ZRÍNYI MIKLÓS NATIONAL DEFENSE UNIVERSITY
DOCTORAL COUNCIL

MIKLÓS TAMÁS KONCZ

APPLICATION AND ELECTRONIC SYSTEMS OF THE METEOR-3R TARGET DRONE

PHD THESIS BROCHURE

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INTRODUCTION

In 1995 after the Velvet Revolution the Hungarian Parliament decided to enforce the low altitude and near ground air defence capabilities. In the same year the Hungarian Ministry of Defence invited international tenders for air defence, but it was unsuccessful. In 1996 the invitation of tender was repeated and five worldwide known weapon manufacturers submitted valid offer. The Defence Committee of Hungarian Parliament (1994-98 Year) suggested the purchase of French MISTRAL air defence system. In 1997 the defence minister announced the winner of the tender, who the MISTRAL-2 system was. In 1998 the delivery was started and this was worth about 100 million US dollars in past value, which included 9 pieces MCP[1], 45 pieces ATLAS[2] launcher, 54 pieces Mercedes Unimog trucks. The main contractor was the French-British Matra Bae Dynamics and the SHORAR[3] radar system was delivered by the Swiss Oerlikon-Contraves. The Hungarian HM Arzenál Rt. made the modification of the transportation vehicle, the integration of radar system. After the much reorganization the MISTRAL air defence system with KUB[4] and IGLA[5] systems is operated by 12. Arrabona Légvédelmi Rakétaezred[6]. In 1998 the WEAG[7] declared in its report that the MISTRAL-2 air defence missile system would provide a practical solution for up to 20 years of use; it meant that the operation of the missile and the target system should have been provided in long run.

The high volume investment only can serve the interest of the country, if the state of the weapon system, the preparedness and training of the operation crew allow the immediate deployment of the weapon with appropriate screening and deterrence. The operability of the weapon system can be provided by continuous training which provides good routine. The extensive training can be achieved by military exercises, live firing exercises or by practicing with the simulator of ATLAS man pads. Despite of the recommendation of the manufacturer of the missile neither the simulator nor the suggested target drone was purchased within the confines of investment. The MBD[8] suggested the BANSHEE drone from Meggitt Defence Systems or FOX-TS3 drone from CAC Systèmes (EADS) as the target drone system for MISTRAL air defence missile system. Both of them are very high quality and price category reusable target drones.

At the first exercise and in 1999 at the deployment exercise opened for the public (near the town of Drégelypalánk) the existing traditional METEOR-1 and METEOR-2 target drones were used with more or less success. Based on the experiences of the live firing exercises there were many evidences that the traditional target drones were inappropriate for MISTRAL system, because the silhouette of them was low, so impossible to remote control them from long distance, they could not transport target imitation devices (Luneberg-reflector, long burning time flares). In order to minimise the cost of the development, manufacture and the operation of the target drone it should have been completely Hungarian solution.

These design aims and reasons initiated the development of METEOR-3 target drone, which was led by Mr. György Görög (Aero-Meat Ltd.). The main design

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[1] MCP – MISTRAL Coordinating Post
[2] ATLAS – Advanced Twin Launcher Anti-air Strikes
[3] SHORAR – Short-range Anti-aircraft Defence Radar
[4] KUB – Russian made Short Range Air Defense system
[5] IGLA – Russian made Very Short Range Air Defense system
[6] 12. Arrabona Légvédelmi Rakétaezred – 12. Arrabona Air Defence Missile Regiment
[7] WEAG – Western European Armaments Group
[8] MBD – Matra BAe Dynamics

objectives of METEOR-3 target drone were to provide the ability to carry 18cm in diameter Luneberg-reflector and flares, to have good visibility and modular nose-cone, to be controlled by radio control. The experiences of exercises and the flights with METEOR-3 target drone confirmed that it basically was an appropriate target system for the MISTRAL, but it was not able to provide enough length of approaching active flight path for targeting of the missiles operators. The imitation of intruder fighter aircraft could be more realistic, if the target drone is auto-piloted and able to flight without manual control or two or more relay remote control pilots, which is under given circumstances impossible (for example over the see).

At the turning point of the research and development in the summer of 2000 I joined to the development team and faced to the complex problem. The first phase of the development was the implementation of an onboard GPS telemetry computer, which permitted that the pilot drove the drone from a closed cabin based on the flight instrumentation and video transmission to extend the active flight path. The next phase was an autopilot electronic system which provided the automatic follow of the pre-programmed flight trajectory without manual control. I started to develop this system commissioned by the Aero-Target BT. in the beginning of 2003. The first successful flight with the auto-piloted METEOR-3R was on 28th of December 2004 and this milestone established the official modernisation of METEOR-3 system. The new target drone was a low cost Hungarian alternative of the target systems recommended by the missiles manufacturer which was our response for the challenging requirement of the Hungarian Army and allowed the successful target services for MISTRAL air defence system. The auto-piloted target drone by flexible extending the active path of the flight trajectory provided realistic target imitation and appropriate path as the specification of MISTRAL air defence system in this way achieved successful live exercise.

In my thesis I detailed the phases and results of my research and development related to the target drone systems, especially the METEOR-3R target drone for MISTRAL air defence complex.

RESEARCH OBJECTIVES

1. Appraising the European target drones from open information sources and comparing them with the requirements of Hungarian air defence systems especially the MISTRAL air defence system and based on this information work out the specification of the target drone which fulfils the technical, tactical and economical criteria.

2. Based on analysis of the tactical and technical parameters of METEOR-3 target drone reveal the problems and deficiencies which has negative influences for its application on military exercises of MISTRAL air defence complex. Respecting this information suggest the way of the development.

3. Implementing a measurement method which permits to determine the radar cross section of the METEOR-3 target drone and its azimuth dependency. Suggest an alternative radar reflector type which fulfils the application specific criteria.

4. Suggest and implement an onboard autopilot system, which provides automatic flight of a pre-programmed trajectory and fulfils the application specific requirements of METEOR-3R target drone.

5. Justify the necessity of trajectory design and its criteria collection for the target drones and analyse the problems of traditional tracks of the METEOR-3. Based on this work suggest a new trajectory design method for the METEOR-3R which provides the operation of target imitation devices, the realistic target imitation and exploits the possibility of automatic flight with taking into consideration of the aspect of operation without endangering humans or assets.

APPLIED METHODS OF THE RESEARCH

In order to realize my research objectives first of all I accomplished wide range of literature research related to the subject of my dissertation. I extensively used electronic information resources, articles, application notes and publication from the internet. Most of this information was archived in my private archives.

I made a market research for sectors of the European target drone manufacturer in order to position our product, know and compare the relevant properties, parameters and specification of the similar systems.

I attended scientific conferences and lectures as lecturer and also as audience. I published my technical achievements related to the theme of my thesis in journals and conference proceedings.

I consulted with experts from 12. Arrabona Légvédelmi Rakétaezred[9] and MH LEP[10] TACEVAL[11] and accepted their recommendations, suggestions, opinions and corrections related to the application of the target drone.

I attended numerous practical workshops[12,13,14], military exercises[15], live firing exercises[16,17], civil protection meetings[18] and tests with our drone flights when I shared the information and the newest result of my development[19] with users (fire brigadiers, militant, experts from civil protection, nature protectors and vigilantes), developers and colleagues. I showed that my work was successful and widely usable for them.

The METEOR-3R[20] target drone with my control electronics were successfully deployed several military exercises for MISTRAL air defence complex. I collected the information regarding to the problem from the UAV pilots, military experts and missiles operators and after the evaluation corrected them.

I documented the most important milestones of the research, I took several digital pictures, videos and notes afterwards shared the valuable information for UAV experts.

Based on my literature research and the analysed problem I synthesized new solutions, answered the revealed questions by deduction.

I created the mathematical models for the simulation of physical systems, made several expediencies, tests and measurements. I compared the result of the simulation and measurements after the conclusion suggested a new solution for the primary

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[9] 12. Arrabona Légvédelmi Rakétaezred – 12 Arrabona Air defence Missiles Regiment

[10] MH LEP – Magyar Honvédség Légierő Parancsnokság: Hungarian Army Air Force Command

[11] TACEVAL – Tactical Evaluation

[12] Jakabszállás, 22nd of November 2006, Military Diplomatic Meeting, organised by QUALI-TOP KFT, Ferenc RINYU

[13] Nature Conservation Workshop: Hortobágy National Park, 3rd of November 2003.

[14] UAVNET WORKSHOP, organised by Szendrői Firebrigade and ZMNE, Szendrő, 23th of November 2005.

[15] „LENDÜLŐ KARD–2005", III. period, Military Exercise, Hungary, Kecskemét

[16] Open day of live firing exercise, Nagyoroszi, 16th of April 2003.

[17] „LENDÜLŐ KARD–2005", IV. period „BALTI-2-2005" Air Defence Live Firing Exercise, Ustka, Poland, 21th of June 2005.

[18] „NEREIDA – 2007" Civil Protection Control System Exercise Miskolc, 29th marc 2007., organised by QUALI-TOP KFT, Ferenc RINYU

[19] „HUMMINGBIRD", „MAYFLY ONE", „MAYFLY TWO" was successfully used in these events.

[20] METEOR-3 (M) official military name in the tenders, M from capital letter of my Christian name R after Robot.

problem.

For the radar cross section determination I developed a new measurement method and software, I tested my arrangement by simulation and practical experiences, where compared the result to the theoretical estimation.

For the flight control system of METEOR-3R target drone I programmed the algorithm in standard ANSI[21] C programming language and checked the implemented routines and source code by simulator and hardware emulator. I wrote some test programs in order to verify the operation of the device with the code and electrically tested the flight control system by a special test setup.

In the laboratory proven algorithms and electronic system were checked in the field with extensive test series by the help of my colleagues and fine-tuned by heuristic method.

I designed onboard electronic system, afterward I build the complete system prototypes including the population of the printed circuits boards and mechanical assembly. Following the successful flight test I organised the manufacturing of the first series. I made the final assembly and electrical test of the flight control systems.

During the development I shared my comprehensive experiences related to electronic design and application of the target drone to the experts and published the new results and questions in order to be able to utilize them.

STRUCTURE OF THE THESIS

I divided my thesis into four chapters:

1st chapter: I defined the target drones, determined its relevant parameters, specification, payloads and application specific properties. Based on the technical specification of MISTRAL air defence system, determined the minimum and ideal criteria collection related its target drone system. Based on my criteria system related to target drones I chose the appropriate targets system for the MISTRAL air defence system from the product range of European target drone manufacturer afterward I analysed their technical specification and compared them regarding to their application properties. I did not detail the non-European market, despite of the fact that there are very impressive and important US target systems. Finally I analysed the properties, application of METEOR-3 and METEOR-3R respecting the requirements of Hungarian Army, and suggested the possibilities of the future development.

2nd chapter: I analysed the problem related to surveillance and recognition of target drone by the MCP SHORAR radar system of MISTRAL complex. I gave a detailed description of radar reflectors used on the target drones, and compared them on application basis. I worked out a new measurement method for determining the radar cross section of the unknown object. Based on my measurement I compared the radar cross section value and azimuth dependency of the METEOR-3 drone family with the specification and the radar cross section of a traditional, non-stealth fighter aircraft. I suggested several solutions for substituting the currently used Luneberg-reflector with a wider azimuth type radar cross section enhancer in this way solving the syndrome of the radar surveillance.

3rd chapter: I briefly described the development of my flight control system including its short history, hardware design, software structure and subsystems. This flight control system allowed the modernisation of METEOR-3 target drone in this way extended the flight path by automatic flight and achieved a very successful live firing

[21] ANSI - American National Standards Institute

exercise in the town of Uska, Poland in 2005. I described not only the advantages of my onboard electronic system, but analysed its problems, imperfection and suggested solution for improving and correcting it.

4th chapter: I summarised the experiences related to the application of METEOR-3 target drone family and based on it created a new trajectory design criteria system, which respecting the properties, requirement of the weapon system, providing the operation of target imitation devices without endangering humans and assets. I shown several example tracks especially one designed for being suitable as trajectory of the target drone of MISTARL air defence complex.

CONCLUSIONS

In this dissertation I summarised my theoretical, practical studies and experiences gained during the development, manufacturing, operation of target drones and its electronic systems and introduced the implemented practical result of the research and development.

In my opinion the most outstanding result of the research was the successful participation with METEOR-3 target drone fit with my onboard flight control system in the „BALTI-2-2005" live firing exercise near the town of Ustka in Poland. During the exercise before and the live firex our target drones performed totally 60 successful flight hours. From the delivered and transported eight METEOR-3R six were destroyed by the direct hit of MISTRAL missiles, one by IGLA missiles and one had a technical failure and fel into the sea.

The very good result of the exercise could be own to the conscientious preparation of crew of the 12. Arrabona Légvédelmi Rakétadandár and I believe in that the new modernised target system, which extended the flight path and allowed flexible routing by automatic trajectory flight, has a very important role in the success.

I compared the experiences of workshops, exercises and test flights with the opinion, requirements of military experts and the directive from the manufacturer of missile afterward by means of studied publications I solved most of the revealed practical problems. The series of the problem mostly can be grouped around the following subjects: target imitation, radar surveillance, trajectory design and the maximum length of the track or farthest point of the track.

In 2005 the determining novelty of the modernisation of METEOR-3 target drone was my onboard flight control system which allowed the automatic trajectory flight hereby the extended the farthest point of the track and provided the realistic target imitation. I shortly described the design goals, hardware and software structure of the controller, its subsystems and the implemented flight control algorithm. Over the introduced extensively tested and practically well acting simple control method I developed a new complex altitude-velocity control principle, which can be applied for other TUAV's[22] or UAV's[23]. Advantages of this new control method are the precise altitude and velocity control, high efficiency, low consumption and the safe operation in the case of engine or motor failure. I suggested solutions for the revealed problems related to the flight control electronics and the possibilities of enhancement confirmed by practical tests and experiments. The first step of the development of new electronics should be the design of high computational capacity hardware.

The requirement of the MISTRAL air defence missile related to the target system only can be achieved economically a jet engine propelled aircraft which provides

[22] TUAV – Target Unmanned Aerial Vehicle
[23] UAV – Unmanned Aerial Vehicle

appropriate speed and at the same time enough infrared radiation with adequate electromagnetic spectrum signature. This presumption I confirmed by theoretical calculation and practical experiences, I anticipate that the new target drone of the MISTRAL system should be a single or twin jet engine aircraft moreover the application of jet engine allows the relatively easy implementation of smoke generator which improve the weak original visibility of the drone.

Nowadays increasing the probability of the attack with the drones accomplished by terrorists therefore our air defence forces should trained for it. On the exercises this kind of attack can be simulated by target drones including METEOR-3 family without target imitation devices with low infrared and radar signature.

By means of new developed radar cross section measurement method I proved that the radar surveillance and recognition problems were caused by the partial space coverage of Luneberg-reflector used on the METEOR-3 drone family. I suggested alternative radar cross section enhancer devices, which provides more space coverage than Luneberg-reflector and/or has other advantages. However, the direction characteristics of the radar cross section enhancer have to be considered during the trajectory design.

One of the key elements of the application of the target drones is the trajectory design which is a very important aspect from the operation of the target imitation devices to the safety regulations. Based on the recommendation of the missile manufacturer, the requirement of Hungarian army and my experiences with METEOR-3 drone family I created a practical criteria collection for the trajectory design and suggested a computer aided interactive method which automatically checks the track besides minimizing the human errors.

I defined the target drones, determined its relevant parameters, specification, payloads and application specific properties. Based on the technical specification of MISTRAL air defence system determined the minimum and ideal criteria system related its target drone system. The ideal target drone is suitable for checking all the specified parameters of the MISTRAL missiles. The target drones fulfils to the minimal criteria just enough to provide service for MISTRAL complex. Based on my criteria collection related to target drones I chose the appropriate target systems for the MISTRAL from the product range of European target drone manufacturer afterward I analysed their technical specification and compared them regarding to their application properties. I did not detail the non-European market, despite of the fact that there are very impressive and important US target systems. The trend in the target drone market is the usage of low cost model jet engines and commercial autopilot systems. In my opinion the low cost, pay-per-flight autopilot systems for target drones do not provide reliable dynamic services, because the limited take-off times. I believe in that an inland flight control system respecting the special requirements of the Hungarian Army and the service provider could be an economical solution for this problem in long term. I analysed the imperfection and application specific requirement of METEOR-3 and METEOR-3R and suggested the possibilities of the future development.

From the beginning of 2008 two batteries of MISTRAL air defence system have been offered for NATO peace keeper missions therefore the training of the operational crew is extremely important. In reflection of this situation I hope that as the recommendation of NATO ACE DIRECTIVE-80 2 dictates there will be live firing exercises in every two years and we could enjoy the results of the new developments.

In my dissertation I introduced my result in developing target drones and with the published achievements I tried to contribute to the research and development of the Hungarian unmanned aerial vehicles.

THESIS

1. **1.** From public information sources I appraised and compared the European target drone types respecting the requirements of MISTRAL air defence missile system and based on my analysis worked out an appropriate specification for Hungarian target drone system, which fulfils the economical, tactical and technical requirements of Hungarian Army.

2. **2.** I analysed the tactical and technical parameters of METEOR-3 target drone family and revealed the imperfections and problems which could cause negative consequences for the application in the military exercises of MISTRAL air defence missile system. Respecting this analysis I worked out suggestion for improving the target system.

3. **3.** I developed a new measurement method which is usable for determining radar cross section and its azimuth dependency of the target drone. With the application of method I confirmed that the value of radar cross section of the METEOR-3R target drone assembled with Luneberg-reflector fulfils a radar cross section of a realistic intruder aircraft, but it is direction dependent. I suggested alternative radar cross section enhancer devices which can provide the radar surveillance over the full trajectory of the target drone.

4. **4.** Using scientific research methods I designed a new inland electronic flight control system which fulfils the application specific requirements of the METEOR-3R target drone and the implemented algorithm provides safe operation of the aircraft.

5. **5.** I worked out the criteria system of trajectory design of target drones especially for the METOR-3R aircraft respecting the target requirements of MISTRAL air defence missiles system. This criteria system provides the appropriate operation of target drone and the MISTRAL complex with realistic target imitation including ability to surveillance the target by its visual and/or radar signature without endangering humans and assets and guaranteeing the predictable outcome of the exercises.

RECOMENDATIONS

I recommend this dissertation for Hungarian UAV developers, engineers and students especially for the experts who deal with operation, purchase, application or development of target drone systems or air defence systems. By means of comparative details of European target drones in the essay the new target system for the MISTRAL complex could be determined and could help for the precise specification.

My work related to the radar cross section enhancers confirmed the source of the radar surveillance problem was not only the target drone but also the not considered direction dependency of the Luneberg-reflector during the trajectory design. Without this study I could not prove that the radar surveillance problem was not caused by the unknown type Luneberg-reflector which was used on the METEOR-3 target drone family. I suggest this study for the experts who deal with radar systems of air defence missiles and the organisers and supervisors of military exercises.

I worked out a practical criteria system for the operation and trajectory design of target drones which can be applicable to other air defence systems with minor modification.

I designed and implemented a new flight stability system, which itself and subsystems also usable for automatic control of aircrafts or other type of robots; I recommend this study for electronics or robotics enthusiasts, developers, professional or hobbyist UAV specialists.

LIST OF PUBLICATIONS

1. *Onboard electronics for target of the MISTRAL air defence system.* in: AARMS, Academic and Applied Research in Military Science, Volume 5, Issue 1, 2006 pp.39-50., http://www.zmne.hu/aarms/docs/Volume5/Issue1/pdf/04konc.pdf

2. *Design of a low-cost balancing machine for the gas turbine of UAV's.* in: AARMS, Academic and Applied Research in Military Science, Volume 5, Issue 2, 2006 pp.289-309. http://www.zmne.hu/aarms/docs/Volume5/Issue2/pdf/12konc.pdf

3. *A MISTRAL légvédelmi rakéta célrepülőgépeinek robotizálása.* in: Repüléstudományi közlemények, Szolnok, XV. évfolyam 35. szám 2003. pp.91-99.

4. *Fedélzeti inerciális adatgyűjtő rendszer alkalmazása pilóta nélküli repülőgépekben.* in: Repüléstudományi közlemények, Szolnok, 2004. XVI. évfolyam 36. szám pp.43-52.

5. *Ki és mikor fogja megnyerni a „Grand Challenge”-t?* in: Nemzetvédelmi Egyetemi Közlemények, 2005. 9. évfolyam 1. szám, pp.102-114.

6. *Mérőpad tervezése pilóta nélküli repülőgépek gázturbinájához.* in: GÉP, A Gépipari Tudományos Egyesület Műszaki Folyóirata, 2006/5 LVII. évfolyam, pp.24-28.

7. *A célrepülőgépek alkalmazása és fejlesztése során szerzett tapasztalatok.* in: Bolyai Szemle 2006. XV. évf. 1. szám pp.40-49.

8. *Célrepülőgépek nemzetközi összehasonlítása.* in: Hadmérnök különszám, Robothadviselés 6. Tudományos Szakmai Konferencia, 2006. november 22., http://www.zmne.hu/hadmernok/kulonszamok/robothadviseles6/koncz_rw6.pdf

9. *Az EGNOS rendszer és alkalmazása során szerzett tapasztalatok.* in: Hadmérnök, II. Évfolyam 1. szám, 2007. március, pp.158-170. http://www.zmne.hu/hadmernok/archivum/2007/1/2007_1_koncz.pdf

10. *Luneberg-reflektor radarkeresztmetszetének mérése összehasonlító FDR módszerrel.* in: Hadmérnök, II. Évfolyam 3. szám, 2007. szeptember, pp.100-197., http://www.zmne.hu/hadmernok/archivum/2007/3/2007_3_koncz.pdf

11. *A Soundcard Based Dynamic Balancing Machine for Model Gas Turbine Engines, Part 1.* in: Gas Turbine Builders Association – News-letter No. 45. November 2004 pp.18-23., http://www.gtba.co.uk/gtba_forums/download.php?id=145

12. *A Soundcard Based Dynamic Balancing Machine for Model Gas Turbine Engines, Part 2.* in: Gas Turbine Builders Association – News-letter No. 46. February 2005 pp.5-11., http://www.gtba.co.uk/gtba_forums/download.php?id=144

13. Miklós KONCZ – Antal TURÓCZI: *Autopilot Applications for Different UAV Airframes*, www.uavnet.com/DL/Document_Library/Budapest_Meeting/Autopilot_Koncz.pdf

14. *Autonomous Flying of UAV*, Szendrő, UAVNET Regional Workshop 23th of September 2005., http://www.uavnet.com/newsletter/NEWSLETTER%2014.htm

15. *Onboard electronics for target of the MISTRAL air defence system*, Budapest, NDU, Robotwarfare 3, 2003. november 11.

16. *A MAYFLY ONE repülőgép fedélzeti irányító rendszer felépítése*: *digitális szervo vezérlő (1. rész)*, Szolnok, 2004. április 23. Gazdaságosság, hatékonyság és a biztonság a repülésben, konferencia kiadvány (CD), http://www.szrfk.hu/konf2004/index.html

17. *A MAYFLY ONE repülőgép fedélzeti irányító rendszer felépítése: központi egység (2. rész)*, Szolnok, 2005. április 15., Fél évszázad forgószárnyakon a magyar katonai repülésben, konferencia kiadvány (CD), http://www.szrfk.hu/konf2005/cikkek/koncz_miklos.pdf

18. *Automatikus irányítású célrepülőgépek pályatervezése*, Zrínyi Miklós Nemzetvédelmi Egyetem Bolyai János Katonai Műszaki Kar, Repülőműszaki Intézet, Szolnok, 2006 április 21., Új évszázad, új technológia – Gripenek a magyar Légierőben, Tudományos konferencia CD kiadványa, http://www.szrfk.hu/konf2006/cikkek_pdf/koncz_miklos_tamas.pdf

19. *Elektrolit kondenzátorok ESR mérése*, Zamárdi, Antenna Hungária Rt. Bartha Attila TV-URH konferencia kiadványa, 2001. június 18.

20. *Alumínium elektrolit kondenzátorok technológiai jellemzői*, Zamárdi, Antenna Hungária Rt. Bartha Attila TV-URH konferencia kiadványa, 2001. június 4-6.

21. *H-tér szonda alkalmazása szervizelési és fejlesztési gyakorlatban*, IX. Antenna Hungária Rt. Bartha Attila műsorszórás technikai konferencia kiadványa, Balatonföldvár, 2004. június 2-3.

CURRICULUM VITAE

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EDUCATION

2003-present	**Miklós Zrínyi National Defense University,** **PhD Institute of Military Technology** (as a civil person), Doctoral topic: Defence Electronics, Thesis: Control System for Target Drones	**Budapest, Hungary**
1998	**Bólyai János Military Technical Collage**, Branch of Electronic Warfare, **Compulsory** Military Service Rank: Reservist Lieutenant	**Budapest, Hungary**
1993-1996	**Budapest Technical University**, Faculty of Electrical Engineering and Information Technology, Branch of Measurement Technology and Process Control, Thesis: Design of a Portable Service Data Acquisition Instrument	**Budapest, Hungary**
1997	Diploma in **Electronics Engineering** (MSEE)	
1995-1997	**College of Finance and Accountancy** Thesis: Data Protection and Cryptography	**Csongrád, Budapest, Hungary**
1997	Diploma in **Economics (Economist)**, specialised in Enterprising (Bachelor Degree)	
1989-1992	**Kandó Kálmán Technical College**, Branch of Measurement Technology and Process Control Thesis: Design of a Microwave Intruder Alarm	**Budapest, Hungary**
1992	**Electronics Engineer** majoring electronics instruments (BSEE)	

FURTHER EDUCATION, TRAINING COURSE

2008 Spinner GmbH, Spinner Broadcast Training
2008 Rohde & Schwarz, DVB-T Transmitter Training
2008 Puskás Tivadar Távközlési Technikum, DVB-T course
2006 TRANSRADIO SenderSysteme Berlin AG, LWC Transmitter Training
2005 National Instruments Hungary Ltd., LabView basic course
2004 ChipCAD Ltd., Xilinx course
2002-2003 Alternative English School, Kecskemét, Business English Course
2003 Analog Devices, 2003 Amplifier Seminar
2003 McMillan & Baneth Ltd., Performance Appraisal Management Training
2000 Budapest Technical University, Institute of Continuing Engineering Studies, Interconnecting Cisco Network Devices
1999 Budapest Technical University - Antenna Hungária Rt., TETRA course
1998 Budapest Technical University, Institute of Continuing Engineering Studies, Long Distance Data Communications
1998 Budapest Technical University, Institute of Continuing Engineering Studies, New Methods of Digital Radio Communications

PROFESSIONAL EXPERIENCE

2000-2008 **Aero-Meat Ltd., Aero-Target Bt.** **Kiskunfélegyháza, Hungary**
(www.aerotarget.atw.hu)
Electronics design engineer (spare time job)

- All phase (from prototype to product) hardware and software design of the navigation, guidance and control electronics (autopilot) of the Hungarian target drone for Mistral air defence system.
- Having experience in extremely reliable multiprocessor system design with low budget and ability to work and tune the software and the electronics on the field.
- Complete design of a low cost balancing solution for small model gas turbine and DSP based software design of a balancer for helicopter rotors and airplane propellers (used by numerous modellers and professionals worldwide).

Greatest achievement: Participating in a great research and development project from the idea to the military exercise.

1994-present **Antenna Hungária ZRt.,** S-E Hungarian Region Operation Centre **Szentes, Hungary**
(Antenna Hungária Hungarian Broadcasting and Radio Communication Corporation, www.ahrt.hu), Szentes Service team
Team Leader (full time job) of Broadcasting Service Group, Nationwide DVB-T installation Coordinator, Technical Coordinator between Broadcasting Division and Service Division,

- Responsible for installation, maintenance, repair, service, operation and measurement of television, radio transmitters (LW, MW and VHF-FM) and transposers in wide power range (up to 150kW), authority to organise the work of our technical team.
- Providing standby service for the above detailed equipment, its infrastructure and assist to ensure continuous operation of the other networks (microwave links and mobile phone base stations, etc.).
- Initiative and chief developer of some useful software and test utilities for the transmitters in order to make the work easier.

Greatest achievement: Friendship based leading of an enthusiastic and very skilful technical team, which consists of different age associates and being able to rely on them in whatever situation.

1992-1994 **Tisza Bútoripari Rt.** (Furniture Factory) **Csongrád, Hungary**
Computer programmer

- Work on CAD/CAE and Production Control Programs

Greatest achievement: Preparation of the right purchase of the company's software for the non-technical decision makers.

SOCIETY MEMBERSHIPS

1995-present **MATE**, Scientific Society of Measurement, Automation and Informatics, Hungary (http://www.mate.mtesz.hu/)
2004-present **GTBA**, Gas Turbine Builders Association, UK (www.gtba.co.uk)
2004-present **MHTT,** Hungarian Society of Military Science (http://zrinyi.zmne.hu/kulso/mhtt/)

SKILLS

IT	Windows 9X, Windows XP and UNIX operating systems, Experiences in Electronics Design Software, Programming of Excel, Programming PC in Visual Basic, C language, digital signal processing experiences in LabView, Programming ATMEL RISC, 51 family µ-Controllers in Assembly and C language, CAE, EDA, CAD programs.
Language	Professional Business English Examinations, Euro pro B2 – Vantage Level (14/06/2003) Pitman Higher Intermediate ESOL – Level 2 (27/06/2003) Technical English Some words in French and Russian
Additional	Driving-license (A, B)

ACTIVITIES

Nature, technical photography and excursions,
Designing and building electronics projects, collecting and refurbishing electronic test instruments
HAM radio license (radio amateur), call-sign: HG0NCB class: UA

Budapest, 2009.

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Miklós Tamás KONCZ