STANDARDS IN CULTURAL HERITAGE: THE MISSING GRAMMAR FOR THE DIGITAL DOCUMENTATION OF THE PAST

M. Ioannides[1], A. Georgopoulos[2], M. Scherer[3]

[1]HTI, P.O.Box 20423, CY-2152 Nicosia, Cyprus, gammat@cytanet.com.cy
[2]NTUA, Iroon Polytechniou 9, GR-15780 Athens, Greece, drag@central.ntua.gr
[3]Geodäsie im Bauwesen, Ruhr-Universität Bochum, Building IA 4/49, D-44780 Bochum, Germany, michael.scherer@ruhr-uni-bochum.de

KEYWORDS: Standards, Specification, Documentation, Archiving, Databases, Monitoring, Archaeology

ABSTRACT:

Information Technology (IT) is traditionally used in most scientific and engineering areas of study, where standards/guidelines already exist to a certain level. Many Cultural Heritage (CH) experts recognize an initial advantage of IT in their field. The revolution and *e-volution* of IT and the continuous expansion of this technology has set the experts of Cultural Heritage (archaeologists, restorators, renovators, civil engineers, architects, surveyors, chemists, physicists, the engineers), under massive pressure to become familiar with and use the computer technology available. These experts have begun to take advantage of IT because the data and information can be reliably read, sorted, indexed, manipulated, retrieved and communicated between different compatible and incompatible systems nationally and internationally. Due to unorganized and non standardised methods of use of these IT-tools, the achieved results are predominantly incompatible for different systems, presentations and future use. "Island solutions" have emerged limiting the study area of the researcher which leads to the incompatibility of cataloguing, archiving, presenting, visualizing and conserving archaeological documents, artefacts, monuments and sites in a unified worldwide format. This situation is a part of the result of funded EU, UNESCO, ICOMOS and other projects which achieved good results, but were not planned for future use in a European albeit worldwide context. It is a fact that there has been *total lack* of global specifications for recording and documenting monuments and artefacts and in general any CH item using traditional or modern technological methods. Monuments, for example, are quite diverse and hence each one should be recorded with its own specifications. On the other hand, specific, unified, worldwide standards/guidelines of general acceptance must be proposed, developed, introduced, applied, tested, accepted and adopted in order to enable specialists all over the world to address this problem with a unified approach for the benefit of CH.

A standard, in Information Technology, can be defined as a set of regulations (*the Grammar*) for *the guarantee of the correct development and protection of the long-term value of digital data* for the storage, exchange, sharing, searching, visualizing/presenting and retrieval of information between different users/professionals around the world using the global computer network (Internet) and different hardware and software structures. These standards/guidelines can help all experts involved in the cultural heritage area in the restoration/ renovation/ protection/ documentation/ archiving/monitoring of the history of mankind and secure this for the future (e-Libraries, e-Museums, etc). *Standards are necessary for an uncomplicated exchange of information today and for the guarantee of the protection of the long –term value of digital data/ knowledge in the future.*

In this paper a proposal for approaching the standards of modern technological advances in CH recording as well as documenting/monitoring is also attempted, with the hope that it will lead to a widely accepted vision for the standardization of such methods.

1. INTRODUCTION

Standards make an enormous contribution to most aspects of our lives - although very often that contribution is invisible. It is only when there is an absence of standards that their importance is brought home. For example, as purchasers or users of products, we soon notice when they turn out to be of poor quality, do not fit, are incompatible with equipment we already have, unreliable or even dangerous. When products meet our expectations, we tend to take this for granted. We are usually unaware of the role played by standards in raising levels of quality, safety, reliability, efficiency and interchangeability - as well as in providing such benefits at an economical cost.

When things go well - when systems, machinery and devices work well and safely - then it is because they conform to widely accepted guidelines. Furthermore, when the large majority of products or services in a particular business or industry sector conform to worldwide guidelines, a state of industry-wide standardization can be said to exist. This is achieved through consensus agreements between national delegations representing all the economic stakeholders concerned – i.e. suppliers, users, government regulators and other interest groups, such as consumers. They agree on specifications and criteria to be applied consistently in the classification of materials, in the manufacture and supply of products, in testing and analysis, in terminology and in the provision of services. In this way, international standards provide a reference framework, or a common technological language between suppliers and their customers - which facilitates trade and the transfer of technology, i.e.:

For businesses, the widespread adoption of standards means that suppliers can base the development of their products and services on specifications that have wide acceptance in their sectors. This, in turn, means that businesses using international standards are increasingly free to compete in many more markets around the world.

For customers, the worldwide compatibility of technology, which is achieved when products and services are based on international standards, brings them an increasingly wide choice of offers, and they also benefit from the effects of competition among suppliers.

For governments, standards provide the technological and scientific foundation underpinning quality, health, safety and environmental legislation.

For trade officials negotiating the emergence of regional and global markets, international standards create "a level playing field" for all competitors on those markets. The existence of divergent national or regional standards can create technical barriers to trade, even when there is political agreement to do away with restrictive import quotas and the like. International standards are the technical means by which political trade agreements can be put into practice.

For developing countries, standards that represent an international consensus on the state of the art constitute an important source of technological know-how. By defining the characteristics that products and services will be expected to meet on export markets, international standards give developing countries a basis for making the right decisions when investing their scarce resources and thus avoid squandering them.

For consumers, conformity of products and services to international standards provides assurance about their quality, safety and reliability.

For the environment we inhabit, standards on air; water; food and soil quality; and on emissions of gases and radiation, can contribute to efforts to preserve the environment.

For everyone, standards can contribute to the quality of life in general by ensuring that the transport, machinery and tools we use are safe (BDI, Digicult, ICOM-CIDOC, ICOMOS, Unensco 2002).

In respect to these standards which make our life easier worldwide, standards must also be applied in the scientific and historical world of CH on an international level.

Acknowledging the existing standardization efforts already implemented in the area of cultural heritage by several bodies, this paper will avoid stating commonplaces. Rather, the aim of this paper is to raise awareness regarding the emerging importance of standardization in CH on an international scale and aid in the effort to build the basis for an international voluntary consensus type standard.

Motivation for this effort is a result of years of collaboration of the authors in different areas of their expertise and cultural heritage, where the need for data acquisition, analysis, storing, sorting, indexing, retrieving, exchange, monitoring especially in the area of *geometric documentation* was identified.

2. HISTORICAL OVERVIEW

Some standards were an outgrowth of man's desire to harmonize his activities with important changes in the environment. Others were created in response to the needs of an increasingly complex society and trade.

2.1 Ancient Times

One of the earliest examples of standardization is the creation of a system to measure and manage the time, the so called *calendar*. Ancient civilizations relied upon the apparent motion of the sun, moon and stars through the sky to determine the appropriate time to plant and harvest crops, to celebrate holidays and to record important events. The Sumerians in the Tigris/Euphrates valley devised a calendar very similar to the one we use today 5,000 years ago. The Sumerian farmer used a calendar that divided the year into 30-day months. Each day was divided into 12 hours and each hour into 30 minutes. The Pharaohs were the first to develop the 365-day calendar and can be credited with logging 4236BC as the first year in recorded history. They based the year's measurement on the rising of the "Dog Star", or Sirius, every 365 days. This was an important event as it coincided with the annual inundation of the Nile, a yearly occurrence that enriched the soil used to plant the kingdom's crops (Neil J.).

Furthermore, two of the most fundamental, and important aspects to understand about Egyptian science, engineering and mathematics is how they measured lengths and angles. Measurement of areas and volumes were based on the basic standard length measurement of the cubit and angles were measured using a gradient technique called sekeds. Ancient Egyptian carpenters employed a sophisticated measuring system when setting out furniture. The standard unit of linear measurement used by carpenters was the 'royal cubit', which was based on the length of a man's forearm (Figure 1). Carpenters placed great importance in measurement to ensure accuracy and uniformity of furniture construction. Although these measurements were standardised, 'royal cubit rods' have been discovered, as one might expect, with an error of up to plus or minus 2 mm in overall length. Later on, King Henry I of England standardized measurement in 1120 AD by instituting the *ell*, which was equivalent to the length of his arm (Neil J., QA).

Figure 1 The relation between the royal cubit and the length of a man's forearm.

From different archaeological excavations and from other ancient documents and sources it is clear that in the Hellenistic time in Athens the Greeks used different kinds of standards as well.

2.1.1 The inscribed stele of Eleusis

This stele (4th Century (325) BC) is kept in the museum of Eleusis. Its text refers to a decree concerning the manufacture of bronze fittings known as "empolia" and "poloi" for the erection of the columns of the Philonian Stoa, named after the architect Philon. The decree comprises strict technical specifications and, therefore, constitutes one of the oldest European standards, concerning the chemical composition of bronze fittings: "That they be produced at Marion, the alloy be made of twelve parts, eleven of copper to one of tin". This appears to mean that the copper alloy should be imported from Marion of Cyprus, a very important commercial and metallurgical centre of that era. An inspector was directed, even at this time period, to apply an empirical procedure of quality control, in order to check whether the bronze composition was in conformity with the requirements of the above specifications (ELOT).

2.1.2 Quality control and certification of the Attic silver

An Athenian law inscribed on a white marble stele of the beginning of the 4^{th} century BC (375) and discovered at the ancient Agora of Athens in 1970, refers to the quality control of the Athenian silver coins. The inscription was studied originally by Professor Ronald S. Stroud. The law required that both Attic and foreign silver currency bearing the same label as the Attic should be tested by skilled public officers, the Dokimastes (the Testers). The existence of the latter signifies that quite a number of counterfeit silver coin were in circulation. Indeed this was the period soon after the Peloponnesian war when the economy had almost collapsed and silver production at Laurion had declined sharply. This decline was, probably, the reason why foreign silver currency bearing the same label as the Athenian coinage and imported into Athens by merchants, shipowners or Greek mercenaries from abroad was welcome; however, importation encouraged counterfeiters to circulate fake silver currency during this troubled period for Athen's economy (ELOT)

2.1.3 Certification and quality control of wine

Two inscribed steles containing three laws/directives pertaining to quality control are kept in the museum of Thasos. One of them dating to the beginning of the 5th century BC (480) refers to two important agricultural products: wine and vinegar. The inscription is fragmentary, and, therefore, the text is incomplete, since the stele is broken and certain parts are missing. Nevertheless, we can still discern the announcement of heavy penalties imposed by the state to violators of the law.

Another law/directive (420-400 BC) mentions that the sale of wine was only legal if the jars containing the wine had been sealed with its quality and age marked on the seal. This marking procedure offers ample evidence of a well organized public mechanism for the purposes of re-assuring consumers with regard to the quality of their wine purchases. This practice in quality wines is also followed in our times, not only to increase their price (ELOT).

2.1.4 European examples

A similar example is from ca. 700 years ago. King Henry III from England reached for a grain of wheat - one of the world's oldest standards - to settle for once and for all an equally ancient problem: "An English Penny, which is called Sterling, round without clipping, shall weigh 32 grains of wheat taken from the middle of the ear and dried. Twenty pence make an ounce, and 12 ounces make a pound, and 8 pounds make a gallon of wine" (QA)

Furthermore, the mathematician J. Kölbel suggested during the Middle Ages: "16 men tall and small", coming out from the church door one after the other after the mass, put their feet one behind the other. The sixteenth part of the whole length shall be one foot (J. Kölbel).

The following three figures illustrate ancient methods for the practical use of standard measurement methods which can still be found in use today.

Figure 2 Black figure amphora. Men weighing merchandise, Taleides 560 - 530 BC

Figure 3 Examples of standard weights used by merchants

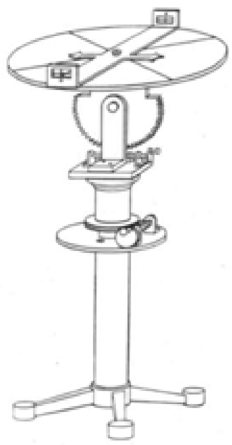

Figure 4 Reconstruction of Heron's dioptra from Schöne, Hero Alexandrinus. Heronis Alexandrini opera quae supersunt omnia. Vol. III: Rationes dimetiendi et commentation dioptrica. Griechisch und Deutsch H. Schöne. - Leipzig: B. G. Teubner, 1903

2.2 Modern Times

The smallest common denominator for communication between computers is the alphanumeric indications. However, mankind only used text and symbols for communication purposes in its history of the development of communication. This development began approximately 6,000 years ago in the Mesopotamian and Egyptian cultures. There significant indications were cut on clay boards and later left in the sun to dry. It is worth mentioning here that only those members of the dominant class as well as priests were allowed to read and write the pictogram indications.

Today the written word still remains as the most important cultural property of a society. Moreover the ability to read and write (following certain guidelines: the so called *grammar*) is essential for the transfer of information and knowledge and is viewed as an inalienable right for each citizen. Words and symbols in any form are seen as the most widely accepted communication system. Thus, it is not surprising that since the beginning of the computer era in the western world, a founding character set was established as a standard: The **A**merican **S**tandard **C**ode for **I**nformation processing and exchanges (ASCII). It is based on the principle of a clear allocation of each individual letter of the English and Greek alphabet to an individual sequence of zeros or ones: *a bit design.*

The ASCII code was the first 8-bit standard code that let characters - letters, numbers, punctuation, and other symbols (all the characters and symbols of a computer keyboard) - be represented by the same 8-bits on many different kinds of computers. Prior to ASCII each computer manufacturer tended to use his own code. IBM for example had EBCDIC. These might be ad hoc, based on a pattern of holes punched on cards, based on the pattern of holes punched in paper tape, or the sequence of bits transmitted by teletypes on the Telex (telegram) network. No single encoding could contain enough characters: for example, the European Union alone requires several different encodings to cover all its languages. Even for a single language like English no single encoding was adequate for all the letters, punctuation, and technical symbols in common use (ANSI).

These encoding systems also conflict with one another. That is, two encodings can use the same number for two *different* characters, or use different numbers for the *same* character. Any given computer (especially network computer servers) needs to support many different encodings; yet whenever data is passed between different encodings or platforms, that data always runs the risk of corruption. Out of the ASCII code in the 1990's a 16-bit code was developed that handled alphabets (characters) of many nations. This new code is known worldwide as *Unicode*. This kind of code provides a unique number for every character, no matter what the hardware platform, no matter what the software program, no matter what the language (Unicode).

Further to the universal use of ASCII code, at the end of the 1980's, the demand for the automatic scanning/reading of information concerning different objects (for example consumer goods), resulted in the development of the *bar code*. This kind of code is like a printed version of the *Morse code*, which was used as a standard in the area of telegraph communication. Different bar and space patterns are used to represent different characters. Sets of these patterns are grouped together to form a language (symbology) (Barcode).

3. THE USE OF STANDARDS

It is clear that standards are developed and used in order to contribute to society, and they play an important role. Groups of people sharing common interests and living in a common society not only see standards as a way to protect their own interests, but also as a way to overcome barriers and find common methods to work together in different areas such as trade, industry, health and environment in order to reach common goals.

One of the most important results for the implementation of the free market was the standardization of rules and regulations as well as the standardization of the quality of goods (an excellent example being the establishment of the European Union Common Market after World War II). Decades later the enlargement of the EU initiated another wave of standardization in that the ten new partner states had to implement a national standard institution before their entrance into the European Union on May 1, 2004. Moreover, 51% of all ECN standards had to be introduced and implemented in the ten new partner countries. This was a very large and almost insurmountable challenge, however, this ensured a common element within the EU and created a common role for harmonization and communication between all EU member states (for example the implementation of EU directives). A few examples from everyday life could be the standards currently applied in food production, health, household appliances, environment or the agricultural industry (EU).

3.1 Definition of Standard

A standard is a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, norm or definition. Standards help to make life simpler and to increase the reliability and the effectiveness of many goods and services we use. They are a summary of best practice and are created by bringing together the experience and expertise of all interested parties – the producers, sellers, buyers, users and regulators of a particular material, product, process or service.

Standards are designed for mandatory and/or voluntary use and do not impose any regulations. However, directives, laws and regulations may refer to certain standards and make compliance with them compulsory. For example, the physical characteristics and data format of credit cards is set out in a document number EN ISO/IEC 7810:1996. Adhering to this standard means that the cards can be read and used worldwide.

3.1.1 Disadvantages

Standards are often developed, but not always appropriately put into action. There may be a number of reasons for this, such as:

Bad experiences with standards: Organisations may have sought to implement standards in the past and experienced difficulties, which may have been costly. Two important examples are the negative experience from the introduction of office automation using international IT standards during the 90's and the newly EU-wide initiation of e-Government/e-Europe using open Web- and database standards.

Lack of awareness of standards: There is a danger that although awareness of standards may be widespread amongst certain sectors of the world development community, other developers may have a focus on development applications and not the underlying standards they support.

Difficulties in monitoring compliance: Even in cases in which there is an awareness of the importance of international standards and a commitment to their use we can find that the

Factor	Question
Ownership	Is the standard owned by a recognised national or international neutral open standards body or by a private/public profit company?
Development process	Is there an independent open and clear community process for development of a proprietary standard?
Availability	Has the proprietary standard been published openly?
Costs	a) Is the standard available on free of charge (on InterNet) or is it payable? b) How much does it cost to use it?
Authoring tools	Are authoring tools (a) available for free, (b) available as open source and (c) available on multiple platforms?
Fitness for purposes	Is the standard appropriate for the purpose envisaged?
Resource implications	What are the resource implications in making use of the standard?
Complexity	How complex is the standard?
Compatibility	Flexibility and/or adaptability of the standard to be used?
Interoperability	How interoperable is the standard?
Ease of long term preservation	Is the standard suitable for long term preservation?
Organisational culture	Is the organisational culture appropriate for use of the standard?
Approaches to migration	What approaches can be taken to migrating to more appropriate standards in the future?
Approaches to assessing compliance	What approaches can be taken to measuring compliance?

Table 1: A decision matrix for use when choosing standards

industry or nations fail to comply with standards. This may be due to the difficulties in monitoring compliance with standards.
Limitations of the quality: Often many industrial goods fail to comply with international quality standards because of the high price for their design, production and testing.
Maturity of standards: Although some organisations may welcome the opportunity to be early adopters of new standards, others may not wish to make use of new standards until they have been adequately tested and a wide range of tools which support the standards are available.
The difference between developed and non developed countries concerning standards (the gap) is that the process from the adoption and implementation of standards up to their monitoring and quality assurance in the praxis is a very expensive and timely course of action for the latter. Furthermore, a national infrastructure must be present in order for a developing country to at least adopt international standards into their society to ensure representation worldwide (Kelly B. et al. 2002).

3.2 Possible Strategies

It is well known that in the area of Cultural Heritage all the involved parties know what the benefits of using international standards are. However, many organisations are simply not complying with standards such as in the area of e-documentation, e-monitoring of sites/monuments/artefacts, e-Libraries and e-Museums. Possible strategies to improve the situation are listed below:

Lobbying for Open Standards: The traditional approach is to attempt to argue more persuasively for open standards. This is the approach taken by the International Committee for Documentation of the International Council of Museums (ICOM-CIDOC) which acts as the development as well as a lobby and promoting organisation for use of standards in CH.
Stricter guidelines and enforcement: Another approach to the lack or failure to comply with international standards is to provide stricter guidelines and to mandate compliance with norms. For example, the New Zealand Government Web Guidelines (New Zealand) state that “The primary format for all content available on government websites must be on standard HTML. The HTML must validate to the HTML 4.01 transitional specification or earlier HTML specifications.” In the area of CH such a stricter guideline could come from UNESCO, ICOMOS and/or ICOM.

It is felt that there are several factors that can be helpful and should be addressed when choosing a standard. Table 1 illustrates important points that a professional has to take into consideration.

4. DEVELOPMENT OF THE *CULTURE* TO INITIATE STANDARDIZATION IN CULTURAL HERITAGE

National CH organizations can be active by participating in national standard institutions. As a first step they can gather information, and then receive training concerning procedures, regulations, and/or how a standard can be created. Secondly, if there are any conflicts with other standards relating to their professional activities, they can then begin promoting their interests within an organizing subcommittee. In this way they can promote and develop their own national norms. Once this is accomplished they can set in motion their standards at international institutions like CEN or ISO. A result of this active participation is that an international compatibility and harmonization in the area of CH can be achieved.

An important alternative to the above mentioned procedure is a *top-down* approach: involvement/participation of UNESCO, ICOMOS and other institutions active in CH as silent partners/observers in the ISO and CEN to learn about the standardization system. Later, these organizations can be active and promote their interests under the umbrella of these institutions as well.

The young generation of scientists should intensively learn about the advantages and disadvantages of standardization throughout their university (implementation of new syllabi and curricula) and research career. It must be emphasized at this point that they should acquire a compatible, global mass of information and knowledge in order to present a fair and well assessed picture of the results of standardization in their own countries.

A campaign from leading international institutions can lead to detailed and well informed public officials and private institutions involved in the area of CH concerning the disadvantages of not having a common documentation and archiving system as well as the lack of fundamental norms for the correct renovation and restoration of CH objects.

Legislation then has to be initiated so that in the 25 EU countries national bodies exist for standards, ISO independent. In this way all interested parties from end users, contractors, academia, foundations/institutions and/or national agencies, up to instrument manufacturers will be involved in the dissemination and follow with their consent.

The international institutions can then contribute to the quality assurance of digital documentation (e-libraries, GIS) and the monitoring/maintenance of sites/monuments/artefacts on a national as well as international level.

4.1 Difficulties as a result of not using/following regulations/guidelines/standards

A human being who does not know the alphabet is called illiterate. A similar definition is the inability of a human being to read and write. The state of the art of many technological implementations in CH in the area of digital documentation, archiving and visualisation/presentation do not follow international standards. Therefore, the collected data presented in studies is not available worldwide because these particular systems run according to individual needs, different data structures and data bank systems. Thus, any person wishing to access the data concerning CH objects, monuments and sites will have a similar experience as an illiterate person because the particular information can not be read by any other source/system other than its own (island solution).

In addition to this, the process used for saving data also causes a problem. For example, data will be saved on data memory media and due to the advancement of IT this data will no longer be accessible because of obsolete technology, i.e. the first floppy diskettes/magnetic tapes. The advancement of internet browsers also prevents the reading of older data. Similarly, there is a lack of a monitoring process that follows the documentation or restoration of a CH objects / sites / monuments. This leads to situations which are not necessarily under a controlled environment.

Another problem when scanning a CH object is that in many cases the customer is only interested in the design- drawing for documentation and reproduction purposes, but shows little interest, if any, of storing and/ or archiving the raw data (i.e. geometric describing data or even background-data, such as raw measurements, original photographs, initial scans), which are actually essential for monitoring purposes. On such data a future study or even a monitoring process may be based, hence they are extremely significant. Their systematic storage and recording in a thorough data base is of utmost importance (Tapinaki et al. 2005). Consequently, the recorded data then serves only to reach a narrowly encircled aim.

When the raw data is available and the monitoring process is intact, the value of CH also increases because the object/monument/site is then measurable and its importance to the history of mankind is also measurable. The creation of international standards can be seen as connecting the past with the present. Through the use of modern methods in IT the value of CH increases ten-fold because the securing of the data on an international basis helps in the preservation, restoration, reproduction and education processes involved in tracing the great archaeological steps of mankind. Thus, if it is possible to develop an international documentation language or "*grammar*" per se, we will overcome the majority of the barriers now present in the archiving and promotion of CH.

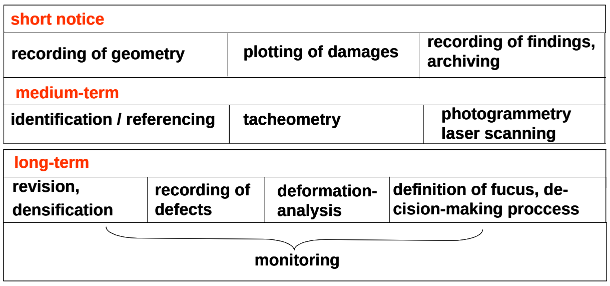

Figure 5 Cost saving

Lack of standardization inevitably leads to the inability of exchanging products/data, i.e. recordings and drawings as well as to the eventual status of every individual using his own method for the task at hand. CH is the main benefactor when all technical findings and processes can be universally shared.

5. WORK TO BE DONE

5.1 Overview

Especially in the area of CH, decisions where different points of view and interests need to converge into one is a vigorous enterprise.

The beaten path to achieve a starting point for any type of standardization would include formal meetings and drafting sessions aiming to produce a standard between all stakeholders. 'Stakeholders' in the case of a multidisciplinary scientific area as CH is a considerable number since many sciences, techniques, policies and philosophies meet. Consequently, any effort has to be carefully planned so that best results can be accomplished.

This section will try to bring together an action plan from the past experience of the authors in cultural heritage –through different projects- and in other scientific areas.

The aim here is to achieve a global participation (if possible from all member countries of the UN) which will lead to a globally accepted voluntary consensus type standard that is self sustainable.

The objectives of such an undertaking are as follows:

- the whole effort to be patronized, supervised and organized by an international, widely accepted, scientific body
- create a complete and solid data structure for all data in cultural heritage

– undertake conformity assessments

In order to achieve the above objectives it is necessary to have the support and acceptance of the scientific community. For this reason, it is important to highlight the significance of standardization and make clear the aims and objectives of such an effort.

Having said that, a responsible body has to be chosen to organise the project. Several criteria have to be fulfilled:

1. *Wide acceptance:* The responsible body must be able to cooperate with all stakeholders. For this basic reason it has to be widely accepted, not only from the academic world of cultural heritage, but also in general since it will have to cooperate with governmental bodies, and private investors, for example.

2. *Expertise:* Largely due to the sensitivity of the researchers to their data, the great expectations from the academic world concerning an international standardization project and / or the extent of the effort itself, standardization has no room for mishandling or failure. To achieve this, it is necessary to ensure that the responsible body has expertise in this field. This would imply completion of past standardization projects and links with standardization bodies.

3. *International:* As expected, the whole effort will demand bringing people, ideas, policies and decisions together from all over the world. Consequently, the body organizing the standardization project will have to have an international character.

4. *Powerful and well linked:* At the same time, it will have to have the power, ability and links to make its decisions heard among all stake-holders. It is very important to have strong links with state institutions so that the latter can act as distributors and keepers of the standards in later stages of the project.

5. *Financially capable:* Last but not least, the responsible body will have to be able to make an investment or find the appropriate funding for such a project.

Several bodies that can be candidates for this place among others are: UNESCO, ISO, CEN, ICOM-CIDOC, ICOMOS and CIPA. The possibility to create a new organisation having as a specific purpose the standardization of data in cultural heritage can also be carefully considered.

Having decided upon the body that is going to act as an organiser, the stakeholders have to be determined. Attention has to be placed into this component of the project since all parts of the academic world of cultural heritage have to be determined. Experts from all domains have to form workgroups that as a whole act as consultants for the standardisation experts from the responsible body.

Bodies that must not be left out in any such attempt are entities at all national, regional and international levels. In more detail, government bodies, industry, professional bodies, NGOs, museums, libraries, academia and researchers in this domain, should have a say in such an effort since a project that aims to construct a platform for standardization will affect everyone to a certain degree.

The output of the meetings and discussions should be a series of tables/regulations that list the data structure when documenting, archiving, presenting and conserving in cultural heritage. They should include all aspects in cultural heritage from museum exhibits, to excavation findings and archive files.

The application work package of the project will take considerable time. Nevertheless, methods to accelerate the process and guarantee compliance can be achieved. Examples of such methods are:

– All state funding to relative projects should demand the application of the standards
– Free training and application of the standards by the responsible body in key institutions (e.g. e-Education/ e-Training)
– Promotion of the project by state organizations

The turning point will be when a growing society accepts and uses the standards to such an extent that the benefits of this effort are visualised.

Thereinafter, the sustainability of the project has to be guaranteed. The responsible body can achieve this by charging training, know-how and / or consulting in other institutions. In addition, it can act as a testing organisation that certifies the good operation of a documentation project.

This is a series of steps any successful standardization effort has to take to be successful. Past experience has shown that standardization efforts in cultural heritage have several kinds of problems that need more time to be solved. Consequently, no magic or fast solution is going to be given when the decision to push such a project forward is to be seen. Time will be needed in order to visualise the benefits of standardisation.

5.2 Implementation

To be more concrete in the area of the digital documentation/archiving and their monitoring activities a series of disciplines will have to work together (archaeologists, museum experts, historians, conservators, GIS-professionals, IT experts, surveyors, civil engineers, architects, internet experts, etc.) under the umbrella of an international independent and recognized institution in order to achieve the above set objectives.

Concerning the areas of specialization and involvement of the authors in CH, the path of standardization begins with the technology (flat scanners for documents, photo-cameras, and laser scanners) and methodology to be used. Starting from the *data acquisition* (for example 2D or 3D-scanning) different guidelines for the calibration of scanners have to be implemented and the different digitizing strategies up to the resolution / accuracy of the points/pixels must be set (for metal artifacts the resolution/accuracy has to be of a certain min. level). Moreover, a uniform procedure for saving and processing the data must be defined. In addition to this, specific internationally recognized standards for the data exchange transfer, archiving and presentation/visualization must be created and used appropriately in order to be able to communicate with Computer Aided Design (CAD) systems, Data Base Management Systems (DBMS) and GIS.

Once the data acquisition has occurred and the data exchange transfer, archiving, modeling and presentation follow, there must be an independent superintendent position or quality control institution available to ensure that the standards have been applied. Moreover, the sustainability of the data and its quality must be guaranteed from the institution involved in this digital process. When standards for acquiring and storing **metric** information are applied, then the information is available for future use/analysis, thus preventing each user from starting from scratch.

Other than the need for standards concerning the technology, methodologies, maintenance, quality and control, it is also evident that there is a need for standards in administration and management. In this way a hierarchy of standards is generated to ensure the safeguarding of the implementation of the directives.

Based on these reflections one can recognize a "horizontal" need for standards, that means dealing in the "present" and a "vertical" one which deals with the time-axis. This is to be seen in the figure:

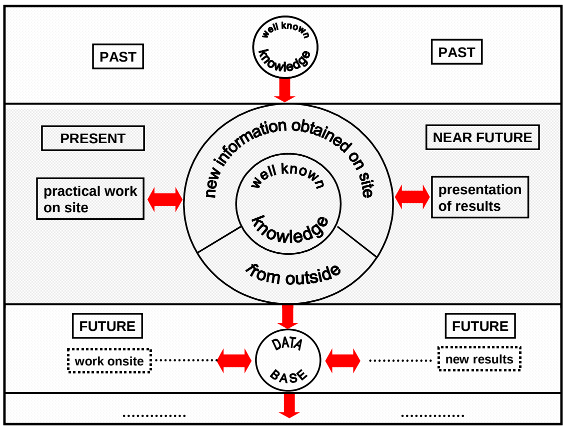

Figure 6 Management, recording and transition of knowledge

Finally, it is necessary to have an accreditation body/committee in order to evaluate whether the work has been done/completed according to the international standards and quality.

5.3 On National and International level/activities

Three examples will be cited to illustrate different initiatives that three different European countries have applied in the area of standards in CH.

In Greece, for example, the Technical Chamber of Greece (TCG) has attempted many times to prepare and help the state establish standards and guidelines for all possible interventions to monuments and CH objects in general. Unfortunately, all such attempts stumbled to the selfish mentality of certain specialists, who would like to retain exclusivity to this very important issue. Lately, however, the TCG formed an interdisciplinary committee that came up with a proposal of broader acceptance under the general title «Guidelines compilation for the diagnostic study on an interdisciplinary basis for its adoption by a relevant ministerial decision of the Ministry of Culture».

This proposal includes guidelines touching issues such as the geometric recording, the architectural documentation, the static study and the study of the materials of the monument.

Meanwhile in the United Kingdom there have been several efforts in creating standards for surveying in the area of CH in the past few years. In Brian Kelly et al. 2003 the initiatives are described in detail. Terrestrial laser scanning is discussed as well as its adoption worldwide.

In addition to this, Germany, through the **V**erein **D**eutschen **I**ngenieur (VDI) professional organization, has established the first national VDI norm for laser scanning in a general application (VDI).

The EU can play an important role at the European level in that it can set as a condition for receiving funding for CH projects that international standards must be met. Theoretically, it can initiate, implement and also provide an infrastructure for movement in this area as well as set an example for monitoring progress and quality of the results. Good examples here are the ongoing EU Network of Excellence in CH. These programs run for only a specific period of time and some of the results remain within the consortiums. Here it would be possible with the implementation of universal standards that results from these projects would be available internationally (everywhere) and infinitively (anytime).

UNESCO can also offer a great contribution in this area. It can initiate standards and have them implemented in all member countries in the area of CH. It is then possible to imagine a world data base having a uniform format/data structure and guidelines for the documentation of different CH objects/monuments/sites. With this initiative UNESCO can create a world CH website "*using a common albeit technological language*" accessible to the universal public.

ICOMOS and CIPA are two professional organizations working together in the area of CH. ICOMOS has developed and is currently working in the area of e-documentation while CIPA developed the 3-by-3 rules for photogrammetry which are widely used throughout the world today (CIPA). These organizations need to be encouraged to continue in this area with common goals and initiatives.

6. THE GEOMETRIC DOCUMENTATION

Over the recent decades, international bodies and agencies have passed resolutions concerning the obligation for protection, conservation and restoration of monuments. The Athens Convention (1931), the Hague Agreement (1954), the Chart of Venice (1964) and the Granada Agreement (1985) are only but a few of these resolutions in which the need for *geometric documentation* of the monuments is also stressed, as part of their protection, study and conservation.

It is here in *geometric documentation* that the authors feel standardization guidelines can contribute fully in CH.

The *geometric documentation* of a monument may be defined as the action of acquiring, processing, presenting and recording the necessary data for the determination of the position and the actual existing form, shape and size of a monument in the three-dimensional space at a particular given moment in time (UNESCO, 1972). The *geometric documentation* records the present state of the monuments, as this has been shaped in the course of time and is the necessary background for the studies of their past, as well as the plans for their future.

This form of documentation should be considered as an integral part of a greater action, the General Documentation of the Cultural Heritage. This comprises, among others, the historical documentation, the architectural documentation and the bibliographic documentation. The Geometric Recording of a monument involves a series of measurements and -in general- metric data acquisition for the determination of the shape, the size and the position of the object in the three dimensional space. Processing of these data results to a series of documents, i.e. products, at large scales, which fully document the geometric -and other- properties of the monument. Usually such products include two-dimensional projections of parts of the object on horizontal or vertical planes, suitably selected for this purpose

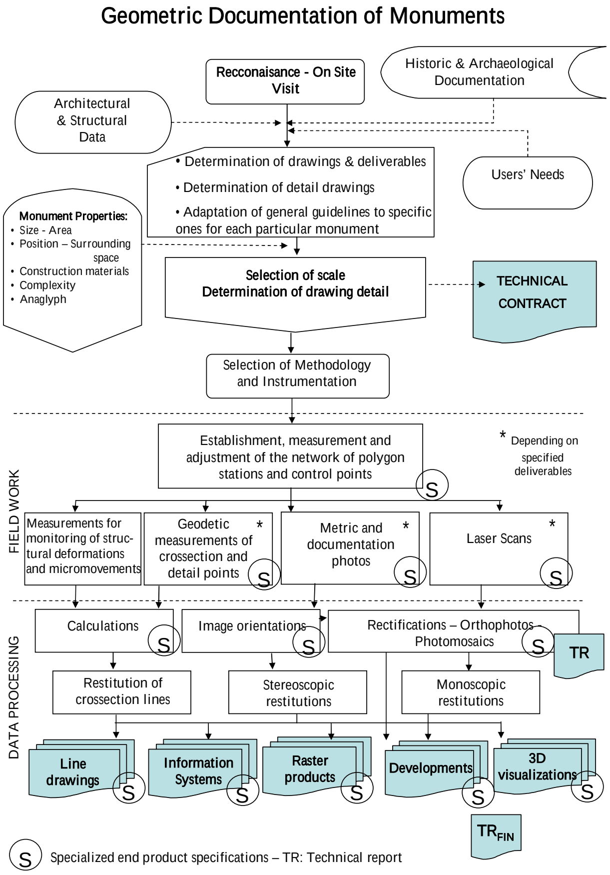

Figure 7 Steps for carrying out the geometric documentation of a monument

The geometric documentation of a monument consists of the suitable projection on predefined horizontal and vertical planes of a number of points (connected with lines) which best describe the shape, the size and the position of the monument in the 3D space. The determination of these points in space and their number should follow specific accuracy rules, i.e. uncertainty specifications, which should describe the end product in detail. The actual steps for carrying out the geometric documentation of a monument appear in Figure 7.

All actual methods work with coordinates (manual measurement in an indirect way). The spatial frame enables monitoring, that means *differential comparisons* between different epochs and eventually extrapolation of changes into the future. Determining differences (differential analysis) may reveal geometrical deformations, changes in colours (caused by humidity, biological-organic, and other chemical reasons). Salt concentration, sufficiently good quality of geometric background is always necessary. So when doing the first recording, the close fixation of the network to the building is necessary – however it should be done not by targets, but exclusively by natural points. These are prominent points of the building existing in its whole lifetime. It has to be expected that points of this kind will not only survive long-time, but can be detected and are of importance not only using actual measuring methods but also future ones.
Table 3 gives an idea about some aspects to be considered when starting a project and about the possible origin of the accompanying standards.

Step	Examples	Standards from/with
0.	Tables defining terms like i.e. calibration, point, pixel, precision, accuracy, tolerance, scanned surface standardized and worldwide.	UNESCO ICOMOS CIPA ISPRS
0.5	Standardized marks of quality for all 2D- and 3D-Scanner and other measuring devices	as above
1. Before starting	"What is to be considered beyond concrete setting of tasks in the course of the practical work?" Check of alternatives concerning • measuring method • presentation • monitoring • continuation / revision	CIPA
2. Practical work	For use of data in future work the lasting effect has to be observed • densification • localisation • coordination of natural points	EU or UNESCO
3. Adaptation of data / data base	Guarantee of standards • interchangeability • quality management	EU-norm resp. EU-standard
4. Presentation	Unified formats (partly existing for ground plane, intersections and projections),	customer / client CIPA
5. Continuation of original data and presented results	• archiving of the original data (existing for historic photos), today i.e. point clouds from scanning • alphanumeric data has to be copied in time for long time use	UNESCO

Table 3 Standards accompanying a project in CH

7. SUMMARY

This paper has described why setting international standards in CH and in particular the IT documentation of CH objects/monuments/sites is so important and beneficial. Historical reference was made in order to illustrate the success of setting standards in our everyday life. Suggestions were given as to how the development of a culture to initiate standardization can begin and the method of implementation of these standards on a national and international level can take place. The stakeholders were emphasized and given suggestions as to how to bring about quick and effective results concerning the planning, design and implementation of standards. It is clear that a worldwide collaboration in this area will bring a harmonization and compatibility and therefore accessibility to the past for the present and the future. It was also suggested that by creating a "*grammar*" for the *geometric documentation* of CH objects that an uncomplicated exchange of information today will result and a guarantee for the protection of the long-term value of digital data/knowledge in the future will occur.

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