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ORGANISATIONAL IDENTITY AND THE APPROPRIATION OF INFORMATION SYSTEMS

Identité organisationnelle et l'appropriation des systèmes d'information

Completed Research Paper

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Abstract

In this paper we explore *the interplay between organisational identity and information systems (IS). More specifically, we examine how the appropriation of new IS may influence established patterns of identity enactment and inter-organisational practices. We report on findings from three in-depth case studies that depict the adoption and use of a new collaborative 3D modelling technology by a metal fabrication firm in the architecture, engineering, and construction (AEC) industry.* We *investigate the manner in which the new technology was associated with changes in the company's practices, interactions, and organisational identity. Our study contributes to the scarce research on IS and organisational identity by emphasising the relational, practical, and dynamic nature of organisational identity.*

Keywords: Organisational identity, information systems (IS), enactment, dynamic relationships, organizational change

Résumé

Cet article explore l'effet de l'appropriation de nouveaux systèmes d'information sur l'identité existante au sein d'une organisation et les pratiques inter-organisationnelles. Nous présentons les résultats de trois études qui décrivent l'adoption et l'utilisation d'une nouvelle technologie de conception collaborative en 3D par une entreprise de fabrication de métaux dans l'industrie de l'architecture, de l'ingénierie, et de la construction. L'étude confirme la nature relationnelle, pratique, et dynamique de l'identité organisationnelle.

Introduction

Much has been written in recent years about the different ways in which new information systems (IS) are intertwined with changes in organisational practices (Vaast and Walsham 2005), roles (Orlikowski et al. 1996), communication flows and collaboration (Avgerou et al. 2004), and power relations (Markus and Robey 1988; Robey and Boudreau 1999; Silva and Backhouse 2003). Accounts of the relationship between IS and changes in the identities of the organisations that use them, however, have been less common (Walsham 1998; Barrett and Walsham 1999; Lamb and Davidson 2005). This is surprising given the centrality of identity to the manner in which individuals and groups make sense of and enact their social and physical environments (Weick 1995), and considering its importance in shaping organisational practices and change (Corley and Gioia 2004; Gioia et al. 2000), learning (Corley and Gioia 2003), and knowledge work (Nag et al. 2007).

Organisational identity is typically understood in the literature to be an organisation's members' collective understanding of the features that are presumed to be central and relatively permanent about the organisation and that make the organisation distinctive from other organisations (Albert and Whetten 1985; Dutton et al. 1994). It is inherent in the interpretive schemes that members of an organisation construct to provide meaning to their shared background, experience, and activities (Orlikowski and Gash 1994). Therefore, identity can shape organisational members' collective behaviours, choice of policies, and strategic plans, as well as influence shared organisational decisions to forge relationships or alliances with different business partners, provide services, and purchase and use new technologies.

Given the importance of organisational identity and the relative lack of attention paid to it in IS literature, we wish to further our understanding of the interplay between IS and organisational identity. More specifically, the purpose of this paper is to provide a detailed account of the way in which changes in IS are associated with new organisational roles, practices, and interactions, and the influence of those on the shaping of organisational identity.

To do so, we draw on data from three in-depth case studies of an ongoing technology-driven inter-organisational change process in the architecture, engineering, and construction (AEC) industry. We look at the replacement of two-dimensional (2D) modelling technologies – Computer Aided Design (CAD) tools and paper drawings – which have traditionally served to facilitate inter-organisational collaboration and knowledge sharing during construction projects, with three-dimensional (3D) technologies. The case studies describe the technological change in the context of one organisation in the AEC industry: A. Zahner (hereafter, Zahner), a leading metal fabrication firm. We observe the changes in the organisation's interaction patterns and identity as it gradually started to incorporate these tools into its practice (Gal et al. Forthcoming). The study will provide a detailed insight into the manner in which new IS enable new organisational practices, interactions and identities to emerge.

The remainder of the paper will be organised as follows: next, we introduce a review of the existing literature on organisational identity and IS. We then describe the research context and methodology. Following this, we present the findings and discuss them. We finish the paper by providing suggestions for future research.

Existing Literature on Organizational Identity and IS

Organisational identity is typically understood to be organisational members' collective understandings of the features that are presumed to be essential, distinctive, and relatively permanent about the organisation (Albert and Whetten 1985). The concept of organizational identity has received significant attention in organisational literature (Albert et al. 2000) and has been studied and deployed from multiple philosophical and theoretical orientations

(Alvesson et al, 2008). Central to most accounts is the recognition that identity is rooted in a deep cultural level of the organisation (Gioia et al. 2000). That is, identity resides in interpretive schemes that organisational members collectively construct to provide meaning to their history, experience, and activities (Ravasi and Schultz 2006). Through continuous interactions, members negotiate a shared symbolic representation of their organisation that renders the organisation's actions, objectives, and existence meaningful. Thus, organisational identity addresses the core questions of "who are we as an organisation" (Albert & Whetten 1985; Pratt and Foreman 2000), "who do we want to be" (Gioia et al. 2000) and "how should we act" (Alvesson et al. 2008).

In this paper, we emphasise the *relational*, *practical*, and *dynamic* nature of organisational identity (Alvesson et al. 2008; Gioia et al. 2000). In this perspective, identity is constructed not only against a backdrop of organisational members' shared histories and experiences, but also in the context of multiple practices that interconnect the organisation with its costumers, competitors, and suppliers (Alvesson et al. 2008; Gioia et al. 2000). Identity emerges in a dynamic context where multiple organisations engage in mutual practice and is reflective of the circumstances in which such practices are situated (Simpson and Carroll 2008). Thus, the mode and scope of the practices, as well as the nature of parties involved, play a salient role in identity construction (Lamb and Davidson 2005).

Because an organisation's identity is tied to the environment from which it materialises, it will vary with changes in the practices in relation to which it is shaped, and with the context for which it is expressed (Ashforth, 1998; Gioia et. al. 2000). Since organisations simultaneously engage in multiple common practices with different organisations, organisational identity is not singular but multiple across intersecting practices and discourses, and not stable but constantly changing (Hall 1996). Accordingly, identity is best understood as a 'work-in-progress' rather than a finished product (Gioia et al. 2000): organisational identity is an ongoing, practice-based, enactment that unfolds as organisations interact with each other. Therefore the articulation of identities takes place in the interfaces among organisations.

Subscribing to this view of a continually-changing organisational identity, we observe that in contemporary organisations, change is often technologically-induced and is frequently brought about by the implementation of new IS. The implementation of IS is a complex process that entails a mix of technological and social transformations, which require adaptations and adjustments in multiple organisational domains. Many times, these transformations are related to organisational identity. The relationship between IS implementation and organisational identity has been documented in a number of studies. For example, Walsham (1998) relied on data from three case studies to illustrate how new IS brought about changes in group identity. Barrett and Walsham (1999) described the attempted introduction of electronic trading applications in the London Insurance Market. They pointed to the manner in which the new technology challenged existing identities of brokers and underwriters by raising concerns for deskilling, eliciting deeper existential anxieties, and presenting opportunities for professional empowerment. Lamb and Davidson (2005) examined the transformations in the identities of scientists associated with the introduction of new IS. They emphasised that identity shaping occurs mainly indirectly, as IS create new networking opportunities and provide new venues for identity presentation, such as project websites.

Despite the contribution of these studies and the recognition that shifts in identity are related to the introduction of new IS, the relationship between IS and organisational identity is still not very well understood (Walsham 2001; Lamb and Kling 2003). In particular, the actual process whereby this relationship unfolds during technologically-induced organisational change is still not very well documented. In this work, we wish to deepen our understanding of this relationship by providing a detailed account of the influence of new IS on established patterns of identity enactment and practice. The context for this investigation is the introduction of 3D modelling technologies in the AEC industry and their implementation by a metal fabrication firm in the industry. In the next section we will elaborate on the research context.

Research Context: Changes in Modelling Technologies in the AEC Industry

The AEC Industry

The AEC industry is one of the largest in the world. In the USA alone, it encompasses tens of thousands of organisations such as architects, engineers, and contractors whose main undertaking is the construction of civic structures. The AEC industry is highly distributed in that the successful completion of construction projects requires extensive cooperation among a diverse set of organisations. Such organisations may have different professional backgrounds and technical expertise, unique business practices, and distinctive ways of representing their work and themselves. Therefore AEC organisations rely on a variety of technological artefacts as a means for maintaining effective collaboration during construction projects.

A prominent technology that has been traditionally used in the AEC industry comes in the form of modelling tools. Modelling tools are commonly used during construction projects to generate 2D representations such as CAD models and paper drawings of buildings or specific systems and objects. The capacity of CAD models and paper drawings to represent different viewpoints that originate from the various organisations that use them facilitates inter-organisational collaboration and knowledge-sharing during construction projects. Modelling technologies are therefore a central element in the coordination efforts during construction projects and play a critical role in structuring construction activities (Beck 2001).

Increasing Use of 3D Technologies

2D modelling technologies have been extensively used in the AEC industry since the 1960's and established as the absolute consensus and norm. Design engineers began to use 2D CAD tools primarily as an electronic draft board. The use of CAD significantly enhanced the accuracy and efficiency of paper drawings, particularly when engineers were able to develop drawings based on existing paper drawings (Baba and Nobeoka 1998).

Since the beginning of the 1990's, a growing number of organisations have started using 3D modelling tools. Compared to 2D technologies, 3D tools have an advanced capacity to represent and communicate rich and complex information within and across organisations. 3D tools make possible a full visualisation of designs in actual scale, and support simulation as well as integration and coordination of detailed design information for digital manufacturing (Boland et al. 2007). With 3D representations, designers and engineers can view a model of a product from various perspectives and angles in a way that captures its entire form. In addition, 3D models not only provide full form geometric representations of objects, but also allow designers to fly through and around 3D digitally-computerised objects. This allows designers to see how various components of the product fit together, what are the distances between different shapes and objects, and view the relative positioning of different planes and edges with few visual barriers. This way, designers can increase the accuracy of the product design and, consequently, reduce errors in manufacturing (Yap et al. 2003).

3D modelling tools were first introduced into the AEC industry by architect Frank Gehry and his architecture firm, Gehry Partners LLP, in the beginning of the 1990's. Gehry is a renowned architect who is internationally recognised for his exceptional building designs such as the Guggenheim Museum in Bilbao, Spain and the Disney Concert Hall in Los Angeles, USA. These buildings drastically break from conventional architectural norms and are characterised by unstandardised curvilinear geometrical shapes. These unique buildings are designed with 3D modelling software, CATIA. Originally used in the aeronautics and automotive industries, CATIA was first introduced into the AEC industry by Gehry when his firm was working on a large fish sculpture for the Barcelona Olympic Games in 1992. Because of the complex structure of the sculpture, Gehry Partners LLP used 3D modelling technologies instead of traditional 2D technologies in the design and construction of the sculpture. The project was completed on schedule and was regarded a success. Having this first positive experience with the new technology, Gehry Partners LLP has since increased its use of 3D modelling tools and incorporated them in most of its construction projects, thereby encouraging other organisations to start using them.

Importantly, the use of 3D modelling technologies by Gehry Partners LLP goes beyond the sheer design and planning phases of the structure to be built. They are also used as a central coordinating mechanism among engineers, subcontractors and construction managers during construction. Therefore, the replacement of 2D with 3D tools implies more than a technological change - the use of 3D technologies can significantly change the way construction projects are managed, and the manner in which organisations interact and collaborate with each other during construction projects. For instance, Boland et al. (2007) and Gal et al. (Forthcoming) observed highly tightly-coupled inter-organisational relationships in construction projects where 3D tools were prominently used. These relationships are starkly different from the loosely-coupled and sparse relationships among participants that characterise projects in which 2D technologies are used.

Today, while working with 2D models is still considered the norm, the use of various types of 3D tools (e.g., CATIA and Rhino software[1]) is continually spreading in the AEC industry. Given the importance of visual models to the organisation of joint work during construction projects, a move to using 3D models can have vast repercussions to the way construction projects are organised, and to the manner in which organisations interact with each other and construct their identities.

Zahner

One AEC organisation that has been influenced by the use of 3D technologies is Zahner, a metal fabrication firm from Kansas City, Missouri. The company is well known in the AEC industry for its advanced technological and design capabilities and for its innovative approach to metal fabrication. Many of the company's works have been designed by leading architects in the field such as Frank Gehry and Randall Stout whose designs are famous for their unique geometrical shapes and use of metal.

Zahner was established in 1897, and has been a family owned business for four generations. In its early years, the company leveraged the increasing demand for housing in the Mid-West of the USA which was brought about by the population spread to the west, and the growing use of steel in the construction industry, to significantly expand its business. The company continued to grow as it started manufacturing and installing metal siding panels for civic buildings and industrial plants in the 1950's and 1960's, and currently employs 220 people.

Zahner's use of computerised technologies began in the 1980's with the commercialisation of the PC. During this decade the company introduced 2D CAD into its design and manufacturing processes. In 1989, the company first started collaborating with Frank Gehry in the construction of the Frederick R. Wiseman Museum in Minneapolis, Minnesota, USA. During work on this project and on the Museum of Science and Industry in Tampa, Florida, USA, which was also designed by Gehry and built around the same time, the company was introduced into the world of 3D design.

Being exposed to Gehry's work and exceptional designs had made Zahner consider adopting 3D modelling technologies into its own practice, which it did in the end of the 1990's during its involvement in the construction of the EMP building in Seattle, Washington, USA, which was designed by Frank Gehry. In the following years the company gradually incorporated 3D tools into its practice and they are now an integral part of its design and fabrication processes. Today Zahner is recognized as a leader in the AEC industry in designing and fabricating metal using 3D technologies such as Rhino, CATIA, and Pro-Engineer.

Research Methodology

To observe the way in which the adoption of 3D technologies influenced Zahner's existing patterns of identity enactment, we draw on data from three in-depth case studies of the replacement of two-dimensional (2D) modelling technologies with three-dimensional (3D) technologies and their use during construction projects. More specifically, the cases illustrate how Computer Aided Design (CAD) tools and paper drawings, which have traditionally served to facilitate inter-organisational collaboration and knowledge sharing during construction projects, were replaced by 3D technologies. The cases follow the involvement of Zahner in three AEC construction projects and document the changes that the company has gone through as it gradually started to incorporate 3D modelling tools into its practice.

Given our interest in the relationships between changes in the use of modelling technologies and the identity of a technology-using organisation, we sampled cases that accounted for this dynamism and reflected a significant variance in the use of modelling technologies. In each case a different type, or combination of types, of modelling technologies was prevalent. In the first case 2D modelling technologies were used, in the second case both 2D and 3D technologies were used, and in the third case 3D technologies were used.

We followed an interpretive research approach which is particularly appropriate for understanding human action and thinking in organizational settings (Klein and Myers 1999). This approach enabled us to examine the interrelationship between technology, users, and their organizational context (Walsham 1993). Our main interest

[1] For more information on Catia and Rhino, see http://www.3Ds.com/en/brands/catia_ipf.asp, http://www.rhino3D.com, and http://www-306.ibm.com/software/applications/plm/catiav5/.

was to understand Zahner's identity, and explore the patterns of its enactment during its interactions with other organisations during three construction projects. We were particularly keen to understand how the conditions for the enactment of Zahner's practices, interactions, and identity were reshaped with the introduction of 3D technologies into the company's practice.

The literature (Alvesson et al. 2008) outlines three broad ways of studying organisational identity qualitatively. These methods rely on interviews, observation studies, and written material. Data for the case were thus collected using observations of Zahner's work practices, interviews with key personnel from the company, and a review of construction documents. Data were collected during three visits to the company's offices in 2002, 2005, and 2007 as part of a broader longitudinal research project that focused on changes in the AEC industry that were induced by the use of 3D technologies (Boland et al. 2007). Out of 93 semi-structured interviews that were conducted with 52 employees from 16 organisations in the context of that project, we largely relied on 16 interviews with six Zahner employees; two project managers, an assistant project manager, a lead designer, a project engineer, and the company's CEO (the rest of the data were used to provide background information about the AEC industry). In the interviews we inquired about Zahner's role, professional practices and typical interactions and communication patterns with other organizational stakeholders during different construction projects. Furthermore, we asked interviewees about Zahner's history, distinctive expertise, use of technology, and the way they perceived their work and company.

Interviews were analysed by relying on established methods for handling qualitative data (Eisenhardt 1989; Yin 2003) and followed these procedures: The first stage involved preparing detailed write-ups for each interview. Based on these transcripts we constructed profiles of three construction projects in which Zahner was involved. Each profile included a story line, or narrative, of a construction project that consisted of a description of the main actors in the project, their main actions and interactions, and the technologies that they used to communicate with each other. Within each construction project we next sought to instantiate Zahner's organisational identity. Consistent with our practice-based theorizing of organisational identities, we examined changes in Zahner's identity mainly as they were reflected in the company's changing tasks, roles, and interactions during different construction projects. We thus relied on concrete evidence of changing practices to make inferences concerning changes in the company's identity. Subsequently, within each project we looked for concrete examples of the relationship between the technology that was used and Zahner's identity, and for changes in organisational practices and identity that were associated with the use of the new 3D technology.

Findings

The cases depict in chronological order an ongoing path of transformations in Zahner's identity as the company starts using 3D modelling technologies. The first case describes Zahner's practices and identity prior to using 3D technologies. The second case demonstrates how Zahner's identity starts changing when it takes part in a project where 3D modelling technologies were used alongside 2D technologies. The third case shows how Zahner's identity continues to evolve when the company partakes in a project where 3D technologies were used by all the primary parties.

Zahner in Typical 2D Construction Projects

Prior to its adoption of 3D technologies, Zahner had typically been involved in 2D based construction projects, which provided the context for the company's identity formation. The organisation of these projects, Zahner's relationships and interactions with other parties during the projects, and the technologies that were used to facilitate them were therefore critical in shaping the company's identity.

Zahner's involvement in 2D construction projects typically starts when the general contractor provides the company with a set of contract documents which are created by the architects. The general contractor is responsible for ensuring effective collaboration among the various stakeholders during construction projects and for managing and mediating communications between subcontractors and the architectural team. The documents convey the architects' design of the building in general terms without specifying the materials to be used, the construction techniques, or the sequence for construction. Based on these documents, the company makes a bid for the project by submitting to the general contractor a set of 2D shop drawings (CAD models and paper drawings) that detail the parts the company intends to fabricate, the materials from which the parts are made, and the way in which the parts interface with other systems in the building. The shop drawings are subsequently reviewed by the general contractor to ascertain that they meet the industry standards and maintain the integrity of the architects' general design intent. When the drawings are approved, they are sent back to Zahner, which can then start fabricating its parts for construction.

With buildings that are structurally simple and that are designed and modelled in 2D, Zahner's modelling and fabrication of its own parts is typically also done in 2D, usually using CAD. Furthermore, during such construction projects, most inter-organisational communication, coordination, and sharing of information are carried out through the exchange of 2D models. In most cases, these communication flows adhere to very specific patterns that reflect the functional structure of the building. That is, a subcontractor would typically only interact and exchange information with other subcontractors whose manufactured systems directly interface with its own, and even then, this would be done through the mediation of the general contractor. Ordinarily, Zahner's manufactured metal parts interface with the structural steel system, the glazing, and sometimes the concrete, drywall and air conditioning systems. Accordingly, in designing, fabricating, and laying out its parts, Zahner has to maintain some level of cooperation and mutual communication with the subcontractors who are responsible for manufacturing those systems. A lead designer at Zahner commented on the matter:

The 2D drawings are mainly done to communicate with other subcontractors. We typically interact with the drywall systems, glazing, and interior steel. We need to make sure the building metal envelope stays watertight so we need to make sure there is continuity between our parts and these trades' parts.

Thus, the pattern of relationships between Zahner and other subcontractors follows a rather orderly inter-organisational structure that is derived from the design of the building. This pattern of relationships is conducive to limiting the scope of inter-organisational communication and the quantity of the content exchanged as it narrows down the channels for inter-organisational relationships. Another reason for the restricted interactions among the subcontractors has to do with the contractual arrangements among the parties involved in the construction project. Contractually, the formal responsibility for maintaining effective coordination among the different subcontractors lies on the shoulders of the general contractor. Similarly, each subcontractor is contractually liable for manufacturing and installing only their own systems and parts. This creates a situation in which each organisation, be it the architects, the general contractor, or any of the subcontractors, has a negative incentive to engage in any activities that even slightly exceed their formal and documented responsibilities. In such circumstances, Zahner, as well as any of the other subcontractors, invests most of its time and effort in its own modelling and fabrication processes, while limiting its interactions and exchange of information with other parties to the required minimum. As noted, these interactions only take place with those subcontractors whose parts and systems directly interface with those of Zahner, and through the mediation of the general contractor.

Many times, the nature of these inter-organisational relationships is characterised by a culture of risk aversion on the part of multiple organisations, and explicit efforts to pass on their responsibilities to their counterparts. Zahner's CEO provided the following example involving the role general contractors play in construction projects:

The general contractors typically do not take responsibility. It always blows me away. So many of them do not take responsibility for knowing the coordinate points, knowing the geometry of the building. It does not have to do with them not having the technological capabilities to do it. They do not have the mindset to do it that way because it takes on risk. They want to put the risk somewhere else, with the architects, with the subcontractors. They do not take on any risk.

An additional reason for the limited direct communication across organisational boundaries during 2D construction projects has to do with that, for the most part, the structural simplicity of the building allows for it to be reliably captured in 2D models. Therefore, the exchange of models across organisational boundaries often is sufficient for keeping the construction process going without having to supplement the model-based information exchange with face to face coordination meeting.

In line with our previous theorising, Zahner's identity is enacted in the context of the interactions in which it is engaged and the inter-organizational system of which it is a part. In 2D-based construction projects this system is characterised by limited connectivity and exchange of information among the involved parties. For the reasons detailed above, each organisation makes an explicit effort to operate within its legal bounds as specified in the contractual arrangements, thereby contributing to an inter-organisational environment in which most subcontractors have very little knowledge of and visibility into the perspectives and work practices of other organisations that participate in the construction process. Within this system of relationships, Zahner's capability to holistically grasp the construction process as well as the design of the building being constructed is minimal. A project manager at the company described the work relations between Zahner and other parties in 2D-based projects:

This type of relationships between us, other subcontractors, the general contractor, and the architect, creates an environment where I am working in my little detached world and all I want from you is the four or five single points that I can relate to. Basically all you do is handing concepts and ideas on paper to someone else and saying here it is. You do not really care what they do with it later just as they do not really care what we do with the models they give us. Imagine reading a chapter in a book without knowing the whole narrative – we have no knowledge of what came before it or what comes after it.

Operating in this kind of environment has impacted not only Zahner interactions with other organizational stakeholders, but also the company's mindset and identity, as was noted by the company's CEO:

This type of hierarchical distribution of responsibilities that has emerged with [the use of] 2D technologies and the linear hand-off process and culture of risk aversion that developed with it, shapes who we are and what we do as an organization. There is a clear lay out of responsibilities that is dictated: the architect is here, the project manager is here, here are all the different subs, you know all your areas of responsibilities and do not blur them. If the system incentivizes behaviors that prioritize inward thinking at the expense of collaboration, then we will play the game.

Accordingly, Zahner's organisational identity may be described as that of a detached worker. The use of 2D-based technologies only necessitates Zahner to be aware of the concerns, perspectives, problems, and activities of other actors to a minimal degree. The company's main focus is on manufacturing and installing its own parts and it only interacts with other parties to the extent that is deemed necessary by the contractual agreements as well as practical requirements.

Zahner in the Construction of the Hunter Museum of American Art

In 2003 Zahner became involved in the construction of the Hunter museum of American Art in Chattanooga, Tennessee. This was one of the first complex, large-scale, construction projects in which Zahner took part, and during which the company actively used 3D digital modelling technologies. The Museum was designed by the architect Randall Stout. Stout is considered among many to be one of Gehry protégés and similar to Gehry, Stout's designs often challenge conventional architectural aesthetics by making use of 3D modelling tools, as was the case in the construction of the Hunter museum.

Image 1. The Hunter Museum of American Art in Chattanooga, Tennessee.

In many ways, the inter-organisational dynamics during the construction of the Hunter museum broke from the traditional 2D-based process. The previously established system of limited inter-organisational communication and interaction was thrown off balance. The major coordinating task usually assumed by the general contractor was significantly changed during the construction process, as were Zahner's role and practices.

The Hunter museum of American art is a highly complex building with very complicated geometries and warped interior and exterior surfaces. Stout designed the building using a digital 3D modelling technology named Rhino, although the official contract documents that he distributed to the general contractor and subcontractors were in 2D. This created a significant challenge for the construction crew because the building design was so complex that it became impossible to reliably and comprehensively model it in a 2D space. In fact, many of the 2D models that were provided to the construction crew by the architect were not accurate enough to be used for construction, as was acknowledged by a project manager at Zahner:

We didn't think 2D was going to work. We anticipated many problems. You have to get the steel very accurate. We talked to the general contractor and said look, you need to set points, establish some points for the steel, and that will be a work point. That never happened, and in some cases the steel was six inches out.

In addition to the official 2D models, Stout also shared a 3D computerised model of the building with the construction crew. However, this model was not fully formed and did not contain detailed information about the surfaces, connections, and materials embedded in the building. Furthermore, the 3D model was not made part of the contract documents package and was not legally binding. Therefore it did not receive the general contractor's full attention and was not regularly used by it in the construction process.

Thus, a major difficulty emerged early on in the construction process. On the one hand, the building design involved highly complex geometries that could not be accurately captured in a 2D space or reliably conveyed in 2D models. On the other hand, the 3D Rhino model that was provided by the architect did not contain sufficient detail to support construction. Furthermore, the majority of subcontractors and the general contractor did not have sufficient 3D capabilities to understand, incorporate, or interact with the 3D model that was provided to them by the architect, and did not possess the required expertise to effectively work in a 3D environment. For example, the general contractor, EMJ Corporation, had very limited previous experience with using 3D technologies and, according to Zahner's CEO, had never been involved in a construction project that was as complex as the Hunter museum. Given the central coordinating role that the general contractor is supposed to play during the construction process, this was a sign of what was to come.

Among all the participants in the construction of the Hunter museum, Zahner had the most advanced 3D capabilities. Initially being exposed to 3D technologies during the late 1990's, by 2003 Zahner had accumulated some experience in using 3D modelling tools to design and fabricate metal parts for structurally complex buildings. Therefore, when it was given the 3D model from Stout, the company incorporated the measurements from it into its own 3D Rhino model that it had created to design its parts for the building.

The 3D model Zahner had created was frequently updated and entailed detailed information about the various aspects of the building. Thus, an unusual situation emerged in which Zahner, rather than the general contractor or the architect, had the most accurate and detailed model of the building that could actually be used for construction. The rest of the subcontractors only had the 2D models to rely on whereas these models only provided a fragmented and inaccurate vision of the building design. As a result, different subcontractors frequently came to Zahner asking for help with their construction and measurements. A lead designer at Zahner explained:

What happened on Hunter was that we were the only subcontractor with 3D capabilities and we had a 3D model and therefore everyone came to us whenever they needed dimensions; we were a central source of information for them, above and beyond of what our scope was on that job.

Importantly, not only the subcontractors lacked sufficient 3D capabilities to independently develop, use, and manipulate their own 3D models, so did the general contractor. As a result, the general contractor often came to Zahner asking for assistance with their coordination tasks. A lead designer at Zahner gave this example:

The general contractor didn't have a 3D capability and therefore had no way of reading our models. They had to trust us that our models were going to work. For instance, when the steel fabricator couldn't use their 2D information, what ended up happening was that we were forced to make the steel fabricator go out and actually survey the steel to determine if their system was going to work with the concrete wall. The surveying was actually done by another company that was hired by the general contractor. But we, not the general contractor, provided them with what we wanted surveyed, particular points located in a 3D space that came from our model.

The fact that they had to step in and manage a process that was contractually assigned to the general contractor left many people at Zahner frustrated. A project manager from the company elaborated on this point:

On Hunter, the general contractor only existed in 2D. And yet the geometry was very complicated. You can see how everybody went to the only player who had 3D capabilities. To me, that's to the fault of the general contractor. How on earth could you get involved in such a project and not realise early on, hey we have to get up to speed. And they were asked to. They were told, or at least suggested, what software and hardware to buy, who you can talk to to get it operated. It didn't happen and as a result we got into a position which we were not contractually obligated to be in.

Zahner's 3D capabilities and the general contractor and subcontractors' lack of such capabilities had drastically changed the nature of the previously established inter-organisational dynamics during the construction process, and Zahner's position within it. Instead of mainly handling the design, fabrication, and laying out of its own metal parts and systems, the company now attended to the tasks of other organisations and served as a major provider of information for the rest of the construction crew.

The changes in Zahner's practices and interactions challenged its established identity. Zahner's detached worker identity drew on the company's position within an inter-organisational system of relationships that was associated with the use of 2D modelling technologies. This system was dominated by a culture of risk-aversion and minimal collaboration. During the construction of the Hunter museum, Zahner's inter-organisational relations significantly changed as the company served as a central coordinating entity and a major source of information for the rest of the construction crew. These new relationships constituted a significant shift in some of the core principles and norms that served as the basis for the company's identity, as was illustrated by one of its project managers:

In a normal situation, the general contractor oversees all the bits and pieces. You have a structural steel subcontractor, a glass guy, a dry wall guy, there's us who do the exterior cladding. The general contractor is in the middle coordinating everything. The subcontractors are there and somewhat interact and do their work. On Hunter, with the general contractor not having 3D capabilities, and other subcontractors not having 3D capabilities, you could see how imbalanced the system was. Everything was tilting towards getting the information from Zahner, instead of being centralised around the general contractor. We had to provide the drywall guy all the information from our 3D model, and the same goes for the glazing people, the concrete and the structural steel. The burden was on us to make sure everything was running smoothly. We were there as an all-around fixer, taking care of everybody else's problems.

Using 3D Modelling Technologies with Randall Stout Architects

As noted above, Zahner had started using 3D modelling technologies in the end of the 1990's when it collaborated with Frank Gehry. Since then, the company had gradually incorporated 3D tools into its shop and its design process as was evident in the construction of the Hunter museum. In 2006, after wrapping up its work on the Hunter Museum, Zahner became involved in the construction of the Alberta Art Gallery (hereafter, AGA) in Edmonton, Canada.

Image 2. The Alberta Art Gallery in Edmonton, Canada.

Similar to the Hunter museum, this building was also designed by Randall Stout who was the lead architect on this project. However, different from the Hunter museum, on the AGA project 3D technologies were comprehensively used by all the major participants from the initial pre-fabrication design phase, through the bidding phase, and all the way to the construction phase.

During the construction process of AGA, Zahner's interactions with the architects, the general contractor, and the subcontractor were significantly different from the ones that characterised the 2D-based projects in which the company had previously been involved, as well as from the ones in which some use of 3D technologies was made, such as the Hunter museum. Compared with the company's limited communication and exchange of information with its counterparts that were associated with the use of 2D modelling technologies, Zahner's scope of interactions with other organisations during the construction of the AGA was considerably broader. These interactions also differed from those that characterised Zahner's involvement in the Hunter museum job; instead of serving as a focal point for inter-organisational coordination and information sharing and attending to other organisations' tasks and problems, Zahner collaborated with other organisations in a more balanced manner and focused on its own tasks.

In many respects, the construction of the Hunter museum was a learning experience for Zahner. It had made the company understand the importance of having all major participants using 3D technologies and caused it to be more assertive in having a say in the selection of the subcontractors for the AGA project. A lead designer at Zahner explained:

Based on the Hunter experience we tried to emphasise to the architects and general contractor in the AGA project that it is very important for all the main participants to have 3D capabilities. This includes the general contractor, glazing, structural steel. When you are dealing with complex structures that are indescribable in 2D, this is absolutely essential.

Accordingly, significant knowledge of 3D tools was made a requirement for bidding on the AGA job and all the main players that participated in the project had had significant experience in operating in 3D environments.

Compared to the Hunter project, Stout's contractual approach on the AGA project was more explicitly 3D aware. Similar to the Hunter museum, the AGA's complex design was modelled using the 3D platform, Rhino. However, unlike his approach on Hunter, and deviating from the established practice in the AEC industry, Stout incorporated the 3D master model of the building into the contract documents package thereby affording it formal status.

This time, unlike the Hunter job, the 3D Rhino model went beyond crudely specifying the surfaces of the building and was in fact a fully formed and detailed representation of the building. In addition, Stout insisted that all the major participants in the construction process use the 3D models to support their respective construction activities and communicate with each other.

Although Stout used Rhino to design his 3D model of the building, other participants in the project used different types of 3D modelling platforms to design their own parts and systems for the building. For example, the structural engineer, De-Simone, used CATIA while Zahner used a 3D modelling tool called Pro-Engineer to design its metal panels. Due to the multiplicity of technological systems, their inter-operability became an important issue during the construction process. To address this issue, another 3D platform, Revit, was used to convert models between the different tools involved in the project. Since Revit exports file in a universal format, any file that needed to be viewed in a third party program (e.g., CATIA or Rhino) was first imported into Revit which then exported it in a format that could be read by any other program. This way, all the stakeholders could read information from and feed information into the Rhino model that was created by Stout.

The nature of 3D models, along with the fact the all major subcontractors as well as the general contractor and the architect used and incorporated the models in their practice, had enabled the creation of a collaborative inter-organisational environment. Within this environment, the participants were able to achieve higher levels of information sharing and coordination than was previously possible. Zahner's CEO noted:

When 3D tools were used by all the major subcontractors on the AGA job, the hierarchical organisational system that emerged with the use of 2D technologies and that everybody was so used to completely changed. It was not a hand off process anymore where everyone was looking to avoid taking risks. Instead, we were able to collaborate and exchange information much more efficiently.

The 3D models that were used by Stout during the AGA project are extremely rich representations of the building design that hold multiple layers of information concerning the different aspects of the building. Thus, the same model can be used by multiple organisations thereby placing them within the same 3D computerised environment and reducing barriers among them. Another feature of the models which helped facilitate inter-organisational collaboration is that they are transparent and interactive such that changes that are made in one segment of the model are immediately visible to other users of the model, and their impacts on other aspects of the model are checked automatically. An additional characteristic of the 3D models is that their users share and operate within the same x,y,z coordinate system. In construction projects in which 2D technologies are used, different organisations typically employ their own surveyors and develop separate measurements for the installation of their parts. During the construction of the Hunter museum, different subcontractors came to Zahner asking for help with their measurements when their surveying information was not sufficient to support their construction activities. However, they still maintained their separate x,y,z, coordinate systems (or rather, x,y coordinate systems). During the construction of the AGA, the use of 3D models by all the major subcontractors and the general contractor placed all of them within the same 3D x,y,z space, and all their measurements were calculated relative to a shared absolute 0,0,0 point which they shared.

Sharing the same 3D technological platform and x,y,z coordinate system with other subcontractors has considerably improved Zahner's ability to coordinate its construction process with other subcontractors. The use of 3D models by all the major subcontractors and the general contractor also enabled the different parties to clearly visualise and surface common issues and problems during the construction process, thereby facilitating their joint resolution. A project engineer at Zahner provided this example:

AGA is probably 4 times as complicated as Hunter but the process was so much smoother and more balanced. For example, we had a meeting to discuss the sprinklers in the building for the fire alarm system. They brought up a 3D model, the master model, and they had the sprinklers in the model in a very complex geometric shape. They couldn't do that if they didn't have this 3D capability and they couldn't put a simple concept as a sprinkler system into this complex geometry. The conversation went on for about an hour and a ton was resolved. Having everyone sharing the 3D model is a huge step.

Compared to the company's situation on the Hunter job, Zahner was in a more balanced position within the inter-organisational system composed of the subcontractors, the general contractor and the architect. In this system, Zahner could focus on its role as a metal fabricator instead of having to provide information to support the construction of other subcontractors. In large part this was because the general contractor on the AGA project had substantial 3D capabilities and was able to communicate with the rest of the construction crew and coordinate their activities through the 3D platform.

The 3D computerised environment and the x,y,z coordinate system that the subcontractors and general contractor shared increased Zahner's exposure to the processes and activities of other subcontractors that it collaborated with, and made its interactions with them, as well as its own construction activities more efficient. A project manager at the company provided this explanation:

3D models tell a story. They tell you how different parts connect. It makes it pretty clear to the glass, and steel and concrete guys, what am I doing, where am I going with this. What happens when we all come together? You get exposed to the whole story instead of just reading one chapter without knowing what comes before it and what comes after it. 3D technology has made it easier and quicker to get to that point.

Zahner's increased ability to communicate, collaborate, and share information with other subcontractors stimulated the following allegory from a project manager at the company:

On AGA, cross-organisational boundaries, as they existed in 2D projects, almost melted away. Because we were all on the same 3D platform we had a much better picture of what other subcontractors were doing and could better collaborate with them.

The changes in practices and forms of communication that were associated with the use of 3D technologies implied significant changes in the institutional norms that characterized the construction project environment. The assumptions that underlined organizational practices and interactions in 2D-based projects fostered low levels of inter-organizational coordination and knowledge exchange. These assumptions were formally reinforced by contractual agreements that discouraged openness and collaboration across organizational boundaries. This environment set the context for Zahner's identity. In a similar manner, the open communication patterns during the AGA project were associated not only with different interactions between Zahner and its counterparts, but also with a different mindset and identity that characterized the company. A project manager elaborated:

Everything was so different on [the AGA] project compared to previous projects that you start wondering: are we actually doing the same thing as before? In the end of the day we still fabricate metal but our way of thinking about it was completely different. We are no longer so restricted to our confined little 2D world; we become more open and receptive to new views and ideas.

Discussion

Above we theorised that organisational identity is relational and practice-based. That is, we maintained that members construct a collective representation of their organisation that is reflective of their relationships with other stakeholders, and of the practices that comprise these relationships (Alvesson et al, 2008).

The case studies we presented demonstrated that in the AEC industry, as in many other contemporary contexts, inter-organisational relationships are mediated by and constructed through the use of IS. Therefore, it stands to reason that IS are implicated in the process of identity construction.

For example, Zahner's identity in the first case was based on the practices in which the company was involved during its 2D construction projects, which, in turn, were intertwined with the use of 2D modelling technologies. The use of 2D models combined with the associated limited sharing of information and scant collaboration among multiple subcontractors, gave rise to an inter-organisational environment in which individual subcontractors were only partially aware of the concerns, perspectives, problems, and activities of other subcontractors. Instead, each subcontractor focused primarily on manufacturing and installing its own parts while interacting with its counterparts only to the extent necessitated by its contractual obligations and the practical requirements of the job. This system of restricted inter-organisational coordination provided the context for the enactment of Zahner's detached worker identity.

The case studies additionally demonstrated that changes in IS were associated with transformations in inter-organisational practices and, therefore, with changes in the conditions for the enactment of organisational identity. For instance, Zahner's detached worker identity started to change when the company incorporated 3D technologies into its practice. Zahner's utilisation of 3D tools on the Hunter museum project and the profound changes in the company's practices and interactions associated with the use of this technology changed the conditions for the enactment of its identity. During its involvement in the Hunter museum project, Zahner no longer operated in relative isolation from other subcontractors or centred on carrying out its own responsibilities as a metal fabricator. Instead, Zahner's expertise in the use of 3D tools and possession of the only comprehensive 3D model of the building had caused other subcontractors and the general contractor to turn to Zahner for help with their tasks. As a result, Zahner had to act as a central coordinator and supplier of information for the rest of the construction crew, which challenged the company's previously established identity.

Zahner's identity continued to change when it became involved in the AGA project. The overarching use that was made of 3D tools during the construction process had enabled the creation of an inter-organisational collaborative environment that was characterised by enhanced coordination, transparency, and sharing of information. In this environment, Zahner's interactions changed again from those that characterised traditional 2D-based projects as well as from those that characterised the Hunter museum job. Compared to the limited interaction and visibility that exemplified 2D-based jobs, Zahner's scope of collaboration with its counterparts was much broader. This was possible due to the fact that all the prime subcontractors, in addition to the general contractor and the architects, were operating within a shared 3D space. Compared to its involvement on the Hunter museum project, Zahner's interactions during the AGA project were more balanced; because the company was not the only professional entity which was 3D savvy, it did not have to allocate significant resources to assist with the construction tasks of other organisations and was able to focus on its own responsibilities as a metal fabricator. The enhanced collaboration and balanced interactions provided the context for the enactment of Zahner's identity that was based on principles of inter-organizational openness and collaboration.

Our findings contribute to the understanding of the relationship between IS and organisational identity in several ways. First, existing literature on organisational identity tends to focus on the way inter-organisational relationships are entangled with the process of identity construction in which organisational members engage (Emirbayer 1997; Hall 1996). However, less attention is given to the technological artefacts that are shared by interacting organisations and that mediate their communication. Our study demonstrates that in order to appropriately understand inter-organisational interactions, technological artefacts and the practices that they are associated with need to be taken into account. Therefore, when setting out to analyse organisational identity, researchers need to be aware not only of the content and form of the communication that takes place between an organisation and its external stakeholders. They should also be mindful of the range of technologies that mediate this communication. The reason is that such technologies are not merely neutral passage points or conduits through which information is transferred across organisational boundaries. The structure and characteristics of these technologies can play a significant part in shaping the content that is exchanged across organisational boundaries, the nature of inter-organisational relationships, and ultimately, the formation of organisational identities. This observation entails practical implications for those people who are involved in and manage IS-related projects as it underscores the significance of the choice of technology that is used for collaboration and communication across organisational boundaries.

Second, our work calls specific attention to the role that technology plays in the structuring of relational and practice-based organisational identities. Our findings suggest that technology which is used to facilitate interactions between diverse organisations is likely to play a significant role in the construction and negotiation of these organisations' identities. The idea that the technologies may be influential in shaping organisational identity is not altogether novel. For example, in their study of research scientists in oceanography and marine biology, Lamb and Davidson (2005) suggest that scientists' professional identity is influenced by their use of technology in three ways: first, development of new core technologies can create new areas of expertise and thus enhance their scientific identity; second, coordination technologies can provide new forums, such as project websites, for identity enactment; and third, dissemination technologies such as email or project websites enable new ways to represent scientific concepts and enhance scientists' professional identity. Thus, in their work, Lamb and Davidson focus primarily on the capacity of technologies to provide new venues to symbolically represent professional identities. Alternatively, our work conceptualises organisational identities as relational constructs and emphasises the role that technological artefacts play in shaping the interfaces between organisations, namely, the manner in which organisations interact with one another. By providing new channels and possibilities for communication, collaboration, and exchange of information across organisational boundaries, technological artefacts can change the conditions for inter-organisational relationships. This, in turn may alter the context for the enactment of the identities of the interacting organisations. This point has an important practical significance as it implies that changes in IS may not necessarily be contained within organisational boundaries. Rather, technological changes could be associated with transformations in practices and identities across multiple contexts.

Thus, our study emphasises the symbolic significance of IS. It suggests that the use of IS goes beyond sheer instrumental considerations of efficiency or effectiveness and cannot be fully comprehended when such logic is applied. IS should be understood not only as physical objects that can enter an organisation and change it in any number of ways, where some may prove to be more effective than others. IS also need to be construed as elements around which organisations develop practices and patterns of inter-organisational relationships, which serve as the basis for the enactment of their identity. Therefore they have a significant symbolic importance for organisational members.

Furthermore, our work points to a reciprocal relationship between organisational identity and IS adoption and use. Previous research has emphasised the changes in identity following IS implementation (Walsham 1998; Barrett and Walsham 1999; Lamb and Davidson 2005). While our study describes in detail the transformations in Zahner's identity as it started to incorporate 3D technologies into its practice, it also demonstrates that the company's identity and practices played a part in its decision to use these technologies. For example, the inefficient process and use of technology during the construction of the Hunter museum and Zahner's identity that was associated with them were influential in the company's decision to use 3D technologies during the AGA project. Zahner's decision to use 3D technologies and its insistence that they be used by the rest of the construction crew during AGA were an attempt to implement some principles from its previous engagement. These included creating a socio-technical environment that is different from the one that characterised the Hunter project. Therefore, Zahner's practices and use of 3D technologies during the AGA project were grounded in the company's previous practices and identity.

Finally, our study highlights the dynamic nature of organisational identity. In line with existing organisational identity literature (e.g., Alvesson et al 2008), our findings indicate that organisational identity is shaped in the context of the environment within which organisations operate and interact with each other. This environment, particularly in contemporary settings, is laden with various IS that may contribute to the shaping of the nature, pattern, and structure of inter-organisational relationships and communication. Therefore, changes in the technologies that organisations use to facilitate their collaboration are likely to change the context in which organisational identities are enacted. This point is particularly plausible and relevant today, as the pace of technological innovation is continually increasing.

Conclusion

As argued in the beginning of the paper, existing studies account for the relationship between IS appropriation and organisational identity by illustrating how new IS bring about changes in group identity (Walsham 1998; Lamb and Davidson 2005), and how existing organisational and group identities can be challenged by new IS (Barrett and Walsham 1999). This paper contributes to the existing literature by providing a detailed account of the process whereby this transformation unfolds. In addition, we highlight the practice-based nature of organisational identity and demonstrate that changes in identity are enacted as organisational practices and interaction patterns are transformed. By relating technological changes to transformations in organisational identity we underscore the symbolic significance of IS. Moreover, our findings from the three case studies illustrate that the relationship between IS and organisational identity is likely to be reciprocal and emphasise the dynamic nature of identity.

These findings suggest several avenues for future research. First, although the concept of organisational identity has received significant attention, mostly from organisational researchers, studies of the role of IS in the shaping of organisational identity are still scarce. Future research is needed to better understand the importance of IS in the development of organisational collective representations. Furthermore, research should look beyond the impact of IS on existing identities to examine the role that established identities play in organisational decisions to adopt and use new technologies.

Second, most relevant research has looked at the relationship between IS and organisational identity within the context of a single organisation. However, as organisations today become more interconnected through a wide range of IS, understanding the way in which new IS can facilitate cross-organisational transformations becomes increasingly relevant and important. Given the relational nature of organisational identity, we have investigated changes in IS and organisational identity in an inter-organisational context, although from the point of view of a single organisation, Zahner. More research on the relationship between IS and identity in inter-organisational contexts is required to examine the manner in which changes in IS are associated with transformation in multiple organisations.

Third, the case studies presented here hint at the existence of inter-organisational conflicts and power relations but do not profoundly examine them. Future research should look in more depth at the way in which power gets expressed in inter-organisational collaborative networks and the role that IS play in its manifestation. Specifically, research could explore how power is articulated, and how it increases, decreases, and influences different actors in networks of collaboration and examine what identities are supported and undermined when relationships are mediated by IS.

Finally, in this study we look at the relationship between IS and organisational identity in the AEC industry. Future studies should investigate this relationship in other types of inter-organisational contexts where other institutional, organisational, and technological conditions are at stake. This should be done to see whether the relationship between IS and organisational identity is conditioned by other aspects than the ones drawn attention to in our work.

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