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Editorial

The current issue of Science and Technology Studies centers around research on innovative projects, networks and publics. These open call papers deal with the potentials and pressures within open collaborative arrangements and tensions therein.

The first article by Anders Blok "Urban Green Assemblages" (responsible editor Brit Ross Winthereik) uses Copenhagen's new eco-friendly regeneration district Nordhavn to illustrate what actor network theory offers for urban studies. In effect, it shifts attention from any grand urbanizing narrative to the study of plural sites at which urban sustainability is known, practiced, scaled, negotiated and contested as heterogeneous and interlinked assemblages.

The second article by Hyysalo, Juntunen and Freeman "Internet Forums and the Rise of the Inventive Energy User" (responsible editor Hannu Hänninen), examines how new forms of Internet-mediated communication have an effect on what citizen users are willing and able to do with their energy technologies. They focus on forums dedicated to heat pumps and show how the depth and breadth of inventions which users perform owes to the kinds of knowledge, skills and orientations which the Internet peer networks foster.

The third article by Torun Granstrøm Ekeland and Britt Kramvig "Negotiating Terrains: Stories from the Making of "Siida"" (responsible editor Brit Ross Winthereik) continues exploring the dynamics of

digital environments by examining the development process of Siida, an arena that sought to challenge the static and monolithic representation of Indigenous Saami culture and history. They report how the site grew as a material boundary metaphor that navigated the high complexities in both technicalities media production and in multivoiced representation of Saami knowledges.

The final research article by Kai Eriksson "Innovation and the Vocabulary of Governance" (responsible editor Antti Pelkonen) examines the themes of openness and closedness of innovation in a more conceptual plane by examining the ontology of innovation networks and network governance in the context of "national innovation system" and its political adoption in Finland. Eriksson concludes that the in principle open metaphor of network became closed in policy practice. This was due to the engineering and technical elites reaching operative aims. Innovation system did add a layer of novelty to Finnish science, technology and innovation policy, but just as importantly maintained the circles for traditional core actors.

The final article shifts focus from the north to the south of Europe by examining the science in media reporting in Croatia. The country report by Adrijana Šuljok and Marija Brajdić Vuković "How the Croatian Daily Press Presents Science News" (responsible editor Aaro Tupasela) examines how particularly the reporting of

biomedical news is still slowly developing in transition countries.

In many respects this open call issue is a preamble to coming numbers of Science & Technology Studies. There are currently three special issues under way related to themes addressed by the current articles. First of these, "Patient 2.0", examines the challenges that new biomedical technologies pose to different stakeholder groups. After this, there are two special issues "Energy in Society" and "The Politics of Innovation for Environmental Sustainability: Celebrating the Contribution of Stewart Russell (1955–2011)" which both deal with environmental technologies and innovation for sustainability. In between, naturally, there shall be open call papers and other themes, but in many respects the current issue paves the way to a more concentrated effort to deepen and extend its key themes.

Sampsa Hyysalo
Co-ordinating editor

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Urban Green Assemblages:
An ANT View on Sustainable City Building Projects

Anders Blok

In this article, I sketch an STS-theoretical approach to world-wide growing concerns with urban climate risks and sustainable urbanism more generally in terms of what I call 'urban green assemblages'. This approach draws inspiration from recent attempts to bring actor-network theory (ANT) closer to urban studies, infusing urban political economies with STS sensibility towards the contingencies of eco-socio-technical design and transformation processes. ANT, I argue, offers a new ontology for the city, allowing the study of those concrete and plural sites at which urban sustainability is known, practiced, scaled, negotiated and contested, in heterogeneous and dynamic assemblages of humans and non-humans. I explore the analytical potentials of this ANT urban ontology through a case study of how architects, engineers, and urban planners currently perform *Nordhavn*, one of Europe's large-scale sustainable city building projects, as a site of multiple matters of public-political concern with urban natures.

Keywords: Actor-network theory; Assemblage urbanism; Sustainable city-building

Introduction: Bringing ANT into Urban Ecology

Urban ecology may have once been the province of community activists occupying industrial waste-lands – but as public concerns with environmental and climatic risks have grown, ideas and practices related to the greening of cities have now entered the realm of urban truths circulating among policy-makers and planners world-wide (Jamison, 2008). On the one hand, figures pointing to cities as responsible for more than 70% of global carbon emissions are now commonplace; on the other, cities on all continents actively re-position themselves as 'living laboratories' for innovating and testing the green technologies needed to move towards a low- or zero-carbon transition (Evans & Karvonen, 2010; Bulkeley, 2012; Blok, 2012a)[1]. Everything from low-energy houses to bicycle infrastructures, from green roofs to solar heating panels, the professional worlds of architecture, engineering, and urban planning are now called upon to re-design long-standing urban metabolisms. Urban ecology, in short, is fast becoming an important domain for observing the large-scale reassembling of nature, technology and society.

In this article, I argue that Science and Technology Studies (STS) in general, and actor-network theory (ANT) in particular, help bring new insights to bear on urban ecology, conceived broadly as relational processes of city-based eco-socio-technical change. At the same time, I deploy urban ecology as an invitation to push STS and ANT thinking in new directions, related to questions of how sustainable urbanism works as a particular mode of knowledge-making and a specific format of contentious (cosmo)political experimentation?

Developing these themes entails positioning ANT at the intersection of multiple on-going conversations on the (un)sustainability of cities, sprawling the hinterlands of STS, urban studies, human geography, and political ecology. Although STS concepts clearly figure in these conversations (e.g. Hinchliffe et al., 2005; Heynen et al., 2006), there is still much work to be done, I suggest, in trying to spell out the exact implications of ANT to urban ecological politics, and, conversely, in specifying the challenge of urban ecology to ANT (and STS) theorizing. This, then, is the task I pursue in this article, in terms of developing the concept of 'urban green assemblages' as an important ANT-derived contribution to cross-cutting debates on sustainable urbanism and urban political ecology.

While thus motivated primarily by theoretical concerns, I want here to pursue this double challenge – of ANT in urban ecology – by an on-going case study, which looks at the dynamics of knowledge-making and political contestation in one of Europe's large-scale sustainable city building projects. In Copenhagen, capital of Denmark and home to 1.5 million people, ambitious plans are underway to rebuild the old industrial harbor area known as *Nordhavn* ('North harbor') into what the urban designers confidently refer to as 'the sustainable city

of the future'. By 2050, this 300 hectare area by the water, to the north-east of city center, aspires to house 40.000 new inhabitants in a 'green', carbon neutral, bicycle-friendly, and renewable energy-based urban district. So far, all of this exists mostly in architectural models, engineering projections, planning documents and local politics. In empirical terms, my aim is to explore how urban natures are mobilized in-between these divergent modes of city engagement. How and by whom are knowledges on (global) ecological risks translated into situated city-making practices, and what kinds of inscription devices and coordination practices does this work entail?[2]

My exploration of these questions proceeds by way of bringing together, conceptually and empirically, two promising strands of ANT encounters with cities-in-the-making. First, I pick up the thread from how ANT has recently been brought to bear on the field of urban studies, in what has become known as 'assemblage urbanism' (Farías, 2010; McFarlane, 2011). Pushing this turn further, I develop the notion of urban green assemblages as a means of bringing ANT sensibilities to the study of how urban green knowledge is produced, translated and contested across specific urban sites, scales and relations. Second, I bring this new ontology of urban ecology together with STS studies that deploy ANT to elucidate specific building and architectural design projects as complex ecologies of professional, juridical, economic and cultural relations (Yaneva, 2009; Houdart, 2008). Using primary textual material from the *Nordhavn* case to illustrate both encounters, my discussion aims also to contribute to a nascent STS interest in practices of sustainable architecture and design (e.g. Moore & Karvonen, 2008). Via the notion of urban green assemblages, however, I want to suggest that ANT entails particular analytical (and ethical) commitments to this agenda, pushing

STS to study the implication of design in (cosmo)political controversies over multiple attachments to urban 'greening' (cf. Yaneva, 2012).

In what follows, I start by developing the conceptual contours of urban green assemblages. Informed by ANT sensibilities, assemblage urbanism, I argue, brings a new ontology of the city to urban ecology, one that emphasize the need for situated empirical inquiries into those practices of knowledge-making, scaling, and material intervention whereby urban actors reassemble city-based natures. Next, I bring this notion of urban green assemblages into dialogue with STS work on architectural practice, in order to suggest that sustainable architecture works as a specific modality of inscribing ecological concerns into urban political life.

This leads into a more empirical exploration of how architects (and engineers) inscribe urban natures into plans for the future of *Nordhavn* – and how these inscriptions are in turn contested in specific urban publics. In terms of method, my analysis relies primarily on access to primary textual architectural and engineering design consultancy material supplemented by media analysis, interviews with key actors, and participant observation at public hearings. In particular, my analysis seeks to show how architectural inscriptions of urban natures in *Nordhavn* come in multiple overlapping forms, each with different dynamics of knowledge and politics. Importantly, this suggests that, rather than facing a singular challenge of rendering places more 'environmentally sustainable'[3], architects are key actors in juxtaposing and coordinating a multiplicity of co-existing attachments to, and practices of, urban ecology (cf. Mol, 2002).

These explorations lead me to suggest, in conclusion, that ANT entails a particular notion of urban political

ecology, one committed to place-based collective experimentation and learning around (global) ecological risks – and one that orients urban design towards the overarching question of cosmopolitics, the politics of the common cosmos (McFarlane, 2011; Latour, 2007). In a world of multiplying ecological risks, I suggest, this may prove an important STS contribution to debating, and rethinking, city-making as currently practiced.

Urban Green Assemblages: A New Ontology of City Metabolisms?

Compared to its substantial engagements with scientific laboratories and technological development complexes, it is fair to say that the field of STS has yet to pay extensive attention to urban sites and processes (Hommels, 2005; Coutard & Guy, 2007). This is surprising, given that – as Aibar and Bijker (1997) note in their study on the planning of Barcelona – cities may be treated as 'enormous socio-technical artifacts', heterogeneously engineered by a range of competing actors and institutions. In the case of Barcelona, Aibar and Bijker show how contrasting visions of city extension among engineers, architects, and local communities resulted from different yet overlapping socio-technical frames, encompassing such issues as hygiene, mobility, social distinction, and land ownership. In this contentious process, closure around a final urban design was achieved through situational micro-struggles and compromises over the width of streets, the depths of buildings, and public access to facilities and parks. While so far rather marginal, STS would indeed seem well placed to study such politics of urban design (Moore & Karvonen, 2008).

To understand this situation of relative non-engagement, however, we should note some intellectual particularities

of that academic domain which claims the city as its 'truth-spot' (Gieryn, 2006), that is, urban studies. As Coutard and Guy (2007) suggest, much contemporary urban studies is marked by a universalized imaginary of urban decline, splintering and discrimination – an orientation at odds with a widespread STS sensibility toward the contingency and ambivalence of *any* socio-technical transformation process. Such divergence, no doubt, may be further traced to the continuing influence within urban studies by various branches of critical theory, including post-Marxist urban political economies of the 1970s (McFarlane, 2011). However internally diverse, urban political economy approaches (e.g. Harvey, Castells, Lefebvre, Sassen) tend to understand cities primarily as local nodes in wider global processes of capital circulation and accumulation. This orientation, in turn, downplays the need for such situated and open-ended ethnographic explorations as favored by STS scholars (Farías, 2011)[4].

Recently, however, the terms of engagement between STS and urban studies appear to be changing, as various critical urbanisms are increasingly being challenged by theorists of 'assemblage urbanism' (McFarlane, 2011). Importantly, assemblage urbanism traces its genealogy in large part to actor-network theory (ANT), including the STS and Deleuzian intersections of this theory, as an attempt to 'test' the contribution of ANT for rethinking the city in urban studies (Farías, 2010). In this vein, assemblage theorists seek to delineate how ANT offers up "an alternative ontology of the city" as a de-centered object (Farías, 2010: 13). According to Farías (2010: 2), then, cities are "relentlessly being assembled at concrete sites of urban practice", as a "multiplicity of processes of becoming, affixing socio-technical networks, hybrid collectives and alternative topologies". Here, assemblage urbanism

resonates strongly with Bruno Latour's own ANT take on the composition of city life through situated techniques and flows (Latour & Hermant, 2006).

Assemblage urbanism has a number of important consequences for rethinking the city – all of which, I want to suggest, will prove beneficial to our understanding of urban ecology, in terms of what I dub urban green assemblages. First, and most literally, assemblage urbanism conceives of cities as ensembles of heterogeneous actors, giving analytical priority to the active dynamics of arranging or fitting together socio-material elements. Cities may be assembled in multiple ways, depending on how heterogeneous connections are forged among objects, places, materials, machines, bodies, symbols, natures, policies and so on (Farías, 2010: 14). This is also the sense in which, like ANT in general (Murdoch, 2001), assemblage urbanism may be said to promote an inherently *ecological* view of the city, one that stresses the agency of urban materiality, natures and non-humans. In the language of Isabelle Stengers (2005), assemblage urbanism invites a view of cities as overlapping ecologies of human and non-human practices.

It is important to note, however, that most urban ecologies – as shaped by obdurate socio-material infrastructures of electricity, water, housing, transportation and waste – tend to remain unnoticed backdrops to city life (Star, 1999; Hommels, 2005). Only under specific conditions, similar to what Geoffrey Bowker (1995) calls 'infrastructural inversions', are urban socio-material relations articulated as matters of (un)sustainability concern[5]. In the *Nordhavn* case, for instance, such articulations were explicitly built into the architectural competition brief, constraining designers to frame their place-making visions in accordance with wider environmental goals of the Copenhagen

municipal government. As such, *Nordhavn* emerges as an urban green assemblage, in the sense that heterogeneous actors here come to orient themselves towards *redesigning* urban eco-socio-technical relations in 'green' directions. I explore what this means in more detail later on. So far, the main analytical point is that, while urban green assemblages may operate at different scales, from the domestic (Marres, 2008) to the global (Sassen, 2010), they will tend to bring together particular constellations of technologies, sites and actors, from engineers and architects to developers, regulators, civic associations and urban residents.

This relates also to a second analytical effect of assemblage urbanism in terms of how it deals with issues of space, place, and scale. The main point here is simple, but it carries wide-ranging consequences: rather than granting explanatory autonomy to spatial categories like *the* city, assemblage urbanism conceives the city as a plurality of *sites*, the connections among which are changing and contingent. In this sense, there simply is no city as a whole, but rather a multiplicity of sites and processes assembling the city in different, sometimes contradictory, ways (Farías, 2011: 369). Importantly, urban sites are defined not by geographical boundaries or scales, but by types and lines of activity, whereby spatialities emerge through the actor-networks that connect places (Latour, 2005; Farías, 2010: 6). An urban green assemblage like *Nordhavn*, for instance, gradually emerge as connections are forged – through such devices as the architectural competition brief – among otherwise non-related places, from the post-industrial landscape of an old harbor area in Copenhagen, via local government bureaucracies to architectural and engineering offices. At all of these sites, moreover, connections will be fanning out to other scientific, political, economic and

cultural nodes, locally and trans-nationally (cf. Yaneva, 2012).

This notion of spatiality as assembled sites also entail a particular approach to scale-making, in that 'local' and 'global' are not fixed geographical coordinates, but rather denotes the variable end-products of collective scale-making practices (Latour, 2005). In terms of urban green assemblages, this is a crucial point, given that contemporary urban ecology derive much of its rationale and dynamics from urban sites being selectively brought into contact with (supposedly) 'global' environmental risks, thereby setting in motion various re-scaling trajectories (e.g. Sassen, 2010). Indeed, the entire *Nordhavn* project might reasonably be described in such terms, in that the project re-scales climate change as being in significant parts an *urban* (rather than, say, national) challenge – while, at the same time, re-scaling *Nordhavn* as an 'eco-city' of potentially *global* significance (Blok, 2012a). Still, assemblage urbanism invites us to also be more specific, in terms of analyzing how socio-geographical scales come into being, in concrete cultural, political and architectural practices, as actors stabilize their connections of proximity and distance (Slater & Ariztía, 2010). Hence, one key question for the study of urban green assemblages is how, by whom, and via what kinds of inscription devices, knowledges on 'global' ecological risks are translated and asserted within 'local' city-making practices, such as *Nordhavn*?

Third and finally, assemblage urbanism also carries far-reaching implications for how to deal with issues of urban asymmetries and power; and hence for rethinking the political dimensions of urban ecology. This is a difficult point, because ANT is often misunderstood as promoting a vision of flat ('power-free') social territories. It is certainly true that, unlike (some) critical urbanisms, assemblage urbanism refuses to

imagine overarching and all-encompassing power structures – such as 'global neoliberal capitalism' – which would over-determine city life and politics, including the politics of sustainability. However, as always in ANT, this analytical refusal is made precisely in order to study those concrete and situated practices of socio-material ordering, whereby agency capacities, resources and power end up being unequally distributed within specific urban relations (Farías, 2011: 370). Inside an urban green assemblage like *Nordhavn*, for instance, particular actors – including developers, municipal planners, and architects – clearly inhabit city-ordering centers, or 'oligopticons', that allow them to act as spokespersons of wider urban constituencies (Latour, 2005). What is made present and what is made absent at these powerful urban sites, and hence which concerns enter the city-building frames and which overflows them (Callon, 1998), are critical questions for urban assemblage studies.

Embedded in this analytical approach to the dynamic asymmetries of urban ecologies, moreover, is a particular vision of democratic city politics, helping to specify the political project wedded with the notion of urban green assemblages. By introducing technologies, natures and non-humans into urban politics, assemblage urbanism amounts to what Latour (2004) calls a 'cosmopolitics', a politics of the common cosmos. No longer a matter solely of human (e.g. class) interests, urban cosmopolitics involve conflicts over different city 'cosmograms', that is, ways of articulating the elements of the city, the world, and their mutual connections (Farías, 2011: 371). Understanding political ecology *as* cosmopolitics means becoming attuned to the way urban democratic publics (in the plural) are dynamically constituted around specific ecological situations and matters-of-concern, say, concerns with inner-city

wildlife (Hinchliffe et al., 2005). Moreover, as I stress in this article, it also entails paying special attention to the ways in which architectural and other professional city-making inscriptions may both *constitute* and *constrain* such engagements. As such, I suggest, the politics of urban green assemblages arises mostly through forms of public experimentation and learning at the fringes of urban expert planning sites.

In sum, this article joins on-going work at the intersection of STS and urban studies, in order to conceptualize urban green assemblages as part of a more general rethinking of the ontology, materiality, sociality and politics of cities. Urban green assemblages are defined as ensembles of heterogeneous actors, human and non-human, which orient themselves to the gradual redesign of urban eco-socio-technical relations in 'green' (or 'sustainable') directions. Such assemblages arise from the way actors forge urban ecological connections between otherwise non-related sites and practices, including those of engineers, architects, regulators, civic associations and urban residents, enrolling technologies, inscriptions, standards and natures in the process. Urban assemblages entail issues of asymmetry and power, but they also open up new spaces of democratic experimentation around ecological matters-of-concern, in and beyond sites of expert urban planning. To further specify how this works, I turn now to consider sustainable architecture as a specific modality of engagement with urban ecologies-in-the-making.

Sustainable Architecture: Urban Ecology as Movable Projects

While there is no *inherent* connection between architecture and urban green assemblages, it remains the case that, throughout the 20th century, architects

have been frequent participants in shifting coalitions of urban environmentalist experimentation (Jamison, 2008). Conversely, lines of influence from the science of ecology run deep in the history of architectural modernism (Galison, 1990; Anker, 2010), as well as in contemporary practices of so-called 'eco-', 'sustainable' or 'green' architecture (Owen & Dowey, 2008; Moore & Karvonen, 2008). From the perspective of assemblage urbanism, the main question is how to conceptualize such architecture as a particular modality of ecological knowledge practice and a specific form of urban cosmopolitics? Answering this question is challenging, in part because 'eco-architecture' clearly does not designate a homogeneous set of practices. Rather, considered as a globalized assemblage in its own right, architectural engagements with urban ecology exhibit widespread differences in time and space (Guy & Moore, 2005). Before turning to the *Nordhavn* case, and by way of capturing the distinctiveness of the ANT approach, it is worth considering some such important axes of difference.

As a first approximation, the recent history of eco-architecture suggests that this assemblage fluctuates together with the vagaries of environmentalist thinking and practice. Hence, as STS scholar Andrew Jamison notes (2008: 290), architects were often central to the many small-scale alternative-technology movements that coalesced in the 1970s, especially in Europe, engaging in decentralized experiments with low-energy houses, urban agriculture, and wind power generation with a view to broad social critique. With growing institutionalization of environmental commitments since the 1980s, however, alignments between architecture, markets and politics also changed. 'Sustainability' has emerged as a polyvalent marker of differentiation, in market and value terms, within the field of architectural consultancy

work (Owen & Dovey, 2008). The architect of sustainability, in this sense, is a fairly recent socio-professional kind, co-emerging with other material practices such as those of eco-engineers, green-tech companies, and environmental regulators (Fischer & Guy, 2009). Together, these will commonly be the most prominent knowledge-making practices involved in contemporary urban sustainability projects.

In the vein of critical urbanism, Jamison (2008: 293) reads these cultural-political transformations largely as a (deplorable) turn to market dominance in urban development, leading to the downplaying of environmental ambitions. This is where assemblage urbanism objects, however, to such structural notions of overarching power relations. In the guise of commercial consultancy practices, sustainable architecture will certainly be shaped in part by its relations to powerful economic actors, such as land developers, as is also the case in *Nordhavn*. However, this point should be extended to include *all* the conflicting stakeholders involved in any urban sustainability project, including urban authorities, expert consultants, environmentalists, neighborhood communities, building users, and so on. In this sense, any building project is a contested ecology of unequal relations (Latour & Yaneva, 2008: 88), making it hard to say *a priori* what relative strength will be exerted by 'economic' concerns. For assemblage urbanism, then, the key point is that capital is hardly the *only* force exerting itself within city-making practices (cf. Farías, 2011). Indeed, focusing too narrowly on the commercial aspects of eco-architecture risks blurring the inherent diversity and socio-technical importance of architectural design practice itself.

Instead, as Moore and Karvonen (2008) suggest, STS needs to be brought closer into contact with the socio-technical frames of

design thinking. This is also where the two ANT approaches to cities-in-the-making come together: on the one hand, assemblage urbanism; and, on the other, ethnographic studies on architectural practice as a specific semiotic-material modality of world-making (Yaneva, 2009; Houdart, 2008). So far, these two creative strands of ANT studies have had little contact. Bringing them together, as I do here, will help position architectural engagements with sustainability projects as urban 'hybrid forums' (Callon et al., 2009), entangling a range of mutually contentious knowledges, material practices, and value commitments within an urban green assemblage. What unites such otherwise divergent projects, arguably, is the fact that *some* architectural proposal will act as an obligatory point of passage, in terms of juxtaposing and giving material form to site-specific settlements amongst contentious forces. In this sense, I suggest, architects and their inscriptions act as important mediators in urban 'greening' processes, as vehicles for articulating urban localities as matters of ecological concern.

In their own work, Moore and Karvonen (2008) suggests to distinguish three 'geo-historical frames' of sustainable architecture, in terms of their relations to 'context': the context-bound, the context-free, and the context-rich. Context-bound design refers to traditions of 'vernacular' architecture, crafted from local materials with 'natural' qualities, such as straw or wood. Context-free design, by contrast, refers to a dominant form of modernist sustainable architecture, centered on the functional deployment of efficient technologies, and without any consideration of particular places or ecologies. Context-rich design, finally, connotes traditions of participatory and community-based architecture, whereby advanced technologies come to be related to their social ecologies by way of inclusive collective experimentation[6].

Cast in these terms, the *Nordhavn* case clearly exhibit strong elements of context-free design thinking: in their design specifications, architects and engineers position *Nordhavn* as an urban 'laboratory' for testing various 'cutting-edge' green technologies, implying that experiences gained from this locality will be readily transferable to other contexts (cf. Gieryn, 2006). Moreover, highly technical and quantified notions of energy-efficiency, environmental impact reductions and carbon neutrality, as tied in different ways to housing, energy, and transportation infrastructures, play prominent roles in the overall design frame. Unlike the grander epochal claims of Jamison's critical urbanism, then, Moore and Karvonen's ideal-types are helpful in drawing out some of the specific features which sets apart a design project like *Nordhavn* from other contemporaneous efforts of sustainable architecture – including other on-going projects in the city of Copenhagen – which draws more heavily on context-bound or context-rich design traditions[7]. As such, their concepts point to important axes of difference among urban green assemblages.

While thus framed through a broadly context-free design imaginary, however, practices pertaining to more context-bound and context-rich traditions are clearly also visible *within* the frame of the *Nordhavn* architectural project. As such, the various traditions seem to intermingle and co-articulate in discernible patterns, often in relation to different aspects, or different eco-socio-technical relations, enfolded within the same plans for this large-scale urban district. This is what I unfold empirically later on through the concept of the 'urban green multiple' – considered as one important form of urban green assemblages – which captures the way a multiplicity of co-existing attachments to urban natures come to be enfolded in a single sustainable

architecture project (cf. Mol, 2002). What this sense of multiplicity and juxtaposition point to, I believe, are the inherent limitations of an ideal-typical approach such as that of Moore and Karvonen (2008). Hence, while their concepts are helpful in sensitizing STS researchers to major differences in design imaginaries, they have little to say about the situational requirements and (cosmo) political controversies that shape how specific sustainable architecture projects unfold.

To fully get at this level of site-specificity, I suggest, we should follow the ANT footsteps of Latour and Yaneva (2008) in making the simple but powerful observation that buildings (and urban settings generally) are not static objects but movable projects. Resonating with assemblage urbanism language, what this suggests is that, in analyzing a specific urban sustainability project such as *Nordhavn*, we need to trace how their complex ecologies transform over time as new elements impinge upon the architectural frame, and as new controversies arise (cf. Yaneva, 2012). Zoning laws, land prices, construction materials, energy technologies, risk analyses, building standards, stylistic fashions, user habits, and so on – all of this (and more) is brought together, worked upon, modeled and modified in and beyond the architectural office. Over time, as powerful allies are mobilized around a specific design proposal, the architectural frame will start to stabilize enough for the project to gain its spatial, temporal, and eco-socio-technical dimensions. Such dimensions are never entirely freeze-framed, however; they may be re-opened for public-political scrutiny once architectural design inscriptions start circulating in media and other formats.

Importantly, in climate-sensitive urban restructuring, part of what impinges on the architectural frame are new local manifestations of global environmental risks,

necessitating material accommodations. In this context, the contested relations that pertain to any building project may be said to gain yet more layers, as design expertise is further pluralized, leading to new co-articulations of architectural, engineering, and natural science tools and knowledges. In the *Nordhavn* case, architectural and engineering consultants have been working closely together for the duration of the design process, thus illustrating a tendency for architectural practice to grow more reliant on engineering expertise in the context of sustainable design (Fischer & Guy, 2009)[8]. Moreover, the exact knowledge ecologies and material natures enacted in such urban green assemblages matters greatly to architectural practice. In the *Nordhavn* project, for instance, architects had to deal in their design with projected sea-level rises, made known through expert agencies' computer modeling on the localized urban effects of climate change. During the architectural inscription period itself, these sea-level projections for Copenhagen moved upwards approximately 30 centimeters, approaching the range of a one meter rise by 2100. This change had major implications, as islet bridges and sea-side front-spaces had to be re-scaled[9].

To sum up, this section situates sustainable urban design within a changing landscape of socio-professional knowledges and tools. In doing so, I critique the tendency of Jamison (2008) and other critical urban scholars to focus narrowly on the (real) market constraints manifested in large-scale (and somewhat 'context-free') sustainable city building projects like *Nordhavn*. Instead, I suggest here to augment the ontology of assemblage urbanism by adding an ANT-inspired view on green architecture, which sees buildings and eco-districts not as static objects but as movable projects, emerging through a complex ecology of contentious knowledges, material practices, and value

commitments (Latour & Yaneva, 2008; Yaneva, 2012). In methodological terms, this requires a site-specific approach, capable of registering how urban building projects change, in part through the architectural inscription of new ecological concerns. In the remainder of this article, I explore these claims further by tracing how different urban natures, in the plural, are inscribed – and publicly contested – in the design of *Nordhavn* as a sustainable city district.

The Urban Green Multiple: *Nordhavn* as Ecological Matters-of-concern

Right from the brief of the international design competition, launched in May 2008, the future of *Nordhavn* has been couched in the rhetoric of sustainable urban development. Hosted by the powerful Copenhagen City and Portland development agency, in conjunction with municipal authorities and the Architects Association of Denmark, the competition brief frames the task as one of envisioning "a sustainable city district of the twenty-first century", capable of providing 'future-oriented solutions' to such challenges as 'climate change and resource consumption'. Of the 180 competition entries, three were singled out for special attention; and among these, the joint proposal by COBE, a Copenhagen-based architectural consultancy firm, and engineering consultancy Ramboll was subsequently appointed winner. This overall design vision (known as 'Urban Delta') has been elaborated since, through processes of policy and public consultation, into a local act for the inner-most part of *Nordhavn* ('Aarhusgadekvarteret'), taking effect in 2012 and allowing construction to commence. Meanwhile, the *Nordhavn* vision has achieved considerable attention and circulation in professional design circuits; in 2010, for instance, the project was showcased and highlighted as a 'sustainable

urban lab' at the Venice Architecture Biennale.

By the time I visit the architectural office of COBE in late 2010, much of the initial work of stabilizing an overall eco-socio-technical design frame, and enrolling urban policy allies behind it, has thus already been achieved. Now, focus is more on details of the local act. In terms of urban sustainability, the overall design principles are highlighted across a range of architectural inscriptions, in textual and visual form: the future *Nordhavn*, I learn, will feature everything from ocean windmills, solar panel islands and geothermal energy to two-lane bicycle tracks, new metro extensions, green roofs, tight housing energy standards, climate adaptation flood protection, and much more. While heavily focused around climate change, the design frame also includes various other ecological aspects, from ample parks, trees and other green-spaces to concerns with urban wildlife and biodiversity. As such, the *Nordhavn* design frame makes it clear how urban sites are traversed not only by a variety of environmental and climatic risks (cf. November, 2004), but also by a dense layering of multiple urban ecological concerns, practices and attachments. Architectural inscriptions, I suggest, thereby enact *Nordhavn* as an urban green multiple.

To Copenhagen policy-makers, *Nordhavn* represents part of a wider climatic commitment, made public in 2009, to become the first carbon neutral capital in the world by 2025. Importantly, this commitment coincided in time with Copenhagen hosting the COP15 United Nations climate summit, an event attracting massive international attention, and thus branding and investment opportunities to the city and its green-tech industries. Indeed, *Nordhavn* designs enjoyed their own exhibition space during the COP15 meeting. Following assemblage urbanism

tenets, the case of *Nordhavn* thus exemplifies how architectural engagements with urban green assemblages arise in response to a variety of ecological concerns, each enjoying particular relations to the urban sites in question. Hence, the Copenhagen case clearly illustrates how anticipations of new climatic risks, in particular, are currently transforming the meaning and practice of urban sites like *Nordhavn*, which in turn acts to implicate cities in new moral geographies of global carbon emissions. There seems to be little doubt that large-scale sustainable city-building projects such as *Nordhavn* – and more generally the select ideas of urban greening that enter the realm of policy truths – stem in large part from growing scientific, political, and public concerns with the cascading urban risks of climate change[10].

In short, *Nordhavn* is presently becoming an urban green multiple through specific constellations of architectural, industry, policy and public sites, knowledges and relations, distributed throughout Copenhagen and beyond. All of this involves partial perspectives and conflicting attachments. When talking to the architects and engineers, it is clear that they view *Nordhavn* partly as a fortuitous child of its specific (trans)local political circumstances, symbolized in the inscription of carbon neutrality as an overall design vision for the district. Amidst widespread concerns with economic crises, this design enactment of strict climatic policy ambitions looks in hindsight like a narrow window of opportunity. Moreover, the political positioning of *Nordhavn* as an experimental site of urban sustainability has allowed the architects to extend their ecological commitments beyond a narrow focus on carbon. In other words, as 'climate' has been translated, extended and contested, both in the process of architectural inscription and as these inscriptions enter into urban public

settings, climate has come to multiply into a variety of ecological 'matters-of-concern' (cf. Latour, 2007).

Apart from extending the project further towards material realization, however, policy and public engagement have also served to spur a variety of new design controversies, centered on attachments to urban natures. In what follows, I analyze the becoming of *Nordhavn* as an urban green multiple by unpacking some of these heterogeneous eco-socio-technical relations – first, as they come to be configured as specific design objects, and later, when they are contested as public matters of ecological concern. In methodological terms, my analysis relies primarily on privileged access to extensive textual material, produced by the architects and engineers, specifying design principles and details of spatial layout. This is supplemented, for contextual understanding, by media analysis of Danish newspaper coverage; qualitative interviews with architects, policy-makers and activists; and participatory observation at a local citizens' hearing on *Nordhavn* (held in August 2011). Rather than exhaustiveness, my three 'eco-objects' (windmills, plantings, frogs) are meant to illustrate the claim, integral to the concept of urban green assemblages, that multiple urban natures are made known and visible in sustainable architectural practice – thereby constraining *and* enabling new urban political ecologies[11].

Ocean windmills: the politics of front-yard aesthetics?

As part of the vision to turn *Nordhavn* into a carbon-neutral eco-district, the design frame imagines energy as flowing from local renewable sources, including four windmills extending into the ocean at the tip of this urban peninsula. According to engineering estimations, four efficient tower-like windmills would provide one-

third of the energy needed by inhabitants in this new urban district. To the designers, windmills clearly stand for 'environmental friendliness': they explicitly state that the windmills should "be visible to future residents", as this will contribute to "the sense of living in a sustainable urban district". However, placing four windmills on their visual maps of the future *Nordhavn* district has also ended up entangling the designers' 'global' carbon ambitions into an intensely local politics of aesthetic value. Often, complaints over unwanted side-effects of large-scale windmills are simply overheard in the name of low-carbon progress. In the case of *Nordhavn*, however, the neighbors that would be affected happen to possess quite some economic and political resources; and their protests have exerted considerable powers of re-design, providing a case in point of conflicting 'cosmograms' in urban green assemblages.

Put briefly, the dramatic cosmopolitical events of the *Nordhavn* windmills can be recounted as follows: in the course of 2010, as design visions were made public, residents in a wealthy, Northern sea-side suburb to Copenhagen started mobilizing against their actual materialization. Were the windmills to be constructed off *Nordhavn*, they argued, this would seriously impinge on their front-yard views of a picturesque ocean seascape, damaging the aesthetic and market values of their property. This claim was picked up also by influential local politicians, helping to transform the windmills from architectural design object into a hotly disputed political frontline between adjacent municipalities. From being inscribed in future-oriented visions of sustainable urban transitions, the windmills thus started showing up within neighborhood association petitions and counter-statements from environmental NGOs. As architectural inscriptions, in short, the *Nordhavn* windmills had become

publicly contested matters-of-concern, re-scaled from an object of global sustainability to a divisive issue in a local political frontline.

From this state of uncertain ontological being, the windmills were to take another cosmopolitical turn (Latour, 2007), as they became judicially enrolled in the machineries of national sovereignty in early 2011. Allegedly through some dodgy political maneuvering[12], the windmills now became part of a national parliamentary law-making exercise to determine the future of the Copenhagen harbor. In a left-right political scenography, the right-of-center government eventually terminated the life of the *Nordhavn* windmills by juridical fiat, much to the dismay of Copenhagen urban planners. In consequence, the vision of a carbon-neutral eco-district has now been placed in doubt, even before any new buildings have emerged on site. When interrogated on the point during public hearings, municipal planners say they are now looking to solar panels as a substitution; as such, the politics of low-carbon energy looks set to continue by other material means, implying further work of eco-socio-technical reassembling.

Green plantings: socializing (in) urban natures?

To future inhabitants of the *Nordhavn* eco-district, the area will look, feel and smell not only blue – owing to its ocean proximity – but also green, as trees, parks, housing-façade plantings and rooftop gardens will make for ample sensuous connections to varied vegetation landscapes. In this vision of a literal urban greening, Copenhagen architects join urban designers around the world, given that the multiple values of green-space has by now entered the mobile circuits of city planning truths. According to the *Nordhavn* designers, the many green-spaces of this district will provide aesthetic and recreational benefits to their users;

foster living-spaces for diverse populations of non-human species; and help collect and channel excess water during heavy rains. Moreover, ample green-spaces are also part of fostering a certain place-identity, making the area attractive to environmentally-conscious (and, presumably, financially well-off) middle classes. In the words of the designers, it will make the city district feel "open, friendly and livable".

Echoing assemblage urbanism thinking, the design frame of architects and engineers thus stages urban greenery as one amongst a range of highly important non-human actors whose services have to be enrolled, and socialized, in order to realize the vision of a sustainable *Nordhavn*. Indeed, their designs exude high hopes on the part of urban vegetation-making. On the one hand, as noted, a dense and variegated landscape of greenery is imagined to shape the urban district as accessible, friendly, safe and livable; small parks, for instance, positioned in-between compact living- and work-places, provide breathing spaces for relaxation, contemplation and play. On the other hand, urban greenery mediates the effort to minimize risks of climate change, without the need for active participation on the part of would-be inhabitants: green façades and rooftops cool down the interior of buildings, thus lowering energy needs in a heated future. In this way, vegetation is socialized to act as a bio-technology of micro-climatic control, serving to counter-act the accumulated effects of anthropogenic climate-making.

Judging from media coverage, and unlike the ocean windmills, the projected green vegetation of *Nordhavn* enjoys wide public support, set amidst a range of civic association and community group activities to establish small-scale urban farming, tree-planting, and rooftop greening projects across Copenhagen. To the urban designers, however, the greening of *Nordhavn* also

implicitly addresses a more serious concern: how to ensure those qualities of an attractive and vibrant urban public life that has so far escaped recent efforts at large-scale urban planning in Copenhagen? One answer, on the part of architects, is that building-near greenery may act to "draw life from inside houses and into the streets", serving as a "boundary zone between private and public states of dwelling". In this sense, while socializing vegetation for human ends (i.e. climate adaptation), architects are also humanizing vegetation for social ends (i.e. an attractive public atmosphere). Indeed, consistent with the idea of urban green assemblages, the two concerns merge in a singular place-based ecology of human and non-human practices.

Protected frogs: urban wild co-habitation?
The derelict post-industrial area on the outer parts of *Nordhavn*, furthest removed from the city, consists in low-vegetation grasslands that are home to migratory bird species, rare butterflies, and an estimated 600 green toads. According to the design frame, much of this urban wild landscape is destined to stay untouched – or rather, to be actively blended into the nearby emerging city, thus providing residents with a sensation of closeness to 'nature'. Here, *Nordhavn* architects and engineers imagine nature as a graded scale, running from the 'urban-like' to the 'wild', with each landscape along the way providing its own set of human and non-human affordances. Closer to the wild pole, "children may play while learning about plant and animal species", and "residents may cultivate fruit plantations"; closer to the urban pole, human-made greenery landscapes provide a 'livable atmosphere'. This is all part, in the language of designers, of strengthening the 'nature content' and 'biological variation' of the city district.

In many ways, *Nordhavn* thus emerges as a site where the value of non-human spaces,

co-habitation and flourishing – in short, of 'urban wild things' (Hinchliffe et al., 2005) – seems comparatively well entrenched in expert and citizen networks of urban planning. One important condition for such multispecies co-habitation, no doubt, are the many amateur conservationists and bird-watch enthusiasts, who frequent the site, make observations, and report data on animal sightings to relevant authorities. Such 'concerned groups' (Callon et al., 2009) help knowing and inscribing animal beings into the sites, documents and considerations of urban planning professionals. This work is enabled, moreover, by various legal instruments, which provide non-human animals a certain standing in expert decision-making processes. Mandatory environmental assessment exercises, for instance, institute a space of public accountability whereby spokespersons of animals may have a say in what constitutes a sustainable politics of co-habitation. This is true even as wildlife enthusiasts, in interview, express some concerns for the future of the district.

In *Nordhavn*, by far the best protected non-human is the green toad (*Bufo viridis*). As a species designated protection-worthy by the European Union (EU) Habitat Directive, this toad inhabits and enrolls an urban green assemblage that stretches well beyond its own place-based ecology. In its legal capacity, the green toad thus illustrates the importance attached to scale-making in assemblage urbanism; embodying powerful transnational connections, the protected green toad acquires significant moral-political standing in its local (cosmo)political setting. Even as urban developments will only gradually encroach on its present habitats, the contours of a conflict-ridden toad-centered cosmopolitics is already visible; with plans to move the Copenhagen cruise ship harbor outward, in the direction of toad territory, terminals, trucks and

tourists will emerge as new menaces to this version of biodiversity. In countermeasure, a set of green engineering techniques – in the shape of new toad-friendly fences, canals, substitute habitats and road exits – are being mobilized by designers. Here, at least, sustainable architecture, and sustainable urbanism, explicitly means building for humans *and* non-humans alike.

Conclusion: A New Urban Green Cosmopolitics for STS?

While STS is yet to pay extensive attention to cities as massive socio-technical artifacts, this article suggests that things may be slowly changing as assemblage urbanism help bring actor-network theory (ANT) to bear on core issues of urban studies. Foremost amongst these issues, I argue, should be those practices of urban ecology, low-carbon transition, and sustainable architecture which are presently shaping the cultural and political agendas of cities worldwide. ANT is well placed, I suggest, to elucidate the (cosmo)politics of sustainable urban design, given its ecological commitment to a view of how situated worlds are shaped in heterogeneous knowledge practices that enroll both human and non-human actors. As cities are increasingly confronted with new environmental and climatic risks, the tools, practices, and value commitments of architects, engineers and city planners are emerging as key sites for STS to explore, engage and debate. Partaking in a large-scale reassembling of nature, technology and society, the complex ecologies of sustainable architecture are nowadays central components of global environmental futures.

In theoretical terms, my argument engages two promising strands of ANT encounter with cities-in-the-making in order to forge the concept of urban green assemblages as a key tool for interrogating

processes of urban sustainability (re) design. Drawing together discussions on assemblage urbanism (e.g. Farías, 2010) and architectural practice (e.g. Yaneva, 2009), I define urban green assemblages as ensembles of heterogeneous actors, human and non-human, that orient themselves towards the practical redesign of urban eco-socio-technical relations in the direction of (some sense of) 'sustainability'. Like other urban assemblages, urban greening practices involve changing constellations of sites, objects and actors, from architects and engineers to regulators, green-tech companies, civic associations and urban residents, coalescing at shifting levels of proximity and distance, from the 'local' (e.g. a specific eco-house) to the 'global' (e.g. climate change projections). Indeed, via the notion of the urban green multiple – conceived as one particular form of urban green assemblage – I stress the inherent multiplicity of ecological concerns, practices, and attachments that come to be juxtaposed, and publicly contested, in projects of sustainable architecture and urban design (cf. Mol, 2002; Yaneva, 2012).

Empirically, I deploy this notion of urban green assemblages in a case study of one of Europe's large-scale sustainable city building projects, situated in the post-industrial harbor district of Copenhagen, known as *Nordhavn*. In analyzing how urban natures are multiply inscribed in the architectural and engineering visions for the future of this eco-district – confidently cast as 'the sustainable city of the future' – I highlight how the design process impinges upon, and articulates, a variety of overlapping matters of ecological concern. Alongside those 'global' political visions of carbon neutrality that come to be translated into a locally sensitive politics of windmills, designers take into account a range of more 'vernacular' ecological attachments, from housing greenery to endangered toads,

allotting each their niche in a conflict-ridden balancing of eco-socio-technical relations. As an urban green multiple, the design frame for *Nordhavn* embodies a gradually evolving cosmogram of more-than-human co-habitation (Latour, 2007).

On this note, however, processes and realities of urban political ecology come to the fore; and I want to end this discussion by briefly suggesting what ANT may imply in terms of rethinking such political ecology. In this respect, it seems important to consider the inherently preliminary character of my empirical case study; while the professional urban design frame for the future of *Nordhavn* is by now largely stabilized, this represents only a first approximation of those multiple processes of translation and contestation whereby this Copenhagen eco-district will gradually attain material shape. As the tale of the *Nordhavn* windmills show, otherwise stabilized design objects may suddenly be turned into publicly contested and legally erasable matters-of-concern, situated in unequal processes of contentious (cosmo)political negotiation. *Nordhavn*, in short, will continue to be a movable project rather than a static object (cf. Latour & Yaneva, 2008) – implying that it will be important for STS analysts and practitioners alike to consider what may count as 'due process' in sustainable city-making (cf. Latour, 2007). My answer, in brief, is urban collective experimentation and learning (cf. Farías, 2011; McFarlane, 2011).

As STS researcher, the inherent future-orientation of sustainable city-building projects poses important methodological and normative challenges. In methodological terms, STS engagement with sustainable urban design will have to concern itself centrally with how future visions come to have performative effects in the present. Indeed, via the techno-science of climate change risks, much contemporary concern with urban low-carbon transitions

– including, to a large extent, in *Nordhavn* – is *at root* a performative effect of specific anticipated futures. Studying how architects, engineers, and urban planners mediate such future-oriented climate inscriptions, and how they scale divergent moral-political concerns in site-specific ways, is an important analytical task for further work on urban green assemblages (cf. Yaneva, 2005; Slater & Ariztía, 2010). Temporal questions, however, should also be extended further: How, for instance, do urban planners imagine the organization of maintenance and repair around future green eco-socio-technical infrastructures? (cf. Graham & Thrift, 2007). From an ANT (and STS) perspective, there is every reason to insist on the importance of such mundane questions – and to cast them in the language of collective experimentation and learning – even as they tend to be sidelined somewhat in the hyperbolic 'futurism' of much sustainable urban design rhetoric.

On the other hand, and on a more normative note, the long-term temporality of urban sustainable design projects – together with their self-consciously open-ended character – also entails that STS researchers will by necessity have to conceptualize themselves as situated participants to such collective urban experimentation (cf. Hinchliffe et al., 2005; Evans & Karvonen, 2010). In this respect, the commitment of assemblage urbanism to democratic, public, and inclusive forms of knowledge-making, in and beyond expert sites of urban planning, provides an important set of questions that ought to inform STS engagements with sustainable urbanism (cf. Farías, 2011; McFarlane, 2011). Situated in *Nordhavn*, for instance, questions should be raised in terms of how inclusive public participation in critical design decisions could perhaps be furthered – by drawing inspiration, for instance, from 'context-rich' traditions in sustainable architecture

(cf. Moore & Karvonen, 2008) – beyond the somewhat techno-centric practices of the present design frame? Likewise, to paraphrase Latour (2007), in the specific case of urban windmill cosmopolitics, how might this contestation of (un)sustainable energy cosmograms be turned from its present state of disarray into a *well-ordered cosmos* of human and non-human co-habitation? While no easy answers to this question seems forthcoming, it seems equally obvious that the actual (cosmo) political process in this case was far, indeed, from any sense of 'due process'.

Further specifying what collective experimentation and learning around urban green assemblages entail, and how STS may participate most fruitfully in it, will have to await further empirical and theoretical engagement. Meanwhile, the present article has aimed to open up a set of important conversations, in and beyond STS, on the future of urban natures. By bringing the multiple agencies of natures and ecologies to bear more forcefully on urban politics, and by providing urban studies with a different ontology of cities-in-the-making, it is my conviction that ANT and assemblage urbanism may slowly help change city life in more sustainable directions. To echo Coutard and Guy (2007), bringing ANT into urban ecology, I believe, is a way of infusing hope into both, as we undertake to redesign the climate of cities for the 21st century.

Acknowledgements

Notes

1   One recent survey of 100 large-scale cities around the world finds a total of 626 urban climate change 'experiments', mainly in the sectors of urban infrastructure, built environment and transport, and most numerous in European, Latin American and Asian cities (Bulkeley, 2012).

2   This article is part of an on-going empirical research project, aiming to compare 'ambitious' urban sustainability and climate change projects in three larger-scale cities in three different parts of the world: Copenhagen (Denmark/Northern Europe); Kyoto (Japan/East Asia); and Surat (India/South Asia). Given this article's more theoretical ambitions, I focus here solely on the Copenhagen case, pushing the comparative dimensions ahead of me as a further challenge for STS and assemblage urbanism (see McFarlane, 2010).

3   Throughout this article, the notion of 'sustainability' refers (unless otherwise stated) only to 'environmental sustainability'. In policy rhetoric, including the rhetoric surrounding *Nordhavn*, it is common to use the term in a broader sense, to include social and economic dimensions. Given my analytical focus on urban green assemblages, however, this broader set of debates is beyond the scope of my argument.

4   The contrast drawn up here between 'critical' and 'assemblage' urbanism derives from on-going debates set on the intellectual territory of urban studies (e.g. McFarlane, 2011; Farías, 2011). While space prevents a fuller discussion, I want to acknowledge that more critical-constructive conceptual engagement with various urban

theories, on the part of STS, is certainly warranted (see, e.g., Yaneva, 2012).

5   Urban sustainability is one domain where further cross-fertilization is needed between urban studies, innovation studies, ANT, and wider STS work on Large Technical Systems – particularly around the key notion of 'infrastructure' (see Monstadt, 2009; Blok, 2012b). In a different context, I am part of an international research project that explores these issues through the notion of 'environmental infrastructures'.

6   Unsurprisingly, Moore and Karvonen (2008: 42) emphasize the strong resonances between context-rich design thinking and core STS sensibilities.

7   In my wider project, I research a Kyoto-based eco-house construction project that draws heavily on (Japanese) context-bound design thinking. As for Copenhagen, the examples are numerous, and would include various urban community gardening and alternative-technology civil society projects.

8   When I asked one of the *Nordhavn* architects about the challenges posed by working so closely together with engineers, he simply laughed and said: "I think the stereotype of the pipe-smoking architect sitting lonely in his office is 50 years behind us"! The architect-engineer relations within sustainable building projects are an important topic for further STS exploration, but it is beyond the scope of this article.

9   Notions of scaling are crucial in the practice of architecture, where modeling at different scales serve as a means of gaining new knowledge of spaces. For an elegant STS elucidation, see Yaneva (2005).

10 In the survey previously mentioned (Bulkeley, 2012), conducted in 2009, the vast majority of urban climate change experiments were found to have been initiated within the last five years. This testifies to the specific and recent temporality in the link between climatic risks and urban territories.

11 A fuller account of the *Nordhavn* site would encompass several additional urban natures-in-the-making, revolving around such eco-political objects as metros, bicycles, algae, and flood-protection barriers. The analyses presented here should be seen as a first empirical approximation, pointing the way towards more exhaustive accounts of this and other urban green assemblages.

12 Basically, a case of pork barrel politics: one national member of parliament, representing the ruling liberal party, happened to also be a local representative of the anti-windmill municipality, making for strong allegations against him for practicing an untimely mixing of jurisdictional competences.

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Internet Forums and the Rise of the Inventive Energy User

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While climate and energy policy voice concerns about citizen's lack of improving their houses and heating systems, some citizens by far exceed the expectations. Our research on heat pumps revealed over a hundred inventions by citizen users in Finland alone, despite the technology being in many respects uninviting to modify. Users' capacity to carry out these modifications owes much to their exchanges at *user-run Internet forums,* a new and proliferating type of setting. These online forums help otherwise dispersed and heterogeneous users to create a specific kind of learning space that helps some users to "grow inventive" even as the majority of users therein remain indifferent towards their specific projects. These findings open a discussion on how the actions of typically a small group of inventive users are embedded in and supported by the activities of a broader user base.

Keywords: User Innovation, Internet Forums, Renewable Energy

Introduction

Recent years have seen many attempts to include citizens as more active players in the realization of energy and climate policy. Most of these have focused on campaigns, means and measures to reduce end-user energy consumption with the thrust on how industry developed products could be made to diffuse and be used to their full potential (Nye et al., 2010). Even as many of the renewable and more local energy technologies are available off-the-shelf, the adequacy of the solutions to local problems varies with regard to building location, housing type, and activities within the house. Such variable user-requirements may spur the making of local modifications to get the best out of generic technologies in renewable energy

(Ornetzeder & Rohracher, 2006; Seyfang & Smith, 2007; Heiskanen et al., 2010b), as has been the case in other sectors (Fleck, 1988; Douthwaite et al., 2001; Williams et al., 2005). It is common that conditions where mass produced goods do not meet the localized needs of users result in what von Hippel calls *user innovation niches* that spur a significant amount of inventions by users (von Hippel, 2005; Baldwin et al., 2006). To date, energy-related user innovations have been researched in renewables such as modern biomass heating systems and solar collectors (Ornetzeder & Rohracher, 2006), wind turbines (Jørgensen & Karnøe, 1995; Karnøe, 1996), and in energy efficient buildings (Ornetzeder & Rohracher, 2006).

Prompted by this background we conducted a line of research on end-users' inventive behaviours in sustainable energy

in Finland. In this paper we examine a subset of this data related to heat pumps, which first made evident the importance of Internet-enabled and user-maintained "forums" in impelling user inventiveness in renewables. These relatively recently matured online environments appear to allow dispersed sustainable energy users to seek information and tap into each others' ideas. The forums appeared to have provided connections and efficacy that far exceeds anything that self-builders had at their disposal in the past. Most of these forums began operating after 2005 and it has taken some years for them to reach a significant scope. It is thus only now that we can take stock of whatever potential these forums may have. This state of affairs is relevant not only for our understanding of end-users' inventive behaviours with renewable energy technologies but also reveals that *user-run Internet forums* deserve greater attention in research on user innovation as well as on intermediation.

In such forums, people organize around products and technologies to discuss use, purchase, experiences, and community knowledge about products and producers. They also include peer support for inventions by some of their members. The dynamics between other users and inventive users holds importance for how we should view user and citizen potential in innovation. To preempt some of our findings, we argue that user-run Internet forums allow for co-existence and interchange between different peoples, competences and interests. This is conducive to some of the members "growing to become inventive", and many members gaining deeper appraisal of the technologies in question. The role of forums is emphasized in the heat pump technology we have chosen to study. Heat pumps are an unlikely area for user invention in renewables. The reasons include their technical complexity, mass production, low

configurability, manufacturer disinterest in niche development, equipment integrating several specialist technology areas, and the loss of warranty and insurance coverage upon making modifications.

The contribution of the present paper is thus twofold: 1) we seek to bring to the fore the supporting role that user-run Internet forums provide for inventive citizen engagement with technology and 2) the particular implications this holds in sustainable energy technologies which is the domain of our analysis. We unite these two areas of interest with the research question:

How do user-run Internet forums support user innovation in sustainable energy technology?

Our exploration proceeds as follows. We first review research on user innovations, user communities, and Internet forums and discuss why a science and technology studies approach helps us gain new insight on the topic. We then present our data and methods and move to outline the inventions of Finnish heat pump users and the direct support they have received for realizing them. After this we examine the mechanisms that lend important indirect support for the inventive users. These findings are drawn together by discussing how they facilitate deeper engagement with technology. In the final section we draw conclusions for energy and innovation research and for related policy. We have placed in the Appendix basic information on heat pump technology and of the user forums we examine in this paper.

Internet Forums and Innovation Communities in User Innovation

Research to date has established several things about inventive users. They tend to

get help from their peers, and this help is often vital for realizing their designs (Franke & Shah, 2003; Jeppesen & Molin, 2003). As in more conventional R&D, inventive users are proficient in particular aspects related to technology and hence the scope of design they can master alone remains more limited than when pooling contributions to realize whole new designs (Franke & von Hippel, 2003; Benkler, 2006). While most attention has been paid to explicitly design-oriented collectivities, such as open source development (Weber, 2004; Benkler, 2006) crowdsourcing (Howe, 2009; Tapscott & Williams, 2011) and variations of the open design movement, these are not the only areas of users' inventive actions in peer-to-peer networks. In many domains innovating users are deeply embedded in communities of practice (Franke & Shah, 2003; Baldwin et al., 2006; Hienerth, 2006; Bethwaite, 2008) or have organized design-oriented networks within them (Hienerth, 2006; Flichy, 2007; Bethwaite, 2008). It appears to be no accident that also in renewable energy the few reported user innovation success stories feature self-building groups and co-operatives (Jørgensen & Karnøe, 1995; Ornetzeder & Rohracher, 2006; Seyfang, 2007).

Invention prone users are, however, often geographically dispersed. Internet-enabled services can boost the visibility and connectivity among potentially innovative agents. This has been observed in many online game environments (Jeppesen & Molin, 2003; Prügl & Schreier, 2006) and also in designing physical products, even if only some aspects of these products can be shared across the web (Sawhney et al., 2005; Jeppesen & Frederiksen, 2006). Studies of on-line support have, however, examined relatively uniform hobbyist communities of practice, and mostly have done so quantitatively (Jeppesen & Molin, 2003; Jeppesen & Fredrikssen, 2006). There

is some research on do-it-yourself (DIY) modifications and related blogs and forums and how they act as information repositories (Shove et al., 2007; Watson & Shove, 2008). These suggest a link between physical innovations and virtual communities as DIY forums showcase how personal experiences and knowledge from creating physical objects are projected into the public sphere (Kuznetsov & Paulos, 2010). Nevertheless, overall there is little research on the interrelation between user innovation and online user forums that are not set-up for innovation per se. User-run community forums are, at most, pointed to as a resource for managers to *harvest* or *mine* innovative ideas to manufacturers' benefit (Jeppesen & Molin, 2003; Pitta & Fowler, 2005; Franke et al., 2010).

To go deeper into the role that user-run (and not innovation-focused) Internet forums play in user inventiveness, we turn to science and technology studies concepts as a means to describe participation in complex sociotechnical formations. Our first point of departure is that design and use are not static categories, but should be examined as emerging and evolving relationships to technology (Hyysalo, 2010). People are not users, lay users or lead users per se, but rather the emergence and evolution of their *usership* should be examined as an accomplishment and a processual engagement between person, the practices s/he enacts and the technology s/he appropriates therein. (Helgesson & Kjellberg, 2009). In such engagement process peers and peer networks have been observed to play a significant role, and terms such as local experts (Stewart, 2007) and user side intermediaries (Stewart & Hyysalo, 2008) are useful in addressing the often mundane but important assistance that goes into making technologies work.

The processual view endorsed by technology studies further underscores that

attention should be paid to more than just information exchange and the giving and receiving of help, which dominates user innovation (Franke & Shah, 2003; Jeppesen & Molin, 2003). Attention needs to be broadened to learning that may or may not take place in the course of the development of usership; i.e. what competences the participants build and with what effect (Shove & Watson, 2007). When it comes to inadvertent support, concepts such as learning through legitimate peripheral participation are particularly helpful, as they help capture the often complex and multifaceted learning (and growth) process of a person moving from being a relative novice towards increasing mastery of a given practice (Lave & Wenger, 1991; Wenger, 1998).

The pertinent questions further concern how the practices at hand are organized; in the words of Blok (2013), what is the nature of the assemblages formed. Here, Internet forums feature important diversity. Some such forums accompany a relatively homogeneous practice, such as the Finnish forum for single speed bicycles, which could well be characterized as a medium for a community of practice (Wenger, 1998). Others are tied to a joint development project(s), such as open source development initiatives, rendering the community primarily into an innovation community (Jeppesen & Frederiksen, 2006; Freeman, 2011, Heiskanen et al., 2010). Yet other forums are diverse to the extreme, such as Suomi24, which features hundreds of discussion areas and interests. Such forums can be best characterized as *boundary infrastructure* (Bowker & Star, 1999), which allows the partial co-existence of multiple social worlds. All these community/ collectivity forms entail different modes of participation and learning. The user-run Internet forums in renewables we research make possible learning through legitimate

peripheral participation, but appear to be more diverse in their participants' orientations, competences and interests than, say, sporting-related communities or project-oriented innovation communities. We come to argue that this is also visible in the outcomes of the projects of their participants.

Data and Methods

Our data set consists of overviewing, sampling and content analysis of the Finnish heat pump forums, www.lampopumput. info and www.maalampofoorumi.fi, as well as 25 related interviews. The forums are actively used by heat pump users. The pages of the larger forum, lampopumput. info, had been viewed over 57 million times by January 2012, while the other forum features no page load statistics. However, a very conservative estimate based on the other forum would be in the order of several millions (if not tens of millions).

Our strategy was to first overview all major categories in the forums (n=42) by going through 40-100 thread headings in each, and following 5-20 threads in detail in order to get a sense of the topics and contents in each category. We then sampled and stored typical postings in all those categories that we suspected could have been somehow relevant for user innovation. It soon became evident that in lampopumput.info most user modifications and inventions had been initiated or moved by the moderators to an "own modifications and improvements" section (hereon "DIY section"), which featured 320 discussion threads. We read through all of these threads in their entirety. The DIY section threads were between 10-15 posts per thread, but included both single posts as well as projects that featured over 300 posts. We filed all those threads, which featured user modification or behaviours that directly or

indirectly appeared to provide support for users' inventive behaviours, and categorized them with both ex-vivo and in-vivo tags/codes. In the ground heat pump forum the self-design projects were scattered across several categories, but could be identified nonetheless, and yielded similar analysis as with the first forum.

To gain a better idea of the inventions and discussants, and their relationship to those in the DIY section, we used the general statistics of the forum as well as manual checking of the profiles of 65 discussants active in the DIY section. The DIY discussants featured few "newbies", and mostly consisted of people whose self-designations placed them as "active participants", "experienced" or "moderators", and had between 50 and 10 000 postings. We conducted 30-120 minute long semi-structured interviews with 22 forum-active heat pump lead users and 3 firms specializing in heat pumps. Our interviews focused on the modifications that these users had made as well as their activity and interactions on the heat pump forums.

Our data analysis then proceeded through categorizing all user inventions and modifications to heat pumps in our sample. In total, we found 113 inventions or modifications that improved either the efficiency, suitability, maintenance or price of the heat pump as verified by the external evaluators we used to assess their inventiveness (reported in Hyysalo et al., 2013). We further clustered these findings into types of projects and then placed these with more general categories typical to user inventions and alterations of technology, following the naming conventions prevalent in research literature (Botero et al., 2010). We further coded the thread topics related to these forms of user inventiveness: what kinds of reactions, help, and other contributions other users volunteered to these postings/projects, and the reasons

users had for their inventive actions. In parallel, we similarly content analysed the interviews with regard to inventive projects as well as the forum activities and the help the interviewed users had received. We sampled posts elsewhere in the forum for behaviours and dynamics that may support or hinder inventive users. These too were content analysed and systematically compared with regard to types of forums postings, thread topics, example solutions offered by other users, function for users and why they facilitate user innovation, and how wide a user population these activities concern. The outcome classifications of the content analysis are presented in Tables 1-4 below.

Despite our data set being extensive and multiform, it has limitations. Our interviewee sample consists of inventive users only, and hence we rely on forum posts alone in analysing other activities and participants on the forum. Notwithstanding the limitations, the present study opens the door for comparing other on line forums and types of user communities related to renewables.

User Inventions and Direct Support for Realising them

Inventive user projects
Finland does not have producer-centred ecosystems that would attract user contributors, yet we could still identify 113 different user inventions or modifications to heat pumps. Most user projects took the relatively cheap Air heat pump (AHP) models as their starting points (n=77), and worked to make them more suited for a cold climate and existing housing stock, but 28 inventions were made also in Ground source heat pump (GSHP) and 8 inventions were made in Exhaust air heat pumps (EAHP). We can cluster these further according to the extent to which the heat

pump equipment was modified (Botero et al., 2010). At one end we find 20 projects we call *user designs*, which altered several subsystems of a heat pump or constructed anew some of its subsystems entirely. Twenty-nine alterations were confined within one subsystem of a heat pump and these we call *user modifications*. Users also created 38 what we call *add-on* features, which enhanced the heat pumps by adding new parts to them without altering the initial product. There were also eight users that did not alter the make up of their equipment as such, but significantly *relocated* and *repurposed* heat pumps or their subsystems in a manner that brought benefits but had not been conceived by the manufacturers. In addition to these, we found various user *work-arounds*, *hacks and rebuildings of* heat pumps from different starting configurations.

To give a better sense of these projects let us recount briefly some examples in the category of "user designs". The most common project type was constructing a new kind of heat pump, mostly using an outdoor unit of the Air-to-air heat pump to build up a water heating heat pump (Air-to-water heat pump, AWHP). Apart from the external unit, this entailed a thorough reworking of the technology. There were also new-to-the-world designs, for example, a double source heat pump, which increased efficiency by using ground and air heat source at different outside temperatures. In many cases users sought optimized solutions to meet the requirements of the Nordic climate:

Often various energy sources are combined to provide heating for a house. In one user design case AWHP was used for both space heating and for hot water. In addition, solar thermal collectors were installed to improve energy efficiency. The user built a control logic to automatize the operation of the system. When solar power is not sufficient to heat up the boiler, an AWHP is automatically turned on, and vise versa. Furthermore, in extreme winter conditions, when solar power is not available and the co-efficient of performance (COP) of AWHP becomes low, the control logic turns both renewable sources off, and electricity is used for heating.

Other innovations in this category related to monitoring, sharing data, new coolant gas mixes, new combinations of heat pumps and solar collectors, etc. For a discussion on details of the projects see Hyysalo et al. (2013).
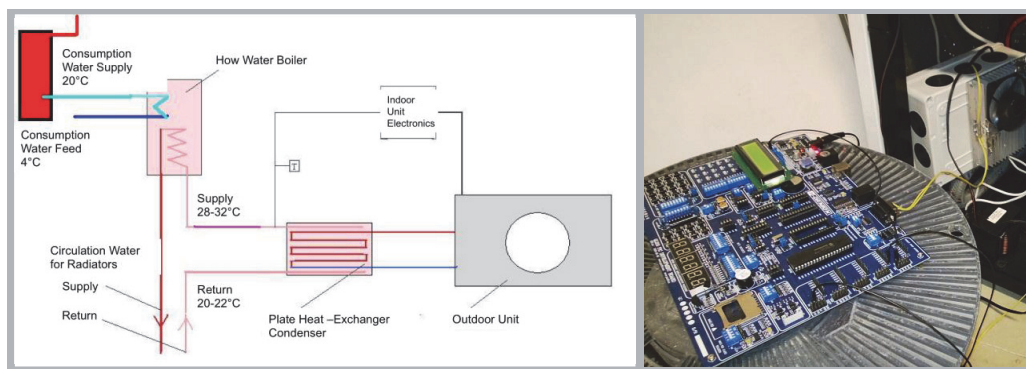

Figure 1. Sketch of DIY air-water heat pump system (left) and photo of an ongoing DIY project (right). (Translated by the authors).

Immediate peer assistance for inventive user projects

Interviews revealed that all inventive users had some presence in these online environments. These interviews and analysis of the discussion threads indicate that inventive users received various kinds of help from other users, most commonly from 2-5 people. The most common responses to questions or flagged projects expressed different forms of community memory and expertize. This, for instance, indicated that an idea was worth pursuing or, more commonly, that something similar had been tried before or that the idea was unlikely to work or at least not likely to produce the kinds of results expected. Typical question-answer sequences related to posting an idea of a modification project can be illustrated with the following exchange (Figure 2.):

> **Melting with the warmth of the return gas?**
> « : 06.05.12 - Time:13:29 »
>
> Is it possible to thaw the outdoors unit with the gas that returns from the indoors unit that still has some warmth in it? Put an extra bend onto the top of the outdoors unit bottom plate? Could one thus use after/waste heat of the gas for thaw instead of direct electricity?
>
> Will such hach create problems with thawing, functioning of the device or efficiency or into the defrosting of the lamelles?
>
> Red house and ...
>
> Cellar + 2 floors:
> 4 x Mitsubishi Electric MSZ-FD25VA+MUZ-FD25VABH

> **Re: Melting with the warmth of the return gas?**
> « **Reply #1** : 06.05.12 - Time:13:59 »
>
> Yes. Apart that its not gas at that point. Or if it is, something is wrong. The only problem you can encounter is that during the defrosting sequence and with reversed circulation the tube can freeze. Even though that doesnÕt seem to create problem.
>
> This one did not ice up the whole winter, apart a small bit in the rear end:
> https://picasaweb.google.com/...
>
> Here is the number one version of AWHP thawing tube:
> https://picasaweb.google.com/...
>
> Version two has that tube raised into the bottom plate, while I turned the water going inside and into the drain. Last winter is through without any need to interfere whatsoever.

Figure 2. The start of an exchange between members at lampopumput.info user forum in 2012. (Translated by the authors).

The discussion then turns more technical, exploring the conditions and limiting issues that affect this kind of thawing solution. The discussion gives to the project initiator fair opinion on whether his suggested hack can be and has been done, as well as some of the likely issues he may be faced with. Our interviewees regarded these kinds of peer responses to be highly valuable:

> The greatest benefit there is that it has experts that really, let us say, know what they are talking about. And towards these specific areas they have [expertise in], you could say, an experts and experimenters attitude. That is what is interesting and useful. On many things you get information that would be very hard to get from elsewhere. *(User inventor in AHP)*

Many user designs attracted further ideas, suggestions for solving problems, and direct iterations of design drawings posted on the forum. However, there was only one open design initiative, where users pooled resources and even this cold air AWHP project appears to end some time after its enthusiastic initiation. Instead, both design and diffusion proceeded sequentially and iteratively.

The users active in DIY threads formed a relatively small group of roughly 300 people that mostly held good technical competence in at least one or two technical areas related to heat pumps. Our interviews brought out, however, a considerable variation within this group in terms of orientation, background, and motivations. Most user inventions were about saving energy through improving the COP of the systems. This is understandable as COP drops dramatically in AHP when outside air get colder, typically turning to the negative somewhere between minus 10 and minus 25°C: exactly at the point when the heating need and thus cost is at its peak in the Finnish climate. Whilst this provided

an espoused rationale for the activity, our interviews and forum postings indicate that roughly half of the inventive users were strictly "hobbyist", interested in tinkering with their machines. However, among the user inventors were also several researchers working within industry and academia, heat pump professionals such as those working as assemblers and resellers, as well as four users with an entrepreneurial orientation in furthering their business in e.g. home automation.

Gaining control of ones technical equipment, the joy of tinkering, training in or for their profession, and the possibility to stretch the limits of the professional skills, were stressed as reason to engage with self-building activities. Yet, two issues featured in next to all interviews: the importance of forums for learning and in offering "a community of the likeminded" which motivated and justified one's tinkering. These observations parallel those made by (Kuznetsov & Paulos, 2010) on other Internet communities.

Both the analysis of forum threads and interviews indicate that multiple modes of interaction made possible through the forums, were key in allowing users to turn their diversity into an asset rather than a hindrance. Forums allowed public as well as private postings and responses. The more advanced and more professionally oriented users used private messages as the predominant response medium when it came to more inventive DIY projects. These people stressed the importance of anonymity in both these posting forms, as well as the possibility to then shift to a one-to-one discussion out of forum, to e-mail, or to the phone. Their occupational reputation and commitments would have precluded them from sharing and playing around with re-designing heat pumps in the open. This range of interaction modes also played a major part in referrals of services, materials and tools, which we discuss below – many DIY projects and help given stretched,

or even violated, permission to access, warranty, insurance and professional rules for conduct at some point in their development.

Table 1. User inventions and immediate peer assistance with them.

Forum posts: DIY	Common technological projects	Typical thread topics	Example contributions offered by other users	What is provided to innovative users
New user designs	- AHP to AWHP - Double source Ground source & AHP - Two phase AWHP - Pre-heating incoming air - Two temp. water boiler - Real time COP & other sensor displays / www-feed - Sun & AWHP - New coolant gas mixes	-Posting an idea or a project aim for comments -Flagging a project underway -Reporting a project progress -Posting problems with the project/ technology -How to improve COP? -How to retain COP in cold temperature?	- Encouragement, discouragement, warnings - Ideas, experiences and help - Iterating design drawings - Links to past projects, problems and outcomes.	- Learning environment - Externalized memory - Contacts with experts on particular issues - Fun and problem solving - Training in/for profession - Gaining control of ones equipment - Insight on cost and energy saving solutions
User modifi-cations	- Altering thawing sequence - Defrosting - AHP Outdoor Unit water removals - Tweaking thermostats to get low 8°C indoors			
User add-ons	- AHP-OU water channeling - AHP-OU boxes and sheds			
Repurposing and building	- AWHP from pool heater - Exhaust air heat pump from dryer - Boiler from oil tank - AWHP from cooling machine			
Work-arounds	- Christmas light to fool temperature sensor - Defrosting sequence tweaks - Spraying noise killer to AHP-internal unit (IU)			

Forum posts: DIY	Common technological projects	Typical thread topics	Example contributions offered by other users	What is provided to innovative users
Hacks	- Ripping sensors out of AHP-IU to optimize feed - Disabling "anti-draft" feature of AHP			
Re-locating HP	-AHP-OU to attic / ceiling / lowered ceiling - Heating garages			
Open design project	- AWHP	- What to include, what basic solutions to build from		

In summary, the DIY threads of the forums featured not only trivial tinkering with machines, but a whole range of viable design ideas and realized designs for improving heat pumps. Peers in these sections of the forums provided active help and experience for most heat pump projects. The way they provided this support is, by and large, in line with results on user innovation in products elsewhere (Franke & Shah, 2003; Jeppesen & Molin, 2003), apart from the importance of multiple modes of communication and anonymity, which have not been stressed by research on other user innovation communities.

Inadvertent Support for Inventive Users in Internet Forums

Supporting acquisitions, use and scaling of technology: Enhancing and diversifying the user base

As long as the innovation community equates to the relevant user community, a focus on user inventors' information exchanges may be sufficient (e.g. Jeppesen & Molin, 2003). But often this is not the case. Often, people are primarily participating in their communities of practice, and innovative activities are a secondary or parasitic concern for most participants (Heiskanen et al., 2010a). Despite its relative indifference towards inventive projects, the larger community can be indispensable to the rise of inventive users. Indeed, in our data set there are a number of community aspects upon which the invention-oriented interchanges build. In the words of one of our informants:

> The heat pump forum is a rather conservative site and [it is] not nearly as welcoming and inventive as people in the free-energy forum or pelletforum... [but] e.g. the free-energy forum doesn't give much help for development work for there are too few folks in there. *(A user inventor in AHP and wood pellets)*

As we can see, an important set of mechanisms by which user forums support inventive actions by users, is through the attraction of new people and new fixtures to becoming users of heat pump technology. This broad recruitment appears pivotal to gaining critical mass in the competences available. To paraphrase Helgesson and Kjellberg (2009), the forum is a key in fostering the emergence and deepening of usership, the relation between people and the technologies they are engaged in. Let us first examine the emergence part.

The bulk of the 200 000 posts in the heat pump forums deal with issues that have most

relevance to people who are considering whether to buy a heat pump, which model would be most suitable, and how to handle typical problems. The posts are well categorized so as to facilitate comparisons and finding information; general discussion, brand-specific discussions, usage stories in addition to sections directly on acquisition, scaling and ordering of heat pumps. To

give an idea of the magnitude of effort (and service) involved, let us briefly recount a calculation posted by one of the users (Figure 3) to aide others in the task of scaling and choosing a heat pump for a newly built house that lacks any energy use history from which to draw upon:

There are several issues in this posting worthy of our attention. It reports a task,

Mitsubishi Electric FD35VABH Row House 96 m2 Hyvinkää
« : 31.01.07 - klo:19:18 »

Scaling the Air-Source Heat Pump into a new house with no prior knowledge or experience of consumption is problematic. Below my own attempts at the subject matter.
http://lampopumput.info/foorumi/index...
http://lampopumput.info/foorumi/index...

The problem of choosing the 'right' pump came after this, once the 'right' size has been defined.
http://lampopumput.info/foorumi/index...
http://lampopumput.info/foorumi/index...

Simultaneously while asking for offers on equipment, one has to, of course, plan where to locate the equipment and rack in the apartment.
http://lampopumput.info/foorumi/index...
http://lampopumput.info/foorumi/index...

It took me 5 months to do the above mentioned, but I could not move into the new apartment before that anyway. 😊

Row house 4 rooms +Kitchen +Sauna heating power need.png

Standardized heating electricity need .jpg
Monthly electricity consumption follow up.xls

Montly electricity consumption 2012.jpg
Home_COP_Test_Mitsu_FD35VABH.xls

« Edited: 31.12.12 - klo:17:10 Written by N.N. »

Row house 4 rooms + Kitchen + Sauna 96 m^2 Mitsubishi Electric FD35VABH Hyvinkää and log data

Figure 3. Example of a forum user giving advice for others regarding scaling and selecting a heat pump and finding a location for it. (Translated by the authors).

scaling and choosing a model, which new users must engage in. One could assume this to be an easy task or at least one easily available from vendors or suppliers, but the post points to the difficulties involved: it took 5 months to do it properly and reliably for a seasoned person. Without it, any supplier or assembler advice would be hard to assess (their numbers potentially having self-serving biases). It also indicates that a one to three hour assessment by a supplier would be a rather rough estimate at best. The uptake of the post, read 60200 times, is a witness to the demand for this type of information and calculation model. Finally, and coming back to usership, the signature of the posting is typical and telling of the forum sociality. Instead of a name or some information about the person (e.g. his interest, education or skill level), there is a description of his house, its location and the heat pump equipment in use. His signature tells what he has done with heat pumps (consumption monitoring, AHP scaling and AHP pictures), in all, it articulates the ingredients that another user would need to qualify and compare with his/her own. The signature is not information about the "discussant" or "person", but of a specific relationship (between person, equipment and their context) and specific relational sociality (between those engaged or engaging in similar relations), that is, of usership. Indeed, in the whole forum one finds only isolated items that broaden the writer's position beyond that of his technological relationships.

In these relationships, the forum helps make available a range of actors we have elsewhere described as *user side intermediaries* (Stewart & Hyysalo, 2008). For instance, the pump-type specific discussion feature peers who are a little more knowledgeable with the technology and can be bothered with questions about technology that may appear silly

– a noted core facet in the uptake of any more complex systems (Sørensen, 2002; Berker et al., 2006). Forums also feature *local experts* (Stewart, 2007), people who are more knowledgeable than most users and to whom more tricky problems can be addressed. Some of the local experts are just seasoned users, but professional heat pump assemblers, resellers, and dedicated hobbyists also volunteer their advice regularly on the forum, once an issue in a thread becomes flagged as interesting and requiring more serious thought.

A key aspect of these intermediary actions is pointing to non-human mediators by providing pointers to previous threads on the same topic, links to manuals, instruction videos on YouTube, web pages elsewhere, and to COP and other calculators. Whilst most users are quite able to follow instructions, the step towards defining the problem or question is the part where more knowledgeable peers become indispensable. As one of the user inventors reflects:

> After all, the forums provide a lot of tips, already before I acquired [a heat pump] [I] looked and read much about what brands would be worth ordering. *(User inventor in AHP)*

The scaling of systems with other renewables and non-standard installations are particularly relevant for the inventive user base. Here the help given not only facilitates the rise of a broader user base, but also the emergence of more diversified installations, and on occasions also more diversified background competences of people who, for example, wish to install heat pumps together with wood, pellet, solar, or wind solutions that they are already strongly committed to, or even in which they are professionally expert. These projects create users that must grow quite knowledgeable

about their systems in order to make them work. Some of our interviewees reported how their competence evolved through grappling with uncatered needs (e.g. keeping a garage at 8°C cheaply despite heat pumps supporting only 15°C or above) or complex systems (e.g. combinations of heat pumps, wood burning stoves and solar collectors).

Table 2. How heat pump forum supports heat pump acquisition and use.

Forum posts: Community support	Typical thread topics	Example solutions offered by other users	Function for users	Why it facilitates user innovation
General Heat Pump information; principles, costs, issues to consider	- Basic information about heat pumps - "Read this first"	- Links to research papers - Links to international forums - Links to educational and training web pages on HPs	- Basics about benefits, suitability and shortcomings of HPs	- Helps expand community and its potential diversity
Acquisitions	- Which type of heat pump to select	- ROI calculators, both self-developed and links to other sites	- Lessens uncertainty	
Discussion / Supporting	- How to sensibly combine HPs with solar or wood stoves	- Checking and updating members calculations - Experiences on how much work goes in different alternatives	- Experience and advice on often complex choices	
Discussion on the scaling of the system	- Given house details: what to do, what is needed? - Could a smaller installation or combination do? - Could old heating system parts be used? - Exposing one's plans and calculations for scrutiny	- Suggestions for alternatives - Experiences with analogous homes	- Verifying calculations - Sharing experience - Support for more complex combinations - "Things to remember"	
Discussions on installation and usage	- Installation costs / problems / issues - Sharing experiences of usage	- Installation problem descriptions and solving them - Long follow-ups of an installation	- Support installations - Getting to the reality of HP heating; pro-con	
Discussion on specific models	- Problems / solutions / experiences with specific HP model	- Examples of similar problems/ behaviours of HP - Suggestions for overcoming them	- "Community knowledge" on manufacturers and models - Counterbalance to supplier information	- Peer support also for cheaper and rarer installations: helps the growth of diversity.

In summary, the most common activities in user-run Internet sustainable energy forums are not primarily or directly related to inventive activities per se. However, acquisitions, scaling, help with problems and help with dealing with suppliers, are topics that draw in thousands of people. This is a critical mass of people, with the potential to answer also DIY-related questions, and is vital for DIY interchanges, not least because it allows timely and competent feedback. We shall next argue that it lays the ground for orientations and actions that are more directly conducive to the effective functioning of a DIY section.

Deepening engagement: Organizing and sharing comparative data

Several of our interviewees stressed that the forum led them into having a deeper engagement with both the knowledge base, as well as with what can be done with the technology. Let us illustrate this with forum members' comments at different stages of their participation; moving from meeting problems in use, towards DIY projects, and finally to top lead user.

Thanks for clear information. In this area [ground circuit] it feels that when one grasps one thing, you just end up with further questions. *(User, GHP forum)*

Without this forum I would have faced huge problems with this unit. I doubt that I would have proceeded building this further. It [forum] has been of great help. *(An inventing user with AWHP)*

I have rather given more to the forum than taken from it, that's the direction"... "I have tried to instruct guys who do this (DIY project), especially in dimensioning so that they get it working and one does not go too far astray. *(This user is a semi-professional, and currently creating designs for a small local heat pump manufacturer-reseller)*

From the perspective of user inventions, important steps lie between just implementing a heat pump installation and seeing it as natural state of affairs to tinker with these machines. A common
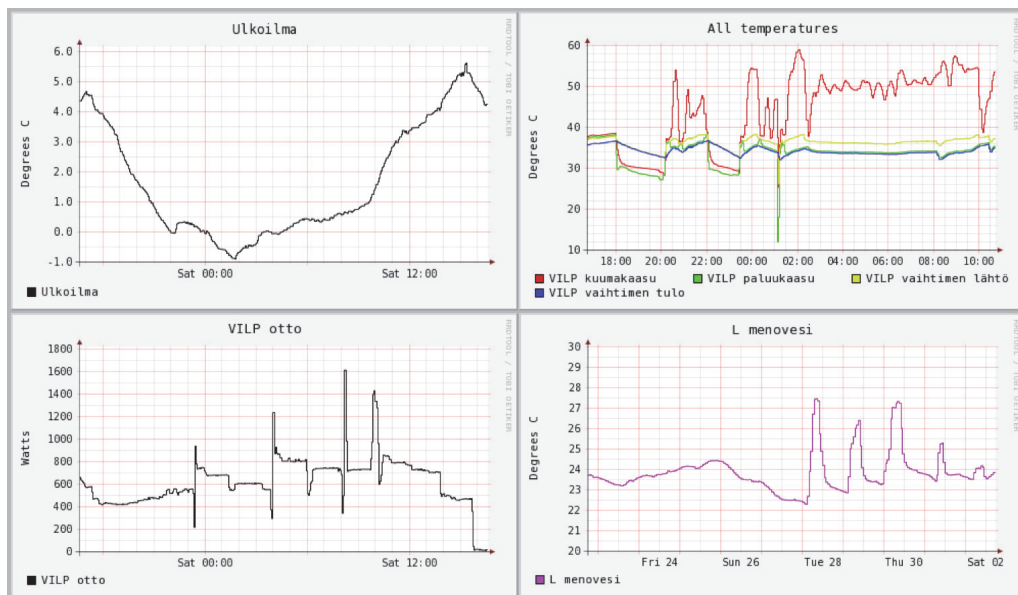
Figure 4. User share heat pump monitoring data graphs via forum and own Internet sites.

step between these two modes is gathering, organizing and sharing of comparative data. In the forums hundreds of people post or feed automatically their measurements to the forum for comparison and comments or answer polls set by others. Most users are out to verify how their installation compares to others and to factory claims. Some have more general interests in establishing how different HPs factually behave in temperatures that differ from the European standard of +7°C. The results tend to show occasions and/or areas where ones installation could be improved and the forums feature active discussions about theoretical matters in HP functioning as well as discussions on trials of changing values and working around sensors. These comparisons also typically involve hacked and redesigned devices, as many hacked systems feature extra sensors and measurement points and are run by enthusiasts – indeed many lead users report having gotten a cheap "toy air heat pump."

Table 3. Sharing comparative data.

Forum post: Comparison data	Typical thread topics	Example solutions offered by other users	Function for users	Why facilitates user innovation
Real life comparisons of different HPs	- Polls to record COP and other values in various set temperatures - Posting all one's (daily) measurements	- Measuring and entering in their data -Links to measurements elsewhere	-Comparing real life and factory values and different test temperatures - Choosing HP models for use & modification	- Points out places for improvement - Reference values for the success of modifications
Real life data of modified systems	- Posting all one's measurements as values, graphs in packets or real time	- Comments and approvals - Explanations why e.g. COP drops at certain temperature - Ideas for further improvement		- Establishing the usefulness of a hack - Identifying further points of improvement
Sharing extra measurements	-Values from extra sensors added in HPs (gas temp., flow speed etc.) - Real time measuremet unit data available	- Comments and encouragement - Explanations of found data - Iterations for how to e.g. improve COP	- More thorough understanding of how a given HP factually works	- Detailed reference data: A view to how A given HP model works
HP adjustment and optimization	- Theoretical discussions - Trials of changing values and working around sensors	-Optimizing (theory& practice): Coolant gas temperature and pressure, de-frosting periods and running times	- Improving the COP of their HP	- Theoretical and practical optimal values - Reference values for the success of modifications

To summarize this section, sharing of comparative data appears to be one of the stepping stones to more active engagement with one's energy technology. Sharing and discussing comparisons draw people towards a deeper understanding of and even hacking their equipment. For users who are already inventing or hacking their equipment, monitoring results provide cues for theoretical optimal values and points of reference on how these have been achieved, as well as which models are most suited for uses and hacks that inventive users have in mind.

Getting the means needed: Exchanging parts, tools and services

The reason for most forms of exchanging parts, tools and services has little to do with invention, but is conducive to it nonetheless. The official sales and re-sales marketplace features both working and slightly or wholly malfunctioning machines. It is the latter that offer DIY people access to cheap materials and projects. DIY section exchanges occasionally bypass the marketplace as parts and services are offered and queried alongside advice. Furthermore, joint orders for parts needed in specific modification as well as informal small-scale sales of modified components also take place. From our user interviews we know that further answers and offers are handled by private messaging, but we also found a case where a system was first iterated over several experienced users, and upon final iteration a custom welding was suggested along with a reassurance that "a real coolant man can do the job for you" indicating that (and where) the needed skills and attitude could be found.

There were also common step-by-step (including pictorial) instruction on how to order, install and use specific tools that are useful for DIY work, such as Mango and a PolluCom-energy meter that spread the required hacking skills within the user group. Finally, many DIY projects were documented meticulously picture by picture, and there were also attempts to create lists of useful DIY parts, both actions that are conducive to repeating redesigns by other users (which they did particularly with regard to AWHP designs).

Figure 5. The forum has a market section that provides a wide range of used parts necessary for modifications and new designs.

Table 4. Forms of parts and service exchange at the forum.

Forum posts: Exchange and service	Typical thread topics	Example solutions offered by other users	Function for users	Why facilitates user innovation
Used HP units	- Sell/Buy	- Sell/buy	- Second hand market	- Second hand gear for modification
Parts of HP and other cooler systems	- Indications at DIY section that spare parts are available - Queries for specific parts	- Pointers to where to get X - Offers of X	- Access to parts - Getting rid of extra parts - Cheap parts	- Cheaper and easier parts availability, help with choosing right parts
Ordering special parts for DIY	- Ordering DIY parts from Chinese manufacturers / German ebay - Having a stock of DIY parts	- Joint orders - Delivering modified parts	- Cut shipping costs - Purchase channels and skill - Micro market	- Parts availability -Motivates DIY solution sharing
Info on assembly and assemblers (for DIY)	- Asking for help in doing some part of a DIY project - Asking who could build a custom system	-"Why don't you do it like this drawing ...a real coolant man can and will do that hack for you"	- Expert help available when needed	- Sympathetic expert help available
Instructions on how to install DIY tools	- "Installing Mango..." - "Using Pollucom energy meter"	- Step by step clarifications - Troubleshooting and advice	- Getting tools to function	- Spreads same tools and measurements and competence to modify and invent
Instruction for DIY design and parts lists	- Pictorial follow-ups of HP projects	- Detailed pictures and explanations - Linking to previous designs - Attempts to make part list	- Helps to build own DIY systems - Making HP cheaper	- Increases DIY user base, builds competence at DIY, mini-market for DIY parts and assembly

To summarize, the parts and service exchanges provide help and ease with acquiring needed materials and facilitated learning in making particular modifications. Using some of the same parts and DIY tools also spread competence and collaboration to further modify and invent, in effect increasing the user base and the (mini) market for DIY parts and assemblies. We argue that this spread of competences is critical for heat pumps that have a mix of digital, electric, cold gas and plumbing parts. In the following section we turn to connecting the modes of support that forums provide by examining this in terms of the learning they facilitated.

User Forums Facilitating Learning among Diverse People

To recapitulate, most participants in user-run forums have no explicit intention to invent or facilitate anybody's inventive behaviour, yet they provide indirect support inadvertently by doing what they do. Substantial amounts of discussions, instructions, manuals, photographs, videos, links, calculators et cetera stored in the forum turn it into a shared tool-box and memory repository (Torrey et al., 2007, 2009). Further, it gives access to peers who contribute their insight into defining and solving posted problems, comparisons, voicing shortcomings and taking part in exchange of services and parts. As Watson & Shove (2008) stress, these resources are crucial ingredients to the emergent nature of competence in the process of doing that is accentuated in DIY activities.

Heat pump users are part of an ecosystem of producers, resellers, importers, regulators, bodies giving professional training etc., as well as peer-to-peer networks such as those found in user forums. This does not, however, make it into an innovation ecosystem per se (Eriksson, 2013). Many, if not most, people engaged in peer-to-peer networks due to a lack of needed information elsewhere in the ecosystem. The forums provided initial help and ideals for one's own actions, and crucially, an environment where one could try, fail and improve with some support and without dire consequences, such as being expelled from the community. This facilitated moving from an apprenticeship position towards increasing mastery. In the words of an interviewee:

> Well, when you first buy a device from the store you sort of expect that now you have it. It is not exactly a natural response to open it up and start messing with its internals, losing warranty and spending a fair deal of time. But then you encounter problems and oddities, go to forums and see that others are not so shy about examination of these devices and report fixes and improved energy yields. It becomes more natural to see the product as not so perfect, learn about the topics more. After a while you find that you have implemented a few simple hacks with nothing to it. That would have been simply unfathomable upon first encountering these devices. *(User having GHP, AHP and wind power).*

Similar deepening community membership was also expressed by other informants:

> The joy of writing in a forum is that you can first be pupil and then you can be a teacher *(user inventor in AHP).*

Such learning trajectories dominate our interviews and fit the ideas of learning as legitimate peripheral participation (Lave & Wenger, 1991). While this may be a more common facet of Internet forum participation, its prevalence with heat pumps clearly owes much to this

technology combining several distinct specialist domains: coolant systems, electronics, software, and in many cases also plumbing. All of the interviewed user inventors had started with modifications for which they had background competence: coders built software, electronics engineers hacked sensors, and so on. None had, from the outset, competence to bridge to a more overarching (re)design, but this emerged gradually in the course of their engagement, often in the course of months or even years.

> By and large it was about a year that I read [those posts] and then when I started to understand a bit then, then a bit more intensive readings, you see, thermodynamics presents a bit of a tricky equation *(user with modifications to GHP).*

The aspects of the systems that inventive users have come to master and to move beyond their initial competences, include terms and notations (e.g. assembly diagrams different for all technical subsystems), background theories (e.g. coolant gas thermodynamics), skills (e.g. attaching sensors), means (e.g. programming languages), regulations (e.g. what licenses are needed to work with each part of the technology). This knowledge determined what one could do with the technology as well as governed which sections of the forum one is welcomed to participate in and contribute competently to.[1] The competence emergence in the process of DIY activities stressed by Shove and Watson (2007), can thus be a substantial achievement in some domains, both in terms of it being achieved and the substantial challenge there is in "growing" into an inventive user, as we indicate in section 5.2.

It is noteworthy that the heat pump forums we analysed were conducive to legitimate peripheral participation to far greater an extent than open source development projects, which we have analysed previously (Freeman, 2007). The open source project "OpenOffice.org", which one of us has followed ethnographically for seven years, features the frequent turn down of volunteers who do not have the required programming skills from the outset; i.e. the project remains open only insofar as one is already competent or close to being competent at the activities in which the community is involved. The heat pump forum's DIY section features some of the same characteristics: excessively incompetent people or overly naïve questions do not receive responses or merely get a referral to a thread elsewhere in the forum. In contrast, however, in the heat pump forum this does not mean a great barrier to entry or learning, as the forum supports myriad other ways to participate other than self-designing. User forums are also more open ended as to what is being done as part of community membership. Most OSS participants are involved in testing and in making small additions to software, whereas user forums are inclusive of also using, sharing, comparing, planning, theorizing, and visioning acts. Furthermore, as noted above, the heat pump forum is comprised of multiple distinct competence areas as well as a range of legitimate roles and orientations. Both are prone to lessen the differences between "in group" and "out group" members. What we hence argue is that while user forums are less organized and less coordinated than OSS projects in their design activities, the former also hold important strengths in fostering the growth of lead user characteristics.

These user-run renewables forums, hence, differ markedly from a clear innovation project or even an innovation community. They also differ somewhat from a clear community of practice, as the forum participants have a wider range of

orientations, expertise and practices that connect them to the forum. The diversity may be less than in what is typically thought to reside in a boundary infrastructure that is partially shared by several intersecting social worlds (Bowker & Star, 1999), yet these forums do feature some such diversity. These differences may find their corollary in the outcomes of inventive activities. Instead of joint efforts to build and commercialize new systems, the inventive users have produced a whole array of individual improvements to different heat pump models as well as a range of micro-innovations (Hyysalo, 2009) to make these technologies perform better in their everyday settings.

The learning and inventiveness found in these forums appear to have ties to them being entirely user-run. Those of our interviewees who had been following forums in other countries, stressed that English-speaking forums had, in their assessment, curbed user modifications and critical evaluation due to being moderated by suppliers. Our informants equally stressed the importance of some of the administering solutions taken in lampopumput.info as being conducive to its success. These include light but active moderation, strong segmentation of the forum into manufacturer-specific parts, a DIY section and debate section "hot ring" where moderators move controversial and contested content and hence have to dismiss only contents that are truly libellous or out of scope of the forum. This was seen as favourable to the outcome that multiple specific orientations can exist but do not burden or take over other orientations in the forum.

With these facets, peer-to-peer forums hold a special place with regard to the maintenance, proliferation and further development of these technologies. What becomes elaborated in the forums is not only technologies but also how they are being developed; what can be modified, how producers respond, how regulation responds, how other users embrace novelties and so on. These are keys to having these systems work and proliferate, particularly when it comes to more complex installations that tend to lead to inventive solutions from their users.

Conclusions

Heat pumps are not the easiest or most likely technology for user invention in renewables, yet the 113 user inventions indicate that users can overcome these hindrances with sufficient peer-to-peer support that is available through user-run Internet forums. These forums play a major role in obtaining help for user projects, the transfer and learning of thematic knowledge, identifying and verifying points of improvement, accessing relevant services, parts and tools, boosting motivation, as well as in the spreading of user inventions among peers.

At the same time, we underscore that these forums' main activities and the main thrust as a novel type of support environment for renewable energy technology, do not reside in these inventions. DIY projects and exchanges between inventive users are a minority phenomenon within the forum activities. The majority of forum activities are centred on scaling, purchasing, maintenance, troubleshooting and comparing of different technology models. They further feature the displaying of monitoring data, parts exchanges, debates and voicing concerns about issues related to these renewables. They act as an informal information infrastructure that, on the whole, acts as central in user side intermediation, offering alternative sources of knowledge and filling information gaps that suppliers, resellers and authorities fail to address.

Against this backdrop, we argue that the rise of user inventions within the forums owes much to a dynamic that can be captured by a set of concepts we advanced in the course of this article. Inventive users are not "born" but "grow" to have the capacities and special needs/wants that drive them towards invention. In this regard, the user-run Internet forums are conducive to the deepening of usership, and allow some of the other users to act as user side intermediaries to aide this. The learning at stake can be approximated as resulting from legitimate peripheral participation. However, instead of a unified community of practice with a clear centre, these forums span different domains of competence, featuring characteristics of a boundary infrastructure and also facilitating their participants' learning from apprenticeship to mastery across domains of competence.

An implication of this argument is that the study of user innovation would benefit from more careful treatment of the nature of communities and the participations in question. Equating user communities with innovation communities – or drawing a demarcation line between inventive and non-inventive users – masks important differences and areas worth researching.

For instance, whilst both company-run and user-run online forums provide an environment where user modifications are adopted, diffused and iterated further, and where their makers found extra motivation to pursue their activities, the latter unite a range of products and technologies that form a technological whole from the users' perspective (e.g. a set of different renewables configured into heating of a house), whereas a given manufacturer is often limited to one part of the product ecology in question. Just as importantly, the greater diversity and lack of central authority/beneficiary in these user-run forums appears to lead not to a concentrated joint development projects but to a range of individual improvements to

many models. Hence, how they contribute to technology development is different.

As to the make up of the forums we examined, they feature several facets relevant to those trying to set up and facilitate technology-related Internet forums: Segmentation of the forum into separate sections to facilitate co-existence of different user orientations, including a separate section for provocative and speculative exchanges; active but tolerant moderation, which primarily refers discussions to appropriate areas, and; allowing private messaging and anonymous presence, which allows different professionals to engage in projects and speculations without reputation loss.

Finally, in terms of policy implications, technology-specific online forums feature several behaviours that Nye et al. (2010) hypothesize as leading to behavioural change among energy consumers (albeit without giving these any empirical backing). Inventive and actively monitoring users set an example to others by deepening engagement with energy technology, arguably leading to higher consciousness of how much energy is consumed and how it has been produced. Easy modifications and add-ons appear to give greater ownership and visibility of energy issues that tend to become "infrastructural" and out of consideration. Most inventive users also provide top end technical assistance to other users that facilitate market creation of these technologies. Hence, whilst their designs can be useful improvements, it may be the competences they create that really matter in terms of energy and climate policy. With regard to facilitating forums themselves, some forums may benefit from nominal support to cover running costs. Companies could also volunteer to further develop best DIY ideas with a compensation scheme in place. Best arrangements in policy, co-design and company involvement are, however, likely to vary with respect to the

type of forum, technology, and user base in question.

Acknowledgements

Notes

1 It is worth noting that even if users would have liked to acquire a formal education, there is hardly any single schooling that would prepare anyone to have the encompassing expertise in all the system areas involved here. The professionals, too, have learned many of their skills out in the field.

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APPENDIX

Heat pump types and their proliferation in Finland

A heat pump is a device that diverts heat from one location (the 'source') at a lower temperature to another location ('heat sink') at a higher temperature using mechanical work. The principle, illustrated in the below Diagram 1 is that a working fluid, in its gaseous state, is pressurized and circulated through the system by a compressor (4). On the discharge side (left) of the compressor, the hot and highly pressurized vapor is cooled in a heat exchanger, called a condenser (1), until it condenses into a high pressure, moderate temperature liquid. The condensed refrigerant then passes through a pressure-lowering device (2). The low pressure, liquid refrigerant leaving the expansion device enters another heat exchanger, the evaporator (3), in which the fluid absorbs heat and boils. The refrigerant

then returns to the compressor and the cycle is repeated.[1]

In cold climate countries different types of heat pumps have a growing but varied market. Geothermal heat pumps (hereafter GHP) have been in use for over three decades and feature models that have been designed for cold climate. Their uptake, however, has been rather uneven to the extent that Swedish legislative action has spurred over 500 000 installations (Muller et al., 2009), whereas Finland features over 70 000 units. The upfront investment cost is 15000-30000 €.

Air heat pumps (AHP) are built for global mass market, principally in China and Japan, and globally their most used function is cooling, not heating. Those designed for heating are targeted at more moderate climates than the typical Finnish annual range between 30°C and -30°C with mean temperature between 3-6°C. Yet the price of 300-2000€ has attracted consumers and currently 430 000 AHPs have been installed in Finland

Air-to-water heat pump (henceforth AWHP) can accommodate a wider temperature range than AHP. Oil burner and water radiators heating structures found in the majority of Finnish detached housing stock encourages fitting an AWHP as it can be assembled alongside or in place of oil heating. AWHP prices range from 7 000-12 000 € and there are around 12 000 units in Finland. Finally, exhaust air heat pumps and some other heat pump types also feature in our data, but only as fringe items.

Internet forums of heat pumps

There are two energy-related Internet forums in Finland specializing in heat pump products. The larger one, a generic heat pump forum, www.lampopumput.info. features over 210 000 posts and over 16 000

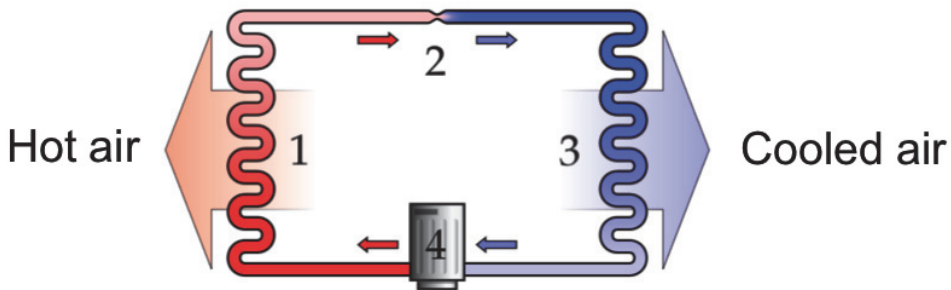1   http://en.wikipedia.org/wiki/Heat_pump

Diagram 1. Heat pump working principle [2.]

discussion threads by over 4300 discussants in its 7 years of existence. The main forum dedicated to ground source heat pumps, www.maalampofoorumi.fi, features over 49 000 posts and over 4300 discussion threads by over 3800 discussants in 8 years of existence.

The forums are maintained on a volunteer basis. Typically, forum administrators are active users of the forums. Administrator users moderate the discussion and are responsible for technical development and maintenance of the site. The forums are used mainly for discussing and finding information about purchase and usage experiences of heat pump products and producers. The discussion is vivid and mostly well-mannered and the moderation principle is inclusive when the discussion topic remains in the area of energy and related technology. In comparison to the forums maintained by commercial vendors, critical writings are allowed and not removed. User inventions are developed further through the help of forums organically, without top down management, which leads to the development of a diverse set of ideas. In manufacturer forums user contributions are directed to help in more

focused areas, whereas user-run forums allow multiple orientations.

Both of the studied heat pump forums are structured in a very similar manner, under main categories. They consist of a general discussion, heat pump technical discussions divided in subsections in various ways (e.g. brand names), and sections for purchasing equipment (commercial vendors and users' second hand market).

The forum users are dispersed around Finland and mostly live in detached family house or in row house. Almost all users use pseudonyms. The interviews of lead users revealed some further demographic characteristics of the forum users: 76% of interviewees had technical education and a majority were middle-aged men. 99% of ilmalampopumput.info and 96% of maalampofoorumi.fi registered users are male. In this regard, we use "his" not because of our sexism but because next to all users are male in these heating technology forums. Corresponding extreme gender bias is visible in e.g. knitting forums. The reasons and implications for, for example, forum sociality is a worthy topic of enquiry but not one we pursue in this article.

Negotiating Terrains:
Stories from the Making of "Siida"

Torun Granstrøm Ekeland and Britt Kramvig

In this article we develop some arguments from a research project where the researchers were also participants in the making of a multiplayer online game. The "Siida" project emerged as a challenge to the static and monolithic vision of Indigenous Saami culture and history. It seeks to create an arena for learning founded on new approaches to research-based historical pedagogy. This involvement became the grounds from where we could reflect upon what design is all about. We will argue that in order to work, design needs to relate to the specificities of place and be located as multiple practices. As a methodological tool for the analysis of partial connections between actors' knowledge practices, we put the concept of material boundary metaphor to work. We tell the ethnographic story of a complex media production as an on-going negotiation between knowledge and technical design.

Keywords: Designing, Material boundary metaphor, Saami culture

Introduction

The aim of the Siida project was to create a multiplayer online research-based digital game that could work in a multicultural learning environment. *Siida – the play for the past, the battle for the future*, started as a pilot in 2002, and the pilot report was completed in 2003. The main project period lasted from 2004 to 2006, with a finished beta version completed in 2007. We as researchers wanted to re-frame what Sápmi might be, Sápmi being the land of the indigenous Saami people, also known these days as the high North, a terrain of migrations of many different nomadic peoples over time. Colonialism has been practiced there by different nation states, and national borders were set as late as in

1905. Before that, different ethnic groups have been competing, interrelating and co-existing for centuries. One of the explicit intentions of the project was to promote justice for people and places. We set out to create a multiplayer online game that would bring out the complexities of something that straddles the past and the present in a particular place and evoke a historical consciousness in the players. The project was grounded in the researchers' commitment to creating an arena for learning founded on new approaches to research-based historical pedagogy or didactics (Ekeland, Kramvig & Orgdot, 2003: 4). We needed to ensure that the past, as our collective memories, could be performed as open and with multiple layers, and not closed as it has been by colonial grand narratives.

Colonial history in Norway has meant that the borders between the Norwegian state and Saami traditional territories (Sápmi) are not easily defined, nor can the Norwegian and Saami identity be clearly defined. Local communities are multiethnic, and people actually insist on making multiple and heterogeneous social relations explicit (Kramvig, 2005). Still, the closure of the colonial legacy is present within communities and within institutions, making Saami knowledge practices subordinate even though decolonization is an on-going practice both in political and everyday life.

Our ambition in the Siida project was to create an intersection between dominant and subordinate knowledge practices, and in this article we suggest one possibility of how this could be done. We wanted to highlight that cultures are highly flexible entities, and that this is no less true for Saami cultures than for any others. This contrasts with the representation of the Saami found in educational programs and teaching materials, which often represent Saami culture and history in a narrow and mythical way. We hoped that getting pupils to perform otherness in the past, within the context of the game, would inspire them to reflect on the challenges of multicultural life in here and now. We saw digital games as a useful tool for entering into a dialogue with young people. We do not limit our thinking to the practices and experiences of a multicultural society as can be found in the High North, but rather see ourselves as taking stories from Sápmi and making them relevant to the on-going 'othering' being done in many classrooms in contemporary Norway.

Negotiating terrains became a useful metaphor in our common aim of keeping the Siida project together, where we needed paths or tracks to walk along and find our way through the terrain. The Arctic landscape may seem limitless and wild; it is easy for beginners negotiating this terrain to get lost. On the tundra there are few mountain peaks or other distinct landmarks aiding navigation. Those familiar with Arctic landscape formations, however, will find tracks and marks to follow and see paths to provide a comfortable journey. If the landscape is unfamiliar, one can get stuck and find oneself at a marshlands or at a riverbank, unable to progress further. This metaphor also made us reformulate what designing is all about.

In this article, we will walk you through some paths that, throughout the project, somehow led in different directions, but also crossed each other along the journey. We will examine the assemblages that emerged in the process of designing the game, approaching the production of the game as a collaborative design issue, and drawing ideas from within Science and Technology Studies (STS) to help guide our analytic framework for understanding the practice of transformation in design. These assemblages appeared as visual objects crafted together by both human and non-human actors. We learn by being involved in the transformation of diverse materials and accountabilities in the Siida game, which also involved a disconcertment that became the basis for making completely new devices. The tracks that we made in this specific project, by celebrating the partial perspectives we encountered, involved change and even cracks, but still the whole remained a project that kept us together. As the community of creators we were at risk of falling apart at times while the project was running and yet we, by which 'we' means a split and contradictory we, were kept together by our loyalties towards the project vision. Here we tell an ethnographic story about designing in a complex media production context, taking inspiration from Suchman (2002; 2011), and Verran

et. al. (2007). They formulate the concept of local accountability as a promising one and enable us to see design as an on-going negotiation between knowledge practice and technical puzzling.

Local Accountabilities in the Social Landscape - Capturing Data

In Siida project a group of researchers, programmers, designers, students and bureaucrats from different institutions set out to intervene in how stories about the indigenous past and present could be told. As a group we were enthusiastic; some of us were friends, coming from the fields of art, programming, game design and indigenous and learning research. Some of us were Saami and some Norwegian; some worked and lived in Sápmi, others in Oslo, the capital of Norway. The fact that the majority of the people connected to the project had multiple kinship- and other relations with the northern region, indigenous as well as non-indigenous, reflected the complexity in the region itself. We wanted to see if we could work and create something interesting for all of us as well as explore the possibility to use digital technology as a tool to do collective memories differently. The game-production company that became involved was established in 1998 by an artist and an author of fantasy. Soon the company became prizewinning and fast-growing in the production of online-games and the designing of new web-solutions (see Orgdot, 2012). We applied and received funds through the ITU´s research programme on learning and digital education to begin searching for common ground.

In the first workshops in 2002 we came together with different historical documents, ethnographic stories, images, maps, tapes with storytelling from indigenous peoples, personal stories and political concerns of what life in the North

in the past and present were all about. During this period we produced quite a few documents that highlighted the specific features and concerns the project should relate to. We all made efforts to translate our different knowledge-practices into something familiar for the others involved. From the beginning onwards it was highly important for us to create a tool of awareness and highlight the political aspects of new industrial ambitions in the High North. Still, with the ambition of using digital technologies to do the collective memories of indigenous communities, this highlighted the way Sápmi and the High North where different landscapes of people, rhetoric and interest played out on the same territory. We also invited researchers from the field of Saami religion and history as well as gaming from the University of Tromsø and Volda University College as partners in our reference group that responded on the script in progress and the prototypes of the object of the game.

These expanding knowledge-practises interacted with the prototype of the game in progress. The prototype was supposed to uncover users' needs, technological possibilities and invent work requirements. We as a group set up a different workshop with representatives for our target groups, logging and filming the use of the game, the dialog between the pupils and the technological errors that occurred during these events. The prototype came as an artefact with particular performative characteristics; still we embarked on a cooperative design effort.

Through the process of the development of the educational game, the participants often met the same challenges and negotiations that we imagined would be central elements of the educational game itself. The project became an assemblage of different human actors in interaction with non-human actors such as technology

and organization-ordering devices. Latour (2005) describe assemblage as a type of connection and a movement deciding what binds us together and how we can destabilize and interrupt and open up social connections for reassembling. Reassembling insists upon reconnecting established relationships in order to ask question on how they come into being. It is not about Hegelian totalities, in which parts are mutually constituted into sameness and the whole, but more about an uncertain and unfolding process that is very partial (Law, 2004: 41). We are asking how reality is assembled, rather than identifying what it is. We position assemblage as a composition solving tool which is emergent through activities, both material and expressive, as components assembled through processes. It is a view that is temporal, situated and relational, local not universal (Mol, 2002: 33).

We – the researchers writing this article – ended up holding more than one position in the project, and we also needed to shift from being researchers to being commissioning agents, teachers, 'experts on Saami culture', and we needed to learn to think about code-crunching, images and characters. "So much comes together in the collaborative webs of complex practice" (Law & Mol, 2008: 73).We can say that there also were different ontics at work. Verran (2007) exceeds the Kantian dualism, or knowledge, as something within the person, complete and static and with a given distinct separation from the outside world. Ontic depends on what we humans contribute in our embodied participation with other entities. We use the term because it describes the outcome, or what is done in the collective acting. Being becomes a multiplicity of differences that is recognised as emergent realities. It is a form of a performative knowledge which directs where knowledge is produced at the point of situated, local and partial understandings.

In an odd way, the process of developing the game became the game that we developed: the different paths and fields of knowledge that were set in motion in the research and development project were just like the paths and fields of the game itself. The project built networks of affinities with few beginnings and no ends, but it also multiplied visions attached to the expanding of the project that exerted obvious control. The company Orgdot also expanded during this period – which had some effects on both the structure and the model of the organization. Orgdot withdrew from the game production in 2006; Copyleft took over and finished the beta-version in 2007. The academic and financial institutions that commissioned the work understood their work to be to initiate processes that contributed to the production of new digital educational objects and new knowledge of their use.

To account for how research can be situated as well as emergent is a step in localized accountability (Suchman, 2002; 2011). Indigenous knowledge, as with the practice of a Siida and the practice of research, is always both local and performed. Our knowing is, in Haraway's (1991) terms, partial, locatable and critical, which makes us responsible for it. The only possible route to objectivity on this view is through collective knowledge of the specific locations of our respective visions (Suchman, 2002: 96). The arguments that follow draw upon a form of auto-ethnography: we were struggling to reflect upon the routes that we were involved in making ourselves. We set out to reflexively problematize the ways we managed the contradictions that appeared in the ongoing project. One of the persons from the game company explained: *"Everything had to be built from scratch – you had to learn along the way, as there were no methods for constructing a multiplayer [game] in an*

educational setting." The Siida project can be regarded as a process where the map had to be created along the way, and the paths towards the finished game had to be cleared. Few of the marks indicating the paths could be found in the terrain, you needed to try it out, moreover, in quite a rugged landscape, examining the paths as you walked. This applied to the landscape, but it even applied to the ethnographers. As Annemarie Mol (2011) has highlighted, the ethnographer is produced through a kind of self-exposure in the text that allows the analysis to change track, tell different stories or articulate different objects. We set out to expose ourselves in the text, but even more to expose the on-going negotiation we had engaged ourselves in.

We use the concept of knowledge practice, which does not deny knowledge structures, but instead draws attention to the fact that all human communities have complex and varied ways of dealing with issues in their practices. We try to show complexity in the knowledge practices the actors perform (Law & Mol, 2002: 11). Knowledge can be formal and well-articulated, but also embodied and passionate, such as some particular contemporary ways of doing knowledge. Knowledge practices are also ways of ordering other practices, bringing different pasts into futures (Verran, 2002a; 2007). In poststructuralist writing, the simplifications that occur in knowledge practices are seen as productive; on the one hand, there is an order that simplifies, and on the other there is an elusive and chaotic complexity that is expelled, produced, or suppressed by it (Law & Mol, 2002; Law, 2004; Latour, 2005). Law (2009) reminds us that creating a new device can be a messy project – so is research. It needs to be grounded in empirical case studies; not case studies in the conventional sense, but case studies where theory is embedded in and extended through practices, and where

storytelling interferes in the way relations are assembled. He also argues that case studies should consider the messy practices of relationally and the materiality of the world (Law, 2009: 142).

In this article, we want to let the complexity run its course whilst still seeing the project, ourselves, and the language we use, as parts of a heterogeneous network. We will, at times therefore, become trapped within the very ordering we set out to challenge. The performed knowledge becomes part of theories of how things, identities and other discursive effects come into being. Here we ask how the multiple performances of actors are engaged and interfered with one another through the complex assemblage of human and non-human elements in a social-material process of production. What sorts of utterance and activities might we read and see that arrange people and objects into sets of relations in the design process? How was it possible to make a new device in the assembling of different actors?

Our first concern is the utterance of the human actors opening the main project. We open up paths towards differences and still argue that the design process was a series of engagements. Designing became the outcome of discursive and material practices, where similarities that enabled the making of difference needed to be uttered. Our second concern is the objects – as effects of networks of relations. Designing performs these relationships, where human and technological aspects enact a specific vision of the real. Our third concern is to incorporate organization as an ordering device where knowledge grows through layers of collaboration. Organization is seen as an object of design – as procedures organizing work activities. This is also a situation where friction occurs as a form of resistance to change. Can innovation destabilize and open up assemblages to other possibilities?

Locating Design: Starting to Follow Some Tracks

In the pilot design project, we noticed that different knowledge-practises existed between the institutions and actors we wanted to bring together. One person from the game company said: *"We have all had an idea of what this project should be, and those of us from the communications and game world had our own view of this, and those from the academic and research world had theirs. But I guess we still felt that there was some progression and found some models for how we could work."* The utterance makes a distinction between 'them' and 'us'. This is an actor's perspective on how Siida was assembled. In the project, many different people and academic interests and forms of language met: education, anthropology, archaeology, history of religion, programmers and gaming expertise, script writers, designers, producers, project leadership and commissioners, for instance. Some of these are part of more recognizable discourses and thus can, to a greater extent than others, move along the same language trails across the terrain. In other settings the statements may be so different that the parties have but little chance of understanding each other's' language games, for instance, when the statements of the researchers meet with a statement from the world of game technology: "…*with his dialogism he sought to show the interaction between varied meanings that circulate in the social universe…*" meets "…*layer 1 in the client will consist of the implementation of the protocol and an interface with layer 2 of the client...*"[1] These examples are linguistic metaphors that the human actors use when they construct and negotiate understandings of realities. But they may also not make much sense in each other's' fields of knowledge, creating a clash between the actors. Our work involved different knowledge practices, so we were, in a sense, walking along different trails through the same terrain. In our discussions during the pilot project, we thought we understood each other quite well in the group meetings, but when it came to reporting we realized we were working on different issues. As a result, two Siida-types emerge in the pilot report. We shared one project, but the design process made it multiple.

Reconsidering the project later, another person from the game company stated that "*the pilot project report can be seen as a report on two pilot projects, different in language and character, and with divergent views of the tasks and solutions involved, put together.*" When we go back to the different texts written up through the process, we can see from the start that we worked not so much together as side by side, something that is clear in the language. One person from the game company expressed his concern that *"at the beginning it took a lot of time to understand each other and to think aloud to see if we could produce descriptions that allowed us to participate in each other´s worlds – and that wasn´t particularly easy."* This utterance can be read as what Verran calls different ontics at work, showing that our knowing is limited to our location and is based on partial perspectives (Verran, 2007b: 166-170). Ontic recognizes itself as performative, emergent and partial. It can be made visible through storytelling or other forms of embodied performance – such as our report. It emerges in collective actions and is not given once and for all. This conceptualization allows for the rituals and routines through which we "do" our worlds to remain a puzzle. Emergent realities can be acknowledged, appreciated, accepted, and recognized – though one may not necessarily be able to account for them. Actors and structures are inseparable and mutually generating processes within a complex field. Therefore, reconsidering

the pilot project, we can find relatively standardized forms of interactions in the form of frequent repetitions of an "access code" – saying the right thing. This is the reality of the actors who become a part of the discourses that they perform. When these meet other actors with other repertoires and performances, the ritualized discourses may turn out to only partially contain overlapping configurations of sameness and difference – and as a result a movement can be created among actors. We can say that different fields use sets of metaphors for thinking and enacting in the world, and this creates disconcertment in the process of knowing and creating (Verran, 2002b). Designing is a negotiation with other ontics, and therefore a kind of intervention, and it can be innovative if it involves making differences that disrupt particular familiar and standardized ways of doing work to create new devices. But in order for a collaboration to succeed, a measure of joint understanding is required, where the trails cut across knowledge and thus also across conceptual boundaries.

During the pilot project, the researchers and game developers worked with loosely organized network-based procedures. Knowledge flowed relatively freely in our exchanges. The actors were mixed together and mutually supportive of one another in the knowledge performance. It was for us a creative and collaborative kind of work, a practice. We made this practice a central concern of the process itself, which meant we had to break up and redesign the uttered framework of "us-them" in our analysis of the working process. We want to attend to practice, and not only people's perspectives, because a perspective tends to refer to meaning alone whilst the physical reality of the object being studied recedes into interpretations (Mol, 2002: 9-13). The 'we' from the communications and game world, for instance, is not a simple category.

One point Banks and Humphreys (2008) have made is that the different levels of the company are counterposed and multiple. Programmers and designers, for example, have different ideas and motivations. Banks shows the complexity of relationships that exists within companies. In our case, we had to find a model for understanding the complexity of modern media production practice and pay attention to how it worked in our design project.

In organizing the main project, we directed attention towards and used resources to negotiate partial connections between the different knowledge practices involved throughout the project. The return to "things or objects" in the social sciences shifts to how materiality acts in the world. Latour (2005) and Law (1999) have shown how materiality plays a part as actors in structuring social relationships. Law calls this "semiotics of materiality" (1999: 3), or material – semiotics tools and describes the enactment of materially and discursively heterogeneous relations (Law, 2009: 141). He takes a semiotic perspective and applies it to materials and pronounces a relational materiality. We want to make a concept that bridge between objects and the semantic in our design process.

Susan Leigh Star and James Griesemer (1989) have developed the concept of 'boundary object' to refer to something that points to the sameness that is required in order to bring different knowledge practices together, to work towards a joint outcome. With a boundary object, it is not necessary to produce the same, and thus overlapping, sets of concepts, definitions of the situation, and understandings of the outcome in order to proceed with collaboration. This concept creates a room to speak of designing objects in a negotiation border zone between actors and as a way of dealing with the complex interactions between people and objects. Our concept of material

boundary metaphor is developed from this idea, together with Paul Ricoeur's (1981) understanding of metaphors and language. This opens up forms of analysis towards a "material-semantic" tool. Designing is an achievement of discursive and material practices that is always partial. Metaphors have to be located because their meanings are floating, local and have to be interpreted; they bring one unambiguous and one implicit meaning relationship together. To understand this, Ricoeur (1981) brings together the gap between symbols and metaphors. The symbol brings together two dimensions, one linguistic and one non-linguistic (Ricoeur, 1981: 61, 174). For example, let us take the well-known symbol of the Swastika – a cross also used by the Nazi – an ornament which can be dated back to the Indus valley Civilization and used by the punk generation, for instance. The symbol refers its linguistic elements to something outside the linguistic reality. When we talk about it, the reference is an orientation against a non-linguistic world. The disclosure is to articulate the meaning we refer to, and this is expressed in the utterance. This metaphorical utterance is a linguistic surface of the symbol. To explain something is to articulate understanding in sentences – a word group. And it is in the local setting this is expressed that we can try to understand the meaning of the text. It is in the semantic surface where we present knowledge about the reality we understand. Interpretation of a symbol is therefore also a speech act were we create language categories of the reality we experience. But at the same time, we will read the symbol differently depending on if it is performed in a Nazi or in a Punk setting.

Assemblage of objects can be read and it can generate affects for acting and being acted upon. We make these connections in order to highlight the relationship between materiality and the semantics of the discourses at work and to better understand partial connection, that is, our ability to understand others. As we shall see, we could not separate object from discourse in the creation of the game, what was "outside" could only be reached through uttering it. In this way, human language and designing are stuck to each other. In the pilot report, different views about which part of the designing was important became performed, and the negotiations that took place in the main project were also a remaking of metaphors in a located situation.

The material boundary metaphor points to the existence of such objects precisely in a border zone between different realities. In the designing process, material boundary metaphors often had divergent referential meanings for the implicated actors, and through negotiations the design object could be redesigned, which will also become clear in this article. Material boundary metaphors are thus intrinsic, both in locally anchored and general systems of knowledge. The formation can make communication and interaction across differences possible – without it, the joint projected outcome may break down. This could work for us to make some of the complexities visible, and to be a methodological tool for how partial connection is incorporated in the designing. Activities take place not as a singular achievement, but the reality can discover multiplicity where differences overlap and interfere with one another. Our vision is to open up some of this situated Siida assemblage.

Material Boundary Metaphors at Work in a Negotiating Terrain

As an illustration to show material boundary metaphors at work, we look at the avatar as a concept and character in a game. In this way, we can pay attention to the role of

"objects" in constituting social relations, but we also explore the ways in which the social interacts with, and shapes, its objects through practice. By following how design was done and performed in our example, we are asking how reality is assembled and showing how its movement can be mapped in the act of doing design.

In the pilot phase of the project, the avatars of Siida were "symbols" in the way that they were not effects of the heterogeneous network between actors uttered as coming from both the academic and the research world and the communication and game world. The design of the avatar in the pilot project was actually a view from somewhere that did not incorporate all the actors in the project. It was a vision where the developers from the communication and game world performed a knowledge practice as a kind of image of the Saami people (Haraway, 1991; Verran 2007b). At the start of the main project, the symbol of the avatar had already been placed in a particular discursive situation. A range of instructions already existed regarding how the concept was to be seen, and these were uttered in the report from the pilot project that had earlier been expressed by actors as part of our divergent views.

Later, in the main project, the "symbol" of the avatar we see in Figure 1 became part of a discourse between different competences among the actors. Let us show a part of these local accountabilities. One person from the developers expressed his idea of the avatars' properties; "*…they should be charming, be easy to like without becoming too banal. At the same time there are technical requirements that need to be met.*" We can say that the statement includes a technical reference, a reference to game design, as well as a reference to the target group. The metaphorical utterance refers to three dimensions: to what the reality of the object means, to who it is talking, and to how he understands the target group. But this is a linguistic utterance that had to be interpreted in the specific and located situation where it was uttered (Ricoeur, 1981). Arriving at explanations of what an avatar is, is to express means articulating knowledge and performing the design of the avatar; and in this way he/she becomes an actor participating in subsequent creations and negotiations of the game. The metaphor
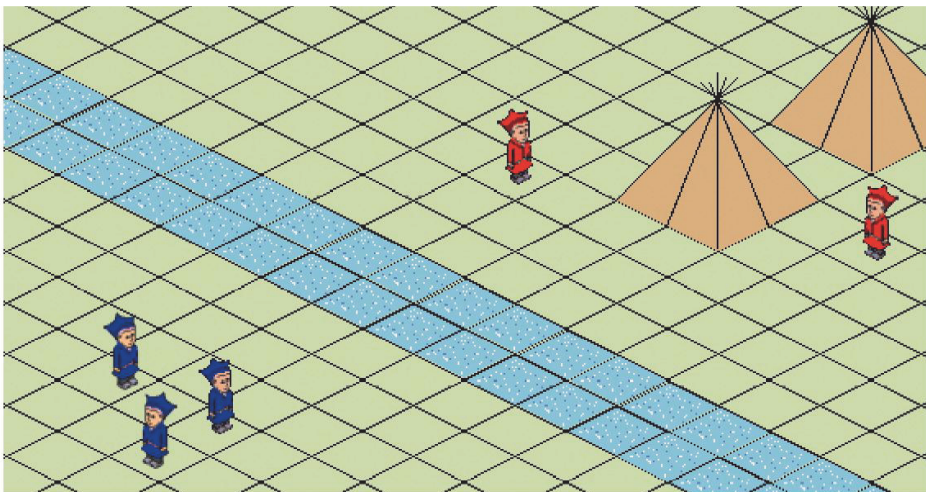

Fig.1: Appearance of avatars in the pilot report

then became the expressed meaning of the symbol (Ricoeur, 1981). The presence of the avatars became an assembling point and made multiple visions possible. The concept of 'avatar' had an associative repertoire, that is, available stories that could be told about it. At this point of the intersection, the avatar became a material boundary metaphor and an actor that could not be separated from the social assembling (Latour, 2005). The avatar became a co-actor in the heterogeneous network. It became a particular performance of technological assemblage, science, design, gender, programming etc.

Bringing together different knowledge among the actors created associative openings. Another person's utterance could interrupt the closure and open things up for change. For instance, the researcher's notion of the material boundary metaphor made other references and therefore interventions possible. One researcher argued in this setting that it was required to challenge the myth of the Saami. It was necessary to avoid portraying the avatar with 'Kautokeino hats'[2]. The avatar also needed to relate to the historical context that was the starting point of the game. The researcher was referring to what was important to her, for example that hats vary from area to area and change over time. It was central that the avatar did not appear as something stereotypically "Saami". These arguments show only a simplified part of the process, where the researcher's utterance led to a significantly different view from that of the other participants in the design. Different ontic in understanding how the avatar could be done became a negotiation that we shall see resulted in a redesigning of the figure. But this knowledge practice of doing the avatar also arranged people and objects into different sets of relations.

The avatar can therefore be understood as a material boundary metaphor that was negotiated into a new way of being

between different actors. We can say that the "symbol" became alive and reborn in the semantic dialogue between actors. The material boundary metaphor had a divergent meaning for each of the implicated actors; it was also a metaphor that pointed to the sameness that was required in order to get different fields of knowledge to work together. It was what made communication and interaction across differences possible. The avatars embodied networks in which knowledge practices were bundled together, and they were transformed through these networks.

The designer produced instructions regarding the properties required in the game; an animator gave shape to the appearance of the character, and this was then tested with the client. This was a reciprocal process between actors who had recognized competencies in each other's fields, and who thus could challenge each other with respect to the final figure. The notion of assemblage can help us to understand the range of actors, practices and relationships that make up the design process. Boundary metaphors also constitute social relations, whilst actors reassemble the social through reassembling the visual (Latour, 2005; Kimbell, 2008). This shows how different actors can come together in complex relationships in the design process. The process both connected and separated actors in different ways in relation to the task.

Fig. 2: The first reborn avatar

Fig. 3: The landscape symbol in the pilot project

The first avatar shows the appearance that was produced through the partial connections made between all the actors in the network. In the process, the figure "talked back" and the developers saw that it had been given too "sweet" an appearance. For instance, the avatars' heads were large in relation to the rest of the body. The reason given by the developers for this choice of dimensions was that it is facial expressions that most easily communicate emotions. With reference to the pupils, it was assumed that this appearance would make it easier for them to identify with the avatars. We do not speak of the avatar as an object outside their relations. Rather, through the process of generating this appearance, with its own particular qualities, the avatar emerged as a material expression of all our relationships, it became an entity but with partial connections. The non-human makes agency – they assemble human performativity (Mol, 2002).

Many processes ran parallel at this stage of the design project: for example, the pilot project was generating a kind of symbol for the landscape as well as the avatar.

This map shows different resources and paths of migration from the tundra to the sea. As the map was reassembled through the practices of the various actors in the main project, it became a material boundary metaphor through which the negotiation of the arctic landscape progressed. The Siida, as an online game and design project, became a representation of an imaginary place in

Fig. 4: The landscape becomes a material boundary metaphor

Fig. 5: The avatar integrated in the landscape

the High North. It was a performance and a way of doing place.

As the development work proceeded and the landscape in the game became moulded in a way that gave it quite a realistic visual appearance, it became clear that the avatars did not fit very harmoniously into the landscape. One main goal in the Siida project was that the landscape or environment should relate to the Arctic region. The player's experience should be one of travelling; with the basic premise the landscape itself should provide a framework for the social activities in the game. A key point of negotiation in the process of developing the landscape for the game was finding a balance between stylization and something regarded as authentic by the various actors.

At this stage, the technological solutions had become relatively fixed and there was little room for change. We had started out with an open framework full of possibilities, and by this point it had narrowed down as the work had been done. Now that the avatar was placed in the technological terrain it almost existed in its own right. And it enacted resistance. A second avatar emerged, this time performed at the level of detail: its head was given more realistic dimensions according to the game designers, the dress was changed from blue as in figure 2, to be more Arctic-looking with fur garments according to the researchers arguments etc.

Fig. 6: The second avatars
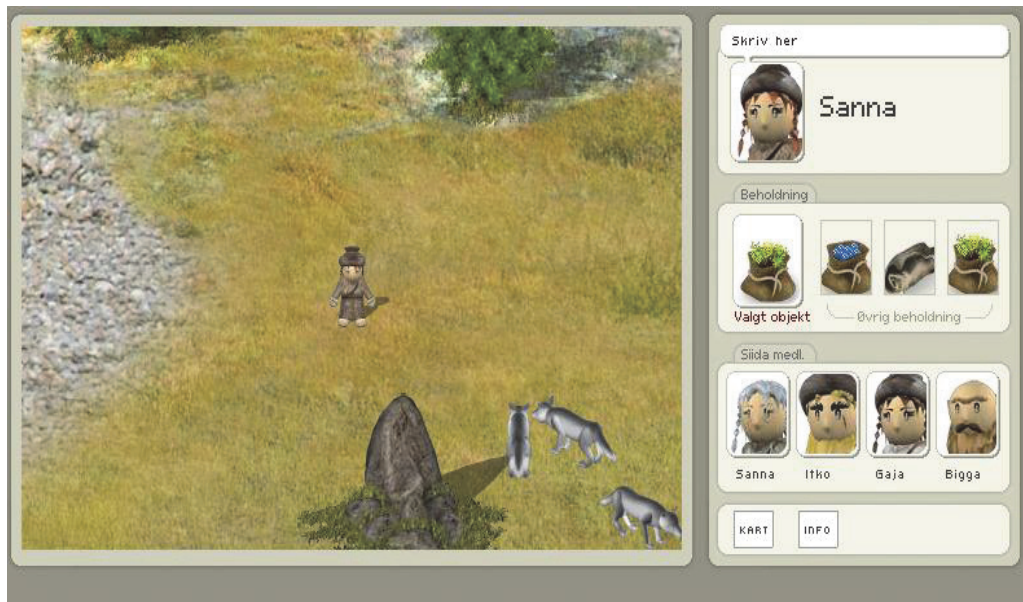
Fig.7: A client window

In the design of the game – the appearance of animals, buildings, equipment and other environmental factors – the same guidelines were followed that had shaped the work with the avatars and the landscape earlier. Some ideas where uttered in the whole group, and at other times the visual reassembling was social in other ways, for example, through the frame specifying what the client-window should look like for pupils entering the game. This work was done without the researchers or the reference group present.

In other situations the reference group was important. For example, it had an important role as the material boundary metaphor reassembled actors in different ways, for instance when an archaeologist from the reference group and the designer worked on some pre-historic items.

Fig.8: Saami sacred drum and ceramics pottery

Another example shows how fieldwork influenced the design of the game. In order to grasp what educational gaming could be about, we started the pilot phase by talking to school pupils and more advanced students within educational programs about their experiences and expectations of gaming. They did not see teachers as relevant, and instead gaming was seen as a possibility to (re-) create their own social networks, to engage with people they could trust and relate to. Within the game, the role of expert and non-expert was given on the basis of knowing the routes and regulations of the game itself. Still, when we were introducing the pilot version in classrooms, we were able to follow how knowledge of gaming became a way to position oneself differently in the classroom. The knowledgeable pupils became the knowledgeable avatars, and this in turn created a different position for the pupil in the classroom. We realized that we needed to position the teacher within the game as well, and we started playing with the metaphor of the teacher as "the game-driver". The pupil-avatar was to be given the possibility of being involved in co-creating events and engaging with the history. This created a situation where the pupils could learn that enactment in the landscape had effects. We set out to create a specific position of teacher/game-driver that could generate events. These events could be ecological changes, hunting preparations, migration and settlement of "others" with unfamiliar rituals and hunting practices, or they could be turbulent economic changes in the stockfish and fur markets. This illustrates our point that design cannot be separated from the social, and that such a project becomes a possibility for engagement more broadly. Design, as Suchman (2002) argues, should be valued as a series of views from somewhere, and in our terms and following our notion of the material boundary metaphor in designing; it was an

assembling of different knowledge practices that made this new device possible.

Another example was when fragments of the script as a material boundary metaphor appeared and were commented upon. Scripting became an assembling of research-knowledge, styles of storytelling, and what was technically possible within the game platform. The religious studies researcher, for instance, argued that the Saami myths were more open and invited a wider range of interpretations than the script did. Through this kind of negotiation, Saami mythology was discussed, but there was also more general discussion around the possibility of more open structures for storytelling than the closed structure of the linear colonial framework.

Computer games also communicate culture through communicating values (Ekeland & Kramvig, 2004). In social games like Siida, award systems can be built into the basic structure. The game industry has developed configurations over time that govern how such a system should be designed in order to provide the best acting opportunities for the players. The researchers insisted that these award patterns should be broken down. They argued that Saami mythology could provide other ways of rewarding the actions of the players as well. The argument runs as follows: technological solutions, together with the usual gaming expertise of young game-players in the West, do not allow Saami ontic to fit within the game format. One example can be given: in the Saami knowledge tradition, conflicts were solved within the Siida. In a situation when disagreement appeared, a council consisting of elders and leaders of the kin-groups involved was set. This organ was known as"norràz" and they negotiated the issue at stake in order to set a statement that the partners involved could live with. Also, a respected person could be called in; or just come into the household to cook and

do the everyday activity until the dispute was settled. The ordinary game format asked for more open combat between the players involved. These should be formatted in a recognizable script for the players. Game designers both consciously and unconsciously embed social values into games through narratives and game mechanics (Flanagan & Nissenbaum, 2007), for example by not allowing certain ritual discourses to be a part of it.

However, in the design process, the drafted scripts were re-opened for reinterpretations, and more associative openings were created. This could be called a postcolonial moment, as Verran has suggested in her studies of alternative firing regimes as understood by environmental scientists and aboriginal landowners (Verran, 2002a: 730). Such a moment might affect opening up and loosening, but importantly it increases the possibilities for cooperation while still respecting difference. It enables difference to be collectively enacted rather than ignored or obscured. Such moments are created when disparate knowledge practices abut and abrade something that is characteristic of the colonizing process. At such points, other stories with Saami ontic emerge and interrupt the performance of situated knowledge. An example might be the bear and bear hunting that has been of great importance for all the peoples of the Arctic region. Images of the bear can be found in 6000-year-old petroglyphs, in stories as well as in yoiking (the chanting tradition of the Saami), and there are around thirty bear graves dating back to around 1000 BC in Sápmi (Olsen, 2000). This was a period of extensive ritual activity and cultural consolidation, brought forward by Norse settlements in the region. The bear stories mark socialites where relationships between women and men, young and old, and structures of leadership emerge. To incorporate this story in the script also

allows disparate ontics to emerge. Here the bears give themselves to the people. Women instruct men on when the hunting should start and men follow their instructions in order for the hunt to go well. The bear meat was consumed in a ceremonial situation that articulated and strengthened the community. This complexity made it a promising point of departure for connecting religion, gender, mobility, cultural tension, cooperation, trade and the use of natural resources together in different ways in the times/spaces of the game. We see the script as a material boundary metaphor that participated in moments of intervention in the designing. This idea is inspired by postcolonial science and technology studies that "challenge us to understand 'global' technoscience as a series of local economic accomplishments, each of them confused and contested" (Anderson & Adams, 2007, quoted in Suchman, 2011: 14).

Many kinds of relationships emerged during the design process; multiple versions of reality performed partial connections to other ontics. This way of conceptualizing the process is one way of learning about the non-coherent flux of forces and relations that produce a particular reality (Law, 2004:6). The social assembles the material, but the material also reassembles the social. We have also shown how the avatars went through a range of transformations in the process: from a "symbol" to an actor in a heterogeneous network, and even an actor performing a form of resistance. In practice, the avatar and the game came together. This was not because its coherence preceded the knowledge generated about it, but because the various coordination strategies involved succeed in reassembling multiple versions of reality (Law & Mol, 2002:10). Another form of social entity emerges when we situate the material boundary metaphors within a substrate of matter, making the multiplicity to emerge.

Projects as Projecting: Boundaries and Possibilities

We have shown that in the Siida project several innovation processes ran parallel to each other, and that this made collaboration an even more challenging process. Multi-stakeholder project situations imply creating routines, meeting-points and occasions for different fields of knowledge to come together. The actors in the fields are linked together in overlapping connections in the production of material boundary metaphors. The project allowed for assembling between both actors and institutions. One of the people from the game company reflected on the challenge: *"I think that Siida is both a meeting between individual actors and a meeting between institutions, and this is the problem. I think that such projects require a much more internal, a much less formal treatment – in order to talk together and understand each other. We should think about gathering this competence under one roof – in one institution, at least during parts of the development period. … In my world, knowledge is found less in individuals than in institutions."* Paradoxically, he continues: *"I link what I have learned to the organization. … It is a life-long relationship. If we didn't have that attitude, we would never have entered this project"*.

Organizations can be explained as different modes of ordering that extend through people to include technologies and organizational arrangements (Law, 1994). An organization can also become an object of designing (Suchman, 2011: 12). In our example, the actors expressed their sense that a loose coordination of the project during the pilot period led to more mutual responsibility in the remainder of it. Parallel to the project's formal organization, an informal structure was produced.

The game-production companies involved, Orgdot and later on Copyleft,

had a growing portfolio of projects and the organisation expanded in relation to the areas of competence and people, involving programmers, drawers, storyboard-writers and project-leader relating to budgeting, formalization of work and different clients. The artist in Orgdot did the following reflection on the project multiple:

> We needed to set a system with a project-leader in our organization that could take on the responsibility to protect on-going innovation from systems that did not match in regard to time, resources etc. Our organization needed to employ more people, lack of time set us in a position where the openness that we started out with had to go, and we needed to set the technological solutions. This came together with more awareness of the limitation in the budget, altogether ordering device in the organization of work.

As argued by Winthereik (2010), the project shaped participants behaviour and what it was possible for them to know. The project shapes the work done, how the project was perceived and how the participants know both the world and themselves.

Technology at work made it difficult to connect the various fields of knowledge. In the production phase of the main project, the head of the company, who as the producer of the game was responsible for coordinating the knowledge built into its components, insisted that most of the communications between the fields should go through him as a leader. The existence of an authority structure shows that we were also dealing with a different assemblage, the organization. This encouraged a set of practices by established gatekeepers that informally protected the different knowledge practices and the generalizations made on their behalf. But as Verran (2002b)

shows, rather than dissolving difference, a useful sameness, and one that is good enough for a few here-and-now ideas can create openings for symmetry. We have tried to show this relational effect through using the notion of material boundary metaphors, but at the same time we wanted to keep up awareness of the different rhetorical devices that produced distancing in the organizational activities and the procedures of design work.

The investments that the individual actors made in realizing the project stretch beyond the obligations they feel as representatives of the organization to which they belong. This loyalty is mainly linked to the realization of the project. In such a process, there is a need to link the actors closer together in the different parts of designing. It is the journey itself that is seen as meaningful, clearing paths in an unknown landscape. At the same time, the actors are aware that the work feeds back to other participants and into the institutions that are involved. The Siida project was seen by the people involved as an object in which they had invested knowledge, while the structures they worked within were seen as limiting. All participants experienced the ritualistic practices as limiting to creativity and innovation. At the same time, alternative models for organizing encounters that respected both sameness and differences were insufficiently articulated. From our point of view, we see how those utterances both depend on and "change" some of the people involved.

Producing the script has been an on-going process. One person who developed the game platform noted: *"Our competence was concerned with what it was technically possible to do, so the script writer came to sit with us."* The utterance constitutes a "here" – it positions the speaker in a particular territory. It is a form of performativity that says something about what is the most

relevant location. In order to continue the process, the outcomes of on-going technical tests and considerations of the game itself were built into the script. It was also revised according to what was possible or desired in terms of technical factors, gaming experience and didactic aims. This generated important dialogue and had a significant influence on the relationship between the goals of gaming and academic aims. As one person from the game development company expressed it, *"the requirements of gaming experience are bad for academic content and vice versa. If you squeeze too much academic content in, you may reduce the gaming experience."* He continued, *"I think we will see good learning games in the future. But the appearance must be developed."* The claim was that the more academic the content or didactics, the less the gaming experience with its technological or game-based concerns could take priority – something gets in the way of progress towards a new future. This means that the statement above delimits the understanding of the relationship, or how the relationship should be seen. Positioning is partly taken for granted – a form of natural rhetoric that claims: "This is simply how the world is". But the last sentence opens up an opportunity to see a limit in their work. In order to work, the design process needs to acknowledge the specificities of its place and locate itself as a multiple practice (Suchman, 2011: 2). Routinization can be seen as a factor that stabilizes the identity of an organization, whilst innovation can destabilize this identity and open up the assemblage to other possibilities.

We are suggesting that technology at work became a performance that frames the technological stories around the concepts of designing and of a 'project' (see also Law, 2004). To put it another way, *the project multiple,* as argued by Winthereik (2010: 61), comes with the means to conceptually

deal with the fragmentation that threatens to dissolve many IT projects in the public sectors and elsewhere. *The project multiple* is a way of recognizing that differences are continuously produced within and through a project. In our example, we saw how boundaries were established and how, little by little, gatekeepers made themselves felt. They kept the respective fields of knowledge pure enough so that they could expand, while other fields of knowledge were prevented from expanding into their own field.

Different reciprocal social images interacted and led to the devaluation of the Other. One of the game developers described the process as follows: *"I design instructions for the sets of characteristics that the avatars will have, for instance that they should be easy to use. What is important is to stick to an established rhetoric; they should be charming and likable without becoming too banal. There are technical requirements that need to be met, and all these aspects must be tested and tried in order to find a model that works. The interface needed to be intuitive, which means that you need to use a language that is recognizable. And recognition becomes more important than distinctiveness. The avatars are unique, they are influenced by pop culture, but they still satisfy something unique."*

Through referring to an established rhetoric that exists within the field, boundaries are erected that demarcate this field from other fields of knowledge. What this means is that the dependence on others is obscured and the technology being used becomes the most important gatekeeper for the other fields of knowledge to expand meaningfully into the design. But innovation involves making differences that disrupt particular interests. In our discussion of the designing of the avatar, we showed that precisely such an expansion did take place. The work of the material

boundary metaphors showed a different assemblage than what came out of the actor's utterances. That is to say that in this case, conceptually we could not draw upon experience in any immediate sense, but we could see that what was said and done about the relationship was not the same.

Multiplicity and the enacting of different versions of reality – or ontics – are necessary in the process of creating a new device (Verran, 2002a). Such tensions and multiplicities will appear and need to be uttered as a part of innovation. The concerns of social research grew into the technology at the same time that the technology became available for the social researchers in ways that make it possible for us to perform it. Technology has to be in motion for it to work (Law & Singleton, 2000); it does not work by insisting on rigidity and translating a single order. It has to change shape through a process of interacting, negotiation and multiplicity, where various modes of ordering come together. O´Donell (2011) shows in his work following the production of Spiderman Three´s development, that the industries in the so-called New Economy are dependent upon new modes of collaborative practice. However, structural conditions can undercut creative collaborative practice. In our case the complex assemblages of human and non-human actors in the designing process were telling us that we agree that making practice is the central concern. The design cannot be separated from the social localization of design, and the organizational culture of the designers has to be brought more clearly into the various coordination strategies, not merely as an actor's utterance of how ordering works.

Conclusion: Assembling Multiple Others through the Design Process

We opened this article by arguing that Siida could be considered as an assemblage

constituted through the design project and that all the knowledge practices involved were tied to their location. When we reconsidered the pilot report, we found that it had incorporated a series of standardized forms of interactions, and furthermore that these had created disconcertment among some of the actors. We had to find strategies for working their disparate knowledge practices together. In the main project, we found that the notion of assemblage helped us to understand a range of human and non-human actors, systems, technologies and practices that make up the game, and we saw that design proceeds through multiple collaborations. The notion of the material boundary metaphor became a methodological tool we used to see how partial connection is performed in designing. The material boundary metaphor had divergent meanings for the implicated actors, but it was a metaphor that pointed to the sameness required for working together. Multiple versions of realities were performed in partial connection to other ontics, and this created associative openings. These allowed us to work together toward visions of what Siida could become. This happened due to the plasticity of the material boundary metaphor at work in located situations.

More generally we suggest that the notion of the material boundary metaphor opens up the possibility of ontic in the work of designing an online game. In this case, it helped us to show how a range of different Siidas were being assembled as the design progressed. It was not a single project that emerged; rather, as we followed the paths of the design process we could see that Siida, the game, was made real as quite a heterogeneous assemblage – as a project multiple. Through the main project, entities that had started out as "symbols" were opened up and given new life, where non-human actors also made agencies as they assemble human performativity. Through

internal negotiation and in a network of actors that performed a particular knowledge practice, utterances, stories and materiality were produced and connected with each other. In this process, we had some postcolonial moments that interrupted the existing relationships between the actors. In the case of the avatar, we showed how the avatar changed from a stereotype of a Saami figure in the pilot report to a more open Arctic-looking figure in the main project, all the while of course remaining an imaginary actor in a historical game designed for the future. The avatar from the pilot report thus effected an opening up and enabling of difference to be collectively enacted.

The design activities arranged people and objects into sets of relationships, with the process of both connecting and separating actors in relation to the task. Innovation in general involves making differences that disrupt particular positions and interests. What we found was that the limits of designing were established in the procedural structures of our organizational activities, where technology at one point became a particularly privileged narrative. The project acted as if the work of designing was a singular vision, and this meant that any assemblages not already at work were not recognizable and as a result silenced. However, relations between actors and the investments made by those involved kept the project together, even when one of the companies that we had worked with withdrew from production. The beta-version came about as an effect of these relationships, even at a moment where the original contracts were no longer part of the project and could hardly be conceived as "actors" shaping it. The connections and separations produced through the process indicate that socio-technological innovation requires flexible organization and some ordering device, that is, a culture where different ontics are seen as partial

and imperfect knowing and yet are more able to see together to find a better solution.

Clearing paths in unknown terrain is not possible without trial and error, or without tensions. Our experience of participating in the creation of a research-based digital educational game shows that we had to cross over into new land in many new areas. One of the commissioners said that *"we would like to show that ITU also dares to back things that are cutting-edge, with certain risks attached … The process has been immensely educational and incredibly good fun. I think we should continue even if there has been much blood and tears. Really cool! [Otherwise] as so often, we might end up following standardized patterns in what we deliver."* In writing this partial compilation we, the researchers, have considered yet again the paths – in the forest, across the plains – between people. Perhaps in these assemblages of actors we may find new possibilities to expand our being in relation to each other and take up the challenge of games together, creating new devices that opt for a modest symmetry.

Notes

1 Statements taken from application to ITU and Copyleft's memo on tasks in Siida.

2 Kautokeino hat – in Saami called the hat of the four winds due to its star shaped form – is today used as head clothing for men as part of the Saami, but area specific, national costume. This costume is called gákti and varies from one area to the next in Sápmi. Also, it has undergone substantial changes over time and has, even in just the documented part of history, incorporated inspiration, new colour schemes, qualities of fabric, etc., in relation to the movement of people and things in the Arctic area in different periods of time.

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Innovation and the Vocabulary of Governance

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Innovation has become a crucial part of the vocabulary of contemporary political governance and its conceptual equipment. As innovation has emerged as an ever-more significant political issue, the discourse on innovation has become intertwined with the notion of network. This paper argues that certain ontological elements inherent in this discourse tend to lose their openness when they are defined as policy-oriented concepts, and uses the innovation system concept as a case study to illuminate this. Insofar as innovation, the production of something novel, is the basis of contemporary economy, then political language has to strive both to attain what is new and, at the same time, to make it governable. It seems, however, that when a concept receives its political formulation, that is, when it becomes a means for governance, then the unifying process attendant to the production of a field of governance will replace the perspective of change. This essential tension is investigated in what follows through innovation policy as articulated mainly in the Finnish policy discourse.

Keywords: Innovation System, Governance, Ontology

Introduction

With the introduction of novel vocabularies around which new governance strategies are organized, the concept of innovation has come, since the 1970s, to constitute the key concern in areas such as technological innovation studies and evolutionary economic theory. As part of this process, the innovation system has in the early 1990s become a crucial part of the vocabulary of contemporary political governance (OECD, 1992; 1994). Yet many political concepts and ideas, while allowing representations of a complex, changeable and heterogeneous operational environment, tend however to become solidified, and, therefore, insensitive to their original purpose.

There is an interesting theme in Alexis de Tocqueville's De la democratie en Amérique, which deals with the relationship between democracy and language (de Tocqueville, 1966). According to de Tocqueville, the language of democracy has to be flexible enough to allow the movement of ideas along with the movement of democracy (de Tocqueville 1966, 450). Without elaborating this theme further, it is widely agreed that politics is intimately linked with language and that it is possible to identify relationships between political and conceptual qualities. The aforementioned solidification tendency is clearly visible in the concept of the innovation system. It seems that when this concept receives its political formulation, that is, when it becomes a means for

governance, then the unifying process attendant to the production of a field of governance will replace the perspective of change.

In this paper I will consider the innovation system concept from the point of view inspired by Pierre Rosanvallon's (e.g. 2006: 43) conceptions concerning the tension between the 'sociological principle' and the 'political principle'. The political principle – the idea of a unified whole – strives to bring together the collective subject that the sociological principle – the plurality of individuals – tends to make less coherent. What is of particular interest here and what makes the concept of an innovation system an important object for social thought is the tension, inherent in the notion, between an essentially open, network-based political framework that does not form a closure, on the one hand, and the boundary-drawing elements necessary for any governmental concept, on the other. It is this tension or duality between the 'political' and 'governmental' aspects of the notion of the innovation system, resembling Rosanvallon's differentiation but going in the other direction – that is, moving not from a unity to disintegration but rather from an open whole to a closed one – that constitutes the main topic of this paper. In particular, the purpose in this paper is to address the question of how innovation policy in terms of network, information society and liberal governance has come to been articulated within the concept of the 'innovation system' or 'national innovation system', above all in Finland. More precisely, the paper claims that this has taken place in response both to the changing perception of the nature of and the inherent tensions between an ontologically open structure and the administrative need for demarcations and boundaries. While analysing the nature and changes of the

innovation concept, the existing research on the innovation policy of Finland (e.g. Schienstock & Hämäläinen, 2001; Miettinen, 2002; Hämäläinen & Heiskala, 2004; Lemola & Honkanen, 2004; Ali-Yrkkö et al., 2006; Miettinen et al., 2008) often tends to imply a common national interest, understood as natural and unproblematic. In contrast, this paper seeks to open an ontological perspective to the theme in question. Thus, it argues that certain ontological elements inherent in political concepts tend to lose their openness when they become defined according to policy-oriented goals, using the innovation system concept as a case study to illuminate this.

This is basically a theoretical paper which aims at creating conceptual distinctions and an analysis. While the Finnish policy environment provides a context for this, it is not a case which will be examined systematically. Therefore the documents analyzed here serve to illustrate the theoretical argument and not to constitute proper empirical data. This kind of analysis can help us pay more attention to the duality between opening and enclosing tendencies in a politically used innovation concept (in addition to the innovation system, similar concepts include triple helix, mode I/mode II knowledge production, etc.), to the original questions to which it was formulated as a response, to the way it opens a new perspective and novel set of practices in an area of political problematization, and the pressures relating to the need to represent the domain to be governed as a well-defined field with its own limits and the process of naturalization that often follows. In the following pages, I will trace the contours of the aforementioned tension by elaborating on the social and conceptual preconditions of the innovation system approach, the formation of the network as both the object and the means of politics, and the spread of the innovation concept

in Finnish policy language. Let me begin, however, by elucidating the origin and definition of the notion.

Defining the National System of Innovation

The concept of national innovation system was first introduced in the 1980s (Freeman, 1987; Lundvall, 1988) and it began to organize the discourses around technology policy in many countries in the 1990s. The national innovation system has usually been conceived of as a set of country-specific organizations, operations models and connections for the generation, dissemination and application of scientific and technological knowledge. This system is regarded as the totality of all the actors who participate in scientific research, in the processing and distribution of information, education, the development of technology and the creation and diffusion of innovative products and services. It is seen as referring to structures from standards to laws and provisions, as well as government actions for promoting different industries and services and for improving competitiveness as well as strengthening the infrastructure of the economy, all of which aim at producing, shaping and regulating new scientific, technical and social innovations (e.g. Kuhlmann & Edler, 2003: 623).

Yet the concept does not exclusively denote regulation mechanisms, structures and policies, but also a large number of economic theories, innovation models, different forms of knowledge and the attendant positions of expertise and authority. In fact, the concept has given birth to a new vocabulary, used by many economists, civil servants and politicians as well as by labour market organizations, industrial enterprises and universities and other research institutes. In this way they can, at least in principle, meet and

recognize each other as part of an often comparatively consistent discourse when it comes to its objectives and terminology. Moreover, one must not forget the impressive set of measuring techniques, assessment methods and very physical technologies from business accountancy to the methods used by national Statistics Centres for the systematic and routine gathering and comparing of information in order to constantly measure national competitiveness. Thus the concept refers to the institutions related to the production and diffusion of knowledge. It also refers to the interrelations of these institutions from schools to universities and further to research organizations, industrial enterprises and government institutions. The concept thereby connects technical patents, industrial standards, the methods for evaluation and comparison as well as juridical steering mechanisms and views these all from the perspective of generation and the utilization of knowledge and innovations. Through this new language, these elements together define a relatively coherent system of practices, objectives and policies.

The genesis of the concept of the national innovation system is, however, connected particularly to the work done with evolutionary economic theory and innovation research. First, it is linked to the endeavour, having emerged within economics, to try to understand the technological and institutional elements related to economic development. The well-known study by Christopher Freeman (1987), in which he investigated the post-war economic development of Japan in the light of the nation's institutional characteristics, is crucial in this respect. Second, it is connected to critiques of the model of linear innovation and to the attendant idea of interactive learning as the basis of the economy. The central formulation here is

Bengt-Åke Lundvall's (1988; 1992) ideas on interactive learning and the innovation process that takes place within the limits of a nation-state. Rather than viewing them as isolated incidents, the origin of innovation started to be seen as a multilevel, long-term network of development processes, involving concurrently a number of different social institutions and actors.

Seen against this background, the introduction of the concept was connected to the needs of policy makers and students of innovation (Lundvall et al., 2002: 215). J. Stanley Metcalfe has characterized it both as a social phenomenon and as a framework for policymaking (see Miettinen, 2002: 28-9). The main purpose of the concept was to help formulate policies in a time when the significance of innovation for a nation's economic potential became widely recognized (for the controversy concerning the academic or policymaking origins of the concept, see Sharif, 2006). Thus it was not solely a theoretical but also a political concept, being linked to questions of governance.

The concept of an innovation system makes it possible to view the interrelationships between the economy, technology, politics and governance as sets of interdependent processes within the same conceptual framework. It tries to transcend administrative boundaries while forming a uniting, systemic perspective in which different processes and effective relationships can be assessed as a historical-political whole: the interrelationships between the increase in the role of knowledge, the development of technology and the generation of innovations are considered from the point of view of the society as a whole. In this undertaking, it is closely linked to the work done within evolutionary economics, a school of economic thought dealing with the processes that transform the economy from within (e.g. Freeman & Soete, 1997; Nelson

& Winter, 1982). In this way, it is believed, the concept sets a horizon through which national strategies can be formulated in a more comprehensive way (Lundvall et al., 2002: 227). According to a report by the Organisation for Economic Co-operation and Development (OECD, 1997: 11), the concept has promoted the mushrooming of systemic reviews, the recognition of the economic significance of knowledge, and the more versatile and multifaceted view of institutions involved with the production of knowledge. This has arguably enabled the evaluation of economic growth and technological development within a relatively consistent perspective in the light of governance, coordination and diverse controlling measures. Its viewpoint is based on a certain simplification[1], but this is simplification for a reason. Any political concept, in other words, a concept articulating political governance, simplifies out of necessity: administration is about fixing responsibilities and drawing boundaries (e.g. Kettl, 2002: 74, 153). In the end, however, this preempts capturing what is new, transient and boundary-transgressing, which was its original goal. I will discuss this issue in more detail in the following pages.

Network, Knowledge and Governance

The concept of an innovation system can be seen as reflecting the convergence of two pivotal social forces. Although the term has a more specific origin, especially within economic theory and innovation research, as was shown above, these forces have shaped the intellectual field which constituted the precondition for the concept's possibility and its inherent tensions. The first consists of the social order based on knowledge, and the second of the so-called advanced liberal governance. Both of them are structured around the notion of network.

First, the transition to what is referred to as the information society and to the corresponding workings of the economy has been a key topic of political discussion since the latter part of the 1970s (Bell, 1976; Porat, 1977; Lyotard, 1984; Castells, 1996). It has been widely agreed that the logic of the economy is increasingly based on knowledge and learning, which is why these themes have become highly politicized. The OECD has emphasized in its reports the move to a knowledge-based economy in which the constant generation of innovations is crucial (OECD, 1981; 1986; see Godin, 2006; 2008; Felt, 2007). In the 1990s, the OECD (1998) defined the knowledge economy as a form of economy which is based immediately on the production, distribution and usage of knowledge and information. The central idea here is the constitutive role of the innovations related to the circulation and utilization of knowledge as the precondition for the growth of commerce and industry. The concept of an innovation system is precisely connected to knowledge creation, distribution, and utilization (Chang & Chen, 2004: 17-8).

The idea of a knowledge or information society has emphasized the technological dimension of the economy's functioning and has brought together questions related to the development of society from the viewpoint of knowledge and technology. In its simplest form, the advancement of the information society concept meant promoting an infrastructure based on information and communication technologies and the related tele-informatic expertise (e.g. OECD, 1981). Once the information society became the object of political thinking, it was intimately connected to the network approach: networks, in particular information and communication networks, have become a crucial feature of the new societal order. The networks associated with the information

society reflect the functioning of this society in some non-trivial way, not only its technical preconditions.

Second, the concept of an innovation system can be seen as operating as a part of a broader social ethos in administrative politics that has been called advanced liberal governance (see Rose, 1999), based on the decentralized, networked nature of power. If political governance was previously seen as having been articulated largely in terms of central political institutions and the decisions they made, now it is based on relationships and processes which can no longer be reduced to the idea of a dominating centre. As a consequence, governance is no longer viewed in light of state-centric political thought (Pierre, 2000: 4-5). Liberal governance thereby breaks away from an administration taking place through a centre or boundaries–which have been characteristic of modern, hierarchical political governance. Questions and phenomena determining politics today can no longer be dealt with through unambiguous sectoral or geographic boundaries. What is inside and what is outside has therefore become ever more difficult to distinguish.[2]

The new forms of governance have moved from centralist governance towards arrangements which are multi-centred, interactive, and process-based and which are directed at reconciling the interests of both diverse public and private actor groups in the name of some collective strategy (e.g., Rose, 1999; Dean, 1999). The responsibility for the results is divided among the government institutions, legislative bodies, local communities and different experts and consultants which form into chains as a kind of network. In this respect the innovation systems approach is an excellent example of the techniques used by contemporary government. This system engages institutions and processes with a set

of collective aims, advances their abilities for cooperation, and measures routinely their performance and results with an eye to making the functioning more effective. All this takes place by withdrawing central administration, utilizing cooperation networks and developing the potentialities of networks in governance.

As an overarching metaphor, network has come to be established as the salient notion when describing society and its central processes. It has opened such a fundamental horizon, as it were, in and through which society appears to us today and in which this experience of society assumes a conceptual form, amenable to governance (Rhodes, 1997; 2000; Stoker, 1999; Marsh, 1998). Thus the idea of a network is not only an analytical tool for thinking about complex interdependencies, but also and above all, a common framework for our experience of society and a pivotal form of social self-representation. What is characteristic of this representation is that it does not operate on exclusion like many previous models and metaphors (e.g. society as a machine). As a concept, network is ontologically open: it integrates without totalizing (Eriksson, 2005). Due to its quality that allows people to speak about a given whole without the burden of closures and static structures, the notion of network has emerged as one of the key political concepts today.

In technology policy, the idea of the national innovation system has, in recent years, functioned particularly as an integrating concept which articulates its object as being network-like. The growing use of the concept is intimately related to the introduction of the network perspective (e.g., Hughes, 1983; Castells, 1996; 1997; 1998). Freeman (1987: 1) defined the term originally as the "network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new

technologies". Similarly, Niosi et al. (1993: 219) have defined an innovation system explicitly in terms of a network, and so has the OECD (1999: 24). This concept emphasizes the decentralized nature of innovation creation; new innovations depend more and more clearly on mutual cooperative networks between business organizations and different knowledge producers. This concept therefore stresses the relationship between innovation and technical development, simultaneous interactive communication, the distributed, multilateral system of operation and the functioning of coordination between organizations (Freeman, 1987; Schienstock & Hämäläinen, 2001: 73). It is from this same experience of boundaries disappearing that innovation politics also emerges.

Network-policy

The general acceptance of the notion of a network as a major form of society's self-representation, the emergence of a social and economic order termed as an information society, and the engineering of new techniques for governance are by no means independent phenomena. Although they have their own histories, it is precisely the practices in terms of which they are mutually articulated that are of particular interest for our purposes. In fact, it is exactly this mutual articulation which constitutes the connection through which the idea of a network, the concept of information society, and the new political governance, largely appear to us.

This is seen especially in the way 'networks' have become both the object and the means of politics. For the new innovation policy, the network-form constitutes the precondition or foundation for governability, since the structures of business and industry, as well as the central social processes, have converted

mainly into network-like formations in the globalizing world (e.g. Castells, 1996; 2000). Political governance not only takes into account the increasing network-formation as the precondition of its own pursuit, but also actively endorses this process by promoting the mutual networking of actors involved in the production and utilization of knowledge. In Finland, as in many industrial countries, governance moves "from traditional operations models to strategic development and influencing based on cooperation networks" (The Science and Technology Policy Council of Finland, 2003: 26). Government through networks thus does not only denote cooperation with interest groups – although this is one of its most important forms of operation – but above all, it involves political steering through network-cooperation. More broadly understood, it means promoting the self-governing potentials inherent in a political community. Self-activating communities and civic networks are nurtured as an antidote to the negative effects of market forces and remote central government. Therefore, networks are not simply the realm within which projects are to be implemented – they are themselves *a means* of government (Rose, 2000: 329).

On the other hand, new concepts and forms of government have at the same time assumed a network-like shape. In public administration, the growing stature of 'network cooperation' both between different departments of government and between these departments and their interest groups illustrates the point well (The Science and Technology Policy Council of Finland, 2003: 25, 26; the Council directs and defines science and technology policies for the Council of State). Besides the administrative practices of government, the operations models of municipal administrations are also defined today by their intense and pronounced work with interest groups. Yet the streamlining of the central administration and the introduction of network cooperation not only characterize politics by giving it a new attribute, as it were, but the idea of a network has itself become a constitutive horizon for the thought and implementation of politics.

Innovation policy is not, therefore, merely a vehicle leading towards increased competitiveness, usually against international benchmarks. It is also an organized texture of scientific theories, institutional practices and political techniques which shape the decisions and behaviour of social actors, whether they are individuals, groups or organizations. Innovation policy creates subjects and actors by means of the language used. Thus the political language is never neutral but rather an integral part of the articulation of politics itself. The language of innovation policy seems to articulate a new way of thinking about the governance and practice of power in the age of economy, being based upon knowledge, network-form and the blurring of boundaries.[3] The new forms, concepts and practices of network guidance have, in fact, been conceived as a novel style of governance (Hirst, 2000: 19). The discourse of innovation systems weaves the governance of and by networks in a way that is itself both a precondition and a result of the transformation which has taken place in politics and in society.

Thus, networks operate as the means of government through methods and concepts which themselves are grounded in the idea of a network as indicated for instance by the importance of 'network cooperation'. Hence these methods and concepts organize the field of governance as if they were network-like. The forging of networks are supported, developed and assessed; networks are utilized, steered and co-ordinated. Nonetheless, networks are not just the object of politics but also the very form of

its execution: politics is realized expressly as the creation, promotion and development of networks. Network-facilitating policy has, in recent years, become an integral part of the innovation policy of industrial countries, which has also been taken into account in reports dealing with the Finnish innovation system (e.g. Schienstock & Hämäläinen, 2001: 12, 178-199).

An innovation policy is thus based on the immanent networking of socially consequential phenomena. This policy then attempts to exploit and steer the development: "the widening and deepening of network-cooperation has become one of the central issues for the developing of an innovation system" (The Science and Technology Policy Council of Finland, 1996: 42). On the other hand, this developing and steering illustrate precisely what innovation policy *is*: network-formation is the realization of this policy. Thus, it simultaneously both presumes and actively forges network-like reality itself.

Innovation Metaphysics

In the concept of an innovation system, two things meet: the necessity of government and the entailing unifying perspective, on the one hand, and the idea of a network, based on an ontologically open structure, on the other. This encounter, which constitutes the precondition for the concept, however, is also the reason for its principal problems. This encounter also unveils a common problem inevitably involved in all policymaking. Once the idea of a network assumes a technical formulation so as to make it a useful political concept, it closes and erects a boundary demarcating the inside and outside. While fastening all key components into place and closing the field of operations, this concept tends to become naturalized, in other words it becomes a given, uncritical part of the conceptual

system. Besides, this concept often reduces its objects to a group of necessary functional preconditions. This sort of approach, which leads to a kind of innovation metaphysics, tends to become incapable of conceiving innovation processes in the course of their own unfolding. Thus David Hart (2009), for instance, has argued that the National Innovation System approach has a difficulty in accounting for major changes in the US innovation system context, reviewing three such changes which are related to the Internet boom, counterterrorism, and productivity growth.

Nevertheless, this concept does not have any real and pre-existing object to which it denotes. There is no natural social entity called an innovation system. Therefore, it is legitimate to criticize the use of the concept in the research literature (e.g. Miettinen, 2002: 67, 77). But when pointing out the weaknesses of this approach the criticism does not say anything about the notion's truth-effects. Representations also create the object they represent; they give rise to new ways of thinking and acting. The concept of an innovation system has a reality of its own as an initiator of new ways of speaking and seeing – e.g. a new connection between organizations, institutions, and innovation actors that was not there prior to the concept. Thus the notion engenders its own object in the course of its articulation process: it constitutes new domains of reality and makes novel fields of existence possible (see Miller & Rose, 2000: 31). Although many key economic doctrines, from self-balancing markets to the theory of rational choice, have turned out to be fairly problematic and one-sided, they have had a seminal influence on the thought of society and thus on the functioning of society. Their import has broadened out from being a mere tool of analysis aimed at explanation to a whole horizon of social self-representation. These doctrines have intertwined closer

with social practices more than ever, and a greater number of people and institutions have begun to assess their own behaviour and that of others by using these conceptual models.[4] This could be characterized as the ontological dimension of the innovation system concept.

Thus, although an innovation system is an analytical concept, this is not the whole story. The notion should also be regarded as a productive concept which is part of a certain politico-historical condition. As the concept becomes more widespread, it includes in its sphere previously remote and relatively independent social actors who, for their part, by using the concept for the evaluation and anticipation of the outcomes of the different types of action, consolidate and expand the constitutive, ontological position of the concept. This is why one has to investigate how the innovation system concept has become a part of the political domain's problematization and the self-representation of the new technology policy.

Although the concept of an innovation system is metaphysical in the above-mentioned sense, it has its own truth effects and histories as part of the institutional practices it has become involved with. To be able to cut loose from the kind of 'innovation metaphysics' which takes the concept as a given, and secondly to take its ontological dimension seriously, one has to be able to see the concept as not an unchanging and universal frame but instead to draw attention to those historical, theoretical and social conditions through which the notion is given meaning in a given context. This also means that one has to move from the study of an innovation system to investigate how the object of the concept has been problematized as part of the question of governance. That is, how it has been set as the object of political thought through different, yet interlinked discourses.

Here, however, it is possible to present only a preliminary account concerning these questions, as an exhaustive historical analysis would require an investigation of its own. In the rest of the paper, I will examine how the different historical interpretations of the concept of an innovation system have influenced the way in which the concept has gathered institutions, relationships, and processes in Finnish science and technology policy. This also helps us to perceive the new form of governance which, in the name of innovation policy, has organized the thinking of the interrelations between technology, economy, and politics in Finnish society. This last section of the article is based on documentary analysis using surveys published by the Science and Technology Policy Council, although these documents do not constitute here comprehensive empirical data but serve only to illustrate the theoretical arguments of the paper.

The Finnish Innovation System

Finland has been reported to be the first country to adopt the concept of a national innovation system as a basic framework for its science and technology policy (Miettinen, 2002: 12; Sharif, 2006: 745). This notion has guided the implementation and the thinking of this policy not only through the surveys of the Science and Technology Policy Council and the related discourse, but also through different projects and undertakings. Such have been, for instance, the numerous technology programmes, technology centres and cluster projects often organized through these centres. Yet, as noted above, this concept has brought about a fairly coherent discourse which often has a shared terminology and common aims.

The notion of an innovation system has not been an unchangeable constant in the

Finnish technology policy, but it has been articulated mainly through three different interpretations. These are, basically, the notion's systemicity, its knowledge-based nature, and its openness. Each of these interpretations has organized the notion's content in a new way by bringing out dimensions and emphases that have articulated its meaning anew and, in this way, have connected the notion to new politico-historical horizons of action. These can be seen as being historically successive, but they are not entirely mutually excluding; rather they are interlaced with and articulated through each other.

The first interpretation assumed as its starting point the definition, included in the national innovation system, of the systemic, interactive character of the innovation processes. A shift in the technology policy occurred in the 1990s when the emphasis on national competitiveness emerged concurrently as a concern of social welfare. Traditional technology policy has become a science, technology and innovation policy aiming at harnessing competitiveness with the advancement of employment, innovations, and social well-being. At the same time, the linear interpretation of this innovation process was replaced by systemic readings. Whereas according to linear understanding, an innovation process is a succession of distinct, yet consecutive, stages from basic research to research and development, the systemic interpretation views innovations as the result of the interrelations of various actor groups at each stage of the process, as has been mentioned above (Lundvall, 1992: 12-3; see also Kline & Rosenberg, 1986).

The Science and Technology Policy Council (1990) adopted the concept of a national innovation system as a key framework to formulate the aims and scope of science and technology policy. Since then, this concept has been an integral part of the Finnish technology policy discourse. The most important influences, according to Tarmo Lemola (2002: 1485), came from the OECD's Technology and Economy Programme (OECD, 1992) and from the writings by Freeman (1987), Lundvall (1992), and Nelson (1993). In the Finnish technology policy, the concept has been understood to denote a whole set of public and private factors influencing the development and utilization of new knowledge and know-how (Lemola, 2002: 1485). The Finnish policy stresses the "central significance of an extensive *systemic* regeneration of innovation activity and society" from the economic viewpoint (Schienstock & Hämäläinen, 2001: 9-10; emphasis original).

In Finland, the notion of a national innovation system is based on the idea that the components and relationships relating to the developing of 'knowledge and know-how' – the basic elements of the system – can be conceived as a single entity (see e.g. The Science and Technology Policy Council of Finland, 1990: 17). The central value of the term was to enable one to think about these elements, their interrelationships, and the questions concerning the steering and governing of the thus composed, constantly changing structure in a systemic way that transcended the traditional branches of politics. This notion represented a way to recombine the fragmented field of politics from the viewpoint of generating innovations. If the earlier technology policy concentrated on promoting basic scientific research and key technologies because they were seen as starting points for the innovation chain, the concept of an innovation system contains a conception of an ensemble, formed of interlinked components, in which activities are formed into chains as a complex interactive series of events.

Another line of interpretation started to progressively centre on the idea of a 'knowledge-based society'. When Finland was recovering from a recession in the mid-1990s, the Science and Technology Policy Council (1996) introduced the concept of a knowledge-based society as a key vision to direct social development and as a concept to steer the science and technology policy strategy. The view of a knowledge-based society as the model for directing development strongly guided the Finnish science and technology policy in the 1990s (Innovaatiojärjestelmän uudistumishaasteet, 2002: 16). According to Lemola (2002: 1485), the concept and the thinking behind it came from the OECD Jobs Study, an extensive programme that was launched in the early 1990s (OECD, 1994; 1996; 1998). Once the creation of knowledge-intensive jobs was taken as a pronounced objective, it was recognized that a macroeconomic policy and labour policy measures alone could not ensure knowledge-intensive growth and that wide cooperation was needed which would transcend policy sectors (Lemola, 2002: 1485). Like the previous interpretation, the conception emphasizing the knowledge-based character of innovations also organized the fragmented field of traditional policymaking into a single entity, but did so from a somewhat different perspective. The concept of a knowledge-based society stressed the technical dimension of an innovation system and gathered questions relating to society and its development from the point of view of knowledge and technology. In its simplest form, the improvement of a 'knowledge society' – which was, for instance, the aim of the technology policy's definition of the government platform in 1999 – meant the development of the infrastructure founded on information and communication technology. Thus these technologies give the framework to speak of the characteristics of an information society and a way to legitimize this discourse. Attention is then directed especially to the promotion of "the infrastructure of a knowledge-based society" and the accompanying teleinformatic expertise (The Science and Technology Policy Council of Finland, 1996: 9).

In light of the surveys published by the Science and Technology Policy Council, the interpretation of the innovation system changed from a set of factors influencing innovation generation (The Science and Technology Policy Council of Finland, 1990: 17; 1993: 7) to a system which was enacted between the creators and users of knowledge (The Science and Technology Policy Council of Finland, 1996: 23, 39). The utilization of 'knowledge and know-how' came to the fore and what was foregrounded was the forging of efficient mechanisms for this purpose by means of using information technology, promoting the facilities of individuals and businesses, and developing the interplay between distinct political sectors (The Science and Technology Policy Council of Finland, 1996: 9, 39). The development of the Finnish information society, or at least its knowledge economy variant, thus constituted the framework against which the evaluation of the innovation system took place.

Finally the concept of an 'innovation environment' has started to gain ground as a conceptual perspective of the Finnish innovation policy – emphasizing the idea of openness as opposed to a closed innovation system (The Science and Technology Policy Council of Finland, 2003; Ministry of Trade and Industry, 2004; Sitra, 2005). This concept also provides a means to break away from excessively technology-driven approaches. The technology policy in Finland has been largely technology-centred, expert-intensive, and top down directed, which

are all manifested in the interpretations of the innovation system. In Finland, which retains many bureaucratic characteristics in its polity, generation of innovation has mainly been the domain of engineers. When moving from a technology policy, as it has been traditionally understood, to an innovation policy, the area of politics has been widened to include new points of view such as, for example, viewing the video game industry, although small in Finland, as part of technological production. Innovation policy discourse has also begun to stress so-called social innovations instead of those defined narrowly in terms of technology (The Science and Technology Policy Council of Finland, 2003: 4, 25). Secondly, in contrast to the expert-orientated system, formulations emphasizing activity emanating from citizens have emerged (e.g. Häyrinen-Alestalo & Pelkonen, 2004). Thirdly, a new emphasis has been placed on the significance of strategies stemming 'from below', based on individual actors and firms, for the whole innovation system (see for instance, the Science and Technology Policy Council of Finland, 2003: 32). The concept of an innovation environment constitutes an attempt to open up political discourse in all these directions.

The Finnish interpretation of the innovation system has been emphasized as a wide agreement about the existence, nature, and aims (Rask, 2001: 52) of the system. As Pauli Kettunen (1997), for instance, has noted, there is a long tradition in Finnish social thought to see matters as national necessities, and the notion of an innovation system closely follow this tradition. In this way, the discourse concerning the existence, character and aims of the innovation system is transferred outside politics proper and is apt to become a rather technical question. Thus, although the concept apparently allows multiple ingredients and interpretations, it tends, in the Finnish discourse, to emphasize unity at the expense of pluralism: instead of being a tool of bringing different interests and groups together to negotiate policy options, it rather tends to be presented as if it is an already accomplished totality.

Yet pluralism, that is, disagreement and differences of opinion, is an integral part of a political community. According to a long tradition of political philosophy, a political community is often defined above all by the possibility of disagreement. Conversely, each action that restricts this possibility to disagree is by definition antipolitical. The juxtaposition between contention and unanimity has profoundly shaped modern political history. Insofar as governance, functionality, and efficiency have been emphasized, diversity and disagreement have typically been displaced by a unified form as the foundation of mutual understanding. But diversity is, however, a fundamental part of politics itself, because it serves as an empirical basis of politics, as it were, the ground in and through which politics is articulated. Although today there is an attempt to consider diversity and unanimity as being together, as mutually constitutive rather than mutually exclusive dimensions (e.g. Eriksson, 2008), an innovation system concept cannot, in its political use, set itself completely free from the logic of demarcation and exclusion, which necessarily constitutes an integral part of its political identity.

This tension is reflected in the way the national innovation system has been conceived of as part of broader policy questions and is visible in each of the dimensions listed at the beginning of this essay (i.e. information society, advanced liberal governance and network). Thus, while it is important to improve the intellectual capabilities needed in an information society and promote knowledge-intensive growth, it has been said that development

measures should be "accurately assigned" mainly to higher education and research as well as to the utilization of research knowledge (The Science and Technology Policy Council of Finland, 2003: 57, 67). These measures are necessarily based on boundaries because research financing is about making allocation decisions. Earlier, molecular biology, biotechnology, tele-technology and data transmission, as well as industrial design were specifically named as keys for innovation systems (The Science and Technology Policy Council of Finland, 1993: 37), thus excluding many other innovative fields of study. Furthermore, while it has been significant to point out that the public administration is only one, albeit the most important actor in the innovation system, the Science and Technology Policy Council of Finland (1996: 23) has reported having witnessed in the 1990s, "the development of the whole innovation system in the condition of increasing management by performance". Basically, this means that only top-ranked fields and organizations are promoted, with the ranking scheme and the priorities involved being politically pre-set. Finally, while it has been acknowledged, for instance, that different governmental offices have to be able to work as a single network, reaching this goal presumes that policymaking concerning knowledge and information systems is "adequately centralized" to ensure compatibility (The Science and Technology Policy Council of Finland, 2003: 25). In this way, many fundamentally political issues are continuously organized and problematized in a complex relationship between 'governmental' and 'political' interpretations, that is, between the practical need to set boundaries and priorities on the one hand, and the effort to seek the common good without depending on a principle of exclusion on the other.

Thus, given what has been said above, an 'innovation system' can be understood to refer to an ontological area in which phenomena related to innovation creation come to be seen as constituting an intelligible and yet an open whole. This area is not immutable or static but is instead in constant movement, oscillating between opening and closing tendencies. In his writings Rosanvallon does not view the political as a constitutive area but rather as both a general form of collective action and as a formation process of an actual political community. Thus, there is an apparent tension or discrepancy in the political itself: on the one hand, it is the *field* of collective life, a social framework that brings all the different activities together, yet on the other hand it is a *project*, the process of unification of the social forms of self-description. Self-description is an essential part of society; without it no society would be possible (Rosanvallon, 2006: 34–36, 74). This view becomes more complicated as he further distinguishes between the political principle of democracy (the consistency of the collective subject) and sociological principle (multiplicity as a society of individuals) (Rosanvallon, 2006: 43). The political principle thus unifies and consecrates what the social principle tends to make less coherent. There is always a difference between these principles that cannot be undone: society will never truly be united.

However, it is not necessary to start from empirical multiplicity or tendencies to render it a consistent whole. Instead, one can start from the innermost area of meaningfulness that constitutes the precondition for political programmes and strategies, as I have done in this paper. This area is characterized by ontological openness – it forms a code through which different messages can become intelligible and yet it cannot be a message itself. This

is not the 'idea' of a community but rather a field of meanings in which the idea of a community can come into being. This field tends to change when it is appropriated and utilized in governmental discourse: administration is basically about fixing responsibilities and drawing boundaries to accomplish complex tasks (Kettl, 2002: 74, 153). In this interpretation, the tension in the political is not necessarily characterized by a discrepancy between a fragmented sociological multitude and a coherent body politic. It can also lie between an opening and enabling ontological structure (which does not need to be consistent) on the one hand, and demarcating and closing governance practices on the other.

Conclusion

This article has, I hope, clarified the often incompatible tendencies inbuilt in the concept of an innovation system and has shed light on the concept's historical change and articulation with respect to these tendencies. The concept aggregates diverse administrative routines, political institutions, industrial and commercial organizations, scientific theories, technology programmes, ways of representation, and forms of knowledge, which are all intertwined in the light of the perspective of knowledge and innovations. Within its framework, it has become possible, especially in the public administration, to conceptualize the questions of national government under the conditions of an information society and global competition. In this way, it relates to the quite practical, circumstantial needs of government. This necessity of government creates an integrated perspective through which it becomes politically possible to think and act on the implications of complicated social processes. This concept brings uniformity and coherence to a given phenomenon so that it can be taken as an object of thought

and action in some consistent way. This is because government always requires conceptual models to organize the area to be governed as an intelligible and consistent field with boundaries and characters of its own (Miller & Rose, 2000: 31). Nevertheless, this uniformity often causes the closure of the field of phenomena to be investigated. For example, the innovation system concept, according to Nelson (1993) in his retrospective conclusion, presupposes a much more fixed national unity than is actually the case. Moreover, it also tends to simplify the institutional and cultural context of innovation activity by having it wholly defined in terms of the commercialization of technological invention (Godin, 2009: 494). Because of its administrative nature, this concept tends to become a closing term: it gathers the field to be governed, localizes its most important players, and defines its boundaries.

On the one hand, the network-like nature of an innovation system leads one to an obvious recommendation: "cooperation and interaction between different parts of the innovation system has to be promoted and encouraged" (Lemola, 1995: 43). Commentators are invariably in agreement on this particular point (see for instance Bessant & Dodgson, 1996; Edquist & Hommen, 1999; Schienstock & Hämäläinen, 2001). On the other hand, the administrative element included in the concept tends to simplify an innovation system into an unambiguous whole as required by political performance. Although the Finnish interpretation has varied and has assumed different emphases, the uniting and unifying drive of the notion has not changed. This is because in order to be a useful tool for governance, the innovation system has to delimit the sphere of action and determine key players in a commonly recognizable way. Political usefulness requires the closure of the concept, which inevitably results in innovation metaphysics.

We need a conception of some common aims and objectives that enable us to identify what is significant and meaningful for us and distinguish this from what is insignificant and irrelevant. Something that is common and shared is therefore indispensable for the *sense* of an action. However, collective goals and common orientations are always based on the mechanism of exclusion: they exclude all that is dissimilar, that which does not accept the common end or does not go with it. An understanding of the innovation system as a coordination tool of a network-economy constitutes this kind of common space through which what is important can be distinguished from what is inconsequential so as to ensure a consistent orientation. Yet an innovation system is an idea of a set of processes and institutions which unavoidably excludes something. It has to be exclusive in order to be a usable political concept. Yet at the same time, it tends to be naturalized, in which case it is not exposed to radical contention and debate. Thus, what it excludes, then, is essentially the contention that characterizes political community. Society, however, is a pluralistic and constantly reorganizing field of practices and relationships that cannot be predefined, certainly not in a way which would result in some kind of completed whole.

The concept of an innovation system is an academic term, but it is also a political and administrative notion. This notion encapsulates a tension in-built in all policymaking. On the one hand, politics strives towards arrangements which could be capable of taking into account the change and transformation involved in any development, the dynamics of phenomena, and the emergence of what is new. In this sense, the concept of an innovation system is also an open one (e.g. Kaiser & Prange, 2004). On the other hand, politics requires concepts that, in order to be useful in operative terms, of necessity exclude all

that is divergent. By enclosing the idea of an open network into a more or less consistent conceptual system, and by acknowledging that the excluded difference is nonetheless constitutive of the identity of this system, the notion of an innovation system brings out the limits within which innovation policy can be articulated today. Insofar as the possibility for disagreement can be seen as being characteristic of political community, then opening the innovation system to radical contention would render it a genuine political concept. Thus, it would also mean the attempt to outline the kind of thought of an innovation policy that is no longer based on the exclusion of difference.

In conclusion, I hope this paper has contributed to research on innovation policies by showing the risks caused by the coming together of an empirically-oriented field of science, technology and innovation policy research with little emphasis on theorizing (e.g. Morlacchi, 2009: 572), and the tendency of new concepts to become naturalized components of the discourse addressing social problems. This can often result in the implicit belief that the political concepts we use do have a pre-political character, as it were, as if representing neutrally what is empirically evident to all. However, while language is an integral part of politics, concepts do have a political dimension. New concepts open up novel ways of understanding and phrasing social problems which, when becoming widely used, have broader ontological implications. Moreover, what often get unnoticed are the tensions and dynamics inbuilt in a given discourse: concepts are not static elements but they have vicissitudes of their own, as exemplified by the transformation of the concept of an innovation system in the context of Finnish technology policy. What is more, concepts have a tendency to become closed by losing both their openness and a living relation to the questions which formed their context

of origin. Yet maintaining conceptual openness is important not only because it keeps alive the links between language and its politico-historical contexts of use, but also because openness has a close relationship to democracy, at least if we embrace de Tocqueville's (1966: 449) view that language must be loose enough to leave the thoughts of democratic citizens play. This analysis of early American democracy implies that any activity which makes abstractions more precise would be undemocratic as they curb the free movement of democracy. If the purpose of policy scholarship is to understand and shape the ways in which key policy actors address society's problems (Morlacchi, 2009: 573), then paying attention to language and the way it is used is an integral part of this scholarship. These points would suggest focusing more closely on the historical vicissitudes of political concepts and their use, with a view to the social forms that these thwart and enable.

Notes

1 In innovations systems literature, the concept is not normally conceived of as being narrow but, on the contrary, often too broad and all-encompassing (e.g. Edquist 1997; Reppy 2000, 3). However, by simplification I refer not to narrowness but rather to the fact that in order to be a useful concept in policymaking, an innovation system also has to determine what is important and relevant and to demarcate this from what is not, and thus be capable of simplifying and systematizing the domain in question in order to represent it as an intelligible whole in the context it is used (Miller & Rose 2008, 31).

2 This, in fact, is also an important critique of the innovation systems approach, questioning the appropriateness of speaking of a 'national' innovation system as compared to many other,

possible more suitable categorizations, such as regional, technological, or sectoral systems (Nelson 1993; Lundvall 1998).

3 Recent empirical studies on the application of the innovation systems approach to a specific economy include Mathieu & Laberge (2007) and Sharif (2009).

4 See, e.g., Callon (1998, 50) for an interesting analysis of how economics actually creates and not just records the economy by providing the calculating tools for different economic agencies, which then become able to calculate their decision and also to include in their calculations the calculations of other agencies.

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How the Croatian Daily Press Presents Science News

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Research into media representations of science is widespread and well-established in scientifically and technologically highly developed countries. However, very little is known about the characteristics of media reporting of science in transition countries, which are only just beginning to recognize the importance of research into the relationship between science, the media and the public. In this study, using content analysis of the daily newspapers with the largest circulations in Croatia (Jutarnji list and Večernji list) we researched the quantity and quality of media reporting of science. We link them to the characteristics of the Croatian media (tabloidization, the erosion of professional criteria) and the wider social context from which they stem. Our findings have shown poor representation of science news in the daily press as well as a low level of trustworthiness, especially in reporting biomedical news.

Keywords: Science coverage, Media, Croatia

Introduction

Recent social constructivist approaches to the media's presentation of science claim that the media (and the public) are active participants in the process of construction and communication of knowledge (van Dijck, 2003). That is to say, the process of competition and selection of news takes place in the public arena of the media, where journalists and editors assess the newsworthiness of individual news items (Hilgartner & Bosk, 1988). They select and shape the topics and aspects which they perceive as relevant, important or interesting. News are constructed and shaped according to the accepted standards and conventions of the organization in which the journalist works. Those standards

and conventions are most often quite similar to the culture context in which the media exists (Nelkin, 1995; Lievrouw, et al., 1990, see Dimopoulus & Koulaidis, 2002). Therefore, the selection and framing of news are socially and culturally conditioned.

There are several reasons why the analysis of media coverage of science has caught the attention of researchers. Firstly, the media is an important source of information about science (Nelkin, 1995), and it has a specific role in achieving "scientific literacy." Secondly, media analysis can contribute to a better understanding of the social position of science. Many researchers have identified and analysed the dominant characteristics and trends in the media reporting of science in order to learn indirectly which definitions and opinions about science are promoted

and legitimized by various social factors, or what society thinks and knows about science (Anderson et al., 2005; Lewenstein, 1995; Bauer et al., 2006). Researchers study media as one of the (cultural) indicators showing the evaluation and position of science in society (Bauer, 2000). Thirdly, the media is an important part of the public sphere that reflects and forms public opinion.

More recent research into the forms and trends in media communication of science, undertaken in scientifically and technologically developed countries, has primarily shown the following characteristics of the media image of science.

First, scientific themes are not highly represented in the structure of topics covered by the daily press, but over time, there has been a noticeable (absolute and relative[1]) increase in science coverage in some types of media (Clayton et al., 1993; Pellechia, 1997; Bucchi & Mazzolini, 2003; Bauer et al. 2006; Elmer et al. 2008). This may be explained by the more rapid flow of information, the introduction of specialized science columns and supplements (Bader, 1990; Bucchi & Mazzolini, 2003), and also by the process Weingart (1998) calls the "medialization" of science.

Second, science, despite the rise of criticism, is dominantly presented in the media as progressive and consensual activity (Nelkin, 1995; Dimopoulos & Kouladis, 2002; van Rooyen, 2002). Third, media reports covering scientific topics mostly omit the methodology and contextual background, which may be a key to understanding scientific events (Pellechia, 1997; Dimopoulos & Kouladis, 2002). Fourth, in reporting on scientific topics there is a predominance of biomedical sciences (e.g. Bauer, 1998; van Rooyen, 2002; Bucchi & Mazzolini, 2003), which are becoming the prototype of the public image of science (Durant et al. 1992; Bauer, 1998; Verhoeven, 2008).

Researchers in this field have indicated that science news in general is largely considered "soft news" due to the insufficient (media) attractiveness of scientific findings and because the importance of science news is not always direct or immediately visible (Hansen, 1994; Weigold, 2001).

However, these studies were mainly undertaken in (Western) democratic countries, which have a high level of economic, scientific and technological development and a certain tradition of *public understanding of science* as a "movement" and research discipline (e.g. Clayton et al., 1993; Pellechia, 1997; Bucchi & Mazzolini, 2003; Bauer et al., 2006; Elmer et al., 2008).

Because transitional countries went through late social changes, they are only just beginning to recognize the importance of research into the relationship between science, the media and the public. This is why studies on the media's coverage of science are very rare and why so little is known about the characteristics of media reporting of science in these countries[2]. A British-Bulgarian comparative study (Bauer et al., 2006) has already indicated some of the special features of Bulgarian reporting of science, and thereby confirmed the importance of the socio-cultural milieu as the social framework in which science news is selected and framed.

Apart from a lack of knowledge about the situation regarding the reporting of science in Croatia, there are several reasons why we consider the analysis of science coverage in Croatia, as a transitional society, an important research topic. The existing studies of media representation of science in non-Western countries are very rare (Schäfer, 2010). Therefore, knowledge of science coverage in the media is largely dominated by science images in highly

developed countries. Moreover, few comparative studies of highly developed and transitional countries (e.g. the already mentioned comparative British-Bulgarian study) point to certain specificities and possible differences in media selection and approach to science topics, arising from differences between societies. Many researchers have suggested that the socio-cultural milieu is an important factor that shapes media practices and "journalistic culture." For example, Guyot (2009: 92) argues that the actual local "journalistic practice is strongly marked by national historical situations and values linked to a particular context in which the media were built". Similarly, the media coverage of science is also shaped by broader sociopolitical and sociohistorical contexts, social values, general attitudes toward science, etc. This is why generalizations about media coverage of science that are based on analyses in developed democracies and in democratic, highly professional media should not be considered adequate enough for analysing and understanding media representation and science communication in transitional societies.

Despite many similarities in the socio-historical legacies of former socialist countries, some remarkable specificities have marked the transformation of each of these countries. As a part of former Yugoslavia, the media in Croatia had greater freedom in comparison with other socialist countries and could have had a relatively "successful" media transformation. Unfortunately, the transition process in Croatia has been characterized by very turbulent transformations that began during the war and led to social, political and media specificities and deviations.

Therefore, the media image of science in Croatia may be a research topic of wider interest. Croatia is a transitional country in which the media have only recently begun to become democratic and commercial and in which, due to a preoccupation with the major social, political and economic transformations, science primarily has only declarative social relevance.

Croatian Context

It is difficult to objectively assess the quality of the printed media in Croatia today. The liberalization of the media began at the end of the 1980s. Over the past twenty or so years, the printed press, as well as other types of media in Croatia, have gone through many legislative, ownership and economic changes (privatization, de-monopolization), which are also reflected in the editorial concept of newspapers. Democratization and the expansion of commercial media have greatly altered the media, which have taken on market characteristics. On a wider social plane, there is an increasingly obvious link between the media, politics and the market. There is no longer a threat of control nor are there displays of power by the state, but instead, by major media corporations (Valković, 2009).[3]

However, the transition from state ownership towards the mass media market does not necessarily mean an increase in the quality of information (Jergović, 2004a). Guyot (2009) points out that the media and journalists in transitional countries had to deal with previously unknown market pressures and very rapid changes. The previous "social responsibility" of the socialist press (Robinson, 1977), seen plainly in their responsibility towards the state political order and ideology (Vujević, 2001; Jergović, 2004a), has been replaced by tabloidization, sensationalism and an increasing proportion of "soft news" and infotainment (Kronja, 2008; Jergović, 2004a).

According to some assessments, the printed media in Croatia in the 1990s – under the influence of a multitude of transitional factors and the spread of tabloidization – became a media of sensationalism and journalism of questionable quality. Professional and ethical standards became seriously threatened as well (Jergović, 2004a; Skoko & Bajs, 2007). The educational level of journalists in the new media context decreased. According to data from the Croatian Journalists' Association from 2004, 60% of journalists who were members of the association and 75% of young journalists who were yet to become members did not have a university degree (Jergović, 2004b: 400).

Today, analysis of the characteristics and consumption of the Croatian media shows that the printed media have a large share of the market within it. According to research into the frequency of use of individual media in Croatia, the printed media occupy third place, after television and radio (Peruško Čulek, 1999: 176). In 2004, immediately before this research was conducted, according to data from the agency Puls, the daily press was read on average by 44% of the Croatian population[4].

The Croatian public is characterised by a very small proportion of people with higher education, accounting for only 8% of the total population (*Croatian Bureau of Statistics* - CBS). From the rare research into the Croatian public related to the daily press, we have learned that women in Croatia, for example, mainly read the accident and crime news ("The black chronicles") as well as local news and entertainment, while science is not even amongst the top ten topics which the average female audience in Croatia finds interesting (Kunac & Sarnavka, 2006). Therefore the data on the scientific literacy of the Croatian public is not surprising; although not completely disappointing, the data shows a definite lag behind scientifically and technologically more developed countries (Eurobarometer, 2005: 41). Moreover, domestic surveys show both – scepticism and trust – in the cognitive and social benefits of science (Prpić, 2011).

It is therefore not surprising that science journalism was not able to develop in these circumstances. This was certainly encouraged by the intensity of the social transformations in all spheres of society (political and economic transition), which directed the media's attention towards the current radical social, political and economic changes on the one hand, and towards light and entertaining content on the other. Science, as in many other former socialist countries, was considered primarily as expenditure and marginal activity.

Aims of the Study

Since no similar studies have been conducted previously in Croatia, the main objective of this paper is to examine the dominant quantitative and qualitative characteristics of the presentation of science in the most widely read Croatian daily press. Emphasis is placed on identifying the basic formal characteristics of media reporting on science, examining the differences in science coverage between the two leading daily newspapers, examining the differences in the presentation of different scientific disciplines and acquiring basic data about trustworthiness of science coverage. Ultimately, the results are linked with a broader social and media context of a transitional Croatian society, bearing in mind the dominant patterns and trends in media communication of science in developed Western societies. Approaches and results from "western" studies are used only as methodological referent points and frames, as a means for developing instruments and collecting data, without the intention of comparing results. This is

due to the differences in the selection and definition of science news, media types, analysed time periods, etc.

Media credibility, as a complex and multidimensional concept, has long been a research topic in media studies. Researchers point out two types of media credibility: source credibility (trustworthiness of the individual sources, Hovland & Weiss, 1951) and news medium credibility (the overall credibility of television and newspapers, Graziano & McGrath, 1986). Our index is more modestly conceived, and it measures only one part of this complex concept – it manifests impartiality and integrity of media reports. More precisely, in this study we define trustworthiness as an approach to scientific news in terms of the quality of information processing. Due to the fact that the index was post-hoc constructed from the available data, we could not dig deeper into other media credibility dimensions.

Kurtić (2007) indicates the following elements as relevant indicators of manifest impartiality and integrity of media reports: (types of) quotes and citations[5], listing sources of information[6], depth and scope of the verification of information[7], confrontation of information and sources, quantitative relationship between factographic, and finally, interpretative elements. More specifically, researchers indicated that a better quality text will have more of the already mentioned indicators – statements, quotations and additional information (in-depth approach), and only a text that clearly defines its sources of information can be considered trustworthy (Kanižaj, 2007; Žlof, 2007; Malović, 2007).

Taking into account the availability and nature of the analysed articles, we have reduced the indicators to the following elements: *sources of information, quotations of experts and in-depth approach*. Thus our instrument has some limitations (e.g. no

evaluation of source credibility, inclusion of only some dimensions), but it still represents a simple measure for analysing the basic differences in media reporting trustworthiness. Deeper analysis would certainly require further upgrading and introducing other approaches for analysing media trustworthiness.

Method

In order to achieve our basic goal, the research was founded on the content analysis of articles about science published in the period between December 31, 2004 and February 28, 2005 (a total of 116 issues)[8] in two of the most widely read Croatian daily papers, which are also the leading papers of two media corporations: *Jutarnji list* (EPH) and *Večernji list* (STYRIA) (MEDIAPuls, 2004.). The average circulation of *Jutarnji list* in 2004 was 41% and for *Večernji list* 38% of the country's population aged *15 years* and over.

We acknowledge that an analysis of media coverage of science cannot be reduced solely to the press. However, the fact is that most researchers, due to economic and availability restrictions, analyse the press, most often the elite daily press. This study is also determined by availability and costs of the research data. Further important reason for choosing the press was the possibility of expanding a future study to newspapers from the past and then comparing the results. By choosing the two most widely read daily papers rather than elite ones, we attempted to acknowledge the criticism aimed at researchers, saying they should move away from researching the elite press since it is over-represented in relation to its readership (Evans & Priest, 1995).

Since our study is the first of its kind in Croatia, we chose the convenience sample (2 months) to gain basic insights into the media image of science in Croatian most-

read daily papers as well as its specificities. It also allowed us to identify key variables for further upgrading and analyses.

Research into the presentation of certain (non-scientific) types of news in the Croatian daily press has led to the conclusion that, in terms of content and presentation of the news, these leading papers can be defined as "semi-tabloids" (Dragojević et al., 2006). Neither of these newspapers has a separate daily or weekly section dedicated to scientific topics – newspaper supplements mainly focus on other topics, and science news most often competes with other types of news.

The basic unit of analysis were those articles that explicitly reported the results of scientific research (including presentation of scientific discoveries), reported on scientific events (conferences, symposia, seminars and workshops) or gave reviews of science books or portraits of scientists. For research purposes, these articles were called *science news*, and a total of 360 were identified. Articles dealing with events related to science (or higher-education) policy, such as the Bologna Process, or those in which scientists appeared as commentators on current social topics and events (e.g. presidential elections), were excluded from the analysis.

Science news was analysed by using a code matrix adapted to the needs of our research. The code matrix (appendix) was developed by combining elements from previously conducted and published foreign studies that used content analysis to examine various aspects of reporting on science, as well as elements relevant to establishing the basic characteristics of the presentation of science (e.g. thematic division of sections). Coding articles about science was undertaken using mainly manifest variables, such as an announcement on the front page, the length of the article, the use of graphics, and by

avoiding variables that demand a subjective value judgement as much as possible. This increased the reliability of the coding.

The coding was done by the authors of this paper using the printed (paper) copies of daily newspapers, rather than an electronic archive, due to its limitations[9]. All coded articles were selected after carefully reading the complete article according to the agreed guidelines. The data was processed in SPSS, and the following statistical analyses were used: chi-square test, linear regression, *T-test* and one-way ANOVA.

Results

The Formal Characteristics of Science News

Size and Frequency
In a two-month period, a total of 360 articles defined as science news were found and analysed. 163 of the articles (45.3%) were published in *Večernji list* and 197 articles (54.7%) in *Jutarnji list.* About half of the science news published in both papers (*Večernji* – 54.9%, *Jutarnji* – 47.2%) covered only one quarter of a page. If we take into account the total number of articles in both papers, the proportion of science news in both daily papers in a period of two months was only 2.3%. However, t-tests showed that the analysed dailies differ significantly according to the average proportion of articles about science (t=-2.399, df=1, Sig.=.000). The proportion was significantly larger in *Jutarnji list* (2.63%) than in *Večernji list*, averaging 1.93%.

Position and Character of the Sections
Only 2.5% (N=5) of the articles were announced on the front page of *Jutarnji list* and 0.6% (1) in *Večernji list.* The largest number of science news throughout one week was published on the back pages of both newspapers (*Večernji list* – 28%,

Jutarnji list – 27%). More than half of the news published on the back pages fell into the category of regular articles in *Jutarnji* called "Good News" and "Bad News" and in *Večernji* "IN" and "OUT". Both newspapers used special colours to categorize their regular articles ("Bad News" and "OUT" were coloured red, while "Good News" and "IN" were blue-green or green). As a rule, these articles were located at the bottom left-hand corner of the page. The location and average space used was less than 15% of the page, showing that the news published under these headings were truly marginal, and in visual terms, almost excluded from the page.

The thematic division of sections and supplements into *serious*, *mixed* and *entertainment* enabled a more detailed analysis of the positioning of science news within the paper[10]. *Serious* sections and supplements were those whose content was primarily news or analysis of daily socio-political events. *Mixed* supplements and sections contained both serious and entertaining news, and the back page of both papers often featured (apart from entertaining news) the latest serious news items, which usually arrived "at the last minute" just before going to print. The supplements and sections described as

entertainment were those that primarily dealt with topics such as fashion and home decorating, beauty and show business.

Most of the science news items in both papers were published in serious sections of the paper (Jutarnji 45.4%, Večernji 45.7%), and a little less than one quarter were published in the "mixed" sections (Jutarnji 23.9%, Večernji 17.3%). Although *Jutarnji list* and *Večernji list* did not differ significantly regarding the characteristics of the sections in which they published science news, *Večernji list* had a slight tendency to report science news more often in sections of an entertaining nature (Jutarnji 30.7%, Večernji 37.1%).

Journalistic Form

The reluctance of journalists to show interest in research work and editors to allocate more space for science was evident from the fact that more than half the science news published in both papers fell under the journalistic form "(short) news" (Table 1). Still, *Jutarnji list* used this form of journalism less often in comparison with *Večernji list*, but published significantly more commentaries, critical reviews and analyses, which represented about one quarter of the total science news in that paper.

Table 1. The journalistic form of science news articles (N=360).

	Večernji list	*Jutarnji list*	Total
News, information	60.1%	50.3%	54.7%
Report, feature	22.7%	20.3%	21.4%
Commentary, critical review, analysis	12.3%	25.4%	19.4%
Interview	3.1%	2.0%	2.5%
Combination of elements	1.8%	2.0%	1.9%
Total	100.0%	100.0%	100.0%

χ^2= 14.004, df=4, Sig.=0.016

Graphic Design and Appearance

Science news articles have an abundance of graphic illustrations and about 70% of them were enriched with illustrations in both newspapers, which in 95% of cases were photographs. Apart from rare cases, such as a photograph of a plant, the graphics usually did not aid in better understanding the scientific content. They were "visually attractive" photographs, not related to the content of the text, such as a woman eating, children playing or people in a park. Illustrations that could help explain science news or complement them were used extremely rarely, in only 1% of news items.

Types of Science News

The press prefers science news about scientific research results or about the application of scientific results (Table 2), which is in accordance with the observation of the domination of so-called "gee-whizz" subject matter, a large number of "spectacular" discoveries and breakthroughs (Jerome, 1986). Apart from the results of research, which accounted for more than half the news, in *Jutarnji list* another quarter of the science news is related to presentations of scientific publications (books, journals) whilst in *Večernji* about the same proportion consisted of presentations of areas of science, portraits of scientists and/or their work.

How Science News is Reported

The media frequently omit methodological and contextual information, the exact elements which some authors mention as critical for a complete newspaper report on scientific topics (e.g. Pellechia, 1997). Considered in total, science news in both newspapers stayed mainly on the level of description, which means that about 70% of this news did not deal with causes and consequences, nor did they give detailed descriptions of processes or events.

Science news items were mainly written by journalists in both papers (*Večernji list*, 35%; *Jutarnji list*, 50%). However, we noted statistically significant differences in "news authors" (χ^2=42.860, df=4, sig.=0.000). Scientists were the authors of articles to a significantly greater extent in *Večernji list* than in *Jutarnji list* (3.6%), but they still amounted to only 8%. *Jutarnji list* emphasizes more agency news (35%), and a large number of news items, as many as 18%, in *Večernji list* are unsigned, whilst in *Jutarnji* there are significantly fewer of these (9.1%).

Table 2. Types of science news by daily paper.

	Večernji list	*Jutarnji list*	Total
News on scientific research results	53.4%	55.8%	54.7%
Conferences, symposia, promotions	8.6%	5.1%	6.7%
Presentation of fields of science, portraits of scientists	26.4%	13.2%	19.2%
Presentation of scientific books or journals	11.7%	25.9%	19.4%
Total	100.0%	100.0%	100.0%

χ^2= 19.128 df=3 Sig.=0.000

Statistically significant differences were also found in the category *"identification of actors"* (χ^2 =14.232, df=1, sig.=0.000*)*. In about half of their science news articles (55.3%), *Jutarnji list* published the full names of the actors the article is about, whilst in *Večernji list* only one third of the news items gives their precise names (39.9%), and in the other third (36.8%) they give attributes such as "Italian, Czech scientists" or general terms like "meteorologists," "experts," and "doctors." When it came to news on scientific research and the applications of research, *Večernji list* mentioned the exact names of the people involved in the research in only one quarter of these news items, compared to almost one half in *Jutarnji list*. The precise name of the institution where the person came from or in whose name he/she was speaking was given even more rarely in both papers. In *Jutarnji list* the institution name was given in one third of the articles and in only one quarter of the articles in *Večernji list*.

Construction of the Trustworthiness Index

In order to create a clear picture of the treatment of science news in the two daily papers, and taking into account the known characteristics of Croatian media context, we constructed an index of the trustworthy reporting of science news.

The index is a composite scale formed by adding up the results obtained from four variables which represent the elements of trustworthy reporting of science news. These are variables which establish whether the *primary source of information* is given in the article (0= no, 1= yes), then whether an *additional source of information* is given (0= no, 1= yes), whether the opinion of an expert as a "trustworthy" source is cited (*quotations by experts;* 0= no, 1= yes), and how the article is presented (0= superficially, 1= in depth (causes, consequences)), that

is, whether the causes and effects are taken into account. By adding up the answers, a scale is obtained with a range of 0 to 4, where 0 is the lowest level of seriousness, and 4 the highest (Cronbach Alpha=0.71). The index of trustworthiness of science news reporting gives a simple overview of the journalists' and editors' approach to science news in various categories.

In line with the results already described, the t-test (t=4.493, df=358, Sig.=0.000) showed that *Jutarnji list* attained on average a significantly higher result on the trustworthiness index of science reporting (1.82) in comparison with *Večernji list* (1.14).

Linear regression analysis was performed to identify statistically significant predictors ("formal characteristics" as independent variables) of the trustworthiness index (as a dependent variable). Regression analysis indicates the spatial and graphical characteristics (page number, coverage of space, graphics) as significant predictors of the trustworthiness of reporting science news (regression model explained 38% of the variations, F-ratio=34.763 sig.=0.000). Trustworthy science news is characterised by being located closer to the front page of the paper. This is the result of the fact that the front page usually carries news which are dealt with more detail, given more space on the page and accompanied by graphics and illustrations.

The analysis of the trustworthiness difference between the two papers is particularly interesting in terms of the type of science news (Graph 1). Apart from the fact that *Večernji list* lags behind *Jutarnji* in trustworthiness of presentation of all types of news, one-way ANOVA performed on both papers showed that they were least trustworthy when dealing with the results of scientific research, which is also the category of science news most present in the press. When reporting the results of scientific
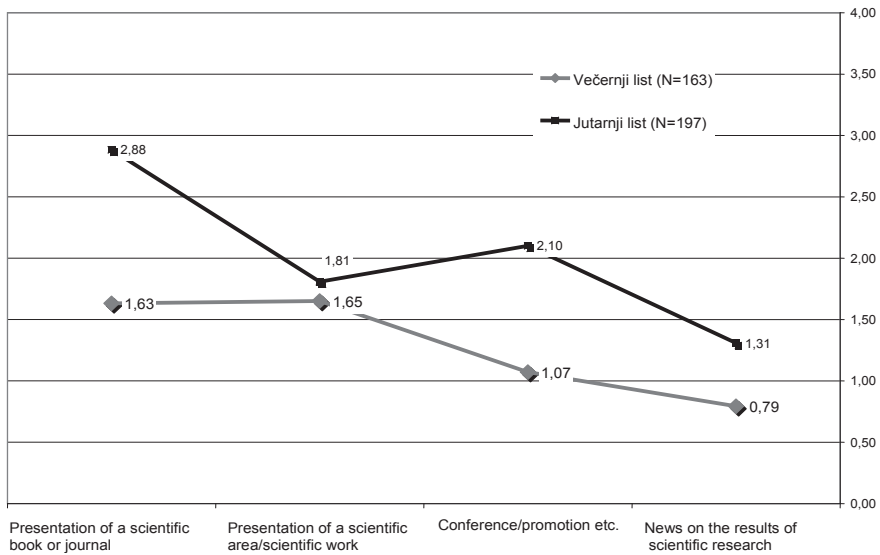
Večernji list: F= 7.007, df=3, Sig.=0.000; *Jutarnji list*: F= 19.068, df=3, Sig.=0.000

Graph 1. Average value of trustworthiness index when reporting science news, according to type of news.
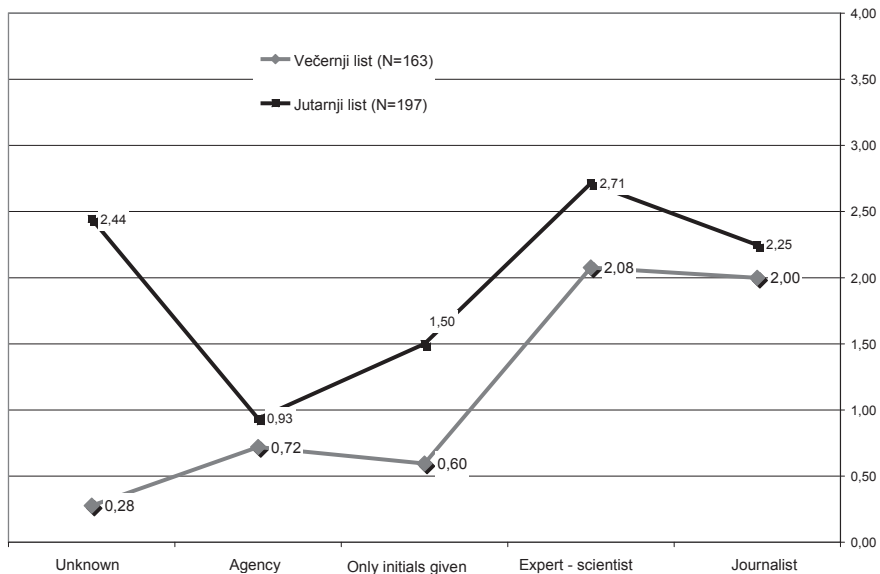
Večernji list: F=26.129, df=4, Sig.=0.000; *Jutarnji list*: F=12.688, df=4, Sig.=0.000.

Graph 2. Average value of the trustworthiness index, according to author of news.

research, *Jutarnji list* met on average at least one of our criteria, while *Večernji list* on average almost never met even one.

Analysis (one-way ANOVA) of the average value of the trustworthiness index in both dailies indicated significant differences between different "news authors" (Graph 2).

The most "serious" authors of articles in both papers were science experts, although relatively few of them were listed as authors: only 8% in *Večernji list* and about 4% in *Jutarnji list.* Next came journalists who on average respected at least two of the four criteria of trustworthiness of reporting in both papers. In *Večernji list*'s articles where the author is unknown, it was usually impossible to find even one piece of information which gave the article even some form of legitimacy. *Jutarnji list*, on the other hand, made up for unknown authorship with at least two of the four pieces of information, making the article trustworthy. In *Jutarnji list*, agency news reports were the least reliable, which accounted for as much as 30% of the total science news in that paper. If we excluded from our analysis news which did not meet at least one of the mild criteria – articles

where no author was indicated, agency news and news signed with initials only – the amount of science news in *Večernji list* would literally be halved, and its share in the total number of articles would fall to less than 1%.

Coverage of Scientific Fields
The biomedicine field was covered to a slightly larger extent than other fields in content analysis of news in both newspapers. This is to some extent in line with the trend of the "medicalization" of the media image of science, recorded in other studies (Pellechia, 1997; Bauer, 1998; Bucchi & Mazzolini, 2003). However, the predominance of biomedicine in the Croatian daily press is still not so strong. Although it covered about 30% of science news, the natural sciences accounted for about 20% and human and social sciences were very close to the same share (Table 3). About 75% of the news concerning biomedical sciences reported the results of research or applications from the field, but this was also the case with social and natural sciences. News from the humanities were significantly different since they were characterised by a high

Table 3. Science news by area of science (N=360).

	Večernji list	*Jutarnji list*	Total
Social sciences	20.2%	17.8%	18.9%
Human sciences	17.8%	23.4%	20.8%
Natural sciences	20.9%	21.3%	21.1%
Biomedical sciences	27.0%	29.4%	28.3%
Biotechnical sciences	11.0%	2.0%	6.1%
Technical sciences	3.1%	6.1%	4.7%
Total	100.0%	100.0%	100.0%

χ^2= 15.393, df=5, Sig.=0.009

proportion of presentations of scientific books, approximately the same amount as the number of news items regarding research results.

Although biomedical news was the most represented, the trustworthiness of reporting on this area in the Croatian press did not follow global journalistic trends. In terms of trustworthiness, biomedical sciences were convincingly the worst off out of all the fields in both daily papers, followed by the natural sciences (Graph 3). Graph 3 shows that most trustworthy reporting in both papers was on news from the fields of biotechnology and the humanities and social sciences.

Further evidence of the fact that biomedical sciences were reported as less trustworthy and more superficial than news from other fields of science can be seen from the following: about half of the articles on biomedicine used only general terms for the people involved, for example, "doctors", "Italian scientists", "Swedish physicians",

while in a further 15% of articles, the people involved were not even mentioned. In contrast, more than half the articles gave the precise names of the relevant protagonists in the category of social sciences. Only about 15% of the relevant participants in biomedical articles were from Croatia, while, for example, more than half of them were from Croatia in news regarding the humanities.

As many as one third of articles published in *Večernji list* related to biomedicine were not signed, and another third were only signed with initials (Table 4). The impression is that *Jutarnji list* treated science news generally better than *Večernji list,* but the relationship towards the area of biomedicine was similar: the editors of *Jutarnji list* used agency sources for half the items of news in that field.

More than two thirds of news about biomedical sciences were published in sections and supplements of an entertaining and mixed character, and less
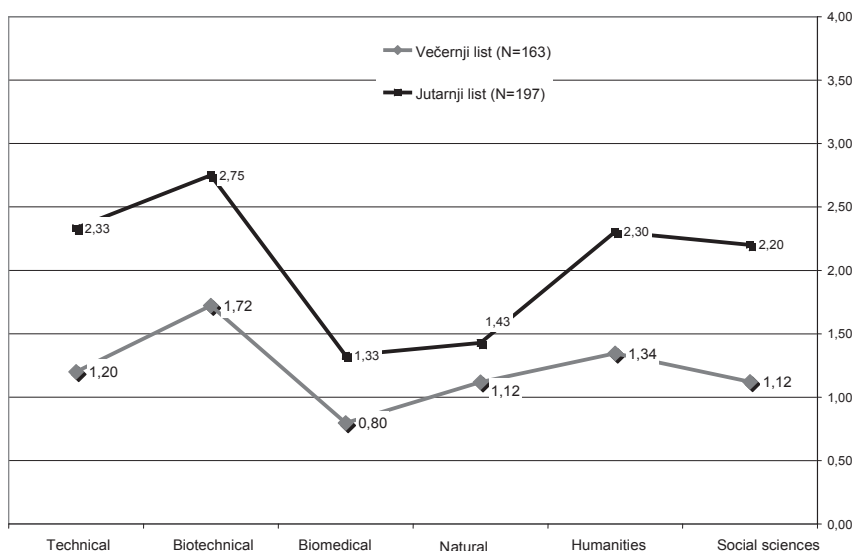
Graph 3. The average values of the trustworthiness index, by scientific field.

Table 4. The authors of science news, by scientific field.

	SOCIAL SCIENCES (N=68)	HUMAN SCIENCES (N=75)	NATURAL SCIENCES (N=76)	BIOMEDICAL SCIENCES (N=102)	BIOTECHNICAL SCIENCES (N=22)	TECHNICAL SCIENCES (N=17)
Journalist	52.9%	38.7%	44.7%	27.5%	40.9%	88.2%
Expert-scientist	4.4%	5.3%	0.0%	1.0%	54.5%	0.0%
Only initials given	10.3%	18.7%	13.2%	22.5%	4.5%	5.9%
Agency	13.2%	24.0%	34.2%	32.4%	0.0%	0.0%
Unknown	19.1%	13.3%	7.9%	16.7%	0.0%	5.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

than one third in sections and supplements of a serious nature. The situation with the natural sciences was similar (Table 5). This is also related to the fact that the news was often published without the names of the author and relevant participants; therefore it was not included in the serious sections.

Such "accommodation" of biomedical and natural science news inside the paper may also be the result of the editor's awareness of their information deficiencies. Just to make a comparison, over two thirds of news items from the humanities and over half of the news from the social sciences

Table 5. Science news in terms of the character of supplements and sections in which it is published, by scientific field.

	SOCIAL SCIENCES (N=68)	HUMAN SCIENCES (N=75)	NATURAL SCIENCES (N=76)	BIOMEDICAL SCIENCES (N=102)	BIOTECHNI-CAL SCIENCES (N=22)	TECHNICAL SCIENCES (N=17)
Serious supplements and sections	55. 9%	66. 7%	28. 9%	22. 5%	95. 5%	58. 8%
Mixed supplements and sections	20.6%	13. 3%	25. 0%	27. 5%	. 0%	11. 8%
Entertaining supplements and sections	23. 5%	20. 0%	46. 1%	50. 0%	4. 5%	29. 4%
Total	100. 0%	100. 0%	100. 0%	100. 0%	100. 0%	100. 0%

were published in serious supplements and sections, which is in accord with the data on the trustworthiness of reporting in those fields.

Discussion and Conclusion

Overall, the proportion of articles about science in the analysed Croatian daily press correlates to some extent with the findings of foreign studies, where the proportion of scientific topics usually ranged between 1% and 5% (Pellechia, 1997; Dimopoulos & Kouladis, 2002). In view of Croatia's transitional social, R&D and media context, especially tabloidization and almost completely undeveloped domestic scientific journalism, we can even say that the Croatian printed media have an enviable proportion of articles related to science. We may ask ourselves whether this is perhaps a reflection of the sociohistorical tradition of "socially responsible" journalism and the declaratory political world view value given to science as a means of social progress, which finds its roots back in the socialist social system and ideology. But this is an open research problem, requiring a more complex diachronic approach and goes beyond the scope of this analysis.

However, the correlation between our and foreign results probably stems to a large degree from a different definition of scientific articles. Our study, in contrast to most foreign ones, included in its analysis articles referring to the social and humanistic disciplines, in order to gain a more comprehensive insight into the representation of scientific subjects. The proportion of articles thereby increased. However, more important than the proportion of science articles was the finding that they were very short, uninformative, characterised by a very superficial description and lack of crucial information. Neither of the two newspapers

can boast of good and trustworthy reporting when it comes to science news. Moreover, in this qualitative dimension, the media image of the sciences can be seen in the lack of journalists' professionalism, not only due to the lack of a group of domestic journalists specialized in reporting on the sciences, but also due to the general erosion of journalistic criteria (Jergović, 2004a; 2004b).

Both daily papers lacked a systematic and analytical approach to reporting science news, whether in terms of the quantity or quality. However, *Večernji list* stood out in both senses as more superficial and more careless in its reporting; despite its longer tradition, it does not have a single journalist specialised exclusively in science news. Although *Jutarnji list* does not have a specialized science column, thanks to its one journalist specialized in covering science news, the paper showed slightly better results.

Carelessness, superficiality and the marginalization of science as subject matter were noticed in both papers when analysing the location of science news within the paper, the length of the articles and especially the journalistic and/or editorial approach to the news. This approach is characterised not only by a lack of additional information regarding sources, but also by the absence of basic information, from the actual source of the journalistic scientific story to the protagonists involved and to linking the causes and consequences. In this kind of approach, graphics, if used at all, were most often decorative and not at all informative.

The domination of biomedicine as a worldwide media trend (especially articles reporting applicable discoveries) was also noticed in Croatia and could be seen in the fact that the media featured news which emphasized the social and not the cognitive dimensions of science, that is, their application and close relationship with everyday life. However, despite the

slight editorial/journalistic preference for news from the fields of biomedicine and the natural sciences, the media treatment of these areas was on a low level. In fact, it was much worse than the presentation of the humanities and social sciences.

The results showed that news about natural and especially biomedical sciences in the Croatian daily press had the status of incidental news, entertainment, news that "fills the gaps" on the back pages, and were taken from news agencies (*Jutarnji list*) or from unknown sources *(Večernji list)*. This tells us that media reporting of the sciences is subject to the general media style of the time, marked by tabloidization and infotainment. In the case of natural and biomedical sciences, domestic sources were very rarely contacted and cited, and the domestic scientific elite in that field were truly neglected in the Croatian press. This may be explained by the domination of more relevant research and discoveries from other (more developed) countries, but also by the fact that the domestic scientific community is neither recognized by the media nor accustomed to public appearances. Their reluctance to appear in public, also reflected in the small proportion of expert articles, could be partially explained by the scientific community's heritage of a certain autonomy in which they did not have any real obligation or need for communication with the general public about their contribution to social development. Amongst Croatian scientific journals, the *Croatian Medical Journal* is the only medical journal that issues regular press-releases. Unfortunately, the results of this analysis clearly showed that the journalistic impact of these press releases, which is a common finding of foreign research, was lacking in the case of Croatia, especially in the biomedical sciences. In Western Europe and the USA, the custom of eminent scientific journals, primarily medical journals, is to publish press releases that contain a summary of the most interesting studies from individual issues. Some studies suggest that as much as 80 percent of news from medicine and other sciences published in daily papers are taken from these sources (Entwistle, 1995: 921; de Semir et al., 1998: 295).

On the other hand, the somewhat higher quality and more trustworthy approach as well as a larger proportion of social and human science news is in contrast to findings that suggest a higher epistemological status and representation of the natural and biomedical or "hard" sciences (Cassidy, 2008). This divergence may be connected to the prestige of the socialist media format, in which the social and humanistic disciplines were covered more often and with more information due to their function within political and ideological purposes. Although the media's social responsibility has changed, and it is not possible to speak of such frequent political instrumentalization of these scientific disciplines today, it is possible that it still exists within the social value system. On the other hand, their relatively solid and "trustworthy" treatment can also be explained by the fact that journalists in the Croatian media, by the logic of their education, are more often recruited from graduates of the humanities and social sciences faculties (Malović, 2002). Editors and journalists covering humanities and social topics are therefore more often educated professionals, who can show their interest and understanding of the topic in a deeper and more appropriate manner.

In order to point out the important implications of our analysis, we recall that the daily press is for the average reader an important source of information about science in Croatia, as well as elsewhere in the world. However, at the same time, the press both forms and reflects the public's interest in these subjects through its attitude

towards science. In terms of media coverage and the trustworthiness of its treatment, science comes across in Croatian society as a somewhat neglected and marginalized topic, which few are interested in. Here we have in mind not just the culture/context, but also the characteristics of a poorly educated and uninterested audience to which a specific content is offered. In such social context, the media treatment of scientific topics is not surprising, and therefore neither are the results of this form of media communication.

Additionally, the poor educational structure of the population, the poverty level in the country and following international trends are all responsible for the widespread sensationalism and tabloidization (Vilović, 2003). Under the influence of the transitional factors and the influence of the international media, bringing commercialization and sensationalism in the approach to news, as well as tabloidization (Vilović, 2003), investigative journalism has not developed in this region. Instead, so-called pseudo-investigative journalism developed, characterised by unverified information, unfounded speculation and the disproportionate use of unnamed in relation to named sources (Vilović, 2003; 2004).

The social context of an uninterested and poorly educated public and the tabloidization of the media where ethics gave way to the aggressive demands of the market (Vilović, 2004), also affected science news. Our results have shown that news very often became only one form of entertainment, somewhere in between superficiality and sensationalism, and were often used to fill empty space at the last minute with news from agency sources. This trivialization and fragmentation of news, according to McNair (2003), affects the ability of the public to analyse information and act rationally.

The growing number of domestic public debates, such as those related to artificial insemination and the reorganization and financing of the scientific research sector, are based on scientific arguments. It is not necessary to point out the advantages of the participation of a scientifically literate and informed public. They are able to objectively assess the arguments in such debates, especially in the context of the mentioned dualism of the public perception of science as well as the gradual "democratization" of the domestic scientific research system. Where can the adult non-scientific public be expected to find information that can help them take an informed and objective part in decision-making, if not through the media?

The question is, who should we expect to offer better and higher quality content, taking into consideration the average journalist's educational level, as well as their journalistic culture. Since 2001, the Croatian Journalists' Association has only accepted members who are journalists with a university degree (Malović, 2000). However, the generational shift has been slow, and the number of poorly educated journalists is still high. A solution could perhaps be found in the greater inclusion of scientists in dialogue and the process of creating news related to their field. In that way, by engaging the scientists with media and public, not only could the level of trustworthy reporting of science news be raised, but also the public's trust in the reported information as well, which would result in a better informed public with greater involvement. According to research into the public's confidence in public figures and institutions, after the Church, Croatian citizens have most confidence in scientists (FPZ, 2009). Also, the results of European research show that scientists are the people in whom citizens have the most confidence when it comes to explaining the impact that

science and technology have on society as a whole. The respondents were asked to rank the institutions and professions they believed were most qualified to explain to the public the impact of science and technology on the development of society as a whole. They first chose scientists working in public institutions or universities (52%), then television journalists (32%), scientists employed in private institutions (28%), and finally journalists in daily newspapers (25%) (Eurobarometar, 2005: 49). Furthermore, Hovland and Weiss's (1951) findings could support the involvement of scientists in media communication of science since they are perceived as potentially more trustworthy than other sources.

The conclusions of the Congress of Croatian Scientists from the Homeland and Abroad, held in 2007, pointed out the need for scientific institutions to aim their efforts towards better, more frequent and efficient communication with the press, as well as the need for journalists to be trained professionally so they are best able to cover and contextualize scientific topics. In line with the guidelines adopted and the increased awareness of the need to communicate with the media, a growing number of scientific conferences and workshops are being dedicated to scientists' education in communicating with the wider public. But only future research will be able to examine the specific results of these activities.

In conclusion, we consider the findings of this study, especially its implications, important on two levels. On the first level, they are significant from the perspective of knowledge and comparison since they pointed out certain characteristics of media presentation of the sciences in a transitional society, which are not only shaped by media and global changes in the relationship between science and society, but are also the product of a transitional context in which

they arise and its socialist legacy. Further research into the media image of science in transitional countries should certainly integrate a developmental but also a comparative (international) aspect in order to enable the adequate contextualization of the findings.

On a second level, the findings are important from a practical perspective. They indicate that the Croatian scientific community should become more actively involved not only in drawing media attention to scientific topics and research, but also to the future participation in the scientific and technological policies of the country, as well as in dialogue with the public. On the other hand, Croatian journalists and editors should become aware of their social responsibility in providing information on science and technology, that is, in (co)creating the public's understanding of science, and in encouraging public participation in scientific and technological debates and policies. The media should develop a trustworthy, analytical and critical relationship towards science, respecting professional (and ethical), and not only the commercial criteria of their profession. The appropriate involvement of all participants in the process of the public communication of science is an important element in the development of what is known as a "knowledge society".

Acknowledgements

Notes

1 Bauer et al. (2006) notice the increase in the absolute number of scientific articles with a simultaneous reduction in terms of actual newspaper space.

2 Schaefer (2010) in meta-analysis of studies on the media's coverage of science noticed that analyses on non-Western countries are extremly rare.

3 The ownership of the Croatian printed media is mainly in the hands of two media corporations: EPH and STYRIA, which demonstrates the concentration and concealed monopolization of the media (Vilović, 2003).

4 Agency Puls conducts regular "media consumption research" 365 days a year, by means of telephone surveys (CATI) on a stratified random sample (sex, age, level of education and county) of 115 people a day (805 a week, 41,975 a year). The survey is conducted not only for radio and television stations, but for all the relevant press in Croatia as well (13 daily papers and about 80 magazines). The survey includes respondents aged 15 and older who are able to read and write.

5 Citing is a method that journalists employ to reinforce the credibility of their data and enhance the content value (Kurtić, 2007).

6 Hovland & Weiss (1951) analysed the influence of source credibility and noticed that trustworthy sources can more easily change the public's opinion than untrustworthy sources can.

7 According to the rules of the journalistic profession, journalists should have at least two independent sources (Kurtić, 2007).

8 Our study is exploratory and serves to define expectations and boundaries for future studies. Although consecutive day sampling can potentially limit generalizibility of findings, this techique is a) commonly used in content analysis (e.g. Sakura, 1993; de Semir et al., 1998; Elmer et al., 2008) and b) relatively representative because it captures variations in day to day coverage, avoiding oversampling individual weekdays (although constructed week procedure is more efficient; see Riffe et al. 1993).

9 Electronic archives of these dailies are incomplete and do not always contain complete articles.

10 The code matrix contains names of all sections and supplements. Later they were grouped by the authors into 3 categories: serious, entertainment and mixed, according to the agreed guidelines.

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