

VISUALISATIONS AND CALCULATIONS OF SPACES: NEGOTIATING HOSPITAL DESIGN DURING ON- BOARDING

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There is a complex relationship between the use of visualisations, and the production of both designs and physical spaces. In the case of hospitals, technical, aesthetic and practice-based requirements are incorporated into negotiations around facilities, layout and operation, and a plethora of stakeholders are engaged in the process. This paper describes a case of the ‘on-boarding’ phase in the design of a new hospital in North Zealand, Denmark. It describes the use of various visualisations in the engagement of actors concerned with managing the budget and delivering the building programme as well as the eventual users of the hospital. It reveals how visualisations are mobilised to form different and overlapping types of spaces. These are described as economic spaces, concerned with maintaining the economic budget frame, when the client organization is communicating the project and the design to healthcare practitioners at the hospital; design spaces, which include forms of user involvement, when the design team is developing and testing a methodology for engaging with medical staff; organizational spaces, concerning the connection between new physical spaces and healthcare professionals, when members of the project organization work with the aim of facilitating organizational changes in the way health care is delivered at the hospital. Finally the paper discusses how these spaces are connected, and how they both enable and constrain innovation in design and healthcare.

Keywords: design, hospitals, space, visualisation.

INTRODUCTION

“We have to give the frame to the users. We cannot change it and they have to understand this”

(Member of project organization, process meeting/ user involvement, May 22th, 2014)

The paper is concerned with the development of designs for a new hospital in Denmark. The focus is on the ‘on-boarding’ of the design team, designs and users, an early stage in the building design process where the client representatives, project management, design organizations and users begin to develop working relationships, and processes to deliver the project. The study inquires into the material link between practices of design and types of space and of clinical work in the context of hospital construction projects. Empirically, the study concerns how the project organization, in interaction with members from the client organization and various forms of visualization, design and develop spaces for the New North Zealand Hospital (NHN),

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part of the Danish hospital building programme currently underway. Theoretically, the paper contributes to our understanding of the role of visualizations in design processes, notably; how methods and technologies of visual representations are being used in the hospital project and thus aims to explore the under-theorized workings of the visual in complex organizational settings (Meyer *et al.*, 2013). We develop this to discuss how particular conceptions of space are developed and mobilized in the process of on-boarding, in terms of the physical architecture (area size and number of rooms, functions), but also the notions of design spaces (especially the engagement of users in the design), organizational spaces (work processes) and economic spaces (cost and budget). To understand how the visualizations are mobilized in the on-boarding phase we focus on how these representations are linked to different concerns and aspects of space and practices.

The paper and argument is structured in the following sections: Firstly, the article presents theoretical perspectives on different understandings of how spaces and visualizations are being conceptualized in construction and design. Secondly, we present our research methodology and how the data was collected. Thirdly, we present our case hospital as a part of the current reform of Danish healthcare delivery. The presentation of the case is followed by an analysis of how the hospitals design is being negotiated in the different spaces during on-boarding. Finally, our findings and conclusions shows, that the visualizations of the different yet connected spaces and the development of the hospital design is related to a number of emergent concerns in the processes of designing and constructing the new hospital.

Concepts of spaces

Space is more than physical Cartesian space (Frandsen *et al.*, 2012). We argue that spaces have different meanings and functions, and that these different spaces can be linked to forms of visualizations in the project. Visual representation can constrain and enable different practices, contribute to the broader construction of organizational spaces, and constitute and create economic spaces. For our case, the selected design proposal consists of complex visualizations of the hospital, and the team consists of many different companies with different competences. We focus on the role of visualizations as a part of design work (Ewenstein and Whyte, 2009; Yaneva, 2005, Meyer *et al.*, 2013) and as design space (Kreiner and Tryggestad, 2002) but we are also interested in what complex roles the different forms of visualizations such as 2-D and 3-D (Justesen and Mouritsen, 2009) have as a part of ongoing negotiations of the future spaces and practices of the hospital between the members of the project organization and the client organization that will own and use the new hospital. The project organization has economic obligations in relation to stakeholders, which in turn influence the project economy (Flyvbjerg *et al.*, 2003). The project economy appears in relation to devices, such as budgets (Tryggestad *et al.*, 2010) that visualize aspects of the project in terms of cost items like building design, eventually also with further links to devices such as building information models. How members of the project organization handle multiple matters of concerns related to visualization (Latour, 1986) of different spaces and functions is one important aspect of this study. Various links between spatial settings and management of organizations have been explored in management studies (Kornberger and Clegg, 2004; Van Marrewijk, 2009) and in relation to organizational changes as a part of designing new buildings (Stang Våland and Georg, 2014). We aim to describe and analyze the process when the design proposal, and the concepts and principles it builds on are being reworked and materialize in new forms in the on-boarding phase and how the visualizations have

different meanings and functions in different project contexts, such as on-boarding of the design team and user involvement (Luck, 2003) of clinical staff.

METHODOLOGY AND DATA COLLECTION

The research builds on an ethnographic study in a construction setting (Pink *et al.*, 2010; Kreiner *et al.*, 2011) during the on-boarding phase at NHN that lasted from April 2014 to July 2014. The empirical study of the on-boarding phase began the week after the winner of the project competition was announced. We studied the on-boarding phase and how the design team and the design project was integrated into the project organization at NHN as a part of forming a new project organization. Our study focuses on the project organizations everyday work, collaborations and negotiations during this phase, and how a new project organization is formed and structured in a way that enables the project organization to handle the new tasks that it will meet in the next phases of the construction project.

Data collection is based on direct observation, meetings and document analysis with the main research method being participant observations of meetings. The observed meetings represented tasks and responsibilities related to different levels in the project organization. These participant observations were supplemented by informal interviews after meetings, or in other informal environments (lunch meetings and talking when transporting back from the meetings). We observed 1) *client-meetings* at the strategic level of the project organization where the management of the project organization participated. At the tactical level we observed 2) *process meetings* that represented the link between the strategic levels of the project organization. We also observed work at 3) *user involvement meetings* are the operational level, where project managers from the client organization and project managers from the design team planned the user involvement in the next phase of the project.

As a part of the participant observations, a large number of documents were collected. The collected documents and objects consist of Gantt diagrams, budgets, project manuals, project plans, contracts, drawings of the new hospital and project office etc. Before each meeting, members of the client organization sent the agenda and the documents that were to be discussed at the meeting. During the observed meetings the members of the client organization, as well as members of the design team, presented documents as a part of the collaboration and negotiations between members of the client organization and the design team. After the meetings the client organization sent minutes and other documents that they worked on to the researchers.

The collected documents, plans and visualizations are not analysed as isolated entities, our research interests is to understand how the different forms of visualizations are used during the meetings (Ewenstein and Whyte, 2007, 2009), and how they are a part of the collaboration and negotiations between the client organization and the design team during on-boarding phase when they form a new project organization. The research entails interventions with practice. After the on-boarding phase ended the researchers invited members of the project organization to participate in a seminar where observations and preliminary results were presented and concerns at NHN were discussed. This seminar gave a more nuanced understanding about the client organizations strategic considerations before on-boarding, which the researchers did not know during the observations.

THE CASE OF NEGOTIATING A HOSPITAL DESIGN

Background: Danish healthcare reform

In 2007 “*Kvalitetsfonden*”, the current building and renovation program for the Danish hospitals was established. “*Kvalitetsfonden*”, is the largest investment in public physical infrastructure in Denmark with a total budget of 42 billion Danish krona; 16 construction projects including renovations of existing hospitals, five green field hospitals, and five new “*super hospitals*”. These 42 billion Danish krona are co-financed by the Danish state and the five regions in Denmark. The ambition behind the reform is to create more effective, cheaper and better healthcare delivery in Denmark.

The construction and renovation of the hospital buildings changes how healthcare is delivered to patients in Denmark, and the construction projects bring with them complex challenges of how to manage several institutional concerns, such as; the location of the new hospitals, the design of the hospitals, new technology and treatment capacity, flexibility for future use, the division of labour between medical professions within and between hospitals, regions and municipalities, patient and end-user involvement, public participation and democracy. These national challenges touch in more than one way on the complex and evolving relationships between the hospital’s healthcare practices and the organization of the physical spaces for these future healthcare practices. The design of the new hospitals is regulated by national standards, i.e., the ‘Expert panel’, a committee jointly formed by the Danish Government and the five regions decided that all the new hospitals had to be designed with single bedrooms (Harty and Tryggestad, 2012). Redesigning the Danish healthcare delivery affects patients and health care practitioners in a number of ways. When it was decided to build the new super hospitals, it was not easy to decide where to locate the new hospitals, many people, especially outside the big cities have been concerned because their local hospitals are being closed, as a part of centralizing healthcare delivery in larger and more specialized hospitals.

On-boarding at NHN

The case hospital NHN is a green field hospital and a “*super hospital*”, with a budget on 3.8 billion Danish crowns located south of Hillerød. When the hospital is finished in 2020 the hospital will treat more than 300,000 persons in North Zealand. As a part of the construction of the hospital the infrastructure in the area changes radically: new train stations and roads will be constructed, and a new suburb Favrholt is being planned around the hospital. The resulting ambition of the competition brief was high “*setting new standards*” in the design and delivery of public health care. For the last phase of the project competition for New North Zealand Hospital the client organization, and a panel of judges, advisors and a group of healthcare practitioners negotiated with three remaining teams, before the teams handed in their final design proposals. The teams with competences within areas such as architecture, engineering and hospital planning changed their designs during the competition to meet the critique and feedback they received in these dialogues. The client and project owner was not just interested in receiving analogue drawings and models in the project competition. The teams’ designs of the future building also included 3D visualizations and film animations. The teams also had to produce Building Information Model (BIM) visualizations which integrate spatial aspects of the emerging designs with quantity, cost and scheduling information, due to economic (cost) concerns, but also because BIM visualizations were seen as a method to secure sufficient amount of total

space in the future hospital. Visualizations of the hospital, spaces and healthcare functions are used as tools to involve future patients and healthcare practitioners in the development of the organization of the future hospital, its working spaces and functions. In the on-boarding phase we identify a number of different yet interrelated concerns related to visualization processes and spaces. We therefore develop the idea of the production of spaces when these different concerns to the future functions and practices at the hospital are taken into account.

VISUALIZATION AND CALCULATION OF INTERRELATED SPACES

We now introduce aspects that show different concerns related to space and practices during on-boarding. These concerns are different from each other, but they are also connected, because they all relate to the visualization of spaces and practices in the construction of the new hospital. First, we illustrate how visualization of *economic spaces* (cost budgets) are connected, and how economic concerns are related to work in the on-boarding phase, when the progression of the project has to be measured on a monthly basis. Next, we show how the visualization of spaces is also connected to concerns about the *design spaces* in the form of the involvement of the users in the next phase of the project. This aspect is about design practices and how spaces can be developed. These concerns are connected to the economic space because the design of the hospital cannot be changed if it adds costs beyond the budget frame. The third aspect is user involvement, and it relates to how the project organization can develop *organizational spaces* through the introduction of design principles and concepts to the health care practitioners, when space is being visualized to enable user involvement. Finally, we describe in our observations a concern related to the *connection between the new physical spaces and emerging concerns in other spaces*. This concern entails the connectivity between economic-, design- and organizational spaces, and their impact in the physical space of the hospital.

Table 1: Overview of different spaces, concerns and forms of visualizations

Spaces	Concerns	Forms of visualization
Economic spaces	Budget frame	Cost figures, time lines, BIM
Design spaces	User involvement	Rooms, corridors, drawings, mock-up's, LEGO
Organizational spaces	Principles and concepts of healthcare	2D models (images and text)
Physical spaces	Interrelated concerns	Artifacts from past dwellings (below construction site), images and texts.

Economic spaces

Prior to the on-boarding phase and during the design competition the project organization submits the 3.8 billion DKK budget to a feasibility test. The project management's concern is about the budget sum, that it might not be feasible, given the high design ambition of 'setting a new standard' of hospital healthcare. The design obtained from the competition in the form of a BIM model was used to estimate the costs of the design solution. Project management concluded that the hospital design was feasible in terms of delivering new standards of healthcare, but not within the existing budget frame. This in turn created a new set of concerns; should the design

adapt to the budget or should the budget adapt to the design? It was decided to negotiate for extra funding in order to maintain the high design ambitions, but the proposal for extra funding was rejected by the expert panel and the Ministry of Health as was project management's proposal to secure additional extra funding for the hospital kitchen.

The hospital project has to be monitored by the project organization that has strict obligations to report the progress of the project on monthly basis to the funding bodies represented by the Ministry of Health and the Capital region. As a part of the work in the on-boarding phase the design is being translated into more well defined categories and spaces that can be measured in economic terms. For this to happen, the hospital project had to be divided into subprojects within a work-breakdown structure. During on-boarding we observed tensions when the new delineated design spaces were going to be measured in outputs translated into economic terms:

“We would like traffic lights. It is important with the output from the user workshops. Are we on track?” (Member, project organization)

“We cannot measure every project every month” (Member, design team)

The project organization uses the metaphor of traffic lights in relation to each of the subprojects. Members of the design team argue that the proposed work-breakdown structure does not reflect the actual design processes and overall design task. Therefore, the team is concerned that too many subprojects will collide with their design work.

How many subprojects that will be established is not settled at the beginning of on-boarding, but is subjected to further negotiations between the project organization and the design team. The design team became concerned about the measurement of the project being too *“bureaucratic”*, while project management with budget responsibility became concerned about how to better measure and control the progression of the project with respect to cost and time.

The budget visualizes aspects of the project in terms of economic quantities such as the cost of an individual design item or work package. The project budget delineates an economic space and affords certain understandings of the physical spaces that are in the process of being designed and constructed, where the value of a design element like a kitchen can be calculated and valued against the budget frame and subjected to further negotiations. In this example, it is the budget frame that is maintained while it is the design ambition of having a kitchen that 'has to pay'. In this process BIM is used to visualize and test the relative feasibility of the budget against various design options. Both project management and the design team develop new concerns about the inflexible ways in which the budget frames the design work during the on-boarding phase.

Design spaces

Engaging with the users of the hospital during on-boarding and design is a requirement for the project organisation. In user workshops the design team have to visualize the spaces of the hospital to demonstrate the design to clinical personnel and to get inputs and feedback from them, related to their own experience and expectations. However, this is not a fully open and negotiable process for the design team and there is, from their perspective, a need to limit the possible requests for adaptations and changes the users and user workshops might produce.

*“How do we explain space in a way that they know what inputs to come with?”
(Member, design team)*

Some important arguments for limiting potential changes in the design are to be found in the economic concerns, with the inflexibility of the budget translating into relative inflexibility of design options. The user involvement is even undertaken by the economic subprojects rather than the design as a whole, showing the connection to the economic spaces. But it is also reflected in the planning of the workshops. During on-boarding the design team and the project organization discuss how to limit where users engage with the design, to reduce the design space in which users can participate. Two aspects are important in relation to this delineation of the design space. The first aspect is how to keep the design intent clear and understandable for the users. There is a challenge to ensure that all aspects of the hospital are being handled and discussed in the workshops and that nothing is neglected. The design team have described their design methods in the proposal for the competition, but in this subsequent on-boarding phase they have to be more concrete. But the second aspect is how to limit the impact on the design, as they want to avoid changes and alternatives. The question is what kind of methods is the design team going to use in the workshops in the next phase of the project to balance these concerns related to both demonstrating the design to the users, but also limiting the design space in which users can affect changes. This is connected not only to the selection of visualisations presented to the users, but also to the decision to make the workshops themed around the hospitals specialities and parallel workshops about particular issues, such as patient security and ‘the secure hospital’ or hygiene, rather than presenting the purely spatial, Cartesian layout of the design.

Organizational spaces

The new design of the hospital has wide implications for the organization of the daily work practices of the future hospital, and the design team is acutely aware of the possible ramifications of this. The design of the hospital is based on a number of principles and concepts. One important aspect of these design principles is that of optimizing the use of space.

“What does ‘right of use’ instead of ownership mean for the staff?” We need many perspectives on this. (Member, project organization)

The quote illustrates a concern about the principle of 'right of use', because the project organization during on-boarding recognizes that there is no simple causal relation between a new spatial-organizational design principle for a hospital and the future daily clinical practices in this new hospital. The perspectives and involvement of the clinical staff are thus required in an effort to further translate the design principle into their daily practices. It is not only functions such as offices, research activities and administration that are being transformed into “*shared spaces*” at the new hospital. Also, the patient bedrooms are organized in a flexible “*snake*” structure and the different clinical specialities have to share these patient bedrooms according to the number of patients they have at any one time. The new design implies, or has embedded within it, new organisational spaces and principles. The project organization is aware that the healthcare practitioners may not understand these spatial principles and concepts, or that they may react negatively, because their territories and usual ways of working are being challenged.

The members of the project organization decide that the schemes that visualize how different rooms are organized are too abstract to communicate this and that the design

team need a more concrete method when they are explaining these principles to them. The design team and the project organization eventually agree to initially leave architectural drawings out of the visualization of the principles and concepts. Instead they decide to initiate the user involvement by discussing with them aspects closer to their own clinical practice such as the movements and ways of working within the physical space. In effect, the discussions are moved away from the design drawings to discussions around the new organizational spaces and new ways of working. When the users understand the principles and concepts it is possible to go into more details of the design. As a part of the involvement of the healthcare practitioners the project organization have agreed with the project owner (the hospital) that they will involve a pilot group consisting of people with an interest in improving the working environment and collaboration at the hospital. This group will do a small pilot test of the method before the larger scale involvement at the user workshops. The assumption behind this set-up is that the pilot group will have a strong voice in furthering the user involvement since it represents both hospital management and the clinical staff.

Physical spaces linking present spaces and concerns to the past

The physical cannot be ignored, and materialization of physical space and place is pushing back, as the project organization initiated work to prepare the construction site. It was part of the plan to drill and investigate the soil and the first holes and samples from the examination only confirmed what was expected. Later, when digging and drilling wider and further into the ground, the crew discovered that the soil was much softer in particular places, with “*pockets*” of very soft material. This unexpected discovery added an unexpected cost of 100 million Danish krona to the project in terms of extra ground work and construction design below ground. In addition, the assumption about a “*green field*” construction project became challenged as further geological and archaeological examinations revealed the construction site to also be culturally very rich, including over 3000 year old dwelling places. These two events; the subsequent materialization of physical spaces and cultural spaces below ground, illustrate the unexpected and negotiated links between them. In summary:

Economic spaces: The project budget as an economic space that visualizes the project in economic (cost) terms. It affords project management with a control device in relation to the design team. The budget frame must be maintained. Additional visualizations such as the timeline and work break down structures helps to detail the control of the design team. We identified tensions between control and innovation in design and healthcare practices.

Design spaces: Control of what users can contribute, and a tension between an economic concern with the project budget and design innovation based on user involvement. The design team becomes a spokesperson of the design, but is also expected to maintain control of the design space so that the project can stay within the budget - one form of visualisation. Thus the design team becomes spokesperson of several concerns, including an economic concern and is in turn monitored on its progress within another visualisation device - the break down structure of subprojects.

Organizational spaces: Materialization of organizational principles and concepts about healthcare in architectural design. The project organization has to integrate concerns about physical spaces for healthcare and facilitate organizational changes in healthcare practices through novel architectural visualisations as a part of their work. The clinical staff cannot understand the physical spaces of the new architectural design without

relating it to their existing practices. Yet, it is these existing practices that are about to change as an integral part of the hospital construction project.

Physical spaces: Work below ground can challenge contemporary assumptions, visualizations and spaces related to building and construction design, budget and time schedules for the project. The construction of a physical space for the building foundation opens up a link to hidden past spaces and places and forges new unexpected links to present spaces. These emerging uncertainties cannot be fully known in advance, but are revealed as the work of preparing the physical space for the foundation materializes in the ground.

Table 2: *Interrelated spaces and emerging concerns*

Illustration of spaces	Illustration of tension	Visualizations in use
Negotiations between economic spaces and design spaces	Kitchen is taken out of the hospital design due to economic concerns about the budget	Budget calculations and design drawings
Negotiations between design spaces and organizational spaces	Without the kitchen the healthcare concern related to nutrition becomes stronger	2D models of organizational principles and design drawings with kitchen
Negotiations between economic spaces, design spaces and organizational spaces	Due to concerns related to the budget and the organizational concerns (principles and concepts) the user involvement have to be limited	Budget calculations and organizational design principles
Negotiations between physical spaces and the other spaces	Artifacts from dwellings and geological surprise increases budget costs related to site development and construction design	New budget calculation (100 mill DKR budget increase) and re-design/downsizing physical spaces

CONCLUSION

The contribution of this paper is the identification of four aspects of space in this on-boarding process and the ways that heterogeneous visualisations are produced and mobilised to support or problematize them. In doing so, we tentatively analyse and discuss how these spaces are connected, and how they both enable and constrain innovation in design and with what practical implications for hospital construction projects and healthcare. These spaces and visualisations are much more than the product of visualizing rooms, corridors and offices, much more than Cartesian representations of physical spaces (existing or to be). This is not the first attempt to develop a more striated or multi-layered appreciation of space. For instance scholars such as Tissen and Deprez (2008), building on Lefevre and Foucault, propose a ‘trialectics’ of space, consisting of representations of space (such as the emerging hospital design), representational space (the ordering of space across, in this case new hospital practices) and spatial practice (the eventual lived space of production and reproduction, or even the social space of design work). Whilst these do not directly map onto our conceptions, a strand of future work will be to explore the connections and possible alignments between the project spaces and visualisations in our analysis with these concepts. Another avenue for further work is the connectivity and interdependencies between these types of space, and the exploration of other possible spaces, such as ‘digital space’ within these representations. Similarly, subsequent

empirical work will provide more detail on the ways that users are able to influence or incorporate their understandings, practices and experiences into the design process.

REFERENCES

- Ewenstein, B., and Whyte, J. (2009). Knowledge practices in design: the role of visual representations asepistemic objects'. *Organization Studies*, **30**(1), 07-30.
- Flyvbjerg, B., Bruzelius, N., and Rothengatter, W. (2003). *Megaprojects and risk: An anatomy of ambition*. Cambridge University Press.
- Frandsen, A. K., Gottlieb, S. C., and Harty, C. (2012). Spatial configurations of healthcare practices. Proceedings of the Joint CIB International Conference: *Management of Construction: Research to Practice*. Thurairajah N (Ed.) Birmingham School of the Built Environment, Birmingham City University, (CIB Proceedings, Vol. 1), 1062-73.
- Harty, C., and Tryggestad, K. (2012, September). The Roles of Representations in Building Design: Materiality and Visualisation. In *28th ARCOM Annual Conference* (45-55).
- Justesen, L., and Mouritsen, J. (2009). The triple visual: Translations between photographs, 3-D visualizations and calculations. *Accounting, Auditing and Accountability Journal*, **22**(6), 973-990.
- Kreiner, K., Jacobsen, P.H. and Jensen, D. T. (2011): *Dialogues and the problems of knowing: Reinventing the architectural competition*. Scandinavian Journal of Management, vol. **27** (1), 160 -166.
- Kreiner, K., and Tryggestad, K. (2002). The co-production of chip and society: unpacking packaged knowledge. *Scandinavian Journal of Management*, **18**(3), 421-449.
- Kornberger, M., and Clegg, S. R. (2004). Bringing space back in: organizing the generative building. *Organization Studies*, **25**(7), 1095-1114.
- Latour, B. (1986). Visualization and cognition: Drawing things together. *Knowledge and Society*, **6**, 1-40.
- Luck, R. (2009). 'Does this compromise your design?' Interactionally producing a design concept in talk. *CoDesign*, **5**(1), 21-34.
- Meyer, R. E., Höllerer, M. A., Jancsary, D., and Van Leeuwen, T. (2013). The visual dimension in organizing, organization, and organization research: Core ideas, current developments, and promising avenues. *The Academy of Management Annals*, **7**(1), 489-555.
- Pink, S., Tutt, D., Dainty, A., and Gibb, A. (2010). Ethnographic methodologies for construction research: knowing, practice and interventions. *Building Research and Information*, **38**(6), 647-659.
- Tissen, R. and Deprez, F.L. (2008) Towards a Spatial Theory of Organizations. Creating new organizational forms to improve business performance. NRG Working Paper no. 08-04, The Netherlands.
- Tryggestad, K., Georg, S., and Hernes, T. (2010). Constructing buildings and design ambitions. *Construction Management and Economics*, **28**(6), 695-705.
- Van Marrewijk, A. H. (2009). Corporate headquarters as physical embodiments of organisational change. *Journal of Organizational Change Management*, **22**(3), 290-306.
- Stang Våland, M., and Georg, S. (2014). The socio-materiality of designing organizational change. *Journal of Organizational Change Management*, **27**(3), 391-406.
- Yaneva, A. (2005). Scaling Up and Down Extraction Trials in Architectural Design. *Social Studies of Science*, **35**(6), 867-894..