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LIFE CYCLE OF MILITARY TECHNOLOGY EQUIPMENT– THE HUNGARIAN PRACTICE

A HADITECHNIKAI ESZKÖZÖK ÉLETÚTJA – A MAGYAR GYAKORLAT

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Abstract

This paper presents Hungarian research and development (R&D) practices through the entire life cycle of military technology equipment in general. The publication reviews the processes from the emergence of an idea to the withdrawal phase and points out their essence. During the lifetime of military equipment there are important milestones preceding the decision for acceptance for service followed by deployment in service. In this article the authors' engineering considerations emphasize that some terminologies may change over the years, but the milestones and phases have to follow each other by a strict and logical order during the life cycle of new equipment beginning from concept through retirement. This publication can significantly help teaching in English-language training programs (BSc, MSc, PhD).

Keywords: *Research & Development (R&D); lifecycle; military technology, acquisition, quality assurance*

Absztrakt

A publikáció a magyar kutatás-fejlesztési (K+F) gyakorlatot mutatja be a haditechnikai eszköz teljes életciklusán keresztül. A haditechnikai eszközök életútjuk során fontos szerepet töltenek be a rendszerbekerülésüket megelőző események. A szerzők ebben a cikkben mérnöki szemlélettel világítanak rá arra, hogy bizonyos terminológiák változhatnak ugyan az évek során, azonban a részfolyamatoknak az életút során meghatározott logikai szempontok szerint kell követniük egymást. A publikáció az ötlet felmerülésétől a kivonásig bezárólag áttekinti a folyamatokat, és rámutat azok lényegére. A publikáció egésze jelentős mértékben segítheti az angol nyelvű képzési programokban (BSc, MSc, PhD) résztvevők oktatását.

Kulcsszavak: *Kutatás-fejlesztés (K+F); haditechnikai eszközök; életút, beszerzés, minőségbiztosítás*

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INTRODUCTION

The ability of a country to deploy its armed forces depends on the structure of the organization, including the number of personnel and training level, the quality and quantity of the equipment, as well as the development and readiness of the combat procedures. We would like to discuss questions of equipment, technology, armament and related procedures in this article. We will show which steps must be taken to make that a newly developed military technology equipment would be able to meet the all the user's requirements and other requirements (standardization, codification, etc.) We also show and distinguish with explanation the major milestones of equipment lifecycle including the final station of lifecycle - which is the retirement (withdrawal) phase and possible destruction.

LIFE CYCLE OF MILITARY EQUIPMENT – STEP BY STEP

This topic is addressed by several other sources. We take the approach of the AAP-48 NATO document. The process - in very simplified form - is shown below.

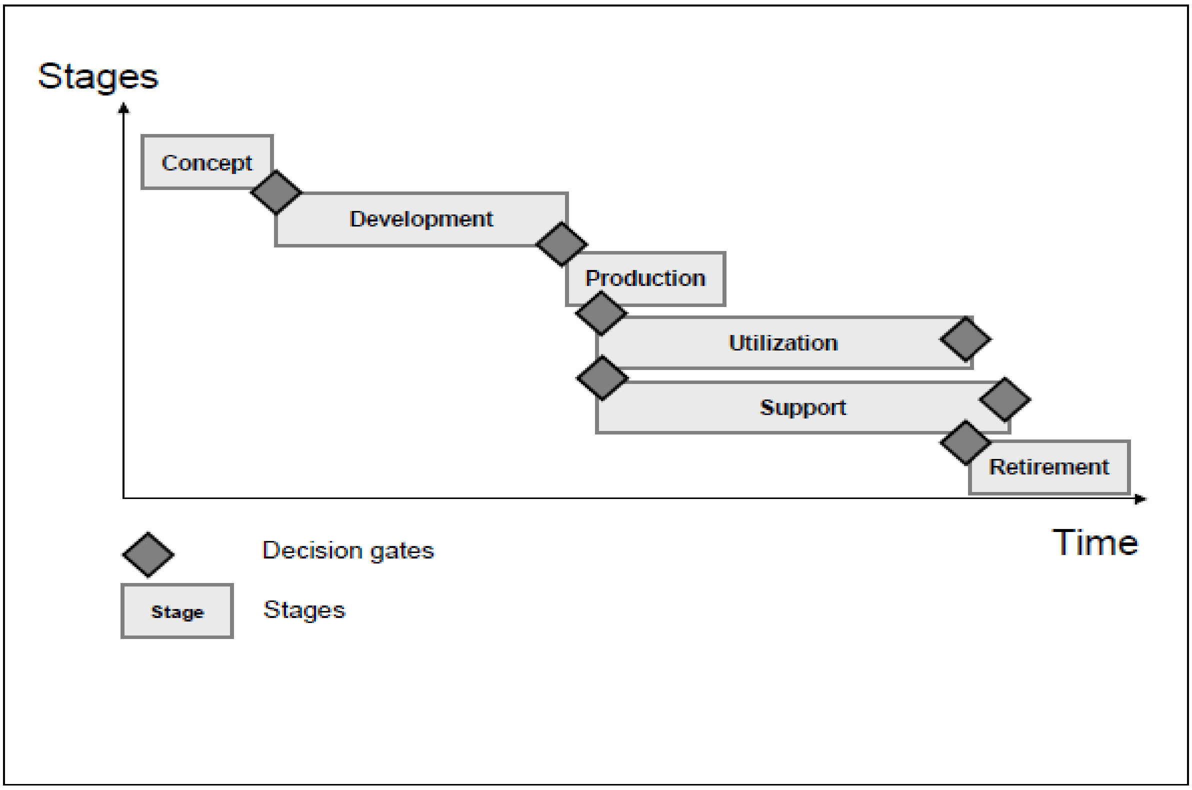

Figure 1 The Sequential System Life Cycle Model[1]

The life cycle process of military equipment is much more complex as shown on the above Figure 1. In order to illustrate the details and the main phases we have put together a comprehensive flow chart (Figure 2 - see at the end of this article) based on our own experiences, in addition to the literature referred in this article.

1. The description of the process is started with the "composition of operational requirements" block. At this stage the formulation of specific requirement takes place which is based on strategic goals and user needs taking into account practical experience. This is the first stage where, besides results of security policy, strategy,

[1] AAP – 48 NATO System Life Cycle Stages and Processes, 2007. Edition 1.; p.36

and other domestic and international research results "supply of achievements" of technical sciences and technical-technological research results should also appear. So, at this phase, there is a need for consensus among politicians, users, experts and researchers representing all fields of expertise to make sure that every demand for a given period of time is properly formulated. Indeed, based on this, a prior order of priorities which is needed to optimize later decisions.

2. During the next phase, in the "analysis phase", engineers need to play an increased and intensified role. Engineers and other experts have to make a proposition - in line with other areas of production logistics - that the required military equipment would be realized through modernization of existing equipment or through acquisition or development of the required equipment. On the basis of expert’s opinions with complex approach and on bases of our own experience we can say that a significant part of the assets acquired from abroad seems only "at first glance" a cheaper and better choice than the domestic solution. This can be illustrated by the following arguments, for example:
    a. a domestically developed and/or manufactured device can be fixed usually much faster and more flexible than a device purchased from abroad. It is especially true if the device is purchased not from a European country or there is no permanent Hungarian service representative of the company who products the purchased equipment.
    b. It is not difficult to understand that it is much easier to upgrade a software application that is being developed and manufactured at home for later updating of this software.
3. Going through the flowchart - phase "R & D" or "upgrading" - we proceed to the section based on the narrower approach of the R & D algorithm:
    a. The essence of "feasibility assessment" is to list realization possibilities of the task and then to analyze this possibilities. As a result of the evaluation, one (or perhaps more) suggestions are formulated for the technical solution of the task and for the process of how to proceed: to continue with the experimental phase or to continue with the device development phase. The adoption and approval of the proposal is within the competence of head of service of future user (this person makes the final decision so we call him or her here and hereafter: the Decision-maker).
    b. The first step of the experimental phase is the development of the Operational and Technological Requirements Draft (OTRD). This document is the base for constructing a new military device that needs to develop "fully from the beginning".. At this stage we are not able to formulate exactly the requirements for the military equipment to be developed just to outline them. Therefore the following types of wording are common in an OTRD: "The device must be able to perform the following functions within the intended temperature range:…”; "It is desirable that the equipment also had the following features:…” Very many important parameters are usually approximate (maximum or minimum can be formulated only) at this stage. For example, "Maximum weight of the equipment should be no more than 20kg" or "The device should be able to operate at least 12 hours on its own battery without recharge"...
    c. "Experimental Model" – or with other terms “First Model" or Board Model" - is made on the basis of the OTRD. This is, in the majority of cases, not the final and optimal model, but an operating model. The upshot of this phase is a properly working device that fulfills (optimally) all the expected modes

and functions. However, its appearance does not have the required final parameters. Because of appearance parameters and some other reason this equipment does not meet the planned final parameters neither of climatic nor mechanical resistance requirements. Nevertheless, this “First Model” must provide sufficient information to determine the above mentioned and other requirements.

d. The next step means examining (testing) and evaluating the Experimental Model. The essence of this step is that the expectations formulated in the OTRD must be compared to the completed Experimental Model. We also have to determine that for what kind of other functions the equipment can additionally be used. A “Test Report” shall be made on the above tests in order to record the results which give the basis to put together a comprehensive “Summary Report”. The goal of the „Summary Report” is to compare results with expectations, evaluate them and make recommendations to the decision-maker. There can be three possible outcome of the experimental phase. Outcome one: in case of positive results the process is continued with the next development phase. Outcome two: In case of partially positive results modifications of the Experimental Model (new experiments and tests) are needed, or, as a result of consultations with the future users the OTRD will be modified. Outcome three: it also sometimes happens in practice. This outcome is the suspension of the topic (e.g. because of lack of resources or of scarce resources) or canceling the topic (due to inadequate results of Experimental Model or change of the original concept). Outcome three is not shown on the flowchart in order to avoid overburdening it. Practically, the Decision-maker can choose the above options (suspension, canceling) at any point of the process.

e. The cornerstone of the next phase, the "equipment development" phase is the task of formulation of Operational and Technological Requirements (OTR). OTR has a necessary and key role not only here but also on all roads and at all phases leading to acceptance for service. In this document (OTR) all the requirements that must be met in the "life cycle of the equipment" must be exactly and precisely specified. The basis for the formulation of OTR is OTRD and the data and other pieces of information determined during test of the Experimental Model. Purchasing a new equipment is a very other task: the situation is significantly different from a development task. The purchasing (acquisition) task might be a bit easier since it is a question of the professional compilation and comparison of ready-made products parameters with user requirements. For comparison of different types of equipment usage of MCDM (Multicriteria Decision Making) methods is advisable.

f. In case of development the new model constructed based on the OTR is called "prototype". In doing so the algorithm contains the same development steps as during the experimental phase. The difference is that the prototype is already a ready-to-use, ready-made equipment which in ideal (best) case meets all requirements set in the OTR. Checking whether the equipment meets the requirements is a process composed of three stages. Stage 1: laboratory tests. Stage 2: test for military applicability (TMA). Stage 3: field trials for acceptance. During laboratory tests all checks (which are possible) are executed under laboratory conditions. Such tests are for example: cooling or warming up the equipment to the required extreme values or the so-called striking, dropping or shaking tests. Results of the laboratory tests will be recorded. On basis of this record the decision-maker decides on the availability of the equipment for further military tests in field circumstances and on modifications of the equipment if it seems to be necessary regarding results of laboratory tests. If justified, some parts of the OTR may also be modified.

4. The next stage of the process is TMA. In this stage all tests that could not be carried out under laboratory conditions must be performed. This includes a variety of official (fire and safety, traffic control, protection against potentially dangerous electrical contact ...) tests conducted by competent Hungarian authorities. These tests have great importance. The reason is that it is not only necessary to prove that the equipment functionally has all the required capabilities, but also that it is not dangerous to its user or its environment during its application. In case of TMA inefficient results the equipment produced through R&D phases will be returned to the "correction" or “modification” phase. In this case additional documents from the manufacturer are usually required. If justified the OTR should be modified.
5. Field trial for acceptance (FTfA) is the last checkpoint on the way to the final decision on approval for service of the developed equipment. The main and general purpose of FTfA is to test the equipment in all application conditions declared in the OTR, and check whether the equipment is able or not to perform all its functions as formulated in the OTR. In this phase we should also check important capabilities such as interoperability, user friendliness and easiness to operate of the equipment. FTfA is conducted at the military unit where the new equipment is to be deployed and is headed and directed by a senior officer of the same military unit or of the Command which will manage the future use of the new equipment. Following the FTfA the Field Trial Committee choose the following suggestions: (1) proposal on approval for service without modifications, (2) proposal on approval for service with modifications - in this case the Field Trial Committee should also suggest that, once modifications happen, the field trials for acceptance must be repeated completely or partially, or no further field trials for acceptance is required, (3) the Field Trial Committee does not propose approval for service.
6. The next step (rather the "big jump") is to take the final decision on approval for service of the developed equipment. In order to put the proposition on the agenda of the Approval Committee for Service, the developed equipment is needed to have the positive results of tests for military applicability (TMA) and the appropriate positive proposal from the Field Trial Committee. The essence of the above tests and trials is to verify compliance of the developed equipment with the requirements set in the OTR. Consequently, we can see again - as we stated earlier - that the OTR is a "cornerstone" of the development process which has a key role in all the paths and avenues leading to the final decision on approval for service. This decision is an act with consequences, in written form, which is published in the official Defence Gazette. In connection with the process of approval for service concept of codification should be mentioned. The essence of codification is classifying and providing a code number for both the manufacturer and the product on the basis of a single registration/marking system.
7. After making the final decision on approval for service of new equipment may begin the production which is followed with the acquisition process. Here we mention that quality assurance (QA) is present in some form during all stages of the development process. Military technology quality assurance systems include quality assurance of all related tasks: procurements, certification of suppliers'

quality management systems, NATO's mutual quality assurance agreements, etc. NATO QA system is based on ISO 9001 wherever possible. NATO QA documentation can be finding in related AQAPs[2] and STANAGs[3].

8. Returning to the acquisition phase: it is followed with the process of system setup by filling the military units with new equipment, execution of related logistical tasks, training, preparation of documentations, etc.
9. The use of combat equipment is made up of several sub-processes, such as: operation, use, storage, transport. These sub-processes can be related to other service tasks of which only the following two are highlighted on Figure:
    a. In the process of supply and repair, apparently only the user and the logistics system have their role. However, it should not be ignored that the information mentioned in paragraph "a)" is generated as input information required to compile operational requirements.
    b. Collection, classification and forwarding of all the direct and indirect experiences in the domestic, international, and operational areas mean the last step or the "closing" of the process. We have put the word closing into quotation marks because, as it is written in "a)" or "b)", the closing pieces of information are really precious and are useful the inputs of a next subsequent process. This is especially true if the user demands, requirements and needs are met by modernizing the existing equipment.
10. The end of the "service period" of military equipment is withdrawal from the system. This decision is based by the same committee which decided on approval for service of the same equipment.
11. After the withdrawal phase equipment are destroyed, reused (whole equipment or some parts of that) or recycled. Some cases the equipment may be sold abroad.

SUMMARY

We wanted to highlight the complexity of the life cycle process of designing and implementing military equipment in this publication. Any unforeseeable omission of any rule of design and of decision points can result in time loss, material loss or, in the worst case scenario, personal losses. It is clear that frequent changes of requirements and expectations make absolutely impossible to supply units with newly developed military equipment. We, serving as military engineers for decades in military technology R&D want to emphasize the importance of the Operational and Technological Requirements (former terminology: Tactical Technological Requirements) and its role and strict observance during the whole life cycle process. With the detailed description of the process we would also like that persons who "look at the eyes of military users" understand the approaches and would become a more competent and more active contributor to the life cycle process. R&D activity is a process which logical structure and sequence has evolved over centuries and works all over the world with insignificant differences. In the bibliography we refer to two papers which are intended to reflect the way of thinking of the authors of this article.

[2] AQAP: Allied Quality Assurance Publication
[3] STANAG: Standardization Agreement

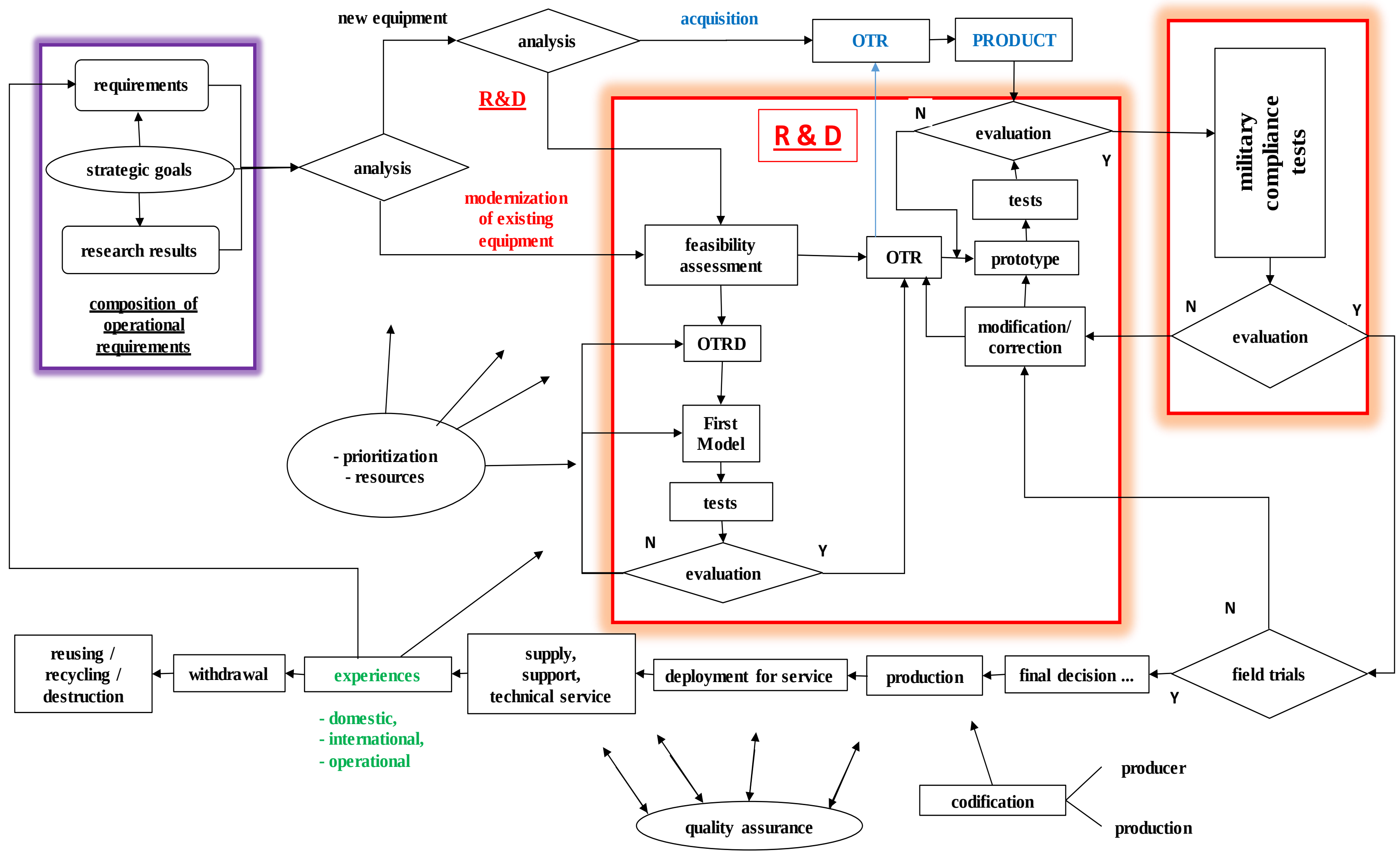

Figure 2 Life Cycle Flowchart (made by authors)

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