ZRÍNYI MIKLÓS NATIONAL DEFENCE UNIVERSITY
Doctoral Committee

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SELECTION METHOD OF TACTICAL FIGHTER AIRCRAFT BASED ON ECONOMIC–EFFICIENCY INDICATORS FOR AIR FORCE MODERNIZATION OF SMALL SCALE DEFENCE FORCES

Author's synopsis and official report on the Ph.D. thesis

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FORMULATION OF THE SCIENTIFIC PROBLEM

Nowadays, in possible war conflicts the key of successful warfare is the unity of up to date weaponry with increased fire range and power, and the weapon platform with enhanced survivability and outstanding information potential. In dense population regions tactical fighter aircraft equipped with precision devices are able to cause serious damages to armoured enemy forces successfully thwarting their invasion. Regarding this fact, as well as taking into consideration that weapon systems of Hungarian Defence Forces are technically and morally obsolete, the upgrade and modernisation of our weaponry is an inevitable task.

Since, maintenance and enhance of our defence capabilities as necessity and the financial situation of our country as objective opportunity is far from each other, the optimal decision making claims especially responsible attention. Preparation of responsible political decision requires analysis of a plenty of military, engineering, economic and financial specialists. In this process first step is to formulate the tactical-technical objectives to help the selection of the most suitable new type of aircraft and after the tender it is practical to make the decision, contract and acceptance of new aircraft, within a short time

The possible modernisation of Hungarian Air Force is an open issue even today. The leasing of JAS-39 Gripen aircraft is a short term, temporary decision. The final selection, purchase and introduction of new tactical aircraft claims extremely difficult, complex and comprehensive consideration. This far-reaching question can be formulated satisfactory, if we analyse the would be aircraft objectively and in multiple way. In addition beside the tactical fighter aircraft the modernisation problem will reach the transport aircraft, helicopter and advanced training aircraft category very soon. Hopefully, a standard analysing and evaluation method can be usable at the acquisition and introducing process of other aircraft categories.

Tactical fighter aircraft all over the world are designed by standard requirements which are based on the experiences of previous war conflicts. Of course, some of the new products do not equally perform all these requirements, because the priorities, design, production, maintenance and technical criteria can be different. To judge the different aircraft, beside how they perform their basic tasks, it is inevitable the exact comparison and ranking by their economic and effective features.

Regarding the defence strategy and the financial endurance of our country acquisition of few, but multifunctional, modern tactical fighter aircraft is reasonable. Beside the air worthiness and

effective tactical adaptability, as much as important features the economical operation, long life time and suitability for possible upgrade.

A good decision is a kind of compromise between the highly effective but extremely expensive and cheap but not suitable types of aircraft, regarding our defence strategy. It is clear, that the decision can't be made by the aircraft producers' promotion and propaganda information. Hungarian Defence Forces needs that kind of equipment which is able to effectively operate in this human and objective environment, which features Hungary and during a maintenance system, we can provide.

Since 1986 as a teacher of Zrínyi Miklós National Defence University, Bolyai János Military Technical Faculty, Aviation and Air Defence Institute, Aircraft and Engine Department and their predecessor organisations I have dealt with theoretical and practical aspects of aircraft maintenance. By my personal experiences, I collected for years I have spent in aviation higher education and studying the different technical maintenance documents I decided to work out a complex aircraft comparing and evaluation system, based on scientific researches, which gives more realistic picture, than the aircraft producers' promotion brochures about stunning aircraft of air shows.

RESEARCH OBJECTIVES

In this dissertation, I have set the following objectives of research:

1. During the preparation of this dissertation, studying the air force task requirements of Hungarian Defence Forces, I have intended to designate the necessary capabilities of future introduced tactical fighter aircraft, which would establish the aspect system of an aircraft comparing and evaluation method.
2. Selection and adaptability development of an adequate accuracy evaluation and qualifying method, based on the multiple aspect decision theory, that would guarantee the selection a type of tactical fighter aircraft, which would accomplish both economical and tactical considerations, while would fulfil our NATO membership commitments as well as our own defence conception requirements.
3. Accomplishment of a practically usable, simple, objective, evaluation method for the conversion of aircraft tactical capabilities and technical features to exact scores and the method adaptability verification through the comparison and evaluation procedure of some – considerable by acquisition process - tactical fighter aircraft.

RESEARCH METHODS

In order to achieve my objectives and write my thesis, I have used the following methods:

I. Using *the analysing method* I examined the task system of modern air force and tactical fighter aircraft as independent system. I highlighted the applied new solutions, the differences and similarities of different types of tactical aircraft.

II. With *the mathematical methods* (decision theory, efficiency examinations, mathematical statistics, linear algebra) I examined the aircraft types, which are potentially suitable for technical modernisation, their price, cost efficiency (life costs), technical, tactical and maintenance features.

III. Using *the comparison method* I compared the representative features of possible introducing tactical aircraft converting these features to numerical indicators. For the research of this field I chose the elements of inductive and deductive method. During the discovery phase by inductive way for the data collection and analysis I used the conversation and questioning method

SUMMARY OF THE TESTS CONDUCTED

In the Introduction I list the motivation facts, which inspired me to write this dissertation. I describe the research actuality, introduce the research method, and formulate the research objectives.

In Chapter I, I introduce the role of tactical fighter aircraft in our country's defence system. I present the task system and resources of Air Force as well as I touch the specialities of technical modernisation process.

In Chapter II, I sketch the main features of tactical fighter aircraft. I choose from present-day produced tactical fighter aircraft that ones, which during the Air Force technical modernisation can be taken into consideration in reality. I demonstrate them with a brief but comprehensive description.

In Chapter III, I present the essence of multiple aspect decision theory, as well as I touch the problem of complex systems' matching and the selection and weighting questions of evaluation aspects.

In Chapter IV, I develop the aspect system, suitable for the comparison of tactical fighter aircraft. I introduce the expectations, which a modern, future introduced tactical fighter aircraft should perform. I present the evaluation aspect system suitable to measure the

necessary capabilities and features, based on the previous expectations as well as usefulness functions, which provides the numerical conversion of these features.

In Chapter V, I measure the sub-aspects' numerical values of previously developed evaluation aspect system. Detailing the complex features and capabilities, I choose parameters, which are quality dominant and suitable for elemental, direct evaluation, then I match numerical values to these parameters.

In Chapter VI, I complete the complex evaluation of chosen aircraft and I rank them by the previously developed evaluation aspect system.

In summary of my new scientific results I summarise the completed scientific work in accordance with my research objectives and compact my new scientific results into theses. At last I give recommendations for practical applicability of my scientific results.

SUMMARY OF CONCLUSIONS

The modernisation of Hungarian Air Force is an open issue even today, because the leasing of JAS-39 Gripen aircraft is a short term, temporary decision. The final selection, purchase and introduction of new tactical aircraft claims extremely difficult, complex and comprehensive consideration

Studying the task system of Hungarian Air Force, can be concluded, that the future introducing tactical aircraft must have air combat, air strike, and tactical reconnaissance capabilities, as well as it has to perform all NATO compatibility and interoperability requirements.

The acquisition process can not be independent from actual political environment, which means, beside the mere capabilities, the membership of military alliance, geopolitical environment, match to the military strength of neighbouring countries and the possible economic agreements can determine the outcome of highest level decision.

During the acquisition process, starting with a preliminary selection, it is necessary to reduce the examined aircraft to those, which in all probability perform the specified tactical and technical capabilities, while their introduction and operation means acceptable burden for Hungarian economy.

The complex comparison of tactical aircraft is a multi aspect decision problem. For the purpose of this comparison, the establishment of a rank list, based on cost-efficiency, can be signed, to perform those aspects, which are defined in Chapter I. and II. Namely, to select,

from the really achievable types of aircraft that one, which is the most optimal choice, by its tactical capabilities and costs, for the modernisation of Hungarian Air Force.

The importance and economic influence of the would be evaluation justify, that the comparison procedure must be completed by team decision method, because it minimises the probable mistakes both in definition of weight coefficient and ranking method.

Certain qualities of tactical aircraft easily measurable and exactly characterised by numerical values (for example tactical range, maximum flight speed), while real judgement of other features is extremely difficult (for example survivability, modernity). Converting these features into marks, the evaluator has to confront the specialities of verbal method. Using any kind of weight method, he has to perform his task with maximum precision.

The selection of evaluation procedure is stipulated by the regulations of related Hungarian Laws. The possible decision objective can be either the choice of a minimum cost project, or designation of cost-efficiently optimal equipment. In booth cases the check of decision accuracy can be completed by creation of a control team.

NEW SCIENTIFIC RESULTS

I summarised the scientific results of my research presented in the dissertation in the following theses:

Thesis I,

I proved that during the acquisition process for the modernisation of Hungarian Air Force we can meet tactical fighter aircraft, which are different in their tactical, technical parameters and their combat capabilities merely in a very small scale. To clear the unambiguous and well-defined differences it is necessary to decide, by preliminary examinations, the suitable evaluation aspects not only the fundamental features, but the differences. [S.1, S.2, S.3, S.4, S.8]

- I proved that the evaluation of tactical fighter aircraft is possible only by complex comparison procedure. From possible methods we must use that one, which can measure the parameters, you have to compare, with appropriate sensitivity. [S.5, S.6, S.7]
- I pointed that, controlling the required evaluation adequacy, minimum two isolated evaluation team is necessary, parallel with each other. The teams can use different examination methods, because the definite differences can be presented by any method.

Thesis II,

I developed the minimal aspect system, suitable for the preliminary evaluation of tactical fighter aircraft. The chosen evaluation factors perform the necessary decision theory requirements with regard to their complexity and integrity. [S.8, S.9, S.10]

- I proved, that the features of aircraft, I defined, can be evaluated and transformed into numerical value. [S.13, S.14, S.15]
- I proved, that the necessary evaluation calculations not definitely claim special decision support software. For the simplified procedure it sufficient to use office software package with chart managing capability (for example the Excel of Microsoft Office). For more difficult evaluation procedure (for example AHP) it is inevitable to use software, which is suitable to solve matrix algebraic operations.

Thesis III,

I certified that the final evaluation result has a great dependency on weight coefficients, which means we have to generate them with extraordinary precision and accuracy. To successfully perform this objective it is necessary to organise multilevel professional teams, which must contain pilots, air traffic controllers, and aircraft engineers, financial and economic specialists. [S.14]

PRACTICAL APPLICABILITY OF THE RESEARCH RESULTS AND RECOMMENDATIONS

The whole dissertation and any chapter of dissertation independently useable for those planning and analysing specialists, who work in the field of air force technical modernisation to provide methodology support, preparation and high-level training by this presented evaluation procedure. With the demonstrated difficulties and recommended solutions it is possible to make the necessary precautions to avoid the prospective problems during the practical aircraft acquisition process and hereby the future aircraft tender can be a shorter and easier process.

The produced evaluation aspect system can be the basis of a later redeveloped, practically elaborated evaluation chart.

Using this method in the university education system it can help to form the students' broader professional view. Students in aviation engineering courses learning this knowledge can be able for the complex analysis of aircraft structures and technical systems as well as to understand reasons of an aircraft upgrade or any kind of innovation.

LIST OF PUBLICATIONS AND OTHER SCIENTIFIC PUBLIC ACTIVITIES RELATED TO THE DISSERTATION

S1. **Kavas L.:** Selection of future introduced aircraft based on efficiency indicator. Szolnok Scientific Publications V. 2001. pp. 174-182.

S2. **Kavas L.:** Objective evaluation of tactical aircraft. Aviation Science Publications, Szolnok "FAT 2002. (Special Edition), pp. 69-74.

S3. **Kavas L:.** Essence and method of comparison, based on the principle of cost-efficiency. PhD Students' "Jász-Nagykun-Szolnok County" Conference I., Szolnok, 08. 11. 2002. Electronic Edition.

S4. **Kavas L.-Dr. Óvári Gy**.: Ideas about the prospective, new tasks of Hungarian Air Force. "Aircraft of Military Blocks, Blocks of Military Aircraft" Conference, Szolnok, 04. 04. 2003. Electronic Edition.

S5. **Kavas L. - Dr. Óvári Gy. - Békési B.:** Mathematical methods for comparison of tactical aircraft. "Half Century of Choppers in Hungarian Military Aviation" Scientific Conference, Szolnok, 15. 04. 2005. Electronic Edition.

S6. **Kavas L. – Varga B.:** A practicable method of comparison of the tactical combat aircraft. „TRANSPORT MEANS 2006" International Conference, Kaunas University of Technology, Lithuania, 19-20. 10. 2006. pp. 332-334.

S7. **Kavas L:.** Comparability of aircraft performance data. "Jász-Nagykun-Szolnok County" Days of Science Conference, Szolnok, 2006. Electronic Edition.

S8. **Kavas L. – Dr. Gyarmati J.:** Some theoretical questions of air force modernisation. "Engineering Science in North Plane Region" Scientific Conference, Nyíregyháza, 16. 11. 2006. pp. 23-32.

S9. **Kavas L.:** Potential comparability of tactical aircraft. "Scientific Session of Young Technical Engineers", Kolozsvár, 16-17. 03. 2007. pp. 105-108.

S10. **Kavas L.:** Problems of weight coefficients in evaluation process of complex systems. "Military Adaptability of Unmanned Aerial Vehicles and Transport Aircraft" Scientific Conference, Szolnok, 20. 04. 2007. Electronic Edition.

S11. **Kavas L. – Dr. Óvári Gy.:** Practical Method for Determing the Weight Number of the Evaluation Factors. "TRANSPORT MEANS 2007" International Conference, Kaunas, Lithuania,18-19. 10. 2007. pp. 222-225.

S12. **Kavas L.:** Analysis of tactical aircraft based on their major tactical capabilities. "Jász-Nagykun-Szolnok County" Days of Science Conference, Szolnok, 2007. Electronic Edition.

S13. **Kavas L.:** Judgement of tactical aircraft based on technical maintenance aspect. "Engineering Science in North Plane Region" Scientific Conference, Szolnok, 16. 11. 2007. DAB Engineering Commission: Electronic Engineering Booklets, pp. 47-58.

S14. **Kavas L.:** Selection of tactical aircraft based on cost-efficiency. "Day of Young Technical Engineers", Szolnok, 14. 05. 2008. (Presentation).

S15. **Kavas L.:** Survivability of tactical aircraft. "Jász-Nagykun-Szolnok County" Days of Science Conference, Szolnok, 16. 11. 2008. Szolnok Scientific Publications. Electronic Edition.

PROFESSIONAL ACADEMIC BACKGROUND

I was born on 16th June 1963 in Balassagyarmat. I finished the secondary grammar school in 1981 in Budapest as an aeroplane mechanic with "good" result. Even that year 26th August after successful Entrance Examination I joined up the former Killián György Aviation Technical College (hereafter only KGYRMF by its former abbreviated name) where I attended the Airframe and Engine Course. In 1985 I was commissioned as 2nd lieutenant and became a mechanical maintenance engineer with "good" result.

My first assignment was deputy company commander of Cadet Company at the Training School for Non-commissioned Officers of KGYRMF. In 31st August 1986 I was commissioned maintenance engineer instructor at Aircraft Maintenance Department of KGYRMF. That time I took part in the training of future non-commissioned officers, officers and reservists for Air Force technical staff. I was responsible for the subjects of Aircraft Maintenance and Repair and Aircraft Special Ground Service Vehicles and Equipments. During that time every year I took part a sex-week long practical training at different Air Force Wings. Beside my main task as an instructor I served as sub-unit technician, responsible for the fighter aircraft of our College. In accordance with this task I took successful examinations at first as Third Class Aircraft-technician Officer, later two times as Second Class Aircraft-technician Officer and at last in 1991 as a First Class Aircraft-technician Officer.

From 1st October after successful Entrance Examination I attended the Mechanical Engineering Faculty of Budapest Technical University, where I graduated in 20th October 1994 as a mechanical engineer with “good” result.

From November 1994 I work in the field of aviation higher education in different educational positions at Aircraft and Engine Department of a multiple structurally transformed establishment, earlier referred to as KGYRMF and which is called today Zrínyi Miklós National Defence University, Bolyai János Military Technical Faculty, Aviation Training and Air Defence Institute.

Between October and November 1995 I took part a practical training again to study the airframe and engine structure, as well as the maintenance of JAK-52 aircraft.

In 1st July 1996 I was assigned to College Assistant Lecturer. Beside different basic knowledge subjects (Mechanics, Mechanical Elements, Light Structures, Mechanics of Solidity, Measure Technology) I taught the subjects of Repair of Aerial Vehicles and Aircraft Maintenance.

In 1992 I passed „C” type intermediate state exams in English.

In 2001 I passed ECDL examination.

As scientific public activity I regularly take part on different conferences for example conference called Day of Science of Jász-Nagykun-Szolnok County. Besides this I am member of Hungarian Military Science Society. In 2nd February 1998, before general timeline, I was promoted to major and 1st August 2007 I progressed up to the rank of lieutenant colonel.

From 1st November 1998 I worked as University Assistant Lecturer and from 2002 after a successful application I was assigned to College Associate Professor.

In June 2001 successfully finished a NATO Orientation Course and after that, from September I began my PhD studies at Military Technical Doctoral School of Zrínyi Miklós National Defence University, where in June 2006 I accomplished the requirements of absolutorium.

Thanks to my practice and experience, I have gained in the higher education for years, from 2006 I was commissioned at first as a Leader of Aircraft and Engine Subdivision, and

after that as a Head Aircraft and Engine Department of Aviation Technical and Air Defence Institute.

I hereby would like to thank all the people who have provided invaluable assistance, in the form of constructive criticism, advice and informed opinion, in achieving my scientific objectives.
Special thanks to Prof. Dr. Gyula Óvári, my scientific consultant, for his efforts and counselling through all these years.

Szolnok, 18th June 2009.

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