BEST-GIS

ESPRIT/ESSI project no. 21580

Funded by:
The European Commission
DGIII - Industry
ESPRIT Programme

Guidelines for Best Practice in User Interface for GIS

Section 8
“GIS user interface standards”

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8. GIS user interface standards

This section explains briefly the status of GIS specific user interface standards and the existing standards and regulations for human computer interfaces with its relevance for GIS user interfaces. Standards and legal issues are important and come into effect when a technology reaches a sufficient level of maturity.

GIS, like information systems of all types, falls under the umbrella of general IS standards regarding the health and safety of the user, such as the European Directive 90/270/EEC and ISO 9241, a multipart standard on ergonomics for the office environment. While these may be somewhat relevant to user comfort in the workplace, there are currently no de jure interface standards which specifically address the use of GIS. On the commercial standards side, however, the organisation Open GIS Consortium-OGC ("The Open GIS Guide", see references) is gaining considerable momentum and support among GIS developers and is progressing on internal communication and data model standards. It should be stated that so far UI issues are not at the forefront of this initiative.

8.1 The wider view of GI standards

In the last few years a wide debate has begun among the European Geographical Information Community and various initiatives are in process also at the European Commission level in order to create a European Geographical Information Infrastructure (EGII), recently renamed the "Policy Framework for Geographic Information".

The EGII is expected to be a stable, European-wide set of agreed rules, standards and procedures for creating, collecting, exchanging and using GI. The EGII would also ensure that European-wide base datasets are readily available and that metadata services exist so that such data can be easily located by potential users.

In general, a GI infrastructure assumes a working system for exchanging data. This requires several components:

- a technical infrastructure over which data can be exchanged (e.g., a WAN, access to WWW or similar)
- a set of standards for data exchange (often called operational, or information technology standards)
- standards for the interpretation of the specific geographic and thematic aspects of the data (semantic or thematic standards)
- organisational arrangements, including economic and legal agreements between the parties concerned.

Implied, but not mentioned explicitly in this scheme, is the goal of advancing system usability in order to facilitate adoption by the general public, which would have profound effects on the GI market.

Most of the European Countries understand the importance of a technical infrastructure and are pushing to have a widely distributed network in place. With this network should come a set of low level standards for the exchange of data (IT standards, for example the set of standards typically used for the Internet and WWW). Unfortunately, wide agreement on the more political and logistical aspects of the infrastructure is still to be reached (as of 11/97).

Thematic standards, which make the effective use of the IT infrastructure to build a GI network, are being promoted at different levels. For example there are ISO and CEN standardisation efforts (e.g., CEN Technical Committee 278, CEN TC 287, ISO Working Group 211) and corresponding groups for national standardisation. In many circumstances national groups work on particular national standards and adaptation of international standards.

Most important is to ensure an approach for an Open System Architecture for GIS and this

concept is crucial to establish a working GI infrastructure, as it goes beyond the standardisation of data exchange ‘file by file’ but allows the intelligent access from a program running in one computer to data supplied on a central server. At the finest resolution, the concept goes as far as the interoperation of distributed geographic objects among systems of various vendors, allowing the user to pick and choose atomic processing modules to be combined to form the ”best” custom GIS for any specific application.

The above describes a complex situation affected by many operational problems that refer to:

users

inter-operability can significantly enlarge the use of GI and the number of users of the corresponding GIS technology (i.e. powerful servers queried by modest clients using free or cheaper software). In general, understanding users is the key factor to develop valuable applications. The software components used in applications must be inter-operable and follow the related international specifications. This has direct implications on usability and workflow management.

data

The availability of common and standardised European data sets is the basic condition for a real European GI environment and for enabling trans-border projects. The forthcoming enlargement of the EU to new countries from Central and Eastern Europe exacerbates the problem. Data are collected and coded according to standards, where the correspondence between national and international standards must be considered initially. At a detailed semantic level there are many subtle linguistic differences in geodata descriptions which cause problems in metadata systems, data dictionaries, query languages, etc. (e.g. an autoroute, autovía, and autobahn are similar yet slightly different entities).

applications

until now GIS technology has been ”product oriented” avoiding or impeding the diffusion or use of specific models in different systems. New technology trends, in particular the Open System Architecture approach, promise to allow sharing of processes and to extend the applications range. The GIS open architecture is compatible with emerging concepts of object-orientation and in workflow design, which promises to better align GIS capabilities with that which the analyst really wants to accomplish.

8.2 Specific standardisation activities

The GI sector is currently working hard on standardisation. The three dimensions of interoperability (data, system, organisational) are attacked from different perspectives by different actors on several continents.

This standardisation process is done at three levels: national (by the standardisation bodies), regional (in Europe by CEN) and global (by ISO). Two categories of standards are produced : de jure standards (CEN, ISO), de facto standards (in general Industry; an example in GIS domain is the Open GIS Consortium).

These standardisation activities need to be better described, documented and promoted. End users from all continents are facing the problem of working with the adequate standards, but the dilemma is, which one to use.

In general terms, we could say that:

- CEN focuses activities on data issues,
- ISO intends to deal with data, system and some organisational issues,
- OGC focuses activities on system issues.

8.3 Minimum health and safety requirements for work with GIS

Poorly designed GIS user interfaces may cause problems and difficulties for the user.

The objective of the Directive of the European Commission 90/270/EEC on minimum health and safety requirements for work with display screen equipment is to prevent health hazards being generated for workers and employees through the use of display screen units. The directive applies to display screens, regardless of the technology used, and workstations, which are defined as assemblies comprising display screen equipment, input devices, software and interfaces. The directive is addressed to employers and employees and to their representatives, and also to manufacturers and distributors of hardware and software. The parts of the directive which relate to physical aspects such as screen size, contrast, character size and other aspects related to the hardware equipment are related to existing legislation and guidelines in most European countries.

The software aspects are innovative, and the respective definitions are that the use of such equipment must not cause health hazards for workers, and that in designing, selecting, commissioning and modifying software, and in designing tasks using display screen equipment, the employer shall take into account the following principles:

- Software must be suitable for the task.
- Software must be easy to use and, where appropriate, adaptable to the user's level of knowledge or experience. No quantitative or qualitative checking facility may be used without the knowledge of the workers.
- Systems must provide feedback to workers on their performance.
- Systems must display information in a format and at a pace which are adapted to users.
- The principles of software ergonomics must be applied, in particular to human-data processing.

The European Directive overlaps to a considerable degree with the most prominent ISO standard 9241 for Ergonomic requirements for office work with display terminals, Part 10: Dialogue Principles (Abernethy 1993, Strijland 1993). The European Directive has been implemented in various ways in the member states; reference can be found at:

(http://europa.eu.int/comm/sg/scadplus/leg/en/chm/c90_270.htm and ..../c89_391.htm)

as legislation relating to safety at work and accident prevention. It is relevant for the design of workplaces, and for software which is used at work.

The main mechanism for testing the compliance of GIS with the European Directive is the obligation of the employer to check and analyse that workplaces are not in conflict with the requirements of the European Directive. As a consequence, it may be determined that certain GIS cannot be used in certain workplaces. It is advisable that GIS developers, vendors and customisers take into account the needs and requirements of their users and customers (sections 3, 4 and 5) to comply with the European Directive in their GIS application.

Out of the European Directive arises the obligation of the employer to analyse GIS workplaces to determine whether the equipment used, including hardware and software, may cause hazards to the health of the employees. An obligation to remove health hazards which are identified follows from this analysis. Because the software ergonomic qualities are today not measurable by accepted objective measurement procedures, no requirement for precisely measurable minimum quality requirements can be defined for software aspects. The current state of the art is the target against which the ergonomic quality of GIS will be measured. It is likely that there will be test procedures which identify GIS applications which deviate negatively from the state of the art, and which may consequently be in violation of the minimum requirements for safety and health as required by the Directive.

The requirements and needs of users and customers, and their appreciation of GIS quality, should be the target for GIS quality, rather than only the juridically defined

minimum requirements.

The most important risk for developers and people who customise GIS arising out of this situation is that the increasing awareness of the problem, and the developing legislation, may lead to a situation wherein it is questioned whether certain products may be used, possibly only for certain application domains. It is obvious, even if this applies only to specific domains of application, such as continuous professional use, that this will have a considerable influence on the quality image of a GIS, and will be seen as a deficiency of the product, even if this may not be the case in strict legal sense. It is also obvious that the required level of quality is evolving, and that the demands of customers and users are rising.

GIS developers and customisers are advised to adopt a quality policy where the verification of their GIS in terms of software ergonomic quality is part of the development and customisation process and of the quality strategy. This should allow them to both stay at the forefront of development, and secondly to enable them to inform their customers and users that the best effort to assure quality of use has been made during GIS development and customisation.

8.4 Checklist for testing conformance with minimum requirements

The checklist below was created mainly for users and customers to determine if health and safety requirements are fulfilled with respect to their task domain, their needs and requirements.

How to use the checklist

The checklist should be used by end-users and customers to test GIS currently in use, or to GIS considered for purchase, and to test GIS designs / prototype interfaces during GIS customisation.

Ideally, all items in the checklist should be answered positevely. Where the answer to an item is negative the reason for causing problems must be identified and the situation improved.

The checklist tests the fulfilment of the seven ergonomic principles of dialogue design:

8.4.1 Suitability for the task

A dialogue is suitable for the tasks a user intends to perform with a GIS, if it supports the efficient and effective task execution without imposing additional workload caused by GIS features on the user.

The task goal can be achieved with the help of the GIS.	
No change between tools is necessary to perform the task (e.g. intermediate calculations on paper, using different GIS tools).	
The relation between time to perform a task (planning, execution, error correction) and task complexity is adequate.	
The time to perform a task with the GIS is adequate compared to the use of alternative methods (e.g. the task can be performed faster with the GIS compared to traditional work procedures or to using an old GIS).	
Similar input procedures are provided for tasks which the user considers to be related or connected.	
The user has fast access to all information or data needed for task execution.	

8.4.2 Self-descriptiveness

A dialogue is self-descriptive to the extent that each dialogue step is immediately comprehensible through system feedback or is explained to the user on his/her requesting the

relevant information. Self-descriptiviness of a dialogue refers to the transparency of the application to the user, existing help and support functions.

The user is provided with help information in order to understand the operation of the GIS application.	
The language is adapted to the user (e.g. use of task domain terminology, no abbreviations, no foreign language).	
The interface supports the user at any time.	
Situated help is provided at any time (e.g. window titles, instructions to proceed).	
The user can determine the amount of help provided by the GIS.	

8.4.3 Controllability

A dialogue is controllable to the extent, that the user is able to maintain direction over the whole course of the interaction (i.e. speed, dialogue sequence, and amount of input/output) until the goal has been met.

The GIS application does not determine work speed (e.g. by refreshing the screen).	
The sequence of commands or steps is - as far as possible - not restricted (e.g. forms can be filled in any order).	
The dialogue can be interrupted at any time and continued later.	
The user can control the amount of information output.	

8.4.4 Conformity with user expectations

A dialogue conforms with user expectations to the extent, that it corresponds to the user's model of the GIS application, his task knowledge, education, experience, and to commonly accepted conventions.

Each object has - as far as possible - the same characteristics in all GIS states (consistency of objects).	
Functions can be activated - as far as possible - in all GIS states in the same way and have the same effect.	
Functions can be activated - as far as possible - in all system states of all application programs the user uses (including the GIS) in the same way and have the same effect (e.g. file handling)	
The meaning of used terminology is always the same.	
Response times are similar for similar procedures, especially such with short processing time. Response times can be assessed in advance. Waiting times are announced by system messages.	
The GIS application provides similar objects and functions for similar work tasks.	
Character input and position are always displayed immediately on the screen (What You See Is What You Get (WYSIWYG)).	

8.4.5 Error tolerance

A dialogue is error tolerant to the extent, if despite evident errors in input, the intended result may be achieved with either no or minimal corrective action having to be taken.

User errors are explained.	
User input does not lead to undetermined system states.	
The GIS is designed such that errors are avoided as far as possible and consequences of errors are made transparent and controllable.	
If it is foreseeable that an action cannot be performed due to given parameters, then the GIS provides an error message as early as possible.	
If an error can be corrected in different ways, then the GIS provides alternatives for error correction and the chance for a new input.	
Error messages are provided immediately. Error messages can be set aside if required by the user.	
Error messages contain information about the location of the error, the cause of the error and possibilities for error correction. Errors are described in an understandable way and structured in a uniform way.	

8.4.6 Suitability for individualisation

A dialogue is suitable for individualisation to the extent, that the dialogue system is constructed to allow for modification to the user's individual needs and skills for a given task.

Various input devices can be used alternatively.	
Command input can be executed with keyboard or mouse.	
The user can use function keys without constraints.	
The user can define macros.	
The user can design menus.	
The user can design modules (functions and objects) for repetitive tasks and work environments.	

8.4.7 Suitability for learning

A dialogue is suitable for learning to the extent, that it provides means, guidance, and simulation to the user during the learning phases.

The GIS application is designed in such a way that it is easy for the user to build a model of the system structure.	
Exploratory learning is supported.	
The logic of usual, familiar work procedures is represented at the user interface.	
Abbreviations and short commands are easy to learn and to remember.	
The presented information is reduced to the amount of information which is needed for the execution of single task units.	
Terminology and abbreviations are part of the user technical language.	

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