic Risk Evaluation

The author's words to PhD thesis

Budapest
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Academic mentor:

Prof. Dr. Lajos Berek

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1. DESCRIPTION OF THE ACADEMIC PROBLEM

Despite continuous efforts, diseases of the musculoskeletal system – the back, the neck and the upper limbs – still represent a dominant healthcare issue and a major cost burden. According to the latest – 2010 – survey of European Working Conditions, the situation in Hungary is unfavorable even in an EU comparison; and the situation of industrial workers is particularly alarming as it features among the worst in the comparison. The assessment of bodily position at work has been rated similarly in the course of the past ten years with relatively small derogations; however, the proportion of working time spent with manual materials handling or repeated hand or arm movements is continuously increasing. Industrial work in Hungary, according to

- 29.3 % of workers involves tiring or painful bodily positions (2000: 32.8 %; 2005: 27.1 %),
- 47.7 % of workers involves the carriage or movement of heavy weights in at least one quarter of their working hours (2000: 35.4 %; 2005: 39.0 %),
- 59.4 % of workers involves repeated hand or arm movements (2000: 45.1 %; 2005: 47.8 %) (*EWS 2010).*

Increasing perceptions of risks by employees could also be attributed to the fact that ergonomic risks are increasingly in focus in addition to industrial rearrangements – e.g. electronic assembly or motor industry suppliers gaining ground – if not only a laggard 8% – compared to 28% in a European average – of Hungarian companies involved ergonomics experts in establishing healthy and safe working conditions. (*ESENER 2010*)

Latest European research also substantiates that musculoskeletal diseases – that is, those of the back, neck and upper limbs – continue to represent a dominant healthcare issue and a major cost problem and their significance is increasing. This is also indicated by the fact that musculoskeletal diseases are within the first three factors of the highest concern in respect of safety and health protection at work amongst European companies.

The Community strategy on health and safety stresses a better adjustment of workplaces to individual needs as well as the importance of the actual application of major principles of ergonomics in workplace design and work organization. (*Community strategy 2007-2012*)

In order to maintain combat readiness, it is essential that the physical capabilities of soldiers enable them to perform their tasks. Accordingly, all attempts to familiarize with military tasks, to identify the physical capacities required to perform them, to select the individuals suitable for completing such tasks and to maintain physical condition are just self-evident.

The issue of preserving physical condition is also particularly important, among other things, because the physical condition of the Hungarian population, including youngsters applying for military service, is constantly deteriorating. The importance of preserving physical condition is also justified by the fact that a reduction of physical capacities by age must be taken into consideration in respect of the contracted military forces to replace the conscript system. In this subject, Zoltán Eleki defended his dissertation titled ”Analysis of the system of physical requirements with respect to Hungarian soldiers and possibilities of optimization” at the Doctoral School in 2003. (*Zoltán Eleki 2003*).

However, ensuring the physical ability of the personnel is not only critical for preserving fight capacity since physical loads by service may lead to injuries and illnesses even in peacetime. Excessive exertion or repeated movements may result in accidents or injuries, leading to sick leave or in more serious cases to a loss of fitness for military service.

The dissertation by Dr. Sándor Sandra in 2007, titled ”Some Issues of Military Fitness and Locomotor Disorders” also points out to the differences of physical loads according to branches, stressing that differences in physical loads must also be taken into consideration in selection. The ”practical ergonomics model” presented by him and the proposed healthcare database suggests a systematic evaluation of physical loads as well as the statistical analysis of diseases in service and feedback of the results to task planning. (Sándor *Sandra*, 2007)

Management of ergonomic risks is also a regulatory requirement as Act XCIII of 1993 (Art. 54, para (2)) stipulates that "employers are obligated to make a qualitative – and if necessary, quantitative – assessment of risks to hazard the health and safety of employees.” (*Act XCIII of 1993*)

The ”Joint guidelines of health and safety supervisory authorities to perform workplace risk assessment” (*MK 2006/4*) list hard physical work and too intensive or monotonous work among hazards identified as ”Physiological, neural, and psychic factors”. Evaluation of this hazard category is based on ”Decree 25/1998 (XII. 27.) by the Ministry of Health on the minimum health and safety requirements of manual load movements involving the risk of back injuries primarily” (*25/1998. (XII. 27.) EüM*) after the annulment of the formerly applicable ”Decree 2/1972 KPM by the Minister of Transport, Post and Telecommunications on the issuance of Chapter IV titled ’Materials handling and storage’ of the Measures of Precaution for Transport Accident Prevention and Health Protection”. (*2/1972 KPM*)

2. RESEARCH OBJECTIVES

The topic of my research focuses on the development of a method to be used for the **qualitative and quantitative assessment of physical load risks** arising from materials handling and repeated movements, primarily based on the standard ”MSZ EN 1005 Safety of machinery - Human physical performance - Part 1: Terms and definitions” (*MSZ EN 1005-1:2001+A1:2009*), to be followed by an **analysis and verification of the applicability of this method**.

The main research objective is to verify that the evaluation of physical loads by military service can be realized and the risk of musculoskeletal disorders can be quantified.

Implementation of the following partial objectives in the course of research:

- survey the international practice for reducing the hazards of musculoskeletal diseases associated with military service,
- collect methods to be applied for the study of physical load and stress by service, and explore development correlations between methods,
- work out a proposal on the basis of standards for a modern survey method to be applied in Hungarian practice,
- determine the applicability criteria, benefits and drawbacks of the method above.

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3. RESEARCH METHODS

The research method involved literature elaboration as well as document and data analysis in the preparatory phase and for the analysis of the international situation. Afterwards, I headed the sub-project titled ”Critical infrastructure protection research” of TÁMOP-4.2.1.B-11/2/KMR and the high-priority research area titled ”Possibilities of reducing workplace ergonomics risks”, and I developed a survey methodology and conducted evaluation and control checks together with my colleagues.

Document analysis involves the collection and processing of regulations and publications on diverse civil and military agronomy programs. One of the results of literature elaboration is a Hungarian description of ergonomics programs, suitable for both civil and military environments. Based on such document analysis, the development correlations of ergonomics methods are identified.

I specifically analyze the *MSZ EN 1005* series of standards to explore internal correlations. I identify risk factors, qualifying parameters, and the components of qualitative and quantitative risk assessment. By formal transformations of the evaluation methods set out in the standard I enable them to define risk levels in an identical format in all the four fields of evaluation – bodily position, exertion, manual materials handling, and repeated movements.

I define the requirements for an ergonomic risk assessment system based on the outputs of the steps taken so far, as well as my experience in workplace ergonomics risk assessment and consultations with major Hungarian experts.

Based on the requirements I develop the Composite Ergonomic Risk Assessment method (hereinafter: CERA) and I conduct trial tests in industrial circumstances. In the course of trial tests, real workplaces are evaluated in respect of their ergonomics, using CERA and other relevant ergonomic methods. The method is further developed and the instructions for use are produced on the basis of experiences.

4. CONCISE DESCRIPTION OF THE SURVEY CONDUCTED BY CHAPTERS

In Chapter *1 – ERGONOMIC ACTIVITIES FOR THE SAFETY OF MILITARY SERVICE* – I analyzed publicly available documents and I defined the legal and organizational framework for the applicability of a survey method. As a part thereof, I analyzed the risk management regulations of physical load and stress, the respective legal regulations applied for Hungarian civil and military purposes, and as a comparison, I analyzed the evaluations of physical load and stress in foreign armies.

In Chapter *2 – EVALUATION OF PHYSICAL LOADS BY WORK OR MILITARY SERVICE* – I worked up the organizational and methodological components of the implementation of an ergonomics development program, by processing literature resources and relying on my own practical experience.

Chapter *3 – STANDARDS ON ERGONOMIC RISKS* – mainly includes a critical analysis of the MSZ EN 1005 series of standards, coupled with the standardization of the evaluation methods set out in the standards and adaptation thereof to the evaluation of industrial workplaces.

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Chapter *4 – THE COMPLEX ERGONOMIC RISK ASSESSMENT SYSTEM* – contains the steps of the user-centered development and testing of the method, including

- needs analysis,
- interpretation of standard requirements,
- evaluation sheet and evaluation worksheet design, followed by redesign on the basis of expert evaluation,
- field testing (preparation, workplace evaluations, interpretation of results),
- laboratory testing,
- finalization.

5. SUMMARY OF CONCLUSIONS

5.1. Summary of research activities

I have been involved in the ergonomic development of workplaces since the beginning of my professional career. I have conducted comprehensive ergonomics surveys in several factories, developed action plans, trained ergonomics teams and introduced ergonomics development programs together with my colleagues. Completion of tasks required on-going methodological developments, assisted by my own field experiences and increasingly accessible international sources of information. During this time, I adapted, applied and introduced several ergonomics survey methods to the Hungarian professional practice of ergonomics and health and safety.

Upon the appearance of contracted military service, more and more attention is devoted to the treatment of musculoskeletal diseases and injuries. I processed Hungarian special literature and regulations in the subject and familiarized with international examples. I presented two typical examples of countries recognizing ergonomic risks and actively involved in reducing hazards, and I drew conclusions.

In the course of my doctoral research, I systematically revised and supplemented my knowledge on the evaluation methodology of ergonomic risks, I explored development trends, and I defined further research tasks to be performed in the medium term.

My doctoral research was focused on ergonomic risk assessment based on the MSZ EN 1005 series of standards, therefore I processed ergonomic standards currently in effect. I analyzed the series of standards above and I carried out formal transformations for practical application.

Development and introduction of the standard-based complex ergonomic risk assessment system resulted in the implementation of several projects under my professional guidance. The criteria and manner of application of the method were determined by surveys conducted in real circumstances, in a way that parallel evaluations were also completed using methods recommended by the international literature.

I took steps towards the implementation of IT-supported ergonomic risk assessment based on imaging; however, we need to wait several years for its practical implementation for industrial

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purposes to be economical in Hungary as well, taking the development of technical criteria into account.

5.2. Final conclusions in summary

Based on the processing of publicly available literature, I ascertained that ergonomic risks need to be tackled at the Hungarian Army as well and measures should be taken to repress musculoskeletal diseases related to service. I explored several good examples available, providing an appropriate basis for us to develop and introduce the version suitable for us.

Through processing the international special literature on the subject, I familiarized with ergonomic risk assessment methods and their aspects of evaluation and qualification, and I managed to recognize a pattern in the development of methods. IT tools open up new opportunities for the development of ergonomic methods, necessitating a significant reconsideration of the methodology of ergonomic risk assessment.

I analyzed the MSZ EN 1005 series of standards and I established that it may provide a basis for a tractable ergonomic risk assessment system. I demonstrated that some limitations and difficulties must be taken into account when applying the standard and that significant simplifications are required for practical applications.

At the head of a research group, I developed versions of the CERA evaluation sheet (paper and pencil) and evaluation worksheet (Excel). I conducted user testing and controlled field tests for verification. I evaluated the usability requirements of methods, their procedures and development requirements.

6. NEW ACADEMIC RESULTS

1. In compliance with the Hungarian context of application, I developed a complex ergonomic risk assessment system, tested and finalized in an industrial environment. Features of the method:

- it is easy to use for the identification of ergonomic hazards, to screen ergonomic problems, providing results on a red-yellow-green scale as customary for risk assessment,
- criteria for usability are clear; green and red evaluations are provided reliably within this framework together with indications of further surveys required,
- it is based on a regulatory and standard background, not ”just” adapting international practices,
- covers a wide range of work-related musculoskeletal risks.

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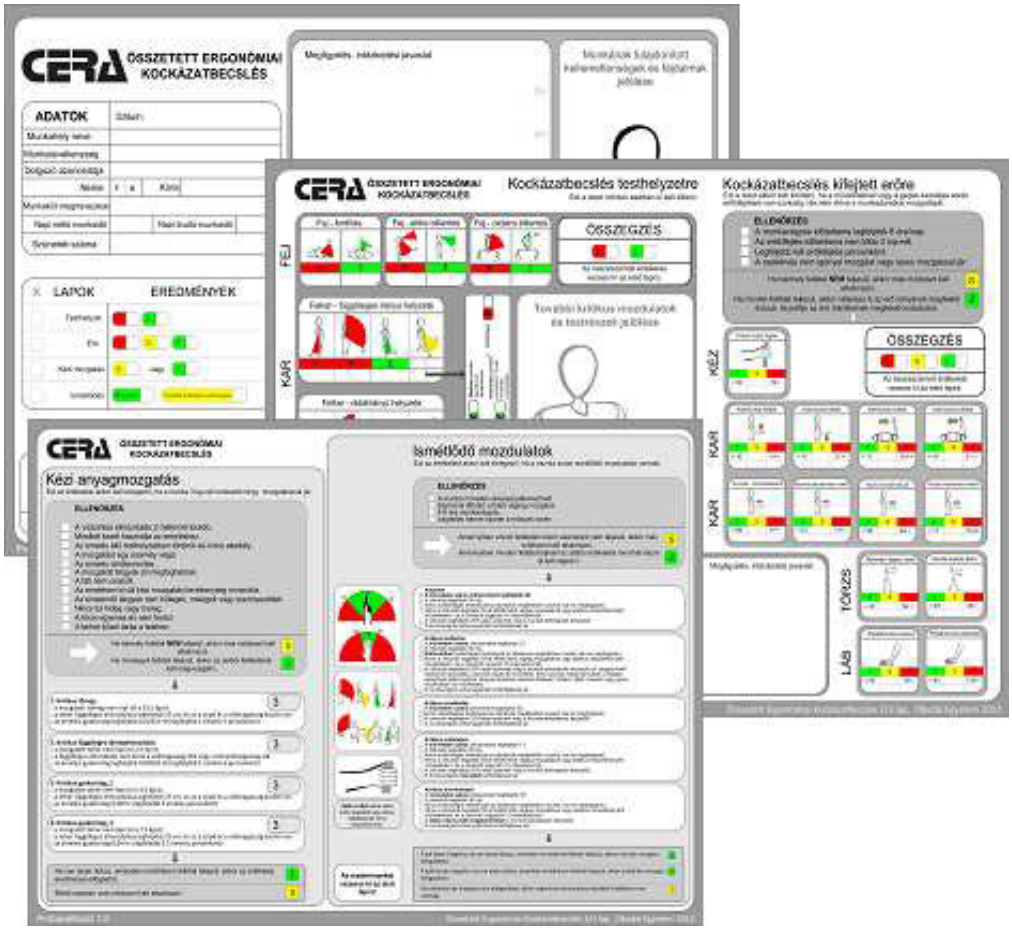

Source: Gy. Szabó

Fig. 1. Worksheets of papír-pencil based CERA

Partial results of the research work to establish results:

2. Based on publicly accessible literature resources, I processed domestic and foreign regulations and practices to manage ergonomic risks, and I established that there are consistent procedures and methods worked out in detail for the management of ergonomic risks; on the basis thereof, substantial results are produced to preserve health and to increase combat value.

3. I created a model for the development correlation of ergonomic investigation methods and I established that IT plays an increasing role therein; ergonomic risk assessment may undergo a quality change as new technologies appear.

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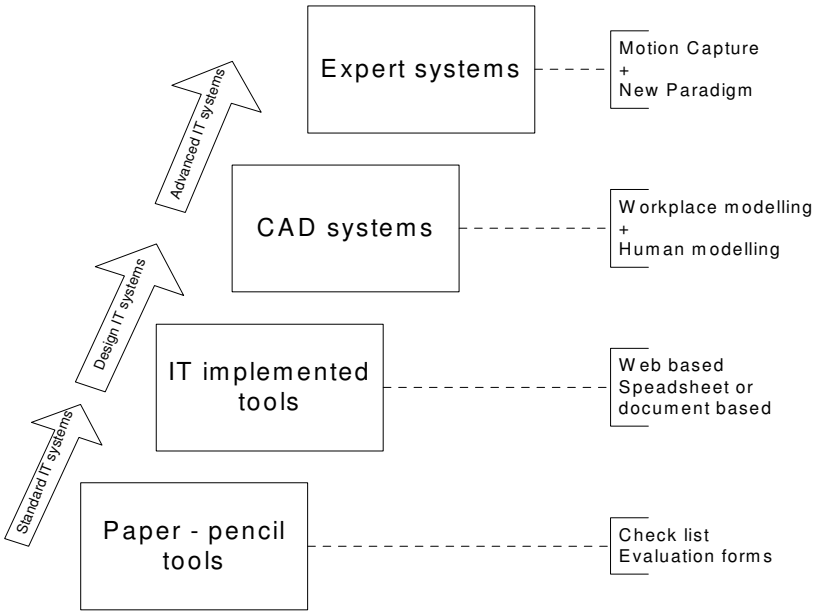

Source: Gy. Szabó

Fig. 2 Evolution of ergonomic assessment tools

4. I defined the internal correlations of MSZ EN 1005, and I established that it integrates the generally accepted methods of ergonomic risk assessment at present, and that it is acceptable as a methodological background to a risk assessment system, but it can only be applied with considerable limitations in workplace risk assessment.

7. USABILITY OF RESEARCH RESULTS IN PRACTICE

This knowledge has also been made available for application in Hungary by ergonomic regulations and the adaptation of procedures and experiences from abroad; they will be required to be applied within a couple of years upon the introduction of contracted service.

The development model of ergonomic methods helps understand difficulties, deficiencies and contradictions in evaluation experienced in practice; it also determines future trends of development and enables the identification of specific courses of research.

8. PROPOSALS ON THE USE OF THIS THESIS

Some of the results of my doctoral research are already utilized in practice, including the website created for health and safety professionals where they can gather information about work-related risk management (*web RISK*), or the complex ergonomic risk assessment system which has already been used for a number of evaluations and which can also be downloaded free of charge (*web CERA*).

My recommendations for decision-makers and researchers:

- At the Hungarian Army, regulations and capacities should be developed to prevent musculoskeletal diseases in terms of all tasks and the entire personnel. This includes both war and non-war activities.

- Research should be continued towards computer-assisted assessment tools, where the development of methods based on imaging and other automatic data collection insinuate possibilities of ergonomic risk tracking.
- The CERA method must be revised regularly to follow changes in the standard.
- Due to the diversity of situations in ergonomic practice (e.g. the activity examined, abilities of the evaluator, time and instrumentation available for the survey) different ergonomic methods are required; their concerted application can lead to reliable results.
- The complex ergonomic risk assessment system developed can be used expediently for ergonomic risk management in the Hungarian circumstances; it is suitable for the risk assessment of work-related musculoskeletal diseases at a state-of-the-art level according to standard requirements.

9. THE AUTHOR'S PUBLICATION RELATED TO THE DOCTORAL RESEARCH

Book, chapter

Szabó Gy.: Evaluation and prevention of work-related musculoskeletal disorders in Hungary, Advances in Physical Ergonomics and Safety, Orlando, Taylor & Francis Ltd. (CRC Press), pp. 195-202, 2012.

Szabó Gy.: A fizikai munkavégzés ergonómiája, OE BGK, no. 3037, Budapest, Óbudai Egyetem, pp. 1-115, 2012.

Szabó Gy.: Antropometria és ergonómia, Akadálymentes építészet, Budapest, Verlad Dashöfer, pp. 3-17, 2007.

Papers in journals in Hungarian

Szabó Gy.: A váz-izomrendszeri megbetegedések kockázatkezelése két ország fegyveres erőinél, Hadmérnök, vol. VII, issue 2, pp. 184-194, 2012.

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Szabó Gy.: Nyomáseloszlás vizsgáló eszközök ergonómiai alkalmazása, Munkavédelem és biztonságtechnika, vol. XXIII, issue 2, pp. 12-15, 2011.

Szabó Gy.: Ergonómiai alapok, Munkabiztonság, vol. XVIII: Fórum Média Kiadó, pp. 12-16, 2010.

Szabó, Gy.: A katonai szolgálatból származó fizikai terhelés értékelés módszerei, Bolyai Szemle, vol. XIX, issue 1: ZMNE, pp. 249-260, 2010.

Szabó Gy., Mischinger G., Moharos I. Mochnács M.: Váz-izomrendszeri kockázatok értékelése és csökkentése gépek tervezésekor, Gép, vol. LXI, issue 9-10: Gépipari Tudományos Egyesület, pp. 98-101 , 2010.

Papers in journals in English

Peczöli I., Szabó Gy: Flexible office environment, Periodica Polytechnica, vol. VII, issue 2, pp. 135-150, 1999.

Full conference papers in English

Szabó Gy: Evaluation and prevention of work-related musculoskeletal disorders in Hungary, 4th International Conference on Applied Human Factors and Ergonomics 2012, San Francisco, USA Publishing, pp. 1325-1332, 2012.

Szabó Gy: Identification of Sitting Positions with Artificial Neural Networks, First International Scientific Practical confrence of the Latvian Ergonomics Society, Riga, Latvia, University of Latvia Press, pp. 85-90, 2011.

Szabó Gy: An integrated tool for ergonomic risk assessment, Towards Safety Through Advanced Solutions, Sopot, Poland, CIOP PIB.

Szabó, G., Koloszár K.: A validation method for ergonomic risk assessment methods, 2nd International Conference on Applied Digital Human Modeling, San Francisco, 2012.

Szabó, Gy: A Pressure Mapping Application: Identification of Seating Positions with Nearest Neighbour Analysis, 3rd European Seating Symposium, Dublin, Central Remedial Clinic, pp. 245-249, 2011.

Full conference papers in Hungarian

Szabó Gy., Krajnc Z.: Civil - katonai partnerség - közös kutatási program a Nemzeti Közszolgálati Egyetem és az Óbudai Egyetem közreműködésével, Katonai Repülő és Légvédelmi konferencia, vol. XXV, no. 2, Szolnok, 2012, pp. 156-175, 2012.

Szabó Gy: A munkából eredő váz-izomrendszeri megbetegedések kockázatát befolyásoló tényezők, International Engineering Symposium at Bánki (IESB 2011), Budapest, Óbudai Egyetem, pp. 1-17, 2011.

Szabó Gy: Váz-izomrendszeri foglalkozási sérülések (CTD) kockázatának csökkentésére irányuló megoldások, módszerek kidolgozása", Nemzetközi gépész, mechatronikai és biztonságtechnikai szimpózium, no. 7, Budapest, Budapesti Műszaki Főiskola, pp. 1-17, 2009.

10. REFERENCES TO THE SUMMARY

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25/1998. (XII. 27.) EüM rendelet az elsősorban hátsérülések kockázatával járó kézi tehermozgatás minimális egészségi és biztonsági követelményeiről

Zoltán Eleki (2003): A magyar katonákkal szemben támasztott fizikai követelményrendszer vizsgálata, és az optimalizálás lehetőségei, PhD értekezés, ZMNE 2003.

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Közösségi stratégia 2007-2012: Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Improving Quality And Productivity At Work: Community Strategy 2007-2012 On Health And Safety At Work

MK 2006/4: A munkavédelmi felügyeletek együttes útmutatása a munkahelyi kockázatértékelés végrehajtásához, Munkaügyi Közlöny 2006/ 4. szám.

MSZ EN 1005-1:2001+A1:2009 EN 1005-1: Safety of machinery - Human physical performance - Part 1: Terms and definitions

Sandra Sándor (2007): Some Issues of Military Fitness and Locomotor Disorders, PhD dissertation, ZMNE.

Web CERA: cera.munkavedelmitovabbkepzes.hu (last accessed: 29 September 2012.)

Web risk risk.munkavedelmitovabbkepzes.hu (last accessed: 29 September 2012.)

11. PROFESSIONAL CURRICULUM VITAE

Work experience	
Dates	From 2001
Occupation or position held	Director general, Senior consultant
Main activities and responsibilities	Ergonomic trainings, Projects to workplaces improvement
Name and address of employer	DSGI Human Engineering Consultancy Ltd.
Type of business or sector	Consulting, vocational training
Dates	From 2008
Occupation or position held	Engineer
Main activities and responsibilities	Leading the Ergo Lab, participating in research activity
Name and address of employer	Óbuda University, Donát Bánki Faculty of Mechanical Engineering and Security Technology
Type of business or sector	Higher Education
Dates	1991 - 2006
Occupation or position held	Teacher
Main activities and responsibilities	Development of educational programs, lecturing, consulting final thesis
Name and address of employer	BME Ergonómia és Pszichológia Tsz. 1111 Budapest, Egry J. utca 1.

Type of business or sector	Higher Education
Dates	1999. - 2005
Occupation or position held	Senior consultant
Main activities and responsibilities	IT Human safety projects, development of IT strategies, methodologies
Name and address of employer	Insurance technology Ltd.
Type of business or sector	Consulting
Education and training	
Dates	2009 – 2012 Doctoral School, National University of Public Service
Title of qualification awarded	Budapest University of Technology and Economics Faculty of Electrical Engineering , Electrical engineer MSc, 1992
	Budapest University of Technology and Economics, Teacher, MSc. (postgraduate degree), 1994
	Budapest University of Technology and Economics - Doctorate courses, dr. univ, (field: Systems Theory and Operations Research), 1996
	Budapest University of Technology and Economics, Human and Technical Consultant in Vocational Rehabilitation MSc (postgraduate degree), 2010
	Budapest University of Technology and Economics, Human and Technical Consultant in Vocational Rehabilitation MSc (postgraduate degree), 2010
	Budapest University of Technology and Economics, PhD school, absolutory, 1999
	5 vocational degrees
Additional information	Awarded member of the Scientific Society for Measurement, Automation and Informatics Secretary General of the Hungarian Ergonomic Society Counsellor of the International Ergonomics Society Registered European Ergonomist (http://www.eurerg.org/?mod=contact&id=643) Counsellor of the Federation of European Ergonomics Societies