GEOMEDIA AND ARCHAEOLOGY

The Best Application of the Intergraph technology in Educational Practices for Archaeology Students

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Abstract
The important part of the study at the Department of Archaeology in Brno is course Computers in archaeology. The aim of the course is the application of computer methods within the archaeological research work: especially geographical information systems (GeoMedia). Methods are demonstrated on concrete solutions used on Breclav Pohansko excavation.
1 Introduction

One of definition geographic information system is: GIS is an organized complex of hardware, software, spatial data and personnel designed to efficiently capture, store, manipulate, integrate, analyze, display, and print all forms of geographically referenced information.

This definition result – GIS is a ideal tool for processing archaeological data.

2 The institute of archaeology and museology-Department of Archaeology

2.1 Generally

The Institute of archaeology and museology Masaryk University of Brno was founded in 1930 as the Institute of Prehistory and Protohistory. The Institute cooperates with a number of foreign universities and archaeological centers, and in the context of an interdisciplinary approach the Institute also cooperates with a number of Institutes of related interests. The study of Archaeology focuses on the Prehistory and Early Mediaeval history of Europe, and mainly on Central Europe. The subjects of study include methods of excavation of the archaeological resource, their conservation, classification and historical interpretation, as well as on knowledge of material culture, and within the protohistoric or early historic period on an ability to work with the oldest written records. The link of archaeology to the humanities requires a general philosophical background; on the other hand, the practical side of archaeology also requires technical and computer skills together with certain management skills. Archaeology graduates are competent to apply for positions as experts at museums, monument care institutes, institutions for science and universities. They are working as researchers in the scientific departments, in the cultural management as well as in the government offices.

2.1.1 Education and computers

The study of the archaeology is divided into three programs – Bachelor Degree program, Masters Degree Program and Doctor Degree Program (postgraduate). The first program lasts three years. The important part of the study is special course Computers in archaeology I. Students gain knowledge in the first place about the databases (Microsoft Access), their projection and implementation and about CAD (MicroStation), use of CAD in digitalization and editing of the archaeological plans. The second program with special course Computers in archaeology II lasts two years. The aim of the course Computers in archaeology II is the application of computer methods within the archaeological research work: especially geographical information systems (GeoMedia) and statistic package (SPSS). Methods are demonstrated on concrete solutions used on Breclav Pohansko excavation.

In the Doctor Degree Program work students on the own research projects and use theirs knowledge in computer methods.

Part of the study is participation in the archaeological field school. The summer field school takes place at the Institute's site at Breclav-Pohansko. Staff members of the Institute supervise the fieldwork. The students apply during the excavation their theoretical knowledge.
2.2 Archeological site Pohansko near Breclav

2.2.1 History of site

The enclosure at Pohansko near Breclav lies in the south-easternmost corner of the Czech Republic, in an area of enchanting forests above the confluence of the rivers Morava and Dyje. The hill-fort was built sometime in the 9th century. It is an oval, lowland type, covering an area of some 28ha.

The easily visible vallum is all that remains of a shell rampart, originally 5.7-6.5m wide, comprising a stone facing wall, earth fill and internal wooden walls. The stone required for the building of the rampart was brought from a distance of several tens of kilometers. The rampart fill reached 4m high, and with a wooden breastwork the defenses would have attained a height of some 6m.

Among the most significant discoveries at Pohansko is the apparent court of a local magnate, found within the enclosure in the northwest part of the site. This was a rectangular settlement formation of around 1ha, surrounded by a wooden palisade, and built in two phases in the 9th century. Within the court, a sacral area containing a church and cemetery was divided from the magnate's impressive dwelling, a large standing building - a meeting place for armed retainers or important members of Great Moravian society, and an economic area. The court presents one of the forms of Early Medieval residence; it is comparable to a palace (palatium) or curtis regalis in the Frankish or Ottonian Empire. Around the Christian church lay a rich cemetery. From the beginning of the 9th century, members of the society, which had its seat at the court, were buried here. Of the 407 graves excavated, 4 contained swords, 8 axes, 32 spurs and 46 gold and silver pieces of jewellery after the Byzantine-Oriental fashion.

Not far from the court of the magnate, some 100m to the east, a contemporary settlement of craftsmen grew up within the fortified enclosure, in a manner similar to that in the German palaces. Over 2ha of this area have been excavated, yet its perimeter has yet to be found; in all 260 features have been identified the presence of various crafts can be ascertained from the finds. The features formed groups divided by open areas or fences; in this was, a craft/production settlement developed. The character of the burials, which occur in small groups or isolated instances in the craft area, indicates that these were the graves of members of the lowest social orders. See Fig. 7 and Fig. 8.

Significant settlement activity has also been identified in the baileys.

2.2.2 History of archaeological excavation

Knowledge of Pohansko near Breclav comes primarily from archaeological excavations, carried out at the site since 1958 by the Institute of Archaeology and Museology of the Philosophical Faculty of Masaryk University in Brno (at the present day led by J. Machacek). To date, an area of some 140,000 square meters has been professionally opened and documented at Pohansko. The archaeologists acquired during this time a lot of scientific data. For this reason began since 1995 work on the digitalization of all archaeological information from Pohansko.
2.3 Science without GIS aid

As has been mentioned, archaeological excavation of Pohansko has been proceeding since 1958. That is mean we deal with an enormous amount of spatial data. During almost 45 year were found tons of individual artifacts-bones, ceramics, jewellery, etc. The number of information in different forms – varying in scale plans, schemes, tables, drawings of ceramic potsherds, pottery, thousands of photographs and so on has increased. Processing of this data took months the results of analysis were published.

Despite the volume of publications and the increasing amount of studies published each year, a number of information stayed unpublished or was a long time in the stage of final publication, regardless archaeologists used computers for typing, computing and database.

2.4 GIS powered science

It comprises a short review of the particular issues that relate to obtaining and integrating spatial data within the GIS database.

2.4.1 Data sources

Scientists and students use several processes to address questions about the history. They gather new data in terrain on Pohansko, what is systematic excavated.

They also reexamine data from previously projects, such as artifact collections, site records, published reports, schemas, books, and maps. New techniques allow them check old data armed with increased knowledge about the past and a new set of questions.

2.4.2 Brief view to history of GIS project POHAN

2.4.2.1 Beginning

Development of POHAN project started as a part of Michal Kucera’s diploma work in 1995. The software platform was MicroStation V5 and Czech GIS application MicroGeo. This “great-grandfather” of today solution runs on MS DOS operation system, attributes were maintained in Dbase IV.

Project was migrated to Intergraph MGE PC2.
2.4.2.2 Heavy set

Times of “heavy set” begun in 1997. Department of archaeology was equipped new hardware (workstation Intergraph TD 30) and software (Microsoft SQL Server 6.0 and Intergraph MGE 5.0).

2.4.2.3 Today

Today solutions is build as light desktop GIS
3 Project POHAN specifications

3.1 Technical information- Powered by INTERGRAPH

Base of today project is a powerful workstation, running on Windows 2000. Both graphical and non-graphical data are deposited in Microsoft ACCESS database file *.mdb.

GEOMEDIA serves as main tool for data integration. Except GEOMEDIA project team use Microsoft ACCESS as basic environment for input of attribute data.

Vector data, (maps and plans) are captured via digitizer in MicroStation.

In 2001 all project was migrated from MGE (MicroStation and SQL Server) to GeoMedia (ACCESS database). Whole process took 24 hours.

3.2 Data capture

3.2.1 Excavation

For students excavation does not mean only hard physical work during digging trenches and practical course of cognition archaeological methods (dating pottery, tools, human and animal bones, plant remains, pollen, charcoal bones, and so on). Fieldwork is environmental education experiences. See Fig. 1 - Fig. 6.

Students learn land surveying, documentation techniques; they help to prepare a research design for archaeological site.

First they establish the grid is a Krovak coordinate system using a theodolit, measuring tapes and red-white metal stakes. Squares are measured in meters 5 meters on a side. Inside primary grid is inner grid constitute by squares 1 meter on a side. Every grid unit is labeled.

During excavation students make drawings, photos and notices. They learn to operation of both classical and digital camera, level and transit. They interpret archaeological strata using the law of superposition.

The attribute data are written into paper forms, printed versions of project ACCES forms. The same day data are copied to digital form.

The plans of the site are made on graph paper; the graph squares correspond to the squares on the ground. Any features are labeled with context number. Paper plans are digitized almost “on-line” in office at the excavation base.

That means students immediate concern is with the integration of paper maps and non-graphical data into a GIS.

3.2.2 Laboratory

Processing results of fieldwork continues at university laboratories. Except pure archaeological advancements like artifact classification and description and material analyses students fluently proceed GIS project development. See Fig. 6.

They finish digitalizing and fill attribute database of artifacts, pictures and photos from excavation and photos of finds. With help of special applications and macros all data are cleaned and validated. Then data enter GIS.
3.3 Data maintenance, operation and integration

Results of data capturing are commonly stored in MicroStation *.dgn files, attribute data in Microsoft ACCESS *.mdb database.

Validated data from *.dgn files are imported to GeoMedia database and joined with non-graphical attributes. General quality control is performed. Using GeoMedia tools geometry and connectivity are validated.

Not only vector graphical data are integrated into GIS database. A lot of land and aerial photographs id produced every season integrated into GIS database. All spatial data must be recorded in the same co-ordinate system. Data that are recorded to some other system are transformed or projected to the Krovak co-ordinate system. See Fig. 11.

Drawing, sketches and photos are keeping in file system. Database contains paths to these files.

Archaeological attribute data from excavation are simply added to GIS project database. Also this data are verified. Primary keys and referential integrity are defined, special control queries are run.

Attribute data are divided into three groups:

- Spatial entries about settlement’s pits, graves, foundations, post holes
- Attribute data about finds, artifacts for example bones, pottery, iron tools
- Special tables, collecting paths to directories of drawings, photos, text files

Besides basic GeoMedia ACCESS warehouse, MicroStation CAD warehouse, season attribute ACCESS warehouse project still maintains MGE warehouse. MGE together with GeoMedia is used for analyzes.

3.4 Data analyze

Project POHAN uses almost all GeoMedia possibilities of analyze. Typical topics of analyze are combinations of database query and spatial condition. The result comparisons of archaeological data serve for new hypothesis development.

Examples of simple analyzes:

- Create density of animal bones (g per square meter) and its relation with settlement features (pits). See Fig. 12.
- Select features (settlement pits) inside buffer zone 10 meters around human graves. Spatial conflict of craft area and graves. See Fig. 13
- Fill squares (main grid 5x5m) with occurrence of postholes-spatial condition for query See Fig. 14.

For example, by displaying the data for the locations of all the ceramic bowls in the cave and creating buffers around these artifacts, it was possible to search for correlation between bowls and other artifact classes. The buffer function also made it possible to determine if particular categories of morphological features of the cave were preferred for ritual activities. Buffers for geomorphic feature coverage were created so that counts for the number of artifacts falling within these zones could be generated.
3.5 Outputs

3.5.1 Digital

Digital outputs are used as inputs to Microsoft Office software bundle. Results of analyzes are processed into Excel tables and graphs, WEB pages, Word documents. These outputs serve not only for scientific articles and publications they are regularly used from lessons and lectures.

3.5.2 Analogue

Equally as digital outputs the analogue ones enhance in education process and in publish. Main types are:

- Maps (scale 1:100 - scale 1:10000)
- Plans (scale 1:20 - scale 1:100)
- Reports
- Tables
- Printing

4 Project POHAN in education

Learning how to apply GIS technology in archaeology is part of complex IT education provided at Department of Archaeology. Computer laboratory is equipped with 9 PC, Workstation Intergraph TD 30, scanners, tablets, digital cameras Olympus.

4.1 IT curriculum

4.1.1 Bachelor Degree program

Computers in archaeology I: 60 hours - 20 hours Unix, Internet and html-editing, 25 hours databases (Access), 15 hours Introduction to CAD and GIS (MicroStation, GeoMedia)

Archaeological field school Pohansko: 120 hours – 70 hours special archaeological techniques, 20 hours Geodesy, 5 hours digital photography, 25 hours CAD an GIS (MicroStation, GeoMedia)

4.1.2 Masters Degree Program

Computers in archaeology II: 30 hours – 15 hours statistic analysis (SPSS), 15 hours spatial analysis (GeoMedia)

4.1.3 Doctor Degree Program

Individual work with databases, statistic packages and GIS.
4.2 GIS is not a fetish

Fundamental part of students GIS education is a work with GEOMEDIA, ACCESS and MicroStation. Students learn how to collect, manage, manipulate and analyze spatial data. Next step after data capturing lessons and practice are lessons about data integration, operation and maintenance.

All of GIS courses are balanced between theory and practice. Students do not solve some “artificial” problems in some test project, they form project team from first year at university.

4.2.1 From digger to project manager

First year they study theory. They take part in summer fieldwork practice. They learn how to excavate, document, photograph, fill database and digitize plans. Lecturer does not teach alone, older students train young colleagues.

Experienced students lead project “subdivisions” like digitizing, database completion, photo and drawings scanning.

Students participate to designing project data structures.

5 Conclusion

GeoMedia helps to implement a new approach to interpreting the archaeological data. This approach combined quantitative and qualitative data. Although this project represents a single site, data generated in this fashion can be compared with data from other early medieval sites.

5.1.1 Complex solution for everyday use

Intergraph Program for Schools „Power to Learn“ allows simplifying GIS education at the university. This tool serves for common student's use. Students apply GeoMedia for regular work such seminar work, simple processing of their partial excavations.

5.1.2 New INTERGRAPH users (customers)

Thank to Intergraph license policy (Power to Learn) academic community can use Intergraph solutions. This strategy educates new-experienced Integraph users.
6 Bibliography


6.1 About the Authors

Ing. Michal Kucera (born 1970, Kyjov, Czech Republic): GIS consultant. External lecturer at the Department of archaeology, Masaryk University of Brno, Czech Republic.

7 Attachments

Fig. 1 Fieldwork

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Fig. 4 Documentation of graves

Fig. 5 Digitizing

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Fig. 14 Squares (grid 5x5m) with occurrence of postholes-spatial condition for query