Archeologia e Calcolatori
20, 2009, 247-259

DIGITIZATION AS A SCIENCE

1. Introduction

The birth of this article is closely related to the processes that have been going on for the past few decades that have brought about changes in the Humanities and have influenced the activities of institutions involved in the Humanities and the practical activities arising from them. These processes include the formation of a network society (Castells 2005), the birth of new paradigms in science theory, the development of interdisciplinarity among sciences, the increased need for education in the Humanities and the development of digital technologies.

The situation is perhaps chiefly characterized by the digital technologies developed over the past few decades that are increasingly influencing all aspects of human life. These technologies provide new means of documentation and communication, and offer opportunities to create new methods of scientific research and models of practical activity in order to optimize pre-existing methods of scientific research as well as to develop interdisciplinary research. They change the processes of accumulation, storage, accounting, study of sources of the Humanities and the spreading of scientific information. At the same time, the role of the Humanities, institutions and researchers in these processes changes as well as the attitude of society towards science and the institutions fostering it. However, many problems related to the practical aspects of digitization[1] have yet to be solved.

We can affirm that one of the most important sources of these problems is the lack of scientific research on digitization. In many countries digitization is basically perceived just as a practical field of activity and it is conducted only on a practical basis[2]. Following this approach, the impression is created

[1] The term "digitization" is mostly used in this work in the sense of application of computer technologies in the environment of cultural heritage, the Humanities and Social Sciences. On the one hand, application of digital technologies in natural (not man made) spaces is sufficiently studied in the contexts of other sciences; on the other hand, explication of the study results of this article beyond cultural (man made) spaces would be incorrect considering the basic education of the author. Moreover, it seems that digitization is becoming a practical and scientific problem namely in cultural (man made) space. But, of course, application of some conclusions given in the article is also possible beyond cultural spaces.

[2] In different countries the relationship between digitization practice and scientific research and the relationship between self-educated persons and professionals participating in digitization is different and depends on the general level of digitization of the cultural heritage in the country. In late 2006-early 2007, during the "Digital Preservation Europe" project a comparison of the situation of scientific research on digitization of cultural heritage in different countries was made. The study

that no specific theoretical knowledge is necessary for digitization and that this can be done by any specialist who has at least elementary training on how to press the buttons on a scanner or digital camera. Therefore, some digitization projects having poorer resources and less-skilled staff become a mere scanning of analogical documents and, after a project is completed, even its users hardly know what they should do with the scanned images since they are not linked to each other by any structure, their scanning resolution and file formats are different, and no plans for long-term storage or further project development are foreseen strategically.

Broader approaches are much more suitable when:

1) Digitization is considered to be a method suitable for documentation, storage, scientific research, communication. If digitization is considered to be a method then, along with its practical application, it can also be comprehensible in the context of scientific research where the basis of scientific research is a method theory (Popper 1959). For instance, methods like mathematical statistics are already included in the Classification of Study and Research Areas, Fields and Branches.
2) Another case in which we may identify a scientific character in digitization, is the empirical and experimental fixing of objective phenomenon of reality that could be investigated by this new science. In this way, the sciences which originated from the practical activities of "memory institutions" – libraries, archives, museums – are defined. Nowadays they are also acknowledged as independent research disciplines and academic subjects.

Consequently, the subject of this article is digitization as scientific research. The aim is to provide the answers to the following questions: can digitization be comprehended as a kind of scientific research? What is the purpose of scientific research on digitization? Can the science of digitization have special terminology and methods?

2. Digitization as a science?

This article will not study any conceptions or paradigms of modern science. There is plenty of special literature on this subject (Popper 2001; Chalmers 2005). For a description of digitization as a science we will use, first of all, the aforementioned theoretical model, according to which the

showed that Lithuania, Serbia and Turkey fall into the last but one cluster. Only Bulgaria, Latvia and Ukraine are worse (in the last cluster). Absolute leader in this field is the United Kingdom. Germany and Holland are in the second cluster (Laužikas 2007). In these European countries, as well as in the USA and Australia, scientific research (especially applied research) on digitization is at a high level. The most tangible results include scientifically reasonable references, rules, and standards intended for digitization practitioners as well as methods and training programs in Universities.

process of conversion of digitization, as a practical activity, into scientific research may be analyzed and described in the same way as the conversion of museum studies, as the field of practical activity, into museology. That is, due to certain specific practical activities, objective and empirically observable phenomenon emerges and scientific research is necessary to perceive it. Therefore, descriptions of the object of scientific research on digitization given in this section are based on Friedrich Waidacher's model for the definition of museology (Waidacher 2007). Waidacher's approach is basically positive, and is founded on the concept that only phenomena soundly based on empirical and experimental experience may be called scientific. Naturally, the model of development of museum studies, as a practical activity, in the science of museology may only hypothetically be applied to modelling the development of other practical activities towards a science. Therefore, we will try to further analyze the concepts introduced into the field of theories of other areas of science as well.

2.1 *Occurrence of a scientific problem*

In order to answer the question of when a practical field of activity becomes a science, first of all we have to determine whether its adequate development, solution of its practical problems «requires theoretical knowledge meeting the highest standards of development in that field» because theoretical knowledge «helps to assess empirical data, to scrap emotional ballast, to foresee proper methods for problem solving» (Waidacher 2007). Are there any problems in digitization, as a practical activity, the solving of which requires theoretical knowledge? In this case we should give an affirmative answer. Consequently, digitization, as a practical field of activity, acquires the features of a science. Therefore, in the following paragraphs we will try to describe the subject of digitization as scientific research, to give its definition, its links to other sciences and practical activities, and the issues of terminology and methods.

2.2 *Possible object of the science of digitization*

The object of the science of digitization would be an objective field of reality, as a part of general cognition, that originated from the practical application of digital technologies and that is determined and studied empirically and experimentally by digitization as a science.

At first sight, it may seem that the object is obviously the applied aspects of computerized science because it is a new field of reality that did not exist before computers came into existence. On this basis, the definition of so-called e-Science was created (*Defining e-Science* 2008). But it is clear that, regardless of whether we use a computer or not, the object of a specific science (history,

archaeology, museology) and its problems remain the same. Only the aspects of information management change. Information systems grounded on digital technologies work like a tool to serve the needs of a scientific discipline and expand its methodological base, but this does not necessarily give rise to a new science ("digital history", "digital archaeology").

Other potential objects are "born digital" and "digitized" data. They also did not exist before computers came into existence. In this case, born digital data, i.e. data existing entirely in the digital environment and having no equivalents in an analogue world, should be mentioned. However, data and information have always existed and became a subject of scientific research on information and communication a long time ago. From the scientific standpoint of a process as well as the semiotic school, we can find few differences between the data functioning in analogue and digital environment. This situation is explained quite well and its scientific character "eliminated" by Arkadij Sokolov's theory of "the effect of information glasses" (Соколов 2002).

One more aspect that could be an object is the methods applied to the practical activity of digitization. But the methods are general, borrowed from the sciences of mathematics, mathematical statistics, informatics and computer science. After all, it does not make much difference whether a three-dimensional scanner is used for making a geodetic topographic survey or for scanning a heritage object; similarly, calculation of correlation coefficients for astronomical and historical data and calculation of the same correlation made by hand on paper and by computer do not differ methodologically.

Therefore, what is the field of reality suitable for potential scientific research, which is studied by digitization? It is already clear that the aforementioned elements – digital tools, institutions, hardware and software, methods, data, information, people, etc. – are not intrinsically separate objects of research on digitization as a science and they may be equally successfully analyzed. They are present not only in the environment of cultural heritage and the Humanities but in natural, technological environments as well and not only in digital but also in analogue environments. But it is relevant for us that in the practical activity of digitization they are not present separately but as a closed set of interrelated elements. Therefore, what remains to be done is to explore their relation that may be an actual object of research on digitization as a science.

This relation (and the object of research on digitization as a science at the same time) may be called *emulativity*. In digitization, it is a specific relation between man and reality when people select from reality and/or artificially generate the objects, on the basis of which they create emulative systems in a digital environment, emulating and imitating the activity of natural systems operating in reality (that operated in the past or will operate in future). Emulativity is a specific phenomenon induced by digital technologies, virtual

world and Internet and may be studied in many ways including personality psychology.[3] but in this article we will limit our comments to that part of emulativity which is related to the application of computer technologies to creation[4], heritage protection, the Humanities and Social Sciences; we will study theoretical interpretations and practical realizations of emulativity in the above mentioned fields only.

It is important to note that emulative systems are not copies of systems existing in reality; but are as independent, dynamic and freely evolving as the systems of reality that they emulate These systems have all the features of evolving systems determined by Ilya Prigogine (Пригожин, Стенгерс 1986; Пригожин 2002; Prigogine 2006):

a) these systems evolve;
b) evolution of systems is based on an objective time line which ensures irreversibility of processes;
c) variability of system components which lasts for a long time causes changes in the whole system;
d) evolution of a system is a process that can be forecast only in part;
e) sometimes an evolving system experiences disturbances that change it essentially (system mutations);
f) the smoother the system is, the higher its level of self-organization and the less it responds to mutational effect;
g) both systems (that of reality and emulative) evolve at different speeds;
h) two systems (that of reality and emulative), the evolution of which started in different points of space and time, increasingly recede from each other;
i) two systems (that of reality and emulative) are not inter-integrating.

In this context, the emulative system appears to be a *perdurant* object[5] while digitization as a science (thanks to digital technologies, by the way) acquires the latest paradigm defined by I. Prigogine; it is not confined to ideal-

[3] Where personality psychology is mentioned, psychological phenomena caused by activity in virtual media typical of many modern people (such as transfer of a part of real life or personality into virtual environments) are kept in mind (Suler 2004).

[4] Creation and creativeness in this article are perceived not in the classic sense – like an artistic activity of some kind – but in the widest sense – like any creating activity by a man, an individual's inclination to new, original or innovatory arrangement, modelling or thinking of something, thanks to which new things are born from knowledge and experience.

[5] Endurantism and perdurantism are two opposing philosophical theories investigating persistence of objects with regard to time and they were formed during the last decades of the 20th century. Endurantists affirm that objects are three-dimensional entities, they have spatial parts and wholly exist at each moment of their existence. Perdurantists affirm that objects are four-dimensional entities (the fourth dimension and component of objects is time) and they exist at each moment of their existence only partially. The origin of these philosophical theories may be linked to A. Einstein's general and special relativities. Endurantism is more suitable for Newton's descriptive space of physics and it is problematic in description of Einstein's space-time objects (Hales, Johnson 2003).

ized and simplified situations but seeks to reflect and cognize the complexity of the real world through emulative systems (Prigogine 2006).

Consequently, the object of digitization, like museology, applied to creation, heritage protection, the Humanities and Social Sciences is immaterial and independent of changes in digital technologies, institutional, legal or otherwise. Technologies may only help or disturb the implementation of emulativity.

But emulativity of cultural heritage, like an object of the science of museology-museality, is related with material, reality witnessing objects that, on the basis of appropriate theoretical assumptions, are selected and transferred to a museum or digital emulative system. Objectification of museality as well as of emulativity is conducted by interaction with material objects. But in this case emulativity has one essential feature, which makes it different from museality. In museology the object is taken from reality, is transferred to a museum and becomes an exhibit. During this process the utilitarian function of the object vanishes and the museum function appears and increases (Mensch 1992). Whereas during the process of digitization, neither the object itself nor its copy is transferred to the emulative system, but the emulant, which operates in other, artificial, non-reality system, is created by means of recoding on the basis of the object existing in reality. This problem is related to the treatment of the relation of the new object, like sign (in the sense of semiotics), existing in other systems with an object of reality.

In museology, treatment of an exhibit (the new object) as an icon is more acceptable, i.e. it is a denotation (Peirce 1894). Whereas digitization of cultural heritage is a transfer of data of an object existing in reality to another, artificial system by means of recoding. During the recoding conversion of the analogue system into the discrete system what usually causes the increase in the level of data structuralization occurs, but there is an unavoidable loss of data. The quantity of the lost data depends on the intensity of simplification or idealization of the emulative system being created compared to the system existing in reality. Consequently, the emulant is by no means an iconic sign. We can assert that it is an index because its links with an object of reality are direct rather than conventional as it would have to be if an emulant were a sign of a symbolic nature (Peirce 1894). Regardless of the option of digitization technology: the object's digital photograph (index I is created), three-dimensional scanning (index II is created) or the description by database fields (index III is created) even if we do not belong to any cultural or subcultural group creating conventional symbols, we will be able to recognize easily that the digitized object of reality is, for example, a car and not a house.

2.3 *Possible trends of scientific research on digitization*

Emulativity phenomenon may be studied from different aspects – historical, philosophical, sociological, psychological, fundamental, applied, etc. This

fact lays the foundations for the systematization of digitization as a science. We can exclude historical, fundamental and applied research on digitization. Historical research is a type of research, the goal of which is to establish the alternation of emulativity like phenomenon and other objects and processes related to this phenomenon in time and its influence on public life. Basically, it answers the following questions: Who/what? Where? When? What were they doing? Why? What were the after-effects? Fundamental research is an experimental and theoretical activity seeking to recognize the essence of emulativity as a phenomenon of reality without having any intention at the time of using the results for any specific purpose. One of the goals of fundamental research is to systemize the field of reality by conceptions, to formulate general conclusions and trace the consistent patterns. Applied research is experimental and theoretical works of cognition are intended for the achievement of specific practical goals of digitization and for solving practical tasks of digitization. Applied research creates the conditions for the application of results of fundamental research[6] to a specific activity of digitization.

More serious historical or fundamental research on digitization requires significant human resources and many research sources. This kind of full research is possible in the countries where the digitization of the scientific data of cultural heritage and of the Humanities, like a practical activity, has been conducted for a long time (for 30-40 years) and where application of digital technologies in the fields of cultural heritage and the Humanities has been a separate academic subject or even a separate university specialty for at least two decades (in the United Kingdom, Italy, France, USA, Australia, Germany, etc.).

In other countries it is more meaningful to conduct applied research on digitization science, i.e. about digital documentation, studies, communication. This kind of research should solve practical problems of digitization, seek practical goals and give methodical instructions.

2.4 *Interdisciplinarity of research on digitization*

On the basis of the inductive theory of science conception we can affirm that in the modern world there exists new, objective, empirically fixable and experimentally approvable phenomenon induced by the development of digital technologies that may be called emulativity. This phenomenon is a basis for the origin of scientific research on digitization and becomes an object of such research. During the study of the phenomenon of emulativity interdisciplinary field of knowledge on this phenomenon appears and interdisciplinary scientific theories are created on the basis of the accrued knowledge.

[6] The definitions of fundamental and applied research are formulated on the basis of the terms of the Law on Science and Studies of the Republic of Lithuania.

There are, therefore, no doubts that digitization research is interdisciplinary. First of all, it is linked by general relations with specific sciences investigating the groups of emulated objects in the real environment as well as with practical activities (librarianship, archivistics, museology, history, archaeology, heritage protection, etc.). Another large group of general relations is that with information and computer sciences. Through the links with these sciences, the technological possibilities of the practical application of emulativity are analysed. Models of the efficient interaction of specialists in information technologies and the Humanities that ensure the origin of high-quality emulative systems are created. In concrete fields of applied research there appear to be specific relations with some concrete sciences or practical activities. In fact, when analyzing the scientific data of digital sciences of heritage and the Humanities from the applied point of view, we cannot avoid links with mathematical statistics, science methodology, content analysis, etc.; since they are necessary for recoding, information management and communication links with semiotics, sciences of communication and information.

2.5 *Terminology of the science of digitization*

In the context of interdisciplinarity, the issue of the terminology of digitization as a science should be determined. Science usually uses three types of terms: classifiable, comparative and quantitative (Waidacher 2007). At first sight, it may seem that in the digitization of the sciences of cultural heritage and the Humanities we may not need a separate terminology because we can use the one which is approved by libraries, museums, archives and specialists in information technologies. But this is not so. A specific, scientifically reasonable terminology of digitization is being created and developed but, naturally, the development of terminology is closely related to the development of fundamental research on digitization which has not yet reached a sufficient level. Perhaps the most significant international example of terminology in this field is the 23 new terms described and used in ISO 21127:2006 standard "Information and documentation. A reference ontology for the interchange of cultural heritage information". Moreover, almost all major institutions conducting projects of digitization or digitization activities have constructed more or less extensive glossaries of digitization terms (*Preservation Solutions* 1998-2007; *NEDLIB* 1998-2008; *Reference Model* 2002; *UNESCO* 2003; *California Digital Library* 2005; *eSciDoc* 2007; *British Library Glossary* 2008; *CSA Glossary* 2008; *North Carolina ECHO* 2008).

2.6 *Methods of the science of digitization*

Moreover, an insufficiently defined situation can be seen when reviewing methods applied in digitization as a science. When talking about methods

we can give two basic opinions. The first involves the repudiation of separate methods in the science of digitization and the second, thinking that digitization may have specific methods of scientific research. The first opinion affirms that the methods of other researches related to heritage and information technologies are used in research on digitization. Historical research uses historical methods while fundamental and applied research use general methods (typical of many sciences) – empirical induction, theoretical critical deduction, etc. or the methods of separate, related sciences in the field of communication research – research of the sciences of communication and information and educology, expression of emulativity in society – sociology and psychology, etc. The second opinion supposes that new specific methods originating on the basis of interdisciplinarity and comparativism of sciences may be applied to the research of emulativity as a specific phenomenon of reality. We can affirm that a proper example of the group of such specific methods could be webometry – methods intended for studying digital emulative information offered in the Internet (Thelwall 2004).

However, the issue of scientific methods can also be dealt with in other contexts. Until now, classic, inductive theory of science conception was followed in the article. But we would be wrong if we did not try the emulativity theory (as existence of independent phenomenon which is a basis of digitization as a science) with other approaches towards science, for example, deductivistic falsifiability, one of Karl Raimund Popper's scientific theories.[7] According to Popper one of the most important requirements for the empirical theoretical system is its difference from other similar systems. This difference may be best determined through different specific methods applied to different systems. It can be affirmed that specific method is one of the most important criteria for describing science; therefore, epistemology of science may be identified with the theory of scientific method.

Popper suggests that we adopt conventional methodological rules that would ensure the verifiability (falsifiability) of scientific statements: empirical science may be described via its own methodological rules in the same way like a game of chess may be described via its own rules. Can we, in this context, treat the methodological rules determined by digital technologies as an example of methodological rules of primary universal level? Can we derive from them singular methodological rules of the secondary level? The answer could be affirmative. Methodological rules determined by digital technologies are justified by universal laws of mathematics and logic. But, at the same time, due to the application of digital technologies, they go beyond the limit of the sciences of mathematics and logic (as well as of information and computer science) and seep into other sciences and many fields of public

[7] This theory was enunciated for the first time in 1934 in K.R. Popper's book *Logik der Forschung* (*The Logic of Scientific Discovery*).

life. The spread of digital methodological rules do not significantly change the universal methodological assumptions of specific sciences (i.e. these rules do not destroy the formed system of sciences) but it influences and transforms the singular methods applied in these sciences.

In addition, Popper formulates three requirements which must be satisfied by a new scientific theory. First of all, a theory must originate from a simple, new, promising and enticing idea that allows us to determine relations among things that, at first sight, are unrelated. But a theory must be independently tested, i.e. it must explain not only already known facts but it should also make it possible to predict new, still unknown phenomena. And finally, a theory must withstand the new and strict empirical and experimental tests in the future (this is the so-called empirical success of a theory). If singular forecasts created by the deductive method on the basis of a universal theory are not proved in the future empirically and experimentally, these forecasts are non-falsifiable which means that the universal theory, from which these forecasts originated in a logical manner, is non-falsifiable too. Consequently, the theory is rejected. The theory of existence of emulativity phenomenon perfectly satisfies the first two requirements. Acknowledgment of this phenomenon allows us to determine universal relations among many different things starting with an individual's psychology and ending with phenomena generated by globalization. Due to strictly mathematically and logically motivated technological emulativity basis – digital technologies – all singular propositions, hypotheses and forecasts originated from this theory are empirically and experimentally tested. But the ability of a theory to stand up against the third requirement may only be guessed.

3. Conclusions

1) In many countries digitization is basically perceived just as a practical field of activity and it is performed according to this perception. We suggest that a broader approach would be more suitable by investigating the scientific character of digitization.
2) Digitization is considered to be a method suitable for documentation, storage, scientific research, and communication. If digitization is considered to be a method, then, next to its practical application, it can also be comprehensible in the context of scientific research where the basis of scientific research is a method theory. For instance, methods like mathematical statistics are already included in the Classification of Study and Research Areas, Fields and Branches.
3) Another case where we could search for the scientific character of digitization is empirical and experimental fixing of objective phenomenon of reality that could be investigated by the new science. According to this concept, sciences which originated from the practical activity of "memory institutions" like

libraries, archives and museums are defined. They are now also acknowledged as independent research disciplines and subjects of academic studies.
4) The object of digitization research may be called *emulativity*. In digitization it is a specific relation between man and reality when people, on the basis of special criteria, select from reality and/or artificially generate the objects, on the basis of which they create emulative systems in a digital environment emulating and imitating the activity of natural systems operating in reality (that operated in the past or will operate in future). Emulativity is a specific phenomenon induced by digital technologies, virtual world and Internet and may be studied in many senses including personality psychology.
5) Emulativity phenomenon may be studied from different aspects – historical, philosophical, sociological, psychological, fundamental, applied, etc. This lays the foundations for the systematization of digitization as a science.

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ABSTRACT

The purpose of this paper is to give answers to the following questions: can digitization be comprehended as a kind of scientific research? What is the possible object of scientific research on digitization? Can the science of digitization have a particular terminology and methods? The paper focuses also on the discussion about the object of digitization research which may be called *emulativity*, i.e. a specific phenomenon induced by digital technologies, the virtual world and the Internet which may be studied in many senses including personality psychology. Possible trends of scientific research on digitization, interdisciplinarity, terminology and methods of the science of digitization are also discussed, from the perspective of digitization as a science. In many countries digitization is basically perceived as just a practical field of activity and performed according to this perception. We suggest that a broader approach would be more suitable by investigating the scientific character of digitization, aimed at the empirical and experimental fixing of objective phenomenon of reality that could be investigated by the new science.