The Optimization of Assumptions of the Reconstruction of Monumental Objects of Romanesque and Gothic Architecture

Computer Aided Archeological and Architectural Research

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The paper discusses the methodological principles, the structure and the application aspects of individually created software application helping in architectural / archaeological research. The program is designed as 3layer software, providing the user with database, application with all functional modules and interface. The key content is the modular application allowing dynamic structural analyses, comparative analyses and other various possibilities, necessary in collecting and revising data from different sources. In author’s opinion the Manticora software is able to vastly support the interdisciplinary research and can help in optimizing its results.

Keywords: Interdisciplinarity, computer aided architectural / archaeological research, programming tools, programming implementations for architecture.

Background of the interdisciplinarity in architectural / archaeological research

The necessity of conducting the interdisciplinary research emerges more and more clearly in architecture now. It appears to be extremely useful in the field of architecture and archaeology and thus also in combined research conducted simultaneously on common ground of these domains. One of the major causes to involve people of diverse specialties is the request to understand the past of the architectural objects in context of historical events with their rich cultural and civilization background and in the light of various information collected to properly estimate the former conditions, circumstances and people’s involvement in the creation of the edifices especially from medieval times (Wyrwa, 2003a). The Preromanesque, Romanesque and Gothic periods can be seen today as a series of snapshots recording selected visions, not always truly reflecting the reality of the past. The remaining architectural objects
from the beginnings of Middle-Ages in Poland are often the austere remnants, ruins or relics hidden partially or completely under ground, destroyed many times and many times burned down. The historical sources are also very meager and provide little information on the origins and the shapes of monumental architecture. Until late 90's the hypothetic reconstructions were prepared by the archaeologists and historians of art with little examples of interdisciplinary consultations. This tendency however is fading now, forcing new interdisciplinary platform of research and resulting in the process of organized optimization of reconstructions (Renfrew and Bahn, 2002).

It proves indispensable to verify accessible facts for the understanding of the heritage of the past. It is also essential to recreate the image of the spatial environment, which preceding generations shaped. A strong component of this environment were the works of monumental architecture, especially sacral architecture. They are often damaged making it impossible to accomplish their reconstruction. The endeavour to recognize the true forms of the architecture of Middle Ages, the oldest examples of the masonry and architecture on the ground of Poland, leads researchers towards the verification and optimization of available historical data, utilization of conclusions from interdisciplinary investigations, aided with contemporary computer technology (Barelkowski, 2000).

**Program of the research – MPARS and the role of computer technology**

The research program, framed in 2003, introduces methodological foundations which serve to qualify limit values of reconstructed architectural object through the widely conceived comparative analysis within the architectural typology. It allows taking into account the wide cultural and spatial context, indispensable to individualize formal features according to engineering premises - such as eg. properties of the ground, possibilities of the masonry workshop, the accessibility and intentions of using of the building material and other. Mentioned procedures along with concurrent components became definite as the

![Figure 1](image)

*The computer technology support related to MPARS method structure.*
method MPARS (the Method of Comparative Analyses of Structural Solutions) and allow more precise examination of architectural structures starting from foundations dimensions and other contemporarily available parameters.

Key activity undertaken within the framework of method is the definition of the core typology, which often relies on the choice of the investigated object as well as the representative group of comparative objects, correspondent both on the field of typology (formal connection) and the builder's (engineering connection). The standard must be found to reference the objects among the selected group. Every object is compared to that pattern which shall be estimated based on existing building (monument). It is proper to precede the selection of investigated group with the analyses of reception directions of architectural and cultural patterns, expansions of forms and detail, what is often related to workshop migrations. Next step is the choice of the set of attributes included in the research. The validation of attributes is proceeded along using selected criteria. After the qualification of the set of the attributes, one defines the PDP factor (the level of comparative exactitude, which describes how much the examined object is similar to the standard one), eliminating the features which are impossible to verify. In the database one enters detailed attributes, among these some are settled deductively or experientially. For every object one marks the WZP indicator (indicator of the comparative concordance) individually. The comparison is made to reference objects or parameters (e.g., average values). A following step is the determination of terminal related structural values including maximum load capacity along with statistically estimated formal features for all examined objects.

The idea behind the deliberate activities is to provide cooperating architects and archaeologists conducting common research with computer aid on most levels of the processing of collected information. The MPARS method demands to assemble different data, where the process of information technology appears to become crucial. The detailed

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_Figure 2_  
The scheme of the role of computer technology support in MPARS method.
requirements are discussed by Barelkowski (2003) and presented as the subjects of the first research were chosen. The quite recently examined Cistercian foundation in Lekno, simple church from the turn of 12th and 13th century was taken as one of the first examples and analyzed according to the specific procedure, similar procedure was adopted in the case of the castle of Poznan (as the first secular object to be investigated).

According to the presented methodology the MPARS IT system is intended to provide wide data exchange and acquisition platform for researchers while in the same moment providing them with the necessary mechanisms to analyze, calculate, evaluate or even define the typologies and individual objects. The optimization of reconstructed architectural attributes serves well in the process of optimizing the reconstruction itself, in the task of visualizing and recreating detailed elements of spatial environment of the past.

The principles of Manticora System in context of 3layer systems of data processing

To create the platform for computer aided archaeological/architectural research the dedicated software system is being created. For now the database and four of application modules are operating, while other three are still elaborated. The system named „Manticora“ is composed on a basis of standard 3layer application (database-application-interface) foundation as a web nested system. The principles of the system were elaborated and presented by Barelkowski, Cellary and Cellary (2004).

The principles of the system

The system is composed of Database and specialized Application provided with the Interface serving as a communication platform for users. The idea was to be able to profit from the Manticora from

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**Figure 3**

General functionality of Manticora system.
every place where a desktop computer or laptop or any other portable equipment can be used, so it resulted in selecting the Web based system (including the Internet connection availability and networking abilities. The system is also equipped with protective tools providing access according to grouping of users and their profiles.
The data are stored in the system and delivered by the Database Server. Every piece of data can be assigned as components of linked or independent package, while the hardcopy of each record or each information is protected and remains in the system (so it can be easily restored in emergency case). The packages can be isolated and copied to the external environment, then processed there and brought back. The implemented mechanism of comparing the hardcopy and the new record is provided so each change in single record is mentioned with individual index (the administrator of Manticora can always check the full history of data changes).

The database
The database for now is dedicated to sacral, architectural, Polish monuments from Preromanesque, Romanesque and Gothic times (with the excerpt of the castle of Poznan and 3 related objects). Each record consists of five distinct data sequences: parametric data, quantified descriptive data, descriptive data, additional text data and visual data. The following lines present the stored attributes in the mentioned sequences.
Parametric data are: the length of the building, the width, the height, the cubage, the dimensions of main pillar/column, the width of the main structural wall, the width of foundation footing under main structural wall, the dimensions of the spot footing under main pillars/columns, the height, the width and the length of main nave, the height, the width and the length of side nave, the height, the width and the length of choir, the height, the width and the length of transept, the height of the foundations, the height of the tower, the structural strength of the foundation, the structural strength of the mortar, the structural strength of the stone/brick material, the height of the corpse of the church, the built-up area, the netto surface, etc.
The quantified descriptive data are: the number of naves in the main corpse, the number of transepts, the number of towers, the number of naves in the choir, the number of chapels in the ambit, the number of chapels by the main corpse, etc.
The descriptive data are: the type of building material for foundations, the type of building material for walls, pillars, columns, the mortar type, the plaster type (if applicable), the type of vaulting, the type of roofing, the type of spatial organization, the structure of the wall, the type of load bearing, the construction threads, etc.
The additional text data are: the name of the object, the location of the object, the type of the object, first historical mentions, the monographies concerning the subject, the remarks, the masonry workshop origins or name, the source of workmanship, the founder, the date of erecting, the dates of major changes, the date of destruction, the ownership data in the past and now.
The visual data are: *.jpg graphic files, drawings in *.dwg or *.dxf format, photographies and static schemes.
The database can be used in few possible modes. According to user rating and profiles it is allowed to add, edit, erase records, however the erased records are also saved in the system hardcopy – similar to 128bit coding with „mirror“-like functionality.

The application
The application provides necessary tools operating on data stored in the database. The tools allow data administration and management, data sorting, generating the reports, structural calculations, dynamic changes to structural schemes attached to files, defining, attaching, changing and removing of weighted factors to specific attributes, examination of attribute concordance related to weighted factors, object proportioning module generating and assigning typology of architectural objects in con-
text of preselected attributes.
The reports can be generated according to various
criteria. The objects can be queried by given num-
ber or set of attributes, by given number or set of
common attributes. The queries may be generated
also taking into account the hierarchy and weighted
factors of different attributes – the hierarchy is
based on the concordance rating.
The calculation of structural attributes reveals the
tensile and stressed forces including normals, mo-
ments, load bearing among others. This module
is intended to operate as linked dynamically to
graphically oriented module rendering the structural
schemes. The object proportioning module calcu-
lates various proportions of selected object reveal-
ing spatial characteristics and architectural features
of the architectural monument. The typology gen-
erator is based on user preset group of attributes,
which are analyzed through weighted factors and
tolerance ranges defined as a concordance mea-
sure. The application module can therefore return
the chart containing the attributes and renders the
typological profile of selected objects.
The structure of the application is strictly modular,
to allow extending and updating or even changing
of one module without interfering with others. The
application is the main software platform to be used
on Internet or LAN.

The application
The interface is responsible for proper interaction
among user and the software mechanisms. As Man-
ticora system is web-based system, it is launched
by the internet browser on user’s computer and it
communicates the main system – the application
on the main server through standard means neces-
sary.

The IT architecture details
The whole Manticora system is internet application.
Its 3layer structure (Reselman, 2000) is based on
the division of logical contents of the system: the
data, the operating logic and the presentation (the
interface).
The data layer is composed of data management
and administrative tools. Final decision to choose
the programming environment was based on Gen-
eral Public License (GNU). The PostgreSQL as a
universal platform was used.
The application layer is the matrix for the indepen-
dent modules, representing the mentioned functions
and responsible for data processing. Functions are
implemented through Java servlets, working on the
server in the mode „request-response“. They are
meant to provide user with dynamically updated
data (eg. webpages). Java servlets were chosen
for their simplicity and functionality, while they al-
low easy functionality expansion of the server. To
distinguish the application and the interface more
distinctively the library Velocity (Velocity Overview,
http://jakarta.apache.org/velocity) is used to define
WWW page templates generated by Java servlets.
This library is very efficient in invoking to data and
methods implemented in servlets without necessity
to interfere in source code of the application.

Towards the practice of operating
Manticora in the interdisciplinary
research

The described system is still in progress in its cre-
ation and test phase, while the database is yet oper-
tional as well as few application modules. The tests
of the interface are also in progress and Manticora
should be fully operational on February 2005.
Various tools are used throughout the system
primarily to gather, to compare, to evaluate and
to visualize the monuments of the past. Although
the system is now designed fro Polish Academy
of Sciences in expectation of using by both the
Institute of Archaeology and Ethnology (Urbanczyk,
2003) and the Commission of Spatial Planning and
Architecture, it is believed that its usefulness may
be also applied in other conditions. For now the
implementation of Manticora led in the analyses of
the Cistersian churches to input the data on German
and even French churches, because the cloister in Lekno is related to Altenberg line (Wyrwa, 2003b). In fact it is hoped to become the international platform to collect important and verified data on different architectural objects. Thus the monumental architecture from medieval times can be, even virtually, brought to life with more accuracy – on the basis of described methodical steps.

It is proper to point that till now similar program of more widely conceived investigative approach to architectural and archaeological research has not been undertaken in Central Europe. Therefore there is need to use different fields in order to bind data of the significant number of ancient monuments into classified and parametrical databases. Unification of such databases from different countries could result in more interesting discoveries that could unveil the mysteries of the former techniques of raising monumental objects. The program MPARS gives, in author’s opinion, such possibility and allows the objective extension of the knowledge about the past, helping the work of archaeologists and historians and conduct supplementary architectural researches with the aid of computer technology.

References


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