Impact of ICT on Archival Practice from the 2000s Onwards and the Necessary Changes of Archival Science Curricula

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At the outset authors of this article investigate the influence of ICT on archival practice. All archival processes are affected by latest developments in ICT. DMS and eSignature requirements and legislation (like MoReq and eIDAS) influenced record management practice. PAIS, OAIS and storage solutions have their impact on the archival management. Special audio and video format solutions influenced specialised archives. Graph databases as a more agile tool for organising information and the upcoming Records in Contexts (RiC) standard are influencing archival description. New preservation methods have emerged - Chain of Preservation model (COP) and the upcoming Preservation-as-a-Service for Trust (PaasT) model. PaasT is the result of growing cloud services. Semantic web influenced retrieval and usage of materials in all heritage institutions. The authors proceed to discuss how the elaborated changes should reflect the archival science academic curricula. They investigate what are new archival science core competences that should be taught to students and archival professionals by university teachers today, how should universities prepare their students of archival science for contemporary (digital) labour market etc. The authors offer a clear position what archival competencies, arising from the influence of ICT and cloud environment, should be built upon in the contemporary archival science curricula.

I. INTRODUCTION

ICT has had an indisputable impact on the reality of organisations and the reality of people's lives for decades. The significant transformation of these realities from the 2000s onwards brought about a change in archival science curricula. The authors of this article investigate the extent of this influence and the magnitude of educational adjustments. Have archival professionals incorporated enough contemporary ICT knowledge into their curricula (and their daily operations) yet? Comparable impact on archival profession happened with the appearance of new storage materials and the development of new physicochemical methods in the 20th century. Those materials and methods had a substantial influence on archival storage facilities and procedures of preservation, conservation and restoration. But, what is happening now is of far more consequence to the future of the archival profession. ICT, led by fresh approaches, trends, values and practices, has moved not just those parts of archival work that were oriented towards the management of digital records, but also parts of more traditional archival practice, like archival description[1], because of new possibilities of computer generation and system-to-system communication of archival finding aids[2].

Digital signature and other authentication and integrity associated technologies altered management of digital records. New digital audio and video formats appeared. Electronic recordkeeping technologies related to Records Management Systems (RMS) / Enterprise Content Management Systems (ECM, ECMS) influenced organisations and supported their abilities to preserve digital records. Storage became portable, designed for massive scalability, and with archival qualities – like SDS (Software-Defined Storage), SSA (Solid State Arrays), scale-out NAS (Network-Attached Storage), and object storage. Cloud services and cloud storage have been developing for the last decade [1]. These services are today fully accepted by individuals for their personal archives and more or less accepted by corporate bodies. Concepts and standards like OAIS (Open Archival Information System), PAIS (Producer-Archive Interface Specification), PAIMAS (Producer-Archive Interface – Methodology Abstract Standard) and XFDU (XML Formatted Data Unit) are shaping the process of transfer of digital content among environments [2-6]. Semantic web and graph databases also occurred in the realm of today's records and archive management. These fresh ICT concepts and their effect on archival science are described in the second chapter of this article. The authors consider that ICT influenced archival science considerably and that archival curricula responded to these developments to a great extent. But, do these curricular changes respond enough to the progress in ICT field(s)?

The aftermath of ICT impact is visible in the courses offered to university students on the global and European

[1] Archival description refers to "the process of capturing, analyzing, organizing, and recording information that serves to identify, manage, locate, and explain the holdings of archives and manuscript repositories and the contexts and records systems which produced them" and "the products of the above process.", International Council on Archives, "Dictionary of Archival Terminology" (Draft Third Edition/DAT III, 1999) and Multilingual Archival Terminology, http://www.ciscra.org/mat/mat/term/51 (accessed March 2017)

[2] Finding aid – "a tool that facilitates discovery of information within a collection of records", Pearce-Moses, Richard. A Glossary of archival and Records Terminology, http://www2.archivists.org/glossary/terms/f/finding-aid (accessed March 2017)

level (analysed in 2003 and 2016). Nevertheless, it is important to constantly monitor changes in ICT and to make timely recommendations for continuing adjustment of archival science curricula.

Next, we will firstly discuss the influence of ICT on the archival science and practice. Then we will show the effects of the development of ICT on university and professional curricula by analysing the changes that were introduced between the two research activities – the first in 2003 and the second in 2016. Finally, we will conduct a SWAT analysis, draw conclusions and offer recommendations.

II. Influence of ICT on Archival Science and Practice

In relation to the processes of transfer and storage, a numerous media types were developed by the ICT industry [7-8]: glass disks, PIQL film, new types of network storage etc. Some recognised media technologies got better over time (e.g. Data Tresor Disks) while the ICT industry has abandoned some of the media types in recent years, e.g. Ultra Density Optical (UDO) disks, High-Density DVD, Holographic Versatile Disks (HVD) etc.

Record Management Systems (RMS) and Enterprise Content Management Systems (ECM, ECMS) have entered the organisations and changed their record management practices and workflows. ECMS and RMS systems are practically comparable, from the pure record management perspective, but then again ECMS systems are conceptually[3] and functionally[4] broader than RMS. From the archival perspective, this broadness of functions is relevant because it shapes creator's business activities and affects archival fonds. Adoption of ECMS and change in workflows can result in business process reengineering activity and change in the business (business activities, business roles etc.). For this reason, ECM systems are not just automation tools; implementations of ECMS systems in organisations are not just trivial modifications. Archivists should be well-aware of this. Recently, the ECMS solutions have been implemented in many organisations. Examples of the most spread out technologies [9-11] are IBM FileNet, Dell EMC Documentum, Alfresco One, OpenText, Hyland OnBase etc.[5] For illustration, the FileNet ECMS implementation in the Croatian Agency of Medicinal Products and Medical Devices (HALMED) in 2013 and 2014 led to changes in recordkeeping, archival management, IT landscape, and business processes.[6] FileNet ECMS in HALMED has been linked with XINO scanner and DPU Scan application, case management application and archival management application.[7] Outcomes of these integrations and interfaces are a) ability to use digitised records as a replacement for paper originals in the workflows, b) linked paper originals and digitised copies, and c) ability to archive new digitally-born records and cases. A threefold usage of various HALMED's ECMS content happens at this time. There are users in HALMED that use ECMS and its content through its own FileNet Navigator interface, users that prefer to use their previously developed business applications (ECMS handles the content in the background), and groups of users that work with new applications, developed on the FileNet platform. Rearrangement of business tasks was done because new applications had required different workflows (e.g. Quality Management application). Outcomes of these new workflows were new groups of records, and thus the change in archival fonds.

Storage and its diversification became very complex; therefore archivists should learn more and absorb more facts about the world of storage. There are several notions about the storage archivists should be able to consider. They have to consider storage memory feature (primary, secondary, tertiary, online, offline, near-line, volatile, non-volatile); the way storage utilises equipment (SAN, NAS, virtualisation); storage hardware dependency (SDS); the question what storage really addresses (content, location, file-addressable); the question what storage actually manages and on which level (file hierarchies, objects, blocks, and entry level, business level, enterprise level). There are numerous subtypes of storage solutions [12]. Today, for archivists it is necessary to understand the software characteristics behind the typology, characteristics like scalability (of solid state arrays, NAS, object storage), hardware-independency (of SDS) etc. Archivists should also know what to do once active storage environment is set up – to apply business continuity and disaster recovery policies as well as to develop long-term digital preservation policies together with IT colleagues and to archive what has to be archived. Therefore, archivists should be acquainted with backup procedures (traditional, snapshots, cloud), replication (replication of content after its creation, host-based, array-, network-, snapshot-based), mirroring etc.

Semantic web brought requirements to semantically enrich descriptions of existing materials in order to

[3] Content vs. record. ECM deals with unstructured organisational (enterprise) content. ECM is "a strategic framework and a technical architecture that supports all types of content (and format)" (Definition from Gartner MQ ECM report 2014 and 2015) and "a set of services and microservices […] to exploit diverse content types, and serve […] numerous use cases across an organization." (Gartner MQ ECM 2016). Gilbert, M. R.; Shegda, K. M.; Chin, K.; Tay, G.; Koehler-Kruener, H. "Magic Quadrant for Enterprise Content Management, September 2014", Gartner, Inc.; Koehler-Kruener, H.; Chin, K.; Hobert, K.A. "Magic Quadrant for Enterprise Content Management, October 2015", Gartner Inc.; Hobert, K.A.; Tay, G.; Mariano, J. "Magic Quadrant for Enterprise Content Management, October 2016", Gartner, Inc. (MQ ECM 2014-2016 v. Licenced for distribution).

[4] ECMS consists of document and records management, image management, collaboration tools, web content management, business process workflows, and vendor-specific components. It is also linked with business applications of organisations. Gartner report from 2016 predicts shifting major ECM solutions to cloud-based platforms.

[5] Gartner MQ ECM 2014-2016.

[6] Part of the IPA 2009 TAIB project preparations for eCTD and Implementation of Digital Archival Information System (in cooperation with Ericsson Nikola Tesla d.d. and AAM Management Information Consulting Ltd.).

[7] Imaging subsystem was developed by EMES d.o.o., and case management and archival management applications by Omega Software d.o.o.

disseminate them in a more efficient manner. Many institutions from the museums/libraries/archives (MLA) community had started with the implementation of the semantic web a long time ago and have enabled better connectivity of descriptions of their objects of interests for different communities. The emerging archival standard Records in Contexts (RiC) represents one step toward this [13-14].

Records in Contexts standard is using graph databases [15]. Graph databases appeared as more flexible and reactive technology for processing entities and their relationships than the technology of relational databases.[8] Creation of graph database (model) implies the creation of nodes (entities) with labels (entity types), relationships, and nodes' and relationships' properties. It is still too early to tell whether RiC will become a new description standard or just another schema in archival description. Nevertheless, it is important to understand the principle behind RiC and to be aware of these changes in the world of databases.

Archivists are often interpreters – they translate from the business language connected with a function to the ICT language that supports the function and vice versa. Some standards that are close to the archival domain, and records & archival management domain-specific languages [16], already possess this translated logic. OAIS standard represents a mixed language of such a sort. ICT professionals can build an OAIS compliant system. A person with a task to transfer records between two systems can conduct a structured PAIS project. But usually archivists have to familiarise ICT professionals with these standards. Also, archivists translate records management parts of business functions to ICT workflows and functionalities. Records contain business transactions metadata and remaining logic while business is driven by records to an appreciable degree.

An OAIS-based system has several functions – ingest of records being the starting one. Archive receives a submission from internal or external, human or computer producer. It has to be validated and transformed into the form suitable for long-term preservation. These standards can be applied [2-6]: PAIMAS to define producer-archive relationships in different phases[9] and conditions of their cooperation; PAIS to formally define digital objects and specify submission models[10] required for transfers into archives; XFDU to support these transfers as the precise packaging standard. Finally, there is an ISO 16363 standard [6] for evaluating the trustworthiness of repositories (i.e. digital archives). It brings to maturity OAIS, PAIMAS and PAIS standards. ISO 16363 covers ingest function, organisational infrastructure related issues and maintenance of producer-archive relationships.

Shifting the focus from the RMS systems to the digital records they are holding, it should be noted that archivists are increasingly dealing with the records having some kind of cryptographic mechanisms applied to them. Namely, the records are being signed by (advance) digital signatures which rely on (qualified) digital certificates; the digital timestamps are being added as well as digital seals. Recently implemented EU-level regulation eIDAS states that "an electronic signature shall not be denied legal effect and admissibility as evidence in legal proceedings solely on the grounds that it is in an electronic form" [21]. This means that the archivists need to know how to preserve digitally signed records in the long-term while addressing the fact that digital signatures rely on digital certificates which are valid only 2-5 years. While considering re-certification and while applying standard long-term preservation technical procedures like file format conversion, media migration, application emulation or system virtualisation they should constantly have in mind standard archival requirements for preservation of authenticity, integrity, reliability, usability and non-repudiation of digital records being preserved. All this illustrates just a fraction of ICT-connected tasks that the archivists need to proactively and successfully accomplish.

Besides the impact of ICT by itself, the authors also recognise the influence of recent professional endeavours like an education and training component of the InterPARES 3 – global, archival science research project (2007-2012) and other similar impacts on professional curricula. Projects like InterPARES laid emphasis on the need to incorporate state-of-the-art technologies into students' and trainees' programmes.

III. EFFECTS ON UNIVERSITY AND PROFESSIONAL PROGRAMMES

The effects of the development of ICT on university and professional programmes were analysed by comparing the two studies. The first one was conducted in 2003[11] and the second one in the last quarter of 2016.

The first study aimed to analyse 23 programmes of archival science globally. They were from Australia (2), Canada (2), Finland (1), Ghana (1), Israel (1), USA (14), and United Kingdom (2). Descriptions of the total of 370 courses were manually identified, collected from the official web pages and analysed. The analysis was focused on identifying if the courses found in the archival science programmes could be relevant for the library science study or museum science/heritage study (the MLA group) or social-humanistic informatics or a combination of them. Also, the level of influence of IT was determined. The results show that:

- 62% of courses are relevant for the study of library science,
- 58% of courses are relevant for the study of museum science,

[8] "Because of their emphasis on global queries, graph compute engines are normally optimized for scanning and processing large amounts of information in batches…",.Robinson, I.; Webber, J.; Eifrem, E. "Graph Databases". O'Reilly Media Inc., 2015, p. 7.

[9] Preliminary phase, formal definition phase or PAIS phase, transfer phase, validation phase.

[10] PAIS define types of submissions and submission containers. Actual submission implementation should be done by applying XFDU standard.

[11] As part of the project HERITAGE Live (Operative programme IPA – Cross-border Cooperation Slovenia-Croatia 2007-2013).

- 37% of courses are relevant for the social-humanistic informatics study,
- 1.9% of courses are exclusively relevant for the combination of archival and library science study (while not for other study combinations),
- 1.6% of courses are exclusively relevant for the combination of archival and museum science study (while not for other study combinations),
- 1% of courses are exclusively relevant for the combination of archival science and social-humanistic informatics study (while not for other study combinations),
- 56% of courses are relevant for the combination of archival, library and museum (MLA) study,
- 35% of courses are relevant for the combination of archival, library and museum (MLA) and social-humanistic informatics study,
- 7.7% of courses have information technology aspect explicitly mentioned in the course name.

The analysis showed that there are firm grounds for the organisation of the multidisciplinary studies (MLA group + social-humanistic informatics) while the combinatorial exclusiveness showed statistically insignificant overlap. This study also served as a starting point for the second research study.

The aim of the second research study was to compare the archival science programmes at the European universities taking into account the programme offered by the Faculty of Humanities and Social Sciences (FHSS) at the University of Zagreb (where the authors are from) as well. For the purpose of research, 20 emails were sent to the official addresses of different universities in Europe. Out of 20 inquiries, 4 faculties confirmed that they are offering archival science programme, 1 faculty has requested to send the inquiry to a different address, 6 faculties reported that they do not offer an archival science study, while 9 faculties did not respond to the inquiry to the date of writing this paper. The authors used faculties' official web pages to gather additional information needed for the analysis. Therefore, the analysis focused on the 5 archival science programmes at the universities that have them (Lund University, University of Amsterdam, University of Oslo, University of Stockholm, University of Zagreb). The goal of the second research was to compare the differences between the studies in Europe by looking at the amount of theory focussed courses versus practical ones as well as the courses that implement ICT. The total of 88 courses was analysed. The difference between the analysed programmes is that the archival science programme offered by FHSS officially starts at the graduate level but also have several archival courses at the undergraduate level. Other analysed programmes are mainly offered at the graduate level, so the archival science courses do not appear during the undergraduate study, the exception being the University of Oslo.

The fact that the graduate level programmes were analysed may be the main reason why the courses are mainly based on theory – the students need to learn the basics of archival science. History is not significantly present. Instead, there are courses which are more practice-oriented and which prepare students to work at the MLA institutions (usually in the second year of the study).

The courses that are IT-focussed use the technology existing in the archives of their countries, therefore giving students the opportunity to learn how to use the technology before graduating. The analysis showed that 17% of courses have information technology aspect explicitly mentioned in the course name. Although the first and the second research did not analyse the same sample so the results could not be directly correlated the increase in number of IT-focused courses may be noticed.

To enrol in the graduate program, students have to finish an undergraduate study. Most of the analysed courses (56%) are in the programme during the first year of graduate archival science studies (Figure 1). Those courses mainly serve to introduce students to the archival science. Broadening the view of the influence of ICT we have identified 27% of courses in the second year of graduate studies that involved work with information technology used in archival practice but not fully focussed on it. This shows that IT has significantly influenced the archival studies.

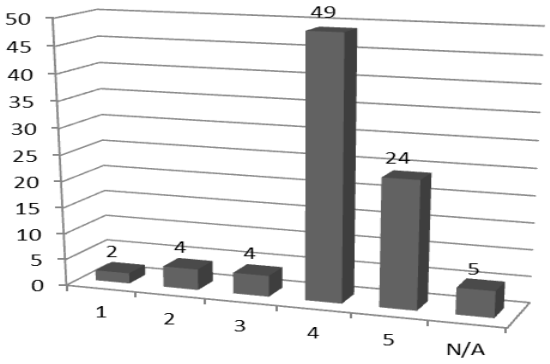

Figure 1. Number of courses per year
(1-3 – undergraduate level; 4-5 – graduate level)

In fact, when we look at the distribution of the courses per semester, 30 courses are in programme during the seventh semester, or first semester of the graduate study (Figure 2).

While the first semester of graduate study is aimed at studying the theory of archival science, the courses which involve information technology used in practice are in the programme of the ninth semester. The tenth semester is the semester when the students have their internship in the archives, so it makes sense that they should be prepared to use the technology.

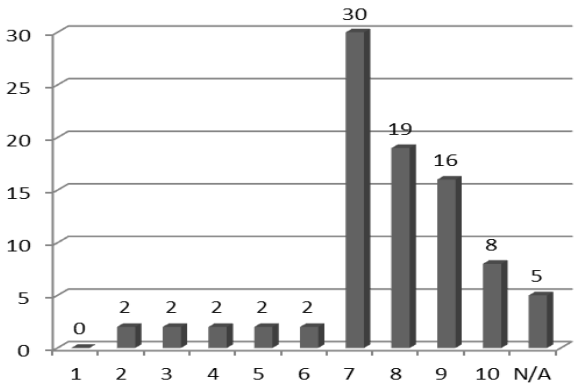

Figure 2. Number of courses per semester

Archival science courses in the analysed programmes of the second research study focus more on theory than practice, but it is clear that they follow the development of ICT. As it was detected in the first research study, here the archival science courses also do not prepare the students to work only in the archives, but in all MLA institutions as well. The analysed archival science programmes in Europe does not perceive archival science as a science that deals only with the preservation of documents, but as a science that deals with information systems, digital preservation and other activities normally conducted by other information institutions too. The analysed programmes last between one and two years, but the trend is to put less focus on courses directly linked to the current archival practices and current technology, and more focus on practical work.

TABLE I. ANALYSIS OF STRENGTHS, WEAKNESSES, OPPORTUNITIES AND TREATS OF/FOR ARCHIVISTS WITH THE MISSION RELATED TO PRESERVATION IN THE DIGITAL ENVIRONMENT

STRENGTHS (KNOWLEDGE)	**WEAKNESSES** (LACK OF KNOWLEDGE)
Classification; arrangement[12]; organisation; document types; document forms; intrinsic and extrinsic characteristics[13]; provenance[14] and the quality of source analysis	Digital formats and standards; formatting standards; system or repository architecture and functioning; storage
OPPORTUNITIES (KNOWLEDGE)	**THREATS** (MINDSET ISSUES)
New types of databases; semantic web; machine learning software; computational archival science[15]; new types of accumulations; personal digital archiving[16]; possible usage of new interactive technologies	Holding tenaciously to workflows and procedures created for handling paper records. Choosing to keep working in closed professional ecosystems.

IV. CONCLUSION

Table 1 uses a SWOT analysis template and links strengths and opportunities with knowledge and positive aptitude of archival professionals. The proposed SWOT analysis derivative outlines today's archival corpus of knowledge related to professional ability to contribute to digital archival management and archivists' ability to absorb IT-related knowledge. Archival professionals are strong in using classifications, so their knowledge can be used in the system design phase. For a good reason the DIRKS recordkeeping methodology [17] had assigned the same role for archivists. Although their new role in the organisational environment is being recognised, the role of the archival professional in open digital social environment has not been defined yet. Archivists' ability to evaluate provenance and the quality of sources could be helpful in this new environment. That ability is also related to ICT and participation of archivists in training phases in pattern analysis and machine learning projects.

Weaknesses are related to archivists' lack of knowledge of particular technologies. Threats are related to archivists' and records managers' way of thinking allied with the paper administration and its functioning. This refers to applying records schedule in some later stage of digital document's lifecycle, sticking to workflows created for paper records, insisting on perfect custodial conditions in a dynamic digital environment etc. If we neglect the threats, they will turn into professional weaknesses.

Therefore, archivists should be abreast of the rapid ICT developments. It is important to recognise and address the needs for further improvements. Opportunity for growth lies in making archival outputs more interoperable, dynamic and usable than before, by embracing semantic web concepts, graph databases concepts, machine learning tools concepts etc. Another opportunity for archivists in the complex contemporary

[12] Archival arrangement – "1. The process of organizing materials with respect to their provenance and original order, to protect their context and to achieve physical or intellectual control […] 2. The organization and sequence of items …", Pearce-Moses, R. A Glossary of Archival and Records Terminology (accessed March 2017)

[13] "Documentary form is both physical and intellectual. The term physical form refers to the external make-up of the document, while the term intellectual form refers to its internal articulation. Therefore, the elements of the former are defined by diplomatists as external or extrinsic, while the elements of the latter are defined as internal or intrinsic." Duranti, L. "Diplomatics: New Uses for an Old Science - Part V." // *Archivaria 32* (Summer 1991)

[14] Provenance – "*Archivists* base their work on the idea that the origin of archival *documents* and *records*, or their provenance, must be known if the purposes of the archives are to be achieved […] The application of the principle of provenance results in division of archival holdings into particular groups of records linked to their creator. "The principle of provenance" // Duranti, L.; Franks, P. C. (ed.) "Encyclopedia of Archival Science", 2015, p. 284.

[15] Computational archival science – "An interdisciplinary field concerned with the application of computational methods and resources to large-scale records/archives processing, analysis, storage, long-term preservation, and access….", Marciano, Lemieux, Hedges, Esteva, Underwood, Kurtz, Conrad. "Archival records and training in the Age of Big Data" (Draft submitted Oct. 2016) // Sarin, L. C.; Percell, J.; Jaeger, P. T.; Bertot, J. C. (ed.) Advances in Librarianship – Re-Envisioning the MLIS: Perspectives on the Future of Library and Information Science Education.

[16] "The term 'personal digital archiving' refers to how individuals manage or keep track of their digital files, where they store them, and how these files are described and organised.", Redwine, Gabriella. "Personal Digital Archiving" DCP Technology Watch Report 15-01, December 2015, Digital Preservation Coalition, http://dx.doi.org/10.7207/twr15-01 (accessed January 2017), p. 2.

world appeared when they accepted personal digital archiving (PDA) conception and harnessed their theoretical knowledge to address PDA challenges. PDA represents a new type of archival fonds or accumulation because it differs from paper personal fonds.

How much knowledge we collect through the never-ending learning and practice makes us competent scientists and good professionals. If archivists will adopt these ICT-related opportunities, they will turn them to their strengths. That is why they have to be recognised and used for fine-tuning of curricula. The analysis of the archival science programmes and their courses in the two presented research studies showed the positive developments. In our opinion, the contemporary archival science programmes should continue adjusting to technological reality. Faculties and archival schools should embrace the new technologies and educate future archivists about them. Consequently, the archivists would be able to bring the needed changes to the archival practice, users' preservation capabilities and the digital meta-literacy related to the preservation in general.

LITERATURE

[1] Wells, Joyce. "10 Lessons learned from 10 years of cloud services", Database trends and applications. May 11, 2016, http://www.dbta.com/Editorial/News-Flashes/10-Lessons-Learned-from-10-Years-of-Cloud-Services-111020.aspx (accessed January 2017)

[2] ISO 14721:2012 Space data and information transfer systems -- Open archival information system -- Reference model

[3] ISO 20104:2015 Space data and information transfer systems -- Producer-Archive Interface Specification (PAIS)

[4] ISO 20652:2006 Space data and information transfer systems -- Producer-archive interface -- Methodology abstract standard (PAIMAS)

[5] ISO 13527:2010 Space data and information transfer systems -- XML formatted data unit (XFDU) structure and construction rules

[6] ISO 16363:2012 Space data and information transfer systems -- Audit and certification of trustworthy digital repositories

[7] Harris, R. "Blu-rey vs HD DVD: Game over", Storage bits, 20.6.2007, http://www.zdnet.com/article/blu-ray-vs-hd-dvd-game-over/ (accessed January 2017)

[8] Harris, R. "Holographic storage bites the dust", 18.2.2010. http://www.zdnet.com/article/holographic-storage-bites-the-dust/ (accessed January 2017)

[9] Gilbert, M. R.; Shegda, K. M.; Chin, K.; Tay, G.; Koehler-Kruener, H. "Magic quadrant for enterprise content management", September 2014, Gartner Inc.

[10] Koehler-Kruener, H.; Chin, K.; Hobert, K.A. "Magic quadrant for enterprise content management", October 2015, Gartner Inc.

[11] Hobert, K.A.; Tay, G.; Mariano, J. "Magic quadrant for enterprise content management", October 2016, Gartner Inc.

[12] Staimer, M. "Defining the software-defined storage market. Techtarget", 4.3.2016, http://searchstorage.techtarget.com/feature/Defining-the-software-defined-storage-market (accessed December 2016)

[13] International Council of Archives. Records in Contexts – A Conceptual Model for Archival Description. Consultation Draft v.01, September 2016. http://www.ica.org/en/egad-ric-conceptual-model (accessed October 2016).

[14] Stančić, H.; Rajh, A.; Crnković, K. "Mapirani metapodaci arhivskih, knjižničarskih i muzeoloških normi i interdisciplinarne platforme", Arhivi, knjižnice, muzeji 20, presentation held 24.11.2016 (manuscript in print).

[15] Robinson, I.; Webber, J.; Eifrem, E. "Graph Databases". O'Reilly Media Inc., 2015, p. 7.

[16] Rajh, Arian; Meze, Krešimir. "A Domain-Specific Records Management and Information Governance Solution Designed to Support the Implementation of the General International Standard Archival Description" // INFuture 2013: Information Governance / Gilliland, Anne; McKemmish, Sue; Stančić, Hrvoje; Seljan, Sanja; Lasić-Lazić, Jadranka (ur.). Zagreb: Odsjek za informacijske znanosti, Filozofski fakultet Sveučilišta u Zagrebu, 2013, pp. 51-61.

[17] "DIRKS manual", NSW State Records and Archives. https://www.records.nsw.gov.au/recordkeeping/advice/dirks-manual (accessed January 2017)

[18] Yakel, Elisabeth. "Educating archival professionals in the twenty first century" // OCLC Systems & Services 20(4):152-154, December 2004

[19] Couture, Carol. "Education and research in archival science: General tendencies"// Archival Science 1(2):157-182, June 2001

[20] Lučić, Melina. "Obrazovanje arhivista i spisovoditelja za novo okruženje: praksa u svijetu i izgledi u Hrvatskoj" // *Arhivski vjesnik, (44)*2001, pp. 33-42. (http://hrcak.srce.hr/9307, accessed January 2017)

[21] Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0910&from=EN (accessed January 2017).

[22] InterPARES 3 project. http://www.interpares.org/ip3/ip3_products.cfm (accessed January 2017)

[23] Duranti, Luciana "Diplomatics: New Uses for an Old Science - Part V." // *Archivaria 32* (Summer 1991)

[24] Duranti, Luciana; Franks, Patricia C. (ed.) Encyclopedia of Archival Science, Rowman & Littlefield, 2015

[25] International Council on Archives, "Dictionary of Archival Terminology" (Draft Third Edition/DAT III, 1999)

[26] Multilingual Archival Terminology, http://www.ciscra.org/

[27] Pearce-Moses, Richard. "A Glossary of archival and Records Terminology", The Society of American Archivists, 2005 (http://www2.archivists.org/glossary)

[28] Marciano, Lemieux, Hedges, Esteva, Underwood, Kurtz, Conrad . "Archival records and training in the Age of Big Data" (Draft submitted Oct. 2016) // Sarin, Lindsay C.; Percell, Johanna; Jaeger, Paul T.; Bertot, John C. (ed.) *Advances in Librarianship – Re-Envisioning the MLIS: Perspectives on the Future of Library and Information Science Education.* http://dcicblog.umd.edu/cas/wp-content/uploads/sites/13/2016/05/submission_final_draft.pdf (accessed March 2017)

[29] Redwine, Gabriella. "Personal Digital Archiving", DCP Technology Watch Report 15-01, December 2015, Digital Preservation Coalition, http://dx.doi.org/10.7207/twr15-01 (accessed January 2017)