PART I:

The Context of City Knowledge

"Beyond six rivers and three mountain ranges rises Zora, a city that no one, having seen it, can forget. But not because, like other memorable cities, it leaves an unusual image in your recollections. Zora has the quality of remaining in your memory point by point, in its succession of streets, of houses along the streets, and of doors and windows in the houses, though nothing in them possesses a special beauty or rarity. Zora's secret lies in the way your gaze runs over patterns following one another as in a musical score where not a note can be altered or displaced.

The man who knows by heart how Zora is made, if he is unable to sleep at night, can imagine he is walking along the streets and he remembers the order by which the copper clock follows the barber's striped awning, then the fountain with the nine jets, the astronomer's glass tower, the melon vendor's kiosk, the statue of the hermit and the lion, the Turkish bath, the café at the corner, the alley that leads to the arbor. This city which cannot be expunged from the mind is like an armature, a honeycomb in whose cells each of us can place the things he wants to remember: names of famous men, virtues, numbers, vegetable and mineral classifications, dates of battles, constellations, parts of speech. Between each idea and each point in the itinerary an affinity or a contrast can be established, serving as an immediate aid to memory. So the world's most learned men are those who have memorized Zora.

But in vain I set out to visit the city: forced to remain motionless and always the same, in order to be more easily remembered,

Zora has languished, disintegrated, disappeared.

The earth has forgotten her.

Italo Calvino, 1972
"Invisible Cities", p.15

INTRODUCTION

importance of information

Information is a fundamental ingredient in all decisions. Deeper knowledge of an issue allows one to better ponder the options and select what seems to be the wisest path to a resolution[3]. Decisions based on "gut feeling" or instinct can turn out to be just as wise, but one would generally prefer to deliberate from an "informed" position, especially when major policy or planning decisions are made, which may entail considerable expenditure of human and financial resources[4].

[informed decisions]

municipal use of information

Every single day, municipal governments make maintenance, management, planning and policy decisions that affect the inhabitants of the city or town as well as its coffers[5]. Invariably, to support these decisions, a great deal of time is spent gathering information by scouring the archives of the various departments and by leveraging personal contacts with those who are the "institutional memory" of the department[6]. Meanwhile, administrative data are gathered by city offices incessantly for specific purposes, most often connected with revenue-generation (taxes, fees, etc.) or regulatory compliance (permits, licenses, etc.)[7]. Yet these data are more often treated as "documentation" supporting a specific act or deliberation rather than as "information" that can be reused over and over in other contexts to support other municipal tasks[8].

[information vs. documentation]

urban information technology

People who are engaged in urban maintenance, management or planning use information daily, thus they have been rather receptive toward the adoption of computers to organize municipal information ever since the early days of personal computers[9]. After the first commercial Geographic Information Systems (GIS) appeared in the mid-eighties, through the nineties and until today (2004), there has been a steady increase in the use of GIS in various city departments[10]. More and more, geographic information systems are delivering on promises[11] and their effectiveness in municipal

[increased adoption of GIS]

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3 Logic and rationality have always been part of human development, at least since historic times. For instance, Adam Smith's "invisible hand" is predicated on the unimpeded circulation of information leading to rational choices about economic options.

4 The "rational" approach to decision-making was the dominating paradigm until the mid-1950's (Caron and Bédard, p. 19), and later reincarnated as "bounded-rationalism" (Simon, 1960). Today, although communicative paradigms (Innes, 1998) are reassessing the role of information in planning, nobody denies its usefulness. See also Hammond *et al.*, 1980, 1991 and Keeney and Raiffa, 1976 and Linstone, 1984.

5 Nedović-Budić *et al.*, 2004, p. 333.

6 See, for instance,. Budić, 1994, p. 244; Nedović-Budić, 2000, p. 82 (see also reference to Arbeit, 1993); Yeh, 1999; Ghose and Huxhold, 2002, p. 5; Ferreira, 1998.

7 ICMA, *Electronic Government,* 2002. See also Ferreira, 2002.

8 Although a tad dated (1984), see the interesting conclusions that Masser and Wilson arrive at when looking at the different attitudes that are connected to the choice between what they call "hard" (quantitative information and data) and "soft" (qualitative documentation) approaches to information management. Apparently, hard approaches are more often restricted to limited domains, whereas soft approaches are more comprehensive and systematic.

9 Nedović-Budić, 2000, p. 81.

10 Masser and Wilson, 1984 ; Budić, 1994; ICMA, 2002..

11 McFall, *ENR*, New York: February 16, 2004. Also, Budić, 1994: abstract p. 244.

practices is perceived to be increasing[12]. The organizational implications of GIS adoption are often underestimated[13], though – perhaps counter-intuitively – it tends to increase the demands on staff[14] as they inevitably changes the internal dynamics of a department[15].

Geographic Information Systems

The diminishing cost of computer hardware and software[16] has led to a proliferation of homegrown GIS initiatives that address specific needs of municipalities[17]. Increasingly, there have been attempts to harness the richness and diversity of such independent activities to reduce wasteful redundancy and duplication and to maximize the synergistic potential of a coordinated approach to geospatial information management[18]. Top-down initiatives emanating from the national level[19] have led to the creation of Spatial Data Infrastructures (SDIs)[20] which in turn frequently include provisions for a core set of so-called "framework data"[21]. Simultaneously, bottom-up efforts are looking at the role of neighborhoods in the development of a finer-grained spatial data infrastructure[22] through Community Statistical Systems (CSS)[23] and the like. Citizen groups, with the aid of academia, are producing the neighborhood-level equivalent of national framework data[24], through such efforts as the National Neighborhood Indicator Partnership (NNIP)[25] that tries to consolidate indicators of urban well-being using public administrative data sources[26]. Meanwhile, technical standards that allow the exchange of spatial data are also being developed primarily by the Federal Geographic Data Committee (FGDC) of the National Spatial Data Infrastructure (NDIS)[27].

[Spatial Data Infrastructure)]

[framework data]

[Community Statistical Systems]

[Neighborhood Indicator Partnership]

[FGDC and NDIS]

Planning Support Systems

Despite all this positive ferment, the development of Planning Support Systems has been lackadaisical[28], perhaps because of planners' own inability to take full advantage of the technology[29], due to organizational,

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12 Budić, 1994, p. 251.

13 Innes and Simpson, 1993; Campbell and Masser, 1995.

14 At least initially, as discussed in Masser and Wilson, 1984. See also ICMA survey, question 7.

15 Budić, 1994, Note 1.

16 *Idem.* Though the lower costs of technology are offset by the "hidden" costs of human resources (see Note 1).

17 Witness the innumerable cases illustrated in *URISA Proceedings* and in trade magazines such as those printed by ESRI and Mapinfo, to name but a few. See also www.nexpri.nl.

18 Like that in the "Digital Earth" initiative (http://www.digitalearth.gov/); see also Klosterman, 2001, pp. 11-13;

19 National Research Council, 1993.

20 Nedović-Budić *et al.*, 2004. See also, Masser and Wilson, 1984.

21 Tulloch and Fuld, 2001. See also the FDGC web site at http://www.fdgc.gov.

22 Talen, 1999.

23 Ferreira, 2002.

24 At an even finer-grain than that discussed in Tulloch and Fuld, 2001, but with similar upward scalability.

25 Sawicki and Flynn, 1996. See also Neighborhood Knowledge Los Angeles. (http://www.nkla.org) and connected efforts.

26 For a complete listing of administrative data sources see also Coulton, Nelson and Tatian, 1997.

27 See http://www.fdgc.gov

28 Budić, 1994, p. 245; Innes and Simpson, 1993; Nedović-Budić, 2000; Geertman and Stillwell, 2004, p. 307.

29 "The most important impediment to the implementation of GIS in planning may be the planners themselves", Innes and Simpson, 1993, p. 232.

institutional, sociocultural issues[30], or perhaps simply because planners are too preoccupied with gathering useful data[31] for the plan at hand[32] to have time to dedicate to the development of tools beyond the mere computerization of manual tasks[33]. In fact, with the exception of a small number of well-funded and established comprehensive top-down efforts[34], and despite the operational benefits in terms of effectiveness that GIS technology affords[35], progress has been slow and "the application of PSS is currently still in its infancy"[36]. The puzzling lack of effective[37] penetration of GIS technology in local planning operations at the municipal level can be attributed to many factors, but "people" issues are always the main culprits[38], followed by issues of technological complexity and cost. Another major stumbling block are data[39]. Planners are voracious consumers of information, but they produce very little new information themselves[40]. "The use of systematic models to bring knowledge to bear on assessing the probable outcomes of planned actions is not a general practice in planning[41]". Comprehensive systems to bring together multipurpose geographic information systems for second-order spatial analyses are needed but not quite available to planners[42].

local GIStrategies

Current trends indicate a move toward the development of local geographic information strategies[43] to capture the finer grain of urban data that community statistical systems require[44]. There begins to be also a discussion about the importance of supporting the development and maintenance of local databases[45] so that a distributed municipal information systems can be assembled without redundancies from a series of networked systems, connected via the World Wide Web[46], and developed in a coordinated manner[47], based on agreed-upon structures, processes and

30 Campagna and Deplano, 2004, p. 35.

31 Nedović-Budić, 2000, p. 82.

32 Masser and Wilson, 1984 (see in particular Table 8 on p. 421).

33 In essence, there is little of Zuboff's (1991) "informating", most efforts going toward "automating".

34 Like those in Singapore (Arun and Yap, 2000) and in Vienna (Wilmersdorf, 2003 – municipal site in German at www.wien.gv.at/wiengrafik/suche.htm) to name a couple.

35 Budić, 1994, p. 251.

36 Geertman and Stillwell, 2004, p. 307.

37 As measured according to Budić's (1994) indicators of "Operational Effectiveness" and "Decision-Making Effectiveness".

38 Nedović-Budić, 2000, p. 82; Nedović-Budić and Pinto, 1999, p. 60.

39 Yeh, 1999.

40 I think Yeh and Webster (2004) meant to say the same thing, though their statement that "urban planning is a process that *generates* a lot of information" (italics added) may be easily misread.

41 Harris, 1999, p. 324.

42 As far back as Innes and Simpson, 1993, p. 232 and as recently as Brail and Klosterman, 2001, "the always imminent revolution" (pp. 2-3). Most recently Geertman and Stillwell, 2003, p. 8 and again Geertman and Stillwell, 2004.

43 Craglia and Signoretta, 2000; Tulloch and Fuld, 2001.

44 Ferreira, 2002.

45 Nedović-Budić, 2000, p. 87.

46 Kelly and Tuxen, 2003.

47 Following a Geospatial Information Management Plan, as suggested by Keating *et al.,* 2003.

policies[48] for the creation, archival, maintenance, updating, removal and sharing of urban data[49].

the challenges

As Keating *et al.* put it, a first challenge "lies in striking a balance in the degree of centralization of data storage, administration, and procedural control while serving the needs of the community […]" [50]. Moreover, according to the University Consortium for Geographic Information Science (UCGIS),

> *"As the variety of geospatial information and data resources increases each year, the demand for understanding and building sustainable information and knowledge structures remains a critical research challenge for the geo-spatial information community."*[51]

So the problem today is not the availability or capability of technology for planning, but rather the availability of "good" fine-grained, up-to-date data[52]. What's also missing is an active pursuit of the creation of systematic storehouses of urban knowledge. According to the established "Communicative Action" paradigm[53], the way forward is to embed in the planning community – and in municipal administration in general – an innate appreciation for the value and importance of information at any level of urban maintenance, management and planning. This shift of mindset would enable a sea-change to take place in how cities collect and organize information.

the solution: City Knowledge

This dissertation, as its title implies, addresses directly the aforementioned research priority of the UCGIS. It specifically focuses on the organizational, institutional, technical, logistical and financial mechanisms whereby appropriate local authorities could systematically build up a comprehensive set of *framework* (and later also *thematic*) datasets and map layers. The gradual, but systematic compilation of all the disparate datasets accumulated by a wide variety of government and non-government organizations is what I term the *City Knowledge* approach. I propose to "grow" this knowledge from the middle-out, integrating a top-down approach to standardization[54], with a bottom-up approach to neighborhood-scale ("atomic") data accrual[55].

Comforted by the latest developments in the definition of "core" framework datasets[56], and by the current trends among researchers toward a "local" approach to the creation of comprehensive municipal information

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48 Nedović-Budić and Pinto, 1999, pp. 56-59.

49 Nedović-Budić and Pinto, 1999 and 2000; For more information about these matters, consult the FGDC web site at www.fgdc.gov . See also the Geographic Information Resource Management short term research priority for the UCGIS at www.ucgis.org .

50 Keating *et al.,* 2003, p. 35.

51 Shuler, 2003. *UCGIS Research Priority.* Last accessed 8/20/04 at http://www.ucgis.org/priorities/research/2002researchPDF/shortterm/g_resource_management.pdf.

52 See Budić, 1994, p. 252, Table 4, under Operational Effectiveness indicators.

53 See Innes, 1998.

54 As in Craglia and Signoretta, 2000 and Nedović-Budić and Pinto, 2000.

55 As in Talen, 1999 and Ferreira, 2002.

56 Tulloch and Fuld, 2001. Harris, 1999, p. 330; Nedović-Budić *et al.*, 2004; See also FDGC web site at http://www.fgdc.gov/framework/framework.html. Last accessed 8/20/04.

systems[57], using smaller and smaller jurisdictions to allocate responsibility over specific data layers[58], I am confident that my City Knowledge approach will prove to be a valid contribution to the creation of emergent, comprehensive, updatable municipal information infrastructures.

Research Question

This dissertation will attempt to answer the following question:

What gradual and unobtrusive approach can cities adopt to create a fine-grained, sustainable, affordable, updatable, comprehensive information infrastructure on which to base decisions about urban maintenance, management and planning?

Methodology

I have grounded my approach on the Case Study methodology[59] based on my own substantial experience in planning-related data collections and spatial analyses in Venice, Italy and in the greater-Boston area. In fact, the primary method I have applied is the "reflective practitioner" approach[60], which allows me to use my own cases as the foundations for the lessons I extract, without being accused of bias. Although I can cite dozens of cases to support my claims, this dissertation suffers from the typical limitations of case-study research[61]. While case-study methods do not allow simple generalizations, they do provide the benefit of richer and deeper datasets, which are not to be taken as "samples of one", but can nonetheless allow "analytical" (as opposed to statistical) generalizations[62], such as the ones I will present hereafter.

My arguments will be based on direct experiences, supported by appropriate references to similar cases in the literature (when available) and framed around logical propositions based on factual evidence. In the spirit of the emerging paradigm of planning as communicative action[63], I put forth this thesis as the synthesis of almost twenty years of *praxis* to contribute to a process that I hope will make "city knowledge" a household phrase when information[64] is treated as any other infrastructure on which our towns can count to support all other municipal activities.

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57 Craglia and Signoretta, 2000.

58 Nedović-Budić and Pinto, 2000, p. 468.

59 Yin, 1994.

60 Schön, 1983.

61 Nedović-Budić and Pinto, 2000, p. 471.

62 Caron and Bédard, 2002, p. 22, citing also Yin (1989), p. 21.

63 Innes, 1998, p. 52 and especially Notes 1 and 2.

64 I refer here to what Innes (1998) calls "scientific" , "technical", or "formal" information and knowledge. It is possible, in theory, that City Knowledge could embrace the other types of information that Innes discusses: personal experience, stories, images, representations and intuition, though these will not be discussed herein.

Intellectual Contribution

To put it in Nietzsche's terms, and paraphrasing philosopher Richard Rorty[65], in this dissertation I am simply putting forth a set of contingent metaphoric redescriptions that I hope will contribute to the process of municipal knowledge-making in ways that go beyond the specific suggestions, techniques and methods I propound herein. I hope the latter will be useful in the immediate and may be inspiration for transformation of communities around the world. However, beyond that, I also hope that this paper may in some measure penetrate into the planning consciousness in the subtle, yet powerful way that the communicative planning paradigm champions. I would be gratified if only a fraction of the "new descriptions[66]" I put forth herein could "also strike the next generation as inevitable" and thus become woven into the fabric of what municipal agencies do. Indeed, as Innes put it "*when information is most influential, it is also most invisible*"[67].

In short, I hope some day City Knowledge will be utterly undetectable, not because it has failed miserably and has been long forgotten, but because it will be completely ingrained into the collective consciousness of those who are in charge of urban maintenance, management and planning.

Problems

My personal experience in urban studies and planning in my hometown of Venice, Italy, as well as more recent forays in Massachusetts, have lead me to realize that cities often lack a comprehensive and systematic "knowledge infrastructure" on which to base planning decisions, from the grand urban design projects to the more mundane municipal maintenance tasks[68]. What I found to be the prevalent mode of functioning of the various branches and departments of a modern city is a form of "ad hoc-ism" whereby data are collected for specific purposes and then quickly forgotten or stored in inaccessible places, unbeknownst to any other department or even to other personnel in the same department[69].

lack of infrastructure

ad-hoc data collection

lack of dissemination and re-use

Although some systematic data collection takes place, mostly for regulatory or revenue-generating purposes (such as for permits, licenses, property assessments, and the like), even these data are often hard to obtain or utilize, both internally – by the rest of the municipality – and even less so externally – by academic scholars, independent researchers or planners. Frequently, access to important information is made possible only through personal connections and by means of "under the counter" transfers which bypass the official channels that otherwise would render the dissemination of data virtually impossible.

redundancy and waste

Due to the dearth of coordination between departments, I have personally encountered several situations whereby the same data were being

65 Rorty, 1989. See particularly p.27 ff. According to Nietzsche truth is "a mobile army of metaphors".

66 *Ibid.,* p. 29.

67 Innes, 1998, p. 54.

68 Confirmed by Geertman and Stillwell, 2004 and Brail and Klosterman, 2001.

69 Evans and Ferreira, 1995; Ferreira, 1998.

collected by different departments almost simultaneously. Moreover, I have also personally witnessed how a single department will pay external consultants to collect the same type of data multiple times, over the course of a few years[70]. Redundancy and waste seem to be endemic when it comes to municipal data collection, due to the apparent lack of long-term planning and standardization. The pursuit of a systematic accumulation of comprehensive urban data has not generally been part of municipal policy for a variety of reasons and this has inevitably led to a number of inefficiencies along the way[71].

lack of a systematic approach

low effectiveness of GIS

So, despite the diminishing cost and increased adoption of GIS technology in municipal government, the impact of these technologies is still very minor[72], since applications have been thus far limited to first-order tasks, where geospatial information technology (GIT) simply replaces procedures that were previously carried out by hand[73]. As Caron and Bédard (2002) surmised, GIT projects tend to follow a "garbage-can" type of development, whereby solutions are "technology-driven and looking for problems to solve, and an *a priori* identification of possible solutions seems to determine the problem formulation"[74].

[technology-driven]

However, as is often the case, these shortcomings in the development of comprehensive municipal information systems can also be seen as opportunities waiting to be seized, as described below.

Opportunities

taming the urban infoscape

The perceived vastness and complexity of the urban infoscape can be tamed with today's technology using a "divide and conquer" approach, as my own experience and that of many urban planners around the world demonstrates. Practically all individual tasks or functions that a municipality performs have been automated and/or informated[75] somewhere by now. In short, we have the technology and we know what we want to do with it.

framework data

neighborhood indicators

Meanwhile, the "framework[76]" and "indicator[77]" movements are clarifying what urban information is useful to collect and what public datasets are available to infer the needed information from[78]. Community Statistical Systems[79] as well as municipal information systems can harness these datasets and make them widely available. In short, we know what data we need and where to get it.

getting it together

It is possible today to envision being able to gather, organize, maintain, use and re-use the datasets that would feed a comprehensive

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70 See for example Flynn *et al.,* 2003.

71 This can be explained if we consider municipalities as "multidivisional" or "M-form" firms, wherein rewards and decision-making exist within isolated, uncrossable departmental boundaries, which in turn creates a dis-incentive for the adoption of coordinated or "enterprise" information systems (Singh, 2004). Caron and Bédard, 2002, arrive at similar conclusions based on empirical data (p. 33).

72 Budić, 1994.

73 Innes and Simpson, 1993, p. 233; Reeve and Petch, 1999.

74 Caron and Bédard, 2002, p. 32.

75 Zuboff, 1991.

76 Tulloch and Fuld, 2001; Nedović-Budić *et al.*, 2004. FDGC at http://www.fgdc.gov/framework/.

77 Sawicki and Flynn, 1996.

78 Coulton *et al.*, 1997.

79 Ferreira, 2002.

[comprehensive municipal information system]

municipal information system. It remains a tall task, but it is no longer an insurmountable one in this day and age. The transaction costs and complexities associated with geospatial data collection continue to decline and the impacts of technological[80] and organizational change[81] have been understood and can be factored into any economic calculation of benefits vs. costs. In short, we know how we could assemble the system and how much it will cost us. We may even be able to afford it.

So, if all the pieces seem to be in place, why aren't cities initiating the process that will get them a comprehensive municipal information system?

the elusive solution

What remains elusive is how to put together and finance a well-oiled and organized machinery that will keep all of the possible datasets organized and up-to-date so that ever-improving applications can run each aspect of a municipal operation in an efficient and cost-effective manner that can be maintained over time, migrated across all of the foreseeable technological advances and in the face of all of the changes that the city will undergo in the future.

This dissertation addresses precisely these hurdles that are preventing the full implementation of City Knowledge systems in municipalities.

capturing permanent features

Fortunately, a majority of the characteristics that make up the physical city change very slowly, if at all, and are thus amenable to a gradual and systematic collection effort, the bulk of which would only have to be conducted once. Until now, the apparent complexity of the gargantuan task of collecting and organizing such a multidimensional body of information has discouraged a wholesale approach to the accumulation of city knowledge. Today, however, technical tools that can facilitate the recording and archiving of most, if not all, of the idiosyncratic features of the urban landscape have finally become widely available and affordable, making it possible to realistically envision how cities could begin to accumulate this wealth of information about themselves. This paper proposes a possible pathway toward this end[82].

[slow change]

[systematic accumulation]

low-cost technology

lower transaction costs

The marginal returns one can obtain by systematically (or even opportunistically) collecting and archiving finer-grained urban data are beginning to outweigh the transaction costs that such refined data collections would entail. The case studies I present herein showcase the actual extent of the first- and second-order returns that we were able to exact from our progressively accumulated knowledgebase, when we used our data for a specific immediate purpose and then later re-utilized these same data for new research on a different topic. This is an important aspect of my dissertation since it demonstrates the obvious gains attainable by "automation", as well as the hidden and somewhat unforeseeable advantages one could obtain by

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80 Evans and Ferreira, 1995; Nedović-Budić and Pinto, 2000, p. 466.

81 Nedović-Budić and Pinto, 2000, p. 467.

82 The pragmatic process I propose – starting from low-hanging fruits and expanding gradually as needed – agrees both with theoretical approaches proposed by Innes and Simpson (1993) and Nedović-Budić and Pinto (1999), but also with the empirical conclusions drawn by Keating *et al.* (2003) based on the Cerro Grande fire.

"informating" through the development of a City Knowledge system[83]. These case studies will make evident both the immediate "value" of a specific GIS application, but also the "value-added" bonus that one often reaps from sowing seeds of city knowledge around town at every opportunity.

recent technological advances

This thesis takes advantage of the window of opportunity created by recent advances in Geographic Information Systems (GIS) , the World Wide Web (WWW) and other information and communication technologies (ICTs) to propose a specific institutional and organizational, as well as technical, approach that will enable cities to gradually and non-traumatically accrue and maintain an exhaustive, comprehensive, flexible, reliable, multipurpose and sharable knowledge-base.

knowledge accrual

Such a distributed, grass-roots, self-organizing system could effectively bring into the world of urban planning what some of the most creative and brilliant scholars in other disciplines have also been trying to harness: the power of *emergence*[84]. One of the core elements of my approach is the reliance on a middle-out tactic for the gradual accrual and permanent upkeep of urban information. In essence, I do not propose an all-encompassing system, but simply suggest mechanisms that will lead to such a system eventually and organically, in true emergent fashion.

emergence

GOALS

With this research, I make the case that City Knowledge is a resource to be fostered and maintained as any other infrastructure of the city is. Through numerous examples, I illustrate the variety of information that municipal departments need in order to fulfill on their obligations toward the citizens of the city or town. Investments in City Knowledge should therefore be viewed as capital outlays and steps should be taken to ensure that taxpayer money is well spent. Just as a city would not dream of rebuilding its sewer system over and over again (or to create two parallel sewer systems), so too each municipality should ensure that information about important urban elements is not lost, inaccessible, underutilized or repeatedly and redundantly collected.

inventory information needs

establish importance

address obstacles

This dissertation proposes ways in which cities can overcome the most common obstacles – be they organizational, financial, technical, psychological or logistical – that are hindering the institutionalization of a knowledge infrastructure.

identify desired qualities

Using real-life case studies and recent literature, I identify the desired qualities of a City Knowledge system, which include being affordable, permanent, sustainable and reusable. These qualities are ideals, but also guidelines. Only well-established, full-fledged, comprehensive City Knowledge systems will be well positioned on all fourteen of the quality dimensions I discuss herein. In fact, achieving at least some measure of

[83] Zuboff, 1991.

[84] Johnson, 2001.

success on some of these factors should also facilitate the implementation of City Knowledge[85].

propose approach

Then, I propose unobtrusive mechanisms that can be put in place at the ground level (or "frontline"), to gradually, but systematically, build up a body of knowledge about the city in an emergent fashion. Using this infrastructure, plans can be devised when needed, but more importantly, with this information readily available, municipal agencies can better serve their constituent taxpayers who are footing the bills and are living, day in and day out, with the positive or negative consequences of the urban management practices adopted by their town.

support with case studies

The feasibility of the institutionalization of a self-organizing city knowledge infrastructure, built from the ground up through a middle-out approach at the level of municipal departments, is supported by numerous examples from personal observation of not-entirely-foreseen outcomes that spontaneously emerged after an initial organization of routine operations in cities as far apart, culturally and geographically, as Venice, Italy and Worcester, Massachusetts. These prototype applications have enabled the target city departments to, first of all, organize the information that is needed for their day-to-day operation, but have also demonstrated true emergent qualities, when the self-serving micro-behaviors that have improved the individual departments' operations have later combined to produce unexpected macro-benefits that have exceeded the mere sum of the parts.

organize routine operations

demonstrate emergent qualities

assess usefulness to planners

When possible, I have investigated how such solid, fine-grained and rich datasets of fungible information can be used by city planners, who most frequently need to gather a variety of information from disparate sources, across department boundaries[86].

distill and generalize

From my case studies, I have distilled a generalizable approach that I then applied in Massachusetts – Cambridge, Newton, Boston, Quincy and Worcester. I have also identified the sectors of municipal operations and services that are more amenable to these tactics in the short- and medium-term. All along, I have focused specifically on the advantages and opportunities that exist in the areas of urban maintenance, management and planning.

maintenance, management and planning

explore planning implications

My dissertation also attempts to demonstrate how the self-emergent process can be enhanced by adopting a "planning mindset" in order to enrich the datasets with teleologic parameters aimed at maximizing the information content of collected data for little or no added cost. This "enrichment" of the datasets in turn facilitates sharing and also guarantees the cost-effectiveness of field campaigns both for the collection of baseline data as well as for subsequent periodic updates.

spontaneous emergence of plans

At the same time, this research also aims to illustrate with real examples that, under certain circumstances, the availability of rich city knowledge can and will promote the spontaneous surfacing of the need for

[85] A good approach would be to give precedence to the qualities that best map onto Rogers' (1983) five principles for success in innovation: simplicity, observable benefits, relative advantage, ability to make small trials and compatibility (in Innes and Simpson, 1993, p. 232).

[86] Yeh, 1999; Innes and Simpson, 1993; Brail and Klosterman, 2001.

new plans that are dictated by the mere existence of such information, in true emergent fashion.

Document Structure

This document is divided into five main parts. At the beginning of each part, a quote from some famous planning personality sets the stage for the topics covered therein.

I: The Context of City Knowledge

The rest of this introductory section (Part I - *The Context of City Knowledge*) is dedicated to the exposition of background materials useful to contextualize the rest of the paper.

II: The Path to City Knowledge

Part II, entitled *The Path to City Knowledge* chronicles a selected sample of my personal experiences in Venice, Italy, as the founder and director of the *Venice Project Center*, where every year since 1988 dozens of students from the Worcester Polytechnic Institute (WPI) have completed research projects exploring different aspects of the functioning of my hometown. These are the core "cases" in which my students and I were forced to deal with many practical, as well as logistical issues pertaining to the collection, archival, manipulation, analysis, and presentation of municipal information in the most diverse areas of urban maintenance, management and planning. What we learnt through these experiences in Venice is highlighted at the end of each section, in order to build support for the conclusions that are later summarized in Part IV. The last chapter in this part showcases how City Knowledge can permit advanced analyses – in this case about the effects of flooding to the physical integrity of the city – that would be unthinkable without an acquired storehouse of information. After years of data accumulation, the availability of "plan-ready" information paid off handsomely in the example illustrated and in several other studies where we were able to quickly get to second-order thinking, leveraging our repository of knowledge for advanced analytical tasks.

III: The Devolution of City Knowledge

The Devolution of City Knowledge (Part III) presents some brief excerpts about my experiences on U.S. soil, primarily in Cambridge and Worcester, which demonstrate how some of the concepts developed in Venice were exportable to "normal" cities – with cars instead of boats. Other examples from Massachusetts are also mentioned throughout the paper in a number of footnotes and references. It is thanks to these instances of successful city knowledge transplants that I began to consider a "generalized" approach to city knowledge. This section also allows me to present a few more "cases" that highlight some additional significant "lessons" about City Knowledge that had not yet emerged in the Venice section.

IV: The Essence of City Knowledge

In Part IV – *The Essence of City Knowledge* – I step back and reflect on the lessons learnt throughout and I formulate my theory of City Knowledge. I begin by distinguishing the containers – the physical structures that compose the tangible city – from the contents – the ever-changing activities that people engage in within the material containers. The second chapter introduces the premises on which the City Knowledge approach is based,

and the third chapter acknowledges and analyzes the *obstacles* that continue to prevent city offices from adopting the City Knowledge approach The fourth chapter on the *qualities* of City Knowledge serves as guidance for the features that we would like to see in a future City Knowledge system. The core of my theoretical contribution, culled from my *praxis*, is in the last chapter dedicated to the six pillars that form the *foundations* of City Knowledge: the middle-out approach, informational jurisdictions, distributed knowledge, sustainable updates, interagency coordination, and information sharing.

V: The Emergence of City Knowledge

Part V – *The Emergence of City Knowledge* – discusses the *emergent* qualities of the approach. The second outlines a middle-out pathway to begin building municipal knowledge infrastructures. Finally, in the last chapter of this dissertation, I look at the future and discuss ways to mainstream these concepts into day-to-day municipal operations, how to spread them to other municipalities, as well as how to extend them and expand them to be even more useful.

MUNICIPAL MAINTENANCE, MANAGEMENT AND PLANNING

This chapter is devoted to introducing what municipalities do as institutions, how they structure themselves to provide services to citizens, how they pay for these services and how exactly the services are performed either by civil servants or by outside agencies, contractors or consultants. All of these city activities are based on the availability of some information and knowledge which are the topic of later chapters.

MUNICIPAL ADMINISTRATION

Whether they are located in Africa or Asia, in Italy or in the U.S., in Massachusetts or Iowa, at the most fundamental level all municipal governments, in order to be viable and to provide a civilized environment for their inhabitants, will always attempt to offer very similar services to their citizens. Of course, some municipalities carry out these duties more diligently than others, and some are endowed with more human and financial resources to provide the needed services than others are. This section explores how cities and towns function both administratively and operationally, as they provide fundamental services for their inhabitants. Although many considerations are applicable to municipalities anywhere in the world, this chapter focuses exclusively on the U.S. situation, except where otherwise noted.

what cities do

Cities[87] are administrative entities set up to provide community services to people who live within their boundaries (and occasionally to outsiders too). Numerous guides, handbooks and manuals[88] directed to city officials are published every year, by organizations like the *International City/County Management Association*[89] and others. Frequently, the chapter breakdown inside these publications follows the structure of an archetypal city government[90]. After all, there are only so many functions that a city government is called upon to perform. Roughly speaking, one could divide the main administrative areas of a city into:

- Political and executive branches
- Internal Services
- Public Health and Safety
- Culture and Leisure
- Education
- Physical Services

[87] Hereafter, whenever the term "city" is used, it should be interpreted to stand for *municipality* and thus to also include towns or villages; the difference being merely the size of the local unit of government. Smaller units will not necessarily have all the departments and divisions that a larger municipality may have, but the fundamental services and functions should remain unchanged. Neighborhoods can also be real administrative entities that provide services that a municipality provides, albeit at a more local level.

[88] Banovetz *et al.*, 1994; Hoch *et al.*, 2000.

[89] See http://www.icma.org. Last accessed 8/20/04.

[90] See, for example Kemp, 1998.

political and executive branch

The political and executive branch includes, for example, the City Council, City Manager and City Clerk who are selected by the citizens to administer the city and make everything else work. Numerous combinations of political and executive bodies exist within the U.S. and in other countries. The bottom line is that the citizens always run their own city either directly or by proxy. In many New England municipalities, town meetings are still used to let citizens express their views on policies by direct vote, without any elected intermediaries. Most of these towns elect selectmen to ensure the town is run according to popular sentiment, with a "first" selectman usually heading the board of selectmen. Many New England towns up to about 20,000 population are run with these "amateur" systems[91], where the pseudo-mayors are frequently local business owners who run the towns part-time, barely compensated for the time they put to the service of the community. These interesting forms of local democracy are common in New England and rare anywhere else. Similar direct systems of local government are en vogue in "tribal" communities in developing nations where councils of elders decide on major communal issues. The Afghan "loya jerga", albeit a patriarchal and conservative system with limited democratic access, represents the equivalent of a New England town council of yore.

[town meetings]

[selectmen]

[first selectman]

In the U.S., cities may have an elected political mayor who heads the city council and runs the city through appointed political department heads. European cities by and large follow this system, which in the U.S. is sometimes termed the "strong mayor" model. In the U.S., Boston, Mass. and Providence, R.I. adopt this model, as do New York City, and most major metropolitan cities like Los Angeles, Chicago, Miami and Atlanta.

[strong mayor]

[city manager]

Another model, involves the figure of the "City Manager", who is hired to run a city without being "politicized". A "weak" elected mayor usually heads the city council and interprets the will of the citizenry to the city manager, who translates the political will into concrete programs and actions. The city of Worcester, Massachusetts has this sort of a structure with a political mayor with no first-hand executive power, but with an electoral mandate to set the direction and strategies for the city, paired with a hired city manager who is the chief tactician as the principal executive implementer of the city's strategies[92]. "Strong City Manager" systems are in place in Cambridge, Massachusetts, and in other mid-sized cities that have elected mayors as well.

bottom-up flow of information

Regardless of the precise form of city government, the city's top administrators are fed knowledge distilled from information put together by the lower echelons, who in turn rely on data collected by the city departments and divisions who deal with urban issues on a daily basis and have a better sense of the "pulse" of the city at any point in time[93].

internal services

Internal services include Legal services, Finance, Human Resources, and other functions that ensure that everything the executive branch

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91 Nelson, 2002, p. 2, Table 2.

92 Interestingly, there is a movement afoot to change Worcester's executive branch into a "strong mayor" system.

93 Reeve and Petch, 1999, p. 25.

deliberates actually has the wherewithal to be implemented successfully. In many ways, these are standard functions found in most businesses and organizations. Just as is true in the world of commerce, city operations need to be carried out inside the bounds of the law, within the capabilities of the available workforce, and under the tight confines of budgets, which in U.S. cities are almost entirely funded by local real estate taxes.

revenues

Revenue generation through taxes, fees and fines is a very important function for any municipality or township. Some State and Federal monies are passed down to local governments through a variety of programs, like the Community Development Block Grants (CDBG's), but – at least in the U.S. – cities need to supplement an increasingly larger portion of their operating budgets through independent revenue, generated for the most part by local real estate and business taxes and a variety of fees (and fines) attached to administrative acts (and infractions) as well as to specific essential services, such as garbage removal and sewage collection and treatment.

public health and safety

Public health and safety, which comprises Fire, Police, Health and Social services represents the safety net that citizens need in order to deal with "bad stuff" that happens to the more unfortunate people, even in the best of communities. In the U.S., this area of municipal operations often represents the second largest expense a city incurs (after education), mostly due to the salaries paid to the policemen, as well as the high cost of the purchase and maintenance of equipment, such as cruisers, ambulances (often donated by a local charity, such as the Lions or Rotary Clubs), and fire engines (also frequently paid for by donations and fund-drives). In large cities, the police chief is frequently one of the highest paid officials on the payroll of the municipality. Firemen, on the other hand, are frequently volunteers, as are often the ambulance drivers as well, especially in smaller cities and towns. In the U.S., fire squads of professional, paid firemen are maintained only in large metropolitan areas of more than 50,000 inhabitants[94]. Only the larger cities have a municipal hospital, which represents another major expense for the city. Despite heavy subsidies from the state and federal governments, city-owned hospitals can be quite a drain on the city coffers. Other social services, such as eldercare or provisions for people with physical and mental disabilities may also be financed by local revenue, depending on the size of the needy population. Public housing is another form of social service that is made available to needy families and individuals to guarantee decent shelter to the working poor and to other disadvantaged people. Community Development Corporations (CDCs) are often created to manage public services (primarily public housing) at the neighborhood level.

culture and leisure

Culture and leisure for most cities include such operations as the running of the municipal library and the management of the various sports leagues in the local park system. Events, such as parades, concerts, fireworks, commemorations, celebrations and other ephemeral public

[94] In Italy, only the alpine autonomous, German-speaking region of *Süd Tyrol* (*Alto Adige*) maintains a tradition of volunteer *Feurwehr* troops in each mountain village, much akin to the tradition that is still widespread in smaller New England communities.

displays of community spirit[95] are often funded both by volunteer donations and by a financial contribution by the town or city.

education

Education is a municipal responsibility from the financial standpoint, though the actual running of school districts is delegated in the U.S. to elected boards of education and to elected or hired superintendents of schools. Sizeable sums of money trickle down from the State government to aid the needier municipalities (i.e. the ones with inadequate tax bases). Education is always the biggest drain of local funds, mostly because of the large number of teachers and employees needed to operate schools from Kindergarten, to Middle Schools (or Intermediate schools[96]), Junior High and High School. Teaching the "three R's" is an expensive activity that falls mostly on the lap of town treasurers. Real estate taxes – somewhat indiscriminately, as libertarians would point out – fetch the needed funds from all homeowners, whether they have children in school or not.

physical services

The rest of the city administration consists of such services as Parks and Recreation, Planning, Facilities Maintenance, Transportation and Public Works that simply make the "physical" city perform smoothly. These are perhaps the most "visible" services the city renders, as evidenced by the ubiquitous yellow trucks that plow snow, collect leaves, sweep streets, fix potholes, mow lawns and generally keep basic city operations in order year after year.

Despite some overlaps, dividing the functions of a municipality into these six areas offers a simple and useful starting point for a discussion of what a city does and how information is used in every area.
This dissertation dwells primarily on the types of information that are specific to city maintenance, maintenance and planning, hence the first two areas above – political and executive activities and internal services – are not analyzed in great detail, especially when many of their information needs are not too different from those of private business enterprises. However, the former area (politics and executive administration) plays a key role in dictating the type of information that needs to be distilled into knowledge to allow decision makers to make wise choices. The latter area (finances, legal and HR) is important to the degree that its departments generate a flow of administrative accounting paper trails that may be tapped into to feed the data streams that make up the foundation of City Knowledge that is the topic of this dissertation.

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95 Discussed in Carrera (1998) as a reaction to early drafts of Schuster in *Imaging the City* (2000).

96 Some school systems, such as in Spencer, MA, where I live, have four levels, whereby Elementary school goes only up to third grade, followed by Intermediate that caters to 4th, 5th and 6th graders, followed by Junior High reserved for 7th and 8th and finally High School for the last four grades (9-12th). Every new building, grade and class, requires additional resources.

DATA, INFORMATION, KNOWLEDGE AND ACTION

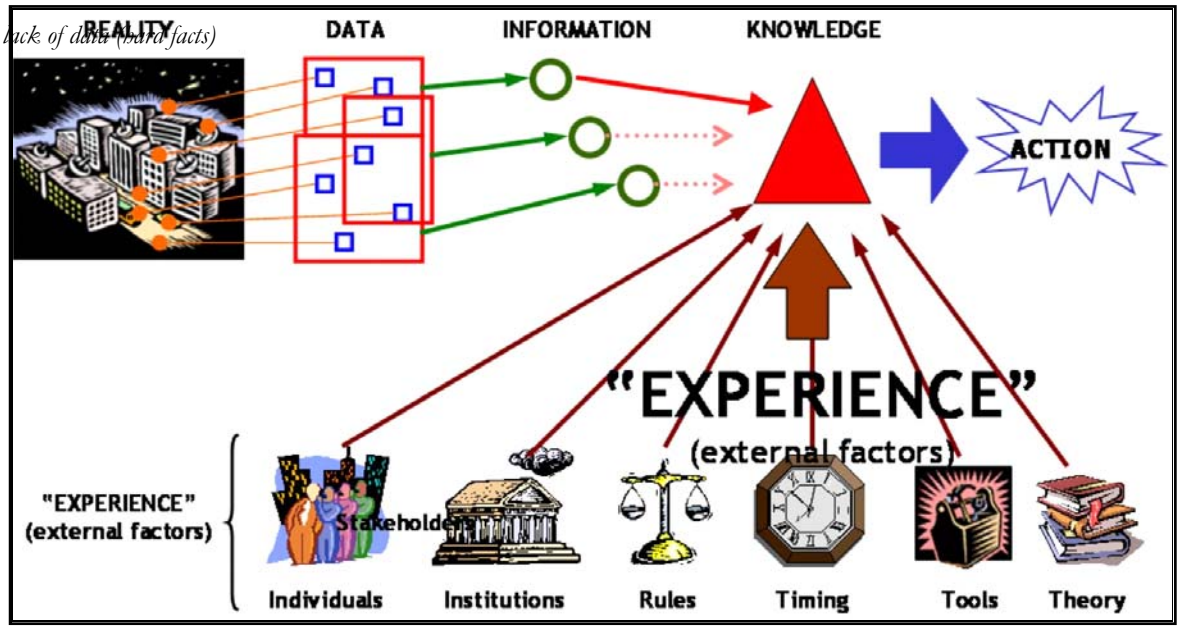
data, information and knowledge

Whereas in the previous chapters I have used the terms "data" and "information" synonymously, there seems to be some consensus on a hierarchy of "types of information", from data to information to knowledge (some scholars, such as Klosterman, even add a fourth level of intelligence)[97]. In this context, *data* would refer to raw facts, both quantitative and qualitative, *information* would pertain to data manipulated and organized in a meaningful form, and *knowledge* relates to "understanding based on information, experience and study".[98] *Intelligence*, a term which agencies such as the C.I.A. frequently use to refer to "top secret" information, is sometimes considered to be the application of knowledge to guide behavior[99]. In this paper, the terms data, information and knowledge are only occasionally used interchangeably, as synonyms, especially in quoted references from third parties[100]. For the most part, though, I have attempted to use them appropriately throughout this dissertation.

from knowledge to action

The figure below reflects the aforementioned taxonomy and also summarizes the typical processes involved in the decision-making that leads to action on the part of municipal agencies. Knowledge is supported by hard facts, based on data, which are organized into information, but it also taps into the "fuzzier" realm of "experience", whereby social, institutional, legal, tactical, methodological and theoretical factors play a role in the shaping of final decisions leading to actions.

lack of data (hard facts)



[97] Klosterman, Richard E.. 2000. "Planning in the Information Age", p. 42.

[98] *Idem.* See also Laurini, *Information Systems for Urban Planning*, pp. 41-42 and p. 149.

[99] *Idem.* I am not convinced by this fourth level, since it seems to me that it basically labels a goal which is implicit in the gathering of knowledge more than a "type" of information…

[100] Often, the authors I quote will use "information" to mean "data, information and knowledge".

The "hard facts" are unfortunately not as available as one would imagine them to be. In fact, many distinguished planners of the past (such as Olmsted[101] and Geddes[102], for example) as well as many contemporary observers of urban affairs[103] clearly point out that we are not doing a really good job of knowing our cities. In summary, as Yeh succinctly put it: "[t]oday, the main constraints on the use of GIS in urban planning are not technical issues, but the availability of data, organizational change, and staffing"[104].

My personal experience confirms these views. Despite the relative "permanence" and "immutability" of the physical elements composing our urban realms, knowledge of our cities is not as developed as one would hope it to be. Although data are gathered daily for a variety of reasons, information is not necessarily obtained as a consequence and knowledge is therefore hardly augmented in the process. The seemingly subtle differences between data, information and knowledge are quite apparent in the fields of urban maintenance, management and planning. Data are all too frequently collected to satisfy very specific needs. They are mostly treated as "documentation" and therefore they are rarely organized into information that can be used for other purposes. Thus, they hardly ever contribute to the creation of knowledge on which decisions and actions can be fruitfully based.

information vs. documentation

Planning Professionals need to navigate the inherent "political realities" of the cities in which they operate since the balance of power within the municipal hierarchy affects a planner's access to information and knowledge[105]. Planners, by the nature of their trade, have to learn how to collect, use and share knowledge using a variety of "rational", "scientific" or "formal" rhetorical forms[106]. They must be "intelligent" in their use of such knowledge and sensitive to the circumstances in which they operate[107]. Most importantly they need to bridge the gap between politicians and citizens[108] while they themselves straddle the fine line between comprehensive rationalistic theories, good on paper but highly impractical, and more realistic muddling-through[109] by incremental empiricism and communicative action[110]. Compromises between the textbook and the ad-hoc approaches have also been proposed, such as the "mixed-scanning" method put forth by Etzioni[111], but the business of planning is and will always remain more of an

communicative planning

101 Olmsted, 1913.
102 Geddes, 1911.
103 For example Geertman and Stillwell, 2004.
104 Yeh, 1999, p. 887.
105 Forester, 1989.
106 See particularly, Mandelbaum *et al*, Part IV (1996).
107 Wyatt, 1989.
108 Meyerson in Faludi, 1973.
109 The classic here is Lindblom's *The Science of Muddling Through*, 1959 (also in Faludi, 1973).
110 Habermas, 1984, 1987; Innes, 1998.
111 In Faludi 1973.

reflective practice

art than a science, as Don Schön clearly emphasized in his *Reflective Practitioner*[112].

It is precisely because of these multifaceted socio-political, psychological and behavioral issues that are so closely connected to the planning profession that I have become such a fervent proponent of the development of a solid, cohesive, coherent and unified knowledgebase of the urban makeup. The fact that I remain convinced that a lot of planning is an art, based on unquantifiable, instinctual, emotional and interpersonal gut feelings should not be construed as being in contradiction to my clamoring for a systematic and continuing accumulation of city knowledge.

I do not advocate total rational planning at all. I consider it utterly impossible and undesirable. What I do think, on the other hand, is that planning is so difficult – hindered as it is by the quagmires of personalities, power-struggles, ambitions and fears – that it would be highly beneficial to be able to rely on a solid foundation of factual knowledge as an anchored platform from which to deal with the capricious rollercoaster of public hearings, municipal commissions and citizen activists. In my view, a comprehensive and well-maintained urban knowledge infrastructure is not only a useful concept, but could really be a valuable reality. It could be, in my mind, entirely feasible as long as its development was approached methodically and modularly, without grandiose schemes and high-tech flights of fancy. My own experience is a living testament to such an assertion.

from information to knowledge

The aforementioned "artistry" with which a good planner has to be equipped has a lot to do with how he or she deals with institutions and organizations, both in the public and in the private domain. Information is useless if it is not accepted, appreciated or welcomed by the powers-that-be. Often, information can be threatening to bureaucrats or politicians and it is not unusual to encounter attempts at "burying" potentially damaging knowledge. Delay tactics are often employed by city officials to thwart the adoption of new data that may offset some real or perceived political balances. Patience is a virtue that planners must develop in order to weather the ups and downs of political whim. I think I have experienced the whole gamut of institutional tactics that are deployed from the arsenal of entrenched "apparatchiks". I was privileged to be exempt from the frustrations of city planners working inside government agencies, whose proposals are often mothballed after months of careful analysis and painstaking data collection. Being a freelancer, with academic credentials, and armed with altruistic motives thanks to the job-security of my American paycheck, I could outwait the long stalemates and eventually I was able to re-propose old solutions when the moment was more propitious.

inspiration and discovery

All the while, I often found myself acting as a go-between, connecting individuals and institutions which probably would not have been interacting so freely or willingly under normal circumstances. I did all this based on instinct and on my growing knowledge of city issues, as well as– quite frankly – thanks to a large dose of naïveté. My motivations were those of a self-serving altruist. I was offering my "free" advice to benefit my own lot as a

[112] Schön, 1983.

citizen of Venice. My perspective was informed by personal experiences in daily living in my city. My concerns, I am sure, were shared by many fellow citizens. I was luckier than most Venetians in that I had at my disposal the tools and resources to do something about my concerns. I employed my armies of undergraduate students to comb the city, studying whatever seemed appropriate and timely. The big discovery for me was that, despite the fact that our data were collected by young troops, – rather short in experience but long in motivation and stamina – what we assembled was an unprecedented collection of city knowledge, unparalleled both in scope and depth and, most importantly, organized systematically for easy access, unlike the piecemeal assemblages that lay scattered in file cabinets and drawers throughout the various offices and agencies that were staffed by "real" professionals.

CITY DATA

City data, in my restricted definition for this thesis, include everything that is of interest to municipal maintenance, management or planning. In a broader sense, however, city data comprises everything within a city that is of interest to anybody for any reason whatsoever. Of course, there will be low-hanging fruits wherein the benefits of acquiring the extra data and organizing them properly according to City Knowledge principles would far-outweigh the additional transaction costs.

low-hanging fruit

Ideally, the ongoing consensus-building efforts will arrive at a finite number of fundamental datasets that can constitute the core data for a developing local spatial data infrastructure framework[113].

local spatial data infrastructure

"PLAN-DEMANDED" DATA

Indeed, the planning process is predicated on the availability of a myriad of data, but information is almost never available as a consequence of a systematic data-collection strategy by government agencies. Rather, "[t]o develop new land-use plans and proposals (or to form opinions as new opportunities and proposals surface), all of these agencies typically spend considerable energy researching and analyzing land use and ownership in the neighborhoods surrounding the sites that are targeted in the plans."[114] Urban Planning is largely based on ad-hoc collections of data, gathered on an "as needed" basis in what I term a "plan-demanded" mode of operation. Every time a plan is envisioned or proposed, "we need to integrate, and reinterpret many data sources now dispersed among agencies and groups that are administratively isolated and focused on different issues and goals"[115].

Automation plays a certain role in this process, in that some planning data are collected fairly rigorously by some government agencies, but the tendency toward automation in this field has been limited, for the most part, to areas that are under strict regulatory control (like land use) or that generate municipal revenue (like parcel ownership). Record keeping in such instances has always been necessary to the proper functioning of civil

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113 See the FDGC efforts in this sense at at http://www.fgdc.gov/framework/. Last accessed 8/20/04.

114 Ferreira, 2000, second page of chapter 7.

115 *Idem.*

society, so the introduction of Information Technologies (IT) has been merely a convenient way to make the process faster and smoother.

Generally speaking, though, the representation of space in many municipal computerization efforts has been shortchanged. At best, locations are represented by address, with all of the standardization and referencing problems that such an approach entails. A systematic approach to the acquisition of fine-grained city knowledge is still considered too cumbersome, even after the introduction of the first G.I.S. tools in the late 80's. Unfortunately, without a reliable, shared knowledgebase of urban information, the "speed-up" effect brought about by traditional automation "may not make much of a dent in the considerable amount of time that our prototypical neighborhood planner must spend studying land use and ownership"[116].

plan-demanded examples

Examples of "plan demanded" data gathering abound. In fact, most data gathering outside of the realms of regulatory or revenue-generating operations probably fits in this category. In my own personal experience, I have actually participated in several plan-demanded campaigns of data collection, both in Italy and in the U.S. For instance, I have led teams of students from the Worcester Polytechnic Institute (WPI) in campaigns to collect information about numerous aspects related to the canals of Venice. The data are currently used by Insula S.p.A. (a private-public company in charge of the maintenance of the Venetian canals) to actually conduct dredging and restoration projects on the Venetian waterways. The data we collected included: measurements of the physical dimensions of the canals, including the water depth and sediment levels at the bottom; a catalog of all sewer outlets and wall damage along canal banks; measures of the water currents in the canals; counts of the boat traffic in the canals and quantification of the wakes produced by passing motorboats; an inventory of all bridges spanning the canals and an assessment of their state of (dis-) repair; a similar census of all boat docks and their condition; a series of campaigns to quantify the amount of cargo delivered to each island in the city; and several other more specific studies.

Similarly, I coordinated programs for the systematic inventory of: trees in the city of Venice and in the City of Cambridge, Massachusetts; parking facilities in downtown Boston, Cambridge and Newton; underground storage tanks for the Boston Fire Department; brownfields for the Boston Redevelopment Authority; historic monuments and landmarks for the Boston Landmarks Commission and for a variety of Venetian organizations; archeological sites both in Boston and Venice; etc. Overall, I have participated in over 100 such projects on both sides of the Atlantic.

All of these projects were completed to fill informational lacunae and were used by the sponsoring agencies to carry out specific actions related to urban maintenance, management and planning that required immediate attention. All of them are examples of "plan-demanded" data gathering.

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116 *Ibid.,* p. 4 of chapter 7.

CITY INFORMATION

communicative planning

The use of information in planning is discussed, among others[117], by Judith Innes (De Neufville) who promotes a new paradigmatic approach of interactive communicative action, based in part on Habermas' fundamental theories[118], which inspired many other authors, including Forester[119] and Faludi[120]. Many of these authors belong to a camp that is in striking contrast to the "systematic thinking" approach of previous academics[121]. The claim is that communicative and interactive action will help close the gap between theory and practice that has characterized the discipline until recently (Innes 1985). More importantly, this literature constitutes a scholarly attempt at understanding "how, and under what conditions, this information makes a difference" and begins to provide "better conceptual tools to see more clearly how public action is shaped by information"[122] above and beyond the usual mode of planning as *analysis for decision-makers*. This new communicative approach, which is gaining more and more currency in the planning world, is very much in tune with my personal experience in the field.

Judith Innes' own 1992 paper on Geographic Information Systems (GIS), albeit a little dated, is one example of the bridge between the more theoretical assessment of the role of information and the more practical implementation of these theories using modern instruments and current technologies. Although some authors were already looking *Beyond Geographical Information Systems* even before the 1990's[123] , it seems that GIS technologies, together with Database Management Systems (DBMS), are really the primary tools at the disposal of planners. A lot remains to be done to make the use of these technologies more widespread and the information they encapsulate more broadly shared among all the actors[124]. My personal practice has relied very heavily on the application of GIS and DBMS to the systematic accumulation of City Knowledge ever since 1988.

The main trend these days, in technical circles, is the push towards "enterprise GIS"[125] and on the use of web-based internet tools to provide shared platforms for the exchange of spatial urban information[126], pioneered, among others, by our own Planning Support Systems group at MIT[127]. While I appreciate these state-of-the-art concerns, which will indeed constitute the next hurdle in the development of comprehensive Urban Information Systems, I find that this sophisticated know-how is only useful, in the "real world", as a teleological guide for active practitioners like me.

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117 For a recent text on the topic of information for planners, see Dandekar, 2003.

118 Habermas, 1984, 1987; Innes, 1998.

119 Forester, 1989, 1993.

120 Faludi, 1986. Although Faludi concentrates on Carl Popper's theories more than Habermas'.

121 Innes 1995.

122 Innes 1996, p. 4.

123 Harris, 1999.

124 Geertman and Stillwell, 2004; Brail and Klosterman, 2001.

125 Keating *et al.,* 2003. Azad, 1998; Singh, 2004.

126 Mancuso, 2003; Kelly and Tuxen, 2003; see also page 103.

127 Schiffer, 1992; Evans, 1997; Singh, 2004.

Being cognizant of the leading-edge trends can help us design the building blocks of much less ambitious systems in such a way as to ensure their future upgradability to these high-tech new systems that, so far, have found very little application in day-to-day municipal operations[128]. In other words, I find it much more useful, at this point in time, to be actively engaged in the promulgation of the "basic" concepts of urban information archival in the many municipalities that have yet little or no direct experience with these computer tools.

Oddly enough, my own experience has provided some disconcerting surprises as to the low level of adoption of GIS and even Databases in the actual workings of many departments, even in such "progressive" cities as Boston and Cambridge[129]. Just like in the society at large, there are definitely major discrepancies between the "haves" and the "have nots" in terms of computerization of operations in different cities and even among different departments within the same municipal governments.

"Plan-Ready" Information

While involved in the aforementioned "plan-demanded" projects, I immediately realized that such Herculean efforts would be much more effective if they not only contributed to the pressing needs of the agencies that commissioned the studies, but also contributed to the long-term creation of a knowledge infrastructure that could be re-used in other contexts. While Insula S.p.A. could use the canal data for its immediate necessities, certainly such permanent and immutable features as the canal lengths and widths could come in handy for some other purpose at a later date. More importantly, the canal coding scheme that we developed, which assigned unique identifiers to each segment of the water network, could certainly be useful for posterity. If all future data-gathering utilized the same scheme, it would be possible to compare and correlate datasets referring to the same canal segment at any time. The benefits of such a standard referencing system and of any permanent records connected to it were indisputable. So, when we collected our data on all of the various elements of the urban realm, we always did so with an eye to this fundamental infrastructure of knowledge that could be reusable by other researchers or government agencies for years to come. We were able to do so, partly because of intuitive insights due to our background in the rigors of engineering, but also because we based our referential system on spatial features, which were part of the unchanging (or slowly changing) urban world. We were fortunate to have been pioneers in the use of Geographical Information Systems (GIS) as early as 1987, which opened up the possibility of actually being able to georeference our data to their real-world locations.

standard referencing system

What is still often lacking in today's municipal agencies, in fact, is a decentralized "informating"[130] strategy that properly accounts for the spatial

128 Geertman and Stillwell, 2004.

129 See Part III.

130 Zuboff, S, 1991. In *the Age of the Smart Machine,* Zuboff coins the verb "informate", which means essentially to be able to archive and organize data as they are produced through automated processes, so

dimension of urban features and makes these and other data available to those who need them. To remedy these shortcomings, I am proposing to introduce a space-based representation of the urban realm based on the fundamental, quasi-permanent physical elements that are already the object of regular municipal attention for maintenance or management. While this may not be a novel idea in itself, the innovation I am suggesting would lie primarily in the manner in which these data could be systematically collected, and especially updated, by capturing transaction data and even some low- to no-cost snapshots, starting from a few key areas that are especially relevant to planning. An important aspect of my approach is to focus first and foremost on the permanent and immutable features of the urban world, which, once recorded and organized should require very little upkeep, thus eliminating any redundant effort to collect the same data for a variety of different purposes.

spatial georeferencing

gradual accrual

low hanging branches

The representation I propose can be gradually and systematically "grown" into a reliable, flexible, multi-purpose and shareable knowledge base of the urban landscape, beginning from the "low-hanging" branches of the hierarchy of municipal agencies, which are most directly interacting with the "real world" of the city and would benefit the most from a structured approach to the representation and computerization of the urban features that are already under their jurisdiction. It is at the level of these "low hanging fruits" that the systematic approach I propose can be most effectively overlaid on ordinary municipal operations where the tradeoffs between maintenance necessities and the added requirements of the encoding of city knowledge are most advantageous.

low-hanging fruit

atomic recordkeeping

Whereas traditional recordkeeping methods for these "atomic" elements of the urban realm are generally ill-suited to planning, because their level and method of representation is usually inadequate for higher-order manipulations, the cumulative process discussed herein can not only produce usable information for both the front-line operators of the municipal departments directly in charge of each set of urban elements, but it can also generate solid, fine-grained and rich datasets of usable information that planners and decision-makers can tap into for the formulation of government actions that address more complex urban conditions. In short, the approach that is going to be explored in this dissertation promises to produce "plan-ready" information and may even lead to the inductive development of plans and actions that may be demanded by the preponderance of evidence produced in the process.

planning "automation"

My own approach to the development of "plan-ready" city knowledge is, in a sense, an attempt to bring more "automation" into the planning process, so that the "informating" will be based on reliable, systematically collected, up-to-date and easy-to-update data. This approach espouses Zuboff's argument, though it is applied to fields (city maintenance, management and planning) where informating requirements are already evident and implicit (or "tacit"[131]) knowledge is already used empirically.

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that this information can be utilized for higher-order management and control activities that go beyond the original intent of the mere automation of routine operations.

131 Choo, *Information Management for the Intelligent Organization*, p. 11.

The difference between the more traditional manufacturing, and data processing applications studied by Zuboff and the urban disciplines that I am interested in, is that while information about many aspects of urban life is somehow available to city managers and planners – on demand and with substantial effort – there is little or no automation to feed the demand for such information. Whereas the traditional industries in Zuboff's case studies followed the straightforward path of technological development from a manual management and control of operations to a computer-assisted, automated version of the same tasks, many areas of urban management and planning do not have any automation in place at all. Yet, the power of information, which was only gradually realized as an afterthought of automation in Zuboff's companies, is an ever present reality in the urban management and planning arena, where the need for informating actually predates the need for automating. In this dissertation, I try to show that plan-ready information can indeed emerge from a sort of "automation" of the front lines of municipal operations.

ambulance dispatching system

Over the years, I have accumulated a number of personal cases in which data that were collected for one purpose were later used for a completely different reason, without the need to go back in the field. For example, in 1997, we were asked to develop a prototype of an ambulance dispatching system for the Venice general hospital[132]. Ambulances in Venice are of course boats that need to contend with the same obstacles as their land cousins, such as traffic congestions and the like, but also have to deal with the vagaries of tidal fluctuations which may make some routes impassable, either because of high tides – which make some bridges too low to pass under – or because of low tides – which make it impossible to navigate where the sediment build up has made the canals too shallow.

To tackle this problem, we actually borrowed a software package (called TransCAD[133]) from the Planning Support Systems group of the Department of Urban Studies and Planning (DUSP) at MIT. This application figures out the shortest route (by time or by distance) and is capable of taking into account "delays" due to a variety of causes. Thanks to our extensive knowledge of the canal system, we were able to re-utilize our information about the depth of canals and the height of bridges to insert appropriate delays along the routes, depending on the tide levels.

More importantly, we were able to create the canal network graph needed to run the whole system, basing it on the canal centerlines that we had already determined in the course of another project[134]. Moreover, we had to tweak the system to allow for two separate routes, a sea route to a specific dock location, and a land route, from the dock to the emergency address. We already had all of the dock locations from another project and all of the address locations as well. The only thing we had to do from scratch was develop a land network graph and we were already in business…

132 Caporale *et al.*, 1997.

133 Which incidentally is produced by Caliper Corp., a company that is an off-shoot of MIT.

134 We had created the centerlines to "measure" the canal lengths.

the power of plan-ready

This project exemplifies the power of "plan-ready" information, when data are collected with an eye to the potential re-utilization of the information in a context that is different from the one for which the original data collection was conducted. In this case, we actually tapped into at least four previous projects, which were completed long before this study was even envisioned. The utilization of all these datasets in this particular application was never even remotely imagined at the time when the data were collected. What made all of this possible was the fact that each dataset was connected to spatial features of the canal network, through standardized reference identifiers of the canal segment codes in all of the records.

CITY KNOWLEDGE

The lesson is clear. If you gradually and methodically collect urban data and systematically organize it in computer databases and GIS maps, the data can turn into information and eventually into knowledge of concrete utility to a variety of city agencies… This may not seem like an earth-shattering discovery, but – alas – it is not a widespread practice anywhere in the world, at the fine-grain that I am envisioning[135]. While I am not sure that my personal situation is typical, I do believe that the moral of the story may be broadly applicable and exportable to other urban contexts. This dissertation addresses these issues in detail.

from knowledge to decisions

I was very encouraged by my discovery that many of my seat-of-the-pants approaches to the institutionalization of urban knowledge were pretty much "standard" practices in the field, although there is certainly a lot of latitude in this arena, where nothing is ever quite black and white and a lot of variations on themes are employed in the management toolkit[136].

"PLAN-DEMANDING" KNOWLEDGE

Although the mere availability of "plan-ready" information would already be a major step forward in the management of urban affairs, there is an even more intriguing byproduct of the approach that I am propounding. It seems plausible that, once enough plan-ready information is available to a variety of municipal agencies, the data may begin to "suggest" the need for plans that would otherwise go unnoticed. Patterns may emerge from the data repositories that require attention and this in turn may lead to the spontaneous emergence of the need for solutions in the form of actions or plans.

from knowledge to action

This is not a far-fetched concept, since it is really how many city plans are born anyhow. Except when real-estate development pressures force a certain "reaction" on the part of city planners, many plans are "proactive" and reflect the overall "direction" in which the city would like to go. If negative trends are somehow noticed, or if citizen groups voice concerns or demands for a certain correction in the way the city is moving,

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135 Cf. Geertman and Stillwell, 2004. This is not to say that there are no examples of comprehensive efforts in the world like the national Census efforts, or the national geological surveys and many others. The emphasis here is on the word "widespread" and on the scale – and consequent "grain" – of such efforts.

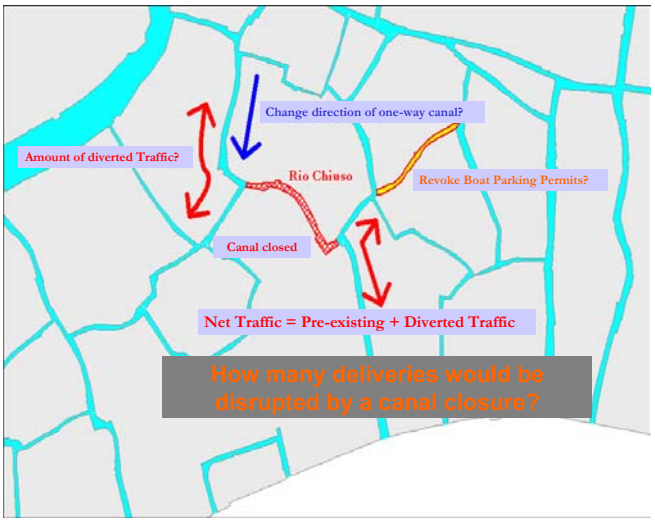
136 I am indebted to Prof. Wanda Orlikowski of MIT for her guidance in the enormous body of literature on organizations. A great summary of organizational theories can be found in Vibert, 2004.

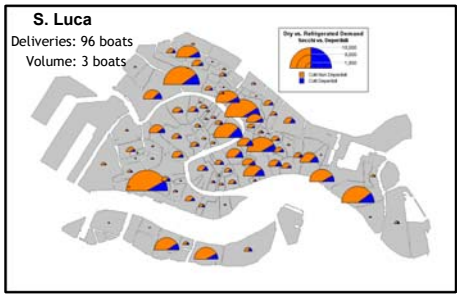
plans are usually generated to counteract these negative tendencies. If a particular pattern of development is perceived as positive in one part of a city (or in a nearby community), plans are created to try to emulate these success stories.

Having a serious critical mass of city knowledge at one's disposal, would probably invite exploratory analyses that would most likely generate ideas for corrective plans (in the case of negative patterns) possibly based on positive trends noticed elsewhere thanks to the same body of knowledge. Sometimes, planners may suddenly realize that they had actually misdiagnosed a certain urban condition or they may find the real cause of a problem whereas they had been attacking only the symptoms for years[137].

plan-demanded: cargo deliveries data

I have at least one example from my personal experience of a real case of "plan-demanding" knowledge, again from a real experience in Venice, Italy. It all started in 1995, when, under the auspices of UNESCO, we first began to study the quantities of deliveries made to each of the 125 islands that compose the city of Venice. This plan-demanded study was meant to quantify the amount of cargo that was unloaded onto each island from each of its perimeter docks[138]. The purpose was to determine how much disruption would be caused to the cargo delivery system if and when a particular canal around an island was closed for maintenance, thus eliminating a number of docks normally used for cargo operations. The study purported to pinpoint critical areas that needed to be taken into account when the canal closures were planned, to avoid isolating an island completely, thus forcing delivery personnel to surmount a number of bridges with loaded carts in order to make a delivery. The best sequencing of canal closures was thus arrived at, taking into consideration not only the effects on deliveries to local businesses, but also the amount of traffic that would be diverted to nearby canals when a specific canal was shut down for maintenance, which would in turn impede the flow of traffic and hence make deliveries on other perimeter canals more difficult. This was a successful project that led to some follow up studies in other areas of the city, commissioned by Insula S.p.A., which is the company in charge of making the canal closing decisions. Thus, plan-demanded data were turned into plan-ready information.

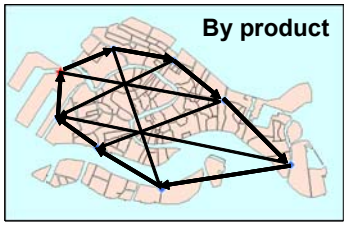




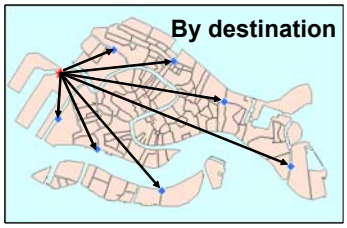
137 See the discussion about the origin of canal wall damage at page 116.

138 Doherty *et al.*, 1995.

plan-ready: canal closure analysis

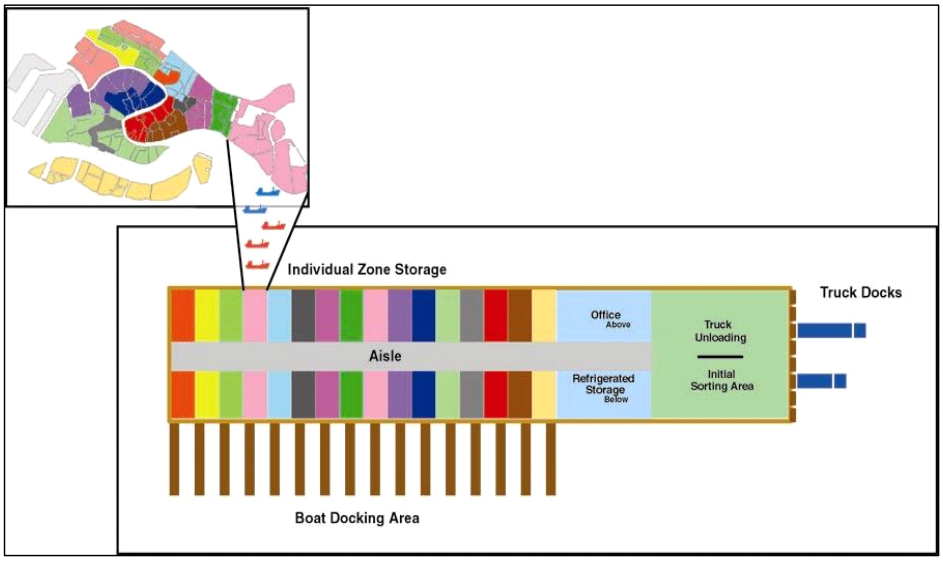


plan-demanding: cargo re-engineering



The plan-ready information that was generated by these projects led to the realization that there were in fact many cargo boats that were affected by these inevitable maintenance works. For instance, a specific island near the Rialto bridge was visited by 96 cargo boats every day. What was even more interesting though was the realization that these 100 boats carried cargo that, by volume, would have fit easily in only 3 fully-loaded boats… The sequencing of canal closures was therefore made much more difficult than it had to be by some absurd inefficiency in the actual cargo delivery system. The problem, we quickly discovered, is that cargo in Venice is not delivered "by destination" but "by product". The "water boat" drops off cases of water in each of the islands, as do the "wine boat" and the "beer boat", and the "toilet paper boat" and so on. Each boat only drops off a few boxes or cases, and each boat visits many many islands every day. No wonder there was such a glut of boats around these islands!

The discovery of the exact extent of the wastefulness at play in what was already known to be a sub-optimal system, transformed the plan-ready information into plan-demanding knowledge when we proposed an in-depth study to the local boat "teamster" union (*Consorzio Trasportatori Veneziani Riuniti – CTVR*) to explore ways to improve the system and eliminate these gross inefficiencies. The study[139], conducted in the summer of 2001, resulted in a proposal for a central warehouse where cargo would be sorted by destination and delivered by only a few fully-loaded boats to only a handful of contiguous islands, in one of the 16 zones in which the city was divided. The project was awarded the WPI President's Prize as the best project of the year 2001. Since then, the City of Venice has embraced the plan and intends to implement the proposal by 2005. Once operational, the re-engineered system of deliveries will reduce overall cargo boat traffic and the consequent wake damage in Venice by over 90%[140].



139 Duffy *et al.*, 2001.

140 More on this topic starting on page 118.

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