

DIGITIZATION OF CULTURAL HERITAGE: MODEL OF AN INTEGRAL, THREE-DIMENSIONAL SPATIO-TEMPORAL THESAURUS

1. INTRODUCTION

Digital technologies, developed during the recent decades, little by little are penetrating into all the fields of human life. These technologies give rise to new research methods and models of practical activities, to develop interdisciplinary studies. The birth of digital technologies substantially changes the processes of accumulation, custody, recording and investigation of cultural heritage as well as the processes of disseminating this information. At the same time the role of institutions protecting cultural heritage in this processes (museums, archives, libraries, other state and non-governmental organizations engaged in the documentation, study, conservation, restoration and dissemination of information on cultural heritage) and the attitude of society towards cultural heritage and institutions protecting it are changing.

Digitization of cultural heritage is defined as the application of digital information and communication technologies in common administrative processes such as documentation, security organization, protection, research and dissemination of information. Digitization is a multipurpose method that can be applied to the administration of cultural heritage information in different forms (textual, sound, graphic, video), at different levels (museum, archive, heritage protection; regional, national, international level).

The result of the digitization of cultural heritage is digital information. Digital information of cultural heritage involves all the objects of cultural heritage: museum exhibits, values of immovable cultural heritage, personalities and memorial objects, geographical regions and geographical locations of cultural heritage, cultural processes, archive documents, audiovisual information; photos, descriptions of the objects of cultural heritage, documents of research, interpretation, management, conservation, restoration; communication material (exhibitions, expositions, trainings, thesauri, etc.) of the objects of cultural heritage¹.

The basic fields of application of digital technologies in the sphere of cultural heritage are database systems, digital photography, three-dimensional

¹ In this article the term “object of cultural heritage” is used practically in the same meaning as the term “museum collections” CIDOC-CRM. Cp. the term “museum collections” is intended to cover all types of material collected and displayed by museums and related institutions, as defined by ICOM. This includes collections, sites and monuments relating to fields such as social history, ethnography, archaeology, fine and applied arts, natural history, history of sciences and technology (CROFTS *et al.* 2004).

modeling, reconstruction, geographical information systems, publication, education, virtual exhibitions, expert systems. Since 1960, when the first trials of optimization of management of cultural heritage institutions and statistic processing of the material of cultural heritage by machines were carried out in the United Kingdom and USA (VOORRIPS 1998), many specialized digital systems designed for documentation, accounting, study and spread of cultural heritage as well as general software versions adapted to these purposes have been created. During this period of time digital publication and training developed greatly.

For more than ten years different works of digitization of cultural heritage have been carried out in Lithuania (GLOSIENE, MANZUKH 2003). The most important are:

- information system of the registers of cultural monuments of the Republic of Lithuania “Voruta” (*Voruta* 1999);
- database of Lithuanian manor heritage (*Dvarų* 2003), database of Lithuanian organ heritage (*Lietuvos vargonų* 2003) – (Centre of Cultural Heritage);
- Lithuanian integral libraries information system LIBIS (*Lietuvos integrali* 1997-2003) – (LIBIS Centre of Lithuanian National M. Mažvydas Library);
- portal of Lithuanian museums “Lithuanian Museums” (*Lietuvos muziejai* 2004) – (Lithuanian National Art Museum, Lithuanian Association of Museums); Information Centre of the Association of Samogitian Culture; Institute of Mathematics and Information, Foundation of Samogitian Culture, Academic Youth and Children Support);
- CDs: “Golden Age” in Lithuania (JOVAIŠA 1998), “Lithuania before Mindaugas” (JOVAIŠA 1999), “Native History” (JOVAIŠA 2002) – (Home of Electronic Publication); virtual exhibition of the millennium of Lithuanian Cultural Heritage (*Lietuvos kultūros* 1998-2000) – (Institute of Mathematics and Information Science);
- databases of Lithuanian archaeologists (*Leidimai* 1998-1999), State Commission of Archaeology (*Valstybinės* 1998-1999), archaeological research in Lithuania (*Archeologiniai* 1997-1998) and aerial photos of cultural monuments (*Kultūros paveldas* 1998-1999) – (Department of Protection of Cultural Heritage);
- digital collections of parchments of the Library of Lithuanian Science Academy (*Pergamentų* 2002) and National M. Mažvydas Library (*Pergamentų* 2003);
- collection of the old documents of the Library of Vilnius University (*Vilniaus* 1998);
- Internet websites of different museums (*Lietuvos muziejai* 2004);
- Cultivate (*CULTIVATE* 2003) and Pulman (*PULMAN* 2003) projects.

In the last years the implementation of several fundamental, inter-institutional projects of digitization of authentic sources of cultural heritage was started:

- Information system of Lithuanian museum collections LIMIS (*Lietuvos muziejų* 2002-2004): working group of the Ministry of Culture of the Republic of Lithuania;
- Aruodai (*Lietuvii kultūros* 2003-2004): working group of Lithuanian Institute of History, Lithuanian Institute of Literature and Folklore, Institute of Mathematics and Information Science;
- Virtual library of Lithuanian cultural heritage (*Virtuali* 2004): Lithuanian National M. Mažvydas Library.

To summarize the current status of digitization of the Lithuanian cultural heritage, several basic features can be singled out. They are: a) the desire of many institutions to digitize their data; b) financial problems of digitization; c) absence of national strategy; d) low level of inter-institutional collaboration; e) low level of standardization; f) absence of theoretical works on the subject of digitization of cultural heritage.

Taking into account the last four features we can forecast that sooner or later (if the situation remains the same) Lithuanian systems of digital information of cultural heritage will be confronted with the problem of usage efficiency that is closely related with the level of standardization (absence of national strategy, theoretical works and poor inter-institutional collaboration aggravate the problem). Data incompatibility caused by insufficient standardization, complicated search and problems of data migration may completely derange the activities of digital information systems. Standards should be technical (file format, methods of compression, encoding, metadata presentation); documentary (material structure); thesauri classifiers and other standards of description and presentation of material (*Digitization* 1998). In the digitization of the cultural heritage one of the most important features is a standard of historical chronology and historical geography – each object of cultural heritage takes a certain place in time and space (these are one of the most important parameters describing heritage).

The subject models applicable in the digitization of cultural heritage have never been analyzed in Lithuania. The object of this article is the models of historical geography and historical chronology applied in digitization of cultural heritage. The aim of this article is the analysis of models and methods of presentation of data of historical chronology and historical geography in other already existing systems of digitization of cultural heritage and presentation and substantiation of, perhaps, the first model of spatio-temporal thesaurus (standard) of Lithuanian systems of digitization of cultural heritage in Lithuania.

2. SPATIO-TEMPORAL CLASSIFIERS IN OTHER SYSTEMS OF DIGITIZATION OF CULTURAL HERITAGE

There are many different geographical thesauri and classifiers in the world. But only a few of them are related to historical geography. According to their scope we can distribute all geographical thesauri into two large groups: global (covering the whole world) and local (covering certain territories only). As a base for creating Lithuanian geographical onomastics, the most interesting for us are global thesauri, while local thesauri may be interesting only as a practical expression of one or another methodical principle. Geographical thesauri can also be distributed into groups according to their subjects: river names, inhabited localities, physical geography, railway stations, etc. But in this review we will only talk about those geographical thesauri that have historical part of onomastics.

Perhaps the most comprehensive geographical thesaurus is the American *Getty Thesaurus of Geographic Names (TGN)* (Getty 2000). This is a huge thesaurus covering the most important place names of the whole world with a very high level description and hierarchic structure. For example, the place name Vilnius is reached through the following hierarchic structure: World-Europe-Lithuania-Vilnius. Each entry of *TGN* has its identification number (Vilnius ID:7006521); geographical map references are given; short descriptions of geographical situation and short historical summaries are given; ancient forms of the place name (*Vilnius, Vilnyus, Vil'njus, Vilno, Wilna, Wilno, Vilna*) and links to the sources of these name forms are given; moreover, functions of the city with historical data are given (Vilnius is described as: settlement since the 10th cent.; town; capital since 1128; centre of the region; diocesan centre since 1387; educational centre; industrial centre); the most important sources of information on the place name are given.

The forms of place names are not linked to time and administrative subordination, and point map references are given not territory, historical data are not exact (the name of Vilnius was not mentioned for the first time in 1128 as it is stated in *TGN*). Talking about digitization of Lithuanian cultural heritage, *TGN* onomastics perfectly fits for definition of geographical links of Lithuanian cultural heritage with the locations beyond the limits of Lithuania (quite a large part of Lithuanian movable heritage values was created abroad or by artists from abroad, Lithuanian cultural workers traveled a lot to foreign countries, etc.). Just for this purpose *TGN* is worth purchasing in Lithuania and integrated as an auxiliary measure into the under-mentioned model of three-dimensional historical spatio-temporal thesaurus. But in respect of the place names of Lithuanian territory *TGN* is rather incomplete (only the most significant place names are given); therefore, the creation of a Lithuanian geographical thesaurus is necessary.

Another global geographical thesaurus containing historical data is *English Heritage* prepared by *NMR Maritime Place Name Thesaurus* (NMR 2003). Here can also be found the hierarchic principle of presenting the place names (Continent-State-Region-Place Name). Historical forms of the place names can also be found (e.g. *Klaipda-Memel*) but there are neither map references of a place name nor any references to its chronology. On the whole, in inventorying and digitization of cultural heritage it is oriented to present administrative distribution and present forms of place names in the United Kingdom (MIDAS 2003). It is quite natural in the United Kingdom – country where the change of forms of place names and administrative distribution was quite rare. But such kind of system is unacceptable in digitization of Lithuanian cultural heritage.

The third largest global geographical project of hierarchic structure is *Aleksandria Digital Library Project* (Aleksandria 2003). On a typical place name description page of this project identification number, present form (e.g. Vilnius) of a place name, versions of the place name forms (*Vilnius Gorod, Vil'nyus Gorod, Vilna, Vilnia, Wilno, Vil'nyus, Wilna, Vil'no*) are given; map references of geographical locations are specified which is very important – a small map is enclosed. But, again, links of place name forms with historical periods and administrative distribution are missing here, only point map references are given and there is no historical data and the list of place names is not comprehensive enough. Such “imperfections” are absolutely natural in global geographical thesauri – it is impossible to range over all the place names of the whole world and it is impossible to give exact information on them. But in local geographical-historical thesauri such information is necessary.

One more very large and very ambitious geographical project is being implemented by Falling Rain Genomics, Inc. (*Global* 1996-2004). In this system many small place names of different countries (around 10.000 of them are Lithuanian place names) are given through a hierarchic structure: World-State-Region-Place. There are also map references, altitudes, a detailed physical map and weather forecasts for the chosen locations. Project implementers refer to serious information sources (Geonet onomastics, GNIS, GTOPO30, Generic Mapping Tools, VMAP, NASA SRTM) but due to insufficient analysis and selection of material the system is rather chaotic (e.g. different forms of the place name Kulionys are entered even 3 times)². The project implemented by Falling Rain Genomics, Inc. is of geographical nature³, oriented

² It should be noted that this system is being intensively developed (by the end of 2000 the place name Kulionys was entered even 7 times). Today there are no more clearly polonised forms of the place name such as Kuliance, Kulince. But at the same time it shows the attitude of the authors of the system towards historical forms of the place names.

³ In Internet there are many projects of geographical nature similar to this one. They give quite exact map references and altitudes of many locations of the world (including Lithuania). E.g. *Heavens-Above...* 2004.

to incomprehensive present territorial-administrative distribution (Lithuania is subdivided only into counties). There are neither historical data nor any sources of the place name forms nor any links with time. Most settlements are not linked even to territorial-administrative distribution. The project is not suited for digitization of cultural heritage but later on, when this system has been sufficiently developed, it may be a good auxiliary tool for geographic information (mere map references of many Lithuanian villages are very valuable only if they are exact enough).

Another part of spatio-temporal thesauri consists of local thesauri, from which we can single out specialized historical thesauri, general thesauri and geographical onomastics of auxiliary functions of DB field filling (*Lookup Wizard*). The most fundamental specialized historical thesauri are *Onomasticon Provinciarum Europae Latinarum* (*Onomasticon* 2003), *Barrington Atlas of the Greek and Roman World* (*Barrington* 2004). They are collections of place names based on the place names found in ancient written sources. But they are indented for one certain historical period, which is slightly related to Lithuania, with concrete administrative distributions and permanent forms of place names. Among local general thesauri Norwegian and Canadian works could be singled out. In Norway many different geographical databases have been created but none of them have any exact links to historical time, only a part of them is digital and only in a few of them there is a part of historical place names (*Audio* 1998; *Literature* 1998; *Norwegian* 1998; *The Home* 1998; *The Land* 1998; *The Place* 1998). From the methodical aspect perhaps the most interesting of them is *The Place Name Archives at the University of Tromsø* (*The Place* 1998) where not only Norwegian place names are given but their forms in Samish and Finnish as well.

From the same methodical aspect *Canadian Geographical Names Data Base* (CGNDB) (*Canadian* 2003) is also interesting. Not only a very wide spectrum of place names (not only settlements but hydronyms, names of landscape objects: totaling 38 kinds of place names, 31.000 of them historical) are given, but also an efficient and informative at the maximum hierarchic DB structure is created. It should be noted that a place name in CGNDB is given in present universally accepted (*Pan-Canadian*) form, its forms in English and French (depending on what language is used in a certain province) and historical names (as well as *Aboriginal place names* that are named as a separate form of cultural heritage) are given.

Another distinguishing feature of CGNDB is that additional methodical material is given in detail, such as *Guide to the field collection of Native Geographical names; Principles and procedures for geographical naming* (*Guide* 1998-2000), necessary for the creation of a thesaurus. In CGNDB there are no links of a place name with an exact historical time and no changes of Canadian historical territorial-administrative distribution but the structure

of fields describing Canadian place names could become an example for the structure of descriptions of specific place names in Lithuanian geographical DB being created (*Canadian* 2003). Many countries have their databases designed for specific fields of cultural heritage where the fields of historical geography have auxiliary (*Lookup Wizard*) functions. Among these DB, the database *Azp_Max* (*Azp_Max* 2004) of the Poznan Museum of Archaeology designed for Polish archaeology and similar DB designed for Romanian archaeology (*Archaeological* 2003) could be mentioned. In both DB one of the fields is designed to specify the old (interwar) administrative unit. But none of them present information earlier than the first half of the 20th century. No geographical information earlier than the second half of the 20th century could be found in any database of French cultural heritage (*Mérimée* 2004), where the geographical part is usually limited to the description of the present situation of an object of cultural heritage.

Talking about Lithuanian practice we should discuss perhaps the strongest digital systems of the National M. Mažvydas Library and Centre of Cultural Heritage oriented to cultural heritage. LIBIS geographical information is dissociated from chronological information. Geographical onomastics are worked out based on the bibliographic information of publications kept in Lithuanian libraries, present administrative distribution and the needs of provision of bibliographic information. This is absolutely enough to describe the publications kept in libraries but does not satisfy the needs of a wider system of digitization of cultural heritage. LIBIS onomastics contains neither the old nor many present Lithuanian place names. In databases of the Centre of Cultural Heritage geographical information is also dissociated from chronological information, and is based on present administrative distribution of Lithuania. Therefore it can be asserted that we, at present, do not have any wider historical spatio-temporal systems for digitization of cultural heritage.

3. MODEL OF INTEGRAL THREE-DIMENSIONAL SPATIO-TEMPORAL THESAURUS

As was mentioned before, the whole present digitization of the Lithuanian cultural heritage is based on present place names and present administrative distribution. But such a system will become absolutely inapplicable when the implementation of the projects of digitization of “LIMIS”, “Aruodai” or Lithuanian archive data is started. In the past, Lithuanian administrative distribution was changing too frequently (just during the 20th cent. not less than 6-8 reforms of territorial-administrative distribution can be counted); moreover, administrative subordination of a territory itself was changing (e.g. just during the 20th cent. Vilnius belonged to the Russian Empire, Kaiser Germany, Bolshevik Lithuania, independent interwar Republic of Lithuania, Republic of Poland, Soviet Lithuania, Nazi Germany, USSR, Republic of Lithuania);

Lithuanian place names were recorded in different languages (just during the 20th cent. in Lithuanian, Russian, Latin, Polish, German) and in different forms (it was noticed even by TGN compilers). Mere Lithuanian historical cultural heritage covers the 13th-21st cent., and what if 12.000 years of prehistory is added? Furthermore, all objects of cultural heritage coexisted (coexist) in space and time, i.e. each of them is related to wider historical processes and most of them are related to each other.

Presentation of the object of cultural heritage in context and by expressing links with other objects of cultural heritage is much more useful than presentation of this object taken from the context or presentation of a context next to the object of cultural heritage. Other problems of digitization of cultural heritage are the following⁴: general indetermination and laxity of Lithuanian historical terminology (cp. different names of the same period: Copper Age, Bronze Age, Early Metal Period); each of them has different definitions and a little bit different (partially coincident) periodization; complexity of definitions, conclusions, features and interpretations (cp. the problem: when were towns born in Lithuania?); related to different interpretations of the conception of town); strong influence of personal (very often different) interpretations of famous researchers of the past (cp. opinions regarding the dating of early archaeological strata in Vilnius: VAITKEVIČIUS 2000); indetermination of many historical processes in time and space; lack of collaboration between different institutions and specialists (especially in standardization of terminology).

So, if we try to construct a thesaurus of geographical names in classical style (DOERR, STEAD 2004), we will immediately be confronted with a great complexity of place names and administrative distribution. Lets imagine that, in generalization of the reality data we have in the first stage of the thesaurus creation, we collect all place names and administrative distributions from the inventory books of all museums, archive documents, inventory books of folklore archives, reports of archaeological studies and other sources of cultural heritage. It is impossible to go on to the second stage automatically, i.e. to convert all of them into thesaurus terms and keywords for the search in digital system – the system would be very chaotic. It is not advisable to reject them and appeal only to the present base of place names because their old place names are already the form of cultural heritage⁵.

Perhaps the best way to solve all the problems of Lithuanian (and not only Lithuanian) space and time presentation in digital (and not only in digital) environment is an integral thesaurus of Lithuanian historical space

⁴ A further list of problems is adapted to Lithuania according to the general list of the problems of digitization of cultural heritage (DOERR 2004).

⁵ More information on place names as the form of cultural heritage can be found in GUIDE 1998-2000.

and time created taking into account CIDOC-CRM references⁶, where the three-dimensional spatio-temporal model would be applied. The basis of this thesaurus would be made of space and time integration (spatio-temporal *continuum*, spatial time), an idea borrowed from natural sciences (H. Minkovsky, A. Einstein) and adapted to history.

The basic aims of such thesaurus would be:

1. Creation of universal method of presentation of historical space and time in digital environment.
2. Consolidation of general scheme of periodization and historical geography (standard) (to finish the specialists' disputes on this subject).
3. Standardization of space and time presentation in digital environment.
4. Organization of administration of digital information on cultural heritage.
5. Geographical and chronological classification of the objects of cultural heritage.
6. Integration of all historical geographical data in one system, which becomes the form of digital cultural heritage.
7. Digitization of the data of different objects of cultural heritage in united and integral form.
8. Analysis and dating of information on the objects of cultural heritage.
9. Creation of schemes of cultural development.

The Lithuanian spatio-temporal thesaurus would basically be a three-dimensional system of axes where horizontal axes X and Y would be an expression of geographical latitude and longitude in degrees (if the geographical object is small enough – then in degrees, minutes and seconds or even in split seconds), and vertical axis Z would be meant only for time. Each historical event, object of cultural heritage, archaeological find, museum-piece, place name, historical document, personality, process or other kinds of the object of cultural heritage would be expressed through space, time and through the spatio-temporal relation. Depending on the relation of the object with place and time, in reality it would look like a point in the system of axes (changed neither in space nor in time), segment (changed in space only but not in time) or curve (changed in space only or in time only).

Seeking to integrate in the system all the objects of cultural heritage and seeking to reflect all conceivable possibilities of dating the objects of cultural heritage, a hierarchic scheme of Lithuanian historical chronology thesaurus (axis Z) like this can be suggested (Table 1). The scheme is worked out based on two basic principles: possibilities of data presentation and stability of the system. Seeking as many possibilities of data presentation as possible all

⁶ CIDOC-CRM does not investigate any specific terminology matters but the references to time and space links in this model can easily be found (CROFTS *et al.* 2004).

Historical period	Part of historical period	Part of the part of historical period	Millennium	Part of millennium	Age	Part of age	Decade	Year	Month	Day
The Stone Age	Neolithic Age	The early Neolithic Age	The 5 th -3 rd millennium before Christ	Beginning (the 1 st -3 rd age of each millennium)	The 48 th -30 th age before Christ	Beginning (the 1 st -30 th year of each age)	The first decade (the 1 st -10 th year of each age)	The 4800 th -2901 st year before Christ	January	1
				Middle (the 4 th -7 th age of each millennium)		Middle (the 31 st -70 th year of each age)	The second decade (the 11 th -20 th year of each age)		February	2
				End (the 8 th -10 th age of each millennium)		End (the 70 th -100 th year of each age)	The third decade		March	3
				The first half (the 1 st -5 th age of each millennium)		The first half (the 1 st -50 th year of each age)	The fourth decade		April	4
				The second half (the 6 th -10 th age of each millennium)		The second half (the 51 st -100 th year of each age)	The fifth decade		May	5
							The sixth decade		June	6
							The seventh decade		July	7
							The eighth decade		August	8
							The ninth decade		September	9
							The tenth decade		October	10
									November	11
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Tab. 1 – Hierarchic structure of chronological part of the thesaurus (example).

dating methods applied in substantive historical and archaeological practice were included into the scheme: exact dates (year, month, day); approximate dating (age and part of age or millennium and part of millennium) and dating according to archaeological and historical periods (the Middle Neolithic Age, the Middle Ages, etc.). Looking for the stability of the system, it is proposed to interrelate and unify all the parts of the scheme though some of them are absolutely unnecessary (e.g. dating to the years and, especially, to the months and days in the Stone and Bronze Ages).

For the same purpose the dates of the beginning and end of the periods are equalized. Each millennium relatively starts on the 1st of January in the first year of the first age, and ends on the 31st of December in the 100th year of the last age; in the same way, each age relatively starts on the 1st of January in the first year, and ends on the 31st of December in the 100th year (though such exactness is absolutely irrelevant for periodization of prehistory). Dating of archaeological periods (prehistory) given in the scheme is worked out based on practical schemes of archaeological dating that are already well-established in Lithuania (according to RIMANTIENĖ 1984; MICHELBERTAS 1986; GRIGALAVIČIENĖ 1995; GIRININKAS 1997; TAUTAVIŪIUS 1997; JOVAIŠA 1998, 1999, 2002).

The date of the switchover to historical times (beginning of the Middle Ages) in the scheme is relatively considered to be the 1st of January 1236

because right in 1236 the Lithuania of the Duke Mindaugas was mentioned for the first time in written sources and the beginning of the most important political, cultural and economical historical events of medieval Lithuania (baptism, coronation, beginning of masonry construction, the first monuments of Lithuanian script (the letters of Mindaugas), birth of towns, beginning of battles with the Teutonic Order) can be linked to it. The 31st of December 1569 was chosen to be the end of the Middle Ages in the scheme.

The second half of the 16th cent. is a turning point in the history of the Great Duchy of Lithuania. 1569-1570 is like a middle point of this period of transition. The most important events of this period are: Valakai (Lith. sg. "valakas" – a unit of measure equal to 21,8 ha) Reform, establishment of Vilnius College and University, Lublin's Union, beginning of publication of Lithuanian books, the first grammar of the Lithuanian language, translation of the Bible into the Lithuanian language, construction of the first Baroque church in Nesvyžius, Orthodox and Catholic churches Union of Brest, Lithuanian Statutes. The New Times that started on the 1st of January 1570 lasted until the 31st of December 1918 because 1918 is a turning-point in Lithuanian history as well as in the history of the world. It is a starting point of many processes that influenced the history of the 20th-21st centuries: the end of World War I and Paris Peace Conference as one of the reasons of World War II; rise of the USA; consolidation of Bolshevik power in Russia; establishment of national states in Eastern Europe and establishment of Lithuanian independent state.

In practical dating of an object of cultural heritage at least one chronological and geographical link of each object would be fixed. Dating should be carried out by filling the fields describing the object with the selected data of the thesaurus that could be relatively called: "Beginning"; "Changes"; "End"⁷. It should be noted that any term in the thesaurus could be used for filling chronological fields. The only limitation imposed by the system would be the limitation of possibilities to select terms to the only possibility of moving throughout the thesaurus in a horizontal direction. For example, a system user who chooses the Middle Ages, can then choose only the 13th-16th cent.; whoever chooses the 13th cent. only 1236-1300; whoever chooses February 1236 only the 1st-29th, and vice versa, who chooses the 15th cent. could choose only the first millennium and only the Middle Ages.

Depending on the object of cultural object, type of personality or process, birth (personality), construction (building), production (article), creation (piece of art), the first mentioning (place name), rise (towns, Christianity, serfdom and other processes), etc. should be reflected in the field "Beginning". Depending

⁷ The model of describing the object of cultural heritage via event is recommended in CIDOC CRM. In this model there is a well-developed hierarchic structure of the fields "Beginning", "End" and "Changes" (CROFTS *et al.* 2004).

on the object of cultural object, type of personality or process, death (personality), destruction (building), decay (article), the last mentioning (place name), end (process), etc. should be reflected in the field “End”. In the field “Changes” double information should be reflected depending on the object of cultural heritage, type of personality or process. First of all, there are basic events related with the object: reconstructions (building), migration (personality), repainting, restoration (piece of art), place name changes (e.g. Starapolė-Marijampolė-Kapsukas-Marijampolė) and auxiliary events related with the object: research, finding, gift, restoration, description. Depending on the needs of the described object of cultural heritage the user of the system should have the possibility to generate an unlimited number of the fields “Changes”.

Next to each field of chronological description of the object of cultural heritage there should be a compulsory field of geographical description that could relatively be called “Place”. Therefore, space as well as time would be divided into sectors linked to chronology that could relatively be called “Beginning-Place”, “Changes-Place” and “End-Place”. The system should have possibilities to describe the geographical situation of the object in four ways: according to its address (Lithuania, Utena County, Molėtai Municipality, Ėiulėnai Neighborhood, Kulionys Village); according to the place name chosen from thesaurus (Kulionys); according to the identification number (ID) of the place name and according to the geographical map references. In the structure of the system these four ways should be interrelated. For instance, when a place name is entered, the system should link it to geographical map references, ID and administrative-territorial structure (address) of a certain historical period and to the contemporary one. In the case of several same place names the system should give several possible versions of the structure of administrative-territorial distribution and geographical map references.

It is important that geographical map references describing a place name of any level of the thesaurus be exhaustive enough but not particular. They should depend on the area of the locality. It is necessary that map references cover all the area named by the toponym (Europe, Lithuania, Vilnius, Utena County, etc.), from the southernmost to the northernmost as well as from the easternmost to the westernmost point of locality. It would not be good if only point references linked to a certain place only (e.g. to the centre of town) are given. Such presentation of geographical map references (area, not point) is necessary seeking for reverse link, i.e. exact links of GPS references with place names, seeking to establish exactly, for instance, administrative-territorial subordination of the place of a fixed immovable object of cultural heritage or archaeological research. When a user of the system enters the references of the object (cult building, place of archaeological research or other), he wants to receive an exact answer in which the location of the building is (was).

The geographical part of spatio-temporal thesaurus as well as its chrono-

logical part should be based on hierarchic structure of presentation of material. This hierarchic structure should depend on the structure of administrative distribution of the territory in each specific chronological period (chosen by the user of the system). Because of that, in this thesaurus it is necessary to enter the chronological data of the object of cultural heritage first. For example, when the system user enters the date 20 April 2004 in the field “Beginning” the options to choose from hierarchic geographical structure, the example of which is given in Table 2, should appear in the field “Beginning-Place”. But if he enters the date 20 April 1906 in the field “Beginning” the options from absolutely different hierarchic geographical structure (an example is given in Table 3) should appear in the field “Beginning-Place”.

CONTINENT	STATE	COUNTY	MUNICIPALITY	NEIGHBORHOOD	LOCALITY
Europe	The Republic of Lithuania	Utena	Molėtai	Čiulėnai	Kulionys
					Toliejai
					Čiulėnai
					Purvėnai and other inhabited localities that are in that neighborhood

Tab. 2 – Hierarchic structure of geographical part of the thesaurus, 2004 (example).

CONTINENT	STATE	PROVINCE	COUNTY	RURAL DISTRICT	LOCALITY
Europe	Russian Empire	Vilnius	Vilnius	Molėtai	Kulionys
					Čiulėnai
					Toliejai
					Purvėnai and other inhabited localities that were in that rural district

Tab. 3 – Hierarchic structure of geographical part of the thesaurus, 1906 (example).

As was mentioned before, the geographical part of the thesaurus is completely coordinated with the administrative distribution of each historical period. But through the links of specific place name of each historical period with geographical map references the same place names are absolutely related vertically independent of administrative distribution of one or another period as well as of one or another form of a place name that is (or was) used. At the same time the possibility of mixing the place names in the field

is restricted through the links of the geographical and chronological part of spatio-temporal thesaurus. For instance, it should be impossible to enter the place name Kulionys in the Stone Age in the field “Beginning-Place” because the date chosen in the field “Beginning” is earlier than the date of the first mentioning of this place name in written sources.

Exact links of archaeological objects of cultural heritage (archaeological monuments, archaeological finds, reports of archaeological expeditions, etc.) with geographical onomastics should be established through chronological field “Changes” [found (find), researched (mound, settlement), described (mound, settlement)] by entering the date of finding, research, description or other (depending of the type of object) and by linking then with the place name and administrative-territorial distribution of that period. Whereas geographical and chronological information of archaeological objects in the fields “Beginning” and “Beginning-Place” should usually be very loose (e.g. Lithuania, 4th cent.).

In such a way, by linking geographical space and time we are necessarily confronted with three subgroups of the geographical part of the spatio-temporal thesaurus. They are: present place names, extinct place names and ancient place names having their equivalents in present times⁸. The simplest subgroup is a subgroup of present place names – this material is well-known and easily linked with the network of geographical map references, administrative-territorial structures and chronology. A little bit more complicated is the situation with the old place names that are known only from written sources of history. When entering these place names into the thesaurus there is a danger of doubling due to insufficient analysis of material. It is a little bit easier with place names that reached at least the 2nd half of the 19th cent. if not today. If they are marked in Russian or German topographic maps of the end of the 19th cent.-beginning of the 20th cent., their identification with present place names and (or, if a settlement is extinct) linking with quite exact geographical map references do not create greater problems.

The biggest problem is extinct ancient place names. Some of them are really impossible to link with the localities or exact geographical map references of the lower level geographical part of the thesaurus but the links with higher level locations (state, county or even municipality or rural district) are really possible. Moreover, the situation is improved by the fact that each place name of the spatio-temporal thesaurus will have an individual identification number (ID) in this system, and the most important place names will be linked to *TGN* as an auxiliary measure of geographical onomastics

⁸ I wish to thank Dr. Vykintas Vaitkevičius and Dr. Daiva Vaitkevičius because the idea of three parts of geographical onomastics was crystallized in the discussions with them.

of historical spatio-temporal thesaurus. Presentation of *TGN* in the model of Lithuanian historical spatio-temporal thesaurus and links of Lithuanian geographical onomastics with *TGN* (via geographical map references as well as via ID numbers) are also important from the aspect of presentation of Lithuanian cultural heritage abroad and integration of Lithuanian systems of digital cultural heritage into global systems of digital cultural heritage. Clear links of Lithuanian place names with, perhaps, the best geographical thesaurus in the world would allow executing without let or hindrance this kind of integration⁹.

In the geographical part of the spatio-temporal thesaurus each place name could be described in one table form (system of database fields) related with geographical (map references) as well as with chronological (axis Z) part of database and with each other (if the place names are equivalent with each other, e.g. Marijampolė-Kapsukas). The most important fields describing the place name should be the present form of the place name, the old forms of the place name and sources of their usage and chronological periods, all known forms of administrative subordination of the place name, geographical map references of the place name, sources where the place name was mentioned and the names of specialists who suggested inclusion of the place name.

As the creation of a spatio-temporal thesaurus is a long process, the system should be open. A new place name should be included in the thesaurus when its “discoverer” fills in “The Form of Term Candidate”¹⁰ (sort of application) and when the administrator of the system checks it. In the Form of Term Candidate there should be the following fields: place name, description of a document where the place name was found, date of document, context and original form of the place name given in the document, former administrative subordination of the place name (at the moment when the document was drawn up), possible links of the place name with already existing present place names of the spatio-temporal thesaurus and present administrative subordination, full name of the discoverer of the new place name, institutional subordination.

Geographical and chronological information in the spatio-temporal thesaurus should also be linked through the maps. Each administrative distribution (chronologically marked on axis Z) should be reflected on horizontal map (axes X and Y). This could be a simple digital administrative map with

⁹ Inter-integration of different systems was discussed and described a lot (DOERR, STEAD 2004).

¹⁰ It is done so in the United Kingdom (MDA 1998).

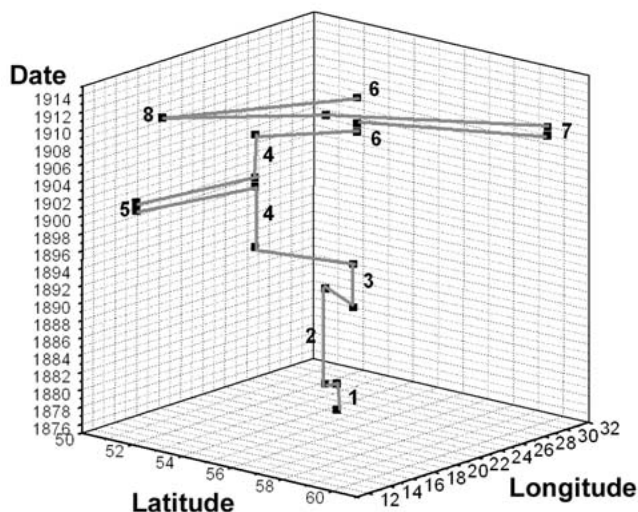


Fig. 1 – Graphic visualization of data of integral, tridimensional historical spatio-temporal thesaurus, personality: Life of Lithuanian painter M.K. Eiuilionis. The lower point of the graph means his birth, the upper one – his death. Numbers show localities: Varėna (1), Druskininkai (2), Plungė (3), Warszawa (4), Leipzig (5), Vilnius (6), St. Petersburg (7), Pustelnik (8). Curve shows the movement of the personality in time and space. Made with data processing program Origin 6.1., one of possible graph projections.

the marked centers of administrative distribution and boundaries of administrative units of a certain period¹¹.

By discussing wider possibilities of application of spatio-temporal thesaurus we can assert that an integral, three-dimensional spatio-temporal thesaurus may be not only a solid ground for entering the data of digitalized cultural heritage but also the model of visualization of the data of cultural heritage and their computer statistic analysis. Each object, personality or process described by the means of the fields “Beginning”, “End”, “Changes”, “Beginning-Place”, “End-Place”, “Changes-Place” may be expressed visually as a point, segment or curve in a three-dimensional system of axes; we can compare their interrelation, look for cohesion possibilities, apply to them statistical methods of analysis.

So, integral historical spatio-temporal thesaurus would be not only a standard of digitization of cultural heritage but a model of computer studies of information of cultural heritage and, of itself, a digitalized value of cultural heritage as well.

¹¹ There are plenty of these kind of maps in Internet, e.g. European historical maps (EURATLAS 2003).

4. CONCLUSIONS

The processes of digitization of cultural heritage are intensifying in Lithuania but there is neither proper national strategy nor standards nor proper inter-institutional collaboration. In the future it may become one of the most important reasons for disorders in the digital systems.

One of the most important parameters in describing cultural heritage is historical space and historical time, but in Lithuania there are no universal systems of description and classification of historical space and time applied to digitization of cultural heritage. Due to the specificity of the historical development of Lithuanian cultural heritage, none of the models of thesaurus of historical space and time presentation that are known in the world suit us. The best solution would be the creation of our own, integral, three-dimensional thesaurus of Lithuanian historical space and time. In the thesaurus all dating methods applied in practice, and all known place names as well as the structures of administrative-territorial distribution would be reflected.

An integral historical spatio-temporal thesaurus would be not only a standard for the digitization of cultural heritage, but a model of computer studies on information of cultural heritage and, in itself, a digitalized asset of the cultural heritage as well.

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ABSTRACT

Digital technologies developed during the last decades substantially change the processes of accumulation, custody, record and investigation of cultural heritage as well as the processes of spread of information on cultural heritage. Basic features of current situation of digitalization of Lithuanian cultural heritage are: a) willingness of most institutions to digitalize the data they have; b) financial problems of digitalization; c) absence of national strategy; d) low level of inter-institutional collaboration; e) low level of standardization. Taking into account the last three features we can forecast that sooner or later (if the situation does not change) Lithuanian digital information systems of cultural heritage will be confronted with the problem of usage efficiency.

Perhaps the most important parameters characterizing cultural heritage are historical space and historical time. But we do not have any wider systems of presentation and classification of historical space and time designed for digitalization of cultural heritage in Lithuania. Object of this article is the models of historical geography and historical chronology applied in the digitalization of cultural heritage. Aim of the article is the presentation and substantiation of the model of a space and time thesaurus (standard) of Lithuanian systems of digitalization of cultural heritage.

The basic aims of such a thesaurus are the following: 1) creation of a universal method of presentation of historical space and time in digital environment; 2) consolidation of a general scheme (standard) of periodization and historical geography (to put on end to disputes among the specialists on this subject); 3) standardization of space and time presentation in digital environment; 4) organization of management of digital information of cultural heritage; 5) geographical and chronological classification of the objects of cultural heritage; 6) integration of all historical geographical data in a single system that becomes a form of digital cultural heritage; 7) digitalization of the data of different objects of cultural heritage in single and integral form; 8) analysis and dating of information of the objects of cultural heritage; 9) creation of schemes of cultural development.