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Preliminary Dissertation Proposal

PROVISIONAL TITLE:

CITY KNOWLEDGE
An Infrastructure for Urban Maintenance, Management and Planning

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1 DOMAIN OF INQUIRY AND RESEARCH QUESTIONS

My personal experience in urban studies and planning in my hometown of Venice, Italy, as well as more recent forays in Boston and Cambridge, 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. 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. Although some systematic data collection takes place, mostly for regulatory or revenue-generating purposes (such as for 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.

Whereas in the paragraphs above 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)[1]. 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".[2] *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[3]. In the paragraphs that follow, the terms are occasionally used more or less interchangeably, as synonyms, especially in quoted references[4], even though a portion of my dissertation will be devoted to differentiating between the three levels and investigating the transformation between one stage and the next, with additional emphasis on how knowledge affects actions (and plans).

Many distinguished planners of the past (such as Mumford, 1961, Olmsted, 1913 and Geddes, 1915) as well as many contemporary observers of urban affairs (e.g. Yeh, 1999) 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"[5].

My personal experience confirms these views.

In fact, the planning process is indeed 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."[6] 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"[7]. 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 society, so the introduction of Information Technologies (IT) has been merely a convenient way to make the process faster and

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1 Klosterman, Richard E.. 2000. "Planning in the Information Age", p. 42.

2 *Idem.*

3 *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…

4 More often than not, the authors I quote will use "information" to mean "data, information and knowledge".

5 Yeh, A. G.-O, 1999. "Urban Planning and GIS" in Longley *et al.,* eds., *Geographical Information Systems*, p. 887.

6 Joseph Ferreira Jr., in *High Technology and Low-Income Communities*, second page of chapter 7.

7 *Idem.*

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"[8].

What is often lacking in today's municipal agencies is a decentralized "informating"[9] strategy that properly accounts for the spatial dimension of urban features and makes these and other data available to those who need them. To remedy these shortcomings, I am proposing is 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 proposing would lie primarily in the manner in which these data would be systematically collected by capturing transaction data in a few key areas that are especially relevant to planning. 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 operations, 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.

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 would quickly begin to produce usable information for both the front-line operators of the immediate municipal departments in charge of each set of urban elements, but would also generate solid, fine-grained and rich datasets of usable information that planners and decision-makers could tap into for the formulation of government actions that could affect 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.

My own approach to the development of "plan-ready" (and possibly "plan-demanding") 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 knowledge is already used empirically. 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.

The domain of inquiry will therefore be the collection, organization and use of knowledge by government agencies for the development of actions related to urban maintenance, management and planning.

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[8] *Ibid.,* p. 4 of chapter 7.

[9] Zuboff, S. *In the Age of the Smart Machine.* According to Zuboff, to "informate" means essentially to be able to archive and organize data as they are produced through automated processes, so 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.

My primary research question(s) can be formulated as follows:

What advantage can be derived from the development of new municipal "Knowledge Infrastructures" that will produce "plan-ready" information for city maintenance, management and planning?

What realistic, short- and medium-term, technical and institutional approach(es) can be used to achieve the advantages hypothesized?

What areas of urban maintenance, management and planning are more amenable to these approaches in the short and medium term and why?

To what degree, and under what circumstances, will the availability of rich city knowledge promote the emergence of a need for new plans that are dictated by the mere existence of such information?

2 RELEVANCE OF RESEARCH AND CONTRIBUTIONS TO FIELD

The municipal IT development paths, prevalent in the late 80's and early 90's, can be categorized in two distinct camps. On the one hand, there were big-league, top-down efforts that nevertheless suffered from a variety of technological limitations, that only recently have begun to be resolved, such as limited processing power, narrow bandwidth, awkward (or non-existent) interoperability and an overall dearth of standardization. Parallel to those efforts, there was a growing number of scattered, haphazard, bottom-up Geographical Information System (GIS) approaches that popped up ubiquitously in public agencies all around the world. These efforts, due to their insularity, were able to sidestep many of the technological hurdles that hampered the success of their contemporary top-down approaches that began to systematically record and manipulate spatial location, but suffered from a host of other problems, such as the almost complete lack of interoperability, a substantial redundancy of efforts and the limited scope and power of the applications that were produced.

The more recent top-down enterprise GIS examples in San Diego, Singapore and Hong Kong are direct descendants of the earlier top-down efforts, but they are benefiting from much improved hardware and software platforms, which have ostensibly resolved many of the technical issues and have begun to integrate georeferencing and geoprocessing methods into "enterprise" Information System (IS) operations. These enterprise approaches seem to be the most appealing to today's public agencies and private businesses. Planning agencies are now attempting to develop fully-functional Spatial Decision Support Systems (SDSS) and Planning Support Systems (PSS)[10], mostly adopting a loosely-coupled architecture whereby data are exchanged through shared files, though tighter coupling is becoming more and more possible (though not necessarily desirable, in my view), especially between GIS and modeling packages.

Advances in Database Management Systems (DBMS), such the Structured Query Language (SQL) standard and Open Data Base Connectivity (ODBC), are making the interoperability of dabasases more and more seamless. Graphics and multimedia can now be intermingled with vector maps and alphanumeric data, through Object Linking and Embedding (OLE) standards as well as COM, DCOM and CORBA protocols, and thanks also to the customization capabilities provided by GIS-specific OCX tools (e.g. Mapinfo's MapX) for the development of front-ends that can bring together a variety of data elements under a unified Visual Basic or C++ interface[11]. Collaborative Planning Systems (CPS) have been envisioned, and pioneered in our own PSS group here at MIT[12], which will make multimedia a more integral part of the planning process. Even the quality and accuracy of electronic basemaps has improved dramatically thanks to advances in Global Positioning System (GPS) technologies and also thanks to the improved ability to reconcile maps based on a variety of cartographic projections.

The World Wide Web represents the next frontier in GIS development, with new possibilities emerging thanks to the advent of web-mapping packages such as ESRI's ArcIMS and Mapinfo's MapXtreme, though bandwidth limitations still limit direct interaction with server-based maps through the web. The current mode of operation still relies on the transfer of map images (in raster format) from the back-end server to the front-end client,

[10] Yeh, pp. 882-884.

[11] I have personally been involved in several projects that produced these types of hybrid, multimedia interfaces.

[12] Schiffer, "Managing Public Discourse".

though JAVA applets are making the actual client interfaces look and feel more and more like "real" GIS. Interoperability can greatly benefit from web-based map servers and appropriate use of metadata dictionaries in conjunction with "smart" web-enabled client applications, regardless of the hardware platforms and the operating system adopted.

In short, the needs and wants of municipalities, which have been computerizing many of their operations and may have been dabbling with bottom-up GIS applications for the last few years can now be met with the most recent advances in spatial management technologies which are not only affordable but also more suited to the new decentralized, "middle-out" approach to the spatial representation of urban features that will be the focus of my dissertation. I call my approach "middle-out" because it does not subscribe to the one-size-fits-all, centralized, top-down strategy that has recently gained some currency in major metropolitan areas, nor is it a mere fend-for-yourself, fragmented bottom-up tactic that, while useful to some agencies, remains largely unusable and unused by anyone outside the small circle of people who are directly involved with it. A middle-out approach would combine the best of both worlds by creating a loosely-coupled, distributed city knowledge system that is built gradually over time by a number of parallel efforts in a variety of city departments, all abiding to a overall coordinating strategy that assures compatibility and opens the door to interagency and interdepartmental sharing. My own research and experience seems to confirm that an informating approach that is neither truly top-down, nor merely bottom-up has a chance to be successful in the real world of municipal governance of urban assets. The current technological trends described above would make my approach much more feasible today that it would have been in the past. In particular, the loosely-coupled nature of web-based applications, and the overall architecture of the WWW provide a natural infrastructure for my middle-out approach which is now "ripe" for real world implementations.

Some development paths being recommended today resemble this middle-out approach[13]. For example, the City of Cambridge, Massachusetts has begun an effort of this sort, by distributing GIS specialists in the main city departments under the orchestration of the MIS department, although that endeavor is still in its infancy. My middle-out approach would be more similar to the Digital Earth effort[14], but limited, at first, to individual municipal boundaries and to the agencies operating therein. Ferreira, in particular, has championed a variation of this middle-out approach when he proposed the use of lookup tables to correct on-the-fly the "stubborn" standardization errors that regularly appear in municipal datasets[15], as well as (with Evans) when he discussed a more general approach to the "messy" technical and organizational issues confronting GIS today[16]. What these new methodologies have in common is a recognition that "GIS technologies are *not* divorced from the interplay of organizational life: rather they are subject to its vagaries and power relationships"[17]. A middle-out approach will not only simplify the more technical pitfalls of pure top-down and bottom-up approaches, but also promises a more gradual, hence smoother, and less traumatic path for the organizational transformations needed to ensure a widespread acceptance and a successful adoption of GIS technologies in municipal agencies.

In fact, Geographical Information Systems (GIS) and DataBase Management Systems (DBMS) – while rather commonplace in today's city government – are scarcely used to systematically keep track of essential urban elements, such as roads, trees, sewers, etc. in an "automatic" fashion. Ad hoc or "implicit" knowledge is used instead to produce maps and datasets that feed the decision-making process on a need-to basis, case by case. Widespread informational lacunae exist despite the fact that many municipal activities leave a paper trail that would easily lend itself to automation. Roads are regularly re-paved, cleaned and cleared of snow, so someone is issuing work-orders or stipulating contracts for these services. Similarly, trees are bought, planted, removed and trimmed and paperwork is produced to make each of these actions happen and to keep track of the corresponding expenditures. Sewers, like many other components of the urban infrastructure, are subject to similar record-keeping procedures, plus they are also regulated and licensed. Seldom are these opportunities for automation tapped into to promote the sort of "automation" that would lead to a more rigorous approach to informating urban maintenance, management and planning. Recently, some city planning agencies have begun requiring that developers submit 3D CAD data in a standard format and while similar attempts at a gradual accrual of computerized records from the ground up are put

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13 See for instance Campbell, *op.cit.* and Yeh, *op. cit.*

14 http://www.digitalearth.gov/

15 Ferreira, *op. cit.*

16 Evans and Ferreira, "Sharing Spatial Information in an Imperfect World: Interactions between Technical and Organizational Issues".

17 Campbell, A. J.. 1999. "Institutional Consequences of the use of GIS" in Longley *et al., op. cit.*, pp. 621-631.

in place in a variety of other municipal transactional contexts, we are still far from a genuine systematic and coherent approach that will ensure that we are not simply replacing the old fashioned paper files with lots of disjointed computer files. My middle-out approach, on the contrary, is an attempt to promote a gradual, modular and methodical process of data collection and organization, predicated on the construction of a space-based "scaffolding" onto which every piece of data that is acquired is archived, thus creating a "useful" and "usable" infrastructure of city knowledge that will eventually perpetuate itself through automation, and will naturally feed into the informating requirements of urban planning.

Despite the fact that Zuboff's *In the Age of the Smart Machine* was written before the web, I think its main message remains as valid today as it was in 1988. If anything, the advent of the Internet and the World Wide Web may accelerate the centrifugal forces that are flattening out Zuboff's "concentric organization" and thus potentially exacerbate the conflicts between managers and subordinates. The technology itself, once again, is not the solution, nor the problem. But it may contribute to a more rapid transformation of the internal organizational dynamics of government agencies toward a "connected distributed"[18] *modus operandi*, that will enfranchise the citizenship as well as the front-line civil servants. This, in turn may set the stage for a truly devolved informating "wholeness"[19], where managers and managed contribute together, "holistically"[20], to a middle-out approach for the management of urban affairs. The Internet and the WWW would certainly facilitate such an approach.

Finally, all of these innovative approaches may incrementally lead to "*a truly interactive, timely planning dialogue between neighborhood planners and city agencies – as well as* [to] *a mode of interagency* [and – I would add – 'intra-agency'] *coordination that might allow agencies to keep pace with one another*"[21] and with their public constituency. Once again, the interconnectivity provided by the WWW today makes this interactive approach all the more feasible and affordable, both for our cash-strapped public agencies and even for the less fortunate groups in our society.

The relevance of my upcoming dissertation is thus threefold.

First of all, I plan to identify and illustrate that there are measurable advantages in a systematic, space-cognizant representation of fundamental aspects of urban form and urban functions. I plan to demonstrate how these physical realities can be systematically mapped into datasets and spatial layers, how these data can be organized into meaningful information, how information can be used, in conjunction with social, legal, economic, political, institutional and tactical factors to produce knowledge and how this knowledge affects the subsequent actions taken by urban decision-makers. This systematic approach, if broadly adopted, could represent a considerable contribution to the field of Urban Studies and Planning and could be of great relevance to all areas of human endeavor related to the functioning of cities and municipalities.

Secondly, the approach I plan to develop, which is based in large part on concrete examples from my personal experience, will be immediately relevant to "front-line" city officials who rely on knowledge in the fulfillment of their institutional mandates related to fundamental urban elements that are the object of maintenance, as well as to equally fundamental urban functions that fall under municipal management or oversight. I plan to show examples of how municipal agencies can (and possibly should) develop a distributed, but interconnectable, knowledge infrastructure, of immediate usefulness to managers of urban services, that is technically and economically viable, as well as compatible with the established distributed, hierarchical organization of typical city governments. This aspect will rely on my personal experiences as well as on examples of similar practices adopted elsewhere.

Thirdly, the creation of a knowledge infrastructure could have great relevance vis á vis the internal organization of, and interaction between, the various agencies within municipal bureaucracies, as well as on the role of individuals within the hierarchy. It is quite possible – even likely – that the inner workings of agencies may be altered, *de facto* or *de jure*, by their involvement in the development of the proposed knowledge infrastructure. I plan

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[18] Thomas W. Malone, *Is Empowerment Just a Fad?* (1997)

[19] Zuboff's term.

[20] This term borrowed from Evans and Ferreira, "Sharing Spatial Information in an Imperfect World: Interactions between Technical and Organizational Issues", p. 458.

[21] Ferreira, *Information Technologies*, *op. cit.,* last paragraph.

to prove that these organizational changes will not be drastic but gradual, even though the roles of individuals within the affected city agencies may change as a consequence of the new approach to knowledge acquisition. The analysis of this aspect will be based both on concrete experiences and experiments, as well as on parallel situations documented in the literature, to arrive at plausible hypotheses of how city knowledge could alter city government.

My contribution to the field will be based first of all on a case- and literature-based analysis of current trends in the management of urban knowledge and, subsequently, on the development of techniques that will employ off-the-shelf technologies, coupled with the necessary institutional strategies, to make the creation of "knowledge infrastructures" a mainstream reality in municipal government operations. Another contribution will be represented by an analysis of the pathways through which data are transformed into information and then used as a knowledge-base for planning. In this context, I will also explore the role of private enterprise in the development of useful information tools that capitalize on niche markets and produce revenue, while satisfying urban knowledge requirements, as was done successfully by the Sanborn Map Company with its famous fire insurance maps.

I also expect to evaluate the degree in which such knowledge can be not only directly applicable to day-to-day urban maintenance and management activities, but how it can also be instrumental to planning efforts that demand such information, while perhaps even creating a demand for plans that can capitalize on the resulting body of knowledge. In short, one of my most fundamental contributions will be in pinpointing the distinction as well as the overlap between "plan-demanded", "plan-ready" and "plan-demanding" knowledge and in proving the superior value of "plan ready" knowledge in the formulation of municipal actions[22].

3 METHODOLOGICAL APPROACH

My overall research design is intended to address the main research questions listed at the end of section 1 through a series of logical steps, to be carried out more or less in parallel, aimed at achieving the following primary research objectives:

- To assess the relevance, feasibility, usefulness and value in the creation and maintenance of a "knowledge infrastructure" alongside the more traditional infrastructure components of a city (transportation, utilities, etc.).
- to identify the practical methods, the information technologies and the organizational strategies that may be widely adoptable by public agencies to collect, organize and apply "City Knowledge" to urban planning and management.
- to demonstrate not only how this knowledge can be advantageous in satisfying the ongoing requirements of day-to-day city operations, but also how it can be profitably used as a tool for the development of decisions, plans, policies and actions that in turn will affect urban maintenance and management, as well as city design and development.
- to explore the implications of this new infrastructure, not only for the careers of planning practitioners, but also in the potential (re-)structuring of government organizations, and in the creation of private enterprise approaches for the actual implementation of such infrastructures.

First of all, I plan to identify the primary informational requirements of a sufficiently rich subset of the areas of city operations which are most ripe for a wholesale "informating" effort, to demonstrate the desirability of reliable, specific, up-to-date (and updatable) urban data for municipal maintenance, management and planning activities. I will prepare for this step through a thorough initial review of the existing literature on City Management. I will also tap into my own personal experience and insight and on my numerous contacts within municipal governments both

[22] The prevailing mode of operation in today's planning is to collect ad-hoc data and organize information as a consequence of proposed plans ("plan-demanded"). Ideally, a systematic accrual of city knowledge would produce "plan-ready" information that officials could tap into whenever a new plan was envisioned. Once such a body of knowledge is made available, it would be interesting to explore the degree in which the mere existence of organized city knowledge may lead to the creation of previously unforeseen plans, dictated by the preponderance of evidence, which I termed "plan-demanding".

in the U.S. and in Italy. Possible field methods may involve the compilation of "free lists"[23] by selected city officials as a starting point, followed by focus groups and/or structured interviews with heads of various departments and divisions to whittle down the initial lists.

Secondly, I plan to confirm the proposition that municipal governments do not, as a rule, approach city knowledge in a systematic way, except when they are somehow forced to by administrative, regulatory or revenue-generating circumstances. In conducting this piece of research I will again start from the literature. This will be augmented with specific examples from the aforementioned interviews with city officials. If needed, I may consider a randomized telephone survey of municipal department heads to get an adequate factual foundation for my claim.

Thirdly, I will try to identify the underlying institutional, psychological, organizational, technical, personnel and/or financial reasons for this lack of a systematic approach to city knowledge accumulation. In addition to reviewing the literature on these subjects, I will include questions prodding these issues in the aforementioned telephone surveys and face-to-face structured interviews. This is the only explanatory component of my research, which is otherwise mostly descriptive and exploratory.

Fourthly, I will try to quantify the financial resources that are devoted to ad-hoc, *plan-demanded* data collection on a yearly basis, to support my claim that a systematic approach would, in the long run, be not only operationally useful, but also economical and affordable. I will explore the possible existence of studies on government expenditures for technical consulting services to try to get a quantitative measure of the level of funding devoted to *una tantum* data collection. I will try to obtain more specific figures in the course of the multiple embedded case studies[24] described below. These quantitative data will help make the case for a distinct advantage to my proposed approach to the cumulative, distributed accrual of city knowledge.

Most of the exploratory and descriptive phases will be based on structured interviews, historical and archival materials, and possibly on questionnaires. I will also try to tease out information about rival approaches to urban data collection and management, i.e. the "top-down" and "bottom-up" strategies that have prevailed in municipal contexts for the past two decades. As part of this study, I will investigate the inner workings of the different departments and try to evince what, if any, overall knowledge management strategy is in place to tie them together. I will also explore the use of automation to informate the municipal government, especially in the realm of permitting and regulation and in revenue-generating contexts.

Finally, I will conduct a multiple case-study on two different cities in two different countries (Boston, MA and Venice, Italy)[25] to confirm that the plan-demanded *modus operandi* predominates even in widely different government milieus and across international cultures. I may also include a case at a different "level" of government, above the municipal realm (i.e. State or Federal) to demonstrate that the same issues exist vertically as well as horizontally. The case studies I intend to conduct are of the so-called "embedded" type (Yin) since they will focus on the municipalities as a whole, as well as on the target departments and their sub-units such as divisions, all the way down to individuals. Multiple, convergent methods of data collection will be used at the different levels of the embedded design to address all of the research questions. From these tasks, I plan to distill a minimum set of building blocks of city knowledge that could be applicable in any municipality, identifying both the required GIS layers and the corresponding datasets.

Subsequently, I will select two departments with similar roles in both Venice and Boston. I will then test my middle-out approach to city knowledge acquisition and interdepartmental sharing in both cities, by conducting a real-world experiment of my concepts through the implementation of small-scale prototypes of my proposed knowledge infrastructure in each department. I will also simultaneously identify and resolve the intrinsic institutional and technical issues in collaboration with the parties involved, in order to arrive at a realistic implementation strategy

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[23] Bernard, H.R., *Research Methods in Anthropology*, p. 282.

[24] Yin, R.K., *Case Study Research*, p. 54.

[25] I may add other cities, especially if I should discover any municipality whose approach to knowledge-building approximates my own.

across the two departments in each of the two cities. Through this experiment, I will be able to evaluate the operational effectiveness as well as the organizational implications of a middle-out implementation by monitoring the progress of my prototype applications and by developing assessment tools to track the transformation of data into information and then into urban knowledge that ultimately will affect management or maintenance activities in the real world (Figure 1)[26].

In particular, I will quantify the costs and benefits associated with the middle-out approach by:

- Assessing the Impact of the prototype infrastructure on day-to-day maintenance and management activities
- Assessing its Impact on organizational structure and on individual staffers
- Assessing its Impact on planning and decision-making activities

In the course of my case-based experiment, I will pay particular attention to the pathways that promise to most easily informate the planning process and will try to detect any signs that may indicate that "plan-ready" knowledge may become "plan-demanding".

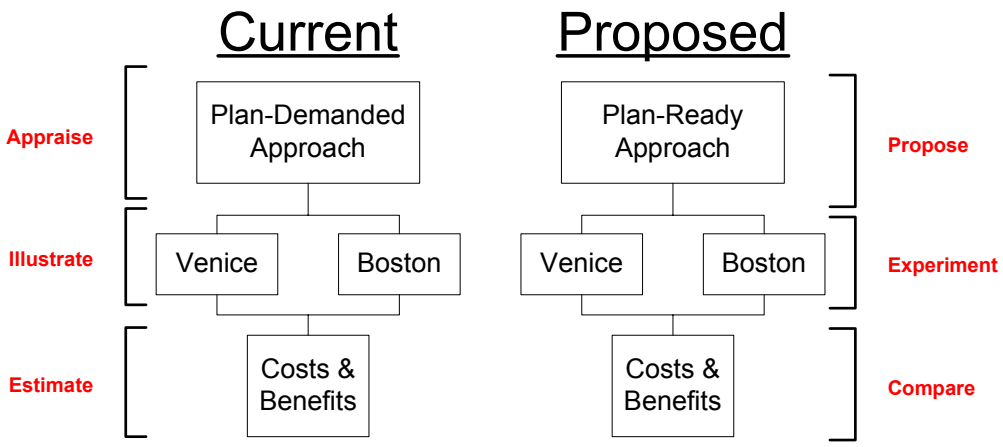

Figure 1. Assessment of the value of the "middle-out", "plan-ready" approach.

All of these research activities should allow me to test the practicality of key examples of data encoding, feature layering, interdepartmental cross-referencing, transaction-recording and data maintenance – the key elements that will determine what value added can be expected from the utilization of recent technology in a "middle-out" strategy, and how effective such an approach is in tracking data that suits urban planning and management as well as operations. This analysis should in turn enable a rich discussion and testing of my urban knowledge ideas which should lead me to produce a final set of guidelines for the creation of full-scale, modular, middle-out knowledge infrastructures that will not only serve the immediate needs of urban management and maintenance that municipal departments are directly responsible for, but will also foster longer-range planning activities across department boundaries.

I will also investigate the repercussions that this informating strategy may have in the composition and structure of these departments, which may be reshaped as a consequence of the proposed construction of a distributed knowledge infrastructure. I hope to demonstrate how a middle-out approach will entail only minor adjustments to the normal hierarchy of a public agency and should thus be less threatening to the "status quo" and therefore more acceptable to staffers and managers than other, more disruptive approaches that could instead upset the entrenched organizational equilibrium.

The final result will consist of an integrated – technical as well as organizational – approach that can potentially be widely applied to certain types of departments in a variety of municipalities, and which could guarantee

[26] The red words in Figure 1 represent the research activities that I plan to carry out in this phase of my research.

both the day-to-day efficiency of maintenance, management and planning operations, as well as the long-term efficacy of overall municipal functions. In other words, these case studies should allow me, in the end, to suggest "middle-out" mechanisms, both technical and institutional, that may be put in place to create the backbone of a self-perpetuating knowledge infrastructure in municipalities worldwide.

4 INFORMATION REQUIREMENTS

The primary take-home message that I will try to impart on the readers of my dissertation is that cities and towns should put in place fairly unobtrusive mechanisms at the ground level (or "frontline"), to gradually, but systematically, build up a body of knowledge about the city, upon which, when needed, plans can be devised, but with which, more importantly, 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 ongoing urban management practices adopted by their town.

I found the Urban Management literature very useful in systematizing my thinking about the gradual accrual of urban knowledge by the various departments that make up a typical city government. A lot of "guides", "handbooks" and "manuals" directed to city officials have been published over the years, especially by the *International City/County Management Association* (Banovetz *et al.*, 1984; Hoch *et al.*, 2000). Frequently, the chapter breakdown inside these publications follows the structure of an archetypal city government (see, for example Kemp, 1998). After all, there are only so many functions that a city government is called upon to perform. So, we find chapters devoted to the political and executive branches (City Council, City Manager, City Clerk), to internal services (Legal, Finance), to public safety (Fire, Health and Human Services, Police) and to common city services (Library, Parks and Recreation, Planning and Building, Public Works). I expect to similarly devote several chapters of my dissertation to these various branches, to present my personal experiences with each of them, and to propose methods for the creation of modular information systems to serve each department's needs with an eye toward progressively constructing a solid, distributed, municipal knowledge infrastructure, as I have done, to some extent, in Venice.

Within each target municipality, I will collect data that will enable me to:

1. Describe the structure, hierarchy and jurisdictional boundaries of the various departments in the municipal government;
2. Summarize the History of the City's approach to the gathering and utilization of knowledge in maintenance, management and planning;
3. Identify the current or planned strategies and tools adopted for the accumulation of city knowledge, if any exist at all, and if they don't, explore why not;
4. Design and test the implementation of a structured middle-out approach to the collection and organization of city knowledge in two different departments in each of the case study cities;
5. Analyze the short-to-medium-term implications of such experimental, middle-out approach in terms of the municipal organization and hierarchy (as opposed to top-down and bottom-up approaches);
6. Hypothesize and/or identify examples of the long-term ramifications of the middle-out approach in terms of interdepartmental or interagency sharing of knowledge to facilitate higher-level maintenance, management and planning activities;

The types of information that I will need to gather from each of my target cities are:

- Breakdown of departments and city services
- Organizational structure, Jurisdictions and Information requirements within each department and division
  - MIS, GIS, IT departments
  - Building, Assessing and Planning departments
  - Public Works, Water and Sewers, Parks and Recreation, Traffic and Engineering, etc.
- Overall strategy for data collection and organization (citywide) if any
  - Current and potential utilization of city knowledge for maintenance, management and planning, or

    - Impediments or obstacles to a more systematic approach to data collection and organization
- Current practices in terms of data collection and organization
    - List of all automated record-keeping services
    - Practices and expenditures for in-house data gathering
    - Practices and expenditures for external consultants
- Existing Knowledge-bases
    - Basemaps (GIS?)
    - Datasets
- Current levels of information sharing among divisions/departments
- Current practices and protocols for interoperability and sharing
    - Standards
    - Codes
    - Oversight

Once the prototype applications have been designed and implemented in my target cities I will collect the necessary data to permit the assessment of the new city knowledge infrastructure on:

- organizational structure and on individual staffers
- day-to-day maintenance and management activities
- planning and decision-making activities

I will also need to gather sufficient financial information about each target department to be able to compare :

- The department's expenditures on outsourced data collection and analysis tasks
- The estimated cost of implementing my proposed middle-out approach to achieve the same tasks.

I will conclude my research by collecting and analyzing qualitative data to determine, for each selected department in Venice and Boston:

- The department's automating potentials (and updates)
- The department's informating potentials (plan-ready)
- The department's informating potentials (plan-ready)

5 DISSERTATION OUTLINE

1 INTRODUCTION

1.1 CITY FORM
- *1.1.1 Structures*
- *1.1.2 Activities*
- *1.1.3 Evolution of City Form*
- *1.1.4 Shaping of City Form*

1.2 MUNICIPAL GOVERNANCE OF CITY FORM
- *1.2.1 Municipal bureaucracy and Jurisdictions*
- *1.2.2 Psychological traits of municipal workers*
- *1.2.3 Agents and roles*
- *1.2.4 Organizational Behavior*

2 URBAN MAINTENANCE, MANAGEMENT AND PLANNING

2.1 URBAN MAINTENANCE
- *2.1.1 Identification, Review and Classification of Urban Maintenance Tasks*
  - 2.1.1.1 Develop Taxonomy of maintenance tasks
  - 2.1.1.2 Identify Target Objects
  - 2.1.1.3 Tasks and Jurisdictions

2.2 URBAN MANAGEMENT
- *2.2.1 Identification, Review and Classification of Urban Management Tasks*
  - 2.2.1.1 Develop Taxonomy of management tasks
  - 2.2.1.2 Identify Target "Realms" (revenue-generation, regulatory)
  - 2.2.1.3 Tasks and Jurisdictions

2.3 URBAN PLANNING
- *2.3.1 Planning Scenarios and Best-Practices*
  - 2.3.1.1 Plan-Demanded Information
  - 2.3.1.2 Computability of Urban Space
- *2.3.2 The Case for Plan-Ready Information*
- *2.3.3 The Potential of Plan-Demanding Information*

3 DATA, INFORMATION, KNOWLEDGE AND ACTION

3.1 URBAN DATA
- *3.1.1 Current Practices for the Collection, Management and Maintenance of Urban Data*

3.2 URBAN INFORMATION
- *3.2.1 Current Practices for the use of Information in City Maintenance and Management*

3.3 URBAN KNOWLEDGE
- *3.3.1 Synthesis and Analysis*
- *3.3.2 Information and Decision-Making*
- *3.3.3 External Factors in Knowledge*

3.4 TRANSLATING KNOWLEDGE INTO ACTION
- *3.4.1 Five Tools*
  - 3.4.1.1 Ownership & Operation (Delegated?)
  - 3.4.1.2 Regulation
  - 3.4.1.3 Incentives/Disincentives
  - 3.4.1.4 Rights
  - 3.4.1.5 Information/Education

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