CHAPTER 7

INTRODUCING INFORMATION TECHNOLOGY TO ARCHAEOLOGICAL RESOURCE MANAGEMENT: TOWARDS A GIS-BASED SMR OF MID-WESTERN POLAND

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I. INTRODUCTION

I.a. IT and ARM: why?

The need to apply computers in the daily practice of the Archaeological Heritage Management Service (AHMS) of the Poznan Province (Midwestern Poland) emerged in a very natural way from the very character of this complex and sensitive field of archaeological activity. It is enough to mention here the typical main tasks of Archaeological Research Management (ARM), which are usually formulated in a global, maximised way, namely to discover, register, document and protect possibly all archaeological sites in a certain area. As a consequence, AHMS datasets (traditional as well as digitised ones) are of large size because they contain a complete list of sites of the area and are of permanent or at least long-term character. This contrasts with most of the research-oriented databases, which are planned as short-term and one-task undertakings. Another reason for AHMS representatives to become involved with Information Technology (IT) was the permanent necessity of fast and efficient retrieval of large amounts of data in order to fulfil the above-mentioned tasks: deadlines are always set by external conditions and by partners of archaeologists rather than by themselves in the context of land planning, construction projects, etc.

To sum up, our long term experience has convinced us that without IT, the standard requirement addressed to the AHMS is nowadays absolutely unrealistic. Only introduction of computer applications to the everyday practice of these services may raise their efficiency and radically improve the ability to achieve fulfilment of their tasks.

I.b. IT and ARM: how?

In the last two decades, the process of applying IT to ARM in most European countries started with simple text databases on archaeological sites —Sites and Monuments Records (SMRs)— and has been continued by the development of much more complex museum databases (data on sites, research actions, assemblages and single finds). These have later been enhanced to include graphical data (photos, drawings, maps). The obvious next step was to combine text databases with Geographic Information Systems (GIS) that could manage archaeological digital maps of a certain region. The first GIS systems played the role of simple site registers and were based on ready-made commercial packages. Later, these were replaced by specialised applications, written in programming lan-

guages such as *MapBasic* and addressed to the ARM professionals, whom they offered several additional adjustments to their specific needs, *i.e.*:

1. automatic generation and printing of standard forms (site register form, scheduled monument form, etc.),
2. analytical tools (e.g. buffer and radius search),
3. arithmetic calculations and statistical tests,
4. the possibility to generate more complex maps for archaeological publications.

The flexibility and efficiency of GIS systems has been additionally enhanced by the combined use of different kinds and sets of data:

1. text data files: one can prepare a collection of files, each containing a list of sites according to different features –*i.e.* chrono-cultural classification but also lists resulting from actual ARM strategy: sites in danger, sites under rescue excavation, etc.,
2. bitmap files containing various types of cartographic materials:

    a. standard topographic maps,
    b. standard topographic maps with inserted air photos,
    c. orthophotomaps, combined with (transparent) topographic maps, providing maximum of visual reality together with cartographic exactness.

3. digital graphic files, containing those map elements which should be then retrieved and analysed, archaeological sites and objects which can endanger them, location of development projects, pipelines, motorways, etc.

I.c. Dissemination of the IT idea within professional archaeology

As far as today's Polish archaeological community is concerned, there is probably no longer a problem of a "future shock" and "computer stress" but still many different ways of dissemination are necessary to introduce any new computer standard to a broader group of archaeological professionals. The following means of activity proved to be helpful here:

1. papers and communicates, presented during conferences,
2. courses, classes,
3. publications (user guides),
4. Internet publications (WWW Home Pages)

Dissemination of GIS systems in AHMS service seems to be more difficult than was the introduction of the major tool of the former period, *i.e.* SMR text database. The main obstacles seem to be:

- the more complex structure of the system which requires some computer experience,
- more expensive minimum software package to start with (*MapInfo* - ca 1.500 USD),

- more complex and expensive data entry (mainly - scanning and digitisation of maps, as
- the official digital maps are still not free in most countries, not even for national services such as Polish AHMS.

The use of computer technology in the daily practice of the AHMS is based on the creation and distribution of successive versions of specialist computer programs, designed as the result of co-operation between archaeologists and software engineers, in order to create and manage archaeological databases. The introduction of computer technology in Polish archaeology has so far proceeded in three stages:

1. since 1986, text databases, e.g., *System_AZP* (Figure 7.1), *AZP_Fox* (Prinke, 1996), *AZP_Max* (Figure 7.2), *AZP_Max_WIN* (Figure 7.3),
2. since 1995, text-and-graphic databases: *KSAWery*, *MuzArP* (Prinke, 1998a), *MuzArP_Win* (Figure 7.4),
3. since 1996, text-and-cartographic database: *mAZePa* (Prinke, 1998b) (Figures 7.5, 7.6 and 7.7).

2. POLISH ARCHAEOLOGICAL RECORD (AZP). A COUNTRY-WIDE STANDARD TO REGISTER AND DOCUMENT ARCHAEOLOGICAL SITES

2.a. Description of the System

During the last twenty years, Polish archaeologists have developed, implemented and utilized a unified, country-wide system to discover, record and document archaeological sites. This system, called *Archeologiczne Zdjecie Polski* (AZP), the Polish Archaeological Record, was first applied on a large scale in the late 1970s (Prinke, 1994b, in Press). Its main aim was to record all archaeological sites in the country, both newly discovered and verified, in the unified textual and cartographic form. At present, AZP has a threefold structure:

1. field survey,
2. traditional (paper) site documentation, including site register forms, site lists and maps,
3. computer application (see below).

The first two parts of this huge undertaking were prepared in the late 1970s, while the computerization of its results started in 1986. Between 1975 and 1978, two proposals of the site register form were presented, one of which used punched cards. Eventually, a compromise version was generally accepted. In the early 1980s several additions and corrections were introduced to the AZP, among them updated 1:10,000 scale topographical maps.

As far as field survey is concerned, AZP is based upon a set of simple rules concerning the national archaeological grid as well as field survey preparations, management and supervision:

- National Archaeological Grid: the whole territory of Poland has been divided into ca 8,500 AZP Working Areas of 35 km² each, i.e. 5 × 7 km in size; such arbitrary

working units originated from the A4 format sheet of a 1:25,000 scale map. The grid provides a standard location background, independent of the map type or of the detailed location methods. AZP Working Area number used together with the site number within the AZP Working Area constitutes a *unique identifier* of a single site, independent of the changing administrative borders, etc. Each site has also its second, more traditional address, which consists of a locality name and a site number within the locality.

- Preparations: the way of preparing and carrying out a *field survey* of a chosen AZP Working Area includes:

    1. *archive and museum research* before a field survey,
    2. verification in the field of all previously known sites,
    3. detailed surface survey of all accessible grounds within the borders of the examined AZP Working Area.

- Management: the AZP survey team can be led only by an archaeologist who is a holder of the AZP license, which can be issued to him after attending a training course and passing the final exam.
- Supervision: the system includes a thorough, three-level quality control of the survey and its results, *i.e.*:

    1. by the specialist-consultants (on the single AZP survey team level),
    2. by the local branches of the AHMS (on the provincial level),
    3. by the Historical Monuments Documentation Center in Warsaw (ODZ; on the central level).

In terms of site documentation, each AZP team produces the results of the field survey in the form of a *standardized set of documentation* for each "working area", containing:

1. a 1:25,000 scale map of the AZP Working Area,
2. site register forms for all surveyed sites (Figures 7.8 and 7.9),
3. standard 1:10,000 scale topographic maps (in the *System_1965* National Grid),
4. a survey report,
5. an excerpt of results in the form of two standardized site lists.

The main element of the documentation set is the *site register form*, which constitutes the *first data standard in Polish archaeology*. After over 20 years of practice it can be characterized as a successful one as it has been accepted and used by practically all field archaeologists in the country.

2.b. Site register form

The form' structure is highly formalized, which made a subsequent conversion of its contents into the computer database structure much easier. It is based upon the Polish core data standard for archaeological sites. The site register form consists of 48 fields, divided into 13 groups which describe all main aspects of a single archaeological site, i.e.:

its administrative and geographical location, present use of the site area, chrono-cultural classification of archaeological materials, soil type, site area, distribution pattern of archaeological materials on the site surface, threats to the site, survey authors, museum collections and other data (research history of the site, archives, bibliography, map sheet number, cartographic coordinates of the site, etc.).

2.c. Implementation of the system

The entire AZP project is carried out under the auspices of the *Historical Monuments Documentation Center in Warsaw* (ODZ). Local coordinators and supervisors of the project are the *Provincial Conservators of Archaeological Heritage* (i.e. Heads of the Archaeological Branches of the State Service for Protection of Historical Monuments in each of the country's 16 provinces and their local departments, altogether around 50 centres). The field survey is carried out yearly by dozens of archaeologists from various institutions, organized in numerous AZP survey teams. The undertaking has been financed by various sources, with major share of the Ministry of Culture and National Heritage.

Presently, the recording and documentation of archaeological sites following the AZP standard constitutes, along with their subsequent protection, the main task of the AHMS. So far, around 75% of the area of Poland has been surveyed following the AZP data standard, with the result of ca 450,000 sites recorded; they date back to all prehistoric and historic periods, from Paleolithic to Early Modern Times.

3. THE BEGINNINGS OF DIGITALIZATION OF THE AZP RESULTS: ORIGIN OF THE POLISH SMR (1986-1992)

As a result of the first two stages of the AZP project, extensive archives of site records in the form of paper documents were soon created in each province of the country (up to 25,000 site register forms in provincial archives and ca 450,000 in the central archive at the *Historical Monuments Documentation Center in Warsaw*. It became clear that only a computer database would make it possible to efficiently collect, process and evaluate this vast and valuable set of information. In 1986 the Poznan Archaeological Museum presented a preliminary version of *a database system on archaeological sites*, called *System_AZP, rel.1*' (Figure 7.1). It was dedicated to the 8-bit microcomputers and written in *dBASE III/CPM* programming language. It covered almost the full scope of the data from the traditional paper form. The data structure consisted of two database files with a total of 41 fields. Later activities resulted in launching in 1989 of the first version of a similar system for the PC computers. It was programmed in *Clipper '87/DOS* (*System_AZP, rel. 2* and later).

Due to the financial limitations, in the further development of the all-Polish archaeological computer system, a model of *dispersed, regional databases* run on PC computers and based upon unified data structure and *identical software* has been chosen, rather than

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one central, all-country database. The *System_AZP* was soon appreciated by its users as a friendly and flexible application, permitting data retrieval in practically any combination of criteria and generating formatted reports. It was then formally declared by the then Ministry of Culture and Fine Arts as the *national standard software* for all branches of the State Service for Protection of Historical Monuments (PSOZ). The program was since then repeatedly enhanced, with some minor changes of its data structure.

4. SECOND GENERATION OF SMR SOFTWARE (1993-1996)

After completing the system in its first PC version, our team of programmers together with archaeologists working at the Poznan Archaeological Museum has accumulated rich experience as the first users of this software, exploiting it in our daily routine work. Simultaneously, as the use of the system started to spread across the country, we began to receive more and more practical comments from other users (who currently amount to over 60). In the meantime, new, much more powerful programming tools became available. All this resulted in preparing the next (third), completely revised version of the system, by the use of one of the fastest and most progressive programming tools at that time: *FoxPro, 2.0/DOS*. This stage of the project was achieved in 1993 and it resulted in the next product called *AZP_Fox* (Prinke, 1996; 1997a).

Accepting the former data structure, it appeared to be around 15 times faster and much more user-friendly. The user could find such improvements as:

1. fully menu- and mouse-driven user interface,
2. enhanced data entry control,
3. context-sensitive help,
4. generator of retrieval conditions, giving the user full access to all database fields as well as to all possible logical and relational operators,
5. basic data analysis,
6. several formats of printouts including user-defined forms.

The upgrade of *AZP_Fox* was accomplished in 1994. It resulted in the preparation of the next, thoroughly revised version of the system by the use of *FoxPro, rel. 2.5/DOS*. For the first time it was prepared in two language versions: Polish and English. The application was distributed as a freeware to all users of the former system as well as to all others showing interest. Today there are over 60 registered users of this application, who have so far entered ca 450,000 records.

In 1996 the system had been thoroughly re-written and launched under the name *AZP_Max*[2] (Figure 7.2); however the full compatibility of data had been maintained. In its present shape, the *AZP_Max* system is designed to aid archaeological documentation and recording, as well as archive research and primary analysis of data in several fields of archaeological activity, i.e.: research, museum works and management of archaeological

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[2]   Authors: Michal Kunze, Marek Wawrzyniak - Datex Consulting, Poznan (programmers) and Andrzej Prinke, Poznan Archaeological Museum (archaeologist).

heritage. It is therefore addressed to survey teams, individual scholars, archaeological museums and AHMS. By means of this system, the archaeologist is able to collect and manage all information on a given site, on all sites from a given area or sharing the same features, etc.

The program was introduced on a whole-country scale on the basis of:

- co-operation with the Centre for the Documentation of Historical Monuments in Warsaw (ODZ), concerning its dissemination among all the regional AHMS branches.
- a publication of a user guide (in Polish and in English),
- a series of schooling sessions, organised jointly with the ODZ in Warsaw,
- presentations and lectures delivered at annual AHMS meetings.

5. A FURTHER STEP FORWARD: INTEGRATED MUSEUM DATABASE (1993-1995)

In the years 1993-95, another, much more powerful computer database system was accomplished by the Poznan Archaeological Museum. It is called *Muzeum Archeologiczne w Poznaniu* (MuzArP)[3], the Poznan Archaeological Museum (Prinke, 1998a). The system has been written in *FoxPro, rel. 2.5/DOS* programming language. It may be called *Integrated System of Archaeological Information* as it allows creation of computer databases containing data on:

1. archaeological sites,
2. research activities carried out on these sites,
3. archaeological assemblages discovered during these activities,
4. single artifacts or elementary sets of artifacts within any of these assemblages.

The data structure of the *MuzArP* system includes 351 fields. Data control is executed with the help of 55 controlled dictionaries. Its logical model consists of four levels of generality; the user, moving from the uppermost level 1 (describing a site) to the most detailed level 4 (that of a single find), and it follows, in a way, a typical sequence of the archaeological research procedures. At its top level, the system is compatible with the *AZP_Max* program (Data Export/Import option). Much effort has been devoted to make the system user-friendly and its data entry option –ergonomic, thanks to such features as:

1. complex search condition, including any number of fields, chosen by the user; the single elements of the search condition can be joined with any logical operator,
2. data presentation: information from different levels can be combined by opening additional data windows on the monitor screen (up to 5 windows simultaneously).
3. primary analysis of the selected data (automatically generated contents list of any database field, together with the frequency of each item); when the option

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[3]   Authors: Marek Grajek, Michal Kunze, Marek Wawrzyniak - Datex Consulting, Poznan (programmers) and Marek Chlodnicki, Bogdan Okupny, Andrzej Prinke and Danuta Prinke, Poznan Archaeological Museum (archaeologists).

of the multiple analysis is chosen, the contents of up to 5 fields can be processed simultaneously; the result of the analysis can be presented in graphic form, whereby the user can choose from 15 two-dimensional and 32 three-dimensional diagrams. To speed up the data entry, a mechanism of 20 user-defined macros is available.

6. ADDING THE MAP: A *MAPINFO/MAPBASIC* APPLICATION (1996-2000)

Maybe the most important argument in favour of GIS applications in ARM (apart from the economy of effort and the increased precision of the results) is the possibility for integration of archaeological maps with other, more general digital maps of a given area (e.g. regional planning document maps). The fact that the same digital tools have been increasingly utilised by our partners in ARM activities (planners, national and local government, etc.) should be recognized and exploited as a strategic topic by archaeologists, especially those active in the AHMS. In such a situation, it would be a good system solution to create a map of archaeological sites as one layer of a multi-aspectual spatial planning document. It would then eliminate the common practice of disregarding the problem of preserving the archaeological heritage in the planning process.

6.1. A GIS module for the computerised SMR standard

The above mentioned standard software to manage Polish SMR text data (*AZP_Max*) radically improved the accessibility of the masses of textual data on archaeological sites. As its use became more widespread, it was recognized as an efficient modern element of the professional archaeologist's toolkit, considerably shortening the searches for archival information of old discoveries, indispensable for almost every research project, museum activities and especially in heritage management. It also allows printing out the data in the same all-Polish standard format as the Site Register Form (Polish abbreviation: KESA), used in AZP survey. It contains, however, only the textual data on archaeological sites, while in many cases it is cartographic information, and even more frequently –the possibility of correlation of both types of information– which plays a key role. Our next step in the standardisation and automation of mass data was therefore to create a standard for archaeological digital maps and to integrate it with the existing standard textual *AZP_Max* databases.

With this aim in mind, in 1996 Poznan Archaeological Museum began work on the new computer application, called *mAZePa*[4] (which stands for: an AZP map; Prinke, 1998b). It was intended to create and maintain archaeological digital maps concordant with the AZP standards (both of its traditional paper as well as its electronic form). The initial assumptions accepted by the authors of the program were:

1. complete logical and software compatibility with the existing textual *AZP_Max* data standard. The mutual exchange of data, compatible format of generated documents, and shared data search mechanisms were regarded as fundamental,

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[4] Authors: Marek Grajek Poznan (programmer) and Andrzej Prinke Poznan Archaeological Museum (archaeologist).

2. the choice of a suitable GIS system, fulfilling the criteria of accessibility, typicality, efficiency and ease of use.

We have selected *MapInfo* software for our tasks as it is one of the most popular GIS systems worldwide, and at the same time one of the cheapest. It is also a product developed for many years so its present version can be regarded as mature. The program is also available in Polish, which certainly aids its introduction as a standard. An important feature of the system is its programmability, thanks to the compiler of a special programming language called *MapBasic*.

6.2. A short overview of *mAZePa*

In its present form, *mAZePa* (version 1.5) is able to execute the following basic functions:

1. The choice of any fragment of a topographical map in one of three ways:

   • according to an AZP Working Area number (choice from the graphic interface of AZP grid),
   • according to a 1:10,000 scale topographic map sheet (choice from the graphic interface of map sheets index
   • according to a name and/or number of 1:10,000 scale topographic map sheet (choice from a list of map sheets),
   • according to a locality name (choice from a list of localities).

2. Choice of any file with textual information on archaeological sites. *mAZePa* reads the files previously generated by AZP_Max which allows the use of the rich databases created by the ODZ and the regional offices of AHMS all over the country. At present they cover the majority of the sites recorded in Poland so far.

3. The above-mentioned data and programs allow the automatic generation and printout of the complete KESA site register form –*i.e.*, together with the 1:10,000 scale location map.

4. The creation of maps of archaeological sites that have been previously selected in the AZP_Max software according to a variety of criteria (the user has a choice of 59 characteristics, according to which the site is described, for example: chronology, culture, type of investigation, physiography of terrain, surface area, etc.). This allows the automatic creation of a wide selection of single- or multiaspectual thematic maps, *i.e.*:

   – a map of sites of a selected culture or chronological period,
   – a map of all excavated sites of a specified period and area,
   – a map of all sites threatened by destruction by a specified threat (planned building of a motorway, pipeline, etc.).

5. Additional elements in the form of vector graphics can be superimposed on such a map. These may represent factors and phenomena important for heritage man-

agement, such as administrative boundaries, the line of a planned investment, areas which have not yet been investigated by the AZP, etc.

6. Changes in the scale of the map. At present these are possible within the range of 1:5,000 to 1:20,000. Maps at a scale of 1:50,000, 1:100,000 and 1:300,000 are in preparation.

7. The possibility to add descriptive labels to any objects on the map. They can be generated automatically from the database (e.g., the label for an archaeological site: locality name + site number + administrative district + chronology + culture).

6.3. mAZePa: the first products

In the course of the exploitation of mAZePa in the AHMS branch at Poznan Archaeological Museum, besides using it in daily routine, it has been utilised as a tool for the creation of several larger cartographic products. These include:

- a map of archaeological sites in the area of the Poznan province,
- a map of sites along the planned A2 motorway (Polish / German border - Poznan - Wrzesnia (Figure 7.7.)
- a map of sites along the trans-European gas pipeline (Jamal/Siberia - Western Europe) in the Poznan area.

The most recent initiative of our museum in the process of perfecting computer tools for archaeologists is the creation of so-called orthophotomaps, new generation maps in which the background is formed from numerous aerial photographs of the area, mounted in such a manner as to avoid the linear and angular errors usual in normal photographs, and which ensure a considerably greater readability of the map.

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