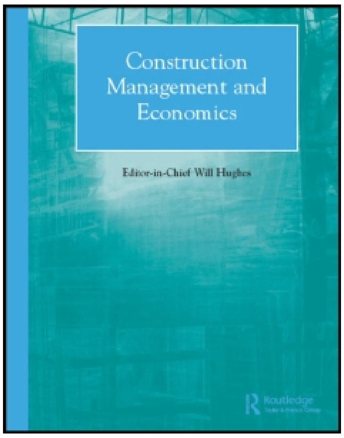

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Constructing buildings and design ambitions

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Constructing buildings and design ambitions

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Project goals are conceptualized in the construction management literature as either stable and exogenously given or as emerging endogenously during the construction process. Disparate as these perspectives may be, they both overlook the role that material objects used in construction processes can play in transforming knowledge and thereby shaping project goals. Actor-network theory is used to explore the connection between objects and knowledge with the purpose of developing an adaptive and pragmatic approach to goals in construction. Based on a case study of the construction of a skyscraper, emphasis is given to how design ambitions emerge in a process of goal translation, and to how, once these ambitions are materialized, tensions between aesthetic and functional concerns emerge and are resolved. These tensions are resolved through trials of strength as the object—the building—is elaborated and circulates across sites in various forms, e.g. artistic sketches, drawings and models. Given that initial goal accuracy is often seen as a key success factor, these insights have theoretical and practical implications for the management and evaluation of the construction project.

Keywords: Design ambitions, project goals, knowledge, evaluation.

Introduction

Few would deny the importance that project goals have for the initiation, development and evaluation of a construction project—the goal is commonly thought of as the project's raison d'être. However, when it comes to understanding and explaining how project goals are established, positions vary. Viewed broadly, one can discern two dominant perspectives within the literature on project and construction management: one that treats goals as exogenously given, as input, and another that considers goals as endogenous to the project, i.e. as evolving in the course of a construction process. Disparate as these perspectives may be, they have one thing in common: neither perspective attends to the contingent role of materiality in the construction process. In what follows we address the question of how objects and technologies used in construction, including the building itself, are actively involved in shaping—or are constitutive of—project goals and the underlying design ambitions.

We argue that these dominant perspectives are problematic because they either ignore or overlook how material artefacts and objects help make project goals and design ambitions what they are. More specifically, we suggest actor-network theory as a way to empirically explore the emergent connections between objects, knowledge and goals within a construction project. Thus, the aim of our study is threefold: (1) to describe and analyse how project goals and ambitions are actively shaped and established by a variety of objects; (2) to develop an adaptive and pragmatic approach to goals in construction; and (3) to discuss implications for the management and evaluation of the construction project.

Goals and ambitions: inputs, outputs or both at the same time

Goals are conventionally defined as an object of a person's ambition or strong desire to achieve something (Webster's, 1995), e.g. be it the development of a new product or the construction of a new building. However, delving further into this definition, the Latin etymology of 'ambition' draws attention to another, less cited meaning—'going around (canvassing for votes)' (Webster's, 1995, p. 31). Both definitions can

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be found within the project and construction management literature: the former figures prominently in the more normative project and construction management literature, e.g. the emphasis given to identifying the client's or stakeholders' goals (Walker, 2002; Winch, 2002; Newcombe, 2003; PMI, 2004); whereas the mobilization of support, associated with the etymology of ambition, is more in keeping with more descriptive approaches to project and construction management (Kreiner, 1995; Engwall, 2002; Pollack, 2007).

The first body of literature devotes little attention to how goals are formed and decided upon. They are often assumed to be exogenously given by the client as input to the construction process (Walker, 2002), and preferably also within the client's corporate strategy (Winch, 2002). Furthermore, it is often assumed that initial goals can be made accurate (Flyvbjerg, 2006) and 'SMART', i.e. Specific, Measurable, Achievable, Result-oriented, and Time-based (Gardiner, 2005, p. 202) and, by doing so, that it will be possible to reduce (project) uncertainty and divide project objectives into sub-objectives so as to enhance coordination and goal realization. Moreover, as projects move through their life cycles towards completion, project uncertainty is also assumed to be reduced as more information gradually becomes available. Should uncertainty prevail due to unexpected events, or lack of information, knowledge, time, and/or money, then the usual remedy is to introduce more sophisticated planning and problem-solving techniques, enhanced managerial and contractual control, different costing techniques, etc., so as to enhance goal accuracy (Winch, 2002; Gardiner, 2005; Collyer and Warren, 2009). This is considered key for successfully implementing the client's overall strategy. Winch (2002) also suggests that goal uncertainty can be reduced by increasing the client's information about the design by introducing devices such as prototypes, mock-ups, computer aided design and simulations *prior to* deciding upon the design mission and the planning of its realization. The normative assumption is that more upfront information will make the client's goals and priorities clearer. To this end, the devices serve as (neutral) means of representation and as vehicles of codified knowledge about the project/design.

The second body of literature, grounded on a critique of the rationalism associated with the 'goal as input' approach, emphasizes participation, learning and exploration (Kreiner, 1995; Green, 1999; Bresnen and Marshall, 2002; Sahlin-Andersson and Söderholm, 2002; Kreiner, 2006; Green *et al.*, 2008). Drawing upon observations that most projects are not the result of rational decision making (Engwall, 2002), it is argued that projects are more likely to be controversial, subject to different interpretations and, therefore, something that has to be negotiated among coalitions of parties involved—a position in keeping with the above-cited Latin etymology of ambitions. Following Brunsson (1985), decision making is understood as a way of achieving collective action rather than as a matter of choice between alternatives. Accordingly, goals and ambitions are conceived of as *outputs* of collective action rather than as (given) inputs. Goals are, therefore, often neither well defined from the onset, nor are they stable throughout the course of the construction project. Scope changes and goal redefinition are a result of the involved stakeholders' learning, and making trade-offs is seen as a matter of mobilizing and gaining support rather than improving calculations, developing more sophisticated planning and control techniques. Moreover, goals, ambitions and trade-offs can be modified through experience, i.e. as people involved gain more insights into what is 'doable' and discover things not previously imaginable. Following from this, goal formation and realization are not considered separate actions but as a continuous process (Engwall, 2002, p. 272). However, precisely because of the contentiousness of many projects, goals must also be considered as 'political products' (Engwall, 2002, p. 275) or as Winch notes (2002, p. 225) 'negotiated order'. Goal formation is, however, conceptualized as *socially* negotiated order, with little or no attention given to the role material artefacts may play in achieving this order. This is surprising given the overwhelming evidence that materiality is substantial in construction projects, and the further evidence concerning unintended outcomes such as accidents (Kreiner, 2006), design and scope changes (Winch, 2002), time delays and budget overrun (Flyvbjerg, 2006).

As an alternative, we introduce actor-network theory (ANT) in order to move beyond considering goals as either input to or the output of decision making. Although once almost exclusively associated with science and technology studies (Callon, 1980; Latour, 2002, 2005), ANT is now being applied in organization and management studies (Kreiner, 2002; Kreiner and Tryggestad, 2002; Czarniawska and Hernes, 2005; Enberg *et al.*, 2006; Kreiner, 2006; Hernes, 2008; Justesen and Mouritsen, 2009; Woolgar *et al.*, 2009), but its use within construction management research is—with a few notable exceptions (Harty, 2005; Ewenstein and Whyte, 2007; Whyte *et al.*, 2007; Harty, 2008)—relatively limited. With its emphasis on how objects, facts and ideas are constructed ANT can, however, provide valuable insights into the serendipitous and contingent ways in which construction projects evolve. There are three central analytical constructs in ANT—goal translation, trials of strength and circulating objects—which are useful to this end.

The connection between goals and objects is discussed by Latour (2002) with reference to a commonplace object in construction—a hammer. When inserted in the hand, the hammer affords different possible courses of action, one of them being hitting nails. If you want to build something, then the hammer is likely to be important for the realization of this ambition/goal. It participates in this course of action but without necessarily 'determining' which way the building activities will go. On a more general note, the role of objects can range from determining the course of action to serving as a backdrop for human action, but in addition to this they 'might authorize, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid, and so on' (Latour, 2005, p. 72), i.e. offer a multitude of options, none of which is necessarily given. One important point following from this line of reasoning is that objects, e.g. technologies and even the materiality of a building under construction, can be regarded as mediators, i.e. as entities actively involved in transforming, modifying or even distorting the meaning that they are supposed to carry. As Latour notes (2002, p. 252; emphasis added): 'If you want to keep your intentions straight, your plans inflexible, your programmes of action rigid, then do not pass through any form of technological life. The detour will *translate*, will betray, your most imperious desires'. The concept of translation (Callon, 1980) directs attention to the (active) mediating role of objects in transforming goals; a process which Latour has elsewhere termed as 'goal translation' (Latour, 1999, p. 179). As people become (re)equipped with different technical objects, it is, therefore, likely that their goals and ambitions will be translated into something different. The ways in which this takes place and the results it has are uncertain and can only be determined empirically.

According to ANT, a chain of associations—of humans and objects—is 'only as strong as its weakest link' (Latour, 1987, p. 121), and it is therefore likely to be subject to transformations as humans and objects interact. In such instances there will be ongoing 'trials of strength' (Latour, 1987, p. 74). These take place when someone or something contends with the prevailing 'order', i.e. challenges the status quo by problematizing the existing (Callon, 1980). However, to do so, the contender must mobilize not only a host of arguments but also many things/objects to build and support these arguments. Whether or not the contender succeeds depends on whether or not the contender can convince others of his/her claims. Take the question of the technical feasibility of a construction design as an example: architectural sketches may not initially give reason to question the technical feasibility of a design, whereas more detailed, technical drawings may. Resolving this may likely call for more calculations, drawings, and perhaps even simulations to demonstrate the feasibility of the design, but continued contention is also costly because, as Latour (1987, p. 78) notes 'the dissenter would need so much more time, so many more allies and resources to continue to dissent that he has to quit, accepting the claim as an established fact'. Following from this, a project goal may be established through trials of strength and, returning to the etymology of ambitions, enabled by the 'going around' or circulation of objects 'to canvass for votes'. The notion 'design ambition' is introduced not only to capture the aesthetic, functional and economic aspects of project goals, but also to suggest a particular 'performative' approach (Latour, 1986; Callon, 2007) that emphasizes the role of circulating objects in negotiating these ambitions: 'they do things. They articulate actions; they act or they make others act' (Muniesa *et al.*, 2007, p. 2).

Hence, ANT offers a different perspective on goals and ambitions from that of the above-mentioned normative and descriptive literature. Rather than conceptualizing goals as either input or output, the notion of goal translation suggests that they may be both at the same time as objects mediate to transform them. Determining what role objects play in changing design ambitions and goal realization is an empirical question, but if thoroughly explored, the analysis can show how collective action is *made* possible, thus adding a material dimension to the understanding of decision making as achieving collective action (Brunsson, 1985; Engwall, 2002).

In what follows we direct attention to the role that artistic sketches, drawings, photos and models play in the construction of a skyscraper. These objects are not just considered visualizations of ambitions and knowledge (Whyte, 2003; Whyte *et al.*, 2008); they are also entities that can actively mediate in the construction process transforming ambitions as they 'go around'; circulating between various contexts such as an architect's studio, a construction site, and a laboratory used to test the design's technical feasibility. We show that project goals and specifications emerge endogenously and continuously as objects, project members, the stakeholder environment and the emerging building interact. It is through these interactions that new insights and new ways of knowing the building can be produced (Yaneva, 2005), and the design ambitions subsequently transformed. This has, we argue, practical implications for the management and evaluation of success (or failure) in construction projects. In conclusion we suggest that managing and evaluating construction projects based on initial design ambitions may be prone to false learning (Busby, 2001; Kreiner, 2006), because design ambitions change in the course of the construction process, not just because additional information becomes available in the course of the project life cycle but because of the contingent role of the materiality involved. This, in turn, allows us to address hitherto unaddressed aspects of goal formation, scope changes and design ambitions, which can augment insights from the existing approaches to project and construction management, and to suggest more relevant procedures and criteria for construction management and evaluation that take knowledge production and learning into account.

Research setting and method

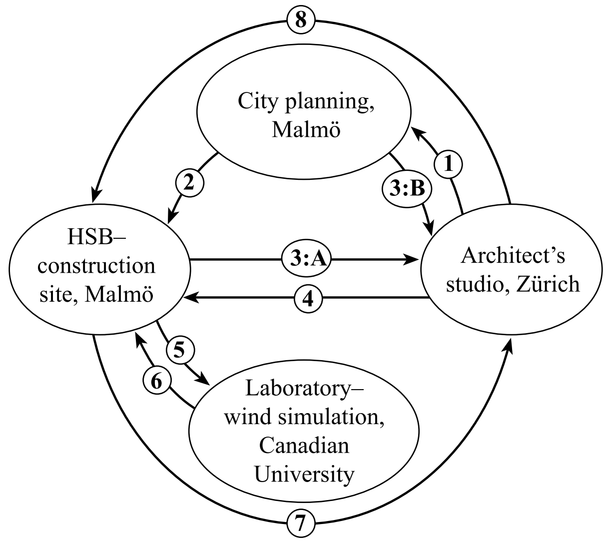
Our research is based on a study of the construction of the 'Turning Torso', a skyscraper in Malmö, Sweden. It is a case study of how goals and ambitions for a construction project are shaped. Construction started in 2001 and was completed some four years later—in late 2005—three years behind schedule and some 800 million SEK over budget, a cost overrun of approximately 100%. The building was designed by the Spanish architect and engineer Santiago Calatrava and commissioned as well as built by the Malmö branch of the cooperative housing association, HSB-Malmö (HSB is the acronym for Hyresgästernes Sparkasse och Bygnadsförening [Tenants Savings Bank and Construction Association], which has 33 regional offices across Sweden). The construction process (as well as the end result) is in many ways spectacular. Not only is the building spectacular aesthetically, given the skyscraper's dramatic, kinetic form—it is 190 metres tall and rotates 90 degrees from the base to the top, just as the name indicates; it is also spectacular because of the engineering ingenuity involved in constructing one of the highest residential buildings in Europe. Moreover, the Turning Torso is spectacular in a political sense because of the controversies it sparked for being over budget, delayed and for changing the identity of the clients, customers and of the city in turn.

The empirical material was assembled by one of the authors in the course of two years, from 2004 to 2006, i.e. initiated towards the end of the construction process but continued in the year following the building's completion. The empirical material consists of documentary material, e.g. city plans, consultancy reports, HSB memos and decision protocols, architectural sketches, drawings, photos, models, movies, press releases, and articles from the local newspapers and magazines, and transcripts of in-depth interviews with 11 key informants from the major organizations participating in the project. The duration of each interview was approximately one and a half hours. The interviewees included the head of project management, project marketing, several architects, quality consultants, the head and members of the city's planning and architecture department, as well as the former and current CEO of HSB. Given that many of the interviews were retrospective, key documents such as architectural drawings were used during the interviews to provide a relevant framework and focus. The purpose was not just to prompt the interviewees' memories but also to simultaneously 'triangulate' or position the interviewees and field researcher in order to jointly recollect and reconstruct the chain of events in this complex and controversial construction process by following document trails (Latour, 1987; Justesen, 2005).

The analysis is based on a systematic reading of the empirical material to develop time lines, identify controversies and changes in the goal specifications, identify objects with a significant role in the chain of events and to follow the chain of associations connecting the key decision makers with these objects, e.g. the architect/engineer's sketch and a model of a twisting torso, the budget (in multiple versions), laboratory simulations, and the emergent building. Our approach is similar to the one taken by Latour (1996) in his study of Aramis, a public transport system in France. The aim is to explain the project events with the help of the involved actors, which means that the study's scope is limited by the boundaries proposed by the actors themselves. One boundary which we were unable to explore was the one set by Santiago Calatrava. Given the timing of our study, we were unable to conduct in situ observations of the bench work within the 'laboratory' of the architect's office (Yaneva, 2005). However, as Czarniawska (1998) and others have argued, chains of events are likely to take place simultaneously at different sites, rendering real-time observations less viable, if not impossible. Although privileging real-time observations at one site can provide valuable insights into the practicalities of constructing design ambitions at that particular site, it is less productive in solving the task of reconstructing a chain of related events that connects sites.

Instead, we relied on documentation and verbal accounts of how architectural prototypes and drawings have circulated and linked up with such diverse localities and temporalities as a construction site in Malmö city and an architect's studio in Zürich. The routes that these circulating objects have taken are depicted in Figure 1 (see the Appendix for project chronology).

The objects that we have focused upon, e.g. artistic drawings, architectural and engineering drawings, prototypes and the building itself are important devices for giving sense, negotiating and making sense of a construction project (Weick, 2001). Not only do they enable different actors to engage and communicate with one another, as boundary objects (Star and



(1) Twisting Torso as sculpure and picture in a brochure
(2) Brochure picked up by CEO-HSB
(3) A + B joint visit to the architect's studio
(4) Architect sketches and drawings
(5) PM request a simulation
(6) Simulation model result
(7) PM request redesign of the building construction
(8) Revised drawings [etc].

Figure 1 The circulation of objects

Griesemer, 1989), but they also mediate and transform knowledge.

Emerging design ambitions: the Turning Torso

How do design ambitions emerge for a particular construction project? We have focused our account of the emerging design ambitions on three episodes: (1) on the 'construction' of HSB's design ambitions and how these evolved from 'just' constructing a small high-rise of 75 metres to become constructing a building twice as high and based on a kinetic design; (2) how the building's materialization led to repeated trials of strength between aesthetic ambitions and functional requirements; and (3) the closure and provisional stabilization of the design ambitions.

Constructing aesthetic design ambitions

Our study has two starting points: one in Switzerland and one in Sweden. Taking the Swiss connection first, this part of the story starts with a sculpture called

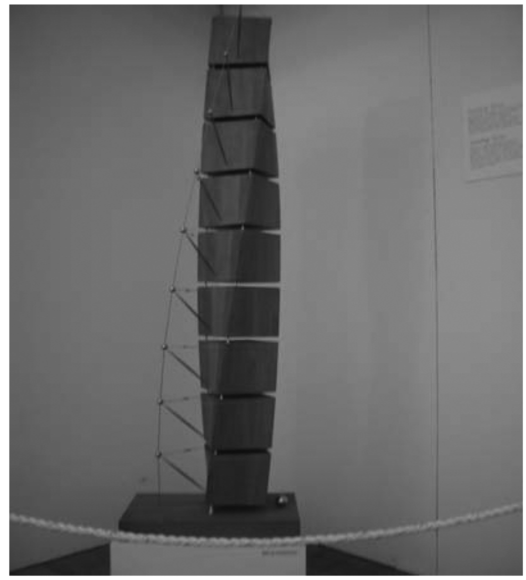


Figure 2 A nine cube version of the 'Twisting Torso' sculpture
Note: For additional images, see http://web.mit.edu/civenv/ Calatrava and Calatrava (2002).

'Twisting Torso', conceived of by the Spanish architect and engineer Santiago Calatrava. Calatrava, known for his interest in organic form and kinetic design, made a sculpture in 1985. It consists of nine cubes (see Figure 2) that:

> … describe the spine, or how our body stands up. The spine is made up of vertebrae that are *represented* in the sculptures in a very elemental way, as a series of cubes … Also quite important is how our spine twists, how it turns around an axis, and how it bends and reaches. (Calatrava, 2002, p. 95; emphasis added)

For many years the 'Twisting Torso' was nothing but a piece of art in Calatrava's private collection. This changed when he put the sculpture into circulation by means of a picture in a brochure, but it was only by chance that it made it to the second starting point of our case—Malmö, Sweden.

The city of Malmö was in the late 1990s in a period of transition. Local government was greatly interested in revitalizing the western harbour that, once the site of thriving shipyards, had been an urban wasteland for more than a decade. Creating new housing was considered pivotal for making this urban transition, and they planned to open a housing exhibition, 'Living 00' [Bo 00] in 2000 in a small town just south of Malmö as a means of spurring this process. However, owing to the construction industry's lack of commercial interests in developing this (relatively) marginal location, the housing expo was relocated in Malmö's western harbour in May 2001 and renamed 'Living 01—City of Tomorrow' [Bo 01]. With this exhibition local government wanted to demonstrate 'that the industrial wasteland could be transformed into the *center of the world*'; a green sustainable city of the future (Homepage Bo 01, http://home.att.net/~amcnet/bo01.html, emphasis added), and as it turned out the 'Turning Torso' was to figure prominently in realizing this ambition.

The 'Turning Torso's' emerging design made it to the expo 'Living 01' by way of the 'Living 00' exhibition. Calatrava had put up his model of the 'Twisting Torso' at this exhibition, and it was the architect responsible for organizing 'Living 00' who brought Calatrava's model to the attention of Malmö's head of city planning in 1999. Up until then, the city planners had not yet developed detailed plans for the 'Living 01' expo apart from designating that the site would contain a fairly tall building—25 storeys with a maximum height of 77 metres—that would 'fit' into the otherwise relatively low-rise cityscape. They did not have a prospective owner, or constructor of the building, nor had they decided on the purpose or design of the building. However, once the head of city planning had seen the model, he knew that he had to visit Calatrava.

The city planners were not the only ones planning to construct a high-rise. The CEO of the housing association HSB-Malmö was also considering constructing a 75 metre high building, and while visiting the city planning office in spring 1999, the CEO came across an exhibition folder displaying a picture of a seven-cube version of the 'Twisting Torso' sculpture:

> I was heading for a different meeting with some architects at the office for city planning. There were some brochures scattered around that Calatrava had left behind and [in the brochure] there was this sculpture Twisting Torso. At that time, it was seven cubes high, because this is the way architecture divides the human body … (interview quote)

and

> having seen the sculpture, I contacted the general management of the housing exhibition ['Living 01' in Malmö] in order establish contact with Calatrava (interview quote).

Two events—'Living 00' and 'Living 01'—a model, and some photos brought the city planners and HSB management together in defining their design ambition, but Calatrava had to be convinced that the western harbour would be an appropriate site for one of his buildings. A visit to Malmö was all that was needed to convince him. His initial free-hand sketches of the building resembled a cobra, and as the CEO explained 'I was not very interested [in the cobra] and succeeded in persuading him to consider doing something else for us …' (interview quote). He succeeded in persuading Calatrava that his small sculpture, 'Twisting Torso' was both a piece of art and a good prototype for a residential building, and together they coined the notion of 'living art' to summarize their design ambition. When Calatrava entered the HSB boardroom a few months later, in February 2000, the architect was so well equipped with sketches and drawings that he convinced the board members to continue exploring the project's feasibility. The name 'Turning Torso' emerged in the wake of the meeting, and as the CEO explained, 'it seemed natural'.

The circulating pictures of the 'Twisting Torso' and the sculpture itself played a crucial role in shaping the largely undefined design ambitions for the prospective clients—the HSB association, the city planners and the management of the housing exhibition. It is, however, a role that developed in serendipitous ways. Had pictures of the 'Twisting Torso' sculpture not made it to Malmö, for example, the building would probably have had a quite different and more ordinary design. Arguably, the objects put into circulation afforded developing design ambitions for a project that would prove to be iconic.

Reconstructing design ambitions through trials of strength

Initially the plan had been to construct a building consisting of seven cubes, but when the CEO and architects working with this model put themselves in the place of the user, they discovered that the dimensions of the cubes would mean that the angles of the windows and walls would be skewed. As the CEO explained: 'when we made the first models we believed that seven cubes and 133 metres would be sufficient, but it turned out that it would be very difficult to absorb the sharp angles of windows resulting from the [building's] 90 degrees twist' (interview quote). If the number of cubes and the height of the building could be increased, then the sharp angles could be reduced. For the prospective end-user this would be quite an improvement, because the sensation of living in the Turning Torso would become less of a challenge, if the angles of windows and walls approached the ordinary 90 degree standard. By adding two more cubes to the building, they could accommodate these considerations while preserving the sculpture's kinetic qualities. Although the building would, accordingly, be much taller, the HSB board decided in December 2000 to, nevertheless, go ahead and build the 190 metres high Turning Torso.

Increasing the building's height led, however, to another functional issue—the structural stability of the building. This issue 'cropped up' just as the excavation for the building's foundation was to start with a symbolic first dig in February 2001. It called for having a project meeting on site. Among those present were a representative from Calatrava's office and his Swedish counterpart, the 'structural checker', whose task it was to audit the drawings and the calculations made by Calatrava's office.

Equipped with the more refined drawings, the structural checker problematized the construction design: he questioned the structural stability of the tower design by mobilizing the building's 'resultant'. The main argument was that the radius at the base was too small to secure vertical stability because the estimated 'resultant' would be outside the structural core of the building. A well-reputed laboratory at a Canadian university was asked to test the construction design by conducting a wind-tunnel test of a nine cube mock-up. This simulation of the building's structural stability under extreme wind conditions confirmed project management's concerns. At high winds, the 'resultant' would most certainly be outside the structural core. As the structural checker explained: '[i]t took some time to get the results, but we had to make sure because it is important to have [the] architecture with us all along' (interview quote). As a result, the radius at the base was increased from 12 to 15 metres, although, according to the structural checker, 'it could perhaps have been 1–1½ metres smaller, but this one [the first estimate of the radius], I do not think would have been sufficient' (interview quote). The functional concern—stability—was so overriding that they also decided to reinforce and enlarge the building's foundation and structural core, thus adding large amounts of concrete and steel to the construction.

These design changes increased project cost significantly and delayed the construction process considerably. Although this refinement of the building's functional design certainly served a basic user need—stability—it unexpectedly undermined HSB's plans to engage prospective users in designing their apartments. Originally the plan had been to design each apartment according to the individual customers' preferences. According to one of the architects, they: 'obtained a list of some hundred interested persons, mainly from Malmö and Stockholm. Then we organized a first meeting, in both cities. We invited all prospective candidates on the list' (interview quote) and met with them on numerous occasions. Moreover, they built full-scale, furnished mock-ups on the construction site so that they could demonstrate what the kitchens and bathrooms would look like. Engaging the users in this way not only made them co-designers, it was also considered an important step in turning the users into owners, willing to pay for an apartment.

However, the stability-related changes in the building's exterior and interior design put an end to these endeavours; as the architect noted: 'it [the project] took too much time. The list of interested users became shorter and shorter as people opted for another place to live, or simply because they started to become concerned about the additional costs' (interview quote). There was only a handful of interested customers left by the autumn of 2003, and the HSB board redefined their interior design ambitions accordingly—from customization to standardization. This design change did something else: it redefined the identity of the coming users from being customers to being rent-paying tenants instead—a move which, in turn changed HSB's role from that of being the owner to also being the landlord. The unexpected functional design requirements of ensuring stability resulted in project delays, increased costs and transformation of HSB's ambitions with regard to both the building's interior design and the prospective users' identities.

Closure and provisional stabilization of the design ambitions

HSB-Malmö is a member of a large national federation of landlords, established in the 1920s with the explicit goal of providing low-cost housing to ordinary citizens. The national federation is one of the major players in the Swedish housing market. However, by 2004 HSB-Malmö had sold off a substantial stock of its older buildings—some 800 million SEK of their own assets—in order to finance the Turning Torso. The move met with considerably criticism, to which the members in the local federation responded by replacing the CEO at their general assembly. This was, however, not enough to stave off criticism from the 'National association for cheap housing' for whom the Turning Torso was nothing more than a phallic symbol and an investment that deviated from the social values that once governed the federation. The federation's national spokesperson admitted that it was a mistake, and the new CEO in the Malmö office stressed that in the years to come they would only build cheap, affordable housing.

These re-evaluations of the construction project are the last (provisional) elements in a long chain of unexpected transformations. The unexpected twists and turns in the construction process point to the performativity of the Turning Torso, i.e., how the emerging object shaped the identity, ambitions and economic rationale of its inhabitants and the project owner HSB. This was, however, not all that the building accomplished. According to the head of city planning, the Turning Torso did something to Malmö's identity: 'the [shipyard's] crane was destined to be sold and sent away. The city's landmark was to be replaced by a new one, representing the transformation from an industrial city to the new area—Malmö, the city of knowledge and events' (interview quote).

Discussion

The episodes above illustrate how circulation of objects helps both to establish the material conditions and context for developing design ambitions, and resolve emergent aesthetic and functional tensions that these ambitions entail in one particular construction project. Although the empirical issues are specific for the case, it nevertheless provides some general insights into the performativity of objects in goal formation and knowledge production that have bearing on our understanding of the practicalities of construction. First, design ambitions emerge from the entanglement of the people and their visual and calculative tools. This is not to say that photos or models are not visual representations of, for instance, a 'twisting torso', but to say that they can do more. As boundary objects they draw different stakeholders into conversations about design, focusing attention, while also allowing stakeholders to explore and further develop the design. Second, not only do different stakeholders have different design ambitions and, hence, different aesthetic and functional concerns, they are also equipped with different circulating objects that they use to convince one another of how the project should develop. The various tools—photos, models, mock-ups, etc.—are performances of the project that contribute to its construction as the circulating objects perform the work of singling out and intensifying themes of contention and reconciliation. These tensions are resolved through trials of strength as the object—the building—is elaborated and circulates across sites in various forms, e.g. artistic sketches, drawings and models. This involves more than coordinating actions towards a particular goal or ambition. Through the insights and knowledge that working with the various objects (including the building itself) provides, the objects simultaneously and progressively participate in the transformation and subsequent articulation of the design ambitions.

This points to a third issue: the contingencies and serendipity of what comes into being. It is a process of *goal translation* (Latour, 1999) that in this case changed the role of inhabitants from first being nondescript users to being customers and interior decorators with high design ambitions of their own, and then into tenants. HSB's role and interests were also subject to a series of transformations: from landlord, to owner, to owner and landlord again. In the course of these transformations HSB is subject to massive criticism for their exclusive elitist business model and for having compromised the housing federation's core values based on providing affordable housing for ordinary citizens. Furthermore, the cost increases and time delays, in combination with the associated loss of interest among prospective apartment owners, translated into a new and unexpected funding requirement, which forced HSB to sell off a substantial part of their own assets. As the building materialized, HSB's core values, interests and beliefs about corporate social responsibility, which previously had guided their strategy and prioritizing of projects, was quite unexpectedly translated into the opposite—providing exclusive housing for wealthy citizens. In short, defining the project mission and managing stakeholders is not simply a matter of implementing one's corporate strategy, based on a set of given core values, interests and beliefs, but something that is subject to reversal through goal translations.

Practical implications

The Turning Torso case points to the uncertainties involved in assessing the status of knowledge when the commitment and decision to construct are in the making. After a lengthy process of elaborating the design with the help of sketches, drawings and mock-ups, the project parties involved assumed that they knew the design sufficiently well only to discover that these assumptions did not hold. New valuable knowledge about the feasibility and stability of the structural design was produced—again with the help of drawings and mock-ups. It was, however, the wind simulation tests that stabilized the building's (re)design, while other circulating objects such as the cost budget and time schedule were adapted to this new knowledge and project condition. Since the building had yet to materialize in a concrete construction, it was relatively easy to redesign. Rather than attribute such goal adaptation to the project members' lack of knowledge, we want to emphasize the knowledge produced through the trials of strength and the importance of the circulating objects for progressively elaborating their abilities to accommodate and adapt to the unexpected.

We wish to end this section by discussing the implications that goal adaptation may have for the evaluation and management of construction projects. As noted in the introduction, project evaluation is often conducted with reference to project goals defined at project initiation. If evaluated on these terms, the Turning Torso would be deemed a failure, because it did not live up to the initial design/quality, time and cost specifications. Adhering to this evaluation approach can lead to dismissing many construction projects as failures and characterizing construction managers as either incompetent and/or unreliable—i.e. to false learning (Kreiner, 2006). Although cost overruns might be ascribed to stakeholders' over-optimism or strategic misrepresentation of the 'true' costs (Flyvbjerg, 2006), so as to ensure project approval, this description seems overly rationalistic. Not only does it presume a correspondence between intention and outcome as the 'best practice' in construction management and evaluation, it also assumes that those involved possess sufficient information to know how to selectively disclose information to best serve their interests. However, it seriously underestimates the active mediating role of objects in construction. It is quite likely that the Turning Torso project would have turned out otherwise, had the design ambitions not been negotiated and dealt with the way they were through various trials of strength. For example, it is possible that the building's structural design and stability could have been questioned later and close to delivery. Stabilizing the construction at this point would have been difficult and costly to accomplish. The trials of strength avoided this outcome. As our findings suggest, an adaptive approach comes also at a cost. But then again, the project can possibly turn out otherwise, and the value of 'getting the building right' through various trials of strength might more than offset these costs.

The collective and distributed knowledge produced through the trials of strength is pragmatic and evaluative as it concerns 'how to get the building right', and can only be taken into account if construction management does not exercise too rigid procedures for 'how things should be done'. This calls for reflexivity and flexibility in adjusting goals and trade-offs, rather than individual penal measures intended to reduce the inaccuracy of initial goal estimations, as suggested by Flyvbjerg (2006). An adaptive and pragmatic approach would also help manage possible disappointments about inaccurate goals and estimations arising from the use of a more rigid approach. It is important to emphasize that the existence of such disappointments is not independent of the approach, but integral to its configuration and use. Rather than considering deviations from initial goals and estimations as something unexpected that necessarily needs to be minimized, a more adaptive approach would consider this as something to be possibly expected in construction projects characterized by substantial materiality, uncertainty and ambiguity. In terms of planning and resource allocation, the implication is that resources for (re)design should be distributed across the project life cycle instead of being solely concentrated to an initial briefing and design phase. For construction management the further implication concerns the importance of taking a distributed and emergent view on knowledge, and the preparedness to mobilize and circulate objects across stakeholders and sites.

Conclusion

The aim of this study was to show how objects in construction can shape project goals and design ambitions. We have shown how goals and ambitions are not just a matter of social negotiations but repeated socio-material trials of strength. Integral to these trials is a tension between the functional and the aesthetic—which leads to the development of new objects (drawings, models, creative solutions, etc.) and new insights that can keep the ambition of designing living art in place. The important point of reference for the emerging project was to stay faithful to the prototype's exterior proportions, i.e. an aesthetic ambition, but it is constituted as such during the progressive elaboration of the objects. This ambition was not given at the outset but, as we have shown, was negotiated in the socio-material trials of strength. Our analysis of the trials of strength between aesthetic design and more functional ambitions suggests the usefulness and relevance of this concept beyond the Turning Torso to other construction projects characterized by contestations and uncertainties as to the technical feasibility of a construction design. Our analysis does not suggest that the resulting building and objects are just embodiments of knowledge. Rather, our analysis reveals a much more active (performative) role for the objects in shaping knowledge production—construction projects and the material objects constituting them need not be just means to implement already existing core values, strategies, interests and beliefs, but can be (more) actively involved in transforming such values, strategies, interests and beliefs. Based on our findings we proposed an adaptive and pragmatic approach for the management and evaluation of the construction project that takes the value of knowledge production and learning into account.

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Appendix

Table A1 Project chronology (numbers in parentheses refer to those in Figure 1)

1999

- In the spring: the project was planned to a 25 storey building/77 metres. Architect and design was not yet decided.
- **(1+2)** The CEO of HSB-Malmö visits the office of city planning and picks up a brochure with a picture of the sculpture 'Twisting Torso'.
- **(3A+B)** The CEO of HSB-Malmö and the head of city planning meets with Calatrava in the architect's studio.
- **(4)** In the autumn: the building is projected to have 7 cubes/42 storeys/160 metres and to be finished by May 2001.

2000

- **(4)** Calatrava revises the drawings and the building is projected to have 9 cubes/45 storeys/186 metres/130 apartments. The estimated total cost is 550 M SEK. Project completion is scheduled for 2002.
- **(4)** The architectural drawings are revised again in the autumn, increasing the commercial area from 14.797 square metres to 17.723 square metres. The total costs are re-estimated as a consequence and set at 728 M SEK, and project completion is still scheduled to be in 2002.
- In December, the board of HSB-Malmö finalizes their decision to build the Turning Torso.

2001

- Breaking ground ceremony: 14 February. Project meeting held at construction site. Structural checker questions the tower's vertical stability.
- **(5+6)** Project management requests a laboratory wind simulation to test structural stability; results are received some weeks later.
- **(7+8)** In the spring the architectural drawings had to be revised, adding 3 metres to the radius of the building to ensure stability. Also the number of floors below ground was reduced from 4 to 3.
- Excavation begins May and is completed by December.

2002

- The foundation slab was finished by March, the number of floors below ground was further reduced to 2 and construction below ground was finished in June.
- February to July 2002 project management re-estimated material use, e.g. adjusting up from a projected use of 1700 tons of steel (the actual use was 4400 tons).
- This called for a re-estimation of time needed for construction above ground from 16 to 19 months.

2003

- The 27th floor was reached by December.

2004

- Total costs were re-estimated: in April expected to be 1392 M SEK, and in May 1600 M SEK.
- Reaching and celebrating the 54th floor in December.

2005

- The 54th floor/190 metres completed by February 2005.
- In June the total costs were re-estimated to be 1500 M SEK.
- In November the construction is almost complete and the inhabitants began moving in.

2006

- All of the apartments had been rented out by March.