METADATA AS A MEANS FOR CORRESPONDENCE ON DIGITAL MEDIA

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SUMMARY: *Metadata derive their action from their association to data and from the relationship they maintain with this data. An interpretation of this action is that the metadata lays claim to the data collection to which it is associated, where the claim is successful if the data collection gains quality as a result of it. We assume that the design process manifests itself in this way: the designer lays claim to data in such a way that this data gains quality. Claims form part of a complex adaptive system in which agreement on the quality of claims is achieved through correspondence. Applied in the context of a design studio, the result is a digital media library that is both the subject and result of the educational process. By teaching students how to express and utilise these claims and their qualities in their communication with peers, they can learn to become more effective in their use of information from various sources to support such communication. They will also learn how to build digital media libraries as a collective result of their communication. In this paper, we describe a methodology for adding, utilising and managing metadata and present some intermediate results from implementing this methodology into education.*

KEYWORDS: *metadata, learning process, design analysis, architectural language, e-learning.*

1. INTRODUCTION

In the early stages of design, it is common practice for (architectural) design students to collect information on prominent (building) examples relevant to their design task. ‘The rationale for banking on so called precedents is straightforward: it is wrong to wish to reinvent the wheel over and over again. […] We should learn from our elders and adopt their successful solutions to problems similar to the ones we cope with’ (Goldschmidt, 1995, p. 70). In the past, such precedent-based learning was implicit in the master-apprentice relationship common in the educational system. Nowadays, academics commonly no longer have the possibility to maintain an extensive design practice, while communication and media technologies and practice give access to a much larger body of (important) outside precedents. While practitioners can rely on the experience of their colleagues, and maybe their own, in the process of a new design, students can only draw upon documented examples of success and failure. As a result, the study of important (historical) precedents plays an important role in design instruction and in the students’ design processes. Akin (2002) compares the experiential approach of precedent-based learning with the normative model of learning by explicit principles and argues that the use of precedents is not only common for knowledge dissemination in architectural education but also in the design process of expert designers.

In this study, students can benefit from a cooperation with peers, when analysing various aspects of a precedent or of a group of precedents. By integrating the respective results into a common library, students can draw upon others’ results for comparisons and relationships between different aspects or precedents. The Web offers various examples of architectural analyses on a variety of subjects (e.g., IAAI/IBa, 2003, Madrazo and Weder,

2001, Heylighen and Neuckermans, 2000). Commonly, these analyses consist of a collection of documents, categorized and hyperlinked to support navigation through the information space. More sophisticated examples rely on a database for storing and managing this data, and offer a more complex categorization of the documents and their relationships.

Precedent libraries that can offer support to the student in the design process, however, do not need to be restricted to prominent examples of good or bad designs. Students do not only learn from such precedents, they also learn from each other, through reviews and critics, but also through direct communication and correspondence on each other's work. Digital media libraries can play a further role in this, by offering students access to a broader selection of student work and by offering additional means for communication and correspondence. We are currently developing a multimedia learning environment to support group work and discourse, named InfoBase (http://www.bk.tudelft.nl/infobase/), that also serves as a digital media library for collections of student work. This development forms part of an educational project that aims to employ ICT means to support educational processes in which students are encouraged to learn from one another and work together, at their own initiative (Stouffs et al, 2003).

InfoBase is a database or digital library that distinguishes itself from an archive, in which the archival and retrieval processes can be clearly differentiated as occurring at different moments and as performed by different actors. With respect to InfoBase, students simultaneously take on the roles of archivists (or contributors) and users of the library. The construction of the library is therefore a dynamic process and is not guided nor constrained by an a priori defined organization. As such, InfoBase is *simultaneously the main issue and the result* of social processes, which are the consequence of the exchange of information among architecture students in a specific phase of their study. Therefore, we consider InfoBase as a *complex adaptive system* (Kooistra et al, 2003).

The complexity paradigm uses systemic inquiry to build fuzzy, multivalent, multilevel and multidisciplinary representations of reality. Systems can be understood by looking to patterns within their complexity, patterns that describe potential evolutions of the system. Descriptions are indeterminate and complementary, and observer independent. Systems transition naturally between equilibrium points through environmental adaptation and self-organization; control and order are emergent rather than hierarchical (Dooley, 1997). (Learning to) design (as knowledge) is (learning) to handle the complexity paradigm. Designs form the fuzzy, multivalent, multilevel and multidisciplinary representations of reality of the designers. Official solutions (opinions) can only exist if these are hierarchically imposed. This does not alter the fact that a 'hierarchical' – or better said – autonomous form must be found in which exactly this aspect (that there are no official solutions) can be communicated. In this respect, InfoBase is an 'autonomous' database in which control and order can 'happen' rather than that these are hierarchically imposed. What keeps a complex adaptive system together is thus not formed by the empirically perceptible results (designs) that can be found in the database but in the way the system of inquiry works. In the case of InfoBase, the system of inquiry works by means of the association of metadata that represent the qualities which are able to order the complex chaos of interrelated elements without having to rank the result hierarchically. The system of inquiry 'delivers itself' by means of a tool (KeySet, see section 3.2). In summary, one might say that InfoBase forms a complex adaptive system that derives its properties from the ability to adapt itself to the changing circumstances without losing its unity. This unity has the form of a system of inquiry that, in the tradition of both Zen ("Fire does not burn fire") and the French philosophy (epistemology is not a superior methodology but the most appropriate way for getting access to what our culture distinguishes from others), shows at a meta-level that self reference signifies a communicative basis and that this basis is unproblematic as long as the origin of it is considered to be 'emptiness'. "The standpoint of emptiness comes about as a negation of 'nihility,' not in order to assert the priority of beings, but as a realization of the non-duality of being and nothingness" (Thompson, 1986).

Because it concerns human systems and knowledge is by definition a form of delay, the characteristics of a complex adaptive system include the relative hardness of information, once used, and the conservativeness of ideas. Among the characteristics of a complex adaptive system are the relative hardness of information, once used, and the conservativeness of ideas. Although contributed values are in principle relative values, through social processes (standardisation) these harden to the structure of an information system. This is the meaning of relative hardness. As an example, consider the use of certain solutions, certain constructs, materials and so forth. The conservativeness of ideas, on the other hand, stems from the human property to embrace ideas acquired during one's youth during the rest of their life (Inglehart, 1979, 2004). Examples are the forming of schools,

cohorts, currents and so forth. In the end, the system threatens to jam due to a lack of new information (self-referencing). A wide supply of currents and mutual competition ensures pressure on the system to keep changing in time.

InfoBase accepts a dual attitude with respect to these characteristics. On the one hand, InfoBase considers separate libraries per course and semester within which these processes take place. This forces the students to build the library anew each time. On the other hand, InfoBase provides public access to these libraries, both current and past. This gives students the chance to learn from the work of others.

InfoBase can be considered both with respect to content and with respect to process. As regards content, InfoBase concerns a collection of constructive and objective qualities: designs, facts, plans, terms and so forth (images, models, drawings, texts, etc.). As regards process, InfoBase concerns a collection of relational and subjective qualities: the students are as a group responsible for relating the contributed constructs and objects through moderation, validation and encoding of the information. It is expected from them that they express their personal opinion over these constructs and objects. In this way, the content of InfoBase changes once more and the process repeats itself.

Metadata serves as the means for students to build an information organization while constructing the library. Metadata are simply data about data or information about information. In practice, metadata form a structured collection of descriptive elements that describe an information object. Title, author and date are examples of metadata with respect to an essay, report or other student work. Metadata may also constitute keywords that relate to the content of the work. In the context of this paper, we primarily consider metadata as keywords, that may or may not be part of a thesaurus. We consider a methodology for adding, utilising and managing metadata embedded in an educational path with increasing responsibility for the student: programmed instruction, networking exercises and community formation. Next, we shortly describe the InfoBase educational project, describe the methodology for adding, utilising and managing metadata and present some intermediate results from implementing this methodology into education.

2. THE INFOBASE PROJECT

The goal of the InfoBase project is to provide students with and teach them how to utilise a digital environment in which they can store, exchange and manage the information they collect and generate, individually and in group, and at their own initiative. Ultimately, our aim is to initiate networks or working groups, within an integration of education and research, which serve as virtual centres of knowledge and experimentation on specific themes, in order to advance both education and research.

The goal of the InfoBase project has both a didactic and a technical component. Didactically, we want to support the students in their switch to the professional world through means of locking scientific value into the students' communication processes among themselves, with their instructors and also with researchers. For this purpose, we are teaching the students how to deal with metadata in the context of their learning processes. We are experimenting with a didactic model that has the goal of serving as a container for metadata that can be used as a design backbone. In the development of the didactic concept, we consider the following assumptions:

- students learn from one another by presenting their work to others and otherwise communicating with others about their work;
- design learning processes require both individual and group activities;
- these activities are both instructor-led and resulting upon students' own initiative;
- design-learning processes rely on both feedback and reflection, where feedback and reflection from the student are also important with respect to the work of others and information used from external sources.

Technically, we are developing an e-learning environment that supports students in exchanging and managing the information they collect and generate, and in adding, utilising and managing metadata, individually and in group, and at their own initiative. The InfoBase environment currently supports two interface modules. The StudentWork module is the main interface module of the environment and contains three parts, a student work submission section, a public section in which student work can be searched and viewed, and an administrative instructor section in which submission deadlines can be set and grades can be assigned to the work.

A second interface module, named MediatedDiscourse, enables students to collectively build an information structure in support of and to represent a discourse. It includes the following functionality: to relate a newly submitted contribution to existing contributions in the information structure, to develop a semantic structure of keywords and to assign keywords to contributions, to mark contributions according to a number of characteristics, and to comment on contributions as well as respond to others' comments. The MediatedDiscourse interface module is used in a number of educational experiments in order to gain insight into the manner in which these functionalities (can) contribute to supporting communication and group processes (Akar et al, 2003).

The InfoBase environment is used in an architectural education in support of design activities of students. For this reason there is an emphasis on multimedia content, including texts, images, audio, video, drawings, 3D models, etc. Overviews with thumbnails must offer the student quick insight into the content of the results of a search query. Images in JPEG, GIF and PNG format are automatically provided with a thumbnail. Other formats can be supplemented with an image by the author. Otherwise, the environment does not impose any restrictions on the format of the content or contributions. Browser plug-ins can assist in visualising the different formats.

At the heart of the system lies a single database model that supplies a simple, open structure for managing documents and metadata. The model mainly distinguishes 8 different object classes, these are *projects*, *documents*, *links*, *persons*, *groups*, *access rights*, (metadata) *dimensions* and *marks* (Fig. 1): projects define workspaces, e.g., courses; all content is defined as documents, documents can be linked; persons can be grouped and access rights defined per group, access rights apply to the entire project or to a specific document; (metadata) keywords are distinguished (and possibly structured) by dimension; marks define assessment marks or grades. Both documents and links are distinguished by type. Document and link types serve a categorization that is mainly semantic but may be used by the interface modules to distinguish functionality.

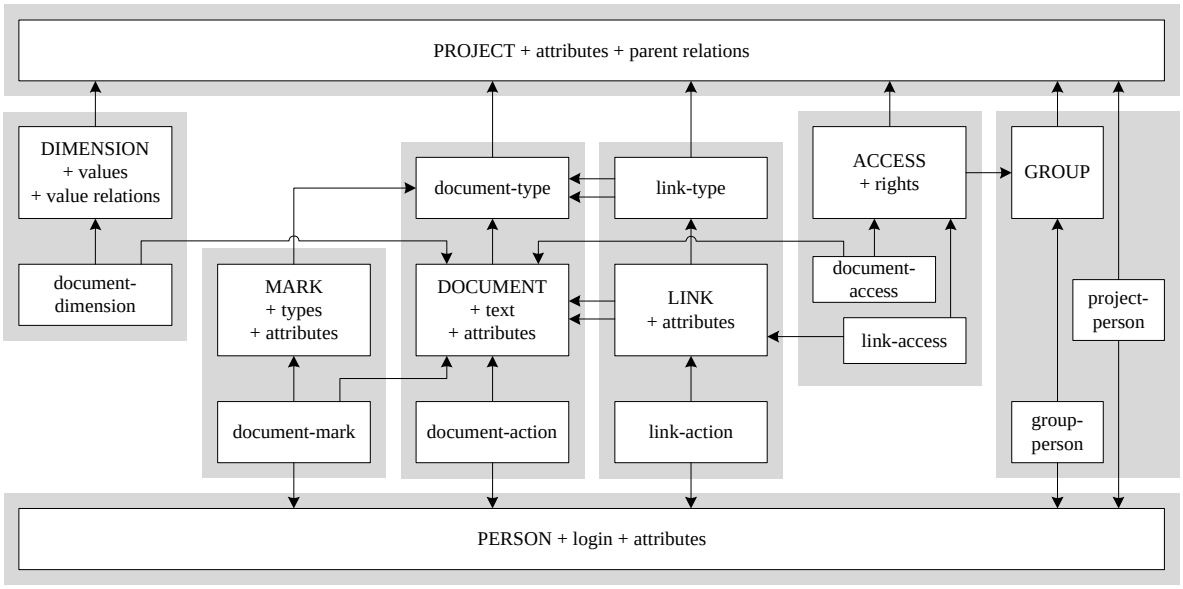

FIG. 1: The InfoBase database model. The shaded areas distinguish the eight main object classes (the respective class names are in all capital letters). For clarity, some tables are grouped together and presented by a single box (each plus sign refers to a separate table in the actual database model).

The InfoBase architecture considers four tiers, the database, the InfoBase Core Library, the server-side interface modules and the client-side interfaces (Fig. 2). The InfoBase Core Library shields the database from the interface modules, offers data abstraction and forces data integrity. It is augmented with module specific layers. All server-side code is written in PHP (and SQL for database access). User authentication is achieved through a university-wide LDAP server. Client-side interface components mainly use (D)HTML and JavaScript, though some components are developed in Java or Flash.

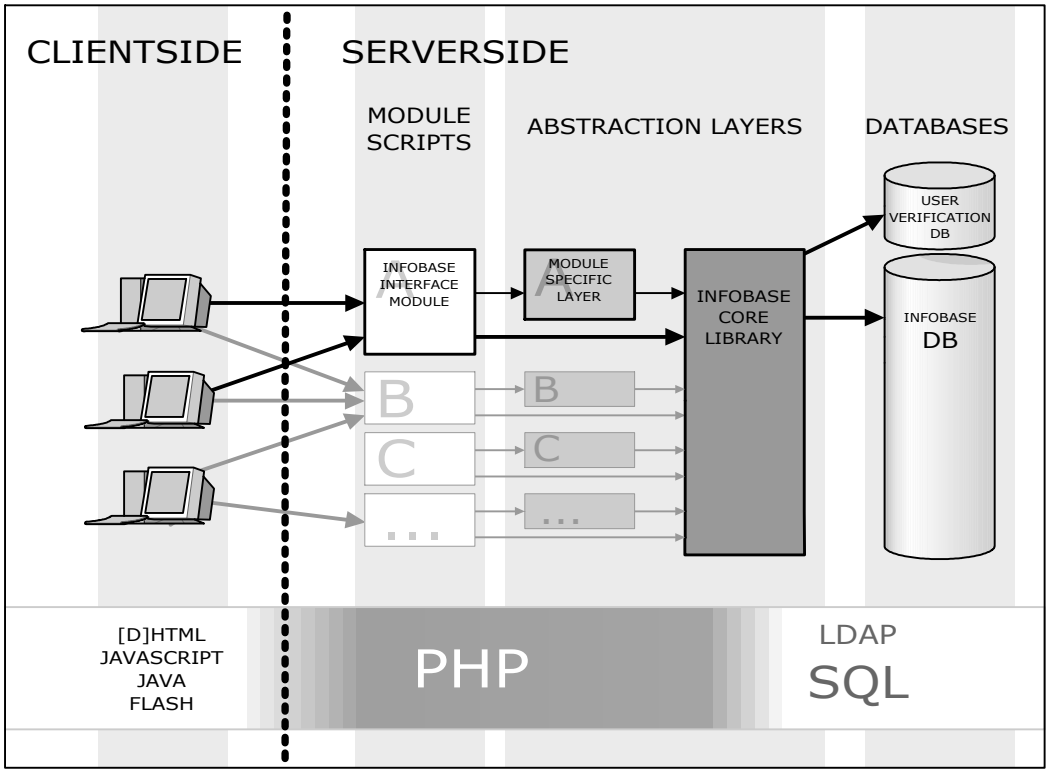

FIG. 2: The InfoBase architecture. Nils Addink.

3. THE USE OF METADATA

Most digital media libraries emphasize the ability to search the library based on an a priori defined metadata structure (organization) (e.g., IAAI/IBa, 2003, Heylighen and Neuckermans, 2000, Akin et al, 1997). This structure can often be quite detailed and extensive, requiring a fair amount of work from the user when entering a new entity (project or image) into the system. Other digital media libraries do not consider an a priori organization but instead rely on synchronous (face-to-face) communication in order to achieve a relevant structure during the process of building the library, e.g., as the result of a brainstorming session (Madrazo and Weder, 2001). The principal aim of the InfoBase digital library is not to serve as an archive that primarily supports searching and browsing, but to have students become familiar with the dynamic process of both contributing to and retrieving from a digital media library, in the context of a loose network or community.

Metadata derive (in a general sense) their action from their association to data and from the relationship they maintain with this data. This action consists of the fact that the metadata lays claim to the data collection to which it is associated. We denote this claim as successful if the data collection gains quality as a result of this claim (i.e., the association of the metadata to it) (Fig. 3). We consider that the design process manifests itself in this way; the designer lays claim to a data collection in such a way that this data collection gains quality. As a simple example, a designer claims that a collection of polygons or other surfaces signifies a house. This claim will succeed only if the concept of a house really occurs in this claim, that is, other designers or persons are willing to consider the collection of polygons or surfaces that has been denoted as a house to be a house. In terms of process, one can say that laying claim (in the form of associating metadata to data) must occur in such a way that through the claim itself the data construction process gains quality. “A claim has the desired quality if in the construction process attention has been devoted to the construction progressing in such a way that using the claim serves to improve the quality” (Groen et al, 1980, Kooistra, 2002). Laying claims in the form of metadata is the engine of the design process.

FIG. 3: Diagram denoting the various stages in an information process and the influence of the use of metadata on this process: information gains quality as the result of the association of metadata to this information.

When we consider a system in which metadata and their use can be organized, this system has to meet the requirement that it should offer the possibility to achieve quality improvement through laying claims as well as to assess these claims with respect to their quality. Therefore, the system must be both robust and flexible. Robustness in this context means that an agreement prevails in the system in such a way that it offers the possibility to "correspond," i.e., communicate in agreement, on the metadata to be associated. With respect to the example above, this means that the designer's claim must be recognized and acknowledged by other designers (Fig. 4). At the same time, the system must offer the possibility for designs to change and in such a way that, in principle, a claim generates quality improvement. In the example, this means that the house that the designer claims consists of an *original* collection of polygons or surfaces. Throughout time, the need for designs to change can easily be followed. The claim to have a house designed hasn't changed throughout the centuries. However, the product of the claim has evolved with the state-of-the-art of technology, society and culture.

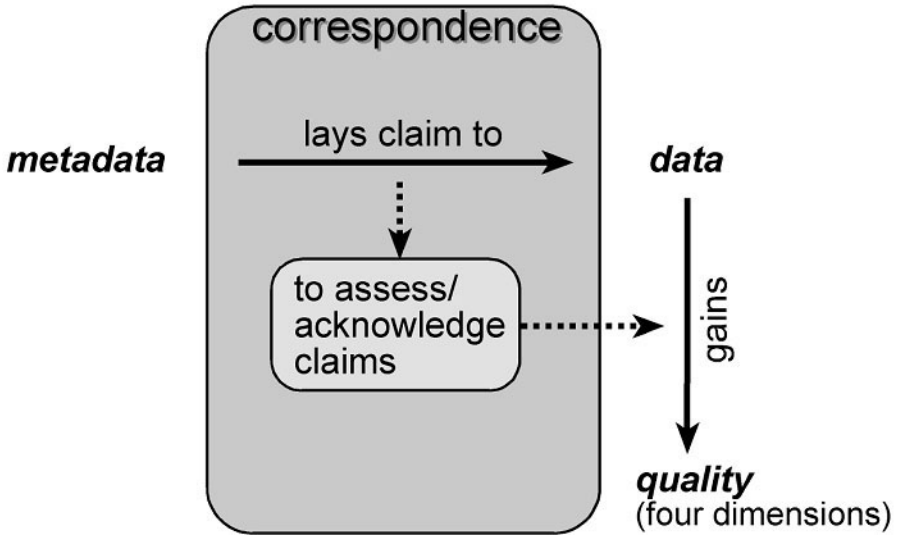

FIG. 4: Diagram denoting the role of correspondence in the process of associating metadata to data: metadata lay claim to data; if these claims are acknowledged, the data gains quality as a result.

3.1 Four dimensions of qualities

Applied to the context of an architectural education, we want the student or future architect to learn to lay claims on data collections in such a way that a vehicle arises with which this student can travel as a designer through

time and space. Therefore, we teach the student to handle and use metadata along four quality dimensions: there are constructive, relational, objective and subjective quality claims (Groen et al, 1981, Kooistra, 2002) (Fig. 5). Constructive quality signifies the *will to design* (the will to improve) that arises from the necessity to achieve agreement through correspondence. It is an intuition that springs from comparison. However, constructive quality has no quality unless one is able to persuade other people (architects / designers) to believe and invest in one's construction. Thus, objective quality is also needed; one needs repeatable observations—scientific facts. Unfortunately, facts don't have a meaning without human intentions, wishes, drives or whatever one may call them. So, intention represents the third kind of quality. It is called: relational quality. Producing survival knowledge relates people; survival is a basic activity not unknown to students in an educational setting. Lastly, the fourth kind of quality is the subjective quality. This kind of quality signifies one's personal taste, conviction and interest. It is presenting what one self is thinking and feeling and through that it represents one's position in the quality system. Special about subjective quality is that it only can exist in *opposition* to objective quality. Objective quality is a (scientific) domain. Subjective quality simply disappears if it comes within the range of this domain.

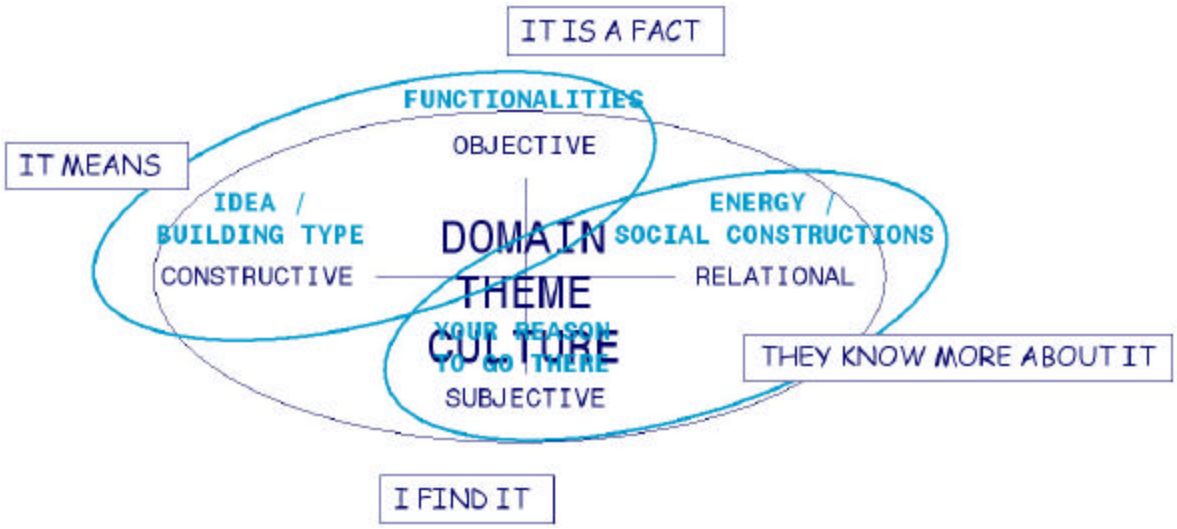

FIG. 5: Diagram denoting the space formed by four dimensions of socio-cultural qualities and their interpretation for architecture.

Subjective and relational qualities are dependent on the community in which students operate. These qualities are not only defined within the social processes in the community but also influence these processes (Hough et al, 2001). By teaching students how to express and utilise these qualities in their communication with peers, they can learn to become more effective in their use of information from various sources to support such communication. In the InfoBase project, we consider the expression of these qualities through metadata in various forms, such as ratings, semantic structures of keywords and different types of links between information. In a first round, we are concerned mainly with the use of the model. Further on in the curriculum, the focus will turn to the handling and steering by the student himself of the vehicle that the model defines. In this way, it is as if the student goes through the process of handling an existing prefab vehicle to designing, building and handling one's own vehicle.

At the level of philosophy, this construction (of the four qualities) represents the theme of the circularity of cognitions and experiences and the question that appears with it, on which ground one can rest this structure upon if one sets loose the 'original' solution of metaphysics which in itself also knows various gradations. One then automatically encounters the discussion about objectivism and nihilism (Nietzsche). We relate the four qualities to the idea of 'Being There' (Dasein) as this is elaborated by the Existentialists, Heidegger (1972) among others. A designer signifies in his design the world that exists for that reason but finds himself at the same time in an already signified world that limits the scope of possibilities of the design. The two types of approaches are opposed in a particular relation of inclusion and exclusion. That is to say, the two approaches are included in their mutual exclusion (Kooistra, 1988). Thereby they open a third domain, the performance. This is the continuing path along which this process both expresses itself and repeats itself. There is no reverse to identity.

"The standpoint of emptiness comes about as a negation of 'nihility,' not in order to assert the priority of beings, but as a realization of the non-duality of being and nothingness" (Thompson, 1986). 'Relative nothingness' becomes 'absolute nothingness,' for nothingness appears at the heart of self-identity. Here the self-identity of an entity is shown to be its nonself-nature.

3.2 The KeySet tool

The InfoBase environment contains a StudentWork interface for students to submit the products and results of their digital exercises. When students submit their work through InfoBase, they can be required to associate metadata in the form of keywords to their submission (Fig. 6). We denote this system of metadata KeySet. KeySet provides each work with a *key* consisting of a combination of four or more keywords. The mutual relationships between these keywords correspond to the primary dimensions of the design process. These four dimensions correspond to the four dimensions of socio-cultural qualities presented above and define the space in which the design process takes place. In order to teach the students the meaning and distinction of these four dimensions, we use the following concepts (Fig. 7, Table 1).

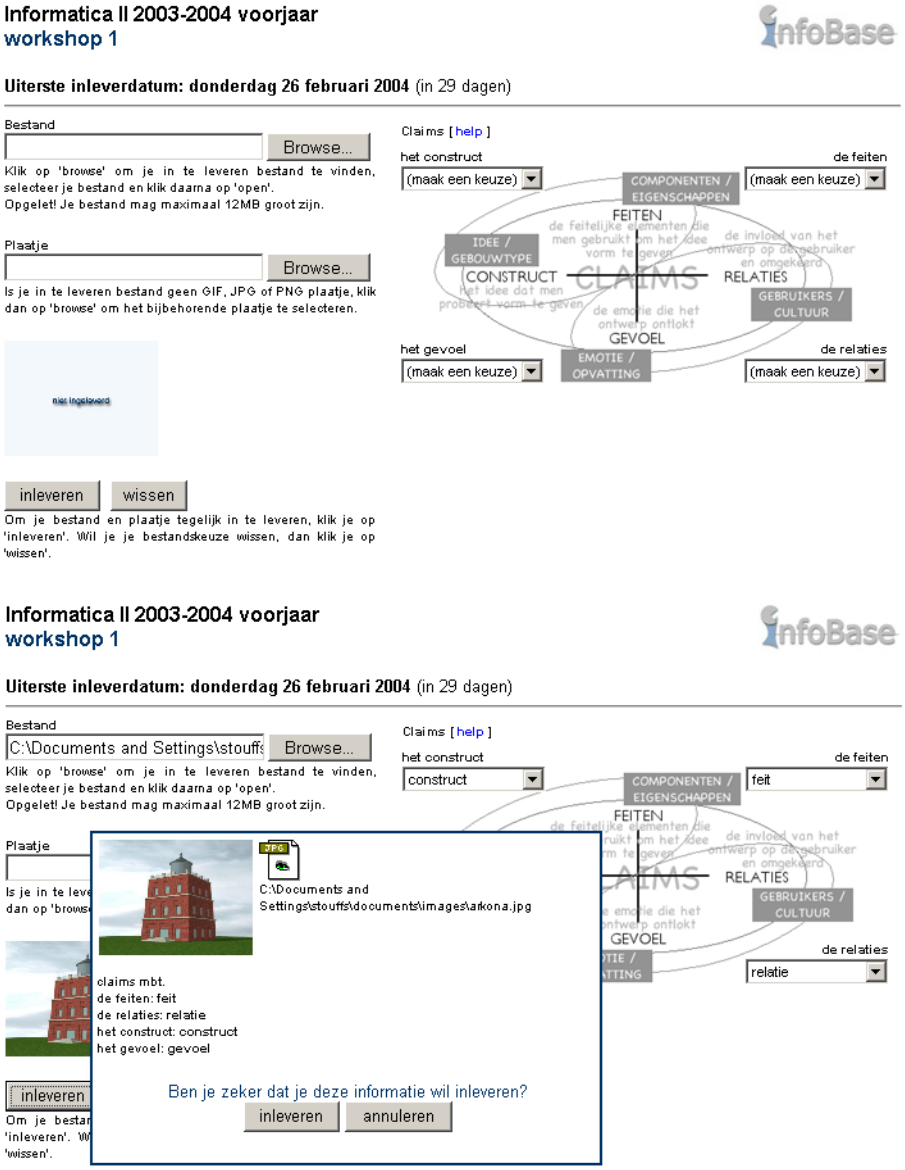

FIG. 6: Snapshots from the InfoBase StudentWork interface for submission of student work. Above, the submission interface with the KeySet submission tool. Below, the submission interface with confirmation window.

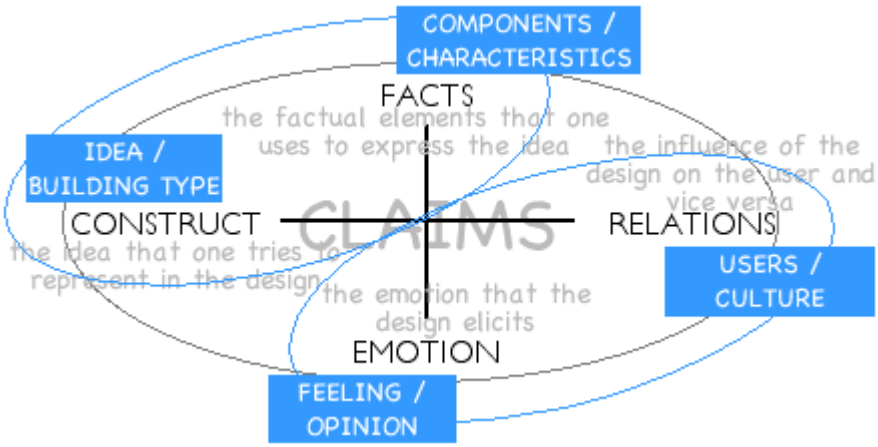

FIG. 7: Diagram denoting the space formed by four dimensions of claims and their interpretation for architecture; this diagram is presented to students as a memory aid when they lay claims on their submission.

TABLE 1: Overview of the four quality dimensions and their interpretations, i.e., what each dimension represents and claims and examples of keywords or qualities.

DIMENSION	REPRESENTS	CLAIMS	EXAMPLE
THE CONSTRUCT (the constructive qualities)	the idea or collection of ideas that one tries to represent in the design	that the design best fits this idea or ideas	abstract: living, working, playing, learning, etc. concrete: house, office, workplace, theatre, school, city hall, parliament, etc.
THE RELATIONS (the relational qualities)	the influence that the design has on the user and, vice-versa, the influence of the user on the design	that the design fits in the social life and culture of the intended user	considering the use by inhabitants, workers, visitors, students, townsmen, parliamentarians, etc.
THE FACTS (the objective qualities)	the (f)actual elements that one uses to express the idea(s)	that these elements give expression to the idea(s) and create a robust entity	robust combination of materials, techniques, forms, etc.
THE EMOTION (the subjective qualities)	the emotion that the design elicits from the designer or the audience	that the design satisfies a certain contributed value	beautiful, ugly, functional, transparent, cold, etc.

The *construct* constitutes the idea or collection of ideas that one tries to represent in the design. The construct claims that the design best fits this idea or ideas. This corresponds to constructive qualities. Abstract examples are living, working, playing, learning, etc. Concrete examples are building types: house, office, workplace, theatre, school, city hall, parliament, etc.

The *relations* constitute the influence that the design has on the user and, vice-versa, the influence of the user on the design. Relations claim that the design fits in the social life and culture of the intended user. These correspond to relational qualities. Examples concern considerations to the use of the designed object by inhabitants, workers, visitors, students, townsmen, parliamentarians, etc.

The *facts* constitute the (f)actual elements that one uses to express the idea(s) (e.g., materials, techniques and forms). Facts claim that these elements give expression to the idea(s) and create a robust entity. These correspond to objective qualities. Examples concern the robust combination of materials, techniques, forms, etc.

The *emotion* constitutes the emotion that the design elicits from the designer or the audience. The emotion claims that the design satisfies a certain contributed value. This corresponds to subjective qualities. Examples are beautiful, ugly, functional, transparent, cold, etc.

We consider a few examples; the italicised terms can be considered as keywords or claims. As a general example, an *art program* on TV is a construct that considers *art loving viewers* (relations). The program presents *facts about theatre shows* that may convince the viewer that it is *worthwhile to attend a theatre show* (emotion)—upon which the viewer may send the program a *disappointing* (emotion) review. Considering the field of architecture, the *theatre* is a construct that considers an *audience* looking for *entertainment* (relations). The theatre has a (large) *hall with 1500 seats* (fact). The audience ascertains that the *seating is comfortable* and the *acoustics are laudable* (emotions).

3.3 Communicability of keys

The students are warned that associating keywords or claims to their work is relative—it always involves interpretations. Thus, the key (as a collection of keywords) a student assigns must be communicable. Furthermore, considering that every design is unique, the students are taught that chaos arises naturally when 'populating' a cooperative database. Every design that is submitted 'queries' InfoBase and forces it to position the design. Since every design is unique, each design receives a position that does not coincide with any other. In this way, InfoBase ends in 'chaos,' unless a constraint is imposed that applies with the input of data. In the case of InfoBase, this constraint is imposed with the aim that students are encouraged to learn from one another and work together, at their own initiative. Specifically, human communication constraints the uniqueness of the designs as positioned in InfoBase through the use of metadata. This introduces the principle of order (and, with it, that of simplification) and self-organisation; "order arises from complexity through the process of self-organisation" (Prigogine and Stengers, 1984). The obligation that correspondence on claims must take place in InfoBase can be regarded as self-organisation in this respect. InfoBase can be considered a self-organising system exactly because the content is placed under the condition of human concepts that can be exchanged through correspondence.

KeySet mediates both technically and strategically to ensure communicability of keys. Technically means that KeySet also concerns a search tool that allows students to retrieve keywords and keys and the associated student works (Fig. 8). Using the search tool, a student can select any number of keywords, including the key assigned to one's own submission, and retrieve all student works that include all selected keywords in their keys. Strategically means that KeySet is implemented into the education in such a way that the student learns to deal with the relativity of the system and learns to use the system to its full extent without a feeling of being left to one's own devices when it concerns learning to handle the body of architectural concepts. In the first year of the architectural BSc program, KeySet is used as a closed or almost closed system, i.e., students are limited in their ability to create their own keywords. Each dimension can either be completely closed (i.e., a single keyword is provided as a fixed choice), coupled to a fixed set of keywords one can choose from, or linked to an online thesaurus with fixed architectural terms. This will stimulate the relatedness of the different keys students use to encode their work while it remains clear that each design is unique and this uniqueness deserves to be honoured. Later on in the BSc program, the correspondence on claims between designs will be primarily dealt with by the students.

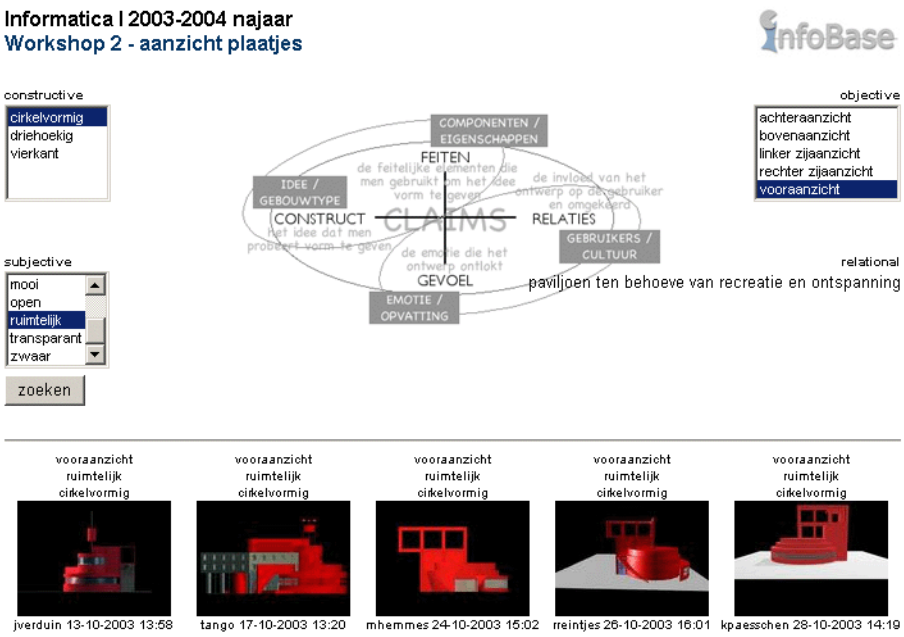

FIG. 8: The KeySet search tool applied to the results of a first semester modelling workshop of Parc de la Villette "follies". The selected keywords are "circular" (construct), "pavilion for the purpose of recreation and relaxation" (relation), "front view" (fact) and "spatial" (emotion).

4. EDUCATIONAL EXPERIMENTS

We have started to implement this methodology in two course components that each form part of a design studio course, one in the first semester of the BSc Architecture program and one in the fourth semester.

4.1 First semester computer lab session

In the first semester course, the students are first introduced to the use of metadata when submitting course work in a computer modelling workshop. This course is offered in the fall semester to about 350 students. In this particular workshop the students are introduced to three-dimensional modelling using computer software and are requested to create a model of one of the "follies" at Parc de la Villette, Paris. Last fall semester, their submission consisted of one model and eight images of this model: one front view, one rear view, two side views, one top view, one bird's-eye view and two perspective views at eye level. For each image they submitted they had to provide a key consisting of four claims corresponding the four quality dimensions. For each dimension, a small set of keywords was provided from which the student had to choose one. However, the relational dimension was a closed dimension: the keyword "pavilion for the purpose of recreation and relaxation" was provided as a fixed choice. The construct was related to the perceived shape of the pavilion. In the case of a front, rear, side or top view, the student was able to choose between "circular," "triangular" and "square;" otherwise, in the case of a perspective view, the available keywords were "spherical," "cylindrical," "conical," "cubical" and "pyramid-shaped." The name of the view was chosen as fact. A few subjective keywords were available for the emotion: "beautiful," "ugly," "open," "closed," "light," "transparent," "spatial" and "dense." 288 students actually participated in the workshop and submitted in total 850 perspective views and 1426 other views. The KeySet search tool provides separate access to both sub-libraries (Fig. 8, http://www.bk.tudelft.nl/infobase/ provides access to all student work).

4.2 Fourth semester design studio

In the fourth semester course, the students build digital media libraries for design analyses and materials, in the context of a design studio. These media libraries are specifically considered as cooperative databases for the exchange of information. The central design theme of this studio is a "small public building," either a small theatre or a museum. It is offered twice a year to about 260 students in total. The students are given a relatively complex functional program and are required to design and work out the materialisation of this public building.

The students begin the studio by analysing selected precedents (historical and contemporary) of the relevant building type with respect to various criteria (composition, program, construction, context, type, etc.) and from structural, formal and functional points of view. Documentation of these precedents is presented to the students in the form of drawings, pictures and texts. The students are provided with a Design Analysis Network (DAN) tool (Kooistra et al, 2003, Tunçer et al, 2002) that allows them to draw relationships between different entities documenting the same precedent and to assign metadata to the analysis as well as to each of the relationships. The students must subsequently search this common library for other analyses that support their design concept and specify these as references to their concept. Next, the students also analyse a material or building component and create a digital texture for this material. Collectively, these results form a material library that the students can access and search in order to support their subsequent design and modelling activities.

4.3 Evaluation

We have evaluated the use of this methodology in both course components, especially the association of metadata to the products that students submit, and the problems they face in the process.

The evaluation of the process in the first semester computer lab session in the fall 2004 semester was carried out by means of two surveys in the form of questionnaires to small groups of students. During this semester, students were not introduced to the concept of KeySet as explained in section 3.1; instead, a short introduction was given to the four quality dimensions (section 3). This introduction proved to be too elusive and students, in general, did not achieve an understanding of the meaning and role of each dimension and the relationships between them. The first questionnaire contained 15 questions and included open questions regarding the meaning of the four quality dimensions. 25 students filled in this questionnaire and it became clear that students associated different meanings with the dimensions.

Students did appreciate the formation of digital media libraries composed of their submissions, encoded using metadata according to the four dimensions and searchable using the KeySet search tool. 32% of the respondents had a clear idea of what was going to be done with the collection of products (36% said it was somewhat clear, 32% were unclear). Students also used the KeySet search tool to search either digital library using one of the keys that they used to encode their own submissions. The second questionnaire contained 32 closed questions, divided into 3 sections: A. associating metadata to a submission, B. searching for submissions of other students with the help of metadata and C. the concept. 68 students filled in this questionnaire and 41 % of the respondents had searched the database. Nearly half of them indicated that these metadata were useful when searching for the work of others.

This spring semester, the students received a new introduction into KeySet as part of a second semester course. At the same time, we have started an extensive scales evaluation of the use of this tool.

In the context of the fourth semester design studio, the use of metadata to form and manage the digital media libraries was evaluated in a laboratory environment, called the Laboratory for Work and Interaction Technology (WIT-lab). Five students were observed and video-taped while performing an analysis using the DAN tool. The students had no doubts about the value and potential of digital media libraries as cooperative databases. However, in the case of the material library, the technical aspects of KeySet were partially used, though, not in support of the strategic aspects whereas, in the case of the design analysis library, the use of KeySet was mixed and confused with the use of the DAN tool which itself suffered from technical problems. Furthermore, the selected students did not know what the general purpose and method of design precedent analysis was and, accordingly, they did not know what the keywords meant or how to use them accurately. Once it had been explained to them and they were able to work with it, students became considerably enthusiastic about the concept and the tool.

Next semester, we will focus on the use of KeySet, both technically and strategically, to support the creation of a material library. We also consider the use of (meaningful) examples about the task at hand in relation to metadata in order to lead to better results.

5. CONCLUSIONS

We have considered a theory of complex adaptive systems in which correspondence among members of a design community leads to agreement on the quality of design. We have applied this theory to the formation of digital media libraries in an educational process. We have presented the translation of this theory, technically and

instructionally, into the KeySet tool. We have presented intermediate results from embedding the KeySet tool in the architectural BSc curriculum. We were able to conclude that the majority of students understood what we aimed for with the application of this theory and appreciated the formation of digital media libraries composed of their collective work.

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