How to Increase Usability of Spatial Data by Finding a Link between User and Data

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ABSTRACT

Usability is the question of how well users can utilize a functionality of a product or solution. As a new facet to the customary usability attributes the Information Quality is added, describing the importance of the needed data for the user. It enables an optimized adaptation of data quality to the user needs. If the underlying data is not sufficient for the user, the usability of a solution is eminently disrupted. Spatial data can be analyzed with this approach by the requirements from the point of view of the user. The resulting user requirements are applied to data and data attributes, and are indexed by priority and importance to insert them in a pyramid, based on the Maslow Schemata. Higher levels of needs are dormant until lower level needs are satisfied. By including the aspects of Information Quality for the user, the usability and acceptance of a system is increased.

KEYWORDS: *Usability, Information Quality, User behavior, User Needs, Maslow's needs hierarchy*

INTRODUCTION

Usability is one of the most important factors in the phases of designing up to selling a product. In the last years, usability and the impacts on products have been neglected by the computer science industry. It refused to accept usability as major criterion in developing products. Instead of usability, the main goals in the product development have been the attributes and the efficiency of products. (Jakob Nielsen 1993; Jakob Nielsen 2000) But the efficiency of a product is influenced by the acceptance of the user. Usability is one basic step to acceptance and finally to efficiency of a product.

„The user is not a designer and the designer is not a user." (Jakob Nielsen 1993) Different users have different needs and the system should provide a usable platform. Most problems occur from the fact that a designer constructs a system from his point of view. Specialists, designers, and programmers work on solutions for user but from their individual point of view.

A new approach is the "User Centered Design", UCD. The prototyping is described with the ISO-standard 13407: "Human centered design process for interactive systems". The main mantras used here are "Know your user!" and "You aren't the user!".Both slogans describe the importance of the user.(Fröhlich and Mühlig 2002) Concluding from the own experience as a user to other user groups is precarious and should be avoided. It is only possible to understand the user groups and the context of usage by careful analysis. (Hynek 2002) The User Centered Design focuses on the user and their requirements from the beginning of achieving a product.

The critical fact is to include the user demands and needs to the process of producing a solution. Finally, efficiency of a product or a solution is the satisfaction of the user. If the degree of data quality is sufficient and the representation of the solution is gratifying, the needs of the user are met and the efficiency of a product is optimized.

WHAT IS USABILITY

Usability can be explained as “user friendliness”. The user is satisfied, and his requirements are met. The conclusion for the user is to accept a system but to ignore the preliminary functionality. The system can be an application, a database, or only a single set of data. The main goal of a system is to reach acceptance from the user.

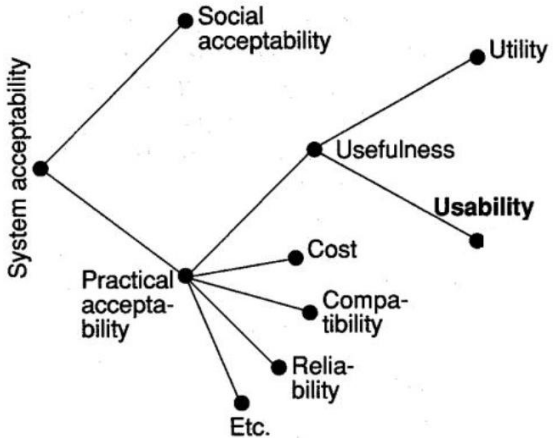

Figure 1: Model of the attributes of system acceptability (Jakob Nielsen 1993).

Usability is one of the main factors that helps a user making up his mind about the system or application. Usability is determined by the purpose and by the individual acceptance of the user. Thus its goals should be kept in mind in all stages of developing a new product or system. Even if only limited resources are available or, as in this case, a system is minimized, usability goals should be preferred to adapt the system as optimally as possible for the user. “Problems related directly to identify goals can be given top priority and problems that do not relate directly to identified goals can be put on the back burner.”(Mayhew 2002) Therewith usability is one basic factor to achieve acceptability.

The major error during developing a system is to insert the usability rules in the last phases of a project. “Usability goals should drive design. They can streamline the design process and shorten the design cycle.” (Mayhew 2002) Factors like reliability, compatibility, cost, and so on affect the user directly. Usability factors influence the decision of the user indirectly and can lead to subconscious decisions that are hardly traceable.

What is affecting or describing usability? The usability of a product is, according to the ISO-standard, “the degree of usage by a certain user to reach certain goals in a certain context efficiently, effectively and satisfyingly.” (ISO 9241:Ergonomic requirements for office work with visual display) Usability is not a single-, one-dimensional property of a user interface and has multiple components associated with the five major usability attributes:

Learnability

Learnability is the first and fundamental attribute of usability. The first experience of a user leads to acceptance or rejection of a system. The user should have a short period of introduction and be able to start to work with the application as soon as possible. All systems have certain learning curves, describing the progress of a user with an application. The learning curve shows the normal behavior of users and their ability to progress in the usage of a system.

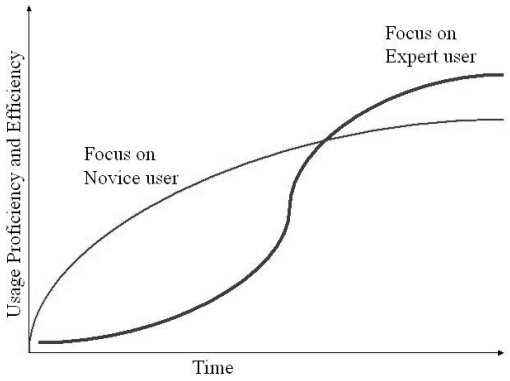

Figure 2: Learning Curve.

Memorability

The memorability is directly linked to learnability. Casual users are defined such that they occasionally make use of the application. They should easily remember the necessary steps after some period during which they have not used the system. These occasional users are the third major category of users besides the expert and the novice users and use the system in low frequency. The casual users indirectly provide the basic information of the memorability of the system.

Efficiency

The efficiency is a very subjective attribute of usability. The degree of efficiency depends on the difference between the expected output and the real output in relation to the demands to the user in a certain user group. The formula is: real output/expected output (user group demands).

The easiest way to increase efficiency is to carefully identify users by observation or direct communication.(Chandler and Hyatt 2003) The important questions are:

- What information/output do the users need?
- Why do users need them?
- How do users use the output after getting it?

Satisfaction

The third factor is the satisfaction of the user with a certain system. The satisfaction is again closely related to efficiency and the identification of user demands. The degree of user satisfaction is hard to evaluate. Not all users can express their feelings about a system. Some of them refuse to answer directly to questions like: “Are you satisfied and are your expectations you had previously met?” Another possibility to evaluate the users satisfaction is to assess the real value for the user. Satisfaction depends on the exact identification of users and their objectives.

Errors

A system should have a low error rate. An error is defined as any action that does not accomplish the desired goal of the user. The error rate of the system is measured by the occurrence while a user is performing a certain task. Therefore errors also influence the usability of a system by hampering and delaying the desired output for the user.

The errors should be easy to remove or correct. The application should not break down because of errors, which is called “robustness against errors”. The user has to be informed about an occurred error, the causality of an error, and the necessary steps to correct an error. (Wenk 1996) Errors influence the time of a user working with a system and therefore directly affect usability of a system.

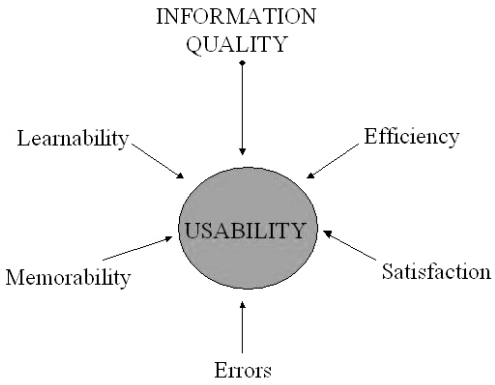

Figure 3: Usability attributes

Information Quality

The Information Quality (IQ) is the connector between Data Quality and the user. General definitions for IQ are “fitness for use” (Tayi and Ballou 1998), “meets information consumers needs”(Redman 1996), or “user satisfaction” (Delone and McLean 1992). This implies data that are relevant to their intended use and are of sufficient detail and quantity, with a high degree of accuracy and completeness, consistent with other sources, and presented in appropriate ways. Many criteria depend on each other and in this case not all criteria will be used. The information quality is a proposal to describe the relation between application, data, and the users.(Wang, Strong et al. 1999)

This paper uses as criteria of information quality the same assumptions as in a user query for an information quest from Web data sources. The complete list of IQ-criteria is classified into four sets and their description is from (Naumann 2002) and the ISO/FDIS 19115. Content-related criteria deals with the actual data that is retrieved and the represented properties are intrinsic to the data. Technical criteria concerns the aspects determined by soft- and hardware of the source, the network and the user. Intellectual criteria measure subjective aspects of the data source. They depend on the user and the developer and can hardly be measured. Installation-related criteria concern the presentation of the data and are related to usability factors. The relevancy of the different criteria can be adapted slightly using network connections from various data sources.

Category	IQ-Criteria
Content-related Criteria	Accuracy Completeness Customer Support Documentation Interpretability Relevancy Value-Added
Technical Criteria	Availability Latency Price Quality of service Response time Security Timeliness
Intellectual Criteria	Believability Objectivity Reputation
Instantiantion related Criteria	Amount of data Representation conciseness Representation consistency Understandability Verifiability

Figure 4: The complete list of IQ-Criteria.

Assessment Methods of IQ

The main crucial factor in an assessment of information quality is the user. His satisfaction is the main goal of IQ-reasoning. The users should participate in the process of selecting the criteria that are used to predict user satisfaction (Chen, Zhu et al. 1998).

The IQ-assessment is rather difficult, because there are different factors influencing this assessment-process. Most of the criteria are of subjective nature and cannot be automatically measured and categorized. The data sources lack sufficient metadata and background-information about the used data parameters. The amount of data is changing according to the user query.(Olken and Rotem 1990) One of the most important obstacles is multiple sources. They can differ in content and quality and the merge of different data sources can cause problems. Each request by a user group needs other basic data and "data quality" to produce the degree of information quality.

Three main factors influence the IQ-assessment. First the user as the most important source for IQ-metadata, providing individual input that is collected and refined to improve the quality parameters. The second source of IQ-criteria scores is the data source with all the provided metadata. Third, the query process itself supplies information about IQ- scores and their degree and usage.

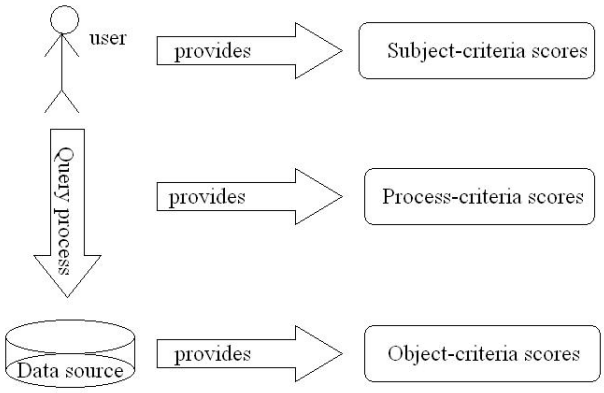

Figure 5: Three sources of IQ-criteria scores.

The IQ-assessment is a continuous process that has to be repeatedly adapted and changed. The criteria are subjectively influenced by the different users and of different importance. The used assessment of the IQ-criteria is only a guideline to offer a basic indicator for the users. The measurement of assessing these subject-criteria is made by three methods. The technical equipment and the software of the application influence the process-criteria scores. Measurement base is previous statistics and knowledge from former experience with the data sources. The object-criteria are measured automatically only in certain occasions the interference of experts or referencing of the contract is necessary.

TASK DEFINITIONS AND USABILITY

What are the tasks of current GIS and is there hierarchy to order them? A comparison between user tasks and task descriptions in different contexts enables a structured overview of GIS use.(Davies 1994) Whitefield *et al.* described the taxonomy (Whitefield, Esgate et al. 1993) of "work tasks" as tasks to be fulfilled the user's work goals and exclude all the extra 'enabling tasks' like switching on and off the computer, starting software *etc*. So emphasize is put on the usage of the GIS software and not the basic and underlying functionality of the system and hardware behind. For example the warm up time of the system is no critical factor influencing the output or the usability. In this work the usability concentrates on the usage of GIS software and his functionality.

Generally spoken, a GIS is capable of storing and displaying maps on a screen, zooming in and out in a map to enhance details or to give an overview, and to change the selected section of the map. Most of the GIS systems allow storage of attribute data. Attribute data is additional information about specific points or objects on the maps. Normally a user can change the color of schemes, annotations, legends and titles. He can plot or print maps or selected areas. The great advantage of GIS software and solutions is the possibility to manipulate the spatial data and to use spatial statistics. Specialists take advantage of the increasing functionality, but, like in this paper, a normal user, moving from one location to another by a vehicle, is not interested in making calculations and analysis of maps. He only wants to use the provided data and solve tasks to find a way from one point to another under some constraints.

Tasks have to meet a purpose and, depending on the user, this purpose differs. GIS tasks can be subdivided into different levels of detail and the granularity of task description can also vary. The Rasmussen hierarchy containing the purpose, the abstract function, the generic function, the physical

function and the physical form can describe each task. (Rasmussen 1986) User tasks are the key element for usability of GIS tasks considering the context of use.

In real life the user is not satisfied with the simple solving of a wayfinding problem. Every user is an individual and has special subtasks to the problem. Of course it is impossible to describe and to meet all individual demands on the system, but it is possible to generalize the tasks.

The easiest way is to consider in brainstorming, questionnaires and interviews, what information could be interesting for a person using a map to find the way? The following elements were mentioned, depending on the different persons and their underlying task.

Example of a navigation problem

The following example is a navigation problem in a city, using a map. The first step was to identify the transport vehicle and the purpose of the movement. The chosen example here describes a truck driver moving in a city and the information he needs. The resulting requirements have been assessed with the Information Quality and inserted in a Maslow's Pyramid by their importance.(Sheth 2000) This enables an easy way to show graphically the important facts for the truck driver. If one of the basic aspects is missing, for example the main routes, the map is not sufficient and the usability of a map has failed.

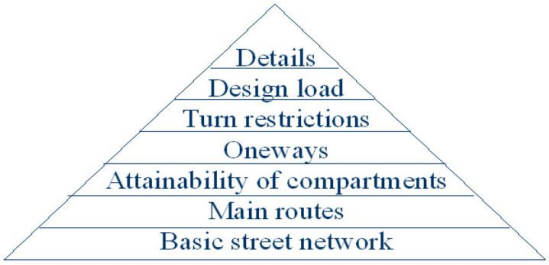

Figure 6: Example of a hierarchy of user information requirements in a navigation problem.

A MODEL OF CONSUMER BEHAVIOR – WHAT INFORMATION THE USER NEED?

"How do consumers make their decisions?" A buying decision is a confusing and most often an irrational action. Consumers are overwhelmed by the huge information flow and the variety of different choices. Typically the consumer's behavior is the result of the influence of a variety of factors and the interaction between them. (Czinkota and M. 2001) For further analysis a separation between environmental influences and individual differences seems appropriate.

As a matter of fact, culture, social classes, family, personal influences, and situations determine the decision process. Individual differences, as consumer resources, motivation, knowledge, attitudes, personality, values, and lifestyle have to be considered. Regarding the variety of factors, the decision process is not simple to understand.

Experience is especially underestimated for the navigation application. Every user has gathered his own set of experiences influenced by different environments, circumstances, and occasions. Every single person has his own set of constraints that have to be met. Some requirements are not so urgent and do not have high priority and other terms can be neglected. It is difficult to gather and group different experiences and influences for the users and belongs to future work.

CONCLUSION

It is crucial to find a link between a system, the data, and the user. The user is interested in a broad variety of aspects not only concerning data and data quality. A user wants an exact solution for his problem and does not care about the solution finding process. The Information Quality is a simple way to describe and assess the importance of data and data quality for the user. Different views of quality of different user groups lead to different requirements.

The critical aspect is to gather information about users and to group them. Each user group has certain requirements and different aspects of usability that have to be considered. The decision function can be easily produced if the exact circumstances of a user, his activity, and the environment are known. A price differentiation between the user groups is finally possible by knowing and analyzing the user group preferences

Ultimately the pyramid of the psychologist Abraham Maslow is applied to show graphically the grading of the requirements of a user group. Maslow arranged human needs in a hierarchy. This concept represents possible hierarchies, showing the result of the analysis of the different meaning of quality from the point of view of the user.

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