

Developing Mixed Reality Technologies for Urban Environments

Communication Bridges

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Abstract

This paper is a contribution to research on mediums of communication in participative urban project processes. It draws upon the results of an ongoing European research project, IPCity: 'Interaction and Presence in Urban Environments'.¹

As city-making practices are evolving in response to emerging social, economical, cultural and environmental challenges, urban projects become strategic implementation tools. This entails wider stakeholder involvement and calls upon participative methods in order to (1) enable co-elaboration of urban projects through encounters between varying levels of knowledge and expertise, (2) support consensus-building among diverging interests, and (3) address individual expectations and principles. The transformation of urban projects from design-oriented processes into multi-actor decision-making environments raises multiple questions concerning the communication mediums used and the dominant role that visual material occupies. Mixed reality (MR) technologies reveal themselves to be promising tools for enriching communication and social interaction. IPCity explores the potential use of MR in urban project negotiation processes and in creating communication bridges between the diverse actors and stakeholders involved. It also investigates the possible communication bridges across the various disciplines involved in the research process and co-design of technologies.

The emerging culture of participatory processes and negotiation in city making

The quest for appropriate responses to the late modernity's social, economical, cultural and environmental challenges, require a major revision of the past's development methods. In the field of urbanism, the realization of the reflexive processes of modernization,² and the world's increasing

entropy and complexity in both private and public spheres, generate concepts such as sustainable and integrated development. These concepts emphasize the interdependencies of various spatial, temporal, environmental and social scales, and give rise to an urban development paradigm based on trans-disciplinary methods.

New urban governance approaches are required to respond to emerging political and social demands for more inclusive and transparent processes, to the growing uncertainty concerning the evolution and management of urban systems, to the search for innovation and creativity, as well as to the complexity of decision-making processes that result from the multiplication and diversification of stakeholders.³ Emerging practices correspond little to the past's normative and regulatory processes, which rely on methods of prediction and aspire to control development through legislation and large-scale public projects. The urban development scene becomes within this context an 'arena' of constant negotiation; negotiation among different stakeholders, over contradictory – even conflicting – interests, based on practices such as communication, trust-building and participation, as well as contractual agreements for collaboration and consensus.⁴

City-making tools evolve in keeping with these evolutions. Urban planning attains an increasingly strategic character while urban projects – limited in time and space – become the structuring elements of the planning process.⁵ Urban projects constitute within this new context the operational framework for tackling technical, social, environmental and aesthetic issues related to different scales of interrogation (local and global, short-term and long-term). Furthermore, they allow a flexible but articulated macro-micro and public-private action, promoting innovation and creativity.⁶ The prominent role of urban

projects entails the participation of a larger number of actors in the project's life cycle. On one hand, the project partners that would previously intervene periodically along the process are integrated on a longer-term basis (politicians, contracting authorities, technical services, real estate developers, project managers, urban experts, architects, etc.). On the other hand, a wider range of local and global stakeholders (local businesses, inhabitants associations, NGOs, etc.) intervene in the process as project partners.

The wider stakeholder participation in urban projects reclaims many benefits. At the same time, it gives rise to questions on the conditions and outcomes of the participative process. These questions concern the power games between stakeholders⁷, the structures and forms of decision-making and participatory processes⁸, the communication mediums, the role of representation, rhetoric, and finally, discourse⁹. The present paper relates to the latter group of research. It questions the relevance of visual materials currently used in urban development practices as communication medium and addresses new perspectives for research on communication tools adapted to the changing urban project process.

In search of shared languages: the question of medium

One of the research issues on participative processes in city-making practices concerns the communication media and the use of visual, oral and/or written expression.¹⁰ Communication and information sharing are challenging issues when actors of diverse professional cultures, academic training, economic standing, and social priorities are involved. This is more in the context of urban projects, which have their proper language codes. Moreover, factors such as the subjective nature of communication and the role that media plays in the communication process contribute to the complexity of the negotiation process and lead to ethical questions on the production and use of the communication tools.¹¹

In city-making practices, visual expression retains a somewhat different relation to oral and written expression compared to other fields of practice. Visual material is commonly used to illustrate texts and speeches; whereas, in city making it constitutes the basis of all written or oral expression.¹² It structures the interaction between different actors, different forms of information concerning the project, as well as different project phases. It also contributes to the distribution of roles among various actors. All these factors affect the power structures

among stakeholders, as well as the themes brought into discussion.¹³

In spite of the fact that visual material proves to be efficient when handled by architects, engineers or urban planners, its central role in city-making practices can be problematic in diversified multi-actor environments.¹⁴ There are several arguments for this. On one hand, visual representations involve language codes that are not always comprehensible for those actors who are not design oriented.¹⁵ On the other hand, the definitive character of most visual material understates the approximations inherent to representation methods.¹⁶ Besides, the subjective interpretations of such representations depend on the socio-cultural and professional background of each actor, leading up to ambiguities with regard to the use and impact of visual material.¹⁷ Nevertheless, visual material seems to inspire trust and more so with the use of new visualisation techniques (CAD, GIS, etc.).¹⁸ Such techniques are perceived as serious, precise and exact by the non-initiated who ignore the fact that their use involves a high degree of subjectivity.¹⁹ Visual material is often conceived with the intention to convince, to please and to seduce. For these reasons, its neutrality, scientific nature, and exactitude of information should be debatable.²⁰ These discrepancies in the use of visual material highlight the risk of 'false' consensus in the participative urban project processes: they may hinder the transmission of information, as well as the communication between different actors and mislead the discussion by curtailing important issues.

One possible solution to the risks involved in the use of visual material would be to provide pedagogic assistance to the non design-oriented actors in order to facilitate comprehension and to prevent misunderstandings.²¹ Nonetheless, as Söderström explains, visual material used in architecture and urban planning has evolved through time in relation with new approaches to architecture and city making: this evolution has in turn influenced city-making approaches.²² Within the transversal, negotiated and participative urban project processes, the projects' represented forms become the supports upon which strategies and programming are taking form through an iterative and integrative process.²³ Thus, there is the need to launch and examine hypothesis for communication media adapted to the emerging city-making practices; that is to say, tools capable of representing urban and architectural issues in ways that promote and expand meaningful

participation by favoring shared languages, interactivity and equity. Recent studies in digital media have shown that mixed reality (MR) is a highly promising field in research on innovative communication means and representational languages.

IPCity: exploring the potential of mixed reality tools as negotiation media

Mixed reality (MR) is the merging of real and virtual worlds somewhere along the reality-virtuality continuum that connects completely *real environments* to virtual ones. MR technologies augment the virtual world with physical elements (augmented virtuality) or the real world with virtual ones (augmented reality).²⁴ (Figure 1) Current research on MR technologies affirms their potential in the creation of collaborative environments that bring a wide constituency of stakeholders together to discuss, negotiate and decide on urban and architectural issues. MR technologies appear to enhance accessibility to the negotiation process by providing multiple and complementary means of expression and by increasing comprehension of the issues addressed.²⁵

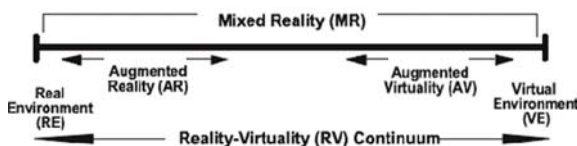


Fig 1: Mixed reality's definition within the Reality-Virtuality Continuum (Milgram & Colquhoun, 'A Taxonomy of Real and Virtual World Display Integration')

IPCity: 'Interaction and Presence in Urban Environments' is an integrated European research project bringing together researchers of various backgrounds.²⁶ The project's aim is to study the potential of mixed reality for the development of technological systems that enable different actors involved in an urban project or event to collaboratively develop their vision, debate over emerging developments, share past and future views of their local environment, and discover new aspects of their cities. The different application scenarios of the project correspond to its four showcases: urban renewal projects; large-scale events; explorative entertainment, and storytelling applications. Within the 'Urban Renewal' showcase, the research revolves around the possible contribution of MR technologies in creating multi-actor collaborative environments that promote and enrich the newly emerging urban project culture. The objective here is to develop communication tools that promote the integration of diverse stakeholders to the negotiation process in

meaningful ways. They support joint itinerancies through a diversity of urban and architectural issues and sustain the co-elaboration of development strategies as well as inventiveness and creativity.²⁷

IPCity's researchers study the representational and social interaction potential of MR technologies through an action-research method: a 'qualitative' approach that combines theory and practice and involves an iterative process advancing on the basis of circles of problem analysis, action intervention and reflective learning.²⁸ The MR systems are being progressively developed as 'technology probes', that is to say, simple, flexible and adaptable technologies that are introduced in an early phase of the development process to support the co-design of technologies. As such, they are meant to contribute to multiple interdisciplinary objectives: the social science's quest for understanding; the user's needs and desires in a real-world setting; the engineer's need to field-test the technology, and the designer's goal to inspire end-users and researchers to think about new technologies.²⁹



Fig 2: IPCity Workshop at Pontoise (June 2009): Inside the MRTent

The 'technology probes' of the 'Urban Renewal' showcase are being field-tested through regular workshops that simulate negotiation processes on urban projects in progress. The workshops bring together a large spectrum of stakeholders concerned by the evolution of the urban projects: public authorities, urban experts, private stakeholders, as well as NGOs and representatives of local communities. They are held in the MRTent, a mobile laboratory which makes it possible to work in the project site. (Figure 2) While participants work on specific urban questions related to the project theme using the MR technologies, IPCity researchers keep track of the progress of the negotiation process. The collected material serves for a joint analysis on both the use and appropriation of technologies and their contribution to the social interactions occurring among stakeholders, as well as to meaning-making

in urban project related issues. The acquired feedback is used to identify and address specific research orientations and to guide further technological development. It also allows researchers to define the guidelines for the following field trial (urban project/site selection, scenario building, urban issues to be addressed, etc.): the aim is to be able to examine the relevance of MR technologies in different contexts and in relation to a diversity of urban issues and stakes.



Fig 3: The 'Color Table' and the see-through installation

The MR system developed within the 'Urban Renewal' Showcase is called 'Urban Express'. This system enables users to augment real urban scenes with computer-generated elements in real-time and in a collaborative manner. The mixed reality urban scenes are rendered against a set of vertical backgrounds that allow for a multitude of viewpoints on the project site: real-time video streams, panoramic photos and a see-through installation. 'Urban Express' actually regroups two applications: the 'Color Table' and the 'Urban Sketcher'. The 'Color Table' is a multi-user tangible interface that allows for creating mixed reality scenes by positioning tokens on a multi-scale map surface and associating them to various visual and sound contents. (Figure 3) 'Urban Sketcher' allows users to create simple 3D models directly on the scenes, to apply textures, to sketch and to annotate on layers or 3D objects. (Figure 4)

content's variables (size, color, transparency, offset, speed, direction and the sound volume).³⁰

The visual and sound contents used to create the mixed reality scenes are prepared beforehand and stored in the system's library and/or generated *in situ* (user-generated). The content library is created by IPCity's urban, visual and sound specialists. It is set on the basis of a collective reflection concerning the characteristics of the urban projects at hand, the workshop scenarios, the urban issues addressed and the capacities of technological applications. The workshop participants contribute to this reflection through a preparatory inquiry process, the 'cultural probes', which corresponds to semi-structured interviews.³¹ The library contains objects such as 3D models, images, textures and sounds that represent different building types, landmarks, green spaces, materials, flows, activities, urban ambiances, paths etc. They may also be abstract inspirational images and sounds, which can stimulate the participant's imagination, draw on his/her memory, inspire creativity, and above all, trigger the expression and exchange of tacit knowledge.

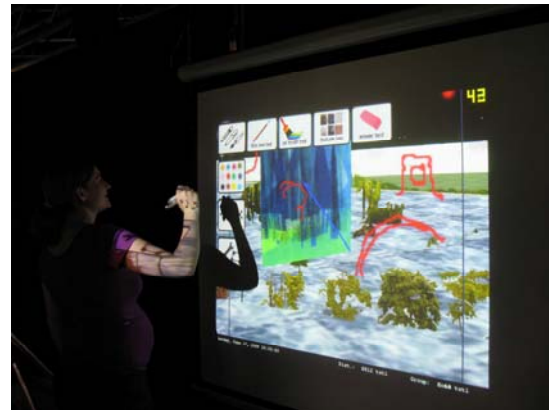


Fig 4: The 'Urban Sketcher'

The purpose of the work undertaken is to provide the stakeholders involved in a project with a wide range of means of expression and to enable them to actively contribute to the collective understanding of urban and architectural issues and stakes related to the project site, as well as to the construction of shared visions of the evolving urbanscapes. Through the collaborative process of collaging and 'distorting' visual material, sounds and animations, it is possible to promote inventiveness, creativity and co-operative brain-sharing.³² The integration of sounds and animations enlarges the means of expression and scope of comprehension by enhancing various aspects of urban experience that are integral to the negotiation process.³³ These include flows,

rhythms, and temporalities. The interactive and real-time simulations enable the engagement in "what if?" games where physical tokens become explicit thinking tools.

While participants discuss issues pertaining to the site with the help of 'Urban Express', and share their reactions to the content library and MR technologies, the research team observes their social interactions. Attention is paid to the participants' needs and expectations with respect to the technologies, as well as to the ways they appropriate and use the tools to communicate, debate, negotiate and collaborate. More importantly, the research team observes the negotiation process from which the collectively constructed cityscapes emerge. These observations allow the researchers to trace the influence of MR technologies on the different modes of expression employed during the interactions, and to determine if there is an impact on the prioritization between the different expressive modes.³⁴ In fact, while workshop participants manipulate the communication tools and contents, their words and gestures are empowered and become an important integrative and integrating component of the consensus-building process. The outcomes of these MR mediated negotiation processes are sets of approximate future urban scenes, bringing together a diversity of visual and sound references that are articulated by shared narrations mixing information and evaluations. (Figure 5) As such, they can serve as 'intermediate design objects', that is to say guidelines for further design on the basis of shared aspirations and visions.

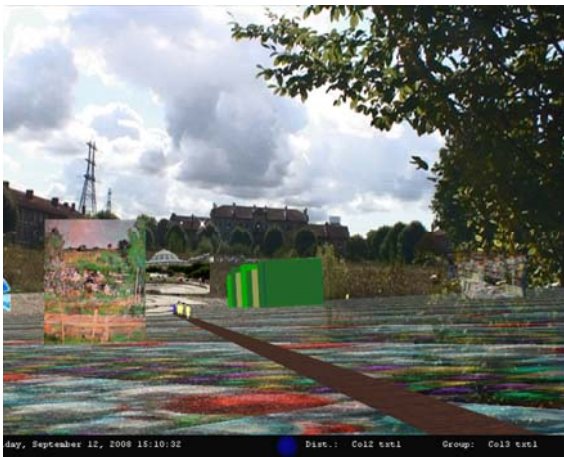


Fig 5: Collective vision for the requalification of the 'Caserne Bossut' at Cergy (IPCity workshop in September 2008)

Discussion and perspectives

City-making practices evolve into transversal and participative procedures, making urban projects both the object of this process and its medium. Within this mutating context, the pertinence of existing communication media is

brought into question. Although visual material - the predominant communication medium - is a powerful tool for design-oriented actors, it involves risks of 'false' consensus within multi-actor environments integrating non design-oriented stakeholders. The emerging urban project culture of wider participation and negotiation requires renewed modes of expression, representation and communication. MR technologies with their capacity to offer interactive and easily accessible communication tools may prove to be an effective way of responding to the specificities of this context. IPCity draws together a wide range of researchers in order to examine jointly the validity of this proposal through an approach that progressively structures the complex and inadequately defined research themes discussed earlier through the bridging of different disciplines and the transgression of their boundaries.

'Technology probes' are the basis of the collective, collaborative and self-reflective inquiry process of IPCity: they serve within the 'Urban Renewal Showcase' as communication bridges structuring a double co-design process. On one hand, they enable participants to appropriate the developed communication media in his/her own way to express his/her needs and expectations. This enables the co-elaboration of MR scenes that render shared visions of the future cityscapes. On the other hand, they become the bridges of communication between the end-users and researchers of different backgrounds in order to co-elaborate the technological specifications of such media on the basis of multi-perspective feedback. The research agenda of IPCity becomes more precise as the experimentations progress, and as researchers and urban project actors identify, specify, implement and test boundary objects.³⁵ The development of such boundary objects enables an increasing number of stakeholders to effectively articulate the design of the communication tools, and to contribute to the urban project negotiation process while ensuring the integration of multiple perspectives.

Notes

- 1 IPCity (FP-2004-IST-4-27571) is an EU funded Sixth Framework programme Integrated project. <http://www.ipcity.eu>
- 2 Ulrich Beck, Anthony Giddens & Scott Lash, *Reflexive Modernization: Politics, tradition and aesthetics in the modern social order*, (Stanford: Stanford University Press, 1994).
- 3 Patrick le Galés, 'Du Gouvernement des villes à la Gouvernance Urbaine', *Revue française de Science Politique*, 45, 1 (1995) : 57-95, in Peter Newman & Andy Thornley, *Urban Planning in Europe: International Competition, National Systems and Planning Projects*, (London: Routledge, 1996).
- 4 Alain Bourdin, Marie-Pierre Lefeuve & Patrice Melé, *Les règles du jeu urbain : Entre Droit et Confiance*, (Paris : Descartes & Cie, 2006).
- 5 Patsy Healey, Abdul Khakee, Alain Motte & Barrie Needham, eds, *Making Strategic Spatial Plans: Innovation in Europe*, (London: Routledge, 1997).
- 6 Ariella Masboungi (ed), *Fabriquer la ville. Outils et méthodes : les aménageurs proposent*, (Paris : Documentation française, 2001) in Peter Roberts & Hugh Sykes, *Urban Regeneration: A Handbook*, (London: Sage, 2000).
- 7 Bourdin, Lefeuve & Melé, 'Les règles du jeu urbain : Entre Droit et Confiance' Ian Bentley, *Urban Transformations: Power, People an Urban Design*, (London: Routledge, 2001).
- 8 James Simmie, 'Planning, Power and Conflict', in Ronan Paddison, ed., *Handbook of Urban Studies*, (London: Sage Publications, 2001), pp. 385-399; Mark Reed, 'Stakeholder participation for environmental management: A literature review', *Biological Conservation*, 141, 10 (October 2008): 2417-2431; Florent Joerin, Aurore Nembrini, Marie-Claire Rey & Gilles Desthieux, 'Information et participation pour l'aménagement du territoire. Potentiels des instruments d'aide à la décision', *Revue Internationale de Géomatique*, 11, 3-4 (2001): 309-332.
- 9 Ola Söderström & Markus Zepf, 'L'image négociée', *DISP*, 134 (July 1998): 12-19; Deborah Martin, Eugene McCann & Mark Purcell, 'Space, scale, governance and representation: contemporary geographical perspectives on urban politics and policy', *Journal of Urban Affairs*, 25, 2 (2003): 113-121
- 10 Visual material such as sketches, maps, plans, models, photographs or computer synthesized images are the central communication media in city-making processes. Oral expression allows for discussion, commentary, explication and narration since it is the most accessible medium to all the implicated actors. Written documents alongside visual material serve to inform, as well as to record the decisions taken at different stages.
- 11 Negotiation implies the encounter of different subjective states and the search for consensus. It is ethical because it aims to define common values so as to support collective action. Since it presupposes diverging or even conflicting views, it involves one's will to convince the others in view of one's economic, social and aesthetic priorities. (Thierry Paquot & Chris Younés, ed., *Ethique, architecture, urbain*, (Paris: La Découverte, 2000). The communication medium becomes in this context a strategic tool to manipulate in order to achieve respective objectives. (Edgar Morin, *La Méthode. La connaissance de la connaissance*, Paris: Seuil, 1986).
- 12 Ola Söderström, (1996), 'Sélectionner et projeter', *Espaces Temps*, 62-63 (1996): 104-113.
- 13 Söderström & Zepf, 'L'image négociée'
- 14 Kheir Al-Kodmany, 'Using visualization techniques for enhancing public participation in planning and design: process, implementation and evaluation', *Landscape and Urban Planning*, 45, 1 (1999): 37-45
- 15 Henry Sanoff, *Visual research methods in design*, (New York: Von Nostrand Reinhold, 1991).
- 16 Enrico Chapel, Isabelle Grudet & Thierry Mandoul, 'Images spatiales et projet urbain', in Yiannis Tsiomis, ed., *Echelles et temporalités des projets urbains*, Paris: Jean-Michel Place, 2007, pp. 111-122.
- 17 Reto Soliva & Marcel Hunziker, 'Beyond the visual dimension: using ideal type narratives to analyse people's assessment of landscape scenarios', *Land Use Policy*, 26, 2 (2009): 284-294.
- 18 Michel Lussault, 'La politique territoriale (trans)figurée', *Espaces Temps*, 62-63 (1996): 92-103.
- 19 Philip Brey, 'The ethics of representation and action in virtual reality', *Ethics and Information Technology*, 1, 1 (1999): pp.5-14.
- 20 Daniel Estevez, *Dessin d'architecture et Infographie. L'évolution Contemporaine des Pratiques Graphiques*, (Paris : CNRS éditions, 2010).
- 21 Jean-Jacques Terrin, 'Les expertises relatives aux ambiances dans la conduite de projet', in Thérèse Evette & Jean-Jacques Terrin, eds, *Expertises techniques et conduite de projets urbains*, (Les Cahiers RAMAU), 4 (2006): 23-56.
- 22 Söderström, 'Sélectionner et projeter'
- 23 Jean-Jacques Terrin, 'La construction des expertises techniques au sein du processus de projet urbain', in Michel Bonnet, *Conception, réalisation et gestion de la ville : quelles perspectives en Europe ?* (Paris : La Documentation Française, 2005), pp. 101-119.
- 24 Paul Milgram & Herman Colquhoun, 'A Taxonomy of Real and Virtual World Display Integration', in Yuichi Ohta & Hideyuki Tamura, eds, *Mixed Reality - Merging Real and Virtual Worlds*, (New York: Springer-Verlag), 1999, pp. 1-16.
- 25 Wolfgang Broll et al., 'ARTHUR: A Collaborative Augmented Environment for Architectural Design and Urban Planning', *Proceedings of the Seventh International Symposium on Human and Computers HC (Tokyo, 2004)*, pp. 102-109; Rune Nielsen, Thomas Fabien Delman & Tobias Lussing, 'A mixed Reality Game for Urban Planning', *Computers in Urban Planning and Urban Management conference (CUPUM 05)*, (London, 2005); Hartmut Seichter & Marc Aurel Schnabel,

- 'Digital and Tangible Sensation: An Augmented Reality Urban Design Studio', Proceedings of the Tenth Conference on Computer-Aided Architectural Design Research in Asia -CAADRIA 2005-, New Dehli, 2005, pp.191-202.
- 26 IPCity's researchers represent disciplines such as computer engineering, cognitive sciences, social-psychological and cultural-anthropological disciplines, architecture and urbanism, industrial design, as well as visual and sound arts.
- 27 Michel Callon, 'Concevoir : Modèle hiérarchique et modèle négocié', in Michel Bonnet, ed., *L'élaboration des projets architecturaux et urbains en Europe. Volume I. (Les acteurs du projet architectural et urbain, Paris: PUCA, 1997)*.
- 28 David Avison, Francis Lau, Michael Myers, Peter-Axel Nielsen, 'Action Research', *Communications of the ACM*, 1, 42 (1999): 94-97
- 29 H. Hutchinson, W. Mackay, B. Westerlund, B. B. Bederson, A. Druin, C. Plaisant, M. Beaudouin-Lafon, S. Conversy, H. Evans, and H. Hansen, 'Technology Probes: Inspiring Design for and with Families', CHI -CONFERENCE- (2003), 17-24
- 30 For a detailed explanation, please refer to the IPCity website: <http://www.ipcity.eu>
- 31 'Cultural probes' is a widespread technique used in Human-Computer Interaction for provoking inspirational responses from the intended users of a design. It is a method inspired by the Situationists (psycho-geographical maps) and the Fluxus movement and it provides the users with means for expressing their feelings, longings, fears, etc. It serves to understand local cultures, bridge distance, identify diversity and differences. (Bill Gaver, Tony Dunne & Elena Pacenti, 'Design: Cultural probes', *Interactions*, 6, 1 (January-February 1999): 21-29)
- 32 Ranulph Glanville, 'Variety in design', *Systems Research*, 11, 3 (1994): 95-103
- 33 Pascal Amphoux, 'Ambiance et conception : de l'analyse des ambiances à la conception architecturale et urbaine', Conférence internationale Herbert Simon : Sciences de l'ingénierie (Sciences de la conception. Actes du colloque du 15-16 mars 2002, Lyon: INSA, 2002), pp.19-32
- 34 This is done within the scope of presence studies. Presence can be defined as the 'perceptual illusion of non-mediation' in a computer-mediated environment. (Matthew Lombard & Theresa Ditton, 'At the heart of it all: The concept of presence', *Journal of Computer Mediated Communication*, 3, 2 (September 1997))
- 35 'Boundary objects' are abstract and concrete objects that inhabit the intersecting social worlds and satisfy the informational requirements of each. They may have different meanings in different social worlds but their structure is common enough to make them recognizable means of translation and to ensure coherence. See Susan Leigh Star & James R. Griesemer, 'Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39', *Social Studies of Science*, 19, 3 (1989): 387-420)

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