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IDENTIFY USER PROFILES IN INFORMATION SYSTEMS WITH UNKNOWN USERS

- A DATABASE MODELLING APPROACH

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Abstract

Most traditional models for system development presuppose that users of the system are known and possible to communicate with. If this is not achievable traditional design methods are less usable in order to analyze and describe the requirements of the users. This paper proposes to complement view design with ideas based on interaction design and semiotics and aims to describe the requirements and wishes of potential and unknown users in information systems supported by image or multimedia databases. In the paper the activity steps of view modelling are brought together with persona techniques from interaction design. The outcome of the proposed method reduces the amount of work considerably and, in addition, reduces the problems associated with involving users in the design process. In addition it forms the basis for the specification of a more informative study to increase the acceptability of databases in public environments.

Keywords: Database design, user requirement, user profile, personas, unknown users, image database, multimedia database, public database, semiotic

1. Introduction

Databases are created with the intention of supporting the intended users in their search for information and knowledge within a particular area. While it is the users' problems or questions which are required to be solved with the assistance of the information in the database, ideally the users should also participate in the design of the database in order to produce the best results. Thus, for almost all database design processes today, the precondition exists that the users are known and, additionally, that their opinions ought to be included in the process. Through the use of these methods is it possible to question the users with regards to their demands and requirements and identify the information that the data must contain from all perspectives. This falls in line with traditional database modelling which presupposes that it is possible to identify user views and by means of view modelling, define all views or user profiles for the database.

A user profile is defined as a group of individuals with the same perspective regarding information and that they share a common view of the Universe of

Discourse (UoD). In such a group an agreement (sometimes silent) exists regarding the understanding of the UoD. Such a group could thus be stated as a particular user profile (represented by a specific user view) among all the users.

However, databases whose ambition is to inform anticipated users in public environments do possess specific problems. Museums, libraries and organisations in general present their information either in local databases or, nowadays, more generally, on the internet. In these situations, the number of users is likely to be large or sometimes extremely large. This, in turn, creates problems with regards to the desired communication and some users may experience some difficulties; firstly, it is impossible to involve them all in the design process and secondly, it is extremely difficult to find representatives for the different user views or user profiles that demand detailed knowledge of the user group. In a situation where the users are not known and, in addition, if the total number of users is unknown, the work of establishing the user requirements must obviously experience extra difficulties.

Databases intended to inform people in a public environment frequently present data not only in text format but also in image and video formats and combinations of these. Multimedia and image databases are therefore often found in such information systems, for example in areas, which traditionally depend heavily on images for communication, such as photographic libraries, art galleries and museums. However, in areas such as engineering, architecture and medicine, advantages are also seen in making their collections available in electronic form [Eakins and Graham, 1999]. Additionally, the number of images available on the Web was estimated to be between 10 and 30 million at the end of the 20th century [Sclaroff et al., 1997].

While the challenges of image databases is a subset of the challenge of multimedia databases [Lew et al., 2002] image and multimedia databases are considered to be equal in this paper.

Access to a desired image from an image database might involve a search for images depicting specific types of object or scenes, evoking a particular mood, or simply containing a specific texture or pattern. Eakins and Graham [1999] give some illustrative examples of questions; an art historian may want a particular painting by Van Gogh; a journalist may want a recent photograph of Tony Blair, not smiling; a social historian may want a picture of sewers in the 18th century; a theology student may want a picture of a female saint with red hair. Others will be more interested in material, which conveys particular sensations or moods (e.g. happiness, concentration).To foresee the type of questions users might ask requires a detailed knowledge of their needs and the kind of perspective they may adopt with regards to the image.

Hence the research question and focus of this paper is; how is it possible to identify user profiles in information systems supported by an image or multimedia database, when the number of users is large or/and when the purposes of users are unknown? The immediate outcome of an analysis process making it possible to increase the number of defined user profiles will be to enlarge the support to all users (all different user profiles) in their search for information and knowledge in the database system. More importantly, the contribution is based on increasing the acceptability and hence the productivity of the database. If the information required by the user is not readily available, then it follows that the system will not be used, which renders it neither useful nor productive.

Furthermore such an approach will reduce the costs involved in information analysis if the result is to reduce the amount of time involved in the process.

In the following sections, view analysis and view integration are described as examples of conducting database modelling in a traditional manner. The necessity of adopting a new approach for the analysis of systems in which the characteristics are of unknown users or unmanageable many end-users is emphasised. Finally a new approach is described based on semiotic discipline and methods of analysing images.

2. Analysis in Traditional Database Modelling

From the very first attempts to design databases, the goal for database design has been able to be formulated as creating a model that is a mirror reflection of the part of the world of interest (Universe of Discourse). Users and designers have - in an ideal situation - worked together to attempt to identify and describe, and above all to understand, all the necessary concepts required in order to depict a relevant model of reality. To facilitate this, users and the designer must agree on a way of looking at (or agree to a common perspective of) the part of the world of interest. This is the part of the world that will be represented in the database and the stakeholders must decide, openly or implicitly, the template from which the reality will be interpreted. It is possible to state that they must create a mutual understanding of the way to observe and consider the part of the world to be modelled.

The original database designers, such as Chen [1976] and Codd [1980], and their successors were designing databases which could be described as models of information systems with relatively limited complexity. It was comparatively easy to define and describe the concepts of these information systems. In these information systems the Universe of Discourse (UoD) and the data structure can be adapted to each other without too many difficulties. A one-to-one relationship exists between the database model and the perspective of the world; if there is one value recorded in the database this value must have one correspondence (counterpart) in the real world [Sölvberg, 1999; Boman et al., 1997]. These models were designed using conceptual modelling as a significant tool in order to understand and describe the area of interest.

2.1. Views and View Integration

As the complexity of database design increased, one means of coping it is to decompose the process into successive refinement phases. Database design is therefore decomposed into three levels; conceptual, logical and physical design, (see Figure 1), [Batini et al., 1992; Teorey, 1999]. The UoD is the part of the real world of interest for the design process. Conceptual modelling is sometimes preceded by a requirement analysis step which involves revealing all the users' requirements and wishes. This step is occasionally included in the conceptual modelling step.

However, in any reasonably large database design project the development of a conceptual model can be thought of as consisting of two sub stages, view modelling and view integration. View modelling is a process of transforming many individual users' requirements into a few conceptual views (or models). When the size of the design task is large and involves a large number of users or user groups the result will typically be a number of different perspectives for the data requirements. It is important to capture each such perspective and distinguish each as a conceptual view [Beynon-Davies, 2000].

View integration is then the process of combining such individual views into a global, unified view that summarizes the requirements from all views. Parsons [2002] argues that a database designer should not build a global conceptual schema without first building local schemas that reflect user views.

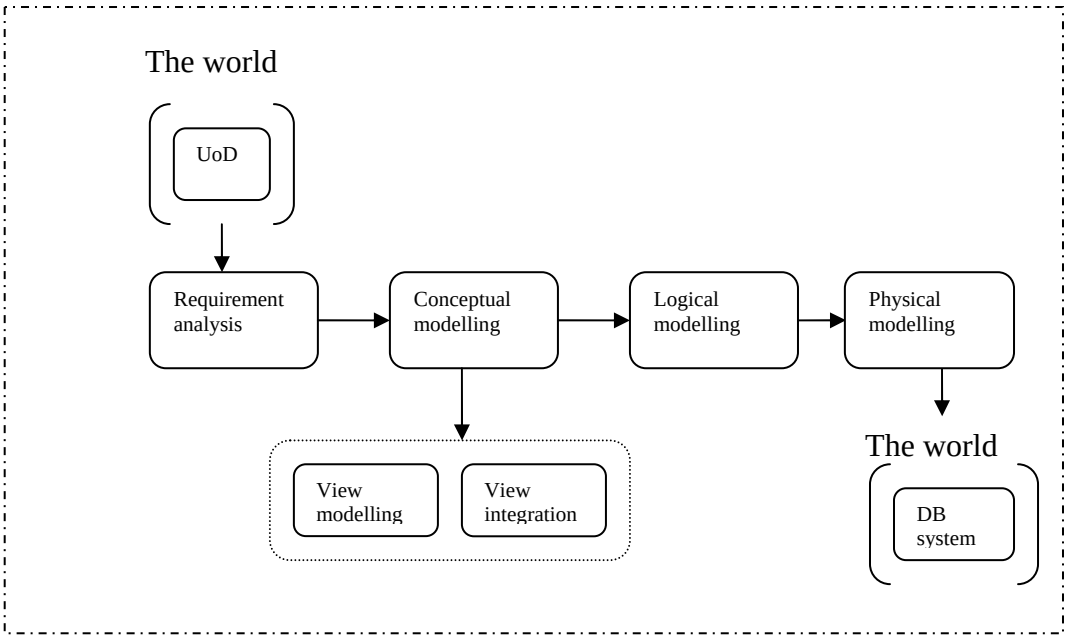

Figure 1. The database design process.

3. Unknown or Undefined Users Require a New Approach of Analysis

Several axioms or natural, self-evident facts exist that are presupposed by the majority of the traditional models for system development. One of these, and probably the most critical statement in the paradigm, is the fact that the users of the systems are known and identifiable at the time of system development [Sundgren, 1996].

This is the case, because the models rely on the assumption that the users of the information systems have, through discussions, declared their future needs and expectations. It is thus only possible to establish a requirement specification because the opinions of the users have been sought. Based on this specification, a systematic work process is accomplished according to the modelling paradigm and a model of the system is constructed [Sundgren, 1996].

The reality, the UoD to design, is, nowadays, no longer purely uncomplicated and well structured. The requirement now is to model and design databases or parts of the world where the one-to-one correspondence is no longer valid. One value in the database does not relate to one counterpart in reality and it is no longer always possible to reach a unanimous view on the part of the world of interest among the users and designers. As a consequence the accuracy of the information is insufficient and therefore the quality of the information is poor [Sölvberg, 1999]. However, many databases have been designed to support users in such information systems.

Sundgren and Steneskog [2003] have pointed out that information systems developed today are more often characterized by their desire to support research, development activities or strategic decisions. Sundgren and Steneskog label them as directive information system. Typical characteristics of such system are:

- users are more or less unknown at the system's development time,
- ad hoc usage is common and as a consequence of this statement
- data are used for different purposes than those originally intended.

These characteristics are identical to the situation faced by database designer in which the aims of designing a model for an image database system are those described in the introduction above. As already states it is extremely difficult to foresee all the users' demands for such a database design.

4. Identify Relevant User Profiles from Analysis of Existing Information

To reiterate, the goal of traditional view modelling process is to capture each view or perspective of the users in the UoD. Each of these views will determine a conceptual view. The view integration process that follows forms a comprehensive and total description of the requirements for the information system and is performed by integrating of all the different user views that have been described.

4.1. The View Modelling Process

The traditional view modelling process involves revealing the requirements of the users and must be done in cooperation with the users (see Figure 2). It presupposes that all users are known and consequently possible to identify.

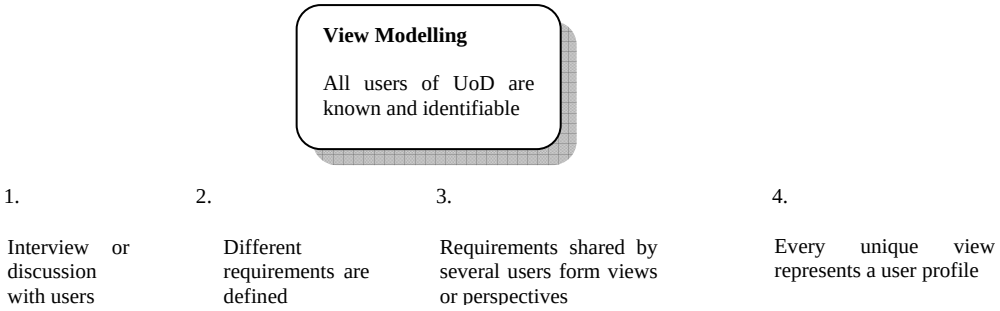

Figure 2. The view modelling process.

The first step is to determine the wishes of the users, which is usually performed by means of discussions and interviews (1). When the number of users is very large, the number of different requirements will almost certainly also be large and each must be defined and described (2). Several requirements shared by several users constitute a view (3). This means that the users have the same perspectives with regards to these requirements. Consequently, every single, unique view or user group represents a user profile (4).

4.2. The Restructured View Modelling Process

Now the situation has to be faced in which the users are unknown or belong to such a large population that it becomes unreasonable to conduct interviews or carry out discussions with the user groups in order to discover their demands with regards to the information.

When designing information systems which are intended to satisfy such a broad number of users it is possible to be misled into attempting to make it as universal or as common and general as possible. The resulting system will not be optimal for the users as the inclusion of such a vast population will actually increase the cognitive

load for all users and thus reduce the usability for everyone. The best means of satisfying a variety of users is to design for specific types of users with specific needs and the key issue is to choose the correct individuals who represent the needs of a larger set or users [Cooper and Reimann, 2003].

In the situation where the users are known, the different views are established because a number of users share the same perspective with regards to the UoD, following the discussion above of figure 2. Even in an unknown population, it is not unrealistic to suppose that several users have comparable or matching demands for the UoD. As Sundgren and Steneskog [2003] assert, human beings are social creature and live and have lived in more or less flexible groups that communicate and influence each others thinking and goals. The starting point must be that every single individual does not have his/her own complete unique demands.

The application of the restructured view modelling process (see Figure 3) in which the starting point is the identification and formation of all reasonable interpretations (perspectives) of a UoD, should allow for the assertion to be made that all reasonable views regarding the same UoD have been identified simultaneously. Additionally, each of these different views contains requirements shared by a group of users.

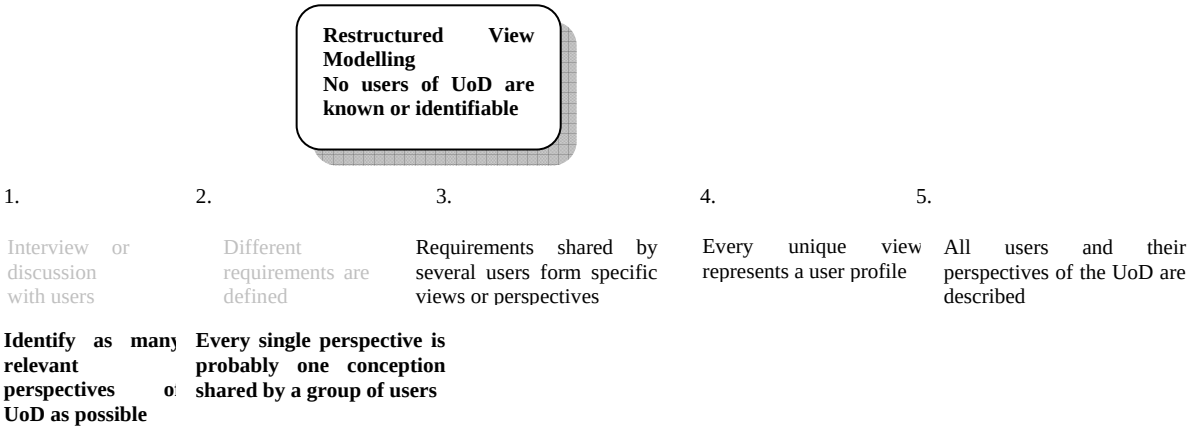

Figure 3. Restructured view modelling process.

Accordingly, if it is possible to identify several different views then the implication is that as many distinct conceivable groups of users have also been identified, each of which has a mutual understanding or common view regarding the UoD. In addition it is obvious that a number of separated user profiles in the information system must also have been identified.

To apply a method to be understood as a restructured view modelling process (see Figure 3), the starting point should be the identification and definition of possible perspectives (views) of the information of the UoD (1). Following on from the discussion, every perspective is a concept of the UoD shared by several users (2). Requirements (or a perspective) shared by several users form specific views or perspectives (3). Every such perspective (or view) represents a user profile (4). When all the perspectives have been described and every user and his/her requirements have been observed and described then all the information in the UoD has been described (5). The combination of all perspectives, in a view integration process, will then be completed by the formation of a global, unified view description that encapsulates the requirements of all the views (users). Each one of the identified views represents one

way of looking at the world of interest, which can be viewed as the mutual understanding of the UoD of the users that form such a user profile.

5. A Review of Proposed Methods that Define Possible Perspectives or Views in Images

The analysis and retrieval of information in images (and videos) is one of the most rapidly growing research areas in present day multimedia technology [Bakker et al., 2003]. A large number of research papers have been presented in areas of Content-Based Information Retrieval (CBIR) and computer vision that have considered problems within these areas of research. However, it has been realized that CBIR and computer vision contain significant limitations such as the inability to deduce the semantic content in images (and videos) [Enser and Sandom, 2003]. Bakker et al. [2003] emphasize that more research must be conducted in order to understand both the intellectual and emotional side and not only the logical parts in the analysis and retrieval of information in images.

Several authors [Bartes, 1977; Panofsky, 1972; Shatford, 1988; Jörgensen, 1996] have described that the semantic content of images is multi-layered and the analysis of information content should not only be restricted to factual levels but also to impressions such as for example uncertainty and pleasure.

The semiotician Barthes [1977] has described methods for analyzing all messages in images. Barthes advocates, in his book ”Image Music Text”, that in any reproduction messages will always be met on at least two levels; the first level can be described as immediate or direct and is valid for everyone who looks at an image. The information identified in the second level depends on the interpretation placed on the image by an individual. Interpretations are affected by both intellectual and emotional influences (e.g. modes such as happiness or dislike etc.). Thus different information is received from the same image by a variety of viewers at this level. A single image contains information that can be identified from several perspectives or in other words; reproductions in general contain information supporting several views.

Ornager [1997] and Lindley [1997] have addressed the problem of development of semantic content models and both have based their findings on principles from the semiotic discipline. Lindley asserts in his content model that the semantic information found in videos will not be described sufficiently if looked at from only one level or paradigm. Video information must be described from at least four different perspectives or levels, according to Lindley. He concludes that when analyzing and describing information systems for video data (that is images in one respect) several perspectives must be observed and the semiotic approach is both necessary and satisfactory. The work of Ornager [1997] discusses both indexing and retrieval with reference to an effective search of digitized images. The conclusion is that indexing must reflect several descriptions or views of the images. Ornager’s conclusions is based on the methodology of Barthes [1977] and Panofsky [1972] and supported by a study among archivists in newspaper archives.

5.1. The Semiotic Approach

Sonesson [1992] points out that the semiotic discipline aims to describe the mechanism of meanings, as they are understood by members of the group using them. The semiotic discipline involves the search for the unconscious knowledge of the users and must not involve, he points out, confronting the users with questions.

To start from the classic semiotic or Ogden triangle [Ogden and Richards, 1949]; The semiotic (Ogden) triangle states that an object (a phenomenon) expressed as a symbol does not directly refer to the object/phenomenon in question but by the means alluded to it by spectators that the phenomenon is understood or interpreted as a concept. The dotted line illustrates that there is no direct connection between the symbol and the object (see Figure 4).

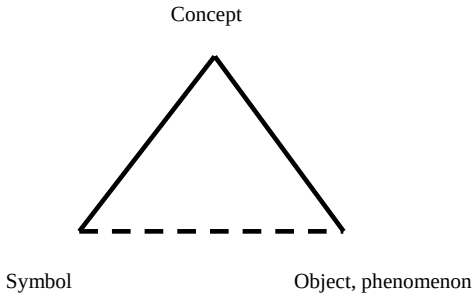

Figure 4. The semiotic triangle.

The semiotic triangle also demonstrates that information included in formats such as sound, gestures, images or others, never possesses only one obvious, self-evident meaning. These formats are not connected to anything until a designation is assigned to them by someone. What is symbolized, whatever the format might be, probably can be understood in many ways; i.e. there is seldom a single view or concept of the phenomenon.

In 1998 the IFIP task group "FRamework of Information System COncepts" (FRISCO) published its report "Framework of Information System Concepts. This report on Information System Concepts is based on semiotics and ontology [Falkenberg et al., 1998]. The FRISCO approach (see Figure 5) has extended the semiotic triangle into a tetrahedron, placing an actor at the centre and has changed the position of the symbol (representation in the Frisco version) and the object (domain in the Frisco version).

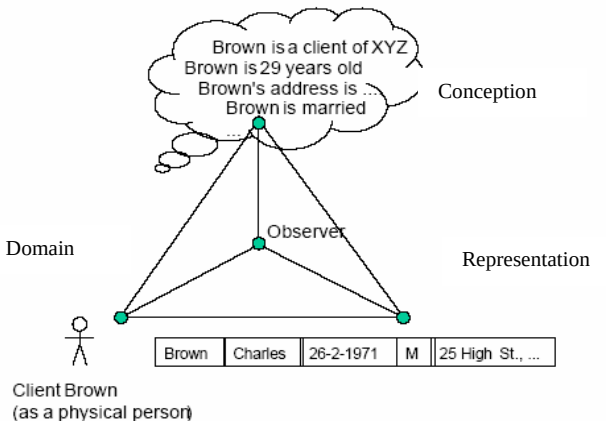

Figure 5. The semiotic tetrahedron of FRISCO
(from [Hesse and Verrijn-Stuart, 2000]).

The actor observes the occurrence of something in a particular domain or area. What the actor actual sees is a result of his/her perception and interpretation and is represented by some data. For example, in Figure 5, a physical person (Brown) can be conceived from a certain perspective as some collection of aspects (that is a conception) and be represented by some data base entry (a representation). The triangle illustrates the difference between symbolic entities (representation), their meaning (conception) and their counterpart in the physical world (domain).

The FRISCO approach explains that, whenever a social group or community, and often after some discussions, agrees to treat a certain phenomenon as a "thing" it *becomes* a thing (by social construction) and is treated as such as long as it is not forgotten or made obsolete by other conflicting constructions (Hesse & Verrijn-Stuart, 2000). This is in fact the same process that actually happens in a discussion when users have agreed on a template to interpret a phenomenon (or object). They create a mutual understanding and form a view perspective with regards to the information system when an agreement is reached to treat a phenomenon in a specific way. However, even if there are no such negotiations a certain phenomenon is probably always conceived and understood in the same way by several individuals in a community. An unspoken, common way of treating (or understanding) a phenomenon will exist, and furthermore in a large population it must be obvious that several different unspoken concepts exist.

6. Involving Personas in Database Design

In database design an obvious fact is that a physical entity (such as the person Brown in Figure 5) can be conceived in many ways (several conceptions can be relevant; Brown can be viewed as a client in one system, as a student in another system or as an customer in a third system and so on). The different conceptions (of Brown) are then normally represented in different information systems. In the view of the semiotic (or Ogden) triangle they are all different conceptions of the same object as in Figure 7.

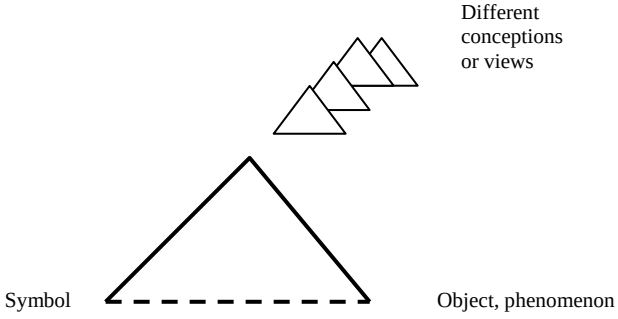

Figure 6. New interpretations leading to different conceptions.

The objects (for example an image) are the origin for several conceptions and each different one or, indeed, views will result in different preconditions for the representations or symbols of the object. The crucial point must be to find these different conceptions or views in Figure 6 or the first step (step 1) in Figure 3 which they obviously correspond to. The aim (and the problem focused in the paper) is to achieve this when the number of users is large and/or when the purpose of the users is unknown. This is the situation or problem database designers will deal with and it has some typical qualities as outlined in the paper.

- The situation is characterized by a large (or very large) group of users and in which the entire set of users is the target group of the design
- These users cannot be considered to be a homogeneous group with respect to their goals, needs, expectations or pattern of behaviours
- In addition, it appears reasonable to assume that the database systems have been created before (perhaps long before) any analysis and definition of the users has been completed. Thus, the database systems have been designed for future or unknown users.

A rewarding means of addressing the situation may be found in the field of designing interactive systems. Designing interactive systems is concerned with developing systems that fit with people and their ways of living [Benyon et al., 2005]. These systems are found in many devices (from cellphones to washing machines) and in public environments such as museums, libraries and, of course, in a variety of ways on the Internet.

Many interactive systems possess conditions that appear similar to the situation described above to be dealt with by database designers. The design of a website typically addresses the goals, needs and expectations of a very large and heterogeneous group of users. To deal with these problems Grudin and Pruitt [2002] assert that interactive systems design has adopted approaches from ethnographic research such as participatory design, contextual design and variations of scenario-based design.

In database design, user scenarios are also a means of analyzing and detecting incomplete or uncertain knowledge concerning users demands [Sundgren, 1996]. In the first step Sundgren argues that all known and imaginable users and user situations should be listed, every user or every usage is then described in a detailed way and these descriptions should be made after discussions with the expected users. If the users are unknown, for a variety of reasons (one reason could be that future users do not yet exist) then scenarios should be created together with individuals who possess good prospects to be able to understand the situations of the imagined users [Sundgren, 1996].

The main issue confronting database designers when dealing with large numbers of users or when the purposes of the users are unknown can be explained, in a somewhat provocative manner, as involving users without including them in the design process. In the Personas method described by Cooper [1999] (actually developed for usability in interaction design) users are excluded from the major part of the design process and personas are instead introduced as a design tool. Personas are user models that are represented as specific, individuals and are carefully described in terms of needs, goals and tasks [Cooper and Reimann, 2003]. The target of the design process is then to satisfy the needs and goals of the personas. In the design process personas can be used as a design tool either as a complement to scenarios or as a stand alone method.

The persona is thus a precise description of a hypothetical user and as such will represent the user throughout the design process [Blomquist and Arvola, 2002]. As the personas are concrete personification of the needs and the goals of the user the persona process can also be described as a human-centred way of working in order to define users' goals.

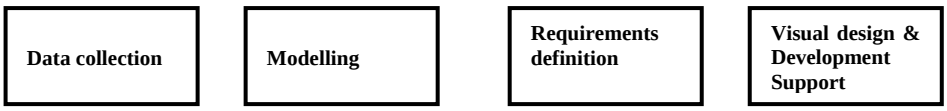

Figure 7. Phases in the Persona process.

Figure 7 illustrates the essential phases and the linear approach of the persona process. In the early phase of the design - the data collection phase - interviews and observations of current users are made and form the basis for creating personas. The purpose of the study is to identify trends or patterns in user behaviours, expectations and motivations. Observations of the users should be made in their own environments. If it proves difficult to gain access to the users, the strategy is then to seek interviews with people who interact frequently with users and collect information from experts and professional authorities of relevant domains of interest. After that - in the modelling phase - every persona is carefully described in terms of the key issues, namely needs, behaviour patterns and goals. To stress the point that a persona is an individual he/she is given a name with an enclosed face or sometimes photo. In the case where several personas have the same goals, it is possible to merge them into one. At the end of the process, several sets of qualities or characteristics will have been formed. The recommended number of personas in one set of characteristics lies between three and seven. One of these (the primary persona) represents the primary goal for the design and the characteristics for any of the other personas cannot satisfy this particular persona. The needs of the other personas in the set (secondary personas) do not pose a problem as long as they do not interfere with the needs of the primary persona. After the personas and the goals have been created, the next activity is to explore the tasks by using scenarios in the requirement definition phase. The final phase - the visual design & development support phase – involves activities such as graphical design and technical support [Blomquist and Arvola, 2002; Cooper and Reimann, 2003].

The idea of the user models created by Personas technique is that every persona summarizes a distinct set of usage patterns regarding activities in a domain (see figure 5). The use of the Personas process (in parts or the whole process) aims at identifying classes or types of users representing different conceptions or views of an object. [Cooper and Reimann, 2003].

7. Summary and Conclusion

Databases in public environments often record data and present information in text, image and video formats and are thus defined as image or multimedia databases. The design of image or multimedia databases in public environment causes specific problems.

The users in such a database system are often regarded as unknown. One reason is that the users in the system do not always exist at the moment of system design. Another reason is that the number of users is so great that it is impossible to communicate with all of them. In addition, in order to foresee a query to an image or multimedia database this involves both the intellectual and emotional side of the

question and requires a detailed knowledge of the user requirements and the perspective they may adopt with regard to the image.

As a result, it is not reasonable to assume that the intention of the design procedure is to achieve an absolute one- to-one correspondence between the database model and the UoD.

The database design process traditionally addresses the design problems using a three step process including conceptual, logical and physical modelling. The view modelling and integration presupposes that the users are known and possible to contact by one means or another. If this precondition is not fulfilled a new situation arises which requires a different approach to be adopted in order to design the image database model to mirror the requirements of the users.

In this paper an approach is presented which is based on a combination of a traditional database design method, the view modelling process, and Cooper's view regarding interaction design and semiotic findings. The semiotic triangle implies that there is never any direct relationship between an object and its representation or symbol. However, this does occur through the conceptions of an observer and every new interpretation is deemed to be a new conception. The maximum number of interpretations is not possible to fix in advance (or probably never possible to deduce). However, the more conceptions or perspectives that have been revealed, the more complete the information is of the object. Nevertheless, there is probably not a one-to-one agreement between the model and the UoD and the implication is that it is unlikely for all the interpretations or perspectives to have been found. In the controversial method of Cooper [1999] the users are not involved in the design process. Instead, they are represented by an archetypical user, called a persona. The persona is a hypothetical user and his/her goals and requirements are revealed by means of a data analysis gathered from interviews and observations. This paper claims that using the proposed approach is an efficient method by which it is possible to define different user perspectives with regards to an image even if the users have not been included in the major part of the design process.

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