

W. Mike Martin · Ann Heylighen
Humberto Cavallin

The right story at the right time

Towards a tacit knowledge resource for (student) designers

Received: 27 April 2003 / Accepted: 15 April 2004 / Published online: 23 July 2004
© Springer-Verlag London Limited 2004

Abstract In response to the lack of systematic study of architectural practice, the Building Stories methodology propounds storytelling as a vehicle for studying active cases, i.e., projects that are in the process of being designed and built. The story format provides a dense, compact way to deal with and communicate the complex reality of a real-world project, while respecting the interrelated nature of events, people and circumstances that shape its conception. With an eye to establishing a valuable knowledge resource of and for the profession, the paper explores how stories can be stored, organized and accessed so as to turn the growing story repository into a convenient instrument for students, educators and practitioners.

Keywords Architectural practice · Design expertise · Knowledge exchange · Storytelling

1 Introduction

A narrative discourse is an account that employs verbs of speech, motion, and action to describe a series of mutually contingent events, and typically focuses on one or more performers of actions. Design education has a core component of learning in action, that is, learning through the practice of designing without being aware of what is learnt (Schön 1983). This tacit socialization process works based on the dyad master-apprentice, both in the context of the studio

W. M. Martin (✉) · H. Cavallin
Department of Architecture, College of Environmental Design,
University of California, 232 Wurster Hall, MC # 1800, Berkeley,
CA 94720-1800, USA
E-mail: wmmartin@socrates.berkeley.edu
E-mail: hcavalli@uclink4.berkeley.edu

A. Heylighen
Department of Architecture, Urban Design and Planning, Dept. ASRO,
Katholieke Universiteit Leuven, Kasteelpark Arenberg 1,
3001 Leuven, Belgium
E-mail: ann.heylighen@asro.kuleuven.ac.be

setting and in professional practice. Granted, studying design products plays a role in design education as well, yet as such, products can never reveal the constantly changing conditions that actually structure the process of designing (Brown and Duguid 1996). Indeed, “conflicting demands from within the client organization, the remoteness of the user, difficulties with the bearing capacity of the soil, an unsympathetic planning authority, changing circumstances during the design period, restricted or inflexible methods of financing scheme... and many more difficulties remain inscrutable to all, but the most perceptible and insightful of architectural critics” (Lawson 1990). Dealing with such changing and conflicting conditions requires a form of knowledge, e.g. knowledge that is embedded within the very action of designing and thus escapes the static form of a design product (Schön 1985).

This tacit, experience-based knowledge is considered the basis for some kinds of case-based reasoning (CBR) in design (Kolodner 1993). CBR is a theory and technology in the field of architectural intelligence engrafted onto a memory-based view of cognition. Central to CBR is the claim that knowledge in human memory takes the form of cases, i.e., interpreted representations of concrete experiences, rather than abstract rules or models. By consequence, human reasoning is viewed as a process of remembering one or more experiences from the past and basing decisions on comparisons between these experiences and the situation at hand.

The intimate relationship between knowledge and experience in design has inspired CBR researchers to develop various case-based design tools which try to support architects (and designers in general) in capitalizing on previous design experience. Examples of such tools are CADRE (Hua et al. 1996) and SEED (Flemming et al. 1997) for building design, FABEL for technical buildings with complex installations (Schmidt-Belz and Hovestadt 1996), Archie for courthouse design (Domeshek and Kolodner 1993), IDIOM for apartment floor layouts (Smith et al. 1996) and PRECEDENTS for museum design (Oxman and Oxman 1994).¹ Despite considerable differences in aim, scope and stage of development, each of these tools is built around a case base, an indexed collection of concrete cases labeled by a set of characteristic features. Across the board, cases document buildings, i.e., design products usually, but not necessarily, at the final stage of the design process. By contrast, Building Stories has chosen to adopt a different approach, which complements product data with stories about the process that led to the product.²

Building Stories is a methodology to record and explore the knowledge capital embodied by design practice through storytelling. The story format provides a dense, compact way to deal with and communicate the complex reality of a real-world building project, while respecting the interrelated nature of events, people and circumstances that shaped its conception. Outside the field of architecture, companies and firms are showing great interest in the potential of storytelling to enhance organizational performance in general and knowledge management in particular (Denning 2001). Stories provide a unique vehicle for tacit-to-tacit knowledge transfer, which is usually done without capturing knowledge in an explicit form.

¹For an overview and comparison of such systems, see Heylighen and Neuckermans (2001).

²As will be pointed out further in the paper, Archie and PRECEDENTS make use of stories too, be it of a different nature than in the building stories approach.

Precisely because of this tacit knowledge transfer, we propose to compose cases by project data *and* stories. The data constitute a first and necessary, albeit insufficient, starting point for the case. They form the skeleton, the bare bones around which stories—the actual body of the case—are woven. These stories are interpretative in nature (as is design) and as such shift the case content into the domain of the subjective. Yet, being built around—and physically connected to—a core of (more) objective data, it is possible at any time to retrace the facts that informed the story, which can serve in turn as the basis for telling another story.

Previous papers have expounded the ideas underlying Building Stories and situated the methodology with regard to other case study approaches (Martin et al. 2003). The present paper focuses on the development of the growing repository of building stories into a valuable resource of and for the profession. After giving a brief picture of the methodology in operation, we will explore a way of storing, organizing and accessing the resulting stories so as to make the repository conveniently accessible to students, educators and practitioners.

2 Building Stories

The Building Stories methodology takes shape in an experimental course called ‘Building Stories: a Case Study Analysis of Practice’. Through a guided set of activities in a case-based mode of instruction, the course engages teams of architecture students and interns, as well as seasoned architectural professionals, in exploring the knowledge embodied by the best practices of significant architectural firms.

Students enrolling in the course (some of which are part-time interns) develop a theoretical and methodological framework for undertaking a case study through storytelling. In addition, they actively engage in building one or more building stories about an active project, i.e., a project that is in the stage of being designed and built, by analyzing primary source documents *and* interacting with practitioners responsible for the project under study. Through a series of weekly lectures and discussions, students and interns become familiar with the materials of the case-based method and with the critical questions needed to explore the richness of the stories embedded in an active project, while opening a dialogue on the rigorous study of the broader aspects of the profession. In addition, teams have weekly meetings with professionals in the office executing the project. The meetings provide opportunities to discuss, clarify, and elaborate these issues, as well as enable students and interns to discuss and evaluate the progress of their case study fieldwork.

During the first seven weeks of the course, each of the research teams investigates the (up to then) entire history of their project, ranging from pre-design, planning and design development, to construction and inhabitation. In addition, each team identifies a series of issues that will provide the opportunity to construct one or more building stories during the second part of the course. We deliberately say ‘one or more’ because any project may provide grist for multiple stories, all of which are incomplete or inaccurate in different ways. A story is likely to cover only slices of the process, since partial description is built into the very nature of storytelling (Denning 2001, p. 173). Any individual story is

necessarily a subjective selection, and thus but one of a host of stories that might be told about the same project.

In the case of the San Francisco Zoo, for instance, so far three quite different stories have been identified: one about the tedious and lengthy process of contract negotiation, a second—aptly entitled ‘*Honey! I shrank the Zoo...*’—about the impact of value engineering on the final result, and a third about the managing of a diverse design team. This trio by no means claims to be complete. It could not be so, since a wealth of other stories is still waiting for discovery by research teams in years to come.

Once the issues are identified, the details of the building stories are formally constructed in the second half of the course. Each story is developed much in the same manner as one would write a novel. The plot or thread is positioned—a failed bond issue; the characters are illuminated—the introduction of a construction advisor as the client; and the settings of the actions established—revised firm organization to value engineer the originally proposed scope, schedule, and budget of the project. Over the next six weeks, new chapters are added, giving meaning and understanding to the building story.

The final case report includes the stories produced by the team, along with the information collected during the investigation, and is presented in a digital format for posting on a public web site (Fig. 1).

3 From story repository to knowledge resource

So far, we have introduced the Building Stories methodology and described its operation in an experimental course. With about four teams participating in the

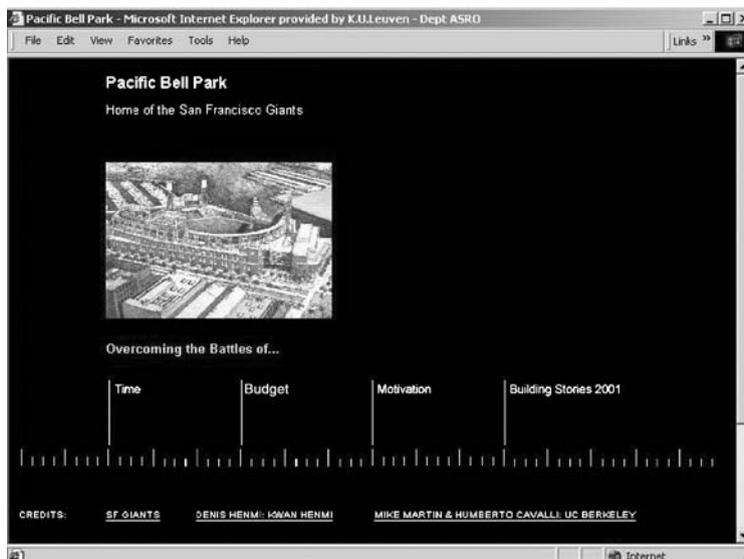


Fig. 1 The final case report includes the stories produced by the team, along with the information collected during the investigation, and is presented in a digital format for posting on a public web site

course annually, we expect the collection of building stories slowly but steadily to accumulate into a sizeable repository. In developing and testing this methodology, however, we are not so much interested in the stories per se. Our main concern is how the tacit knowledge the stories capture can be used by design professionals, students and educators to learn about and improve design practice. We are interested in supporting the reflection-in-action that is an integral part of design practice (Schön 1983) by providing interesting stories about what goes on during the design process and how this impacts the product built. For the repository, to become a valuable knowledge resource of and for the profession, however, merely providing access to a large archive of stories will not do. Instead, we should provide users—professionals, students and educators—with a selection of those stories that are relevant to their specific situation. Practitioners, for instance, will not want every best practice under the sun, but just the lessons of experience that pertain to the particular issue with which they are struggling. This requires devising a format to represent and classify building stories, varied as they might be, in a systematic and easily searchable way. It requires developing a framework to store, organize and access stories, so that the repository can actually start acting as a convenient instrument. This section provides a description of a rudimentary but feasible hypothesis that has been explored to this end.

3.1 Storage

The essence of the Building Stories approach to case studies is that cases do not merely document objective data, but use these data as a foundation upon which one or more stories are built. By consequence, it seems logical to structure the story repository accordingly into two compartments: the ‘objective’ compartment, which logs bare facts regarding the objects, actors, and context that form the skeleton of the case, and the ‘subjective/interpretative’ compartment which stores the actual stories that are woven between and around these facts.

As mentioned before, the stories constructed to date take the form of web sites. Since research teams may structure their site according to the requirements posed by the nature of the project, the sites usually have few commonalities. How then do we marshal this hodgepodge of building stories?

Varied as they might be, all stories unfold in a specific time and setting (Fig. 2). A single story may span a larger or smaller slice of a project’s lifecycle in which a cast of actors, laws, codes, etc. put their mark upon its conception.

Within this time and setting, the story itself can be conceived as a network of events, which altogether form the path from start to end. Each event is made up of two types of building blocks: activities and artifacts (Fig. 3). Activities embody (an account of) the actions and interactions performed by the actors during the event, and link to artifacts they create or use in doing so.

Events can be defined at various levels of abstraction. Indeed, if we consider a building story as a network of interconnected events, one may argue that at a very high level of abstraction the project itself is an event, transforming the program of client needs and requirements (fact) through design and construction (activity) into the final building (artifact). Encoding stories at such high level of abstraction, however, would yield a knowledge granularity that is too coarse for directly assisting architects’ design decisions. If we are to provide them with

Fig. 2 A building story unfolds in a specific time and setting as a network of events

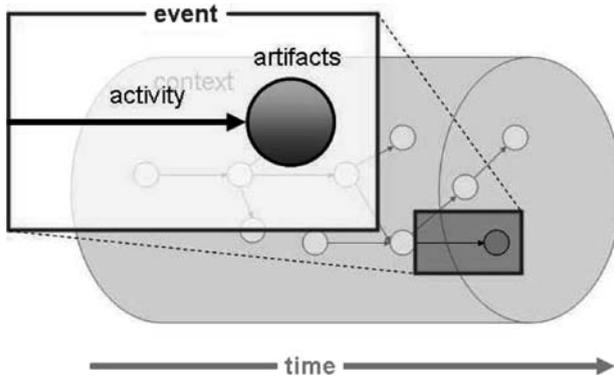
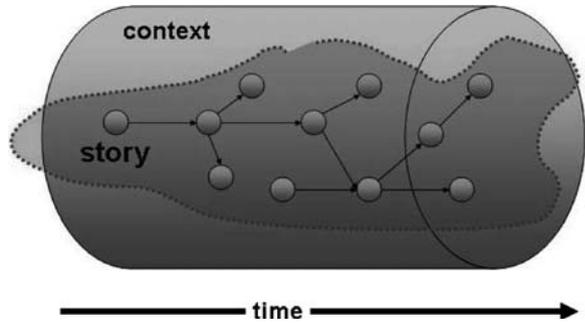


Fig. 3 Network events made of two types of building blocks: activities and artifacts

manageable knowledge chunks, it seems plausible to slice stories in events at lower levels of abstraction. For instance, in the case of the International House and St. Mary's Catholic Center, the revision (activity) by the planning department (actor) can be considered an event that changed the original design (artifact) into a fairly different one (artifact) (Figs. 4 and 5).

"Changes implemented to the design by the planning department can be viewed as taking away from the original intent of the design team. The initial design attempts to minimize the building mass at the street level. In emphasizing the specific program behind the building skin and expressing elements horizontally and individually, the overall scale is reduced. The original scheme also highlights the historical community room by setting back the corner" (Chirakphon and Robie, 2000, unpublished).

Similarly, in '*Honey! I shrank the Zoo...*', several exercises of value engineering (activity) gradually reduced the Panorama Café from the original two-story proposal featuring a 'Coastal California' look and a dramatic two-story banquet room with large fenestration to maximize views over the entire zoo site (artifact) to a down-to-earth, 'barn-look' one-story café (artifact), barely doing justice to its panoramic name (Figs. 6 and 7).

The artifacts used or produced during an event, however, are not necessarily versions of the design product. In the case of the zoo, for instance, another story

Fig. 4 International House and St. Mary's Catholic Center before the revision by the planning department



Fig. 5 International House and St. Mary's Catholic Center after the revision by the planning department



features events in which architect and program manager (actors) negotiate (activity) the draft contract (artifact), which results in a second, revised draft (artifact) and eventually in the contract of record (artifact).

3.2 Organization

Having compiled building stories as networks of events (composed of activities and artifacts), the question arises: how do we locate the right story at the right time? How do we supply relevant stories to an architect or student interested in a specific issue?

The standard CBR answer to this question is by indexing, i.e., by labeling stories with one or a small set of indices that can be compared with features of the probe. In everyday life, we use a similar technique to look up something in a book. Yet whereas we call 'an index' the entire lists of keywords in a book, CBR researchers use the term for each single keyword assigned to a case. In order to eliminate potential confusion, a distinction is made between probe and label indices: the former refers to the description we use to find something in the case base—the reader's guess at a good keyword, and the latter to the description that has been assigned to the contents of the case base—the alphabetized list of keywords in a book (Domeshek 1994).

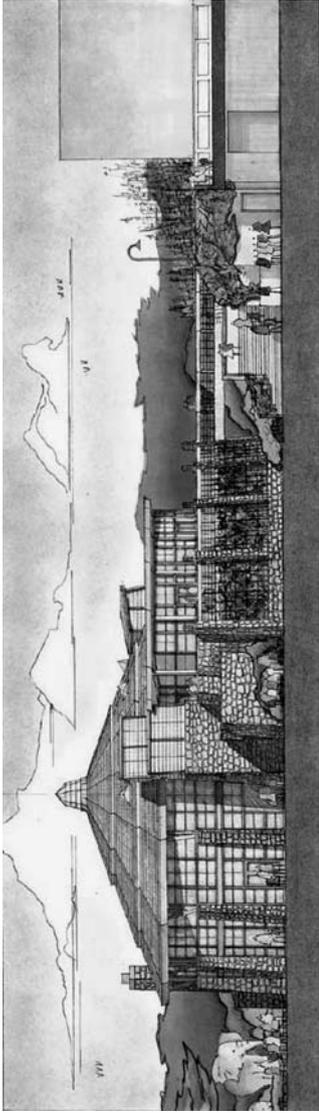


Fig. 6 Panorama Café as the original two-story proposal featuring a 'Coastal California' look and views over the entire zoo site

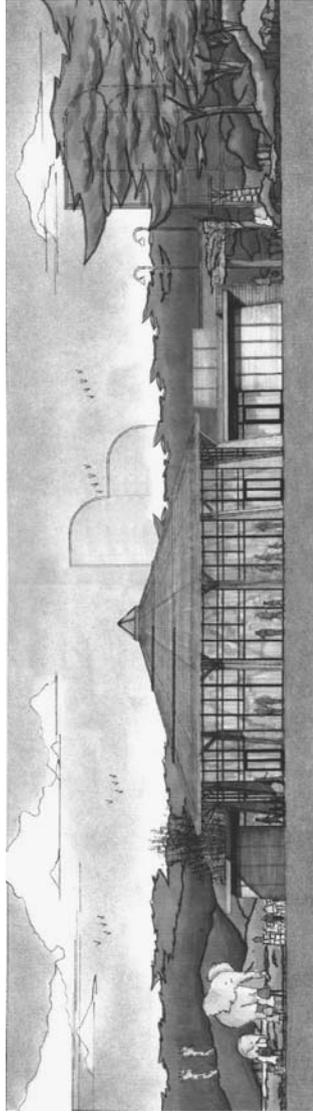


Fig. 7 Panorama Café reduced to a down-to-earth, 'barn-look' one-story café

Since the story format was chosen precisely because it respects the multiplicity and interconnection of aspects at stake in design, it seems likely that more than one label will be needed to index a single story. At this point, we propose a web of indices that allows characterizing, retrieving, and comparing stories along six dimensions:

<i>Actors</i>	Individuals or groups of individuals who make decisions about a project based on their specific values (architects/designers, clients/owners, consultants, (sub)contractors, local authorities, community groups, etc.)
<i>Context</i>	The physical location of the project, including climate conditions, regional characteristics, geological constraints, site boundaries, transportation issues, etc.
<i>Organization</i>	Predetermined organizational structure (e.g., owner-builder delivery process) that affects the outcome of project
<i>Practices</i>	Use of operating procedures, methodologies and/or tools within the design firm
<i>Program</i>	User/client needs and requirements to be accommodated by the project within the given scope, time and budget
<i>Resources</i>	The time and budget within which the project should be completed, as well as any types of documents, tools, or conditions that provide a firm with special capacities to do so

Rather than a straitjacket, these dimensions should be thought of as a set of guidelines to help both (1) storytellers in choosing accurate label indices for characterizing a building story upon submission to the repository, and (2) users in specifying efficient probe indices when looking for stories relevant to their issue of interest. If we consider building stories as encapsulations of design knowledge, this web of indices further enhances each story's value. It allows approaching a story from different perspectives and situating it in relation to other stories. The knowledge content of the story repository, therefore, does not only reside in the content of the stories it contains, but also in the web of indices between them, which changes dynamically as new stories are added.

Yet, helpful as these dimensions might be in labeling stories, it is highly unlikely that a storyteller can predict a story's relevance for all future situations in advance. The sextet suggested roughly covers the issues that shape the projects in the stories collected so far. Yet, despite many shared interests in design practice, there is considerable variation across individual architects and firms in how they go about designing. Therefore, we propose to complement index-based retrieval with a content-based search facility. The idea is to compare the probe of search criteria as specified by the user not only with each story's label indices, but also with the text it contains.

Furthermore, although the building stories approach has not yet been exported to other contexts beyond the experimental course described, we are already aware of some important problems such extrapolation would bring about. It is far from likely that (student) architects in different contexts will automatically use the same vocabulary to tell stories about similar issues,

let alone use the same terms to label these stories. A possible solution may therefore be to preprocess search terms as specified by the user via a thesaurus called WordNet (Fellbaum 1998). WordNet is an online lexical reference system developed at Princeton University which allows connecting words that are semantically or lexically related. Preprocessing probe indices by WordNet would enable users to locate not only stories that contain a given term, but also stories that contain terms denoting similar concepts, which would considerably increase the potential of the repository.

3.3 Access

Having discussed a possible format to store and set mechanisms to track down building stories, this section turns to the interface required to access these stories. At this point, we envisage the user to consult the repository through a standard web browser. Stories can be selected by specifying one or more selection criteria in a query form. The query may contain a single issue, or one may also enter more complex queries to find cases that cover two or more issues.

As soon as the search mechanisms described above are completed, the search result is displayed as a list of story titles. In Fig. 8, for instance, the leftmost frame of the browser displays all stories that are labeled by or contain the term ‘value engineering.’ When clicking a specific title, the corresponding story appears in the main, right-hand frame. The story can be viewed in two different modes. The default mode displays the story web site as created by the storyteller(s). Once users have picked up the story, they can proceed to its analysis in the graphic mode which plots the network of events—activities and artifacts—of which the story is composed (Fig. 9).

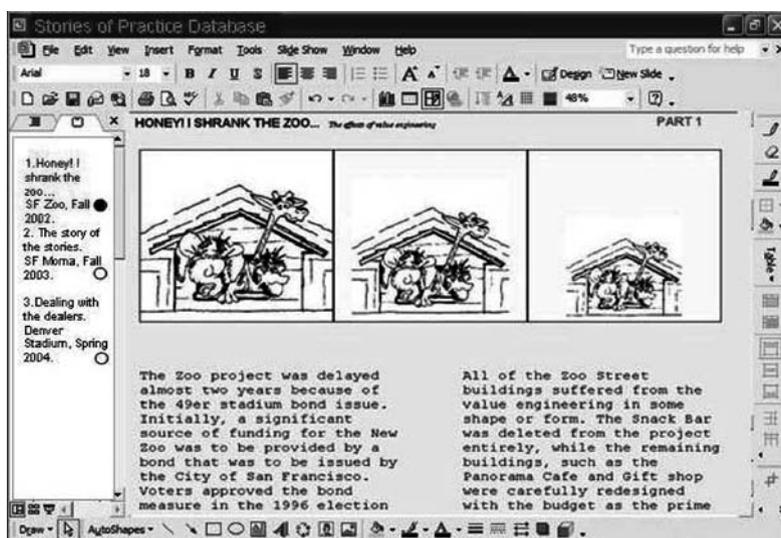


Fig. 8 The *left-hand frame* lists all story titles for the query ‘value engineering’; the *right-hand frame* displays the website of a particular story (default mode)

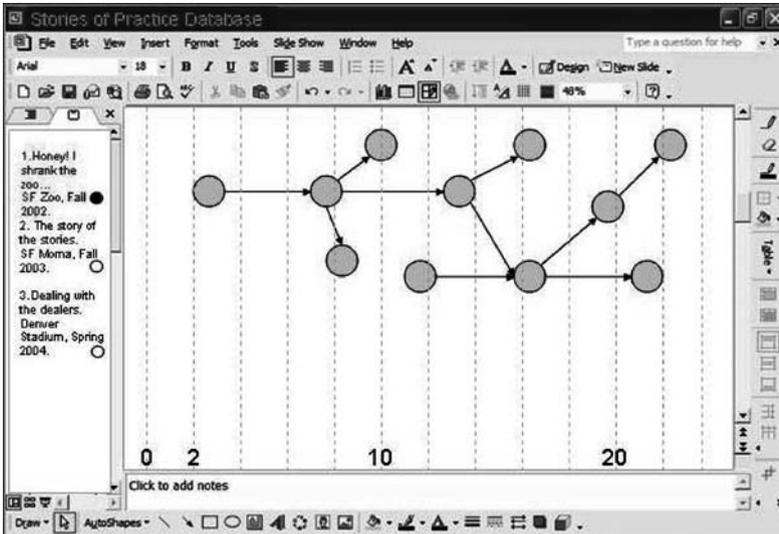


Fig. 9 Graphic mode which plots the network of events—activities and artifacts—of which the story is composed

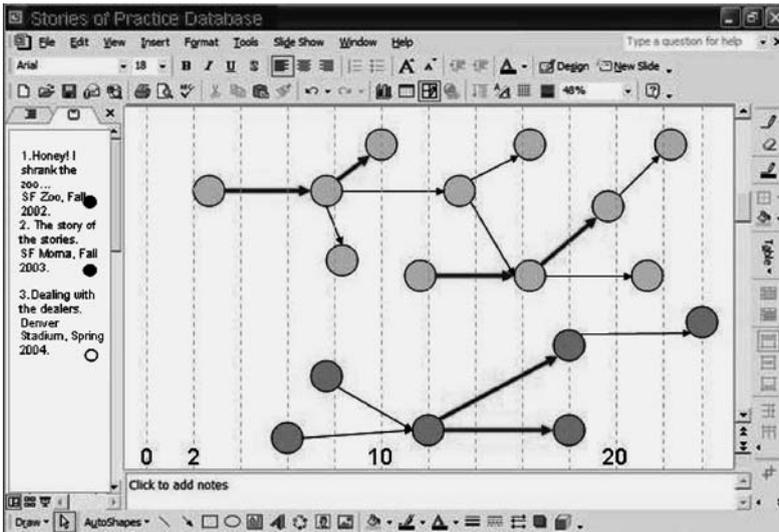


Fig. 10 The graphic analysis allows comparison with other stories about the same or another project

The graphic analysis is an extrapolation of the story to guide the understanding of the narrative and to allow comparison with other stories (Fig. 10). A single project, as we have mentioned, is likely to star in more than one story. Different stories about the same project may have elements—activities, artifacts, actors, perhaps even entire events—in common. At the same time,

stories about projects that look quite different at first sight can show striking similarities, either at the level of an individual event or at the level of the network that ties multiple events into a story. The graphical mode allows comparing and identifying patterns on the basis of the stories that are told up front. Without claiming to duplicate the richness and interconnectedness of the actual story, it illustrates the interconnections and expands their amplitude.

4 Future and related work

Storytelling has been recognized as an excellent vehicle for tacit-to-tacit knowledge transfer and has inspired the development of Building Stories, a methodology to record and exchange the wealth of experience-based knowledge embedded in design practice. With an eye to turning the growing story repository into a knowledge resource of and for the profession, this paper explores a rudimentary model to store, organize and access the resulting building stories.

The model needs to be further studied and refined before it can be implemented as a working prototype. To this end, we are currently verifying the underlying theoretical assumptions with a selection of building stories so as to gain further insight into the taxonomy of events, activities and artifacts, and the feasibility of the dimensions proposed.

Future work we intend to carry out includes the reiteration of this feasibility analysis with other building stories and the formulation of a first implementation plan, as well as the export of the Building Stories approach to contexts other than the experimental course described above so as to share the usefulness of the methodology with other students, educators and practitioners.

Let us close by situating the model proposed with regard to related work. In most CBD tools, we have mentioned, cases document design products at a fairly developed stage of the design process. Three exceptions to this rule are worth mentioning here: Archie and PRECEDENTS because of their use of stories, and Galathea because of its focus on the design process.

Just like the Building Stories methodology, Archie and PRECEDENTS complement product data with stories. Archie composes cases of courthouse design by augmenting existing building descriptions—blueprints and specifications—with evaluations collected through surveys across several stakeholders (Domeshek and Kolodner 1993). PRECEDENTS, for its part, stores recognized outstanding cases of museums to teach students about the spatial-organizational concepts in museum design (Oxman and Oxman 1994). To this end, each precedent is decomposed into design stories: annotated pieces of text, collected by analysing critical writings on the museum at stake, describing a conceptual point that characterizes the uniqueness of the design.

The stories in the Building Stories repository, however, considerably differ from the stories in Archie and PRECEDENTS in terms of both moment and method of collection. Given the experience-based nature of the knowledge it aims to capture, the Building Stories approach tells stories about projects that are still in the process of being designed and/or built. Moreover, for a story to communicate the tacit knowledge and experience embedded in this process, it seems but logical that the storyteller be someone who is to a greater or lesser

extent involved. Therefore, each storytelling team contains interns and practitioners of the firm executing the project under study.

A similar interest in the process behind a project characterizes Galathea, a case-based planning tool aimed at progressively representing the decision-making path of a project (Arlati et al. 1996). Cases in Galathea take the form of so-called design moves, discrete design transactions that produce state transitions in the representation of a design. The notion of a design move shows striking similarities with the notion of an event and/or activity in the building stories model. Yet, unfortunately, the Galathea project ended before the system reached the stage of implementation.

Awaiting the implementation of the Building Stories model, our objective in presenting this preliminary work has been twofold: from a research/theoretical point of view, to develop a critical understanding of whether and how the best practices in the architectural profession can be recorded and exchanged; and, on a more strategic/practical level, to stimulate an awareness of the knowledge capital embedded in real-world projects, and to contribute, however modestly, to a shift in mentality towards a larger process of knowledge sharing in architectural practice.

Acknowledgements Ann Heylighen is a postdoctoral Fellow of the Fund of Scientific Research (FWO) Flanders. This paper was drafted mainly during her stay in the Design Practice Group at UC Berkeley in 2002 and made possible by a grant from the FWO Flanders which is gratefully acknowledged.

References

- Arlati E, Bottelli V, Fogh C (1996) Applying CBR to the teaching of architectural design. In: Education for practice, proceedings of the 14th conference on education for computer aided architectural design in Europe (eCAADe96). eCAADe, Lund, pp 41–50
- Brown JS, Duguid P (1996) Organizational learning and communities-of-practice: toward a unified view of working, learning, and innovation. In: Cohen MD, Sproull LS (eds) *Organizational learning*. Sage, London, pp 58–82
- Denning S (2001) *The Springboard*. Butterworth-Heinemann, Boston, p 173
- Domeshek EA (1994) A case study of case indexing. In: Barnden JA, Holyoak KJ (eds) *Analogy, metaphor, and reminding*. Ablex, Norwood, pp 126–168
- Domeshek EA, Kolodner JL (1993) Using the points of large cases. *Artif Intell Eng Des Anal Manuf* 7(2):87–96
- Fellbaum C (1998) *WordNet*, an electronic lexical database. MIT Press, Cambridge
- Flemming U, Aygen Z, Coyne R, Snyder J (1997) Case-based design in a software environment that supports the early phases in building design. In: Maher ML, Pu P (eds) *Issues and applications of CBR in design*. Lawrence Erlbaum, London, pp 61–85
- Heylighen A, Neuckermans H (2001) A case base of case-based design tools for architecture. *Comput Aided Des* 33:1111–1122
- Hua K, Faltings B, Smith I (1996) CADRE: case-based geometric design. *Artif Intell Eng* 10:171–183
- Kolodner JL (1993) *Case-based reasoning*. Morgan Kaufman, San Mateo
- Lawson B (1990) *How designers think*. Butterworth Architecture, London
- Martin WM, Heylighen A, Cavallin H (2003) Building stories. A hermeneutic approach to studying design practice. Proceedings of the 5th european academy of design conference, Barcelona, Spain, 28–30 April 2003
- Oxman RE, Oxman RM (1994) Remembrance of things in the past: design precedents in libraries. In: Tzonis A, White I (eds) *Automation based creative design. Research and perspectives*. Elsevier, Amsterdam, pp 55–68

- Schmidt-Belz B, Hovestadt L (1996) Scenario for an integrated design support for architects. *Des Stud* 17(4):489–509
- Schön D (1983) *The reflective practitioner. How professionals think in action.* Basic Books, New York
- Schön D (1985) *The design studio. An exploration of its traditions and potential.* RIBA, London
- Smith I, Stalker R, Lottaz C (1996) Creating design objects from cases for interactive spatial composition. In: Gero JS, Sudweeks F (eds) *Artificial intelligence in design '96.* Kluwer, Dordrecht, pp 97–116

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.