# PART III:

# THE DEVOLUTION OF CITY KNOWLEDGE

"In truth, because of the nature of the work to be done, almost all city planning is concerned with relatively small and specific acts done bere and done there, in specific streets, neighborhoods and districts. To know whether it is done well or ill - to know what should be done at all - it is more important to know that specific locality [...]. No other expertise can substitute for locality knowledge in planning, whether the planning is creative, coordinating or predictive.

The invention required is not a device for coordination at the generalized top, but rather an invention to make coordination possible where the need is most acute - in specific and unique localities."

Jane Jacobs, 1961 "The Death and Life of Great American Cities", p. 544

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# **EXPORTING THE LESSONS**

the unreflective practitioner

he indisputable uniqueness of Venice may have discouraged any type of generalization of what we learnt there since 1988. As intriguing as my insights were, it wasn't immediately clear that my work there might contain some exportable lessons for other urban professionals to learn from. I hadn't really had a chance to reflect upon my practice as Don Schön would have encouraged me to do<sup>289</sup>. I was too busy walking the walk to even find the time to talk the talk (or more appropriately to "think the thought"). However, as fate would have it, in 1998 I was asked by my department head at WPI to take over as director of the nascent Boston Project Center, so, quite serendipitously, I was thrust into a new context and began to advise projects for the City of Boston and for other municipalities in the greater Boston area, like Cambridge, Newton and Quincy.

serendipity

"Unencumbered by the thought process"<sup>290</sup>, I went ahead and began to develop projects in the same vein as I had been doing in Venice for a



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decade, in order to help frontline city officials to find practical solutions to day-to-day issues confronting the municipality. The issues were unlike those in Venice, but not drastically so. The approaches we developed seemed also different at first sight, but upon further inspection, they revealed some common principles not too dissimilar from those we employed in Venice.

In the two chapters that follow, I introduce a small sample of the projects we have conducted in Massachusetts. Together with the over 30 other projects we have completed on this side of the Atlantic using the approach developed in Venice, this sample demonstrates – if nothing else – that the City Knowledge approach can work in widely different social, cultural and administrative contexts.

After each section, as was done in Part II, I summarize the *lessons* learnt through the experiences described therein. All of these lessons will come together into Part IV which represents the culmination of the dissertation.

<sup>289</sup> Cf. Schön, 1983, The Reflective Practitioner.

<sup>&</sup>lt;sup>290</sup> I couldn't resist the opportunity to quote the "Tappet Bothers", fellow MIT graduates from "our fair city" of Cambridge, heard weekly on National Public Radio's *Car Talk*.

# CAMBRIDGE CITY KNOWLEDGE





## CAMBRIDGE TREES

"the Works"

tree maintenance



tree-induced energy savings



he City of Cambridge was one of the towns founded in the 1630's by the earliest pilgrims. It is home to two of the most prestigious universities in the world, Harvard and the Massachusetts Institute of Technology (MIT). As of the 2001 census, Cambridge had a population over 100,000. The municipal government in Cambridge is composed of an elected mayor and a hired city manager that effectively runs the city in the day-to-day sense. The city has been a leader in innovative bottom-up planning initiatives and has even instituted a form of "middle-out" strategy, orchestrated by the MIS department, to distribute GIS capabilities into many of the front-line departments. Simultaneously, there has also been a topdown push to institute uniform accounting practices such as the management of work-orders, with a system by a company called Hansen Information Technologies<sup>291</sup>.

Through a fortuitous connection, I arranged the first WPI project in Cambridge during the spring of 2001. This was the third year of operations for the WPI *Boston Project Center* and it marked the first time we actually stepped outside of the boundaries of the city of Boston proper.

came in contact with Mr. Larry Acosta, City Arborist in the department of Public Works of the City of Cambridge<sup>292</sup>. Despite the conspicuous resources allotted for the maintenance of the urban forest, the City did not have a detailed, computerized inventory of its trees. From year to year, tree pruning was carried out "by zone" instead of more selectively. Basically, in a given year, a fixed amount of money was set aside to take care of any maintenance need for all trees within a certain neighborhood. The work was contracted out to private firms who were expected to provide detailed records of the work carried out, so that payment could be made appropriately. Staffers from "the Works" inspected the work done and confirmed that the job had been properly executed. Despite all of the checks and balances, Mr. Acosta felt that the scheme he inherited when he moved to Cambridge from California was still inadequate vis-à-vis the millions of taxpayer dollars spent on tree maintenance. He envisioned a computerized system that would enhance the overall accountability and would thus also optimize the allocation of funds from year to year.

In parallel, the same department was also interested in quantifying the benefits in term of energy savings that the "urban forest" brought to the citizens of Cambridge. Trees shade buildings in the summer, thus reducing the need for air conditioning, and they also protect buildings from chilly winds in the winter, thus reducing the heating bills. The quantification of the energy savings is based on the size of the canopies as well as on some topological relations between the trees and the buildings in the city. The public works department had acquired a special software to help in this

September 2004

<sup>&</sup>lt;sup>291</sup> See <u>www.hansen.com</u>.

<sup>&</sup>lt;sup>292</sup> Officially nicknamed "the Works" in its logo.

exercise<sup>293</sup>. The approach the city adopted, which was dictated by the structure of the simulation software, entailed using aerial photographs to measure the total canopy in order to enter the necessary figures into the software application, which was then able to produce estimates for energy savings based on the information received.

My instinctive recommendation in reaction to the issues presented to me was to suggest scrapping the software package and to invest resources in a thorough inventory of all city trees, which would serve the dual purpose of supporting the maintenance activities as well as to create the platform for the subsequent canopy calculations that could be translated into estimates of energy savings, without the need to pass through another software program.

The WPI project was therefore conceived to develop and field-test a methodology for the inventory of individual trees in Cambridge<sup>294</sup>. The catalog included all of the parameters that are useful in order to maintain the tree in good physical health, free of diseases and deformities. The parameters included were also deemed sufficient to derive the energy saving estimates that were of interest to some sectors of the municipal government. In concert with Mr. Acosta, the WPI students defined the syntax of a "tree code" that would identify each tree uniquely and proposed a list of useful parameters that should be collected about each tree while in the field.

Defects and disease symptoms were codified and a rubric for their evaluation was prepared by the student team who then took the methodology into the field to test its validity and efficacy.

🖽 View Open Spac	ce Trees Database			- 🗆 ×
TREE CODE	0500090	DEAD BUDS	10 - 20%	-
SURVEY DATE	4/9/2001	LEAF DAMAGE	Not Surveyable	-
SITE	Cambridge Common	INSECT INFESTATION	(None)	-
SECTION	C	MAJOR VISIBLE INJURY	0	
TREE#	90	DISEASE	(None)	<u>.</u>
SPECIES	GLTR	FUNGI	ч Ч	
DBH	13	PLANTING BED		
CANOPY SIZE	21.5	OBSTRUCTION TYPE	(None)	<u>-</u>
DEADWOOD	10 - 20%	OBSTRUCTION DISTANCE		<u>.</u>
CAVITIES	(None)	SIDEWALK DAMAGE		
		CONDITION RATING	94.29%	
TREE PHOTO:		TREE VALUE	\$6,504.10	
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<sup>293</sup> See for instance <u>http://www.americanforests.org/productsandpubs/citygreen/</u>.

<sup>294</sup> For something similar and with the addition of a web-GIS, see Kelly and Tuxen, 2003.

tree inventory

[tree codes]

[tree condition assessment]

[low-tech beats high-tech]

trees and energy savings





update mechanisms

The location and species of a tree, together with its unique code, constitute the fundamental items of information associated with each plant. Locations were first pinpointed using a laser-guided GPS. This system was plagued by systemic errors<sup>295</sup> which required extensive manual corrections. In this case, as we had already realized during the measurement of canal depths in Venice, the manual process of positioning the tree on a map using local reference landmarks and tape measures proved to be more effective and expeditious than the high-tech solution involving GPS<sup>296</sup>. Fortunately, the position of the tree may be corrected repeatedly as better and better geopositioning tools become available, but the object itself will not need to be modified after its initial mapping. The codes and basic information associated with each tree symbol are good forever, irrespective of minor positional adjustments that may follow.

Energy savings were calculated by adding the canopies of all individual trees in the catalog. First of all, the "atomized" information about canopy radii enabled us to calculate the area of each tree's canopy<sup>297</sup>. The sum of individual canopy areas would approximate the overall canopy coverage, which in turn was converted into an estimate of energy savings through proven formulas obtained from scientific literature. If one had started by measuring canopy areas as amorphous "blobs", the energy calculations could have been made just the same, but the human and financial costs incurred would have been useful only and exclusively for this effort. No useful information about single trees could be possibly derived by attempting to disaggregate the "blobs" into individual trees. On the other hand, once all the trees in a city have been immortalized in a GIS and recorded in a relational database, the catalog will lend itself to a variety of uses, making the long-term endeavor I propose well worth the protracted effort.

Some may argue that the widespread availability of aerial or satellite imaging, coupled with remote sensing techniques, make the top-down analysis of tree canopies more and more affordable and feasible. My counter-argument would be that the tree-by-tree approach I propose is going to provide a more sustainable, updatable and re-usable foundation for <u>multiple</u> applications – including the tree canopy energy estimates – for years to come, provided an appropriate update mechanism is adopted.

To ensure that tree information is always as current as possible, we proposed that the update mechanisms for tree information ought to be tied to the physical maintenance of the plant. In essence, we suggested that the

<sup>&</sup>lt;sup>295</sup> Even though this project took place after the US government loosened the anachronistic, nationalsecurity restrictions on the accuracy of GPS, our GPS results were not satisfactory. Prior to May 2, 2000, the US government inserted errors into the system on purpose, through a process termed "selective availability". The error went from about 45 meters to about 6 meters overnight

<sup>(</sup>http://www.igeb.gov/sa/diagram.shtml). However, a 6 m error is still unacceptable for pinpointing a tree's location.

<sup>&</sup>lt;sup>296</sup> The discrepancies we encountered when using our laser-guided GPS may have been at least partially due to inaccuracies in the basemaps we were using at the time and not only due the selective availability limitations of the GPS itself.

<sup>&</sup>lt;sup>297</sup> Assuming, of course, that a circle would sufficiently approximate the shape of a tree's canopy.

[informational returns by contract] [lower cost of maintenance-based updates]	tree-pruning squads measure a new canopy radius and a new trunk diameter during routine maintenance operations, providing an informational return together with the horticultural services. In addition to these physical measurements, we recommended also that the maintenance crews provide feedback about the health of the plant, by noting telltale signs of disease or damage, based on an evaluative rubric that we developed and tested for efficacy. Finally, we proposed that the field teams should also note the impact of the tree on surrounding assets, like power lines, sidewalks and storm-drains by using objective metrics that could be applied consistently by different staffers or contractors.
	in such a way as to allow non-expert individuals, with a modicum of training, to consistently measure, evaluate and assess the collection of trees in a city <sup>298</sup> , translates into tangible savings for the city coffers because:
[no waste]	(1) Superfluous maintenance is eliminated. Trees are maintained selectively based on solid factual information, instead of applying blanket procedures to entire sections of town based on brute- force, information-blind methods:
[no travel] [blue-collar updates]	<ul> <li>(2) The time spent to reach a tree in order to collect updated information is eliminated. Information can be kept up-to-date by appropriately-trained ground crews who are already sent out to the field anyhow, thus eliminating one of the major cost components of information retrieval, namely the travel time to and from the assets to be monitored;</li> <li>(3) The cost of retrieving updated information is greatly reduced. Ground personnel is less expensive than a trained botanist, even if</li> </ul>
	we factor in the limited training needed to ensure adequate data quality and consistency <sup>299</sup> .
maintenance-based cataloguing	Of course, if we are willing to be very patient, we could use the very same maintenance-based approach I just described to simply initiate the process of gradual data collection and mapping of each tree as it becomes the object of maintenance. The only difference here (which may be actually a major issue in terms of cost and training) is that the ground crews would have to also be able to recognize the species of the tree and would need to be trained in surveying techniques, either with GPS or otherwise, to produce accurate positional coordinates to generate the correct GIS maps. These added tasks would demand a considerable amount of time from the maintenance crews, though they would not necessarily cost significantly more, thanks to the widespread availability of low-cost technology in this day and age. Despite the ever-diminishing cost of technology, using ground crews to create the catalog from scratch will always be much less cost- effective than employing them to simply update existing data.
	<ul> <li>Following Hammond <i>et al.</i>, 1980, 1991.</li> <li>It could be argued that collecting updated information all the time, even if done by blue-collar workers, may in the end cost more than biring a botanist once in a while. However, the sheer magnitude</li> </ul>

workers, may in the end cost more than hiring a botanist once in a while. However, the sheer magnitud of an urban forest, with tens of thousands of trees, makes it unrealistic to consider using highly-trained individuals to conduct a thorough survey of all plants owned by the city.

Nevertheless, a maintenance-based approach to cataloguing could work for simpler types of point-like city assets – like street lights or fire hydrants – which would only require adequate GPS locating skills (not very complicated to teach) and would not bog down the maintenance crew with too much additional work above and beyond the actual maintenance.

On the other hand, this promising approach would not work well for region-like assets – like lawns, or flower-beds – which require a more concerted initial effort to map out, just as it wouldn't work well for more complicated point-like objects that present complex challenges, like the need to determine the botanical species of a tree. My personal bias here is that the initial catalogue should be done by trained professionals if financially possible, to guarantee that the whole database and GIS infrastructure is constructed on very solid and reliable foundations, leaving just the updating (which will be the bulk of the work in the long run) to less-skilled individuals.

Aside from the aforementioned "instant savings", achieved through our City Knowledge approach, the fine-grained nature of our deconstructed datasets engenders numerous – sometimes unforeseen – opportunities for creative re-use of the data to produce information above and beyond what was intended originally.

For example, our tree canopy area calculations were not only useful for determining energy savings, but were also leveraged to calculate the impact of trees on air quality. Depending on the species and the canopy dimensions, we could estimate the quantities of major pollutants (like CO<sub>2</sub> or SO<sub>2</sub>) removed from the air by our trees, thus providing an additional measure of their "value" to society, who might therefore be more forthcoming with the funds to support the efforts to catch up with the backlog of tens of thousands of trees in each city that are already out in the streets and parks and need to be recorded into GIS and Databases to begin applying these cost-saving measures when it comes to their upkeep.

Tree limbs constitute ever-present threats to public safety. Every year, dozens of people die because of tree accidents, exposing municipalities to potential liability lawsuits. A well-designed updating protocol would try to capture potentially dangerous situations and nip these hazards in the bud, within reasonable limits. The inclination of a tree, for instance, could constitute a factor in determining its level of threat. As tempting as it may be to simply assign "danger levels" based on visual inspections, we have always tried to stay away from these "value judgments" that are prone to be inconsistent and subjective, preferring to focus on the ingredients that factor into such judgments, and trying to objectively quantify these factual components before applying more value-based weights to each factor and before applying judgment-based techniques to combine the weighted factors into a final "danger score"<sup>300</sup>.

Similarly, we devised a way to separate visual symptoms of disease ("facts") from the determination of the level of health of the plant ("value").

[start catalog with professionals]

leveraging plan-ready information

[trees and air quality]

separating facts and values

[trees and safety]

[danger]

[disease]

<sup>&</sup>lt;sup>300</sup> Hammond *et al.*, 1980, 1991.

maximizing informational returns

[trees and power lines]

[sidewalks]

This way, after minimal training, ground crews would be able to detect early warning signs of illness.

Another source of potential harm, as well as costly damage, is the interference of tree branches with power lines. Utility companies routinely hire tree companies to trim down trees that are threatening to interfere with the power grid. Trees are a major source of blackouts in the world<sup>301</sup>. Our approach in Cambridge took these issues into consideration and a special parameter was set up to record the closest type of obstruction to the tree, which often was a power line. The distance was estimated to the closest foot. In a similar vein, we also made provisions for the assessment of the status of the root system vis á vis the sidewalks and roads.

The project produced a very successful demonstration of a system that would allow the city arborist to:

- plan future maintenance based on full knowledge of the tree inventory, including tree locations and species
- detect spatial disease patterns thanks to GIS mapping. This in turn would dictate preventive measures to deal with epidemics.
- receive early warning signals about diseases, defects, interference with power lines, disruption of sidewalks, and other useful diagnostics.
- estimate energy savings and pollution abatement based on the cumulative sum of all canopies, calculated according to sophisticated spatial analyses.
- maintain a constant watch over the "urban forest" and react accordingly in a timely fashion.

 $<sup>^{301}</sup>$  Fifty million people across the entire country of Italy were left without electricity on September 29, 2003 after a tree branch fell on a power line in Switzerland. This was one of the largest blackouts ever and was the cause of at least three deaths (AP, 9/29/03, 11:10am).

#### LESSONS FROM CAMBRIDGE

transferability of City Knowledge

[transatlantic cross-cultural transferability]



[transferring from academia to municipality]

transaction	vs.	snatshot
<i>indrastaction</i>	vs.	Shupshov

[transaction approach for permanent features]

[snapshot approach for dynamic features]

maintenance-based updates and cataloging

separating facts and values

T he tree management application described herein allowed us to first of all demonstrate that basic City Knowledge tenets apply in Cambridge as well as in Venice. Of course, the way in which we go about pursuing City Knowledge is skewed by the fact that we are outsiders coming in laterally with an army of skilled students. This fact may account for much of the similarities we encountered between Boston and Venice.

Interestingly, the Cambridge tree project gave birth to a sequel in Venice, bringing the process full-circle. In turn, the Venice project lead to my involvement in the development of a professional tree-management web-GIS that is currently in the process of being brought on line at VESTA, the public/private company that manages garbage, water and parks for the city of Venice.

The main challenge remains how to set up virtuous mechanisms that will self-generate similar successes – without relying on free academic studies – but tapping into a variety of resources and using a variety of schemes to move the process forward in a financially sustainable way. The real transfer does not have to take place from Italy to the US or vice versa. It needs to take place between academia and municipal administration.

In this project, the demarcation between systematic tree-by-tree cataloging and the broad-brushed canopy assessment made clear that one of the hurdles that City Knowledge systems need to address is the cost/benefit dilemma between transaction-based and snapshot-based systems . The onetree-at-a-time approach which I propose can serve multiple purposes and will completely eliminate redundancy and waste. The snapshot approach of doing the canopy analysis and move on seems utterly wasteful. In a sense, the tension is really the familiar one between short-term gratification versus long-term commitment. City Knowledge relies on the transaction model to capture the changes that occur to "permanent", administratively-controlled elements of the city. The transactional approach could potentially be fed by tapping into administrative databases, but could also extract greater informational returns from outside contractors and internal staff to slowly but surely build the storehouse of urban information that City Knowledge calls for.

Nevertheless, for dynamic anthropogenic activities such as traffic, as well as natural phenomena such as hydrodynamics, there are no transactions to be captured, so a snapshot model is the only one applicable.

Hybrid approaches can also be advantageous. Tree assessments consist of a the tree-by-tree snapshot of current dimensions, health and contextual impact. This snapshot-type of information gathering can be turned into a combined transactional/snapshot hybrid by attaching the data collection activities to routine maintenance operations through contractual obligations.

One way to ensure that tree maintenance crews can be competent participants in the proposed distributed, maintenance-based data collection system is to devise a fool-proof methodology for the data-gathering. The key to a successful field methodology is to limit the number of decisions that the field worker needs to make while gathering data. Ideally, field forms should aim at collecting the most objective type of data, without any judgments or interpretations needed. With some training, crews can be taught not only how to make simple measurements, but also how recognize diseases and how to assess dangerous or dubious situations.

cost savings

By removing expert-judgment and allowing lower-paid employees to conduct the data-collection, this approach can greatly reduce the costs of information management. The information can be gathered *ex-novo* or simply updated using lower-skill personnel, thus achieving a net cost saving. Additional savings come from requiring the collection of up-to-date data concurrently with regular maintenance activities, such as pruning. It is hard to put a precise dollar value on the savings, but logic suggests that the solutions I propose would indeed provide sufficient cost-savings to justify pursuing a rigorous and systematic knowledge acquisition process.

# WORCESTER CITY KNOWLEDGE



D espite being the home of our Institute, the city of Worcester was initially neglected by the WPI Global Perspectives Program. As our sights were set to global horizons, we passed up the challenges and opportunities that were in our own backyard. Nevertheless, it is not surprising that we were slow to recognize the desirability of offering the same "full-immersion" project experience to students who were not as interested in exotic locales, but nonetheless equally eager to make a difference in the community in which they lived.

#### THE WORCESTER COMMUNITY PROJECT CENTER



IMBY - in my back yard

#### a city as a test bed



To address this shortcoming, WPI created the Worcester Community Project Center (WCPC) in the year 1999, with support from local foundations. After the initial stewardship of Associate Provost Lance Schacterle, Prof. Rob Krueger was nominated director of the center in 2001. Worcester is the second largest city in Massachusetts and third largest in New England, just slightly behind Providence, Rhode Island in terms of population<sup>302</sup>. After playing a major role in the War of Independence and in the Industrial Revolution, Worcester underwent the same boom-and-bust cycles of many other manufacturing towns that have had to reinvent themselves in the post-WWII period. Worcester has the advantage of having been traditionally the home to several colleges and universities, including Clark, Holy Cross, Assumption, Worcester State, Quinsigammond Community, Becker Junior College and UMass Medical, in addition to WPI.

The colleges have been an economic staple of the city and have contributed to the establishment of a strong biomedical and biotechnological sector in recent years, which has in part offset the continued losses in the manufacturing base.

Since its founding in 1865, WPI has contributed greatly to the development of the city's industrial heritage. WPI intends to play a renewed role of economic stimulus in its own backyard by leveraging its expertise in science and technology, as witnessed by the recent creation of the Metal Processing Institute, the Bio Engineering Institute and the plans to incubate new high-tech businesses through the Gateway Park redevelopment.

From my perspective as a student of urban issues, I have also belatedly awakened to the opportunities that Worcester provides to be a reallife test bed for my municipal information theories. In that vein, starting in 2002, I began to become engaged in the WCPC to explore how City Knowledge principles could be exported to a city of significant size, yet amenable to new ideas.

The first opportunity to play an active role in the functioning of the city of Worcester was provided to me by my participation in the creation of a

 $<sup>^{302}\,</sup>$  In the year 2000, the population in Worcester was 172,648, versus a total of 173,618 in Providence. (Census Bureau, http://quickfacts.census.gov/qfd/)

# EXECUTIVE ORDER 418





regional planning agencies

community development plan

build-out

community visioning

Community Development Plan (CDP) for Worcester, as part of a statewide planning initiative called Executive Order 418.

Executive Order 418 (EO418)<sup>303</sup> financed a state-wide effort for the development of "Community Development Plans" to "help communities plan for new housing opportunities while balancing economic development, transportation infrastructure improvements and open space preservation"<sup>304</sup>. The upshot of this innovative program was to create a widespread planning consciousness at the local level, where change really happens. EO418 addresses four main areas:

- 1. Housing
- 2. Economic Development
- 3. Transportation
- 4. Open Space and Resource Protection

The primary focus of EO418 was to assist "communities in addressing the housing shortage", so the Department of Housing and Community Development was the leading agency in the effort, under the auspices of the Executive Office of Environmental Affairs. Each of the 351 communities of the Commonwealth of Massachusetts received \$30,000 to complete the EO418 process. Regional Planning Agencies (RPA) would act as intermediaries between the towns and the State. The RPAs would conduct the initial buildout studies and support the development of the CDP. The general purpose behind this very progressive initiative was to engender many local conversations about the lot of each town in order to inspire citizens to consider if the future that was on the horizon was truly what they envisioned as a community. If the "probable, almost certain, future<sup>305</sup>" of a community does not match the collective "vision" for the development of the town, then each city and town should fulfill on the expectations of the population through the implementation of the Community Development Plan.

In order to raise the consciousness of the citizens of Massachusetts, the first step in the process entailed a form of "shock therapy" to jolt the apathy out of their systems. The best way to make people pay attention is to show them how bad things could get if they don't. The buildout analysis that forms the foundation of EO418 is supposed to do just that, by simply demonstrating the extent of construction that the current zoning regulations would allow if each zone was developed to its maximum allowed envelope, taking into consideration other physical or environmental limitations. This is what EO418 calls the "Default Future Land Use Map"<sup>306</sup>.

Once citizens were awakened to the real impact that current zoning could have on the shaping of our urban realm, EO418 foresees tapping into the collective imagination in order to extract an alternative "vision" that could be used to reinvent the zoning regulations and to creatively apply the

<sup>306</sup> EO418 Technical Assistance Bulletin #3, p. 2.

<sup>&</sup>lt;sup>303</sup> Cellucci and Swift administration, 2000 (http://www.massdhcd.com/eo418/homepage2.htm).

<sup>&</sup>lt;sup>304</sup> Commonwealth of Massachusetts, Building Vibrant Communities, p. 1.

<sup>&</sup>lt;sup>305</sup> I am borrowing this phrase from Landmark Education.

assets and liabilities inventory deliverable GIS maps	other four tools of government action <sup>307</sup> to realign the future growth of the city with the will of the people. Such a process would entail conducting surveys, focus groups and other participatory interactions with the inhabitants of the town, representing all categories of people and all demographic segments. Each of the four main areas is then scrutinized carefully and thoroughly, by using available information and, when possible, by collecting new data about useful indicators of the state of affairs in each area. Although the various EO418 documents do not put a lot of emphasis on this aspect, the underlying inventory of existing assets (and liabilities), such as the housing supply inventory or the inventory of environmental resources and others are essential foundations for the subsequent analyses. City Knowledge approaches could be applied to the accrual of these inventories, as will be described below. The main deliverables of all these four sector studies would be the following maps:
	<ol> <li>Open Space Suitability Map</li> <li>Housing Opportunities Map</li> <li>Economic Development Opportunities Map</li> <li>Transportation Issue Map</li> <li>Community Development Plan Final Land Use Map</li> </ol>
[supply and demand]	Of course, the production of each map would in turn demand the collection, organization and manipulation of several datasets – some easily available in the public domain, some not. Suitability analysis entails the establishment of a rank-order classification of uses that would be most suited to each parcel of the city based on the result of the visioning sessions discussed above. The documentation that accompanies EO418 <sup>308</sup> is not very specific about the exact nature of these suitability analyses, except to require that they result in suitability maps that display the "best use" that could be located in each part of town, depending on physical features (such as slopes), environmental characteristics (like the presence of wetlands), current zoning regulations (like Commercial, Residential, etc.), as well as a host of other parameters that are deemed important by the community. All suitability analyses really need to be framed by a careful assessment of current and for each of the parameters have a parahele of the parameters have a parameter of the parameters have a parahele of the parameters have a parameters h
review of past plans	future demand for each of the possible land uses, as well as supply of resources to meet all or some of the predicted needs in the years to come. A useful preamble to the suitability analyses is a through review of past plans. I a sense, plans represent an expression of demand. Some plans embody a collective vision and some only the will of an individual. Some may express powerful social demands, others venal yearnings for financial gain. Plans offer important snapshots of the local conditions at a certain moment in history. They synthesize a multitude of city information and
	<sup>307</sup> Schuster <i>et al.</i> , 1997. The five tools of government action are: (1) Ownership and Operation; (2)

Regulation; (3) Incentives and Disincentives; (4) Information and Education; and (5) Rights (the most confusing and controversial). I would recommend thinking of something like "quid pro quo" or "barter" as a better name for the 5<sup>th</sup> tool.

<sup>308</sup> http://www.massdhcd.com/eo418/homepage2.htm.

often try to predict the future development of the area, with or without the implementation of the proposed plan, so as to provide a "before and after" comparison of alternative futures.

Open space suitability would entail the determination of what parcels should be protected from development and which would be best suited to be used as parks of various shapes and sizes, from the small neighborhood Playground, to the larger City Park (which may or may not include sport fields), to the more protective Conservation Land, which is often fairly extensive in size. Citizens ought to have a say about the criteria that combine to make a parcel suited to be a park. The various types of parks will abide by different criteria:. Moreover, different criteria will also carry different weights in the overall suitability determination. Again, the local population should be dictating how much importance (or weight) to attribute to each suitability factor.

The economic development component of a CDP would start with the specification of current and future economic profiles, followed by a goal statement that would lead to an implementation strategy that would include an assessment of where different types of economic development could and/or should take place. Parcels can be more or less suited to house economic activities, depending on several factors, such as contiguity to population centers, accessibility to highways, presence of rails, etc. A suitability map in this arena would showcase what type of business would "make sense" in different parcels of the city.

In the area of housing, the CDP would first include the inventory of the current housing stock, and an assessment of demand for different types of housing to determine the housing needs of the town. After setting community goals, a housing suitability map would be produced to show how suitable each parcel is for housing units of various types (single-family, multifamily, etc.) and whether the housing should be specifically dedicated to the elderly or to residents with special needs. Once again, a public participation process would be used to identify what criteria should play a role in the determination of suitability for housing as well as how much weight these criteria should carry in the overall suitability.

EO418 is rather vague of how to deal with mobility despite its being a major determinant of development, for good and for bad. Economic development is frequently dictated by accessibility as is housing. Conversely, housing and businesses also generate the <u>need</u> for additional transportation capacity when the infrastructure that supported the initial development becomes inadequate to support the subsequent growth. In a nutshell, though, the transportation element of a CDP should identify transportation improvements that can be implemented within one to five years.

economic development

open space protection

housing suitability

transportation issues

# WORCESTER E.O. 418



Thanks to the resourcefulness of WCPC director, Prof. Rob Krueger, we were asked by the City of Worcester to act as consultants on the EO418 project through the Sustainable Cities Research Group (SCRG) at WPI, which included. beside Prof. Krueger and myself, a local professional Architect and Planner, named Daniel Benoit. The SCRG received the \$30,000 state grant, which was administered through the local regional planning commission, the Central Massachusetts Regional Planning Commission (CMRPC). By the time we were hired by the city, the CMRPC had already conducted some of the preliminary work and had produced a buildout analysis by land use zone.

Part of the required asset inventories were available to us thanks to previous WCPC projects, such as a "blue-green amenities<sup>309</sup>" inventory and a brownfield inventory<sup>310</sup>. In addition to the existing datasets from previous projects, to fulfill our mission we conducted four additional undergraduate

interdisciplinary studies, through the WCPC, starting in the spring of 2003<sup>311</sup>. The first of these EO418 projects consisted in a review of existing plans and resulted in a database of plans that made it possible to search and retrieve the principal plan documents<sup>312</sup>.



## **REVIEW OF EXISTING PLANS**



More importantly,

our plan review identified ways to capture the considerable amounts of information that plans contain. There is a lot of data about demographics, markets and traffic that is included in many plans, be they at the level of a master plan or at the scale of a site plan. A strategic plan, such as the Community Development Plan required by the EO418 process, naturally results in the proposal of a series of actions based on the five tools described by Schuster *et al.*<sup>313</sup>. The more concrete and specific site plans are instead negotiated between the developer and the town, through a planning board (or the like) that cajoles the proponents into adapting their plans to the dictates of the strategic master plan or the visionary Community Development Plan.

What became clear in the course of this study – but also in similar experiences I had in Cambridge<sup>314</sup> and elsewhere – was that plans represent a missed opportunity for a city to acquire and <u>retain</u> useful urban information

<sup>311</sup> Brown and Groeli., 2003; Farmer et al., 2003; Hamir et al., 2003; Jajosky et al., 2003.

- <sup>313</sup> Schuster et al., 1997.
- <sup>314</sup> Gage et al., 2003.

<sup>&</sup>lt;sup>309</sup> Dow et al., 2003.

<sup>&</sup>lt;sup>310</sup> Bassa et al., 2003.

<sup>&</sup>lt;sup>312</sup> Brown and Groeli., 2003.

that can be reused by itself outside of the scope of the plan, or in the evaluation of a single plan over time, or in the comparative evaluation of the net effect of multiple concurrent plans. Plans will almost always contain upto-date information about land use, building use, traffic, jobs and other economic indicators of supply and demand.





[before and after building use]





To be able to make use of the data included in plans, these data would need to be parameterized into atomic chunks that could be reutilized, aggregated and analyzed in any combination from then on. In particular, the current use of each floor of each building affected by the plan would be extremely useful, whether the plan became a reality or not. The main upshot of any plan is that buildings will be created, destroyed, modified and/or converted to different use. In turn, the net square footage dedicated to each use will dictate the types of people who will frequent these buildings and hence the type and quantity of traffic that the new uses will generate, the number of jobs that will be created, and the municipal services that will be required.

With a proper method of parameterization, each plan could produce

the "before and after" in terms of square footage of each building's floor dedicated to each of the main uses (retail, office, industry and residential for example). Using SIC (or NAICS) codes will provide the finest grain of business use, whereas MacConnell codes would specify the uses for parcels of land. An information-aware planning ordinance could force all developers to produce a detailed, building-by-building inventory of current uses for all edifices within the boundaries of the plan area.

The uses forecasted by the plan for each of the "new" buildings would be thus comparable to the pre-existing uses and a net square footage could be calculated for each of the uses contemplated by the plan. Using standard metrics, it would be thus fairly straightforward to estimate the trips

generated by these uses, as well as the jobs that would be created by the businesses that the plan expects to move into the newly created spaces. These new spaces will satisfy some "demand" for the various uses (like housing, retail, open space, etc.) that will thus diminish the overall demand for them vis a vis other plans elsewhere who are also

expecting to satisfy those same unmet needs of the local population. Thus the synergies between different plans will come to the fore and a more holistic approach to town planning will become possible, as envisioned by Frederick Law Olmsted Jr. in 1913<sup>315</sup>.

Two possible outcomes could result from the proposal of the plan with all of the accompanying "before use" data: (a) the plan is implemented and some or all of the forecasted uses become a reality, or (b) the plan is

<sup>&</sup>lt;sup>315</sup> See quote on p. 159.

#### [lasting benefits of "before" data]

never put into action and target area undergoes the "natural" evolution that the place was destined to experience in the absence of planning efforts. In either case, the before data would be an extremely useful addition to the requirements for submission. If the plan is implemented, then the before data can be compared to the "after" a few months or years down the line to see if the forecasted benefits of the development have been achieved as planned. If the plan was rejected, then the before data would still be useful for any other town activity that will be planned for the same geographical area in the immediate future. Building use, in particular, would be of great interest to many types of municipal activities and some form of use recordkeeping would be highly desirable.

In addition to uses, the before-and-after datasets could include traffic (volumes and turns), jobs (by occupation code and NAICS), open space (acres per 1000 inhabitants) and several others parameters that could help evaluate the "success" of a development as well as its impacts on the surrounding areas and on the outcome of adjoining plans.

[synergy between plans]



As an example of the possible <u>positive</u> synergy that could result from such detailed and uniform knowledge across multiple plans, we explored the feasibility of relocating some industrial and commercial

Franklin Science Park	
Company	Area (sq. ft.)
lexographics	14659
Visi	14659
Burton	14659
Come Play	91977
nrich Foods	16000
resh Foods	14350
DNS Printer	14350
onsolidated	8180
Tetal	188834

Anterprises from the site of the proposed Branklin Science Park to aid in the proposed evitalization of the South Worcester Industrial Park. Due to the proposed demolition of 283,185 sq. ft. of industrial space at the Branklin site, eight businesses would need to and a new home in the South Worcester site where 218,500 sq. ft. of industrial space are blanned to be created. Detailed knowledge of loor space usage building by building enabled

us to map these eight businesses to four new buildings in just a few minutes.

On the flip side, one new development could engender additional traffic that ought to be taken into account in the planning of a



nearby complex. A successful project will instantly affect other plans that are contiguous to it, but it may also affect sites that are on the opposite side of town, if the target audience of those plans are the same. If one development is supposed to capture the demand for new high-end retail shops, another similar development anywhere else in town would be deleterious to the financial viability of such an enterprise no matter how far.

The approaches to the parameterization of plan data that we experimented with in this project will enable city planners to engage in "concurrent holistic planning" instead of being trapped into the more typical, and almost inevitable, discrete mode of planning that is the norm in most cities and towns.

September 2004

lessons form plans	The revelation during this project was that, since plans are catalysts of
	information, they could be treated as vehicles for the accrual of city
	knowledge. A parametric approach to the structuring of plan data would
	allow the city to accumulate useful data from each plan submitted for
	approval. Even if the plan was eventually botched, the data it furnished
	would be nonetheless acquired by the city for re-use in any of its activities <sup>316</sup> .
[building use by floor]	Plans could produce gradual inventories of building use, potentially
	even floor-by-floor. They could provide current traffic data for affected
[free traffic data]	intersections <sup>317</sup> . They could even provide useful macro-economic regional
[supply and demand basins]	information about unmet "demand" as well as exiting "supply" for specific industries, services, labor or housing.

<sup>&</sup>lt;sup>316</sup> This approach would fit well with the Planning Analysis and Modeling Markup Language (PAMML) proposed by Singh (2004).
<sup>317</sup> As was proposed by our project for the City of Cambridge(Gage *et al.*, 2003) which suggested to require developers to submit traffic impact studies in formats that would lend themselves to instant geocoding and acquisition.

# BUILDOUT ANALYSIS

parcel-level build-out







**B** eing believers in the "atomization" of information, we conducted a parcel-level buildout analysis that calculated the maximum buildable area in each parcel, after removing all regulatory and physical limitations. The total surface area of a parcel was reduced first by the amount taken up

by water bodies, inclusive of the mandatory 30' buffer. Then, a fixed 15' ring of land was removed to approximate the setback requirements for the lot. Any area that was already built (e.g. map to the left) was also deducted from the total to give the net buildable surface.

The resulting "number of developable square feet" did not account for sites where construction would be difficult or nearly impossible due to steep slopes. Since there is no law to prevent construction on such rough terrain, we treated sloped parcels separately. In essence, by ignoring slopes we could visualize a maximum buildout scenario, with the largest amount of land open for development. We then produced a more realistic case where slopes were allowed to preclude some construction. We calculated a sort of "maximum growth index" by calculating the percent of expansion that each parcel could undergo from the current situation to the maximum possible buildout. Note that this analysis does not take current zoning into account, except for the provision of a generic setback buffer around the perimeter of each property.

The map below shows in redder tones the areas where more growth is physically possible due to the morphology of the terrain and in the absence of zoning regulations to keep development in check.

The gray areas above (and left) indicate existing parks or bodies



[parametric zoning]

of water that are not going to be developed at all. When one zooms into this map, it becomes possible to distinguish the parcel-level detail that this approach affords. With a complete City Knowledge system, a more sophisticated differentiation among parcels would become possible, thus allowing this analysis to focus only on the truly realistically developable tracts.

Such an approach opens up the possibility of introducing zoning as a variable in this analysis to experiment with "what-if" scenarios for exploring how much development would be allowed under different zoning regimes.

A parametric approach to zoning would make the process of recalculating offsets, FARs, maximum footprints and the like quite effortless. Reclassification of a parcel from one zone to another would simply result in a recalculation of the amount (and type) of development that would become possible after such a change. Parcel level knowledge of the terrain (slope and water primarily) may even suggest the possibility of making zoning a <u>dependent</u> variable, determined by suitability, which is discussed later in this chapter, and by accessibility to transportation, which is the topic of the section that follows.

lessons from buildout analysis In order to carry out the four main tasks that follow, as required by EO418, we relied on existing studies and data that formed an adequate factual foundation for our analyses. Our successful use of less-than-ideal [pseudo-City Knowledge situation] datasets reinforces how useful a fully-developed City Knowledge system of plan-ready information would be. Thus, one of the principal recommendations that emerged from our work in Worcester was that the city should invest into the creation of virtuous mechanisms that will produce "plan-ready" information, using a middle-out tactic according to the tenets of City Knowledge. In other words, the availability of a more complete and up-to-date foundation of knowledge would have allowed us to produce an even finer analysis of the challenges and opportunities facing Worcester in the years to come. Parameterization of the zoning regulations would further enhance the [exploratory vs. optimal] capabilities of a comprehensive municipal information system. The

the need for obtaining "optimal" solutions.

confidence and ease with which one can re-run exploratory analyses, reduces

# TRANSPORTATION ACCESSIBILITY<sup>318</sup>



lessons from traffic accessibility

T he purpose of the transportation section of EO418 was to determine where the transportation infrastructure should be improved. We found that the best way to achieve this goal was to simply determine how accessible each parcel is. To do this we used existing traffic volumes to identify the major arteries that crisscross the city. We then attributed higher accessibility to parcels that were closer to highways (up to 2 miles) and major arteries (up to  $\frac{1}{2}$  mile away).

Separately, we also analyzed accessibility with public transportation, attributing higher scores to parcels within a <sup>1</sup>/<sub>2</sub> mile of a bus route (blue buffers at left) and an even higher score if they were within <sup>1</sup>/<sub>2</sub> mile radius of a bus stop. Each parcel would thus receive a cumulative accessibility score that represented how easy (green in map below), or hard (red) it was to reach it with either private or public means of transportation.

This accessibility information was used in all further suitability analyses, since transportation plays a major role in the choice of land use, be it for residential, commercial, industrial or recreational purposes. All sections that follow incorporate, in some measure, the accessibility scores at the parcel level.

The main lesson from this section was that transportation data ought to be more easily accessible and usable. We had to resort to manual data input from paper maps just to get volume information for major arteries in



the city. Obviously the cost of our manual data entry – or even worse the cost of field data collection – would be spared if the data were acquired through mandatory impact study submission requirements attached to developers' plan proposals<sup>319</sup>.

<sup>&</sup>lt;sup>318</sup> This section and the next (on open-space) are based on Farmer *et al.*, 2004. All figures come from that report.

<sup>&</sup>lt;sup>319</sup> As proposed by Gage *et al*, 2003 and implemented by the City of Cambridge and as discussed earlier in this section on page 140.

#### OPEN SPACE ANALYSIS



The next step in the EO418 process deals with environmental preservation. The goal here is to identify what parcels are environmentally precious and ought to be preserved and what parcels are better suited to be parks instead of being turned to other uses. We subdivided all open space into three main categories: Conservation Land, City Parks, and Neighborhood Playgrounds. The criteria used to assign a higher or lower open space suitability to a parcel were the following:

- slope (not desirable for playgrounds, but good for conservation)
- presence of water (desirable except around children in playgrounds)
- deficit (whether a particular part of town was lacking open space)
- proximity to other OS (conservation land is better in large swaths)
- ownership (public is easier to convert to OS than private)
- ✤ size (playgrounds small, conservation big)
- value (the cheaper the better in general)

The open space deficit was calculated based on industry benchmarks like the de-facto standard metric of 10 acres/1000 inhabitants<sup>320</sup>. The map on the left shows in red the areas where there is a more pronounced need to



<sup>&</sup>lt;sup>320</sup> Recommended by the National Recreation and Parks Association (NARPA).

[open space suitability map]

	offer green amenities to the population. Not surprisingly, in the results
	shown below the most suitable OS parcels are concentrated around these
	areas of higher deficit.
feasibility and desirability	By including information about parcel value and ownership, these
5 5 5	calculations reflect not only desirability but also feasibility. Nevertheless,
	these fact-based rankings and classifications represent only the first step
	toward protecting open space. The next step would be to act on these
	indications and begin the more painstaking process of turning them into
applying the 5 tools	reality. The five tools of government action mentioned elsewhere in this
11.7 0	document <sup>321</sup> would suggest a combination of the following actions:
	1. Conversion of highly-suited, publicly-owned properties to OS;
	2. Give incentives to owners of valuable parcels to convert them to
	public use;
	3. Regulate the use of these parcels through zoning and other restrictions;
	4. Educate and inform the public about OS conservation;
	<ol> <li>Transfer property rights of some crucial parcels of land to some other less precious parcels (better if the latter are publicly owned);</li> </ol>
	Once the most "actionable" parcels are identified, a visual survey of
	the sites ought to be made to ascertain their true potential as open space.
lessons form open space analysis	In the end, if done well, the McHargian analysis <sup>322</sup> of Open Space
	suitability can be a great time-saver and represent an excellent filter that can
[exploratory filters vs. perfect match]	quickly lead to the most desirable and feasible parcels to target for protection
	and/or recreation. Once again the ease with which rough filters can be
	applied removes the need to more precisely identify the "most suitable"
	parcel up front. Instead the tool gets us close enough to allow more
	nuanced decisions to take place.

<sup>&</sup>lt;sup>321</sup> Schuster *et al.*, 1997.
<sup>322</sup> McHarg, 1969.

## HOUSING ANALYSIS<sup>323</sup>



he primary stated purpose of EO418 is to assist communities in addressing the housing shortage, so the housing suitability map is an

essential deliverable of this process. The housing analysis is meant to start from a thorough housing inventory, which was not available for the city of Worcester. We were nonetheless able to develop a housing market profile based on a recent study conducted by a local consulting firm on behalf of the city<sup>324</sup>. Using the MacConnell coding scheme<sup>325</sup>, one could try to roughly classify the housing typologies by parcel. Unfortunately, the Worcester Assessor's data does not explicitly describe land use, though it contains a useful description of the building (blddesc). In all, the Worcester parcel dataset categorizes buildings with 103 different descriptors. Single family homes are the most numerous (23,075), followed by triple-deckers (5,046), then by twofamily homes (3,780). Compared to other major New England cities, Worcester seems to have more single-family homes and more triple-deckers, with relatively few duplexes and a moderate amount of multifamily dwellings.

Some of the building categories betray a lingering bias toward taxation (e.g. *exempt* classifications). It would be worthwhile to make a renewed effort to standardize land use codes using an improved version of the MacConnell codes and/or MassGIS's Land Use Zone crosswalk table<sup>326</sup>. Housing inventories would be instantly available at any moment if a set of building use codes was developed and attached to the spatial object through a unique building code. In parallel, a land use coding scheme should also be used to account for differences between unbuilt parcels.

Despite these difficulties in use classification, we were able to analyze the housing suitability for two fundamental types of dwellings: single family and multi-family. Moreover, we also considered the suitability of parcels as sites for housing for the elderly or for people with special needs.

From other sources<sup>327</sup>, we had already surmised that Worcester homes are more affordable and that there is a decent demand for rental units. Triple deckers recently surpassed single-family homes as the dwelling with the greatest median resale value, which suggests that high-density living is still a desirable quality in this city.

327 RKG, op. cit..

 $<sup>^{323}</sup>$  This section and the next (on open-space) are based on Hamir *et al.*, 2004. All figures come from that report.

<sup>324</sup> RKG Associates, Inc., Housing Market Study, 2002.

<sup>&</sup>lt;sup>325</sup> See for instance <u>http://www.mass.gov/mgis/landuse\_stats.htm</u>.

<sup>&</sup>lt;sup>326</sup> Idem.

To simplify the visualization of the data, the suitability analysis for opportunistic choice of criteria housing was divided into three sub-categories: Single-Family 1. 2. Multifamily 3. Special Needs and Elderly Housing The principal criteria that were brought to bear on the housing suitability calculations were:  $\oplus$ lot size (smallest and largest more suited for multi) 0 accessibility (multifamily and special needs require better access) elderly housing  $\Phi$ deficit (for elderly housing only)  $\oplus$ proximity to OS (more important for high density multifamily) As was the case for the housing and transportation analyses, the choice of criteria is based in part on the availability of data to support the inclusion of each criterion. Spatial metrics that can be directly extracted from GIS - like size and proximity - are always available with a modicum of manipulation. Other, more complex proxies – such as accessibility – may require considerable computational efforts<sup>328</sup>. Deficit was probably the most sophisticated indicator that we were able to calculate based on Elderly Housing Deficits available datasets. We did not pursue even more complex suitability factors, such as the homogeneity of the housing (8) (8) (8) (8) (9) stock in the neighborhood, since such measures are impractical, if not utterly impossible to even approximate with the typically available urban datasets. Elderly housing was allotted according to the deficit that was calculated as the actual number of people over 65 in each of Worcester's census tracts minus the number of beds in that tract that are already dedicated to elderly people<sup>329</sup>. One of the complications was that these data were based on 126 census tracts instead of parcels. The scalability of the units of analysis is thus very important when performing these 298 analyses. When making decisions about how to allocate suitable 300 uses to the various parcels based on the results of these analyses, housing would probably be given a lower priority than Open Space and Economic Development, as will be

discussed below.

<sup>&</sup>lt;sup>328</sup> As briefly discussed on page 143.

<sup>329</sup> From the Massachusetts Housing Finance Agency Housing List.

Another thing to keep in mind – and this applies to all suitability maps – is that these maps provide a "portfolio of choices" and are not meant to point to the optimally best choices. The colors show only the highest suitable use. The second highest use may be right up there, but only slightly lower than the topmost. On the other hand, the unsuitable uses should be fairly clear, so these tools are primarily useful to identify sets of suitable uses versus unsuitable ones. Once a particular parcel is assigned one of the more



suitable uses, surrounding parcels may become suddenly less suited for their topmost use. For instance, if a particular parcel was selected to be the site of a new elderly housing project, any additional parcels in the same census tract that had been earmarked for potential elderly housing will need to be reassigned to the next highest suitable use.

Far from being the silver bullet that will make planning a largely automated enterprise, suitability analysis does provide a powerful tool for screening potential uses in the early stages of planning. It also provides enough intelligence to guide a possible rezoning effort and it helps to focus our limited resources on important situations that may be the target of incentive programs.

suitability analysis as a tool

housing suitability map	In the bigger scheme of things, if we leave current zoning out of the picture, the suitability map shows multifamily houses (green color in map below) clustered around downtown and along major arteries, with single-family homes filling the in-between spaces (red color).
lessons from housing analysis	This section showed how much more useful it would be to have a true City Knowledge system in place so that we would not be forced to resort to opportunistic choices for our suitability criteria. It also reinforced the benefits of adopting suitability analyses as precursors to planning decisions, more as a way to weed out unsuitable locations than to truly zero in on the absolute best options.

# ECONOMIC DEVELOPMENT ANALYSIS<sup>330</sup>







Industry

he final aspect covered by the EO418 process is Economic Development. Our students compared Worcester to the

Massachusetts cities of Lowell, Springfield and Cambridge as well as with the capital of Rhode Island, Providence. Basic workforce statistics were used to determine the human resource pools that these cities are able to dip into. Worcester has the second highest level of education after Cambridge, which is very encouraging for future business development.

The income distribution of the populations of these cities was also examined and once again Worcester faired comparatively well. Cambridge is undoubtedly the leading city in this comparison group, but Worcester is well equipped too.

Our students then conducted a quotient analysis<sup>331</sup> to bring out the strengths and weaknesses that Worcester exhibits in its business sectors, as compared to other Massachusetts cities.

Based on the NAICS codes<sup>332</sup>, the leading industries in Worcester turned out to be Health Care, Management of Companies, Educational Services, Finance and Insurance, and Other Services (not public administration). Yet, despite the fact that these are the best sectors of Worcester's economy, the city only leads all others in health care and in the management of companies. All of its colleges notwithstanding, Worcester is only third in the field of educational services after Providence and Cambridge, which far outdoes all others.

The trailing industries in Worcester are Accommodation and Food, Real Estate Rental and Leasing, Professional Technical Services, Information and Transportation and Warehousing. The fact that Cambridge and Providence, who are leaders in educational services just ahead of Worcester, are also leaders in professional and technical services – where Worcester lags even behind Lowell – suggests that Worcester may be missing an opportunity in this area. Even more acute is the shortcoming in the realm of Information, where Worcester sits at the bottom of the heap despite its educated workforce and despite WPI itself.

In the end, a detailed economic profile based on 21 industry sectors (2-digit NAICS) suggested that Worcester should focus its economic development efforts on declining industries that are complementary to the strong sectors. For instance, the declining manufacturing base in Worcester could be reconstituted in part by providing incentives for the development of biomedical manufacturing plants that could ride on the coattails of the very successful biomedical and health sectors that are thriving in the city.

<sup>331</sup> Jajosky *et al.*, 2003.

332 US Census Bureau. 2001 MSA Business Patterns (NAICS).

<sup>&</sup>lt;sup>330</sup> This section and the next (on open-space) are based on Jajosky *et al.*, 2004. All figures come from that report.

In developing these insightful recommendations, we were yet again limited by the availability of good local data. Business activity, like many other phenomena, is poorly represented at the local level, especially at the scale of parcels. Even when datasets containing addresses are obtained, they only provide a partial and potentially misleading picture of the actual economy of a place. Most data are available only at the census-tract level, if not at just the overall municipal scale.

economic development suitability map

Thus, when it came to analyzing the suitability of locating different industries in different parts of town, the data had to be extrapolated from the tract-level sets available<sup>333</sup>. Despite the difficulties of spreading these data across individual parcels, the resulting suitability map seems to capture the essence of a rational siting strategy, which is based on the following main parameters:

- ✤ accessibility to major arteries(important for retail and commercial)



<sup>&</sup>lt;sup>333</sup> Massachusetts Division of Employment and Training. 2003. ES-202 data.

Suitable industrial sites (in red) are strung along the main roadways and railroad tracks, especially in the Southeast part of the city, where Route 20, 146 and the Massachusetts Turnpike are located and through which the main north-south rail trunk between Worcester and Providence, along what used to be the Blackstone Canal that connected the two cities. Retail (in blue) is also laid out in big chunks, not far from the principal roadways, but with a more equitable distribution in the various neighborhoods, where shoppers live. Parcels that are highly suited for commerce (green) create a rather thick buffer around the main arteries whence goods and customers would reach the businesses.

[arts district prediction]



lessons from economic analysis

[regional planning]

#### COMMUNITY VISIONING

As an example of the siting potential for specific NAICS sectors, the economic suitability maps show the best locations where Arts and Entertainment businesses could be established (purple in maps above and below). It was rather amazing to see how this computational analysis ended up mimicking real life in an astonishing manner, by picking as the prime locality for this type of activity precisely the neighborhood where the "Arts District" is being planned, yet doing so based on a purely numeric algorithm predicated on objective physical parameters.

The big issue here was not so much the siting suitability for the various types of businesses, but just which businesses it would be preferable to try to attract to Worcester. Our quotient analysis achieved just that by using census data. Of course, a full-fledged City Knowledge system may afford us much more latitude in the locational choices, yet the problem here is much more regional than local, and it is not so much spatial as economical.

So the lesson here is that a uniform treatment of datasets across town boundaries would enable Regional Planning Authorities (RPAs) to coordinate macro-level economic development decisions.

T he relative weight of the various factors that participated in our suitability calculations can be adjusted to account for differing perspectives on what is more important or more appropriate. The EO418 process encourages public participation in the formation of the sets of important criteria and in the assignment of relative weights between all criteria in each of the three suitability categories. As the overall suitability across the three domains is ascertained, once again the community could be given the chance to voice its opinion and sway the importance of the three aspects in one direction or the other. As part of our Worcester EO418 study, we conducted three visioning exercises involving a cross-section of individuals representing a broad spectrum of views. Before the EO418 process even began, Prof. Krueger had already conducted an international workshop entitled "Envisioning Worcester's Future" that provided a foundation for our subsequent work.

## A PARTICIPATORY PLANNING TOOL

H aving spent many hours to develop the initial sets of suitability maps, we quickly realized that we needed some way of streamlining the suitability calculations in order to rapidly incorporate citizen comments in the iterative process of successive refinements that is needed to create a

uitability Database	Category Weight Adjustment Housing
Accessibility Adjustment	Economic 1
Economic Adjustment	Open Space 1
Housing Adjustment	Recalculate Using New Category Weights
Open Space Adjustment	Re-run all calculations (Intensive)
Recalculate A	rea (Must Run Adjust Category Weights when finished
Housing	Economic Open Space

consensus over the most appropriate land use for the future of the city. To do this, we developed a computerized tool that would interact with the three databases we had developed for Housing, Open Space and Economic Development and allow a dynamic modification of the relative importance of each set of criteria associated with each of the three main areas of study. These suitability databases were directly linked to GIS maps to instantly produce a visual rendition of the suitability produced by the citizen groups.

As was summarily discussed above, we identified a list of criteria culled from planning texts and interviews with professionals, but filtered by

SCRG: Planning Tool v2.0			
Planning Tool			
Adjust Criteria Values	Recalculate		
Transportation Accessability	Transportation Accessability		
Open Space Suitability	Open Space		
Housing Suitability	Housing		
Economic Development Suitability	Economic Development		
	Category Weights		
Quit	Recalculate All		
Category Weight Modifier-			
Open Space: 1.00			
Housing: 1.00			
Economic Development: 1.00			

how feasible it was to obtain the data necessary to adequately "measure" each criterion, directly or by proxy. After the criteria were selected and filtered, we were left with 7 factors for the analysis related to the 3 main types of housing considered, 7 factors for the assessment of economic development suitability across the 4 broad business segments we analyzed, and 8 factors for the identification of ideal sites for the 3 types of open space.

In essence, we set up three independently-modifiable lookup tables wherein we recorded the scores that the focus group participants assigned to each of the relevant criteria. The first completed version of the tool was built using Microsoft Access<sup>®</sup> for both the calculations and the data storage. To calculate the suitability after modifying the data, a number of macros would run a sequence of queries that would cumulatively produce the end result.

The databases include data that have been pre-processed to reflect some of the useful measures dictated by the analyses. For example, a number of spatial queries involving buffers of varying widths were used to assign a proximity value to each parcel vis a vis parks. These spatial queries would typically be at our disposal without much additional information, since they are based on the geographical characteristics of the GIS objects.

The next generation of the system was written in Java<sup>TM</sup> to add more power and flexibility. Adding a new criterion is as simple as adding another row in the criteria lookup table, and separately providing the data necessary. Some criteria, however, may be based on knowledge collected from government databases – such as the US census, or the city's real estate tax assessments – so these would need to be manipulated to suit the desired analysis. Even though our data are stored using Microsoft Access<sup>®</sup>, this program is very flexible and is capable of working with any other standard database type that supports SQL. The interactive visualization tool allowed us to conduct our visioning sessions in a more constructive and efficient manner, which in turn allowed us to progressively refine the delicate balances of weights and scores that led to the development of our final composite suitability map.

lessons from public participation

The visioning sessions made clear the instant value of the suitability analyses that would make them immediately cost-effective with today's tools and knowledge. Moreover, these sessions added credence to the potential of City Knowledge as a foundation for citizen empowerment through education and information dissemination.

#### COMPOSITE SUITABILITY MAP

A fter each of the four main areas of study have been analyzed, a composite suitability map was produced to visualize the net effect of all of these suitabilities taken together. In creating this combined map, the relative importance of each land use category needs to be decided whenever different uses are competing for the same parcel. During the visioning sessions such tacit hierarchies were made explicit. In the map below, we placed the open space parcels suitabilities on top of the other layers, giving them priority over all uses. Next we placed the economic development set of suitable parcels and finally, at the bottom of the land use food chain, we relegated the housing suitabilities, which would fill in all the land gaps between the higher priority parcels that would be better suited for recreation or for business.



#### LESSONS FROM MY OWN BACKYARD

plans as information

buildings as atoms

[building IDs]

floors as atoms

free traffic data

[building typology and use by floor]

[volumes and capacities by segment]

plan-ready facts and interactive values

W orking on the Worcester EO418 project enabled me to specifically focus my attention on the impact of City Knowledge on municipal planning. I awakened to the fact that plans are untapped repositories of upto-date information, but unfortunately they are still treated as nothing more than "documentation", made up of paper reports and paper maps. As is the case in other departments, the data that are received by the planning department as part of a plan are still considered like accessory documentation instead of being treated as crucial, up-to-date, free-of-charge, retainable and reusable information.

Our efforts in Worcester<sup>334</sup> and Cambridge<sup>335</sup> have shown how, by simply revising existing plan submission requirements, cities can begin to amass a considerable amount of current information on urban data such as traffic, land use and business activity. I expect more cities will revise their guidelines for the submission of plans to maximize the informational return of these routine planning processes.

Another lesson that was emphasized in Worcester, though it had already become evident in Venice and elsewhere, was the desirability of acquiring and managing information at the level of the individual building. This type of information would have been very useful for our buildout, economic development and housing analyses and it would also have permitted the apple-to-apple comparison of adjoining or competing plans. The start of this effort would be the creation of a unique building ID to identify each single edifice in the city.

Once building IDs were assigned, we could begin to keep track of building typology (including architectural styles), as well as building use, which I recommend to be collected using the individual floor as the unit of measurement, as discussed earlier in this chapter<sup>336</sup>. It would be good to adhere to standards for the classification of uses according to either the NAICS (for business uses), or the MacConnell use codes (especially for undeveloped parcels)<sup>337</sup>.

A similar lesson was learnt with respect to our transportation analysis. If the road network had been appropriately subdivided and organized to provide segment-by-segment information about traffic volumes and capacities, and if a method similar to that adopted in Cambridge<sup>338</sup> was put in place to obtain "free" traffic data from developers' impact studies, the accessibility map would have been much more representative of the real level of access that is available to each part of town.

When we tried to adopt the "separation of facts from values" approach<sup>339</sup>, we gained the insights that lead to the development of the suitability maps and subsequently to the interactive visualization tool. It would be great to be able to dig deeper into the variety of additional criteria

<sup>&</sup>lt;sup>334</sup> Brown and Groeli, 2003.

<sup>&</sup>lt;sup>335</sup> Gage *et al.*, 2003.

<sup>&</sup>lt;sup>336</sup> Page 138.

<sup>&</sup>lt;sup>337</sup> See for instance <u>http://www.mass.gov/mgis/landuse\_stats.htm</u>. Last accessed 8/20/04.

<sup>&</sup>lt;sup>338</sup> Gage et al., 2003.

<sup>339</sup> Hammond et al., 1980, 1991.

[suitability criteria and values]

demonstration of value of plan-ready

that may affect land use choices and to arrive at a comprehensive review of the datasets that could be used to inform the factual component of such decisions<sup>340</sup>, leaving the "value" side open for consensual modification through the participatory process, augmented by the interactive tool that allows instant visual feedback and iterative refinement.

The Worcester case highlighted the potential returns we could get if we were able to reliably tap into administrative databases or into other existing municipal knowledge bases. Partially developed versions of the plan-ready exhaustive municipal information system that I envision were used fairly successfully in the example illustrated herein. This bodes well for the full-fledged systems I propose.

<sup>&</sup>lt;sup>340</sup> Tapping into such rich literature as that produced by the Urban Institute, with its *Catalog of Administrative Data Sources* and the like (Coulton *et al.*, 1997).

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