MIKLÓS ZRÍNYI
NATIONAL DEFENSE UNIVERSITY
PhD Council

dr. univ. Marianna Lendvay

Reliability analysis of military electronic systems

PhD theses

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Budapest, 2006

Scientific problem definition:

In our days the reliability analysis methods of complicated electrical systems have been getting more and more important not only at military systems but at some civil technical systems which are of a great value or demanding care in view of personal and property safety. The reliability analysis methods aim at contributing to up-to-date maintenance and to the development of system structure.

Realization of reliability requirements on military systems are excellent important. Membership of our country in NATO determines the direction and content of strategic modernization in national defense. Important aim of modernization is getting of modern instruments that cover co-operation with NATO forces, and development of available instruments. The defense capability depends, to a great extent, on the quality of defense systems. Quality is best achieved through an integrated systems approach throughout the life cycle. The overall aim is to acquire products that fulfill the quality and reliability requirements as seen from a life cycle perspective. The challenge for industry is to emphasize the processes for planning, controlling, assuring, and improving quality early in, and throughout all the processes and activities of the life cycle.

Object of my research work is examination and application of reliability analysis methods for concrete military electronic systems. The dissertation depends on my teaching and research experiences of twenty years, summarizes my scientific results in quality assurance and reliability tests.

Research objects:

1. Investigation and comparing of reliability analysis methods for reliability tests of electric systems. Evaluation of advantages and disadvantages in respect of application for military electric systems.
2. Working out of reliability analysis of concrete military systems.

Research methods:

- Evaluation of quality and reliability bibliography, conference reports and drawing the conclusions.
- Professional consultation with technicians in Miklós Zrínyi National Defense University, Budapest University of Technology and Economics, Budapest Tech, Dénes Gábor College, Ministry of Defense Technology Agency, Ministry of Defense Electronics, Logistics and Property Management Co. Electronics Directorate about quality and reliability management systems.
- Analysis and evaluation of international standards from quality and reliability managements systems.
- Analysis of military quality assurance systems.
- Scientific investigation of reliability analysis methods, research of their applications.
- Publication of research results.

Research results, conclusions:

In Chapter 1 a review can be found about development of quality definitions and realize, characteristics of international standards from quality management systems, reliability definitions, quantitative characteristics, and specifics of military assurance. I established that in international technical literature can be found very much definition about quality: on the basis of philosophy, product, production, customer's requirements, market value. Accordingly with it different activities became important in order to achieve quality aims. In our days meeting a claim from quality point of view realizes with quality management systems. The adoption of a quality management system should be a strategic decision on an organization. The international standard ISO 9001 promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements. The standard ISO 9004 stress the importance of product reliability and useful.
Military quality assurance has to take safety also into consideration. In organizations for supply of national defense organizations have to perform task that are in Allied Quality Assurance Publications (AQAP) and in Allied Reliability and Maintainability Publications (ARMP), through an integrated systems.

In Chapter 2 I examined and evaluated the reliability analysis methods. By their means in the process of reliability analysis of a system the numeric figures of the reliability components – faultlessness, utility and maintenance can be predicted and revised. Recently another element, security is also taken into account. The analysis methods are used at different system levels and with different specification. The analysis methods make it possible to evaluate the quantitative characteristics from one part, and the estimate of the numerical values from the other part that describe the forecasted, long term operation of the system. Taking into consideration that the system analysis should be carried out systematically and in a reproducible way, it is extremely important to use an expressly defined procedure. After general steps of reliability analysis procedures I demonstrated fundamental characteristics of procedures, defined advantages and disadvantages of methods. In order to choose the suitable procedure for investigation of military electronic system I worked out a criterion system. On the basis of criterion system I appreciated the procedures for military electronic systems. Results of compare I illustrated with diagrams. By reason of diagrams I established that exacting requirements for military electric systems it can be satisfy above all with Failure Mode and Effect Analysis, Fault Tree Analysis and Reliability Block Diagram.

Chapter 3 contains reliability analysis of concrete military electronic systems. During my research work I could study the military aircrafts and infrastructure in Miklós Zrínyi National Defense University, János Bolyai Military Technical Faculty, Aviation Technical Institute.
In the first section I worked out the reliability analysis method for reliability operation of building's electronic fire alarm system on military airport. The electrical systems of buildings generally consist of several subsystems (energy supply systems, electronic systems, communication systems, etc.), parts of which are located at a distance of several kilometres from each other. Operability of complex electric systems depends on the one part on the value of parameters (harmonic distortion, collapses and increases of voltage and transients) that effect on quality of energy supply systems and on the other part on reliability of connecting electronic systems, electronic devices and equipment. Success of operation of systems basically can be measured on how they satisfy to user's requirements. Satisfaction to these user's requirements, expectations can be accomplished by a properly designed and regular activities, examinations that can provide some warranty for satisfaction of requirements for fault-free operation and maintainability. On the basis of criterion system I chosen the Fault

Tree Analysis, because it deals with determination and analysis of conditions and factors that cause an occurrence of a preliminary defined not desired event, or that significantly effect on the operation, safety, economy or other prescribed parameter of the system. Starting out the structure of the fire alarm system I determined factors by that operability of the system can be effected: in case of a newly installed system and in case of an already taken-over and working system. I defined regarding the fire alarm system three main events and designed fault trees. I worked out logical analysis of fault trees using methods of Boolean algebra. By decomposition of branches of the fault tree, by analysing reasons of the output event, by decomposition of the factors that effect on the operation of the system I got to lower and lower levels of the system. During examination of the first "main event", of the effecting factors those that determined operability of the system most of all, were the following: existence of a reserve power source or replacement of the battery that serves for the supply of the reserve power source at specified intervals, supporting structures of wires must be suitable for loading even in case of fire, by build-out of the looped system, significant reserves can be established in the system, thereby its effectiveness will increase, component faults, professional knowledge of the operating personnel, its regular training, performing of necessary revisions, circumstances of maintenance, of operation.

The second section contains reliability analysis for electronic system of military aircraft. Important phase of jet planes was development of aircraft MiG 21 after world-ware II. On the basis of study of aircraft in Miklós Zrínyi National Defense University, Aviation Technical Institute I worked out reliability block diagram of electronic fire alarm system. The fire alarm system guarantees fire signal and function of fire equipments in driving mechanism space. The reliability block diagram provides a graphic characteristic of the logical structure of the system where the reliability relations between individual part systems and/or the spare parts are illustrated. This makes it possible to illustrate the successful operation of the system by the blocks (part systems/spare parts) the concurrent operation of which (logical relation) is necessary for the operation of the system. Starting out the structure of the fire alarm system I determined system functions, criterions of the successful operation. I designed reliability block diagram and defined the reliability function of system using methods of Boolean algebra and with truth tables. For the control of fire alarm system function is used the control apparatus PP-5M. Reliable function of fire system can be made likely with application of control apparatus and reliability block diagram. During application of this method I supposed the independence of system elements.

In Chapter 4 I summarized research work and research results. At the end of the dissertation a bibliography, my publications and the appendix can be found.

New scientific results (PhD theses):

1. **I evaluated** the reliability analysis methods in application's respect for military electronic systems /subsection 2.2., publications: A1, B2, B3, D7, D8/

2. **I worked out** a criterion system to compare the reliability analysis methods for military electronic systems, evaluated the methods during criterion systems and results of compare I illustrated with diagrams /subsection 2.3/

3. **I worked out** fault tree analysis of concrete military electronic system, made proposals for increasing of system operation safety. /subsections 3.1.1, 3.1.2. publications: B1, D2, D5/

4. **I worked out** reliability block diagram of concrete military electronic system, defined the reliability function of system. /subsection 3.2.1, 3.2.2/

Proposals to practical employment of research results:

- For prevention of military electronic systems, maintenance of operating state.
- For electric defense of military buildings.
- For military higher education in study of military electronic systems, in planning, development and operating of reliable electronic systems.

Future plans:

- Reliability analysis of special military electronic system.
- Evaluation of other reliability analysis methods, research of application for military electronic systems.

Publications:

A Scientific books:

1. **Marianna Lendvay** – Attila L. Bencsik: Using a FMEA to reliability assurance system in computer manufacture process, in „Intelligent Systems at the Service of Mankind" Ubooks Vol. 2, Germany 2005. (Willfried Elmenreich, J. Tenreiro Machado, Imre J. Rudas editors), pp. 389-402. ISBN 3-86608-052-2
2. **M. Lendvay** – A. L. Bencsik: Production Part Approval Process in Quality Management System, in "Intelligent Systems at the Service of Mankind", Ubooks, Germany, 2003. (Wilfried Elmenreich, J. Tenreiro Machado, Imre J. Rudas editors) pp.169-177. ISBN 3-935798-25-3
3. **Dr. Lendvay Marianna**: Minőség-ellenőrzés, Termék-megbízhatóság c. fejezetek /subsection: Quality control, Product reliability/ In: Bálint J. ed.: Minőség – tanuljuk, tanítsuk és valósítsuk meg, Terc Kereskedelmi és Szolgáltató Kft. Kiadó, Budapest, 2001.
4. **Dr. Lendvay Marianna**: A Kálmán Rt. esete, Önértékelés c. fejezetek pp. 25-26, 31-33. In: Bálint Julianna ed.: Minőség – Tanuljuk és tanítsuk, Tanári könyv, Műszaki Könyvkiadó - Magyar Minőség Társaság, Budapest, 1999. ISBN 963 16 3016 1, ISSN 1419-4376
5. **Dr. Lendvay Marianna**: Minőség-ellenőrzés, Minőségügyi rendszerek, Termék-megbízhatóság, A minőségköltségek tervezése c. fejezetek /subsections: Quality control, quality systems, plan of quality costs/ pp. 28-32, 55-58, 109-115, 118-120. In: Bálint Julianna ed.: Minőség - Tanuljuk és tanítsuk, Műszaki Könyvkiadó - Magyar Minőség Társaság, Budapest, 1998. ISBN 963 10 3007 2

B Scientific periodical reviews:

1. **Marianna Lendvay**: Reliability analysis method for military electronic systems, Bolyai Szemle 2005. XIV. évf. 2. szám, pp. 93-111. ISSN 1416-1443
2. **Dr. Lendvay Marianna**: Katonai célú elektronikus készülékek minőség- és megbízhatóság-biztosítása, /Quality and reliability assurance of military electronic systems/ Katonai logisztika, /Megjelenés alatt/
3. **Dr. Lendvay Marianna**: Elektronikus készülékek üzemeltetésének megbízhatósági kérdései, /Reliability problems of electrical apparatuses operation/ Bolyai Szemle, 2003 Különszám, pp. 87-98. ISSN 1416-1443
4. **Dr. Lendvay M.** – Dr. Zsigmond Gy.: Komplex villamos rendszerek megbízhatóság-elemzési módszerei, /Reliability analysis methods of complex electrical systems/ Hadtudomány, 2004 /2. pp. 110-116. ISSN 1215-4121
5. **Dr. Lendvay M.** – Dr. Bencsik A.: Szoftverek minőségfejlesztése funkcionalitás mérés alapján, GÉP, LII. Évfolyam, 2001/ 9 pp. 24-29. ISSN 0016-8572
6. **Dr. Lendvay Marianna**: Minőség és megbízhatóság az Elektronikus eszközök szakirány hallgatói számára, Acta Politechnika, Budapesti Politechnikum, 1995, pp. 147-166.
7. **Lendvay Marianna**: Tapasztalatok a CB 76-os asztali telefonkészülékek megbízhatósági vizsgálatáról, Híradástechnika, XXXVII. Évf. 1986. 5.sz. pp. 225-226

C Text-books:

1. **Dr. Lendvay M.** – Kupás Deák B.: Készüléképítés, Főiskolai jegyzet, BMF-KKVFK-2037, Budapest, 2005. pp. 5-71.
2. **Dr. Lendvay Marianna**: Ipari formatervezés, Főiskolai jegyzet, BMF-KKVFK-2014, Budapest 2002. pp. 1-102.
3. Dr. Lehotai L. - Dr. Novothny F. - Szenes I. - **Dr. Lendvay M.**: Biztonságtechnikai, környezetvédelmi és minőségbiztosítási alapismeretek, Főiskolai jegyzet, BMF KKVFK-1192. Budapest, 2000. pp. 139-179. /Javított kiadás: 2005, pp. 139-203/
4. **Dr. Lendvay Marianna -** Hartványi Tamás: Minőségbiztosítás, Akkreditált Iskolarendszerű Felsőfokú Szakképzés tankönyve, SzIF - UNIVERSITAS Kft. Kiadói Üzletág Győr 1998. pp. 1-42, 65-102.
5. **Dr. Lendvay Marianna** et al: Technológia laborgyakorlatok, Oktatási segédlet, T1 – T 37, KKMF Mikroelektronikai és Technológia Intézet, Budapest, 1994. pp. 1-20.
6. **Lendvay Marianna**: Megbízhatósági vizsgálatok, Főiskolai jegyzet, KKVMF - 1099, Budapest, 1989. pp. 1-130.

D Conference reports:

1. **Dr. Lendvay Marianna**: Minőségfejlesztés „hat szigma" módszerrel, Quality development with six sigma method, OGÉT 2006. XIV. Nemzetközi Gépész Találkozó, Marosvásárhely, Románia, 2006. április 27. – 30. Kiadvány pp. 235-238 ISBN 973-7840-10-0
2. **Dr. M. Lendvay** – Dr. A. L. Bencsik: Quality Assurance for Electronic Systems Using Fault Tree Analysis, 9th IEEE International Conference on Intelligent Engineering Systems (INES 2005), Cruising on Mediterranean Sea, September 16-19 2005. [CD: /INES 2005 /lendvay-bencsik.pdf] ISBN 0-7803-9474-7, IEEE Catalog Number: 05EX1202C

3. Dr. A. L. Bencsik – I. Nagy – **Dr. M. Lendvay**: Characteristics of the Mechatronics Curriculum to the BSc Level Mechatronics Course at the Budapest Tech, 6th International Workshop on Research and Education in Mechatronics (REM 2005), Annecy, France, June 30-July 1 2005. [CD: /REM 2005 ESIA FRANCE/Education/bencsik-nagy-lendvay.pdf] ISBN 2-9516453-6-8.
4. **M. Lendvay** – A. L. Bencsik: Examination method for quality assurance of electronic and electromechanical components, 2nd Romanian-Hungarian Joint Symposium on Applied Computational Intelligence (SACI 2005), Timisoara, Romania, May 12-14, 2005. Proceedings pp. 459-466, ISBN 963 7154 39 6
5. **Dr. Lendvay Marianna**: A hibafa elemzés alkalmazása elektronikus rendszerek megbízhatóság biztosítására, OGÉT 2005. XIII. Nemzetközi Gépész Találkozó, Szatmárnémeti, Románia, 2005. április 28. - május 1. Kiadvány pp. 223-226 ISBN 973-7840-03-8
6. **Dr. M. Lendvay** – Dr. A. L. Bencsik: Quality Development with Six Sigma Method, IEEE 8th International Conference on Intelligent Engineering Systems (INES 2004), Cluj-Napoca, Romania, September 19-21, 2004. Proceedings, pp. 590-594. ISBN 973-662-120-0
7. **Dr. Marianna Lendvay**: Dependability Assurance of Industrial Production Processes, Budapest Tech, Jubilee Conference, September 4, 2004. Proceedings, pp. 193-203. ISBN 963 7154 31 0
8. **Dr. M. Lendvay** – Dr. A. L. Bencsik: Reliability Analysis for Computer Manufacture Process, IEEE International Conference on Computational Cybernetics (ICCC 2004), Austria, August 30-September 1, 2004. Proceedings, pp. 297-302. ISBN 3-902463-023
9. **M. Lendvay** – A. L. Bencsik: Software Development with Quality Control, 1st Romanian-Hungarian Joint Symposium on Applied Computational Intelligence (SACI 2004), Timisoara, Romania, 2004. Proceedings, pp. 303-312. ISBN 963 7154 264
10. **Dr. Lendvay Marianna**: Elektromechanikus készülékek minőség- és megbízhatóság-biztosítása, OGÉT 2004. XII. Nemzetközi Gépész Találkozó, Csíksomlyó, Románia, 2004. április 22-25. Kiadvány pp. 178-183. ISBN 973-86097-9-8
11. **M. Lendvay** – A. L. Bencsik: Quality Management System with PPAP for Computer Components, IEEE International Conference on Computational Cybernetics (ICCC 2003), Hungary, August 29-31, 2003. [CD:/ ICCC2003/systems engineering/lendvay.pdf] ISBN 9637-154-183
12. A. L. Bencsik – **M. Lendvay**: Industrial Technologies and Know-how, Experiences in Distance Education, IEEE 4th International Conference on Information Technology Based Higher Education and Training (ITHET 2003), Marrakesh, July 7-9, 2003. [CD: /ITHET2003/Distance education/bencsik-lendvay.pdf] ISBN 9954-8352-0-2.
13. **Dr. M. Lendvay** – I. Nagy – Dr. A. L. Bencsik: Quality Improvement of the Base-Board Production Process, 7th IEEE International Conference on Intelligent Engineering Systems (INES 2003), Egypt, March 4-6, 2003. Proceedings, pp. 545-550. ISBN 977-246-048-3, ISSN 1562-5850
14. **Dr. Lendvay Marianna**: Benchmarking, a folyamatos minőségfejlesztés eszköze BMF Kandó Konferencia, Budapest 2002. november 14-15. [CD:/ BMF Kandó 2002/Minőségbiztosítás/ea/lendvay.doc] ISBN 963 7158 03 0
15. A. L. Bencsik – **M. Lendvay**: Industry-institute partnership for PLC education and training, IEEE International Conference on Information Technology Based Higher Education and Training (ITHET 2002), Budapest, Hungary, July 4-6, 2002. Proceedings, ISBN 963-7154-07-8

16. **M. Lendvay –** A. L. Bencsik: Production Part Approval Process in Quality Management System, 6th IEEE International Conference on Intelligent Engineering Systems (INES 2002), Opatija, Croatia, May 26-28, 2002. Proceedings, pp. 459-463. ISBN 953-6071-17-7, ISSN 1562-5850
17. **M. Lendvay –** A. L. Bencsik: Quality Improvement by Function Point Method, 5th IEEE International Conference on Intelligent Engineering Systems (INES 2001), Helsinki, Finland, September 16-18, 2001. Proceedings, pp. 249-253. ISBN 952-15-0689-X
18. **Dr. Lendvay Marianna**: Integrált vezetési rendszerek oktatása villamosmérnök hallgatók számára, Minőségoktatók konferenciája, 5. jubileumi Rendezvény, 2000. október 26. Szent István Egyetem Ybl Miklós Műszaki Főiskolai Kar Budapest, Konferencia kiadvány pp. 39-42.
19. **Dr. M. Lendvay**: Works in the Quality Management System on the Basis of QS-9000 Requirements, 4th IEEE International Conference on Intelligent Engineering Systems (INES 2000), Portoroz, Slovenija, September 17-19, 2000. Proceedings, pp. 221-224. ISBN 963-6303-23-6
20. **Dr. M. Lendvay**: Operating Principle of the Quality and Environmental Management Systems, IEEE International Conference on Intelligent Engineering Systems (INES '99), Poprad, Slovakia, November 1-3, 1999. Proceedings, pp. 265-267. ISSN 1562-5850, ISBN 80-88964-25-3
21. Dr. A. L. Bencsik - **Dr. M. Lendvay**: Eine Prüfungsmethode des Einbeförderungsprozesses im Qualitätssicherungssystem, 44. Internationales Wissenschaftliches Kolloquium, TU Ilmenau, Deutschland, 1999. Band 1. pp. 399-403.
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23. Dr. A. L. Bencsik - **Dr. M. Lendvay**: Product Follow-up and Final Stage of Inspection for Electric Switches in the Reliability Assurance System of the Producer, IEEE International Symposium on Industrial Electronics (ISIE '99), Bled, Slovenia, 12-15 July, 1999. Proceedings
24. **Dr. M. Lendvay -** Dr. A. L. Bencsik: Life Tests of Electric Switches in the Reliability Assurance System of the Producers IEEE International Conference on Intelligent Engineering Systems (INES ’98), Vienna, Austria, September 17-19, 1998. Proceedings, pp. 139-143.
25. **Dr. M. Lendvay -** Dr. A. L Bencsik: Applied Mathematics in Quality Assurance System of Electric Switches Producers, XIII. Conference on Applied Mathematics, University of Novi Sad (PRIM '98), Igalo, Jugoslavia, May 25-29, 1998.
26. **Dr. Lendvay Marianna**: Billenő kapcsolók villamos élettartam vizsgálata a vállalati minőségbiztosítási rendszerben, Kandó Kálmán Műszaki Főiskola XV. Tudományos Ülésszak, Minőségbiztosítás - Környezetvédelem Szekció, Budapest, 1998. Május 7-8, Kiadvány pp. 84-89.
27. **Dr.-Ing. M. Lendvay -** Dr.-Ing. A. L. Bencsik: Verbindung der Qualität und Zuverlässigkeit zur Entwicklung elektromechanischer Geräte, Pannonian Applied Mathematical Meetings, Interuniversity Network in Central Europe, Kosice, Slovakia, October 23-26, 1997. Proceedings.
28. **Dr.-Ing. M. Lendvay -** Dr.-Ing. A. L. Bencsik: Industriekooperation des zeitraffenden Zuverlässigkeitstests einer Schalterentwicklung, 16. Internationales

Kolloquium Feinwerktechnik, TU Budapest, Oktober 1-3, 1997. Proceedings, ISBN 963 420 531 3

29. **Dr. Marianna Lendvay**: Accelarating Reliability Tests of Electromechanical Contacts to Robot Controlling, IEEE International Conference on Intelligent Engineering Systems (INES '97), Budapest, Hungary, September 15-17, 1997. Proceedings, pp. 421-425. ISBN 0-7803-3627-5
30. **Dr. M. Lendvay** - Dr. A. L. Bencsik – J. Z. Szabó: Vibration Diagnostic Examination of Strongly-Integrated Electrical and Mechanical System, Mechatronics '96 The 5th UK Mechatronics Forum International Conference, Guimaraes, Portugal, 1996. Proceedings, pp. 323-328.
31. **Dr. M. Lendvay** – Dr. I. J. Rudas: Maintenance System of Industrial Robots, Third Biennial European Joint Conference on Engineering Systems Design and Analysis (ESDA), Montpellier, France, July 1-4, 1996. Proceedings, pp. 265-276.
32. **Dr. Lendvay Marianna**: Aspects of Reliability Analysis in Electronics, Konferencia ELMAT '96, Technická Univerzita Kosice, 8th May 1996. Proceedings, pp. 41-45.
33. **Dr. Lendvay Marianna**: Professional Questions of Training Total Quality Management Approach at BSc level Education, RELECTRONIC '95 9th Symposium on Quality and Reliability in Electronics, Budapest, 1995. Proceedings, pp. 449-454.
34. **Lendvay Marianna**: Experiences on the reliability tests of CB 76 desk telephone RELECTRONIC ′85 Symposium on Quality and Reliability in Electronics, Budapest 1985. Proceedings, pp. 640-647.

CURRICULUM VITAE

Personal details

Name*:* **DR. MARIANNA LENDVAY**
Date of birth: 21st of June, 1953.

Career history

Education and training:

1972-1977	Technical University of Budapest, Faculty of Mechanical Engineering
1977	State examination in sciences of mechanics
1978	Technical University of Budapest, Postgraduate course in pneumatic and hydraulic
1987	Scientific Society for Telecommunications, Course in planning and assuring of technical reliability
1989	Doctors degree at the Technical University of Budapest
1992	Hungarian National Committee for EOQ, Course in quality techniques
1993	State University of New York - The Center for Private Enterprise Development, Course in Total Quality Management

1993	Technical University of Budapest, Course in quality assurance systems
1994	Technical University of Budapest, Course in Total Quality Management
1995	The State University of New York at Buffalo, Program of Professional Development in Distance Learning and Open Learning, Total Quality Management in Higher Education
2004-2005	Miklós Zrínyi National Defense University Budapest, PhD school

Experience

1977-1980	Research - Developing Institute of MMG Automation Works *Job:* Developing Engineer *Duties:* Development of stream measuring instruments
1980-	Kandó Kálmán Polytechnic, Institute of Microelectronics and Technology
2000-	Budapest Tech, Kandó Kálmán Faculty of Electrical Engineering, Institut of Microelectronics and Technology *Job:* Associate Professor, Deputy Director *Duties*: **Education** in subjects: Precision-mechanics, Technology, Knowledge of Constructions, Reliability Tests, Technical Drawing, Quality Assurance, Planning and Control of Quality, Industrial Design, Quality development, Quality in practice, Reliability Analysis Methods.

Research-Development in themes:

1981	Development of TV antenna systems
1982-87	Accelarating reliability tests of industrial products
1985	Development of antenna torsional system
1994	Control system of telephon-exchange ARF 102
1997-98	Switchis test method project

Languages

Medium State Degree in Russian (1979)
Medium State Degree in German (1983)
Positiv Degree in English (1991)

Membership

1982-	Scientific Society for Telecommunications
1991-99	Hungarian Society for Quality
1992-	Hungarian National Committee for European Organisation for Quality
2003-	Hungarian Association of Military Science