BEST-GIS

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Guidelines for Best Practice in User Interface for GIS

Section 4
"Analysis of GIS users, tasks and workflows"

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4. Analysis of GIS users, tasks and workflows

A majority of GIS projects fail because the true user problems, needs and requirements were not identified (Gould 1994, 1106). By more precisely identifying user requirements and better translating these to system functionality (sections 5 to 7) we can improve on the current situation.

The general aim of this section is to characterise the GIS user groups by analysing who the end-users are, which tasks they perform with GIS in order to achieve specified goals, when and where they use GIS, the way they react and what they expect from the usage of GIS.

Structured interviews were carried out and a checklist was devised to determine general user requirements. The results are summarised into typical scenarios of GIS use which the beginning user can treat as reference situations to better understand his/her GIS needs with the goal of promoting more successful purchase, development and customisation of future GIS products.

4.1 Analysing user requirements for the GIS domain

Fully understanding the users' abilities and goals can positively influence the entire GIS design, development and customisation process.

Practical analytical and empirical methods for capturing user specific issues to be addressed in system development activities are available in the Human-Computer Interaction (HCI) literature (section 3).

Whereas traditionally GIS developers assume the user will adapt to any reasonable system design, experts in the field of human factors require the GIS design to meet the expectations of end users.

GIS need not be tailored to individual differences. However, specific user groups and scenarios can be identified representing users with similar abilities and skills who make similar use of the same GIS functionalities. One of such categorisations is the following:

Type of User	Information demand	User demand	Type of GIS	Development
information specialist	raw data	analysis, flexibility	large, flexible	links to other packages
preparer of policy	raw and pre treated data	analysis, good accessibility	compact, manageable	interfaces to other packages
policy decision maker	strategic information	users accessibility, optimisation models	'small and beautiful'	friendly interface, key information
interested citizen	relevant information	'real life' information	'small and beautiful'	intuitive interface

Table 4.1: Types of user and their demands for a GIS (from Nijkamp & Scholten, 1993)

In this section the reader will find information necessary to construct a similar categorisation. The available methods for user requirement gathering, task/workflow analysis and context-of-use analysis have been screened to identify those which are best suited for a brief analysis of the GIS domain.

To produce the information of this section, a structured interview and a checklist were chosen for their simplicity and effectiveness.

4.1.1 Structured interview

The structured interview used in this study consists of pre-defined questions tailored to address the most relevant issues for the characterisation of GIS users and other stakeholders who have an interest in GIS, their specific tasks and the relationships and interdependencies occurring in the GIS work environment.

The issues addressed by the interview are:

- identifying the people involved in the development, purchase and customisation of a GIS;
- identifying GIS end-users;
- basic skills and expertise of GIS end-users;
- the physical environment where GIS activities are carried out;
- exploration of the objective for GIS applications;
- tasks to be achieved with GIS applications;
- workflows (interactions and dependencies among GIS end-users and other stakeholders);
- reactions while using the GIS application in order to identify problems, difficulties and overall user satisfaction with the GIS.

Adoption of a structured interview, in which the questions are prepared ahead of time but the users can respond in an open-ended manner, provides the researcher with a clear picture of the "GIS world":

1) various stakeholders, i.e. people having specific interests in GIS;
2) users with *hands-on* GIS experience;
3) emerging difficulties, problems, satisfaction with GIS, expectations using GIS;
4) relationships and interactions among end-users and other stakeholders.

The aim is to provide those end-users responsible for requirements specification with a practical example on how to perform user requirements and task analysis. Particular trends, which are discussed in the remainder of this section, have been highlighted based on the users' positions with respect to the GIS context as gathered during the interviews and from the experience of this document.

4.1.2 GIS usability checklist

Usability describes the extent to which an end-user is able to carry out tasks successfully (*effectiveness*), easily (*efficiency*) and pleasantly (*user satisfaction*) using a computer system.

The widely used usability checklist developed by Ravden and Johnson (1989) was chosen as a suitable method to collect the opinions of GIS end-users. The checklist was slightly adapted to the GIS domain. End-users with practical GIS experience were asked to rate specific aspects of the GIS they were using with respect to nine ergonomics criteria which a well-designed user interface should aim to meet:

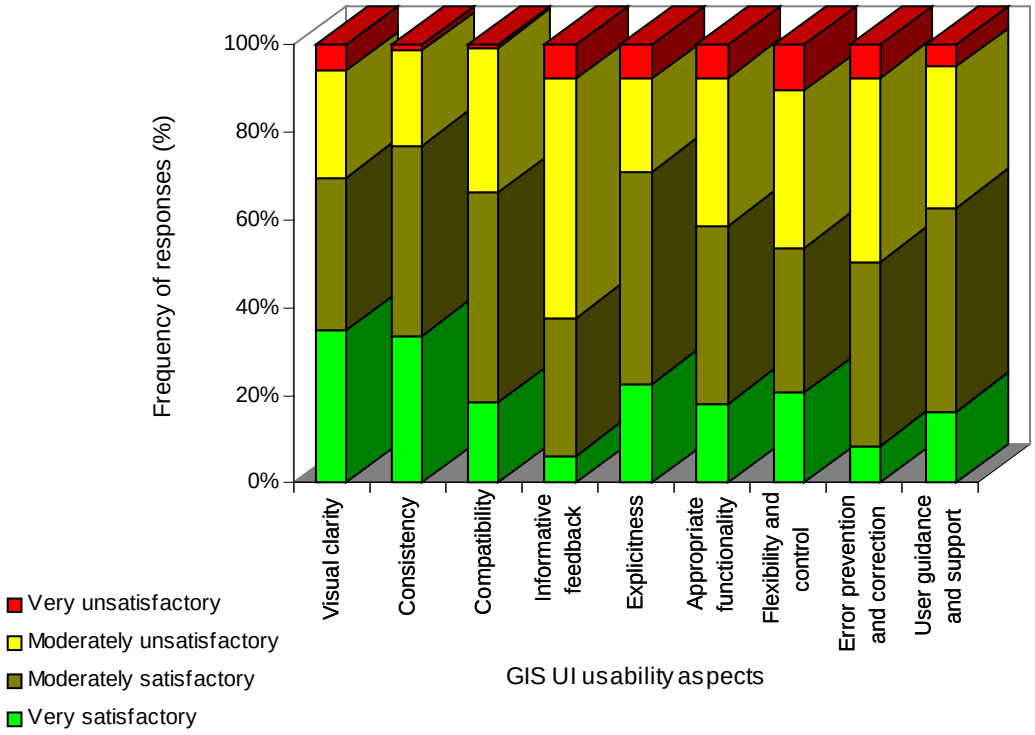
- Visual clarity
- Consistency
- Compatibility
- Informative feedback
- Explicitness
- Appropriate functionality
- Flexibility and control
- Error prevention and correction
- User guidance and support

The checklist also contains a list of general questions on the most common system usability problems which might be experienced during the use of GIS.

Adopting the checklist has the twofold advantage of:

- disclosing the most common usability problems while one is facing GIS;
- highlighting important weaknesses and strengths of the most common GIS development environments.

A first result from the checklist analysis is the assessment of the interviewees' opinion on the nine usability aspects of the GIS user interface they use:



By correlating common problems and difficulties the users experience with the use of GIS to the nine usability criteria mentioned above, it is possible to detect critical aspects of GIS functionality which merit closer attention (e.g. improvements) by developers and customisers, as well as to reveal aspects of GIS usage which satisfy the users.

4.2 Description of GIS users and stakeholders, tasks, workflows

GIS applications are used in a dynamic environment composed of:

- **GIS users and other stakeholders**, people who somehow influence or are affected by GIS;
- **Tasks** the users intend to perform with the GIS in order to achieve specified goals;
- **Workflows**, the interaction and information exchange occurring among users themselves and with other stakeholders contributing towards the achievement of a shared GIS objective.

The findings from both the usability checklist and the structured interview, conducted on some thirty subjects from Italy, Greece, Portugal, Spain, Germany and the Netherlands, have been analysed and cross-correlated to derive the following descriptions.

GIS users and stakeholders

Two broad GI user categories can be distinguished:

- *Consumer/end-user* (domain specialists, who may not be GIS specialists, and spatially-aware professionals), and
- *Super-user* (analysts with a higher technical specialisation in software environments for the development and customisation of GIS applications).

Within the “Consumer/end-user” category, at least three basic user groups can also be distinguished: the *viewers* (who access, visualise and print GI data and may not have GIS experience); the *users* (who analyse and process GI data, as well as add derived information to databases; they most likely do have GIS experience); and the *implementors* (who set up databases and maintain them and normally have GIS experience).

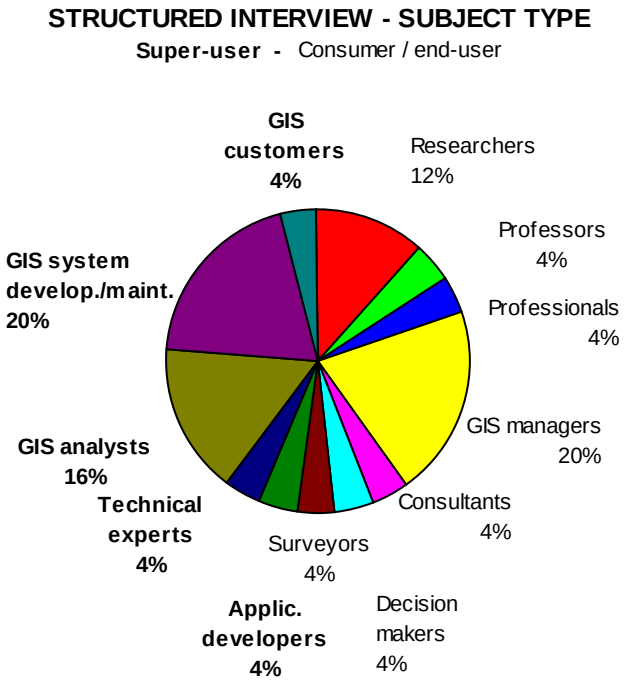
Interviewee profile. 52% of the interviewed persons were identified as “consumers/end-users”. They are mostly GIS managers, work for national and regional public and private companies and for the local government and are mainly involved in decision-making activities. Some GIS system analysts with a higher commitment to specific field applications also belong to this category: They are mostly engaged in cooperative work on large application projects or in consulting activities.

A few of these users are researchers and university professors of GIS disciplines; especially the latter have a long experience in specific GI application domains and are often involved as domain experts within application projects. Professional users, e.g. architects, civil engineers and surveyors are also among the “consumers/end-users” of GIS tools for their professional activities.

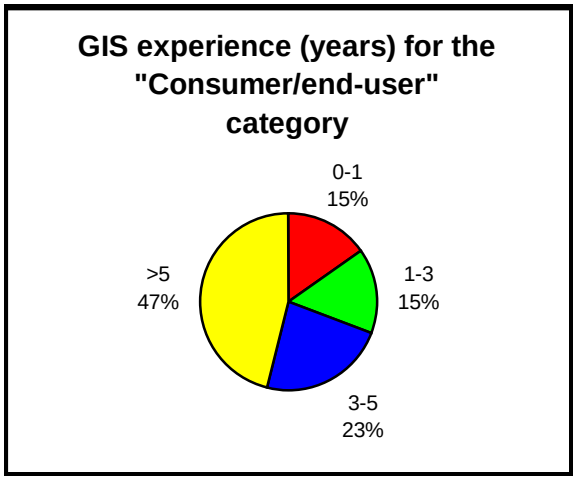
Additional GIS stakeholders, which can be classified in the “Consumer/end-user”, emerged as single indications from the interviews; these act in the GIS scenario but do not use GIS directly:

- those responsible for the purchase of GIS: the technical director, the company owner, the GIS vendor, specific technical commissions who evaluate the GIS vendors’ commercial proposals. The technical expert/manager and the high management with few application domain specialists and very few end users are the most common professional roles involved;
- producers of the base data to be processed using GIS (cartography producers, surveyors, local authorities departments, professionals);
- those who purchase/use the output of the GIS activities (local government, municipalities, decision-makers and planners, educational organisations, utility services).

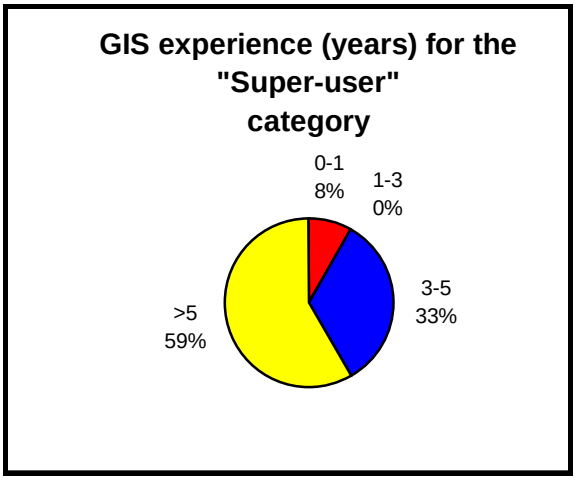
The other 48% of the interviewed subjects were in the “Super-user” category, represented mostly by GIS technical experts who work for private companies and also for local authorities.



The GIS experience of the subjects in the "Consumer/end-user" category is on average 5 years, with an intermediate to advanced level of expertise in using different GIS products:



The subjects in the "Super-user" category have most experience in the GIS domain (around 8 years on average) and much deeper expertise in the practical use of different GIS environments:



56% of the interviewed users believe they have sufficient knowledge, both in terms of GI domain knowledge and of *hands-on* experience using GIS, 40% affirm that their geographic experience and knowledge is barely sufficient for their job.

Some (48%) of these users have learned GIS by themselves working directly on projects and succeeding in gaining a good level of expertise thanks to the practice and the personal enthusiasm in using the system. The same percentage of users has received training courses from GIS vendors and 24% from other staff within their own work organisation.

The users who have received GIS training at university generally complain that their courses have focused too much on the theory, almost always excluding sessions for the practical use of GIS.

Asked to indicate the shortcomings of such courses, the most experienced GIS users pointed towards the importance of teaching how to use GIS for decision support analysis, for creating sophisticated output products, for managing complex databases. In general, the users indicate the lack of a connection to real practical situations during GIS courses.

4.2.1 Application domains, Tasks and Workflows

The interviewed users recognise the fields of Environmental control/monitoring or Urban planning as the most popular application contexts of their GIS everyday work, which typically regards, in a broader sense, activities as development of application projects, consulting, planning, decision-making, teaching.

Other emerging application domains, coming from single isolated responses, regard the fields of multimedia GIS (very often for teaching, education/entertainment, tourist, diagnostic purposes); analysis of social and economical phenomena (e.g. from the points of view of specific services demand); geomarketing (analyses of marketing dynamics performed on georeferenced data, e.g. optimisation of the allocation on the territory of given vendor networks).

Asked to identify and represent tasks related to their GIS experience, the users described the most common and frequently performed activities of any GIS application project: database creation; core analysis; production and visualisation of thematic results. Specialised modelling activities were reported for the different application domains (seismic risk, irrigation planning, soil erosion, environmental pollution).

Regarding the structure of GIS tasks, users were not able to break down global tasks into sets of specific or unit tasks. Tasks were reported, instead, as single macro-steps of entire GIS projects.

This finding may indicate the holistic nature of the users' perceived workflow. Whereas the typical GIS package breaks functions into small pieces, each designed to attack a small part of the work, apparently users view their workflow at a coarser resolution. A properly designed user interface should perhaps make it easier for the user to continue viewing the work at this general level.

The interviewed users tended to identify their GIS tasks with the five basic steps of most GIS projects: database management, spatial analysis, modelling, output and visualisation. The reason for such responses is probably that *hands-on* users are, for most of the time, involved in one specified phase of a GIS project, mostly digitising or mostly editing for example. Hence, the description of a task (e.g. performing a query on a database) is often treated as the description of the GIS project in which they are (have been) involved.

Application areas. The reported GIS application projects cover a wide range, including the management, monitoring and control of various territorial situations (e.g. forest fires, source pollution, uncontrolled waste discharge, site planning, irrigation planning and management, land suitability analysis) and general urban management activities (e.g. historical city conservation,

city network management, cadastral management, urban development changes). Some other projects focus on the creation of large public domain databases often integrated with national systems of geographical and environmental information.

A few others are decision support systems (desertification prevention, irrigation planning, land use suitability, soil erosion) which are equipped with specialised domain-dependent modelling capabilities (hydrological balance equations, forecast models, water quality assessment models). These application categories are the most demanding with respect to GIS functionality for the creation/manipulation of attribute databases and specific queries for complex analyses and simulation purposes (e.g. predicting the behaviour of environmental systems under changing situations).

Most of the geographic information resulting from these applications is provided to territorial planners/managers and municipal services, who need easy-to-produce and ready-to-use information for their decision making activities. Since the reported applications are primarily based on information creation and cartographic production and interpretation, users stress a need for more efficient tools for:

- graphics and map layer management through better display functionalities (pan, zoom, view);
- analysis of combined and linked map properties for comparisons and interpretations (e.g. maps overlay, background images exploitation) finalised to *what-if* analyses;
- creation and maintenance of thematic representations (views) resulting from specific analyses and/or from features/attributes databases query activities.

Expert users also point out the usefulness of equipping GIS systems with more suitable functions for digital terrain modelling and raster images treatment (e.g. raster/vector conversions). Limitations in current GIS are mostly recognised by those users who perform environmental analysis for large scale territorial planning (soil erosion containment, environmental impact analysis, land use change detection).

Less experienced users feel the necessity of equipping GIS products with more explicit informative messages and error identification and interpretation facilities.

Obviously, it is common knowledge that novice and expert users have differing needs and preferences with respect to the GIS use, and this was illustrated by the results above.

More specific GIS interface-related problems, such as programming limitations, emerge during the most advanced projects phases when the whole collection of base data and derived information (tables, maps, graphs, texts) and database, modelling and visualisation components have to be organised for final product/service delivery.

The **personal interactions** during a GIS-related work were considered of primary importance by users, mainly because GIS work is a multidisciplinary experience and must therefore rely on the availability of different skills and knowledge. This further complicates the necessity of interacting with other organisations for data/information exchange: municipal departments, cartographic production services, image processing firms, existing GIS databases, census departments, the company itself where GIS work is performed.

Cooperation among colleagues working on GIS was judged as a necessity. Very few users have declared that they do not cooperate with co-workers: these are mostly researchers and professors engaged in less practical GIS work.

The interaction among GIS users occurs mostly during project meetings to set goals and assign tasks; this cooperation helps project teams learn about new features, find out how to correct errors, discover alternative ways of performing tasks, share computing resources, take advantage of complementary expertise and parallelise work when possible. In general, GIS was described as a technology which demands teamwork.

4.2.2 User requirements for GIS applications

The acquisition of a GIS is prompted mostly by application project necessities, although GIS acquisition might be strongly encouraged also by commercial competition with companies that already use GIS successfully. The three most important factors which, in the surveyed users' opinion, influence the purchase of a GIS are:

- the availability within GIS of a powerful and efficient database management facility;
- a user-friendly interface;
- compatibility with the existing hw/sw equipment.

With reference to user interface, users feel more confident in buying a GIS if it is easy to learn and use. This is obviously satisfied if the interface is sufficiently "readable" (*visual clarity*) and supports the user's learning and usage phases with clear informative messages, error prevention and correction facilities; these are, in fact, among the additional aspects which users want to evaluate when a GIS is going to be purchased.

The purchase decision is a very important task which, in most cases, involves the work of specific technical committees who first specify the application objectives, then identify the end-user community needs and thereafter investigate how the requirements can be reached. This is checked against the GIS market availability, where a comparison between similar, competing products is made (*benchmarking*) in order to finally make a decision based on information about cost/benefits of long term GIS use, database, analysis facilities, compatibility with existing hw/sw resources and ease-of-use.

From the interviews it has emerged that usability engineering and UI quality evaluation activities are still not a "practice" within most GIS projects. A consequence of this is that **end-users complain that too often GIS design and customisation are carried out 'without the user in mind'**.

This is confirmed by the fact that most 'first time users' feel no confidence in the understanding and usage of GIS at the beginning. The more experienced users recognise that the GIS does not always allow users to do what they actually need to do for their application necessities.

The **physical environment** where GIS work is performed was rated by the surveyed subjects in a rating scale 1(insufficient) to 5(good). It seems to satisfy users with respect to lighting conditions and equipment accessibility (mean score 4.1). Available space and furniture scored 3.2. Noise and thermal conditions (heating, cooling) both scored 3.5.

The findings are summarised below for the two most common GIS application domains which emerged from the interviews: Environmental Control and Urban Planning.

Summary of the analysis for the ENVIRONMENTAL CONTROL application field

Users

Highly domain-specialised (researchers, university professors, consultants, GIS application analysts).

Work in private companies, R&D institutions, universities, Public Administrations.

Intermediate to advanced experience with the most common GIS.

A high degree of decision capacity in establishing goals and directions for their GIS activities. Equally distributed in two categories:

1. Consumer/end user (GIS researchers, professors, consultants, *hands-on* users, domain experts);
2. Super-user (GIS application analysts, technical managers).

Stakeholders

Subjects participating in the decision process of purchasing GIS: upper management from the organisation, technical experts, the company owner, application domain specialists, end users (very few cases).

The subjects involved in activities of customisation of GIS user interfaces are mostly external consultants, GIS vendors/suppliers. Most interviewees declare they prefers to perform GIS/GUI customisation on their own. Training activities on the use of specific GIS products are mostly performed by GIS vendors/suppliers, university professors and other staff in the interviewees work organisation. But most interviewees declare they have learned GIS by themselves on a *learning by doing* basis.

Parties involved in the production of the raw data (base maps, satellite imageries, field data) to be processed with GIS: Public Administration (territorial management depts.), local environmental agencies, cartography production institutions, university departments, Environmental ministries, Remote Sensing data producers/vendors.

Some of the above subjects (Public Administration, environmental agencies, territorial managers) together with educational organisations, represent to various extents the final consumers of the products/services realised with GIS (feasibility studies for land use planning, thematic maps of environmental phenomena).

R&D and technology transfer companies use the outputs of their own GIS activities for demonstration and educational activities (prototypes, GIS courses).

The most common tasks

Simulation analyses for decision support activities; Production of thematic maps for site monitoring and planning; Feasibility studies for territorial development and conservation; Creation and maintenance of large databases of environmental information; Realisation of Environmental Decision Support Systems (most at a prototype stage); Application systems for territorial monitoring (water and air pollution, soil erosion, contaminated sites monitoring, seismic hazard, desertification, irrigation planning, land suitability analysis).

Workflows

Interactions with colleagues for: parallelisation of GIS activities, sharing of experience, learning from other users' experience, working together on how to correct errors.

Data exchange and purchase from other institutions.

Cooperation during the various decision steps for the purchase of GIS.

Interaction with external institutions for data and information exchange(acquisition) and for the exploitation of GIS output products.

Problems & needs

Activities in the field of Environmental Control rely heavily on the analysis of different types of data (raster/vector/imagery/temporal) whose treatment requires the availability of more adequate data conversion, integration, modelling and visualisation tools.

Users agree on the fact that it is by no means easy to get started using GIS: according to them, the GIS user interface needs to be particularly improved in such usability aspects as informative feedback, explicitness, error prevention and correction, user guidance and support.

Summary of the analysis for the URBAN PLANNING application field

Users

Mostly these are GIS managers, geographers, GIS technical experts and executive decision-makers. They are mostly employees of private companies.

Many also work in the Public Administration, municipalities and Local Governments acting as planning managers and technical officers (cartographic applications departments).

Their daily GIS work can rely on a good knowledge of the GI domain. Users show advanced expertise when working with some of the most commonly used GIS products.

They are divided almost equally between the two categories of Consumer/end user (GIS analysts, geographers, decision-makers) and Super-user (GIS application developers and technical experts).

Stakeholders

GIS technical managers and especially GIS technical experts are in most cases responsible for the purchase of GIS in their work organisations. In some cases, the high management and the GIS application developers are as well involved in the GIS purchase decision.

The stakeholders involved in GIS/GUI customisation activities are in large part the interviewees themselves.

Those involved in training activities on the use of specific GIS products are mostly GIS vendors/suppliers, university professors and other staff of the interviewees work organisation.

More GIS stakeholders are found among the producers of the raw data to be processed with GIS: the responsibles of municipal databases of socio-economical and cadastral data, base cartography (urban technical maps) producers, satellite image vendors, professional categories (architects, engineers, surveyors, topographers), the National Statistics Institutes, urban facilities companies (telephone, electricity, gas, light, water).

Almost all of the above (decision-makers, municipal planners, governmental managers) represent also the subjects which use, for their institutional activities, the outputs realised with GIS (thematic maps, services to citizens, decision support systems for the control and maintenance of the urban technology networks, consultation systems as the city guide).

The most common tasks

Emergency monitoring and management, urban cadastre management, databases development and maintenance (road network for optimal routes calculation), production of technical maps (for historical sites monitoring, cadastral statistics, tourist, education/entertainment), planning of recovery of historical buildings, utilities management.

Prototypes and consultation decision support systems are developed for helping municipalities with optimal planning urban decisions. Demonstration activities for technology diffusion and education are performed to present GIS potentials.

Workflows

Cooperation among co-workers during GIS projects is for learning purposes from the most experienced and skilled, to speed up work by sharing workloads.

External interactions are related to data and information purchase/exchange, to seek expert opinions on domain-specific issues and test the GIS results and outputs with end users.

Problems & needs

Users working in the Urban Planning application field are typically managers and planners who have to manage large databases and perform queries for fast and accurate decision-making. Hence, attention should be paid by GIS developers to the improvement of specific functionalities for more adequate database queries, creation of “situational” views (databases, thematic results) and views/visualisation of graphic results. These aspects are related to the usability of GIS during such phases as consultation and result interpretation.

4.3 Typical scenarios of GIS use

A typical GIS usage scenario illustrates a GIS project with its GIS users, the tasks they perform, how users interact with each other and with other stakeholders. The primary objective of scenario building in the early phases of a GIS development cycle is to identify user goals, tasks and requirements.

The idea of creating typical GIS user scenarios is:

- to help development and customisation find out what kind of GIS user interface is needed (for beginners, for infrequent users, for experts; with specific functionality for specific subsets of tasks such as data entry only, visualisation only, for simulation and visualisation)

- to help the users describe their requirements. Users should look at these scenarios and say "*this could be my case, this scenario represents the work I mostly do and the experience I have*".

Examples of typical GIS usage scenarios extracted from real GIS projects are provided below to show what is expected from users and what would be best practice.

At least three components can be identified in properly constructed scenarios:

- **Task breakdown**[1], a graphical representation of a common GIS task as a suitable hierarchy of high level goals, tasks, sub-tasks and operations (or actions) numbered as a sequence. This can be useful for GIS applications developers and customisers to help them understand how end-user intend to use GIS to reach their application goal.

- **Workflow**, to recognise relationships and dependencies among people directly and indirectly involved in GIS work. This can be useful for GIS applications developers and customisers to help them understand the "dynamics" of GIS work as it focuses on processes.

- Relevant **User requirements** identified for performance of the given task in order to achieve the goal.

Scenario 1

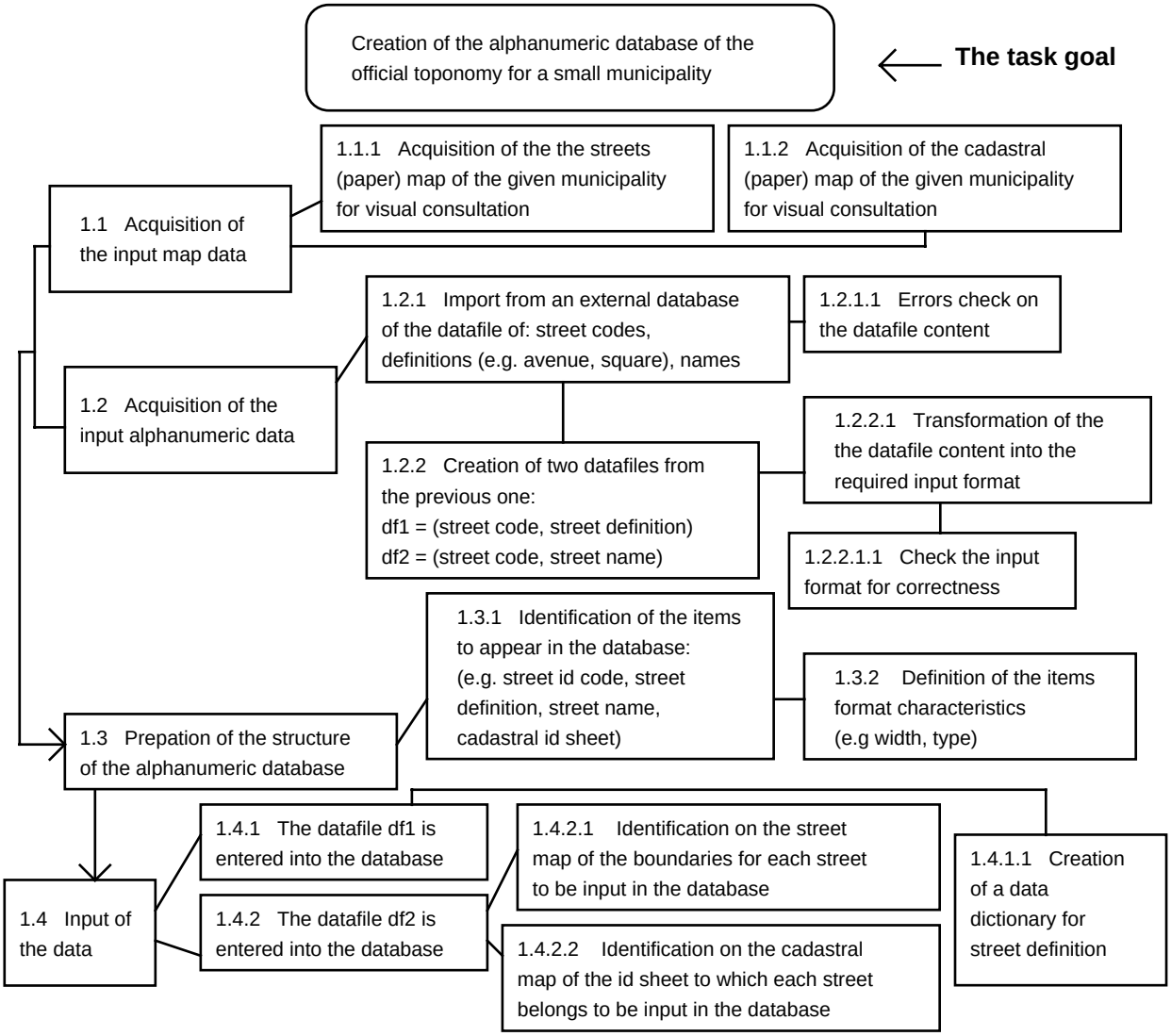
This scenario from Urban Planning describes a part of the automation of the cadastral system of a small municipality.

The task "Creation of the alphanumeric database of the official toponomy for a small municipality" is one of the most common tasks performed during GIS project development and implementation. Key GIS functions for the execution of this task are described in section 6.7 "Attribute data management".

This task is performed by users engaged in databases creation and maintenance. Cartographic and GIS knowledge, and experience with cadastral information are needed. The task requires interactions with external institutions (municipality) for data exchange.

[1] For demonstration purposes, tasks were selected for their representativeness with respect to three of the most common GIS projects activities described in section 6.

Task breakdown



Workflow

The cadastral department	→	provides base maps (paper) to end-user 1 of the DB maintenance service to perform activity 1.1
The cadastral department	→	provides end-user 2 with alphanumeric data (to perform activity 1.2).
End-user 2	→	provides end-user 1 with a database of input information to perform activities in 1.2.1, 1.2.2, etc.
End-user 1	→	performs quality and error checks on input data.
End-user 1	→	enters data in the previously structured database.
End-user 1	→	provides end-user 3 with the input (activity 1.4.1) for data dictionary creation.
End-user 1	→	provides end-user 4 with the input for further analysis.

Relevant user requirements for the task

- The system should inform the user when the format of the input file is not adequate.
- The system should check the input data to ensure error-free and high quality of results.
- Connections to other databases should always be made obvious; the user should be informed if operations on the database are restricted.
- The system should provide end-users with a suitable way for controlling such GIS impediments as incompatible formats, different map scales/projections, different storage media, etc.
- The interface should provide menus for creating and updating a database, instead of issuing commands.

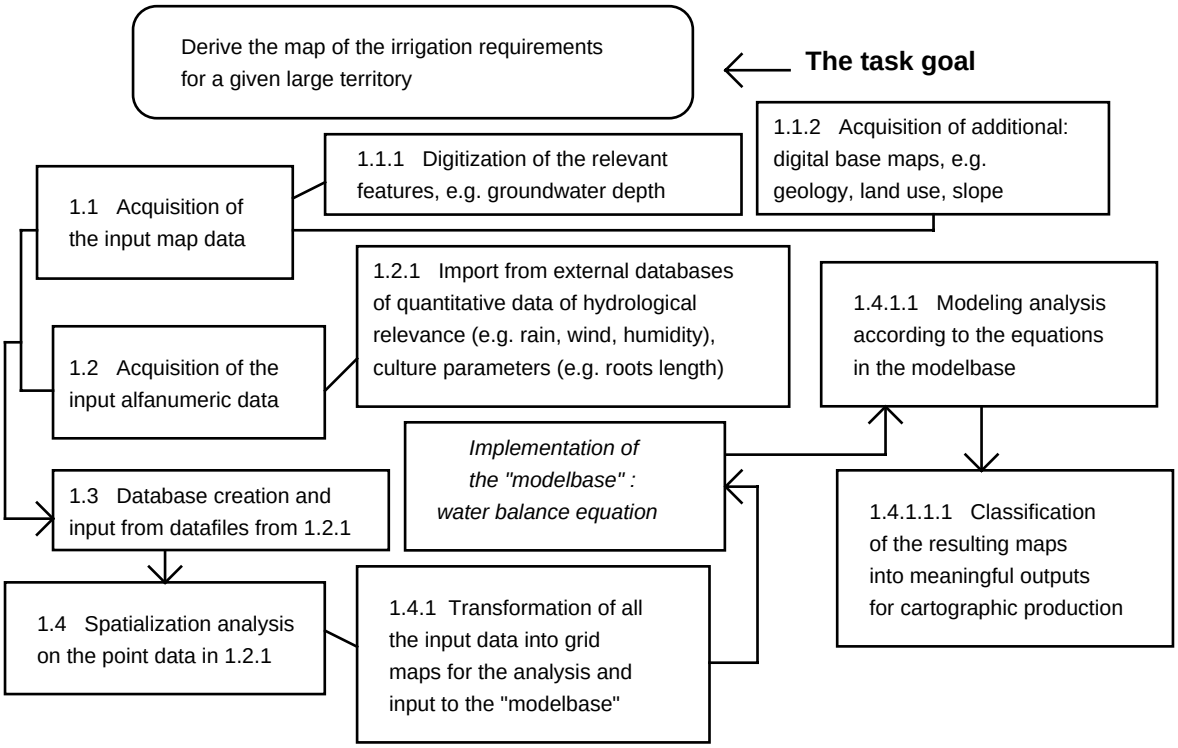
Section 5.3.8 may help to identify more requirements.

Scenario 2

This scenario from Environmental control describes a task needed for the implementation of a decision support system to aid territorial managers in planning irrigation on a large agricultural area. The task “Derive the map of the irrigation requirements for a given large territory” is performed whenever planners need to monitor the irrigation needs of the territory they control or to assess the area water requirements to plan future irrigation equipment. Key GIS functions needed for this task can be found in section 6.8 “Data processing / analysis”.

GIS and domain knowledge, and analytical capabilities are required. Data acquisition (base maps, field data) requires interactions with external institutions (meteorological service, cartography producers).

Task breakdown



In the above scenario, the implementation of the “modelbase” is an activity which can be performed any time in parallel to the group activities 1.1, 1.2, 1.3 and 1.4 before 1.4.1.

Workflow

Public territorial sectors	→	provide base maps to end-user 1 from the involved company for digitising relevant themes and setting up the attribute database. This normally follows a preliminary phase where maps are checked for compatibility.
End-user 1	→	provides end-user 2 with the input for modelling.
Problem expert	→	helps end-user 2 in establishing a suitable model for the relevant analysis, checking inputs and working at the model perfomance.
End-user 2	→	provides end-user 3 with the final results for producing cartographic output.

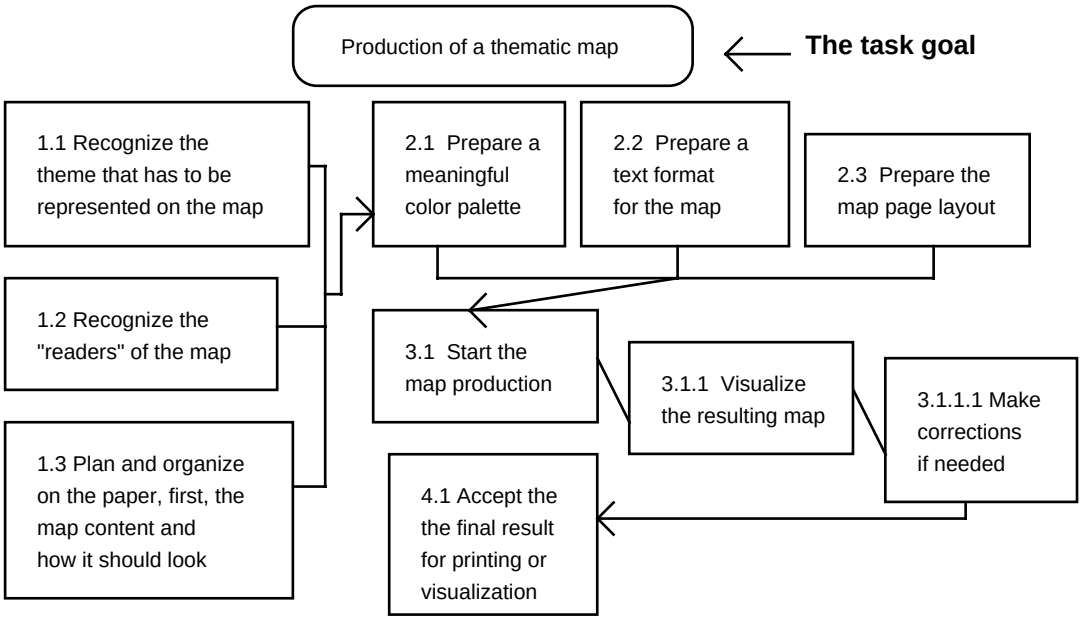
Relevant user requirements for the task

- The basic analysis tools of the GIS (e.g. kriging, DTM) should be made clearer to the user with the help of realistic examples where possible.
- The system should provide users with a suitable way of implementing or accessing external models.
- The system should allow users to quickly verify (possibly using graphics) the results of the analysis, in order to facilitate 'real time' modifications or corrections.

Scenario 3

This scenario describes the task "Production of a thematic map" performed during GIS projects development and implementation. This is a frequent and critical task requiring an accurate planning of the GIS functions needed (see section 6.9 "Output: map productions / reports) and the requirements (see section 5.3.7) in order to make GI information a "tangible" product.

Task breakdown



Workflow

End-user 1 →	provides end-user 2 with the input (both the map content and requirements) for cartographic production. All sorts of data are integrated with the map data: legends, tables, titles, imagery, etc.
End-user 2 →	checks results with end-user 1 for modifications or acceptance of the product.

Relevant user requirements for the task

- The system should provide end-users with a straightforward way of managing and creating the cartographic attributes of the map.
- The system should provide end-users with the possibility to visualise on the screen exactly what the printed map will be (WYSIWYG).
- The system should facilitate the integration of map data with other data sources which are key to the final graphic composition.
- The map tools module of the system should be integrated and consistent with the rest of the system.

4.4 Summary

Until recently, system designers have paid little attention to user needs in order to develop GIS systems with functionality and appropriate user interfaces to match those user requirements.

Fortunately, the situation is starting to change, but still many developers do not know how to go about involving users. Involving users in system specification generally has two main outcomes:

- it allows one to find out about users so that the resulting system is both useful and usable;
- it vastly increases the chance of user acceptability.

A lesson that can be learned from the analysis discussed in this section is that to be successful, GIS designers must go beyond the broad notion of user-friendliness to have a thorough understanding of the diverse community of users that are likely to use the system, of the tasks that must be accomplished and of the way users solve given problems in their everyday work life.

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