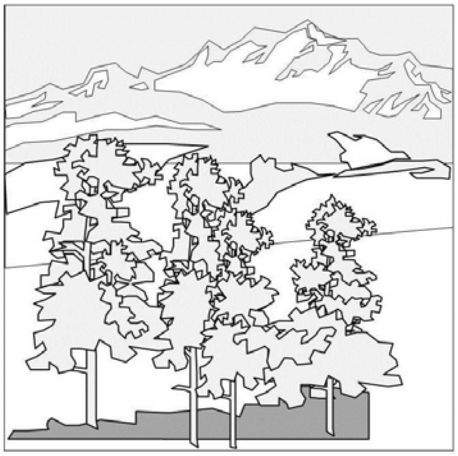

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Projecting An Information Infrastructure – Shaping A Community

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PROJECTING AN INFORMATION INFRASTRUCTURE – SHAPING A COMMUNITY

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ABSTRACT

The classification of building information is often seen as a key enabler for interoperability and a common information infrastructure in the sector. This paper studies how a community develops an infrastructure using standards and classification. It takes issue with inclusion/exclusion of actors and analyzes relations between the technical and the social. The paper draws on a longitudinal case study of three attempts to create a classification and standards for interoperability of building information within a particular socio-material community – the Architecture, Engineering and Construction (AEC) community in Denmark. This involved examining the interdependencies between human and material elements in the two failed attempts – embodied in a series of socio-material ruptures and conflicts – along with the third, ongoing attempt of designing a standard for building information classification, property data, information levels and metrics. Our analysis shows the crucial role played by the technical approaches to classification in mobilising support and excluding social players in the endeavour to develop this information infrastructure. The contribution of this paper lies in extending our understanding of information infrastructure as a socio-material community.

KEYWORDS: Community, Information Infrastructure, Classification, Construction, Denmark

INTRODUCTION

The design of a common information infrastructure for an industrial sector is a major endeavour. The paper is based on an ex ante study of a programme centre that received €10m worth of public funding. This programme centre sought to develop such an infrastructure encompassing classification of building lifecycle information, with the ultimate aim of integrating such classification within the IT-systems used across the sector. The programme centre is organised with a programme manager, a secretariat, a steering group and a number of projects (currently 18). In this paper, we trace the (ongoing) development of this programme centre to explain how building a community of practice around a common information infrastructure extends beyond human interactions to include what Orlikowski and Scott (2008) calls sociomaterial character (Orlikowski & Scott 2008). Put another way, to understand the intricacies of creating a common information infrastructure, one needs to consider the interdependencies of both human and material elements that go into creating an entangled sociomaterial community. In relation to this programme centre, two interrelated questions are specifically explored in this research, including:

- How does the community form and develop as an information infrastructure through the design of standards and classification?

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- What kind of inclusion/exclusion and relations between the technical and the social is in play?

In this paper, we study the longitudinal, political processes (see Pettigrew, 1985) of developing this programme centre. The particular industrial context studied is the Architectural, Engineering and Construction (AEC) community in Denmark. Players in this industry carried out three attempts to establish standards for interoperability through classification of building information (1999-2002, 2004-2007 and 2010-). A central player in the last two attempts has been the association called BIPS (Building Information technology, Productivity and collaboration (S stands for Samarbejde in Danish, i.e. collaboration). BIPS' members are AEC enterprises with an emphasis of large architectural and consulting engineering companies. Thee attempts occur in parallel to international and other national efforts such as Industry foundation classes (Laakso and Kiviniemi 2012) and Omniclass, Omniclass 2013).

The theoretical contribution consists of adding three concepts to that of "community": inclusion and exclusion, hierarchy, and the ubiquitous commercial aspect. This leads to thinking of communities as not necessarily pluralistic or flat but with a thoroughgoing commercial aspect of the alignments and relations. The empirical contribution lies with the *ex ante* longitudinal study of an information infrastructure design and its classification and standards, in contrast to the archeological approach to infrastructural inversion suggested by Bowker & Star (1999) and in prolongation of the studies of Ribes & Finholt (2009), Yoo et al (2005) and others.

FRAME OF UNDERSTANDING: SOCIO-MATERIAL INFORMATION INFRASTRUCTURE COMMUNITY

In the following, the frame of understanding is developed. It draws on information infrastructure, socio-materiality and community concepts and arrives at placing classification and interoperability into this conceptual context.

An infrastructure should be understood as something that is connected to activities and structures that emerges in practice (Star & Ruhleder 1996:112),. According to Star & Ruhleder (1996) an information infrastructure encompasses a series of characteristics: It is embedded, transparent, has a certain reach or scope, is learned in connection with membership, links with conventions of practice, embodies standards, is built on an installed base and, as mentioned in the introduction, becomes visible when a breakdown occurs. This very social analysis needs to be enriched with a more technically-oriented appreciation of that aspect of information infrastructure.

A series of other contributions (Hanseth et al. 1996, Hanseth & Lyytinen 2010, Gal et al. 2008, Monteiro et al. 2012) are based on Star & Ruhleder's seminal work. Monteiro et al. (2012) propose the following definition of information infrastructure (II):

> "IIs are characterised by openness to number and types of users (no fixed notion of 'user'), interconnections of numerous modules/systems (i.e. multiplicity of purposes, agendas, strategies), dynamically evolving portfolios of (an ecosystem of) systems and shaped by an installed base of existing systems and practices (thus restricting the scope of design, as traditionally conceived). IIs are also typically stretched across space and time: they are shaped and used across many different locales and endure over long periods (decades rather than years)" (Monteiro et al 2012:2).

Monteiro et al. (2012), in comparison to Star & Ruhleder (1996), clearly put more emphasis on the technical side in their conceptualization. Both these definitions are characterized by underlining the inseparable social and technical elements of infrastructure. In a similar vein, Orlikowski & Scott (2008) and Scott & Orlikowski (2012) propose a socio-material approach to information systems. The central strength of this approach is the understanding of the close intertwinedness of social and material elements of information systems. There is however a need to address the specific materiality characterized by information systems (and by information infrastructure). Rather than 'just' being material, information systems rest in a tension between being physically present while also being absent and elsewhere – being localized and delocalized at the same time. Information runs in a space of flows (Castells 1999) that is invisible and, in a sense, abstract. A too limited understanding of materiality risks leading to a too well bounded, 'tool-like' conceptualization of information systems. The socio-material approach is therefore here extended, in appreciation of a more heterogeneous materiality, into viewing IT as a socio-abstract/material construct.

An information infrastructure's central dynamics involves first of all, the range of active actors (not only users); secondly, the status of commodity driven by business dynamics; third, and less obviously, a tendency to downplay politics and conflicts in and around information infrastructures; and fourth, the fact that due to these dynamics, information infrastructures are on the move under more or less constant change. A similar problem occurred when trying to understand the Enterprise Resource Planning system phenomena when SAP and other players expanded it throughout the nineties (Pollock & Williams 2009). Koch (2007) suggests that an ERP-community could be understood as:

> "Heterogeneous assemblages of human and material elements. These assemblages can be understood as ERP communities of software companies, customers, professional associations, various kinds of hardware and software, procedures implementation, practices and rhetoric spanning time and space. The systems are not solely malleable clay; rather they are heterogeneous materiality composed with abstract discourse elements that possess certain hardness. Moreover, ERP is driven by commercial business interests; software, hardware, consultancy and training are commodities, and design of these systems occurs under strategies of mass customization, in which the encoding of the generic user is a necessary tool to reduce development costs and time to market" (Koch 2007:427).

This conceptualization is addressing the conflicting and discontinuous elements of an ERP community; it also underpins this further by underlining the differences in relation to "communities of practice", which are viewed as more harmonious and consensual as a concept than the ERP communities. In a similar vein, information systems communities such as the open source community, would bear fewer commercial traits than the ERP community would (Chua and Yeow 2010).

Bosch and Bosch-Sijtsema (2010), drawing on Messerschmidt et al. (2003), similarly view a community with an embedded infrastructure through the lens of software-producing companies. In this perspective on 'community', the software-developing company is central, first focusing on its internal processes but then also involving domain experts, users, external third-party companies (also in developing parts of the software) in the collaboration. A software ecosystem in this perspective is defined as consisting of "…a software platform, a set of internal and external developers and a community of domain experts in service to a community of users that compose relevant solution elements to satisfy their needs" (Bosch & Bosch-Sijtsema 2010: 68).

This assumes a community perspective, with the infrastructure embedded, and includes external developers, domain experts and users. Bosch & Bosch-Sijtsema (2010) argue that, seen from a business perspective this requires a community-centric way of collaborating and coordinating that involves interdependencies between components and their associated organizations. Yet an asymmetry of the community understanding is clear and should be appreciated. Communities of information infrastructure may be entirely equal for all parties, but it is likely that the pluralist, 'democratic' notion of a community glosses over such asymmetries rendering software developers as more equal than others, or in Ribes & Finholt (2009)'s wording that the constituency, taken to be the inner circle of developers, are having more influence than the surrounding community whose need might only be construed through surveys or other dissociated measures. Where Koch (2007) and Bosch & Bosch-Sijtsema (2010) both study communities with an installed base of system Ribes and Finholt (2009) provide ethnographic studies of the design of e-information infrastructures with a less present installed base of systems. They address tensions in such development processes, which can be seen as resonating with Koch (2007) emphasis on internal conflicts and politics in a community. Ribes and Finholt suggest that central dimensions of an infrastructure is institutionalisation, organising work and enactment of technology. They point at institutionalization as the formation of particular groups and organizations tied to the project, which they label a constituency and a more general body of the domain which they label community. The constituency in each of the four cases studied has a mandate to serve particular communities developing the information infrastructure. The process of designing the infrastructure is characterized by tension between planned and emergent, between core constituency and community in terms of "designing for use" and between todays and tomorrows users. Also it should be noted that Ribes and Finholt (2009) study research communities, which implies a set of dilemmas less relevant for a study of an industry community.

The community conceptualization can be extended even further by drawing on software ecosystems studies (Manikas and Hansen 2013). Manikas and Hansen (2013) find a whole range of possible roles for the core developer entity and community entity, a number of relationships as well as of the role of business, and relationships. Participation mechanisms offered to users and niche software developers, also differ characterizing the core as more or less open and the community as an onion where merits and presence would imply a journey towards the centre for the participant.

Classification

Having established the broad sociomaterial community conept, the next step for theoretical conceptualization is placing classification, standards and interoperability within this . As Star & Ruhleder (1996) note, information infrastructure involves embodiment of standards, and from the Monteiro et al. (2012) definition, it follows that information infrastructure involves a multiplicity of systems that are supposed to exchange information in a seamless manner. Douglas (1986) even sees classifications as being central for establishing and sustaining a community. Yet this proves to require a series of additional technologies and standards in order to handle the transfer of data and information, including standards for organizing information, and classification and standards for interfacing data.

Classification involves ordered data, information and the concept of a specific domain (Bowker & Star 1999, Hanseth et al. 2006, Hanseth & Lyytinen 2010). For decades, a series of concept for such ordering have been articulated – from Aristotelian or prototypic (Bowker & Star 1999), hierarchical tree-ordered concepts using 'part of' or 'type of' to less hierarchical using facets. Kobberø (2003), for example, describes how classes in facetted classification systems are not ordered in tables but are generated in the actual classification process by combining tables that cover aspects or facets of the topic. Controversies occur over the scope and depth of standardization, including the debate on risk of over-detailing in an attempt to gain accuracy (labeled "finitist", Hatherly et al. 2007). However, as Bowker & Star (1999) demonstrate, practical classifications are often hybrid or mixtures of these abstracted categories of classification.

Design of classification would involve the attempt to standardize (Yoo et al 2005, Zimmerman 2008). The formalized, institutionalized CEN/ISO version is in continual competition with the business- and market-driven type of standards. In other standardization communities, both centralized, disperse and network-like, locales for design occur as Maniken & Hansen (2013) maps them. Monteiro et al. (2012) take issue with the localist design approach, asking for an extended understanding of what creating an information structure may imply, and this point is also well placed here. Yoo et al (2005) study the formation of standards as mediation between actors including local and national players. While there may be many good reasons for a local focus (Leonardi & Barley 2010), it is the combined and extended view that is of interest here. Moreover, information infrastructure is not designed here and now, but over a long period of time while modifying existing infrastructures (Ribes and Finholt 2009).

Summarizing, the framework proposes to understand design of information structure as a sociomaterial community developed through a political process involving inclusion/ exclusion, the formation of a core organization and intertwined sociotechnical issues of types of classification, hierarchy of data and degree of openness. The delimitation of the design is viewed as emergent and analyzing and understanding the design of an information infrastructure requires a longitudinal research set up.

METHOD

The particular industry studied is the Architectural, Engineering and Construction (AEC) community in Denmark. The industry did three attempts to establish standards for interoperability. While the long term story enables insights in recurrent actors in a constellation we interpret as an elite, the paper focuses on the third attempt showing how the sociomaterial entanglement of classification and an industry association develops, stabilizing itself through in- and exclusion, public funding and performing hierarchy mechanisms.

The paper takes issue with concepts of community, and adopts a flat sociomaterial approach to the role of classifications and other material elements. The overall approach is a critical interpretivist. The central methodological approach follows Bowker & Stars methodological themes for studying information infrastructure, uncovering the practical politics of classification and standardization as they are designed (Bowker & Star 1999).

The empirical material used here is mainly focusing on third attempt of building an information infrastructure 2010-2015(?) involving the first author acting as process evaluator for the program center. Data collection encompasses interviews (35) of program managers, project managers and externals, participant observation at events (16), document analysis (128 documents. It covers the classification projects, project developing standards for property data, project on information levels, project on metrics as well as project with more strategic and infrastructural focus. The material is interpreted in regular half year evaluation notes and these form the basis for the present analysis, doing a sequential second analysis of the material (Lewis and Grimes 1999). Also juxtaposition of interviews, documents and other material is systematically carried out to assure trustworthiness (Alvesson & Sköldberg 2000).

The limitations of this present study involve the known risk of deep engagement with an empirical field (Alvesson & Sköldberg 2000). The second and third attempt to realize a classification has been followed closely from a legitimate process evaluation position, but also through board memberships one of the first author of the industry association, BIPS, 2008-2013 and Cuneco 2011-2012. It involves a risk of going native, i.e. not being able to maintain a critical distance. At a time however it enables the insights of the dynamics of the process, so it is viewed as a condition of possibility.

It should also be noted that the material involves an asymmetric coverage of the three attempts. The study only has ex post coverage of the first attempt (1999-2003), whereas the second and third attempt has been followed ex ante and closely. Finally the third attempt is ongoing, yet developed to a degree where a series of insights in information infrastructure development can be condensed.

THE EMERGING CLASSIFICATION –CASE

From 1998 to 2007 two attempts to create a classification failed. We focus here on the third and ongoing attempt which is described in greater detail to support the subsequent analysis.

In 2010 a center for development of a Danish classification of building information was established. Prior to the establishment of a development center, industrial players made some important moves that paved the way for a third attempt. An organized alliance of the largest engineering and contracting companies, called Digital Convergence (DiCon), that included the largest Danish companies operating multinationally, carried out an investigation of classification and published a report advocating a Danish classification in construction. This gave extensive and somewhat external help and support to the core classification advocates. The government authority also generated a funding possibility by positioning an EU program in support of classification in the building industry.

BIPS took charge of formulating an application, and a positioning process commenced in which some community players, with their understanding of classification, were included, while others were excluded. The Danish CEN/ISO organization became involved and so did the building clients association. However, the constellation did not allow in Technological Institute or Ålborg University, two important institutional players in the AEC sector. Ålborg University was profiled with an alternative technology, a facet classification, and also with outspoken criticism of the very idea of making a classification that the DBK had attempted (the previous attempt). BIPS managed to collect a winning coalition and received the funding. In this process, the basic ideas of DBK (the second attempt) were incorporated to begin with, but shortly after obtaining funding, these were extended into a vision of developing a compositional classification (see below). The center took the name of Cuneco, inspired by the Esperanto word for community (“kuneco”, Cuneco 2013). The organization of Cuneco involves a centre manager, a secretariat, a steering group, a partnership and a project organization. Projects cover the four main areas given below and projects for testing the developed elements of infrastructure.

The Cuneco classification system is envisaged to consist of a series of elements (Cuneco 2013):

- Classification
- Property data
- Information levels
- Rules for measuring

The classification is to provide a systematic ordering of information about a building using a basic process model linking resources, processes and results (Ekholm & Häggström 2011). The single building is broken down into elements. The data related to the properties of these elements is to be given a decoupled structure, where information levels refer to the gradual levels of detailing in the process of designing, building and operating a building. The rules for measuring the elements (metrics) are to be standardized as well, so that elements are assigned well defined volumes, lengths, weights etc. All these elements are to be stored as basic digital data on a server that is available for users. Cuneco's vision also encompasses forming a business model for the long-term maintenance and further development of the classification and especially the accumulation of property data for building elements.

Ekholm's (2010) vision for compositional classification, which was introduced when the center started, uses categories that resemble Danish Building Classification (DBK), the result of the previous attempt to make a classification. Ekholms vision also encompassed a hierarchy from buildings, to building parts and then building part types. A reference system is added to this classification system.

Compositional classification views the building with its compositional parts viewed as part of the construction, categorized according to main function (Ekholm 2010:54). Ekholm (2010) gives the example of a class B house, BC wall system and BCD wall construction. Functionality equal to work results related to parts of the building should be inserted in the classification system.

When funding was obtained in 2010, the center initiated and gradually finalized a series of development projects covering the vision for the entire program. Elements of the classification are thus materializing. When initializing the project, much of the basic thinking and results obtained from the previous development program were adopted again. This provoked criticism from some players, as they meant that these concepts had proved unusable in practice (including ISO 12006-3, IFC, and DBK 2006); however, leading players from Cuneco insisted that this basis was fundamentally solid even though it needed updating and further development.

One design issue is the relation between classification and property data. Ekholm (2010), who proposes a reference system for property data, argues for a need for a theory for structuring property data (see also Ekholm & Häggström 2011). The 2012 proposal for property data was a rather independent development of property data with a systematic structure and relation to classification, but it was not a theoretical foundation. As such the developed classification is more of a part of classification with a continued unclear theoretical basis.

In spring 2012, a proposal for the Cuneco classification system (CCS) was launched – first, a system for classification on a relatively aggregate level, and later a set of tables for six structural aspects: type, product, composed product, place, function and supplementary aspects. It is proposed to separate classification and property data, keeping classification as one property among others for objects. This is also seen as a preparation for future use of IFC or even other international classifications.

By summer 2012, the first major test project commenced concerning a large hospital project, which hardly constitutes a typical AEC community case. The first prototypes and testing activities developed during the autumn. In this context, the building client became allied with six software suppliers. Together, their six systems cover a part of the information flow from early conceptual design of a building (one system), over detailed design (two CAD-systems and a BIM system), cost and budget calculation (one system), and space management (one system). According to the project manager, the systems are able to identify building components, classify them and sort them. This also involves data flows supported by the chain of the six systems (project manager interview).

The Cuneco center communicates with the broader AEC community in a number of ways; however, the AEC community comprises mostly passive spectators, or it may even be occupied with other agendas of contemporary construction, such as sustainability and the use of Building Information Models (BIM), which were developed parallel to the center by large commercial players such as Autodesk and Bentley.

After half a year of operation, the center and BIPS managed to obtain a mandate for an ISO task force 12006/2 standard for classification in construction, which mentions compositional classification as an option.

By January 2013, the information level structure proposal has been launched and sent to a hearing. The proposal operates with six levels of information, but the sixth level should only be used for machine codes for robotics or the like.

Some ruptures also occurred, however, in the 2011-2012 process. In the application process, BIPS and their allies either did not want or did not manage to integrate an alliance centered around Ålborg University and a facet classification (Bertelsen et al. 2010). Later, the large and important industry association, Dansk Industri, left the center, because the classification would not be user-friendly enough and the IT companies were not sufficiently involved. Moreover, the ministry responsible for social housing issued a proposed bill for building social housing that did not give preference to the Cuneco classification but left it open for social housing players to choose freely among four different classification systems, which can be seen as braking diffusion of the Cuneco standard.

DISCUSSION

The long term case presented above is an example of three attempts to design a socio-material information infrastructure community. This section discusses the results of the present ongoing process (covering the third attempt), , we first ask who was member of the emerging AEC community both through participation in the core development organisation and beyond it. And focusing in on inclusion/exclusion as part of the formation process Then the sociomaterial relationships is discussed. Also regarding the longer-term insights generated by the case. Third, some reflections are presented on the result of using the theoretical framework.

The formation and delimitation of the community

The AEC Information Infrastructure Community (AECIIC) followed here encompasses the following types of actors and material components : architects, consulting engineers, clients, real estate owners, real estate administrators, IT companies, professional associations, various kinds of hardware and software such as systems for conceptual design, computer-aided design, building information modeling, cost and budget calculation, scheduling etc., procedure implementation, practices and rhetoric spanning time and space. The AECIIC is driven by commercial business interests; software, hardware, consultancy and training are commodities, and design of these systems occurs in accordance with strategies of mass customization, where the encoding of the generic user is a necessary tool to reduce development costs and time to market.

The project organisation of the center involves a number of individials and representatives from enterprises and other organisations. Small specialized consultants, Large consultants, engineering companies, architect firms, public real estate administrators and university representatives. This core is located within a broader and less involved set of association and other institutional players represented at strategic level in the project organisation.

Ongoing negotiation challenges the delimitation of the community.. The project organization are embedded in BIPS which at a time have character as a business association with enterprise members and features of a commercial organization with a permanent basis organization and a portfolio of standardization projects, where BIPS offers payment for participating project members. Where BIPS earlier during the second attempt was one among several operators of a public development program, the third attempt features BIPS as the core organization. BIPS are allied with a series of community players such as other community associations, universities and representatives for private companies in the sector. The establishment of the center involved first a central placement of BIPS, which manages the center and is centrally placed to become the long-term classification institution. Moreover, the center-process, at a time, involves inclusion of new players; the Danish CEN/ISO and the clients association whose involvement is both counter to the second attempt, and also the exclusion of others; Technological Institute, Ålborg University and material suppliers and their information infrastructure. Ålborg University was profiled with an alternative technology, a facet classification, and also with outspoken criticism of the approach of making a classification such as DBK (the previous attempt). Ålborg University has good contact with the funding authority and could have threatened the very establishment of the center. Subsequent to the center's start, however, Ålborg University was enrolled in several activities in or related to the centre.

IT suppliers, mostly small, are involved in testing but less in the basic development of the center , and the larger IT suppliers follow the development at a distance. Yet their contribution to the market-driven classification, standardization and thereby information infrastructure are very important for the design attempt. Contractors and the production domain are dealt with as being secondary. Relations with an international community, AEC and the 'classification-active' are continually stated to be important, which occasionally also influences practice, even though evaluations of international tools and standards are ambiguous. There is thus a tendency toward a 'not invented here' attitude towards the international. Finally the vast majority of the AEC community is not yet involved in the information infrastructure development, and they are construed or construe themselves mostly as passive spectators. However the centre has a clear agenda of designing for use (Ribes & Finholt 2009), carrying out an early "user need" analysis, hearings and workshop on preliminary proposals, and professionalized communication. This is clearly a managerial approach to interaction, but it does stage contributions and participating from others and from outsiders (re Makines & Hansen 2012).

Moreover another "activation of externals" occurred in late 2011 where the ministry responsible for social housing announced the non-obligatory use of another (local Danish) classification in social housing projects. This revealed the distance from this sub-community to the development center. A major industry association also withdrew from the center partnership.

So, in terms of inclusion/exclusion two major ruptures occurred; first regarding the structural principle of the classification ('part of', facet, compositional) excluding Ålborg University, and second regarding network business relations and institutionalization, leading to a withdrawal of Dansk Industri. It is important that the IT suppliers for the sector are participating, at least partially, even though the broader IT market mechanisms driving classification and standardization are not aligned. Some players participate actively and vividly in a design arena of classification, whereas others are spectators and still others are excluded to some extent.

The sociomateriality in play

The sociomaterial issues cannot be seen as separate from the above formation and delimitation process. However technical design targets, apart from the delimitation of the covered community, involve choice of hierarchy, degree of detailing, domain and process conceptualization. The design strives for little detail in the standards in a minimal structure approach, opening for local negotiation and accommodation – features that echo Bowker & Star's (1999) discussion of the inter-relationships between generic standards, elements and contextual practice. Small groups of experts debate these principles (hierarchy of the data structure etc.), recasting most of the community into spectators. From an outside perspective, differences between the expert positions are difficult to pinpoint, but hierarchical versus compositional classification is one example.

While the center considers many of the design targets to be technical, some design elements clearly address the social. The four main areas of development are all technical goals: classification, property data, information levels and rules for measuring, and their storage on a server as "basic digital data". They are accompanied however by a set of management and communication goals, and goals for the long-term institutionalization of the classification (formulated as "making a business model").

The more important design issue, however, is to establish an aligned social and technical community of institutional players in line with the socio-material understanding.

Meanwhile, a small core group is developing a classification that encompasses several legitimate functional aspects. The classification design progresses and is reaching the level of a prototype of an infrastructure – i.e. a software package constellation using the classification, property data, information levels and metrics is being tested in January 2013. The classification design has become legitimized internationally through a review of an ISO standard. The classification inevitably looks backwards, yet involves a dynamic element for the future embedded in the proposed business model (re Ribes and Finholt 2009), and the separation of a frame classification and property data seems to address too-long strings in the classification code.

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Over a longer period of time, the process reveals that some community players try three times to establish standards for classification of building information. These community efforts occur in continual competition with market drivers of building information modeling (BIM), which is gaining terrain through private companies installing IT. This is leading to an emerging installed system base and an information infrastructure, but only in (enterprise) islands and gradually over a long period of time.

The three approaches to making standards that have been introduced over time clearly differ. Where the first can be said to barely involve any IT support opportunity, the next two – 'part of' and type of/compositional – are different, even of not in any major way. Central actors in the core group alignment have thus continued moving around these two types during the second and third attempts.

The association BIPS has emerged through an institutionalization process (re Ribes and Finholt 2009). BIPS has become the central carrier of the infrastructuration,. Earlier, during the first attempt, BIPS played no role, since the association did not exist. The establishment of BIPS in 2003 occurred as a deliberate strategy by some players to enable private sector and enterprise representatives to act almost as a "quango", a quasi non-governmental organization (Ferlie et al. 1996). During the public development program that framed the second attempt, BIPS was responsible for several roles such as facilitating debate and dialogue regarding the development and running the classification project that led to DBK. But in the present third attempt, BIPS has become the central player managing the development center and positioned to take over the results and run them as part of their business. The socio-material alignment means that the information infrastructure community has changed and is beginning to accept BIPS as a central player, even if early user accept still is limited (Hanseth & Lyytinen 2010).

The community formation involves inclusive and exclusive mechanisms and more or less conflictual social order(s) as well as tendencies toward creating hierarchies. The core group of classification designers exhibits quite some stability over the three attempts. At least four central figures out of roughly ten have participated in core positions in all three attempts. Since about fifteen persons occur again and again in the core of the three attempts, it may well be asked whether a classification elite is in place. Ribes and Finholt (2009) find a similar hierarchy of a core group of developers of an e-infrastructure, which they label a constituency. Here however the core group is relatively tightly organized in a funded centre organization and thereby only share some characteristics with a constituency (see also Molina 1995). Mills (1956) describes elite as a small group making decisions that have national impact. Putnam (1977)'s technical elite are constituted by training and an apolitical ethos similar to the present core group, which however apart from trained engineers also encompasses architects. Both Mills (1956) and Putnam (1977) are characterizing a relatively broad societal phenomenon through the notion, whereas the present group is small and even if dependent of state support and funding decoupled from the state. Mills (1956) also talks about organized irresponsibility, which can contribute to explaining why the same group of people three times in a row over a period of 11 years can apply for and receive public funding for the (same) classification vision. Similarly, Alvesson & Robertsson (2006) characterize elite tendencies among consultancy companies, from which most of the present core group also comes. So it seems that the belief in this core group and its supporters is that if these recurrent actors just try harder this time, a different result will occur.

It should also be noted that the internal classification elite has to a varying extent been matched over the three attempts by an oppositional elite, an equally small group, which is continually critical, whereas the vast majority of the community acts as spectators and only sporadically becomes involved.

The third attempt clearly encompasses a systematic managerial element of involvement. Compared to the DBK (second) attempt that was characterized by a heavy emphasis on the technical aspects of the classification, the third attempt is less elitist. At present, the core group is gaining legitimacy and thereby contributing to building the AECIIC, which involves the central position and institutionalization of BIPS.

The theoretical idea of the approach to the processual formation of an information infrastructure as a formation of a socio-material community has triggered an emphasis on combined social and technical phenomena. The frame is broad and invites rich empirical accounts. To some extent, the framework may be too loose, challenging the empirical material too little. The analysis of the various texts also tends to fall apart into social and material sub-analyses, and has to be kept together through the process of analysis. In an attempt to improve this, three additional concepts are introduced – inclusion and exclusion, hierarchy, and the ubiquitous commercial aspect. This leads to thinking of communities as not necessarily pluralistic or flat and with a thoroughgoing commercial aspect of the alignments and relations. Moreover, the social and technical parts of the analysis are held as closely together as possible.

CONCLUSION

The aim of this paper is to develop a conceptual framework for understanding information infrastructure as a community and analyzing an ongoing longitudinal case study of a particular socio-material community. This is helpful in further studies of development of information infrastructures in other context.

The theoretical framework proposes to extend the socio-material approach into a socio-material community approach, contextualized in architecture, engineering and construction in Denmark. This community mandates a core group to carry out three attempts to establish standards for interoperability, in the form of classification of a building information model. The first two attempts fail while exhibiting a series of socio-material ruptures and conflicts. The third is an ongoing design process that clearly exhibits the practical politics of delimiting the classification, inclusion and exclusion of actors, and the degree of fixed and flexible elements of the classification. At present the proposed classification tables, the standard for information levels and property data all appear relatively open and flexible towards bottom up contributions.

The technical approaches to classification organize social players and also involve positioning an industry association, BIPS, in a central role. This institutionalization process leads at the same time to a stabilization of small core group with traits similar to elite. And their projection of classification gives them hard work.

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