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Semiotic evaluation of Lithuania military air navigation charts

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Abstract: Research of semiotic aspects Lithuanian military air navigation charts was based on the semantic, graphic and information load analysis. The aim of semantic analysis was to determine how the conventional cartographical symbols, used in air navigation charts, correspond with carto-linguistic and carto-semiotic requirements. The analysis of all the markings was performed complex and collected by questionnaire were interviewed various respondents: pilots, cartographers and other chart users.

The researches seek two aims: evaluate information and graphical load of military air navigation charts. Information load evaluated to calculate all objects and phenomenon, which was in 25 cm² of map. Charts analysis showed that in low flight charts (LFC) average information load are 4 – 5 times richer than in the operational maps. Map signs optimization on LFC has to be managed very carefully, choosing signs that can reduce the load of information and helps for the information transfer process. Graphical load of maps evaluated of aeronautical maps is not great (5 – 12%) and does not require reduction the information load and generalization of charts. Air navigation charts analysis pointed that not all air navigation sings correspond carto-semiotic requirements and must be improved. The authors suggested some new sings for military air navigation chart, which are simpler, equivalent to human psychophysical perception criteria, creates faster communication and less load on the chart.

Key words: cartographic methodology, aviation cartography, aero navigation charts, low flying charts, aero navigation signs, semiotic of aero navigation signs

1. Introduction

Military aero navigation charts are intended for flight planning and navigation from movement in an airfield and take-off to landing and movement to hangar. They are are used by very narrow group of professional, therefore their cartographic researches in Lithuania are very few. In military aero navigation charts semantic implication are offer by different graphic symbols (STANAG 2215, 3408, 3409, 3412, 3591, 3600, 3676, 3677, 7164). Graphic symbols (signs) show navigation obstacles, electricity supply lines, smokestacks, airports, protected areas and other over-ground objects (Sobczyński and Pietruszka, 2002, 2004; Sobczyński, et al, 2000). Lech Ratajski

(1973; 1989) described cartographic language structure and emphasized that in special maps, aeronautic too, used all possible implements for cartographic view creation. Lithuanian cartographers tried analyzed semantic aspects of different special maps: educational, roads, tactilic (Dumbliauskienė, 2002; Dumbliauskienė and Bautrėnas 2005; Dumbliauskienė and Ročiūtė, 2009). In this paper authors suggested signs changes, which maintain by semantic analysis of military aero-navigation maps. The main aim of this study is optimization of military aero navigation charts and aero navigation database for Baltic States.

To reach the aim the following tasks were raised:

– conduct survey of military aeronautical charts;
– conduct analysis of military aero navigation charts and summarize research data;
– create specifications of military aero navigation charts;
– provide recommendations for Baltic States military aero navigation database;
– provide recommendations for vertical obstacles (above 200 feet) collection and administration;
– summarized results of analysis and provide recommendations.

After semiotic analysis of aeronautical signs of military aero navigation charts it was determined that this system of signs has some semiotic shortages. After determining shortages, recommendations to improve systems of signs were provided.

2. Methods

Methods of military aero navigation charts is concluded taking into consideration requirements described in STANAG documentation, after conducting analysis of geographical and aeronautical parts of Baltic states, Polish, German, USA and Great Britain aero navigation charts. Conventional aeronautical signs are presented and described basing on data collected during analysis and author's recommendations.

The most important task is the cartographer's surround sound encoded graphic communicative piece of information for the chart creation. This means that the chart maker has to take into consideration all aspects of the user's needs, while evaluating his cartographic analytical skills. It is extremely difficult to ensure proper communication quality of the maps, which is often accompanied with the usual non-generalized or minimally generalized topographical basis of the air navigation information. The latter greatly increases the load of the information in the map, burdens its readability and communication.

Semiotic military air navigation charts research in Lithuania was based on the semantic analysis of the principles of graphic symbols and information load of air navigation charts. This allowed perform air navigation semiotic analysis to submit proposals for the following use of marks and their improvement. In view of the findings, the developed aeronautical structural classification of marking, including special low-level flight M 1:500 000 chart markings and operational air navigation chart conventional marks.

Analyzing air navigation charts, 5 most used military aviation maps were selected:
- Low Flight Chart (LFC), M 1:500 000.
- Joint Operation Chart (JOG), M 1:250 000.
- Operational Navigation Chart (ONC), M 1:1 000 000.
- Tactical Pilotage Chart (TPC), M 1:500 000.
- Jet Navigation Chart (JNC), M 1:2 000 000.

During semantic analysis, the aim was to determine how the conventional cartographical symbols, used in air navigation charts, correspond with carto-linguistic and carto-semiotic requirements by:
1. The collection or semantics of the marking expressions.
2. Sign combination into groups or syntax.

While performing an entire navigational conventional marking analysis of air navigation charts, their shape, color and size were analyzed. Received results of the analysis are captured in the report form:
1. Sign description.
2. Sign form.
3. Sign similarity:
   - by shape,
   - by size,
   - by color (boundaries and area).
4. Examples of logical structure improvements of aero navigational signs:
   - by shap,e
   - by size,
   - by color.

Operational chart signs were evaluated in individual groups, i.e. properties in certain groups were assessed:
1. Sign description.
2. Sign form.
3. Sign similarity:
   - by shape,
   - by size,
   - by color (boundaries and area),
   - by group.
4. Examples of navigational mark logical structure improvements:
   - by shape,
   - by size,
   - by color,
   - by groups.

3. Evaluation of military air navigation chart signs

Performing this evaluation, 141 low flight charts (LFC), joint operation chart (JOG), tactical piloting chart (TPC), operative navigation chart (ONC) and jet aircraft navigational chart (JNC) air navigation signs were analyzed. The analysis of all the markings was performed completeness, because the formed air navigation chart signs are often identical or very similar, however, often having a different meaning. This situation can be misleading for the recipients, military pilots.

Performing the semantic marking evaluation, it is stated that air navigation markings are not completely identical they often differ, when marking the same phenomena. Some of them must be changed. The proposed new marks account for 12 percent of all marks analyzed and are presented in the table.

In order to evaluate the efficiency of air navigation chart signs, load, its readability, and to objectively analyze the applicability of the proposed markings, various respondents were interviewed with a questionnaire. The total number of respondents was 120. They were split up into three groups:

1. Pilots.
2. Cartographers.
3. Other chart users.

All respondents have graduated high schools in Lithuania. This suggests that a unified secondary school geography program gave equal content of cartosemiotic perception.

The questionnaire presented old and new sign sets, the respondents were offered to select those, which they consider to visualization the represent objects more accurately and better. Also, the old and the new marks were given in various fragments of the map, where the use of a time determines which marks are found faster. In this way, marks, which have a larger logical connection with the represented object, were selected. In extreme situations, when the time to look for marking on the map is very short, these characters will significantly help for faster orientation in navigation (Table 1).

Table 1. The newly proposed aeronautical characters

Object description	Old conventional markings	Conventional markings
Overland helicopter routes		
Helicopter route		
Helicopter corridors		
Glider protection zone		
Tow glider hang site		
Hang glider site with starting device		
Marine light		
Light vessel		
Lighthouse with a radio navigation transmitter		
Glider activity		
High intensive radio transmitter area (HIRTA)		
Suspended obstruction		
High tension power line poles on one line and the height of 80-200 feet		
High tension power line pole height of 200 feet		
Aerodrome with a hard runway over 3,000 feet		
Minor aerodrome with unknown runway (JOG)		
Civil aerodrome with an unknown runway (ONC, JNC)		
Military aerodrome with an unknown runway (ONC, JNC)		
Civil-military aerodrome with an unknown runway (ONC, JNC)		

3.1. Information load of the military air navigation charts

In order to pinpoint the use information of air navigation chart load, an evaluation method has been developed to objectively estimate the help of this chart load characteristics.

Performing the evaluation of air navigation chart readability in maps, 10 x 10 cm record plots were used, i.e. 100 cm² (dm²). Evaluated all space of air navigation charts and calculated all signs and letters in plots, which had the informative map load estimated, including air navigation signs and general geographical signs:

1. Map title.
2. Maximal signs amount in 1 dm² of map.
3. Minimal signs amount in 1 dm² of map.
4. Average signs amount in1 dm² of map.
5. Commentary.

Finally was calculated average information load in air navigation charts. The result was compared with optimal information load in civil air-navigation charts, which amount 150 signs in 1 dm². Results are presented in the Table 2. It shows how much information in one unit of area is visualized in particularly map and helps cartographer decide level of generalization.

Table 2. Information load in military air-navigation charts (in 100 cm² charts space)

Map type	Maximal information load	Minimal information load	Average information load
LFC	240	137	189
JOG	96	4	50
TPC	68	20	44
ONC	68	16	42
JNC	67	15	42

LFC Information average load 4-5 times richer than the graphic load on the operational maps, and map signs optimization on LFC has to be managed very carefully, choosing signs that can reduce the load of information and helps for the information transfer process. Graphical load on the other brands of aeronautical maps is not great and does not require the information load reduction. The newly proposed maps sign was offered only to standardize the operating maps signs as well as for special maps and choice is most suitable label to describe the phenomenon or object (Fig. 1-4).

3.2. Graphical load of the military air navigation charts

Determining the graphic military air navigation chart load, the same 5 x 5 cm record plots were used as for determining the informative load. In order to establish graphical

chart of the load, it is necessary to calculate the area of cartography elements in each plot and to obtain the overall chart graphical load average. All cartographic chart elements are areal, linear, raster objects or inscriptions.

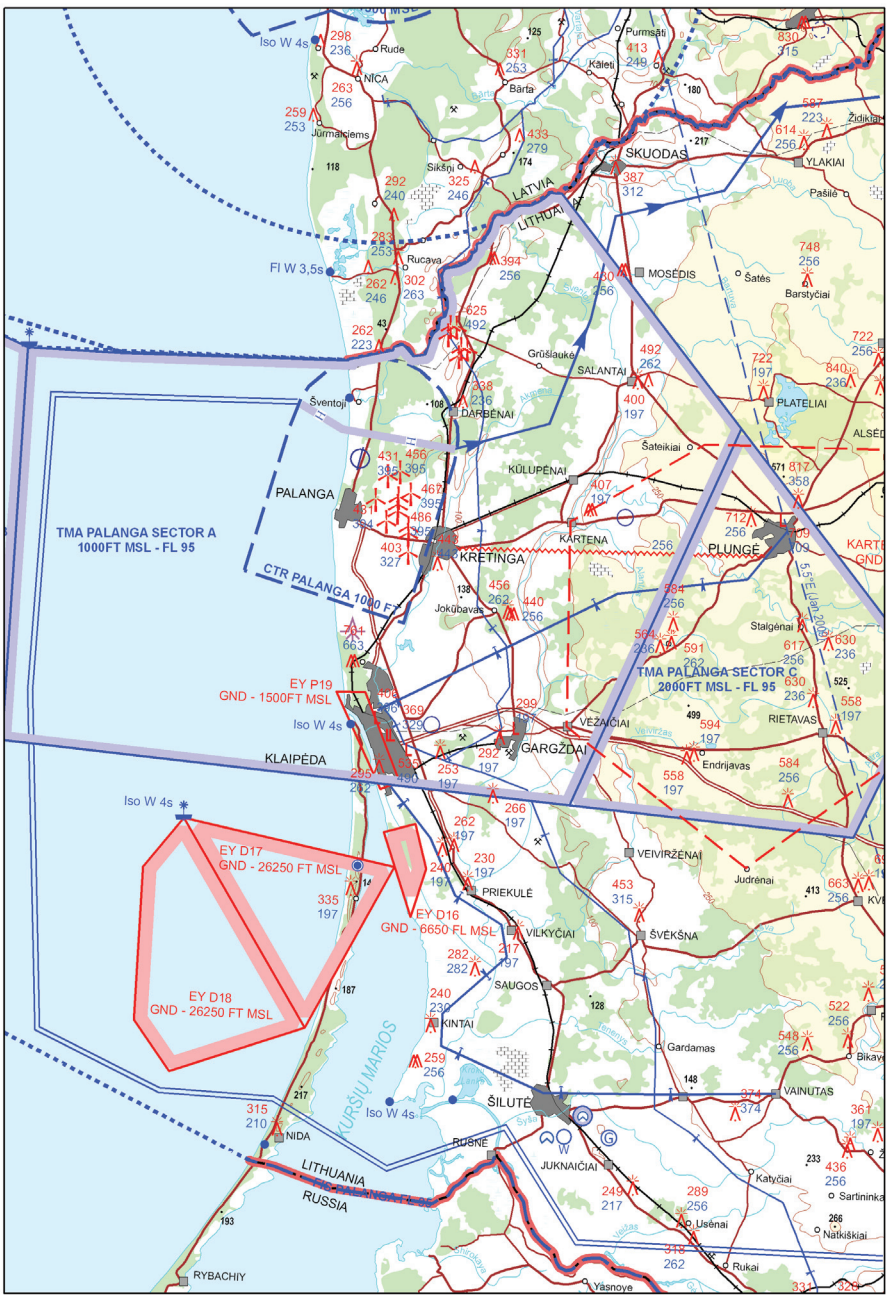

Fig. 1. Fragment of LFC 1:500 000 scale chart with Great Britain specification signs

The graphical map load can be expressed by the formula:

$$A_{map} = \frac{A_p + A_l + A_d + A_n}{n_{cm^2}} \times 100 \quad (1)$$

where A_{map} – map graphical load percentage.

A_p – polygon graphic elements in plot space. In self-coloured cases $A_p = \sum p \times 0.0125$, where p – linear elements (units). In multi-colour cases linear elements counted for all different colour contours.

A_l – load of linear graphic elements. In self-coloured cases $A_l = \sum l \times 0.02$, where l – length of linear cartography elements (in cm). In multi-colour cases linear elements counted for all different colour lines.

A_d – dotted graphic elements load. In self-coloured cases $A_d = \sum d \times 0.0125$, where d – dot elements (units). In multi-colour cases dot elements counted for all different colour.

A_n – notes graphic elements load. In self-coloured cases $A_n = \sum n \times 0.0125$, where n – individual letters or symbols (units). In multi-colour cases notes elements counted for all different colour.

Adjust the coefficients allowed to evaluate the distribution of regulatory polygon, linear, dotted and notes graphic elements. Coefficients express the optimality of map information load. Using a formula, chart or chart fragment graphical load percentage was calculated. Later, according to this indicator, and theoretically optimal load (5-12 percent) navigation graphical chart load can be optimized and generalized one or few chart layers (Table 3).

Table 3. Information graphic load in military air-navigation charts (percentage, in 100 cm² charts space)

Map type	Maximal graphical load	Minimal graphical load	Average graphical load
LFC	15	9	12
JOG	24	10	17
TPC	10	8	9
ONC	9	3	6
JNC	10	6	8

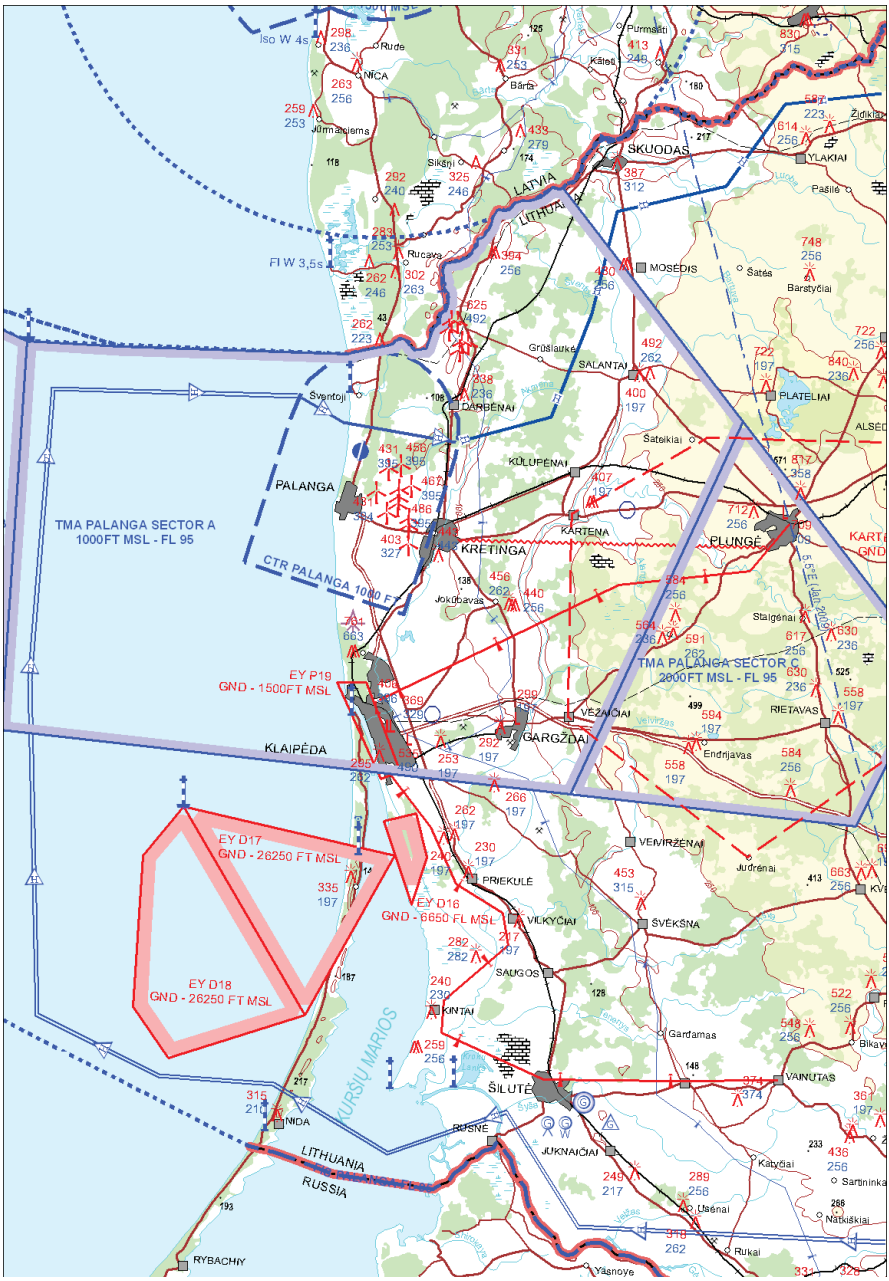

Fig. 2. Fragment of LFC 1:500 000 scale chart with new specification signs

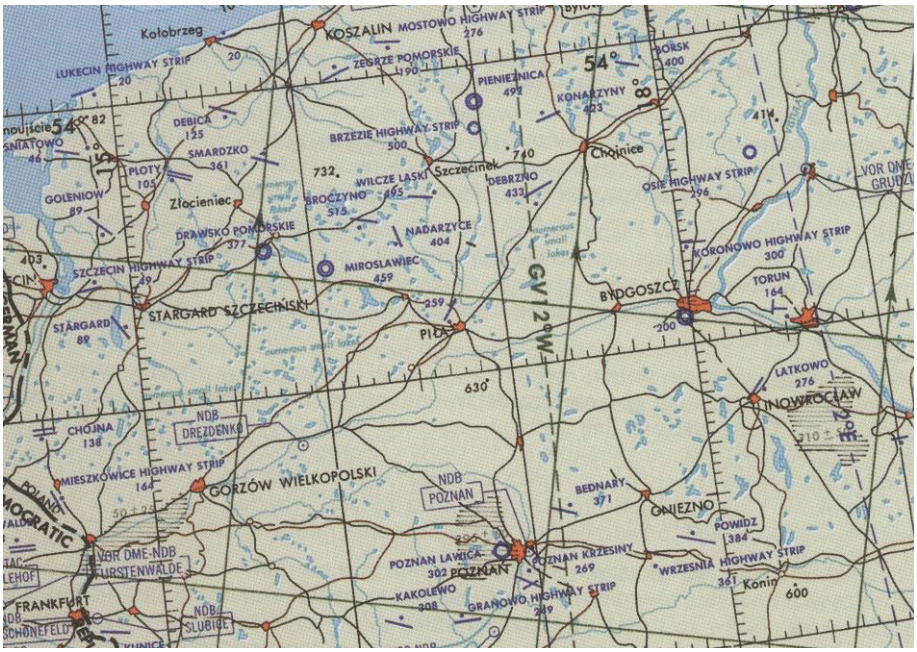

Fig. 3. Fragment of JNC 1:2 000 000 scale chart with Poland specification signs

Fig. 4. Fragment of JNC 1:2 000 000 scale chart with new specification signs

4. Conclusions

1. After military air navigation chart mark analysis, it was noted that not all air navigation marks meet cartosemiotic requirements and must be improved. The newly set up military air navigation chart markings are simpler, equivalent to human psychophysical perception criteria, creates faster communication and less load on the chart. The proposed marks and mark specification accessories semiotically are more accurate and are in accordance with the established tradition of Lithuanian cartography, so it can be effectively adapted to the conclusion of military air navigation charts of Lithuania.
2. Information load of the military air navigation charts is normal for all analyzed products except LFC where information load is 4-5 times richer then on the others charts. It shows that for LFC it is very important to use and develop signs which will be simple and readable for users.
3. Graphical information load of the military air navigation charts shows that all analyzed charts have normal 5-12 percent load and generalization is not necessary.

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Semiotyczna ocena litewskich wojskowych map nawigacji powietrznej

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Streszczenie

Badania semiotycznych aspektów litewskich wojskowych map żeglugi powietrznej bazowały na semantycznej, graficznej i informacyjnej analizie treści tych map. Celem analizy semantycznej było określenie na ile tradycyjne symbole kartograficzne stosowane na mapach nawigacji lotniczej są zgodne z wymogami języka kartograficznego oraz zasadami stosowania znaków kartograficznych. Powyższe analizy przeprowadzono w sposób kompleksowy, informacje zebrano za pomocą ankiet, przeprowadzając wywiady w różnych środowiskach, w tym m. in. wśród pilotów, kartografów oraz innych użytkowników map.

Prowadzone badania miały dwa podstawowe cele: ocena informacyjnego oraz graficznego wypełnienia treścią wojskowych map żeglugi powietrznej. Wypełnienie mapy informacjami oceniono zliczając wszystkie obiekty i zjawiska znajdujące się na obszarze 25 cm² mapy. Analiza ta wykazała, że mapy dla lotów na niskich pułapach (LFC) posiadają średnio 4-5 razy większy zasób informacji niż mapy operacyjne. Zatem dobór znaków na mapie LFC powinien być wykonywany bardzo starannie, poprzez wybór takich znaków, które mogą zmniejszyć nasycenie mapy informacjami jednocześnie ułatwiając proces ich przekazywania. Nasycenie graficzne ocenianych map lotniczych nie jest zbyt duże (5-12%) i nie wymaga ograniczenia ilości przedstawianych informacji ani generalizacji.

Analiza map żeglugi powietrznej wykazała, że nie wszystkie znaki występujące na tego rodzaju mapach spełniają wymagania dotyczące stosowania znaków kartograficznych i powinny być one udoskonalone. Autorzy zaproponowali kilka nowych znaków dla wojskowych map żeglugi powietrznej – są one prostsze, odpowiadają psychofizycznym możliwościom percepcyjnym człowieka, sprzyjają szybszej komunikacji oraz zmniejszają nasycenie informacyjne map.