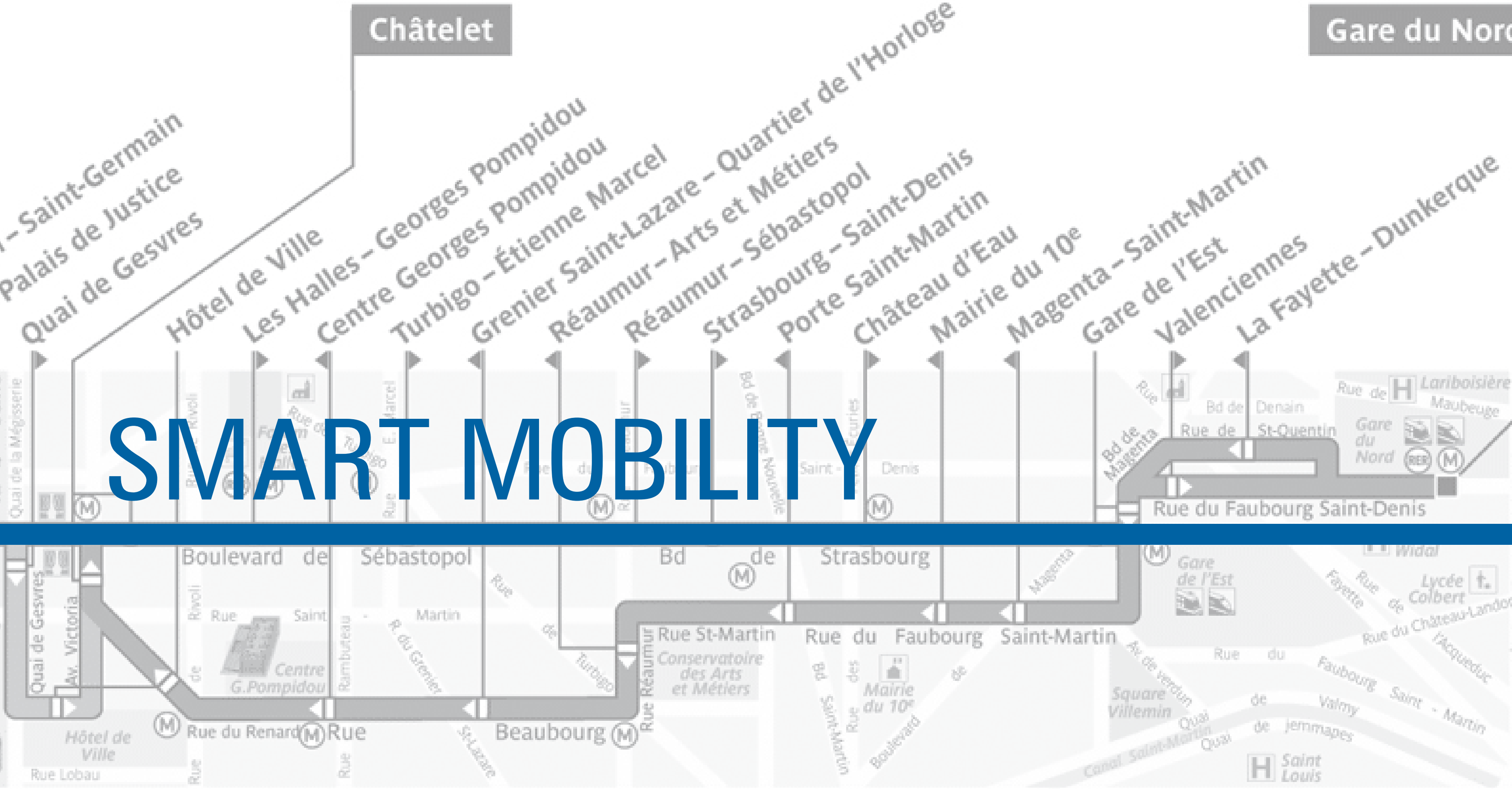
SMART MOBILITY



Rethinking the Paris Bus Line
Smart Cities Group/MIT Media Lab
Spring 2005

William J. Mitchell
Federico Casalegno

Massachusetts Institute of Technology

FOREWORD

THE WAY people move within the city context changes with the development of transportation systems, information and communication technologies. In our project, we investigate new ways of urban mobility from both a cognitive and a transportation perspective.

We start by considering a bus line as an ecosystem from two main perspectives. First, bus lines are embedded in a global transportation system — private and public — that encompasses multiple modes (connections between bus, rail, metro, car, bicycle, and so on). Re-defining one element of the system means to redesign the system with its complex mutual relationships. Second, bus lines are integrated into the urban, social and economic fabric of the city. Here, the convergence between ubiquitous accessibility to digital information and the urban territory is crucial. People navigate through the city to access resources, goods, information; redesigning a bus line means to try to optimize the strategies to access these resources. Furthermore, with the use of electronic devices and wireless connectivity, there is both the possibility to design better interfaces for people to navigate through information and access customized content as well as to create new barriers.

The synergistic overlap of these elements relates to the potential for the successful evolution of public transportation systems. Moreover, these connections are strengthened by new emerging communication technologies and the proliferation of wireless media.

Considering these elements, we ask: What will be an intelligent bus line in the near future? How will bus lines continue to adapt to the needs of bus riders and city users? How will ubiquitous location-awareness change the way people navigate in the city as well as access and produce information and goods?

The content of this report and of the related web site http://cities.media.mit.edu/mobile/RATP is based on the educational design workshop “Smart Mobility. Rethinking the Paris Bus Line,” held at the Massachusetts Institute of Technology, Media Lab, Spring 2005. MAS 966, in collaboration with RATP, Paris. This report, more then a structured linear text should serve as an instrument to “think with” that reflect a collective work and a collaboration process between MIT and RATP.

PARTICIPANTS

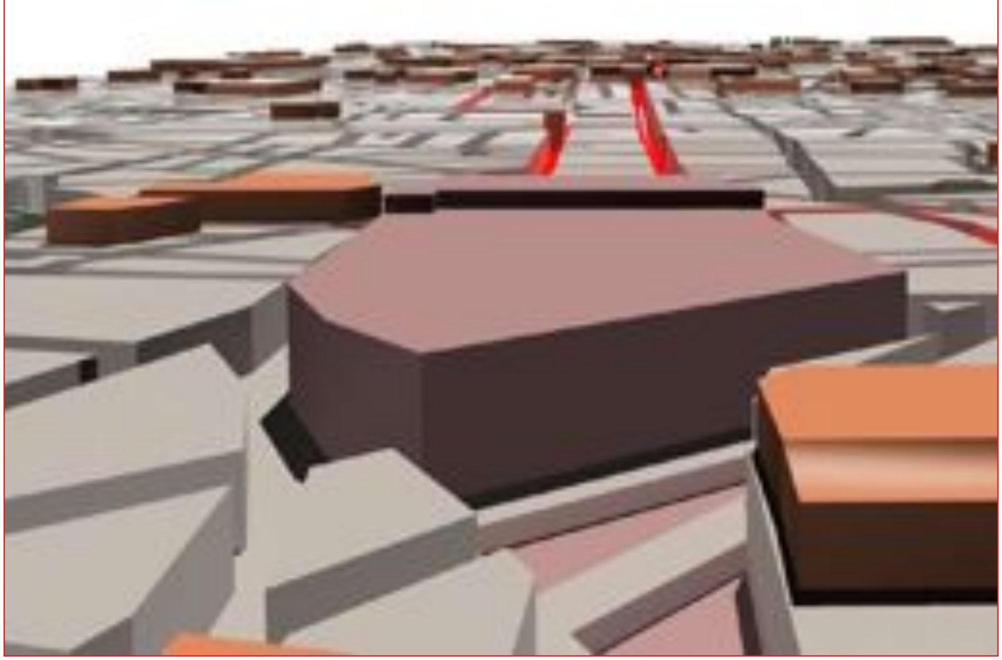
Class Instructors: William J. Mitchell, Professor of Architecture and Media Arts & Sciences;
Federico Casalegno, PhD, Research Scientist, MIT Media Lab, Motorola

Course Collaborators: Ryan Chin, Media Arts & Sciences; David Raul Poblano, Media Arts & Sciences;
Susanne Seitinger, Media Arts & Sciences

MASS. 966 Students:
Sergio Araya, Design and Computation - Architecture; Marcel Botha, Design and Computation - Architecture;
Sylvain Bruni, Aero-Astro Engineering; Stephanie Groll, Urban Studies & Planning;
Onur Yuce Gun, Design and Computation - Architecture; William Lark, Media Arts and Sciences;
Phillip Liang, Media Arts & Sciences; Arnaud Pilpré, Media Arts & Sciences;
David Raul Poblano, Media Arts & Sciences; Susanne Seitinger, Media Arts & Sciences;
Miriam Sorell, Urban Studies & Planning; Tango Aaron Tang, Harvard School of Design;
Edgar Torres, Civil Engineering; Aaron Zinman, Media Arts & Sciences

RATP:
Georges Amar, Dominique Laousse, Prospective et développements innovants;
Marc Bensimon, Mathieu Dunant, Systèmes d'Information et Télécommunication;
Stéphanie Bouché, Design

INTRODUCTION




line 38

A BUS LINE is a complex system that includes at least five elements:

1_the bus, as mechanical transportation systems, as well as a place where people socialize, access information, see the city and travel;

2_the bus station, where passengers wait for the bus, access information, rest and communicate;

3_the information/communication system, channeling information from/to the bus and to/from pedestrians, information from the city to the bus / to the passengers, but also information delivered to passengers from different types of media while they are on the move, as well as passenger-to-passenger communications;

4_the people, tourists, workers, retired, occasional users, young, night/day users, with their differing transportation needs;

5_and, finally, the city, the urban territory, the political and administrative environment, the cultural and social environment.

As indicated by these categories, to rethink the Paris bus line we selected an ecological approach that draws inspiration from the classical definition of the term ecology: the study of the relationships between living beings and the environment in which they live in (Oikos, from the Greek "home", in the holistic sense as geophysical and social environment and Logos "speech, reasoning). From this starting point, the definition of a bus line must be expanded to mean a complex living system that unfolds within its mutual interactions with a social, technological and territorial environment.

When designing a transportation system, the correlation between the urban territory, the digital information and the people is crucial. Mobility happens equally from a physical and from a cognitive point of view. Gregory Bateson had begun to realize, we are not fully contained within our skins, and our extended networks and fragmented habitats make us spatially and temporally indefinite entities: designing a bus line implies giving coherence to an entire system that includes multiples elements. In this mobility system, the superimposition of the real territory with the digital information of cyberspace is central. We deal with a superimposition and not with a mutual exclusion between urban spaces and electronic information. These are not only a central part of the system but they define new ways of mobility within the city context. Techno-pessimists, rebels against the future, think of a dark universe where users, prisoners of the electric virtual sphere, tend to confine themselves in the golden cages of the electronic bits and to be disconnected from the world. On the other side, the growing number of available digital information that are scattered throughout the territory, emphasizes the element of physical places; the environment becomes a real interface of mobility, a connective tissue, where digital locally based information enriches people's experience of their navigation through the city. Cyberspace superimposes itself onto urban space creating a larger topography of places that coexist and create a new form of city topology (William J. Mitchell, E-topia: Urban Life, Jim—But Not As We Know It). Here, urban space is perceived as an allegory of mutual and complex relationships, of electronic presences, physical trips and relative representations of the territory. E-Topia is therefore a kind of new configuration that considers the superimposing of physical space and interconnected electronic environments.

It is not possible to dissociate the transportation system from the access of electronic information. Ubiquitous and pervasive access to information reconfigure not only the way people travel through the urban territory, but also the way people form societies, belong to communities and access the resources that the city offers. This is a fundamental aspect in the design of a transportation system. On the one hand, exists the risk of increasing the so-called digital divide; but, on the other, exists the opportunity to design more comprehensible interfaces to allow people to navigate through the city as well as to access the available resources and electronic information.

Keeping in mind these aspects, this report considers the potential of new technologies and design strategies to enhance the Paris bus system, and makes several specific proposals.

In doing so, it views the system from several different perspectives: (1) as an urban movement system that is connected to other movement systems operating in Paris and embedded in global transportation networks, (2) as a system of spaces, both static and mobile, that play a vital role in the social, economic, and cultural life of the city and (3) as a key factor in shaping the experience and identity of Paris, both for residents and for visitors.
The main designproposals, as detailed in the following pages, are:

1_Self-Organizing Bus System
2_Reconfigured Bus
3_Electronic Guimard
4_Neighborhood Concierge

Perceived Complexity

IN A transportation system, both users and operators must tackle issues of complexity in order to maintain a successful and enjoyable experience. Throughout the research on smart mobility, we took into account the difference between the perceived and real complexity. Especially when designing complex information spaces, this distinction serves an important purpose, namely to provide the best access to knowledge for users and the easiest operating strategy for RATP.

What is perceived complexity?

Perceived complexity must be distinguished from what can be considered as actual complexity of a system. Miller [1] separates them with the following attribtses:

.:: Perceived complexity is internally linked to cognitive complexity, that is the amount of cognition required to understand a system, or how much a system "[is] difficult to understand or to deal with." This definition is plainly relative to the individual human being.

.:: Actual complexity is related to the functional complexity of the system, defined by Miller as the "state of being so complicated or intricate as to be hard to understand or deal with." This definition refers to some undefined objective, true criteria of complexity that is independent from the human involved.

Perceived complexity can be further described, as done by Rauterberg [2]: perceived complexity is a multidimensional concept where the perceived stimulus of complexity can be divided into a known stimulus (KS), a new stimulus (NS). Rauterberg's theory is that NS+KS is held constant, and that humans, in order to deal with complexity will use "perceptual chunking" a cognitive technique aimed at reducing complexity in NS (and thus increase the accessibility to a complex system), while increasing complexity in KS (by refering to a more complex mental model or technique). Perceptual chunking refers to the technique of subdividing the problem space into smaller problem spaces that are expected to be easier to handle individually. This is also a technique used to structure a problem space, as emphasized by Miller in [1].

Other theories, like that of Miller, subdivide perceived complexity into a multidimensional concept that encompasses the so-called "component complexity," the "relational complexity," and the "behavioral complexity." The component complexity is based on the number and the homogeneity of elements that encapsulate the system. The more elements, and the more different they are from each other, the more complex the system will be perceived by the user. Similarly, the relational complexity is based on the number and the homogeneity of the links between these elements. Finally, the behavioral complexity is defined by the number and the nature of the different states the system can adopt. This latter concept is closely linked to the unpredictability of the system.

In order to mitigate the complexity/ies that can result from all these elements (component, relations, and behaviors), several strategies can be implemented. Structuration and ordering of the problem space is key in clarifying the system from a user's point of view: right now, the bus system is seen as a complex network of lines with (perceived) random stops along the way, and an incoherent time schedule. Adding structure in the three dimensions of time, space and function can be a mitigating solution that would create a much clearer mental model of the system, for the passengers. In addition, this mental model should be based on high-level knowledge or metaphors, commonly assimilated by large populations (see Riley in 31] for a complete description). It is extremely efficient to create a mental model that finds its roots in an intellectual construct that has already been "validated" by most users. Hence, a new bus system should re-use common properties and characteristics of existing transportation systems. As shown in Miller's work [1], another mitigating strategy is to act directly on what causes the complexity: by decreasing the number of *elements in the system, and/or making them similar, users will find it easier to understand (and thus use) the global system. In the same idea, a strategy could consist in reducing the number of behaviors or functions of the different elements of the system, or accentuate strongly their common relations to make it easier to assimilate.*

[1] Miller, C. (2000), "The Human Factor in Complexity," in Automation, Control and Complexity: an Integrated Approach (T. Samad and J. Weyrauch, eds.), John Wiley, New York.

[2] Rautenberg, M. (1994), "About the Relationship between Incongruity, Complexity and Information: Design Implications for Man-Machine Systems," in Mehrwert von Information—Professionalisierung der Informationsarbeit (W. Rauch, F. Strohmeier, H. Hiller and C. Schlögl, eds.) Universitätverlag.

[3] Riley, V. (2000), "Perceived Complexity and Mental Models in Human-Computer Interaction," in Automation, Control and Complexity: an Integrated Approach (T. Samad and J. Weyrauch, eds.), John Wiley, New York.

CONCLUSION

THE project of rethinking the bus line should be understood within the context of the long-term evolution of cities toward the condition of large-scale, intelligently integrated and coordinated organisms.

Pre-industrial cities consisted essentially of skeleton and skin. They provided shelter and protection, and through stacking floors vertically they enabled intensification of land use. This conception of the city is beautifully illustrated by Nolli's famous map of Rome.

Cities of the industrial era acquired increasingly extensive and sophisticated artificial physiologies – water supply and drainage systems, energy supply systems, and mechanized transportation cities. This later conception is illustrated by the well-known map of the London Underground, which abstracts away from topographic and architectural detail to present the city as a flow network.

Now, cities of the digital information era are developing electronic nervous systems. Increasingly, they are acquiring embedded sensing, processing, telecommunication, and automated actuation capabilities. When these electronic nervous systems are integrated with other networks and systems, cities begin to operate as intelligent organisms that make coordinated responses to changing conditions and needs. Electronic nervous systems can weave together hitherto independent systems into a more effectively integrated, intelligent whole.

The aim of the smart mobility workshop was to rethink the Paris bus line for the new era of cities that are coordinated and controlled by electronic nervous systems. It considered five elements: people, the urban environment, the bus, the bus stop and the information/communication system. It did not seek to identify possible incremental improvements (which will probably happen anyway), but to discover ways of fundamentally re-imagining the whole system in response to the conditions of the digital information era. Its proposals were developed and elaborated to the extent possible within a short project, but their details should not be taken too literally; they are intended primarily as suggestive

Image by Marco Susani.

starting points for further investigation, development, and critical analysis.

The main proposals that resulted from the workshop's investigations are:

1_Self-organizing Bus System

Traditionally, urban train and bus systems have operated with fixed routes and timetables, while private automobiles and taxis have offered transportation whenever and wherever it was needed—but at much higher cost.

In the ubiquitously networked environment of the twenty-first century, though, the increased availability of information, combined with capacity for computer control of complex, dynamic systems in real time, begins to break down this traditional distinction. Bus operators can keep precise track of vehicle movements, electronically monitor demand from minute to minute, and responsively allocate service capacity to where it is currently needed most. In addition, by means of mobile electronic devices, potential passengers can be informed of when and where service will be available to meet their needs.
We suggest, then, that there is considerable potential to reduce reliance on fixed bus routes and timetables, and thus offer better service at still acceptable cost, through a combination of digital networking and sophisticated computer control. In

other words, the bus system could shed much of its traditional rigidity and become intelligently self-organizing.

2_Reconfiguring the Bus

The traditional bus is basically a long, narrow box on wheels—or, at best, two or three boxes joined by flexible connections. It is not particularly agile at navigating through crowded city streets, it does not allow passengers to make particularly pleasant and productive use of their time, and it does not provide very efficient ingress and egress. We suggest, therefore, that there is room for a great deal of improvement.

This improvement can be accomplished by embedding much more electronic intelligence in buses. More sophisticated electronic control systems can allow buses to become flexible rather than rigid, so that they wiggle themselves—snake-like—through the streets in more agile fashion. Buses can become mobile network nodes, so that passengers are connected for guidance, entertainment and mobile work. And interior and exterior surfaces can carry information displays.

It is possible to make incremental improvements to bus design by gradually incorporating such capabilities. But it seems likely that the greatest gains will be achieved through some experimentation with radically reconfigured buses that are designed, from the beginning, around the capabilities of new electronic technology.

3_Electronic Guimard

As Guimard's famous Metro stops demonstrated, it is possible for transportation stops to have a distinctive character and to contribute to the overall image of a city. However, bus stops are rarely so memorable, and this represents an enormous lost opportunity.

In some historic parts of Paris, we recognize, it is appropriate for bus stops to be as discreetly unobtrusive as possible. But this is not a universal condition. In many areas, beautifully designed bus stops can be an enhancement, and a system of vivid, well-designed bus stops can help to provide a sense of citywide identity.

Guimard developed his famous designs around the new architectural possibilities of that particular time, offered by iron and glass. The equivalent new possibilities of our own time are offered by electronic display surfaces. Media companies have already begun to explore this possibility by negotiating agreements to attach advertising display screens to existing subway and bus stops, but this is just a small step towards an electronic urban architecture.

We therefore propose the development of powerful new bus stop designs that take particular advantage of electronic display to create a unique character for twenty-first-century Paris—electronic Guimard.

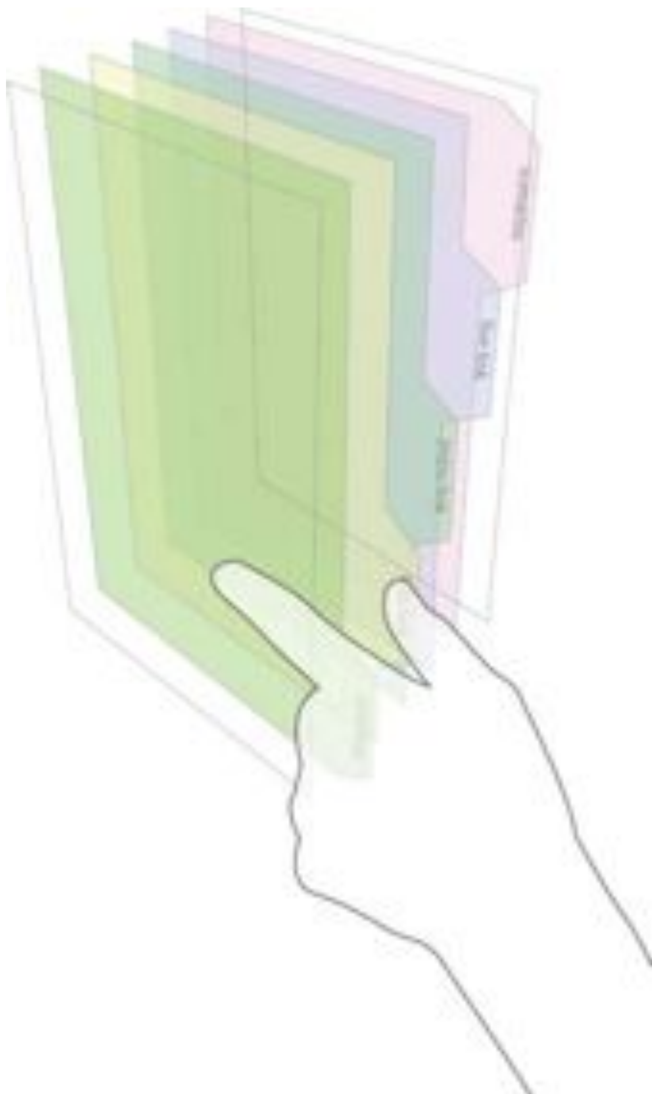
4_Neighborhood Concierge

Bus stops are entry points to neighborhoods. As such, they have the potential to function as landmarks that distinguish and characterize neighborhoods, and as convenient sources of information about the things that neighborhoods have to offer.

If it conceives of bus stops in this way, RATP can broaden its role from simply provider of transportation to comprehensive provider of efficient access to the varied and far-flung resources and attractions of Paris. This can open up new business opportunities, and RATP is well positioned to exploit them because it already has infrastructure strategically distributed throughout Paris.

The traditional concierge is a person with a great deal of local knowledge. One model for the new neighborhood concierge is that of a person—either mobile or at a fixed location—who has efficient access to much wider information resources through network connectivity. Another model, appropriate to less heavily used locations, is that of a fully electronic information point.

We therefore propose a transformation of bus stops into a system of electronically supported neighborhood concierges, which take varied forms according to their locations and the particular communities that they serve.



SELECTED REFERENCES

A

Augé, Marc, Non-lieux, Seuil, Paris, 1992.

B

Bachelard, Gaston; La poétique de l'espace, PUF, Paris (1957) 1964.
Baudrillard, Jean : L'échange impossible, Galilée, Paris, 1999.
- Simulations et simulacres, Galilée, Paris, 1981.
Bataille, George, La Part maudite précédé de "La Notion de dépense", Les editions de Minuit, Paris, 1949.
Bateson, Geogory, Mind and nature: a necessary unity (advances in system theory, complexity and the human sciences). University of Chicago Press, USA, 1999.
Benedikt, Michael: Cyberspace, First steps, MIT Press, Cambridge, USA, 1999.
Benjamin, Walter, Ecrits français, Gallimard, Paris, 2003.
- Paris, capitale du XIXème siècle, Paris, Editions Allia, 2003.
Berger, Peter and Lukmann, Thomas, The social construction of reality: a treatise in the sociology of knowledge, Anchor Books, USA, 1967.
Boyer, Christine, The City of Collective Memory, Its Historical Imagery and Architectural Entertainments, MIT Press, USA, 1994.
Bonnie, A., Nardi et Viki L. O'Day, Information Ecologies. Using Technology with earth, MIT Press, Cambridge, USA 1999.

C

Calvino, Italo, Le città invisibili, Oscar Mondadori, Milano, 1993.
Casalegno, Federico, Les cybersocialités. Nouveaux médias et nouvelles estéthiques communautaires, (Doctoral Thesis, Université Sorbonne, Paris V, July 2000, to be published, Il Saggiatore, Milan, Italy, 2005).
- Mémoire Quotidienne. Communauté et communication à l'ére des réseaux Université de Laval, PUL, Presse Universitaire de Laval, Québec, Canada, February 2005

C

- Communication Dynamics in Technological Mediated Learning Environments International Journal of Instructional Technology and Distance Learning, Vol. 1, No 11, USA, 2004.
- Media ambiance in remote collaborative environments, Conference proceedings, HAAMAHA 03, International conference on Human Aspects of Advances Manufacturing: Agility and Human Automation, Rome, May 2003
Castells, Manuel and Susser, Ida, The Castells reader on cities and social theory, Blackwell Publisher, USA, 2002.
Castelles, Manuel The Internet galaxy : reflections on the Internet, business and society, Oxford University Press, USA, 2001.
- The Information Age: Economy, Society, and Culture (three volumes):
Volume 1: The Rise of the Network Society, Blackwell Publishers (Oxford, and Malden, MA), 1996.
Volume 2: The Power of Identity, Blackwell Publishers (Oxford, and Malden, MA), 1997.
Volume 3: End of Millennium, Blackwell Publishers (Oxford, and Malden, MA), 1998. The rise of the network society, Blackwell Publisher, USA, 1996.
Chatwin Bruce, The songlines, Penguin Books, USA, 1988.
Chin, Ryan C.C., "How Mass-Customization Changes the Design Process: MIT Media Lab's Concept Car Project", MIT Media Laboratory MCPC 2005 3rd Interdisciplinary World Congress on Mass Customization and Personalization (Hong Kong University of Science and Technology, Hong Kong, September 18-21, 2005).

D

Davis, Mike, The city of quartz. Excavating the future in Los Angeles, Vintage, USA, 1992.
Debord, Guy, La société de spectacle, Gallimard, Paris, 1992.
- Théorie de la dérive. Internationale Situationniste n° 2, décembre 1958.
Deleuze, Gilles et Guattari Félix, Mille Plateaux. Capitalisme et schizophrénie, Paris, Ed. Minuit, 1980.
De Kerckhove, Derrick, The Architecture of Intelligence (The It Revolution in Architecture) Birkhauser Publisher, USA, 2001.
- The Connected Intelligence: The Arrival of the Web Society, Somerville House Publisher USA, 1997.

D

- Brainframes. Technology, mind and business, Bosh & Keuning, Olanda, 1991.
De Rosnay, Joël : L'homme symbiotique, Seuil, Paris, 1995.

H

Halbwachs, Maurice The Collective Memory: Harper Colophon, USA, (1950/1980).
Heidegger, Martin, The question concerning technology and other essays, Harper and Row, (1955) 1977.

J

Johnson, Steven, Emergence. The connected lives of ants, brains, cities and software. Scribner, 2001

K

Kelly, Kevin, Out of Control , Addison-Wesley Publishing, USA, 1994.
Kitchin, Rob, Dodge, Martin, Atlas of Cyberspace, Pearson Education, USA, 2002.
Korzybski, Alfred, Une Carte n'est pas le territoire, Editions de l'eclat, Paris, 2001.

L

Latour, Bruno, Aramis or the Love of Technology. (transl. Catherine Porter, Harvard University Press, 1996).
Lévy, Pierre : L'intelligence collective. Pour une anthropologie du cyberespace, La Découverte, Paris, 1994.
Lovelock, James : Les ages de Gaïa, Éd. Robert Laffont, Paris, 1990

L

Lynch, Kevin, The image of the city, MIT Press, Cambridge, USA, 1960.
- A Theory of good city form, MIT Press, Cambridge, USA, 1981
Lyotard, Jean François, La condition Postmoderne, Les éditions de Minuit, Paris, 1979.

M

Maupassant, Guy de, La vie errante, La table ronde, Paris, (1890) 2000.
Mc Luhan, Marshall, and Quentin Fiore, The medium is the message, , Random House, NY, USA, 1967.
Mc Luhan, Marshall, Understanding Media: The Extensions of Man, McGraw-Hill, USA, 1964.
- The Gutenberg Galaxy: the making of typographic man, University of Toronto Press, Ca, 1962.
Mc Quail, Denis Mass communication theory, Sage, London, GB, 1983
Maffesoli Michel, Notes sur la postmodernité. Le lieu fait lien, Éditions du Félin, Paris 2003.
- Du Nomadise. Vagabondages initiatiques. Le Livre de Poche, Paris, 1997.
- Le Temps des tribus. Le déclin de l'individualisme dans les sociétés de masse. Ed. Meridiens Klincksieck, Paris, 1988.
Meyrowitz Joshua, No sense of place, New York, Oxford University Press, USA, 1985.
Minsky, Marvin, Society of mind, A Touchstone Book, New York, USA, 1987.
Mitchell, William J., Placing Words. Symbols, space and the city. MIT Press, Cambridge, 2005
- Me ++: The cyborg self and the networked city, MIT Press, Cambridge, 2004.
- E-Topia, Urban life Jim- but not as we know it, MIT Press, Cambridge, USA, 1999.
- City of bits. Space, place, and the infobhan, MIT Press, Cambridge, USA, 1996.
Morin, Edgar, L'intelligence de la complexité, L'Harmattan, Paris, 1999.
- La méthode. Tome 3. La connaissance de la connaissance, Seuil, Paris, 1996.

M
- La méthode. Tome 4. Les idées, Seuil, Paris, 1995.
- Terre-Patrie, Seuil, Paris, 1993.
- La rumeur d'Orléans, Seuil, Paris, 1969.

Myerson, George, Heidegger, Habermas and the mobile phones, Totem Books, USA, 2001

N
Negroponte Nicholas, Being digital , Vintage, USA, 1996.

P
Perec, Georges, Tentative d' épuisement d'un lieu parisien, Paris, Christian Bourgois, 1975

Q
Queneau, Raymond, Zazie dans le metro, Folio, Paris, 1972

R
Rheingold Howard, Smart Mobs, the next social revolution, Basic Books, USA, 2003.
- The virtual commuities, MIT Press, Cambridge, USA, 1993.
- Virtual reality , Touchston Books, New York, 1992

Rifkin, Jeremy: The age of access: the new culture of hypercapitalism, where all of life is a paid-for experience, Penguim Putnam, USA, 2001.
- The end of work: The decline of the global labor force and the down of the post-market area, Putnam Book, USA, 1996.

R

Rossi, Aldo, The Architecture of the City, MIT press, USA, 1984.

S

Sansot, Pierre, Poétique de la ville, Armand Colin, Paris, 1996.
Seely Brown, John and Duguid, Paul: The Social Life of Information, Boston, MA: Harvard Business School Press, 2000
Simmel, Georg, La Tragédie de la Culture, Éditions Rivages, Paris, 1988.
Sitte, Camillo, City Planning According to Artistic Principles, Rizzoli international publisher, USA, (1889) 1986.

T

Turkle Sherry, Life on the screen. Identity in the age of the Internet, Simon & Schuster, New York, USA, 1995.
- The Second Self: Computers and the Human Spirit, Simon and Schuster, USA, 1984.

V

Varela, J. Francisco, Autonomie et connaissance, Seuil, Paris, 1989.
Vattimo, Gianni : La fine della Modernità, Garzanti editore, Milano, 1985.
- La società trasparente, Garzanti editore, Milano, 1989.
Virilio, Paul, La vitesse de libération, Galilée, Paris, 1995.
- La bombe informatique, Galilée, Paris, 1998.
- Esthétique de la disparition, Galilée, Paris,1989.
Von Neuman, John, L'ordinateur et le cerveau, Flammarion, Paris, 1996.

W

Watzlawick, Paul, How real is real? Confusion, disinformation, communication, Vintage, USA, 1977.

Y

Yi-Fu Tuan, Space and place: the perspective of experience, University of Minnesota Press, 2001.

ACKNOWLEDGEMENTS

We are grateful to the collaborators from RATP, especially Georges Amar and Dominique Laousse (Prospective et développements innovants), Marc Bensimon and Mathieu Dunant (Systèmes d'information et Télécommunication), and Stéphanie Bouché (Design), participated very actively and constantly collaborate during all the phases of the workshop. Their work, help and support has been fundamental to the success of this workshop and subsequent report.

Thank you to all the participants in the MIT workshop held at the MIT Media Lab in the spring 2005. We would especially like to thank all the students, Sergio Araya, Marcel Botha, Sylvain Bruni, Stephanie Groll, Onur Yuce Gun, William Lark, Phillip Liang, Arnaud Pilpré, David Raul Poblano, Susanne Seitinger, Miriam Sorell, Tango Aaron Tang, Edgar Torres, Aaron Zinman, and course collaborators, Ryan Chin, David Raul Poblano, Susanne Seitinger, whose hard work resulted in the contents of this report.

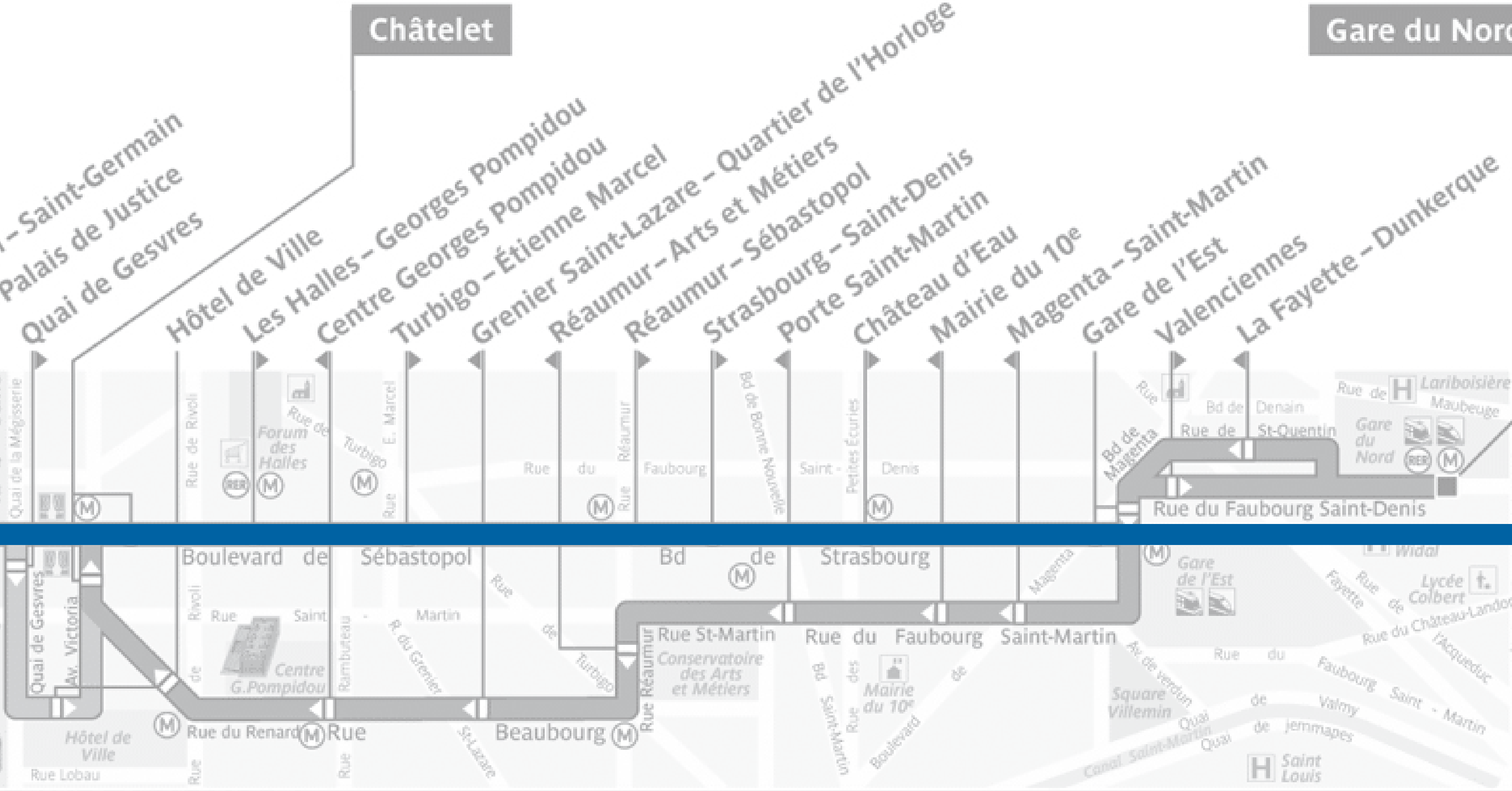
Finally, we would like to acknowledge the unstinting support and insightful guidance of Professor William J. Mitchell and Federico Casalegno without whom this workshop would not have been possible.

Project Director:
William J. Mitchell, Federico Casalegno

Final Report Design:
Susanne Seitinger

Content Editing:
Ryan Chin, David Raul Poblano, Susanne Seitinger

Multimedia Edition (http://cities.media.mit.edu/mobile/RATP):
Michael Humphrey, Video Editing and Visualization; David Raul Poblano, Visualization; Caitilin Winner, Web Design and Visualization



Châtelet
Gare du Nor
– Saint-Germain
Palais de Justice
Quai de Gesvres
Hôtel de Ville
Les Halles – Georges Pompidou
Centre Georges Pompidou
Turbigo – Étienne Marcel
Grenier Saint-Lazare – Quartier de l'Horloge
Réaumur – Arts et Métiers
Réaumur – Sébastopol
Strasbourg – Saint-Denis
Porte Saint-Martin
Château d'Eau
Mairie du 10e
Magenta – Saint-Martin
Gare de l'Est
Valenciennes
La Fayette – Dunkerque
Rue du Faubourg Saint-Denis
Boulevard de Sébastopol
Bd de Strasbourg
Rue St-Martin
Rue du Faubourg Saint-Martin
Quai de Gesvres
Av. Victoria
Rue du Renard
Rue Beaubourg
Rue Réaumur
Bd de Magenta
Rue de St-Quentin
Forum des Halles
Centre G.Pompidou
Conservatoire des Arts et Métiers
Mairie du 10e
Gare de l'Est
Gare du Nord
Lariboisière
Lycée Colbert
Square Villemin
Saint Louis
Hôtel de Ville
Rue Lobau