A COMPARATIVE ANALYSIS BETWEEN TWO TYPES OF VEHICLES WHICH COULD BE USED AS UAV LAUNCHERS MOBILE PLATFORM

Cornel ARAMĂ, Constantin ROTARU, Mariana ARAMĂ, Eduard MIHAI
*"Henri Coandă" Air Force Academy, Braşov, Romania
DOI: 10.19062/1842-9238.2015.13.3.25

Abstract: *The following scientific study is about of two possibilities to use different types of vehicles as mobile platform which could be used to launch an UAV. One of them is a light off-road articulated prototype vehicle, DAC 2.65 FAEG and the other one is a classic off-road vehicle named BCV-320, prototype too. Both of them are going to be integrated into a mobile cell for forward reconnaissance missions. The advanced multi-criteria analysis method is going to be used by the researchers in order to establish the best solution for a mobile platform capable to launch different types of UAV's. Due to the fact that both suggested prototype vehicles have high modularity, the final conclusions are very interesting and some test exercise in military fields is going to be done.*
Keywords: *prototype, UAV, off-road, mobility, platform*

1. INTRODUCTION

The current global situation is an unstable environment which is characterized, first of all, by a lot of asymmetric conflicts where one of the engaged parties, the weak one, has been specializing in classic or urban guerrilla conflicts and the military-developed countries have been developing their antiterrorist fighting capabilities continuously.

This is one of the reasons why the weapons industry of these military-developed countries is focusing more and more on the combat mobile cells production as a solution to fight against terrorist cells. These kind of military technical systems have to display a more increased viability in antiterrorist or guerrilla fights. From the point of view of the researchers who try to find out new solutions of the problem, a combat/fighting mobile cell, which could be seen as a military acting system, must comprise the following main parts (Figure 1):

- the ground subsystem which could consist of crew, intelligent equipment (gadgets such as: special shock resistance computer, data sensors, signal and reception data gadgets etc.), maintenance equipment, different military assets and the special vehicle;
- the flying subsystem consisting of, first of all, the UAV, the intelligent equipment for acquisition, signal and control data, and maybe special equipment for self-destruction;
- the interface/link between flying and terrestrial parts.[1]

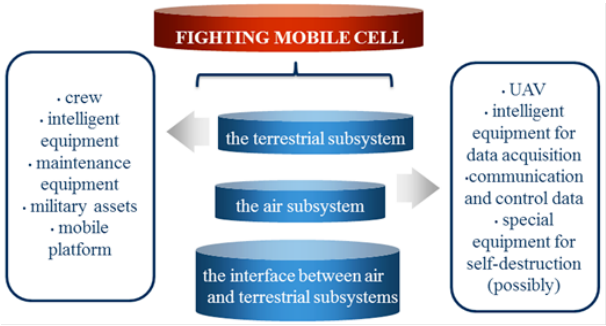

Fig. 1 The overall structure of a fighting/ combat mobile cell [1]

The researchers analyzed two possibilities to use two types of vehicles as mobile platform which could be used to launch an UAV.

One of them is a light off-road articulated prototype vehicle, DAC 2.65 FAEG (Figure 2) and the other one is a classic off-road vehicle named BCV-320 (Figure 3), prototype too.

Both of them are going to be analyzed as the terrestrial mobile part for an UAV Forward Reconnaissance Mobile Cell.

Fig. 2 The light off-road articulated prototype vehicle, DAC 2.65 FAEG

Fig. 3 The classical off-road vehicle named BCV-320

2. A SHORT PRESENTATION OF THE VEHICLES

As it is known, the maximum weight for a light off-road articulated vehicle (in our situation, DAC 2.65 FAEG) is less than three tones.

It consists in two equal vats connected to each other through a central pivoting bearing which allows moving both parts around the vehicle longitudinal central axis.

All wheels of this kind of vehicle are live and steering and it has no suspension.

The transmission is inside of the body (capsulated could be said), so, theoretically, the designers consider that the vehicle cannot be stuck in the mud.

BCV 320 is a prototype too, as the DAC 2.65, but this general structure has a classic conformation: 4 live wheel, high ground clearance, front wheels steering etc.

The DAC 2.65 FAEG vehicle was made up by the designing engineers from the National Institute of Road Vehicles (INAR) and ROMAN/DAC Truck Factory in the late 80's and BCV-320 is proposed by the Institute of Road Vehicles (INAR) in the beginning of 2010 decade. The main technical characteristics of these vehicles are presented in Table 1.

Table 1. The main technical characteristics

Item	DAC 2.65 FAEG	BCV 320
Weights and dimensions		
Overall length [m]	2.95	4.67
Overall width [m]	2.06	1.89
Overall height with hood [m]	2.05	1.95
Unload vehicle weight [kg]	1600	1750
Gross vehicle weight [kg]	2000	3500
Crossing capacity items		
Ground clearance [m]	0.27	0.285
Front overhang [m]	0.75	0.72
Rear overhang [m]	0.565	1.35
Wheelbase [m]	1.634	2.6
Track (front/rear) [m]	1.65	1.475/1.525
Engine performances		
Type	4-cylinder, Otto cycle	4-cylinder Diesel engine, turbocharged
Displacement [cc]	1397	2436
Maximum output [HP/rpm]	65/5500	120/4200
Maximum torque [Nm/rpm]	102/3300	260/1800-2200
Transmission		
Type	combined: automatic +conventional	conventional

3. THE SUGGESTED OPERATIONAL MILITARY REQUIREMENTS WHICH HAVE TO BE TAKEN INTO CONSIDERATION

Due to the fact that the rear vat, in case of the DAC 2.65 FAEG, and the platform, for the BCV 320, are almost empty, the vehicles have large possibilities to be equipped in order to fulfil different kinds of missions from the civilian and military fields.

A wide range of vertical equipment can be attached on the DAC 2.65 FAEG platform (the rear vat) without affecting too much its stability because it has the advantage of the low center of gravity.

The BCV 320 is rather high for an off-road vehicle but it has a large platform which could be endowed with a large area of types of assets.

The operational military requirements which could influence the mission and which is studied in this article (the forward reconnaissance missions using the UAV-s) are [1]:

- constructive simplicity;
- high reliability;
- compactness;
- tactical-operational mobility;
- low overall dimensions;
- low weight;
- easy exploitation to fulfil the missions;
- high maintainability;
- high ergonomics for the crew;
- high range;
- transportability;
- efficiency of combat actions – the results that can be obtained;
- profitability – the fast and restoration costs of fighting capacity.

First of all, the researchers will remove one operational requirement which has the same value for both vehicles: the profitability.

Also, the efficiency of combat actions criterion will be eliminated because it is going to be derived from the other criteria.

After that, they are going to select from this list the most important military operational requirements.

The purpose of the study is to reveal the most viable vehicle for this kind of mission.

4. ESTABLISHING THE BEST VEHICLE FOR THIS KIND OF MISSION BY USING THE ADVANCED MULTI-CRITERIA METHOD

As we know, in order to compare many item categories the advanced multi-criteria analysis method is one of the best methods.

The main reason is to obtain some important conclusions for the vehicle which are going to be used as a mobile platform which has been purposed to be part of the mobile cell which is going to be used in air force missions in general, and to launch UAV in our situation.

In this situation, the market demands involve the endowed of the mobile cell for forward reconnaissance missions with a new type of vehicle (the most viable) which are going to be used as mobile platform to launch an UAV system. So, the project main theme and the purposed mobile platforms for the project have been identified. The suggested types of vehicles (there are two completely different types of mobile platforms) are:

- the light off-road articulated prototype vehicle, DAC 2.65 FAEG and
- the classic off-road vehicle named BCV-320, prototype too.

4.1 The Criteria Establishment. In this research eight operational requirements were selected as criteria for the advanced multi-criteria analyzing method. Thus, the chosen criteria are:

- constructive simplicity;
- low overall dimensions;
- low weight;
- tactical-operational mobility;
- easy exploitation to fulfil the missions;
- high maintainability;
- high range;
- transportability.

4.2 Determining the weight of each criterion. A weight factor is calculated separated on each criterion. The following abbreviations are used into Table II:

- constructive simplicity - CS;
- low overall dimensions - OD;
- low weight - LW;
- tactical-operational mobility - TM;
- easy exploitation to fulfil the missions - EE;
- high maintainability - HM;
- high range - HR;
- transportability - TB.

Within this table, the classical annotations, for this method, to compare the criteria are used: 1 when the row criterion is more important than column criterion, 0,5 when both of them are equally important and 0 when the column criterion is more important than the row criterion.

The amount of the row points for each criterion determines the classification of the criteria.

The weight factors can be calculated by using different formulas. The very practical formula FRISCO was used to calculate the weight factors in this situation:

$$\gamma_i = \frac{p+m+\Delta p+0,5}{-\Delta p'+\frac{N_{crt}}{2}} \quad (1)$$

where:

p, m, Δp, Δp' and N_{crt} are according to the technical literature

Thus, the results are presented into the Table 2.

4.3 The identification of the variants, granting the N grade and the establishing of the consequences matrix. This comparative analysis intends to compare two variants of special vehicles and establishing the best of them in order to fulfill the air force mission, mainly forward reconnaissance missions using UAV systems. The suggested mobile platforms are the light off-road articulated prototype vehicle, DAC 2.65 FAEG and a classic off-road vehicle named BCV-320, prototype too.

Each criterion received a grade of importance from 1 to 10. Normally, it is called importance grade or contribution to a criterion grade. This importance grade is granted to each variant based on the technical and/or tactical characteristics, taking into consideration each criterion. The grades N_i which were granted to each variant are presented in Table 3.

As it is known, the weight factors influenced the importance grades. The wedge between the weight factors and the importance grades must be calculated for each criterion in this method. The final classification will be logically established by the sum of the N_i x γ_i wedges. Into the Table 3 these calculations are presented.

THE RESULTS INTERPRETATION – CONCLUSIONS

Under this analysis, as it could be seen in Table III, DAC 2.65 FAEG has the best structure for this kind of missions. What is remarkable is that the difference between the purposed variants is quite large. This situation can suggest that the designers of DAC 2.65 FAEG prototype were well inspired and the solution of this kind of structure (light and articulated vehicle, all live and steering wheels) is viable for forward reconnaissance missions using UAV systems.

This situation is a challenge for the researcher in order to try to insert into exploitation this type of vehicle taking into consideration more criteria, for example the ease of manufacturer. It could be difficult to make an original vehicle from the zero stage.

Table 2. The main technical characteristics

Criteria	CS	OD	LW	TM	EE	HM	HR	TB	Points of the criterion	Level (classification)	Weight factor [γ_i]
CS	0.5	0.5	0.5	0	0	1	0	0	2.5	6	0.61
OD	0.5	0.5	1	0	0	0	0	0	2	7	0.47
LW	0.5	0	0.5	0	0	0	0	0	1	8	0.14
TM	1	1	1	0.5	0	1	1	1	6.5	2	3.70
EE	1	1	1	1	0.5	1	1	1	7.5	1	5.37
HM	1	1	1	0	0	0.5	0.5	0.5	4.5	4	1.64
HR	1	1	1	0	0	0.5	0.5	0	4	5	1.40
TB	1	1	1	0	0	0.5	1	0.5	5	3	2.07

Table 3. The consequences matrix

The type of vehicle		**DAC 2.65 FAEG**		**BCV 320**	
Criteria	**Weight factor** $[\gamma_{ij}]$	**Importance grade** $[N_i]$	$N_i x \gamma_i$	**Importance grade** $[N_i]$	$N_i x \gamma_i$
CS	0.61	9	5.49	8	4.88
OD	0.47	10	4.70	7	3.29
LW	0.14	9	1.26	8	1.12
TM	3.70	8	29.60	7	25.90
EE	5.37	9	48.33	7	37.59
HM	1.64	9	14.76	8	13.12
HR	1.40	6	8.40	9	12.60
TB	2.07	7	14.49	9	18.63
The final classification			**127.03**		**117.13**
The place			**1**		**2**

Fig. 4 DAC 2.65 used as an UAV Forward Reconnaissance Mobile Cell (temporary launching platform)

Fig. 5 DAC 2.65 used as a combat mobile cell carrying a mini antiterrorist team (demonstrative exercise)

Only one DAC 2.65 vehicle is still functioning and it has been tested during some demonstrative exercises by the researchers of the "Henri Coandă" Air Force Academy from Brașov in two conformations: as an UAV Forward Reconnaissance Mobile Cell (Figure 4) and as a combat mobile cell carrying a mini antiterrorist team (Figure 5).

The BCV 320 structure is a classical one and it can be manufactured very easy comparative with the DAC 2.65 FAEG.

Thus, the analysis can become more complex and it can be the main subject of some next investigations…

BIBLIOGRAPHY

1. C. Aramă, M. Sava, L. Cucu, "*Analysis of the light off-road vehicle endowment possibilities in order to use it for air force missions*", "Scientific Research and Education in the Air Force" AFASES 2015, "Henri Coandă" Air Force Academy, Braşov, 2015.
2. M. Sava, "*The analysis of the modern mobile radars*", Bachelors Degree thesis, "Henri Coandă" Air Force Academy, Braşov, 2014
3. C. Aramă, A. Aramă, "*A Study Regarding the Analysis of the Fulfillment of the Operational Military Requirements by the Light Off-Road Articulated Vehicle*","Review of the Air Force Academy", The Scientific Informative Review, No 1(23)/2013, "Henri Coandă" Air Force Academy Printed House, 2013.
4. S. Bobancu, "Creativity and Inventiveness"-course, "Transylvania" University of Brașov, 2014.
5. V. Prisacariu, V. Şandru, I. Cârciu, "Aspects regarding the concept, development and use of modern UAVS", "Scientific Research and Education in Air Force", "Henri Coandă" Air Force Academy AFASES 2011, Brasov, 2011.
6. V. Prisacariu, M. Boşcoianu, A. Luchian, "Innovative solutions and UAS limits", Review of the Air Force Academy, 2(26)/2014, Braşov, 2014