# GEOGRAPHIC INFORMATION SYSTEMS FOR BOTANICAL GARDEN - STEPS OF DESIGN AND REALIZATION

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## ABSTRACT

Geographic information systems are used for administration various regional information system. The application area of GIS is extremely wide from the state administration, cadaster, utilities management as electricity, water, gas supplement etc. Botanical information system BotanGIS is one of extraordinary utilization of GIS. The area of interest is the small bound area in the center of Olomouc city in the Czech Republic. Botanical information about plants (especially trees) from the University botanical garden and tropical plants from the Collection conservatories Flora are stored in the database. Database information about plants is connected to the interactive orientation plans of all area.

The main activities and steps of design of information system BotanGIS are the same as design of other information systems. Project of information system consists of the analytic phase, design phase, testing phase and the final implementation phase. Analytic phase consists of a conceptual database modeling and specification of function. The user interface draft was designed. Some techniques as unify modeling language (UML), CASE tools etc. were used. The most difficult part was database design according to specialists–botanists requests. Group of specialists-geoinformatics arranged a base measurement of spatial data and their converting to the digital form. The article deals about specific tasks in the case of design of botanical geographic information system. Specificity was in collecting botanic information only about plants in the botanical garden and conservatories. Some experiences from managing of this software project are mentioned.

**Keywords:** Information system, geoinformatics, database, plant, map, botanical garden, conservatory.

## INTRODUCTION

Botanical information system BotanGIS arose from older cooperation of expert on botany and expert on geoinformatics at Palacký University in Olomouc [4]. The main reason for the realization of information systems was the botanical education of students at Palacký University. The detailed information about plants is connected to specimen that actually planted at small area of the Botanical garden and Collection conservatories Flora. BotanGIS differs from other plant databases that collect information systematically about whole families, genuses, taxa [7, 9, 10]. Systematical plant databases have no connection to real individual plant in wild and their real location. Supplement photos are taken very often from several plants vegetated at various place.

BotanGIS is botanical information system about real plants. They have punctually botanical determination and description.

Information system BotanGIS is available for student and public for free. The access is not limited to Palacky University. Amateur visitors are also invited. BotanGIS is available at http://gislib.upol.cz/botangis.

Information technology project management as a discipline involved many concepts, skills, tools, techniques and recommendations [8]. Basic steps of developing and testing phase are described in the literature. Some crucial steps and threats that can have influence to fulfill the successful finish of information project are also mentioned in literature [2, 5, 6, 8]. Experiences at other projects in the field of geographic information systems are inspiring [2]. This article brings a brief overview about experiences about the development and managing of software project.

## BASE STEPS OF SOFTWARE PROJECT DEVELOPMENT

The main activities and steps of design of information system BotanGIS are the same as design of any other information systems. The steps are in most cases [5, 6, 8]:

1. Analysis of requirements
2. Specification of functions
3. Design of technological architecture
4. Implementation
5. Testing
6. Deployment
7. Maintenance

What was solved under steps in BotanGIS design is described in next chapters of article.

### Analytical stage

The first stage was analytical stage that collected all requirements. The analytic phase of information systems was discussed in 2011 with botanists. The specialist of several fields in botany discussed together. There was a specialist in dendrology, in tropical (subtropical) plants, in morphology of plants etc. All suggestions and requirements were considered by informatics. Each other understanding of both type of specialist was sometime complicated.

At that phase was discussed the amount of descriptive data for every plant. Besides that, it was discussed the way how utilize collecting descriptive data. It was also determined which data as important data for selection suitable plants from the database (by species, genus, family, etc.). The taxonomical data are collected both in scientific terms (Latin) both Czech names. Some descriptive data appeared additionally suitable for selecting, e.g. color and arrangement of flower, type of fruit, shape of leaf etc. The structure of descriptive data for every plant has been stepwise refined. Base characteristic of the plant was supplemented by more detail description of leaf, flower and fruit.

All plants have a unique number at Botanical garden (at plastic labels). The base taxonomical characteristics of the plant were supplemented was by extended information (origin of plant, origin of taxonomy, information about leaves, flowers). Every plant has descriptive localization by part of garden (park 1, park 2, plant beds Z12, etc.). Localization for plants from Collection conservatories it is the name of conservatories: palm, tropical, subtropical and cactus conservatory.

Gathering of ideas take a long time, and several meetings were held. The outputs of analytical phase were database model for plants and description of expected function. The database was modeled as ER diagram. Functions were listed and formed as use case diagram in UML language.

Setting of project scope is mentioned by K. Schwalbe [8]. Two scopes were set. The scope of attributes is the first and the scope of recorded plants. To collect data about all plants is not possible in areal. Some plant are contemporary placed, especially herbs naturally disappear and move. The scope was set only for essential plant for education.

**Specification of functions**

Analytical phase brought requirement to store descriptive botanical information about every important plant (from the education point). Furthermore, the list of functions was created. Basic requirement was to select plant or plants according to one condition or combination of conditions. The specific requirement was to connect database of plants to the orientation plan of areal. Expected functions were:

- show selected plant from the database on the plan (zoom in to plant),
- select plant on the plan and skip to its information in the database.

That functions were aimed to the student-user. Moreover, functional analyses brought requirement to administrate the content of valid value tables (enumeration domains) for filling data about genus, species, family, inflorescence etc. Administrators of database mainly fill and edit data about plants. The role of administrator was separate to the administrator of Botanical garden and administrator of Collection conservatories. The reason is that both garden both conservatories has own head person and belongs different institutions. Garden only borders with conservatories in the central part of Olomouc town. This reality had to be considered in design of rights of administrators. Two roles exist: administrator – garden, administrator – conservatories. One role – super admin was defined above partial administrators.

Next requirement function was the collection of photos for every plant in photo gallery. The requirement was to assign photos into various categories (photo of habitus, flower, fruit, leaf and others), to set the title of photos and to record the name of the author of photo.

**Design of technological architecture**

MySQL database version 5.1 was chosen as database management system. The database model consists of the main table with records about plants. Number of descriptive attributes is 49. Half of them is foreign keys to the valid value tables. The structure of the database is arranged as snow flake schema represented by centralized table (plants)

and connection to the valid value tables. Beside them, there are tables of users, table with administrator's logs and table for storing information about photos (Fig. 2). Photos are stored as files in file systems. One photo had three forms: photo with full resolution, photo with small resolution and photo with very small resolution (used as icon).
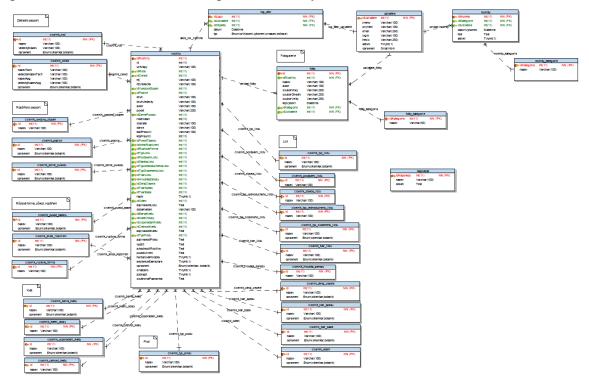


**Fig.** 1: ER database model of BotanGIS

Design stage covered the graphical design of the interface. Set of graphical layouts were prepared firstly in graphic editor Coreldraw. Design of interface considered the good and simply arrangement to respect usability. Start page has five buttons in a vertical line: Introduction, Botanical garden, Collection conservatories, Map and Info (Fig. 2). The second and third buttons are entrances to the databases of plants. Button Map is the third. More important part of information system is a database, so they are firstly than Map. The middle part contains the description and illustrative photo of both botanical areal (Fig. 2).

Arrange of page for selecting data from database was also prepared in graphic format before design final HTLM pages. The line with buttons remains. The boxes for construction of selection condition are in the middle. Remain bottom part of the page is a list of plants. The width of the page allows only six columns to display base identification and description of plant in one row. Small photo of plant or part of the plant is on the left side in a row for each plant. Icon *i* on the right side allows to switch to the window with detail information about plant. Next icon is magnifying glass that switches to the plan to show localization in areal (Fig. 3).

Plans of garden and conservatories were prepared according to experts in cartography [3]. Mainly the choice of colors and symbols fulfill the cartography associativity rule. The cartographers recommended the green color for park places, brown for plant beds, etc. The labeling of plants and parts was also cartographical task.

**Fig.** 2: Interface of information system BotanGIS



**Fig.** 3: List of plants in Botanical Garden

**Implementation**

Activity diagram (UML language) helped to arrange the sequence for creation of information parts. The first starts the collection of geometrical data of Botanical garden. Buildings, pathways, plant beds and ponds were measured in garden. Cadastral map was taken as a base for digitalization of shapes of building parts. Cadastral map secured that all features at Botanical garden had geographical coordinates.

Next activity was database design and map component design. Map part of information systems BotanGIS is based on ArcGIS technologies. ArcGIS Server is on the server side, and ArcGIS Viewer for Flex is on the client side (producer ESRI company). Base of the map is an aerial photo (Fig. 4). Configuration of widgets was prepared for better using of application.
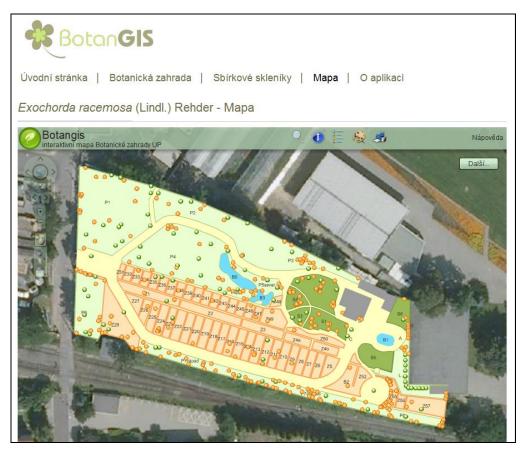


**Fig.** 4: Plan of Botanical garden in ArcGIS Viewer for Flex

Last activity was filling all botanical information to the database now. It started by filling ID numbers and base information about plant. Next activity was filling extended botanical information. Photo gallery was filled simultaneously with extend information.

**Testing phase**

Test of application started in the phase of implementation together. Firstly was implemented administration interface. Botanists filled records into the tables with valid values (domains). Separate domain tables are for botanical garden a separate tables are for conservatories. The reason is that tropical subtropical plants belong to different Taxa.

The second testing phase started by recording information about trees and bushes (shrub) in Botanical garden. The number of trees and bushes is 358 together. This phase verify the full functionality of database part. It was tested the construction of conditions and the correct displaying of detail information about plant (Fig.4). The point layer of trees and bushes in Botanical garden was added to the plan. It was necessary to test the join of each plant in the map to the database and reverse join from the database to the map. The testing set was chosen very well. The collection of spatial location of trees in the garden was easier than collection localization of herbs.



**Fig.** 4: Detail information about plant ID 24 (Acer opalus)

### Deployment and time managing

After testing phase, the installation of application to the university server was realized. Storing information about plants from Collection conservatories started. The subtropical conservatory was the first from all four conservatories. The correct determination of plants was the easiest there. The specialist for tropical botany guaranteed it. The tree other conservatories will be filled in 2012 and 2013. Herbs at Botanical garden are also planned to digitize and record to database in the end of 2012.

### CONCLUSION

Management of project BotanGIS putted botanist and geoinformatics together. The main activities and steps of design of information system BotanGIS is correspond to the theory. Management of collection data, programming of application and filling by

botanical data and spatial data was complicated. Timing diagram helped in managing. It was not possible to wait to the full implementation of information system. The collection of graphical part for plans started at the same time for both areal, for botanical garden and conservatories. Graphical part was digitalized in geographic systems. The base feature classes were measured. List of plants was written in MS Excel spreadsheet. The analytical part was run in the same time with collecting of graphical data. Implementation of information system BotanGIS followed. The simultaneity was necessary. The real descriptive and graphical data about trees and bushes in the garden allowed to start the testing phase. Stepwise filling of information about herbs and plants from other conservatories start in 2012 after the implementation and testing phase. The information system will be used in teaching and lecturing of botanists in the academic year 2012/13. The collection of all data especially photo gallery will be continued.

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