

Trimbur, J. (HU)
JOT-3L05
Type: IQP
Date: 3/2005

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Merton City Knowledge

An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
and members of
London Borough of Merton Council
in partial fulfillment of the requirements for the
Degree of Bachelor of Science

Sponsoring Agency: Merton Housing and Social Services

Submitted to:

Project Advisor: Professor John Trimbur
Project Co-advisor: Professor Joseph Fehribach
On-Site Liaisons: Michael Kelleher, Assistant Head of Housing
Adrian Hewitt, Principal Environment Officer

Submitted by:

David Casavant

Michael Guay

Kevin Moore

Joshua Morin

Date: 25 February 2005

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Abstract

This paper serves as a proposal to the London Borough of Merton as to why it should adopt a city planning and management concept called City Knowledge. The concept of City Knowledge is defined, explained, and illustrated with examples from cities in Europe and the United States. It details how the idea is a change in the way a municipality usually thinks about information. The current situation in Merton is used as a backdrop and an example of why a municipality should employ this scheme. Real life examples are used to show how City Knowledge could benefit the borough, with special attention to a case study involving safety in the Housing and Social Services Department. The situations are tailored in such a way that the reader can easily relate to them. Some initial suggestions and considerations are given for implementing such a system and the future of such a system is also touched upon. Also included is a description of the resources that are available from the creator of the concept.

Executive Summary

A well oiled machine is less likely to wear out and break down at an inopportune time. When we apply this old dictum to a city management and urban planning scheme the oil in the machine is City Knowledge (CK). This new way of thinking about information and its uses will not only increase data flow in a municipality but also give several value-added benefits in the process. By incorporating the communal knowledge base of the Borough, that is, combining everyone's data, we begin to think of information not simply as something to be hunted but rather something that is farmed and grown over time. By combining the little atoms of data the larger molecules are formed which then can be used to create bigger bits of information.

Through the use of a centralized City Knowledge database, data that was previously unheard of by other departments becomes ready to use by those who need it. Think of City Knowledge as an all encompassing information warehouse holding massive amounts of data that are ready to be displayed in a quick, easily understood manner. Now instead of employees tracking down pieces of information when they need it, they can access the CK database and expedite the process.

There are several direct benefits from employing this approach. First, there is a great reduction in data redundancy. Since everyone's information will be available there is no need to perform the same surveys time after time. Second, there is a dramatic slashing of time required to find information. The system is designed for quick referencing of data which in turn leads to less time consumed by data location. Third, there is a dramatic reduction in cost that stems from improved efficiency. With surveyors not recollecting the same data again and employees not spending hours tracking down information, more time can be spent completing other tasks. This will

save the Borough on labour expenses. Fourth, when information is layered on top of one another new plan-demanding data are created. Now, for example, people from the Housing Department can access Regeneration's crime statistics and notice trends that may not have otherwise been apparent until the information was related.

Preface

Our IQP team arrived at Merton in early January of 2005. Our original objective was to create a GIS-based system for the Housing and Social Services (HSS) department that would help it map and manage public safety hazards in the area. We chose a small area of the St. Helier estate as a pilot study in order to gauge how effective GIS based solutions would be for the HSS department. Our first goal in establishing this GIS system was to acquire the data that would populate our sample database and later be displayed on a map.

As it happened and completely unbeknownst to the HSS department, Merton already had the base maps and many of the data sets that we were going to collect on our own. It was through our own research that we discovered Merton's internal GIS mapping department. We decided that it would be best to continue on with the work that we were doing and build on Merton's existing system. Our team went on collecting data from utility companies, identifying their assets in the area (manhole covers, inspection covers, stopcocks, electrical boxes, etc.) for another two weeks.

During our third week in Merton we discovered that not only did the Borough possess GIS capability, but it was actually planning to bring on a professional GIS team in June of 2005. We sat back and thought about our experience, trying to identify what had happened to cause this discrepancy. One issue that stuck out in our minds was that the HSS department did not know that Merton already had GIS work being done. Rather than tap that resource in the Borough it was going to have the same data collected again by our group. We reformulated our project to propose how Merton could deal with these problems of information management and dissemination.

Introduction

In every city, large or small, planning and management go hand in hand as vital activities that must take place in order for a community to thrive. By definition, city planning is the action of determining and creating plans for the future physical arrangement and condition of a community. Management is the action taken to ensure these plans are implemented and intended goals are reached. The planning and management process deals with every aspect in a community including the aesthetics, safety, transportation, and the environment, to name a few. When all of these different areas are taken into consideration in a management scheme, the result is likely to be a more organized and sustainable community.

The successful management of a community follows from far-sighted plans that have been carefully crafted to serve particular purposes. In order for a plan to be effective it must be formulated not haphazardly, but with much thought and based on considerable amounts of information. Therefore, in order to ensure the most efficient plans to manage the city, there must be large collection of high quality data on which to base the decisions. In this section we will explore city management and establish a context in which to set our project.

The power behind a successful management scheme is a resilient information infrastructure. Decision makers in the community need to have substantial amounts of data when making decisions in order to create a plan that will most accurately and effectively address the issue at hand. In some cases, for a plan to be instituted, there must be evidence to back it up in order for it to gain support from others within the community. When this is the case, a considerable amount of time and effort must first be put forth in order to obtain this information, slowing the planning process.

The lack of a structured and organized compilation of data can be detrimental to a local government's planning strategies. Instead of efficiently making plans they consume time and resources to compensate. Having comprehensive data at their disposal would increase the effectiveness and efficiency of the planners and smooth out the overall operation of the municipality. In the London Borough of Merton this is becoming evermore apparent.

Presently, it seems as though departments within the Borough operate almost entirely independent of one another. In a sense this problem could be seen as a communication issue and a partial solution would be achieved by independent departments within the borough more readily communicating and sharing information with each other. Improving communication between departments however, would only partially address the issue of being able to easily access information and would serve only as a bandage to a larger issue of a weak information infrastructure within the Borough.

One area where this undercurrent is most evident is in the accessing of data. The Borough has data that it uses to make their administrative decisions, as they would not be able to function without it. The problem with the data that they do have is that they are in a form that is not accessible. This inaccessibility comes in varying degrees. In a lesser degree there is a problem when each department has their own records that they use to make decisions. The data are filed away within that department unbeknownst to other departments, making it difficult to locate and use by others. In a more severe case the data may exist, but it is possible that no one knows where to find it. Instead of putting forth the effort to find it, it is conceivable that a department requiring certain data may take it upon themselves to collect it, leading to

redundant data collection. This in turn creates a highly inefficient process in which both time and money are wasted.

Stemming from the problem of accessibility are jurisdictional issues. As with any type of organization different tasks are divided up and distributed by means of division of labour. The problem in Merton is that there is a significant amount of confusion as to who is responsible for what in the division of labour. The few individuals that do understand the interdepartmental framework are unable to share their information because they lack the means to do so effectively. This can be attributed to the issue of accessing data. If a department could easily reference a knowledge base and see which department was responsible for taking care of, say, a particular piece of land then there would not be a problem.

The two issues mentioned above are inextricably linked and combine with the third dimension that they create: superfluous expenses. The lack of structure, organization, and knowledge unnecessarily consumes time, thereby creating unduly high management costs.

The Borough is aware of the benefit of having centralized information available for use by various council departments. Currently, there is a fledgling Geographic Information System (GIS) program that is aimed at inventorying Borough property and keeping records on it. The system, however, is not populated with nearly enough data. The base maps that have been purchased by the borough have only limited general data. There is evidence that there is a push to increase the information contained within the system which is a step in the right direction.

One problem however, is that there is not a unity and understanding throughout the various departments that this is a resource that should be utilized. In other words, there are only a limited number of departments that use the system,

leaving a system that only has limited data on it. A problem that ties directly in with this is the fact that very few people know about the system. And even then, only a percentage of those few know how to use the system. The need is for something that will unite the various departments and encourage them to contribute to a unified database. This would lead to a more complete knowledge base and get everyone on the same page as far as data sharing is concerned.

City Knowledge is a concept that revolutionizes the way we think about urban planning and management. It is a wide-reaching, methodological approach to collecting, storing and using data that would bring about a change in the way things are currently done. Instead of there being discrete sources of data throughout a municipality there would be one central source of information that everyone would both contribute to and take from. It would save time because people would no longer have to wonder where to go to retrieve data, nor would there be questions as to whether the certain data existed or not. A user could access the centralized system and if the data were not there then he or she would immediately know that it would be necessary to collect it. Otherwise, if the data were there it would be ready for them to use.

The benefits of employing this system are many. At the most basic level is having a detailed catalogue of every spatial aspect that each department is responsible for. Once base information is put into the system it is there permanently and can be used over and over again. The system would save money as data would not be collected more than once with less time was spent on data location. By compiling various layers of information, issues that would possibly not have otherwise been noticed can be brought to the forefront as complex correlations are made. City Knowledge encompasses a system that stores vast amounts of data that can be

accessed and displayed in highly visual, easy to understand formats. The applications are numerous and may include criminal analysis, open-space monitoring, and the tracking of various public works and maintenance.

All of the departments within Merton could undoubtedly benefit from an easily accessible mutual information infrastructure. The Housing and Social Services (HSS) department is one such division of the local government. This department is responsible for the maintenance and management of over 7,000 council owned properties. The HSS department is charged with the repair of outdoor features such as trees, grass verges, lampposts, and sidewalks. This department will be used as a case study with a particular focus on safety. It will show how City Knowledge can be used to address one of the most pressing issues within the department.

Failure to repair outdoor features presents a significant safety risk to the public and leaves the Borough vulnerable to litigation from injured citizens. Ideally, all repairs would be conducted in a timely manner and preventative maintenance scheduling would aid in the elimination of serious problems before they occur. Such a system would be a huge step towards ensuring public safety on Council properties. Unfortunately, the current plan does not address the issue of safety with such fervour. Instead of damaged features going unfixed for extended periods of time, a City Knowledge system could aid in locating and understanding exactly what the problem is with very little effort. Also, by analyzing data routine schedules could be formulated to curtail problems before they become safety issues.

The main objective of our research is to explain the concept of City Knowledge to the Merton Council and show the many benefits of the system by taking our understanding of City Knowledge and applying it in a unique way to the problem of safety that is faced by the Housing and Social Services Department. Our

hope is that this study will illustrate the usefulness and the benefits of a City Knowledge scheme, in one department of the borough. A successful demonstration of this powerful way of thinking could lead to other departments seeing the merit in such a system and prompt a borough-wide initiative to invest both time and money to expand the system.

City Knowledge Explained

City Knowledge is a revolution in the way we think of urban planning and management. It is in and of itself an information philosophy. The concept's aim is to create a massive data repository that is easily expandable, highly adaptable, and accessible to various bodies within a municipality. Instead of departments keeping data to themselves they contribute to a centralized City Knowledge system where the data can be used by others. City Knowledge represents a sea-change in the way people think about information. Rather than using a "hunter/gatherer" approach to data collection where data are collected for one specific purpose when they are needed, there is a shift to a more agrarian, "farming" philosophy where data are collected over time and are used by multiple sources. In this section we will explain what City Knowledge is, how to set up and maintain a City Knowledge system, and what it is used for and the benefits that are produced.

What Is CK?

City Knowledge is the work of Dr. Fabio Carrera, a professor of Urban Information Systems and Planning at the American university, Worcester Polytechnic Institute. His doctoral dissertation, *City Knowledge*, is the basis for all work currently being done in this field. He has spent years of his life working with local municipalities, and his students have employed his methods in a handful of cities around the world.

There is a tendency for people who are unfamiliar with City Knowledge to confuse it with Geographical Information Systems (GIS). However, there is a clear difference between these two entities. GIS is merely a tool that is used within the

construct of a City Knowledge system and will be discussed later on in this paper. It is necessary to make this distinction early on to ensure there is no confusion between the two and that City Knowledge is seen as the methodology that fuels information handling in general.

One aim of City Knowledge is to encourage community leaders to see information as an infrastructure and elevate its status within a municipality to that of any other infrastructure. The transportation infrastructure, for example, is held as something that is vitally important to the life of a city. Information should also be held in such regard. After all, it is information that governs and guides any decisions that are made within a community. A municipality would not think of going out and haphazardly laying down asphalt to make roads. Instead there would be a systematic approach that the process would follow including planning and discussions to ensure that it is done correctly. Therefore there is no reason that information should be dealt with in an unorganized manner.

To say that a municipality has data “somewhere” clearly shows a lack of organization. This lack of organization leads to lost time which in turn is lost money. In the worst case scenario extremely poor organization can lead to not locating the data at all. City Knowledge proposes a direct solution to this problem by making data centralized creating an easy way for everyone to access the information. Such a system serves to create a feasible way to store incredibly detailed amounts of information.

In order to understand City Knowledge as a concept, it is important to first understand the differentiation between the terms data, information, and knowledge. Carrera describes these terms as though they were three stages in a metamorphosis. *Data* are simply raw facts that are collected and are the first stage of the

transformation. A project inventorying a group of items, such as trees, would generate raw data. Included in the raw data would be location, type, condition, and any other facts deemed useful. Raw data is of little use since there is no real structure to it. Once data are collected they can be organized into *information*, by storing the data in a way that allows a user to search and manipulate it. *Knowledge* comes about when the information is taken and used to make informed decisions, for example figuring out an appropriate maintenance schedule for the trees from all the information that has been gathered. Knowledge is the basis for decisions that are made throughout a community and should be seen as something of utmost importance.

The purpose of introducing and differentiating between these terms is twofold. The first reason is to immerse the reader in the jargon that is used in describing the concept so that they can use their understanding to follow this discourse as well as future discussions on the topic. The second is defining the terms to the reader so that they understand the logical progression of how knowledge is formed from small pieces of raw data. Knowledge is the end goal and holds the power when it comes to planning.

According to Carrera, knowledge comes in three forms: plan-demanded, plan-ready, and plan-demanding. Plan-demanded is the sort of information that is “hunted” for. When going to collect the information the user has a very specific purpose. If the user required information on locations of lampposts and none were available he or she would go out and record their locations by hand. The user has now identified a need for information and collected it. The plan the user needed to execute *demanding* that he or she collect the information in order to successfully complete it.

An example of plan-demanded knowledge can be seen when the WPI Venice Project Centre teamed up with a company called Forma Urbis to inventory paved

streets, bridges, and public docks within the city. The city needed an inventory of this important infrastructure, and did not currently have the data to the detail that was needed. The plan-determined data they collected was then used to conduct a study on flooding and produce maps of different flood levels.

Plan-ready knowledge, on the other hand, is information that has been collected previously and already exists in the system. The knowledge may have initially been used for one particular purpose but conceivably is ready to be used for something completely unrelated. The idea is that the information is there and ready to be used at anytime. The information sitting in a CK database is plan-ready data. If someone requires it for a project it is available to use, similar to books in a library with the exception that information can never really be checked-out of a CK system. The information is *ready* to be used.

We can see how plan-ready knowledge was used in the case of the earlier WPI Venice Project Centre project, when a team used information and maps on canals and canal intersections to investigate the effects of boat manoeuvres on canal wall damage. The team took a range of measurements and linked the new information to the canal segments and intersections that had already been mapped.

The last type is plan-demanding knowledge. To explain this concept it is best to think of transparencies on an overhead projector. When overlaying pieces of plan-ready data, patterns may emerge from the new composite image. These patterns may bring up an issue that requires action or show a more efficient process for a task. The principle is that the combined data generated new information that wouldn't be seen if the data were viewed separately. The information is *demanding* action.

An example of plan-demanding knowledge comes from a tree mapping project in Cambridge, Massachusetts. WPI students created a methodology for inventorying

trees in the city. The information about the trees was taken and used to create maintenance routines based on location, species, and condition. There was also merit placed on this as far as disease control was concerned as sick trees would be removed before infecting the rest of the population.

When discussing the subject of plan-demanding knowledge, people sometimes have a tendency to think that the data will always be a one-to-one correlation and that the CK system will draw conclusions by itself. The point to stress here is that when layering related information the CK system can only provide suggestive information. There will always be a vital human factor involved in the interpretation of patterns. City Knowledge will not solve the problems themselves but simply show that there possibly is a problem. It is up to the human interpreter to determine the proper course of action in order to solve the problem.

Carrera gives the analogy that each collected piece of datum is like an atom that can be recombined to form different molecules. Logically following this argument would be that the more atoms that are collected, the more molecules could be created. That is why when collecting the data, it is suggested by the experts that the most detailed data be collected, with reason in mind of course. The more data that are collected, the more combinations of all the little pieces are possible. By aggregating various data sets across a community, whether those data are related or not, a very powerful tool is put in the hands of the municipality. So just how exactly does one go about establishing a CK system?

Set-up and Maintenance

Ideally a City Knowledge system would be inclusive of all departments within a municipality. This however is not always the reality because there is no way to force

a department to participate in such a system. Rather there must be a willingness to share their information. This willingness comes from a department seeing the benefit of being part of such a system. When this program is initiated, not everyone has to be involved. A few departments start to collaborate and contribute to a City Knowledge system. Over time, as other departments start to see the merit of being part of the system, they will subscribe to these information sharing methods. As the program grows the benefits grow with it. Eventually the system will reach its full potential when all the departments within a municipality have joined.

Creation

When creating a City Knowledge system Carrera suggests a middle-out approach be taken. The middle-out approach is described as a combination of the bottom-up and top-down approaches and is intended to unite upper-level management and the lower-level municipality workers in an effort to create a CK system. The bottom-up approach relies on the idea that a worker has the ambition to complete their work successfully. The workers must think that the CK system will help them to accomplish their everyday tasks in a better fashion. This will in turn prompt them to make significant contributions to the system. As contributions come in from all directions there must be a way to coordinate the actions of the users. The top-down approach overlooks the activities concerning the system's growth to ensure that the information is unique and organized. The marriage of these two concepts will help to ensure a successful implementation of a City Knowledge system.

Instituting a City Knowledge system requires an intense amount of planning to ensure the most beneficial implementation. There are several key strategies to keep in mind when creating a system that will permit resilience. One overriding idea is that items in a municipality that lend themselves the best to City Knowledge are those that

have a spatial representation. Aspects such as land plots, houses, roads and trees are examples of aspects that can be represented on a map whereas accounting information, for example, could not be represented in this way. Visualization is a large part of the system which is why the idea of space is so important. Space is referred to as the “glue” of such a system. It allows for meshing of detailed data with easily identifiable map objects.

With this initial thought in mind, the process of creating the system can begin. The first step can be thought of as an integration process whereby initial data collection takes place. A substantial part of this step includes entering current data into the system. It could be thought of as taking everyone’s filing cabinet in various municipal offices and emptying them into a large warehouse. By having one central location that stores information, there is no question as to where to go to find certain data. The amount of data that is involved and the number of people the municipality employs will dictate the time spent to complete the process. This initial step is seen as one of the major investments in a CK system.

The initial data collection entails gathering the raw base data that will serve as the foundation of the maps and data tables; including features in the area that do not change or change they do so very slowly. This may include streets, property boundaries, houses, and locations of trees or various utility fixtures in the area. The data and information for these aspects are collected only once and remain valid throughout the life of the system, with possible minor changes.

All of these files that have been emptied into the warehouse would of course be useless unless they were organized. The second stage of the process is the organization of the data. As the initial data is collected it is entered into the centralized system where it can be neatly organized in tables. Powerful databases are

used to form the backbone that supports City Knowledge. The organization allows for users to easily manipulate and search the information for their particular use. This system allows the information that is in the possession of the municipality to be used to its potential.

Visualization is the third step of the process whereby the information that is stored in the centralized database is linked to entities on a map. Since the users of such a system are just as numerous as the data that it contains, there must be some type of user interface that allows the users to easily access the data. Geographic Information Systems using mapping software such as MapInfo are used to represent the spatial aspect of the information that populates these tables. By opening a map of a certain area and loading the desired layers a user can simply click on a map item and see the information that is associated with it.

This process would be a daunting one for one department to undertake, but there is a remedy. Since one of the encompassing ideas behind City Knowledge is the sense of sharing, a delegation of tasks approach can be useful and plays into the concept of the middle-out building approach. The managing body of City Knowledge system would find it beneficial to make each department responsible for their own data thereby distributing the workload. Each department would collect their own data and be responsible for entering it into the system. Once all the initial data has gone through this process, there is a strong base on which the remainder of the system can be built.

Upkeep

Over time, with proper maintenance, the data warehouse created by the City Knowledge system will be extensive. Maintaining such systems is a critical factor when considering deployment of a City Knowledge scheme. A system of high calibre

is achieved by each individual department within the organization contributing to the system as well as a well thought out management scheme to keep the data organized. That is why it is so important to realize the breadth of such a system and be willing to make a commitment to maintain it so as to ensure its value. The system that holds and displays the information is only as good as the data it contains. It is a waste if the initial investment is made to build such an infrastructure and with time the data within it becomes outdated. Performing routine maintenance and updates are needed to make the system sustainable.

It is suggested that routine activities that normally occur within a municipality be used to their full advantage when it comes to information collection. Included in a maintenance crews regiment should be some sort of basic data collection. With little training, those who once were regular maintenance workers could now be a valuable asset in keeping the system up to date. The benefits of utilizing the municipality workers are it takes little training to teach grounds crew how to perform such tasks, and it is more cost effective. It is much less to pay these individuals than it would be to pay highly trained professionals to do the same work.

In order for this to actually work however there must be an infrastructure to support it. The first part of an infrastructure would be a manageable way to get new data into the system. It can not be expected that every maintenance worker will know how to work with a database or use complicated mapping software, which implies the need for easy to understand input method. The answer to the question is customizable user interfaces. An example of such an interface would be a web based form containing simple drop-down menus and comment boxes. These forms would only display the data pertinent to a particular department or user. The “regulars” that input the information would never have to deal with the back end of the system, and instead

would see an easy to understand and use interface that would update the knowledge base.

Methods such as those described above sound very promising however; the use of this technology needs to be shuttled in with a change in consciousness. Every worker must be aware of the system, feel comfortable using it and make it a part of their routine. With the onset of the technology age, there have, in some cases, been times where those not well versed in technology have been reluctant to partake in its uses. This must be avoided because without a unified attitude towards the technology, the system will not be able to grow in a sustainable manner.

Sustainability

Sustainability is a fundamental component of City Knowledge. There will always be new information coming into the municipality as well as the need for new information. A very serious commitment must be made to make sure all the data that comes in is entered into the system. Carrera suggests that municipalities “catch the data as it crosses the administrative horizon.” Stated more directly, a municipality needs to take every opportunity they can to intercept data. By doing this, each municipality will be contributing to a sustainable growth. Not only will they be protecting the investment made in creating the system, but they will also be nurturing a highly valuable resource.

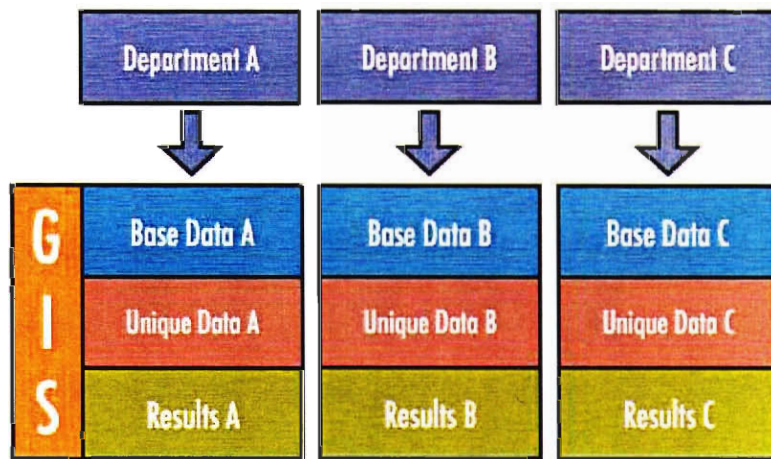
Uses

City Knowledge is both a broad sword and a scalpel. Its wide-sweeping, robust features allow it to be applied from the largest of needs to very small, specific tasks. The uses of City Knowledge are so numerous that it would be impossible to

explain them all. This is due in large part to the fact that while some of the uses are foreseen, many others only appear after the system has been implemented. It is not possible to predict the all the uses and benefits that the system may offer because the relations only become evident as data are layered. This section will show some of the general uses and benefits from using the City Knowledge scheme.

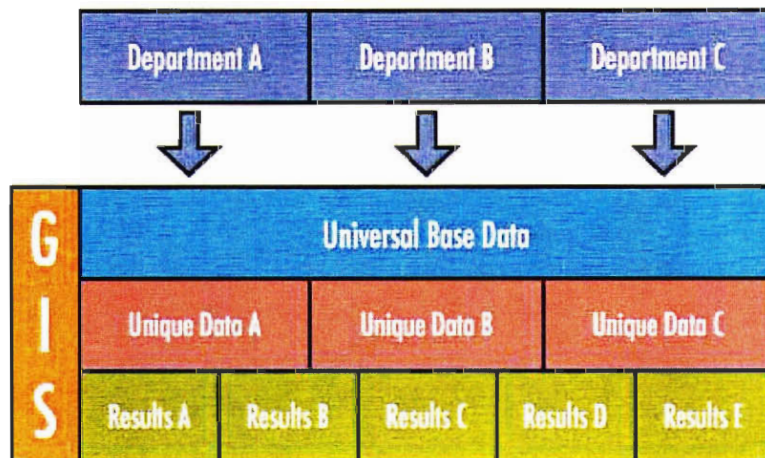
Not Using CK versus Using CK

Below are pictorial representation of two municipalities – the first not using, and the second using a City Knowledge approach to information.



The figure above shows how a municipality functions without the use of a City Knowledge system. There are three separate departments represented in the diagram. Underneath each department there is the base data that the department uses. This data would be the same for all three departments. However in this case there are three separate instances of it. Underneath the base data is the data that is specific to each department. This data would be used in conjunction with the base data to make decisions in each particular department. The results from using the data are then stored locally. The one aspect that is most noticeable in this diagram is the isolation of each department from one another.

This presents problems from the very beginning, namely the redundancy of the base data. At the next step where department specific data is applied there is a problem because while one department may need that specific data there could be another department that could also use it. Again this creates redundancy as well as an underutilization of the data that is available. At the last step where the results are presented only each individual department knows what is going on, instead of sharing the information with others. It could be thought of as three independently operated information systems. Now compare this mode of operation with that of a municipality employing City Knowledge.



The figure above shows how a municipality would function with the use of the City Knowledge system. There are still three distinct departments. However the first important feature to notice is at the first level where the base data is found. Instead of being repeated within each department, the base data spans all three departments as it the shared platform on which everyone builds. The next level is very similar to that of the last scheme, with a minor exception. This level still contains data that is specific to one department. However it is contributed to the overall knowledge base instead of being kept isolated. At the last level, the results, there is a very noticeable difference from the last scenario. There are more results generated from the same data. The

reason for this is because departments can now cross reference their data with data from other departments. The idea that the diagram clearly shows is that the knowledge that is used within the municipality is unified. There is one common information system that everyone uses, that is greater than the sum of its parts.

First and Second Order Analyses

Once data is stored it can then be used for the purposes of analysis. Fabio Carrera talks about two types of analyses in his paper. These are first order and second order analyses. They represent the most basic of functions to the most complex respectively. They provide the core for the day-to-day usage of the City Knowledge system. Anytime a person interfaces with the CK database they will utilize one of these two analysis types.

First order analysis with City Knowledge and GIS are the fundamental operation of such a system. These types of analyses constitute the most basic functions that a user can perform. A first order analysis is a basic search for information. It is when the user wants a particular piece of data and goes and retrieves it for his or her use. An example of first order analysis can be seen going back to the examples discussed earlier about inventorying the trees in Cambridge, or the bridges and canals in Venice. In both of these cases the primary objective was to create a catalogue of selected items. Once in the system, this catalogue can be searched and used to display pertinent data. For example, if a user wanted to see the condition of a particular tree, they could bring up a map and simply click on that tree and find all the data stored about that particular tree.

While these are the basic functions the simplicity must not be overlooked. The first order analyses are very useful as far as being able to access general data. The first order analyses are also what encourage various departments to take interest in the

system and subscribe to it allowing it to grow. It is as the system grows and more information becomes available for use that higher order analyses can be performed.

Second order analysis brings together various data sets and allows the user to perform sophisticated relational analyses between the data sets. This is where it is possible to see trends that would not otherwise be apparent. Results from second order analyses are not always unexpected. It is possible to foresee relations just on assumption. Second order analyses validate these assumptions. In Cambridge with the tree mapping project, second order analyses included predicting disease patterns and creating a plan to combat the problem.

Benefits

City Knowledge is such an influential way of thinking that the specific benefits that can be had from it are numerous. There are however, four general benefits that any municipality employing the system could expect to see.

1) A City Knowledge system will increase data accessibility. The whole philosophy behind CK is community information sharing. It puts information at the fingertips of the users. The time it can take to locate a paper file or even digital file that has been buried and forgotten about over time can be astonishing, and not in a good way. The benefit of the City Knowledge system is that there is no question as to where to find the data. Everyone using the system knows that it is stored in one central location. With a few button clicks on the computer a user is able to readily access the information he or she is looking for.

An example of accessibility more specific to the Borough of Merton is that of Best Value Assessment. This is a process by which central government will conduct audits to evaluate the workings of a borough. Generally, when a borough is given this

assessment there is a need to organize and get ready to present to the auditors. As has already been discussed earlier, with the organization and ready access that the system provides it would make this process run a lot smoother and take less time.

2) A City Knowledge system will reduce redundant data. Redundant data collection occurs when a person requiring certain information can not find it or does not know where to find it. If all the data is in one place and easily accessible then a search can easily be instituted. If the data is found it can then be used, otherwise the user knows that he or she will have to collect the data. If this is the case then once the data has been collected it is put into the system where it can be accessed in the future.

3) A City Knowledge system will save money as a result of increased accessibility and reduced redundancy. Employee will spend fewer hours locating or recollecting data which is what will save money in the long term. A municipality could always stand to cut costs regardless of whether they have a balanced budget or they are in debt. This is a very appealing aspect of the system to as it calls to the very basic instincts of the leaders within the municipality. Money that is saved can then be reallocated to other areas that may need it more.

4) A City Knowledge system can be used as an analytical tool. As the system grows, and the amount of data stored in the system become very elaborate, datasets can be layered together resulting in the possible illustration of trends. In some cases these trends would not have been noticed without the use of such a system due to the difficulty in aggregating the various datasets. When trends appear they present themselves as plan-demanding knowledge. This puts a very powerful tool in the hands of policy makers that will aid them in informed decision making.

While the investment in such a system can be steep at some stages, it is important to remember in the end there is a high benefit to cost ratio. There are

programs such as City Lab that are intended to help cities get a City Knowledge system started. In the long-term CK will save money and time for the Borough as well as add the potential for community enriching projects which have been formulated in conjunction with CK.

Safety in Merton: A Real Life Example

The Housing and Social Services department is committed to providing affordable housing to those members of society who seek it out. With each rental agreement that is signed the department makes a commitment to tenants that their property will be maintained to a certain minimum standard. In this section we will give a brief description of the HSS department's current concerns, overview what a CK system would entail for their purposes, and give some hypothetical situations demonstrating CK's effectiveness in addressing real world problems.

The HSS department has many responsibilities, mainly to keep its residents safe while providing affordable housing. There are many aspects that play into safety, one of which is making sure that physical entities on the Borough owned properties do not pose any safety threats. This means that property must be maintained and looked after to ensure that nothing is wrong with it. In keeping with the department's dedication to its resident's safety, they want to make sure that the grounds that they own and manage are safe places to live.

Accidents that may occur as a result of failing to meet the prescribed standards leave the department open to substantial financial losses that may be sustained in any ensuing litigation. Money is very tight in the HSS department and so any means of reducing cost is of great interest to it. It needs an effective way to manage and access data so that it can more efficiently conduct repairs. This will help to keep residents safe as well as maintain a small financial overhead for the Borough.

Our team was called in to develop a system by which maintenance can be regulated. Having already noticed the Borough's blossoming GIS system we decided that we did not need to focus simply on mapping data but rather to show the department, and indeed the Borough, a better way to manage and use this data.

Merton is making large strides forward in the proliferation of GIS-based technologies but will soon need effective means of sifting through and accessing information.

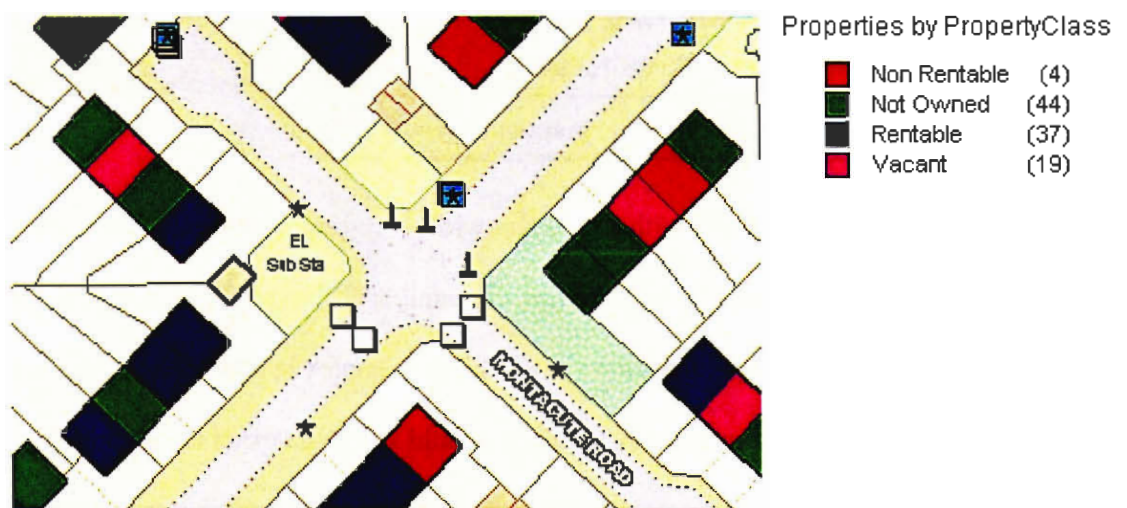
We propose using City Knowledge as a means of making the Borough a safer place to live. By combining data gathered from the various departments in Merton, new plan-demanding data will be generated. Recall that plan-demanding data are data formed by layering different sorts of information on top of one another like transparencies on an overhead projector. The bigger picture that is sometimes seen when all the information is layered is plan-demanding data. There may be underlying problems in Merton that would only become apparent after using a technique such as this. The fact of the matter is that Merton has already gathered a lot of data but has not shared it or in some cases mentioned that it existed in the first place. It is through information sharing and strong communications that the larger issues facing the Borough will begin to peel away.

A CK system will make crime statistics from local community safety organizations readily available. A department such as HSS could then access the CK system's crime data and compare it against lighting fixtures on its properties, noticing that crime is more evident in the rat runs that are poorly or entirely unlit. In the same token, the HSS department could contribute its data on housing ownership to the CK knowledgebase where the criminal analysts could make use of it. The following three examples illustrate how a City Knowledge system can be used in Merton.

Questionable Ownership: Identifying Housing Types on Council Estates

An employee of the HSS department wishes to examine the St. Hellier estate to append the general maintenance contracts. She requires information regarding

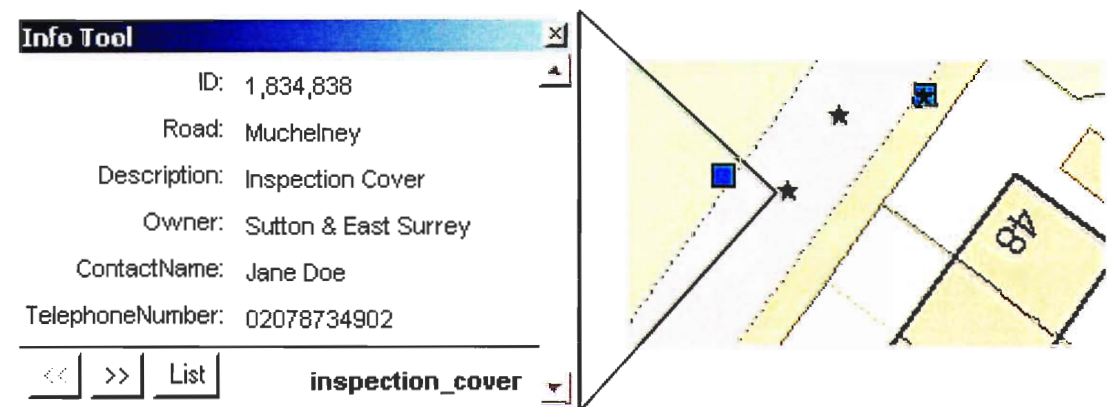
which homes are the responsibility of the HSS department so that the appropriate values and dates can be entered into this contract. Rather than attempting to find some obscure spreadsheet with the information, she logs into her computer and accesses the Merton City Knowledge system and searches for rental housing ownership. She is then presented with the information in a text based format as well as an easy to read, colour-coded map highlighting rented homes, homes purchased under the Right-to-Buy act, and private homes. This combined with details regarding land use on the target properties will allow for very accurate calculations of the maintenance contracts. Routine maintenance can now commence with the added benefits of increased public safety and reduced cost in contract estimates. This new accuracy in contracting will ensure that all repairs and maintenance will be done on time. This greatly reduces the chance of being injured from damaged features.



The Inspection Cover: A Current View and a City Knowledge View

There is an inspection cover in the middle of the street. The cover has become dislodged creating a hazard for children playing in the area. A member of the public works crew notes this and reports it. The problem has been reported and the repair process has begun. The first barrier to a problem resolution that would be encountered

would be the question of ownership. It most likely belongs to a utility company, but which one? This is a critical piece of information to have, so that that particular company can be called to deal with the issue. As it stands now the Borough may send someone out to inspect it. Once inspected the department would have to contact the utility company that owns it. This is a potentially tedious process that drains the resources of Merton Council. Once the utility company arrives to repair the problem it is out of the boroughs hands, however, the process by which the work order was generated was a lot longer than necessary.

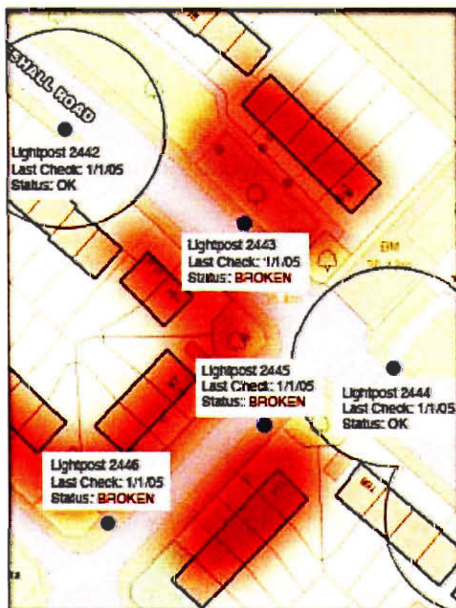


We propose that with a City Knowledge system in place the information would be at the employee's fingertips. By using a GIS mapping tool with a quick, user-friendly database, that same public work's employee could quickly reference the inspection cover. Immediately he or she would know the exact location of the cover on the map, the utility company that owns it, the contact information for the utility company, and any history of problems with that cover. The contacts can be made and the problem is solved. We've now reduced the time in diagnosing and resolving the problem and have thus saved the borough money.

Law and Order: Crime Statistics and the City Knowledge System

A criminal analyst working for the Regeneration department has noted increased incidences of crime on one of the Council's estates. Apparently there are three small alleyways in which a number of assaults have occurred within the last four weeks. Concerned by this discovery, the analyst logs into his Merton City Knowledge system to see if there are other factors which may be contributing to the problem. When he overlays his crime statistics with data made available on lighting from the housing department he makes a new finding. The very same areas where the crimes have been committed are very poorly lit and it looks as though this criminal has taken advantage of it.

The analyst uses the contact info made available to him by the City



Knowledge system and contacts the housing department. They agree that this is a serious issue and immediately put out a new contract to install additional lighting in that area as well security gates. Weeks later the analyst notices that incidences of crime in those three alleyways have dropped to zero. City Knowledge has been used to uphold public safety as well as shield the department from

future lawsuits.

Future of City Knowledge

As we progress further into the 21st century and advanced computer technologies are increasingly integrated into daily life, City Knowledge can play an even larger role in city management. Customizable web interfaces allow employees and residents to expedite routine paperwork and processes. Residents will be able to submit comments and complaints via the World Wide Web. These forms can then be directly routed to the appropriate department. The department can then use its own web interface to access the City Knowledge database and reference the appropriate material. This means that now not only can the employees working with and updating the system but the citizens themselves. Each complaint a citizen submits becomes a part of that vast CK information warehouse. By incorporating citizens into city planning and management the departments will be truly diversified. The ultimate responsibility of the municipality is to its constituency. Knowing what the public wants and involving them in public decisions as well as keeping them informed of events in the Borough will only enhance community relations.

Expansive databases will store everything from building permits to ozone measurements. Regular maintenance and update cycles will ensure that the Borough has the most current, high resolution information enabling decision makers to choose the right courses of action. The skyrocketing increase in information flow will nearly eliminate calling around from department to department in search of data. This means the Borough will have more money to spend on meaningful projects.

There are almost no limits to what a City Knowledge system can do with information. In the end, the Borough will only get out of it what it puts in. The system would be nothing without the people, the real end users, to create and foster its growth. Like any successful garden it takes time, effort, and a little bit of patience, but

the fruits of your labour will be well worth any headaches. With the information age coming into full effect it is important that communities change with the times lest they run the risk of being left behind. City Knowledge is the future of the information age, today. The ground floor is available and there is no limit on how high the community can build.

For Further Information

The primary source of information on City Knowledge is Professor Fabio Carrera's doctoral dissertation *City Knowledge*. This document can be found at his website located at <http://users.wpi.edu/~carrera/>. It consists of a thorough discussion of what City Knowledge is and the governing principals behind it. The paper is filled with examples from the projects that he has conducted. Also available is the extended bibliography along with the original presentation.

The website also contains links to detailed information on the various projects he has advised in conjunction with the WPI project centres in the both the United States and abroad. Since 1997, WPI students, under the guidance of Fabio Carrera conduct projects yearly. Original paper copies of these projects are also on reserve in the WPI Gordon Library.

City Lab is a tool that is used to assist cities in the development of their technological advances in the urban setting. It focuses on areas such as City Knowledge, Urban Studies and Initiatives. More information on this program can be found at the website listed above.

Professor Carrea has also be featured on a National Geographic special *Out There: City Under Siege*. This documentary explores some of the work that has been completed in Venice.

A useful source for information on GIS is <http://www.gis.com>. This site concentrates more with the mapping of data than the centralized database of City Knowledge. The website offers information about GIS software and training on how to use it. There are also additional resources with sample images and data to help

explore the power of GIS and practice key techniques utilizing the tools such as MapInfo.

Merton City Know



QUESTIONS?

WHAT IS CK?

More than an idea. City Knowledge provides a way to link departments together with a single common repository of information.

WHAT KIND OF DATA ARE WE TALKING ABOUT?

Trees, houses, crime rates, roads, telephone poles... stray dogs and cats? You name it. The City Knowledge concept is designed to be a one stop shop to store every bit of location and trend specific data in each department.

WHY IS SHARING GOOD?

Sharing promotes interdepartmental communication and team work to develop a whole that is greater than the sum of its parts.

HOW CAN IT BE DONE?

By supporting a single knowledge-base and bringing together all existing data, City Knowledge can make its way off the paper and into the community.

What is City Knowledge?

Moving from the hunter-gatherer approach to the farmer style of acquiring and using information.

City Knowledge is a revolution in the way we think of urban management and planning. It enables municipal departments to access data from a range of sources and layer it with their own to see patterns and relationships in the information. Simplicity is the key to the solution. Without City Knowledge (CK), everyone must sort through piles of paper and online documents. With a central system in place, that information becomes searchable and accessible.

The system's aim is to create a huge data repository that is easily expandable and highly adaptable. Departments contribute to a City Knowledge system that can be used throughout municipal government. The strength of City Knowledge comes into play when one considers its widespread reach and power. The information is already in the repository and can be readily recalled saving both time and money.

For example, a department may collect data for its own use and store the collected data in the repository. Then another department may need similar information. Having the data shared, the second department can easily access the information already available, thereby saving resources in two ways:

- ◆ First CK reduces redundancy of data collection. Instead of going out and collecting data every time it is needed, the data can be found in the centralized location.
- ◆ Second, this system saves time.

Instead of spending a day on the phone being transferred from department to department looking for data, one can easily access City Knowledge through a user interface

such as MapInfo or the web and find the needed information.

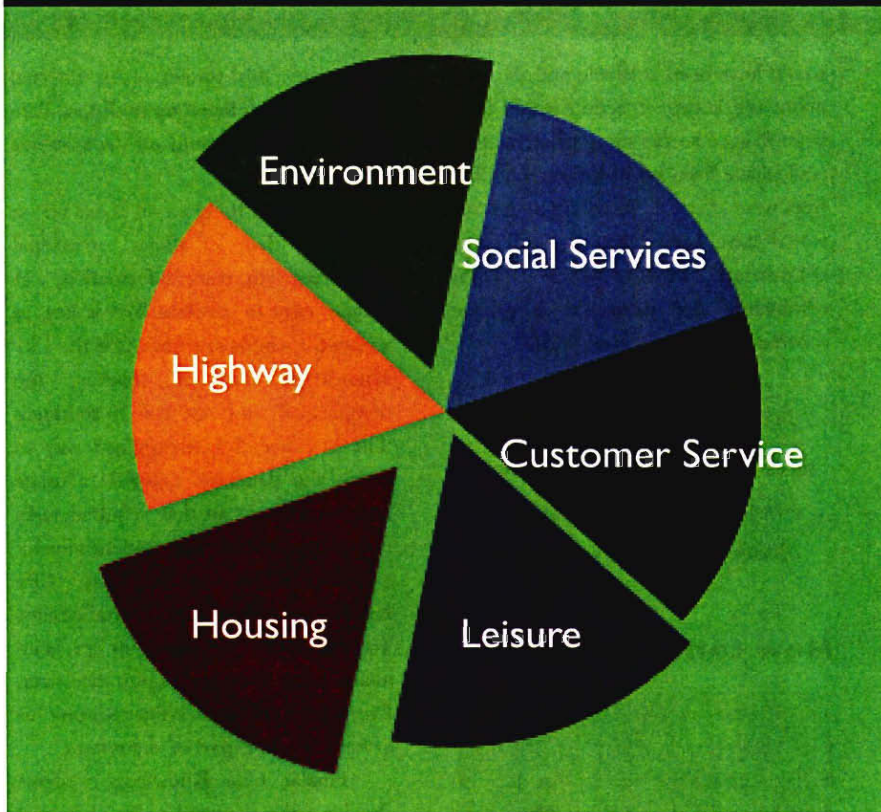
City Knowledge is made possible by such modern advances in technology as powerful databases and mapping software. Reduced cost, increased availability, and increasing quality of these technologies are making City Knowledge a very attainable reality.

In Ontario, CA (USA), GIS found \$190,000 of unpaid business license fees in just one year.

What kind of data are we talking about?

For the system to work as efficiently as possible, all available data needs to get stored in the system. This base layer consists of things in the physical environment such as roads, trees, and houses. On top of the base layer can be overlaid further data such as property ownership information or municipal activities.

Layers can be set in such a way that a specific department controls them, while making them available for other departments to see and analyze. Property data may consist of textual information such as addresses but the system can support other data types as well. The Highway Department may want to add bus and trash collector routes in the form of lines or paths. Geographic Information Systems (GIS) can support many types of information and cross-reference them to enable analysis or reports for maintenance work orders or Best Value assessments.



SHARING DATA THE KEY TO CITY KNOWLEDGE

The City Knowledge solution relies on the sharing of data. Each department commits its own part and is responsible for it. As the individual parts come together, a larger, more complete database will emerge. Every user of the database will be able to find information and generate reports (given security clearance) that would have previously taken days or even weeks to come up with. It all starts by sharing the knowledge.

-WPI City Knowledge Team

Why is sharing good?

The whole is greater than the sum of its parts.

The benefits of sharing information are evident when the Housing Department shares crime rate data with a criminal analyst to determine what types of houses are more likely to be broken into. In Merton, analysis such as this can give neighborhood wardens critical information on high crime locations and allow them to coordinate patrols more efficiently.

By using GIS to analyze the location of break-ins, the Regeneration Department in Merton determined that many houses were being entered from the rear. When the department installed locked gates at the end of the alleys and gave residents keys, crime in those areas fell by 90%! With a centralized database, Regeneration and other departments would be able to make many other analyses like this one. Neither the Housing nor the Regeneration Department can create such a relation like this on its own without a central database. By using City Knowledge, it becomes easy to cross reference databases because they are all centrally located.

Unexpected benefits also tend to arise by implementing City Knowledge. These unforeseen benefits can save departments a great amount of money by bringing to light inefficiencies in the current system. In Cincinnati, Ohio, after a central database was installed, the Metropolitan Sewer District discovered that many individuals were not being billed for their sewer connections. The district then used the information system to find the estates and bill them. This example shows how information can become available when departmental data is linked and cross-referenced. By creating a database of what were formerly disconnected pieces of information, you can turn this information into hard, searchable data.

Paperwork is incredibly time consuming. With City Knowledge, paperwork is greatly reduced because all data on paper gets entered into the system. Once it is part of the database, it becomes knowledge that can be searched and analyzed.

When a developer submits a planning application, any department can look at its layer of the database and compare it with other layers to gain more information about the built

environment. This can speed up the process of determining if the build can or cannot take place.

Having information accessible reduces the time needed to find it by employees. By spending fewer employee-hours on searching for crucial data, departments can save money. Moreover, the data that helped save department resources may have been previously hidden because it was not cost effective to try to find the information.

Another benefit of data sharing is the efficiency gained in searching for information. If an employee needs to find who is responsible for the maintenance of a particular grassy verge, the answer may not be readily available. Any amount of time can be wasted tracking down who is responsible for the verge as the employee could be transferred through the phone system while hunting for this information. If information sharing and City Knowledge were in place, there would be only one location to search, adding to the ease of finding answers. This in turn would speed up the maintenance process.

Service with Sharing

Sharing has added benefits in customer relations as well. Having data in an easy to access location can speed up turn around time for customer problems. Better service delivery times can lead to more satisfied residents and increased approval for the borough.

For example, if a resident requests that a tree in front of his house be pruned to provide more sunlight, this request might involve lots of paperwork. The claim may need to be addressed to the Highway Department because it is on a street, or it may be Leisure because it is next to a park. After that information is sorted out, there would need to be a check on the tree to see if it is endangered. If the request were approved, a contractor would be hired specifically for the job. In Cambridge, Massachusetts, some trees were found infected with a parasite. A lack of coordinating management led to the pruning crews infecting other trees. This in turn created the need for all of the trees on the street to be treated. If City Knowledge were in place, the claim would be sent to the right department initially with just a click. All known information about the tree

would have been available and the facts about the known infection would have been flagged so the appropriate actions could have been taken before the other trees were affected. In addition, the tree would have been taken care of on a scheduled maintenance cycle, eliminating the need for a private contractor to make a costly visit.

Philadelphia, PA (USA) now saves over \$1 million in employee overtime each year by using GIS to optimize garbage truck routes.

How can it be done?

Merton already has the base of City Knowledge in place. Each department already has its own part of the solution. The only thing left to do is centralize the knowledge.

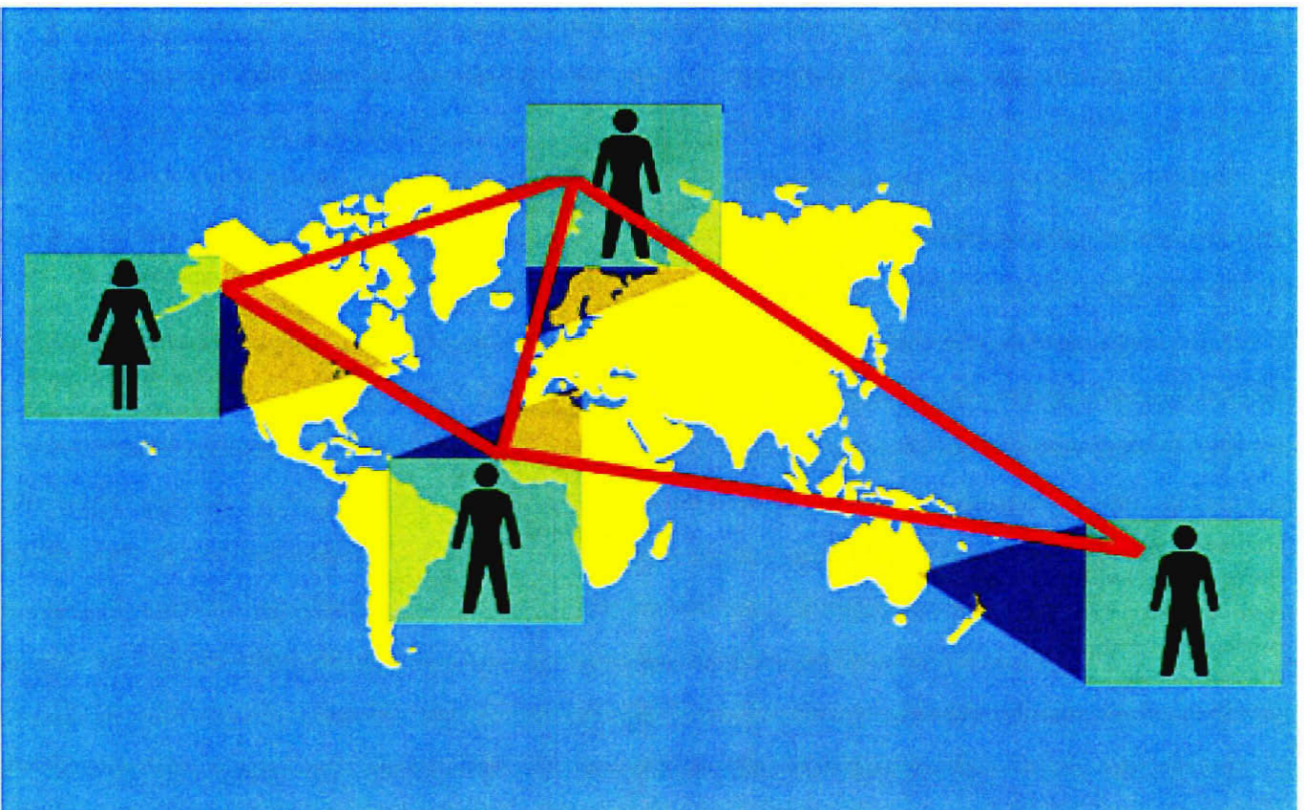
Merton has invested substantial resources to develop the current Geographic Information Systems. Expanding into City Knowledge would maximize the investment by utilizing what has already been put into

developing this system. An internal repository must be set up to deposit data that is accessible from all departments within Merton

The next thing to do is set up an interface that allows municipal employees to enter information. A simple, easy to use interface is key, as without it, employees may find the City Knowledge way of thinking too complicated and not use it routinely. The interface is a streamlined way to access the database, tailored to usage and department so that required tasks may be performed easily and intuitively.

Crucial to making the City Knowledge system work is sustainability. To maintain the most up to date analysis, one must keep up to date data. Everyone is responsible for updating his or her own small part of the system

Finally, City Knowledge systems also have the potential to be upgraded so that residents and business owners can log in on their own through a special interface to get limited access to request information or report problems with things like telephone poles, drain covers, or any other responsibility of the borough.





Cost - Benefit

Cost benefit is an analysis that shows how much is gained from a system in comparison to how much is put in. GIS is a large investment on any level. It takes significant time and resources to install a mapping system and gather data to populate it. The benefits of such a system, however, are numerous.

Costs of the System

Merton has already paid the cost of a GIS system. There is a GIS in place and a single department is maintaining it. Such a large system has a great price tag associated with it. Most of the cost was spent in two areas.

- ♦ The first was purchasing the software and hardware required to run GIS.
- ♦ The second was the gathering of the base map data.

The base map data is the lowest layer of data consisting of roads, buildings and other objects that are not likely to change. There are computers in several key departments that already have the needed software loaded. The base map data is also available internally.

The investment has been paid to develop a technologically advanced system and now it needs to be integrated with the rest of Merton. It would make sense to finish the system by centralizing the database and opening it up for access by other departments. The costs of the system yet to be paid are interfaces for specific departments, the organization of the current data, and the collection of additional data.

The state government of Victoria conducted a GIS study in 1991 and found a cost-benefit ratio of 1:5.5 (benefits of \$312 million after an investment of \$56 million) over just six years!

Direct Benefits

Direct benefits are foreseen and immediate benefits that can be produced from the earliest stages of the system. City Knowledge solution provides a workspace to develop solid, guaranteed benefits.

- ♦ Tasks have greater automation.
- ♦ Resources are saved because redundancy in data collection is removed.
- ♦ Data is more secure with fewer weak links.
- ♦ Less time spent researching lawsuits because there is more solid evidence.
- ♦ Reports can be generated for numerous occasions including Best Value assessments.

The reports that are derived from a centralized GIS can be very dynamic and provide concrete data for projects or reports.

Unforeseen Benefits

Unforeseen benefits are the results of the system that were not predicted or accounted for in advance. If, for example, the Highway Department utilized the system to help it identify road hazards and create maintenance schedules, it could bring to light analysis that shows commuters avoid traffic on major roads by using certain back roads. The department could then formulate a solution to deal with the problem of unexpected and extended wear and tear on these smaller roads.

Something that is not expected can quite often be the greatest benefit of the system. This is because the problem may not have been considered an issue previously and therefore not explored. Such indirect and unexpected benefits can save Merton significant time and resources.

THE FUTURE OF WORKFLOW

**PLAN DEMANDED
Hunter Gatherer**

Information is researched and gathered when it is deemed needed on demand.

PLAN READY

Information is already researched and ready to go. When information is needed, it is available.

**PLAN DEMANDING
Farmer Approach**

The data shows what actions need to be taken. See new patterns emerge and take preemptive action based on the trends. This is the most efficient way to operate.

WPI CITY KNOWLEDGE TEAM - MERTON 2005

**David Casavant
Mike Guay
Kevin Moore
Joshua Morin**

Produced by the WPI City Knowledge team for the Merton Council.

City Knowledge

City Knowledge Team

WPI Project Center :: Merton 2005

David Casavant • Mike Guay • Kevin Moore • Joshua Morin



What is City Knowledge?

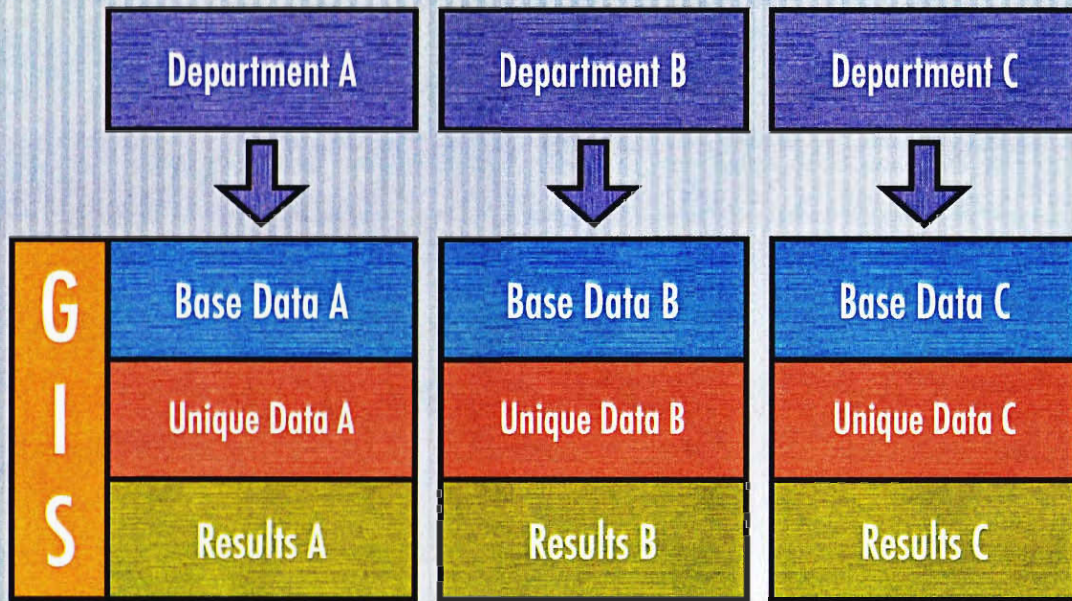
— [**City Knowledge (CK) is a common repository of information.**

— **Allows for easier accessibility.**

— [**A method to reduce redundancy of data collection.**

— [**City planning and management.**

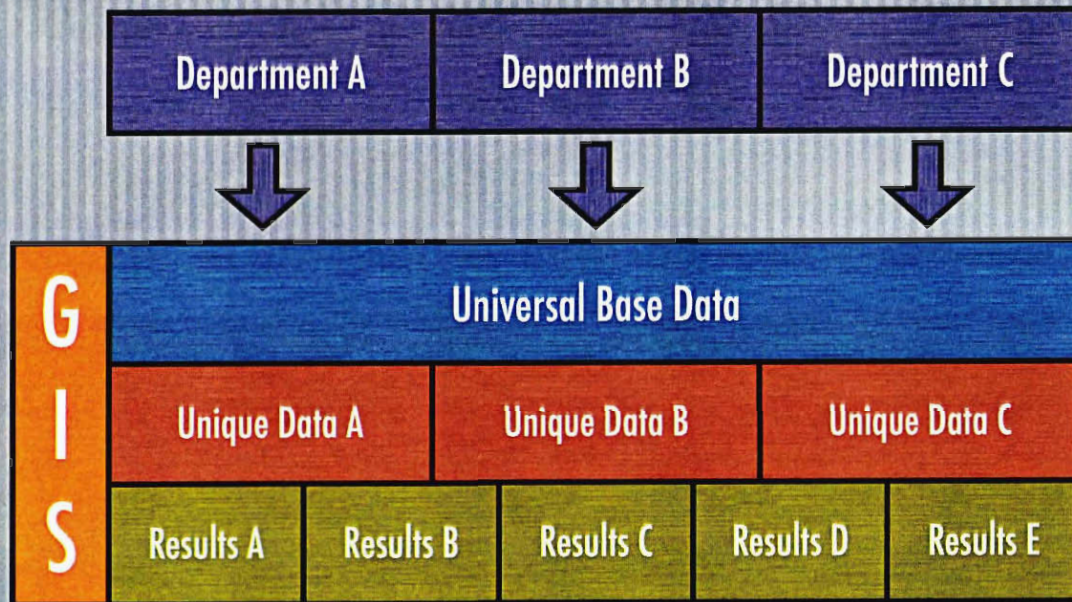
Using CK to Share Data



- [Sustainability problems.
- [Standalone results.
- [No accessibility across systems.
- [Underutilized resources.

3 Departments
3 Systems

Using CK to Share Data



**3 Departments
1 System**

— [Each update to the Base Data only needs to be done once.

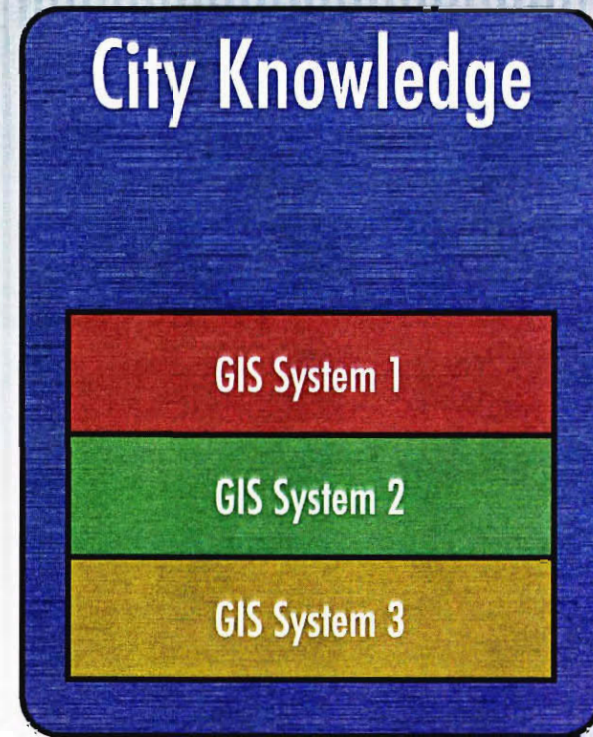
— [More results by cross referencing departmental data.

— [The whole is greater than the sum of it's parts.

How does GIS fit into CK?

— [GIS is a way to map an area comprising of physical objects and relational data.

— [City knowledge is the greater centralization of a GIS foundation.



An example of CK: Venice

— [Before City Knowledge:

- Inefficient boat routes caused the same trip to be made several times.
- Harmful for the environment.

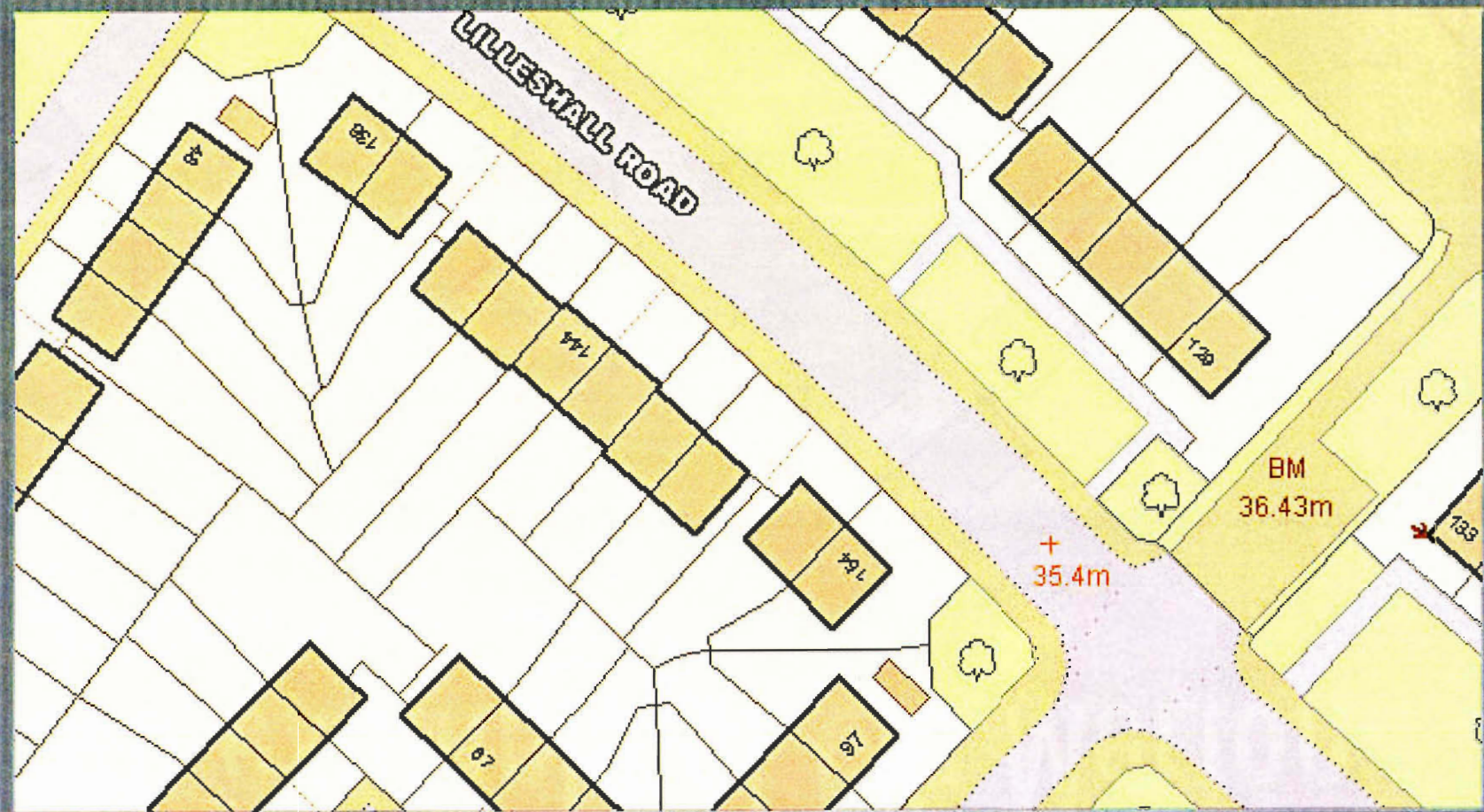
— [After City Knowledge:

- Realization of problems.
- Items sorted by destination.
- Boat traffic reduced 90%.

Planned Knowledge.

- [**Plan Demanded.**
- [**Plan Ready.**
- [**Plan Demanding.**

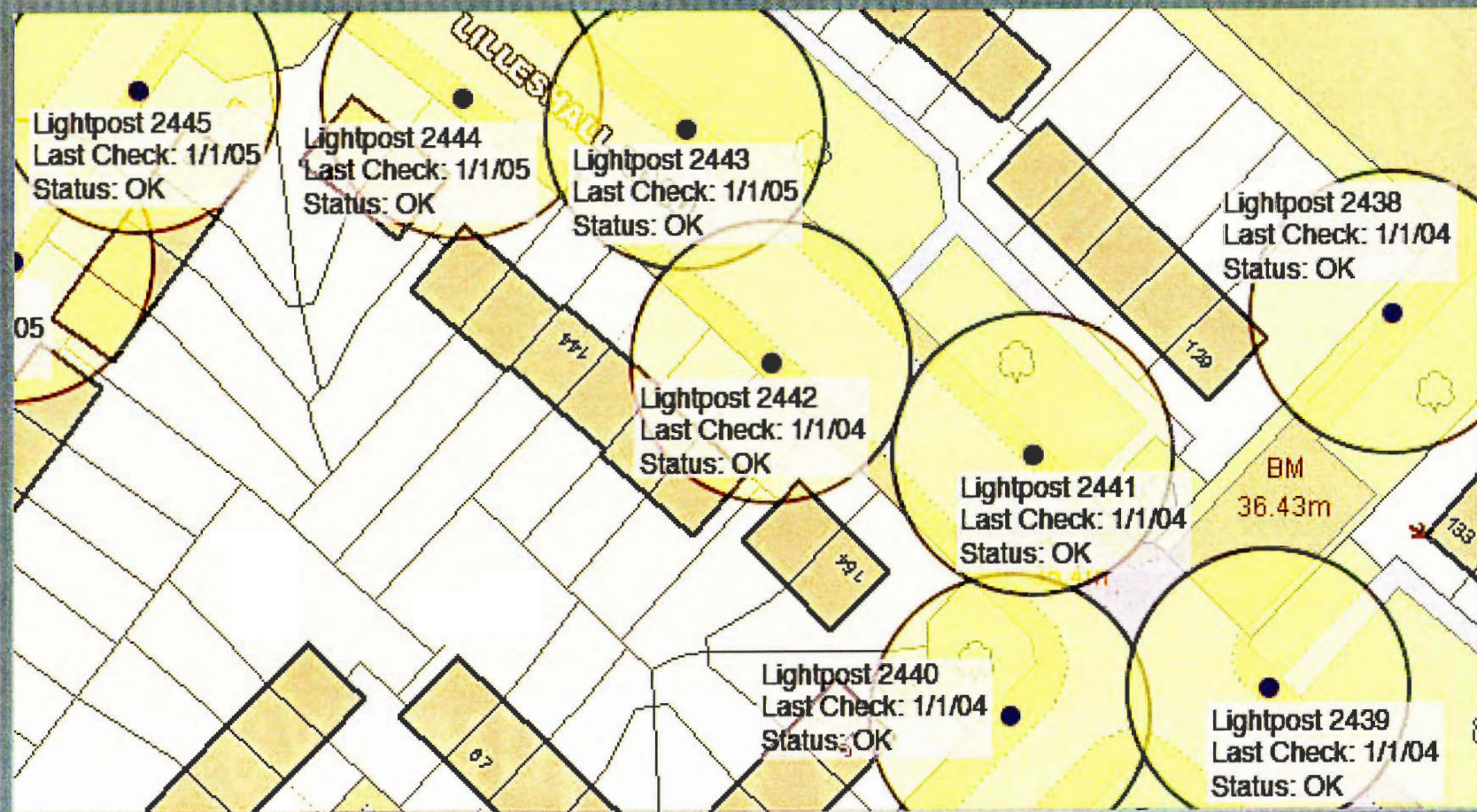
An example of CK: Merton



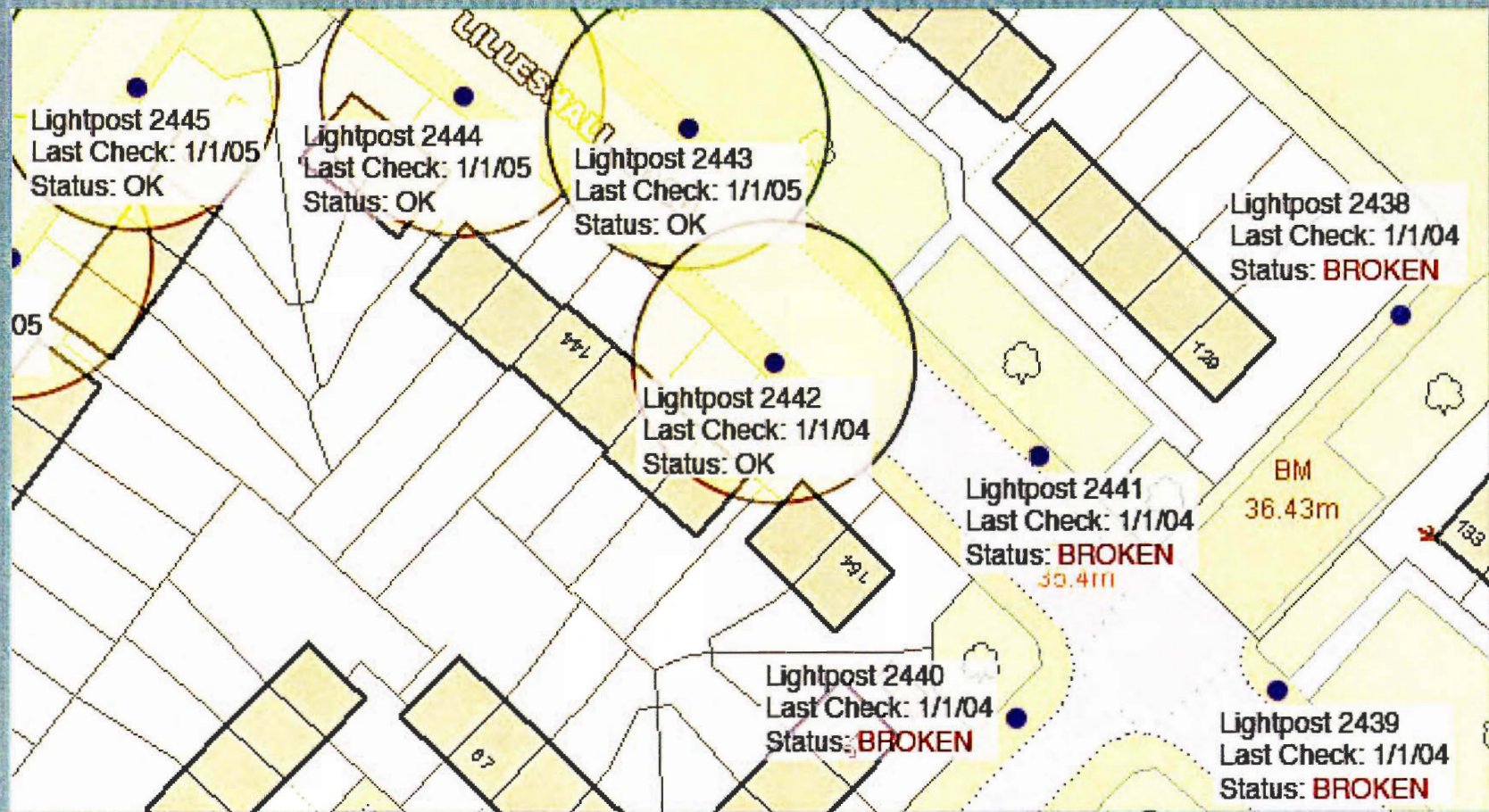
An example of CK: Merton



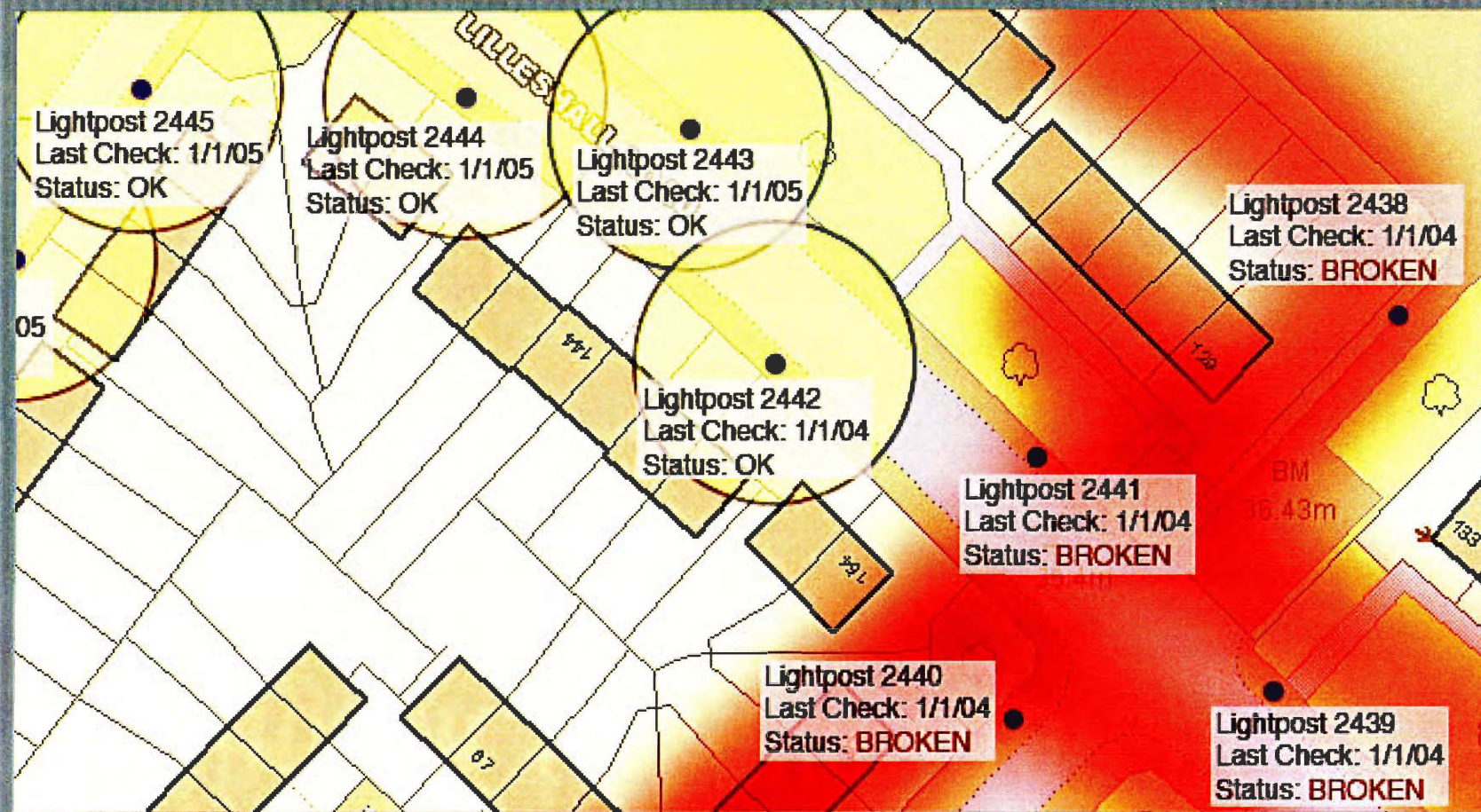
An example of CK: Merton



An example of CK: Merton



An example of CK: Merton



Using CK to save money

— [Save work hours finding information and researching solutions.

— [Many tasks are automated.

— [Audit information to prevent problems later.

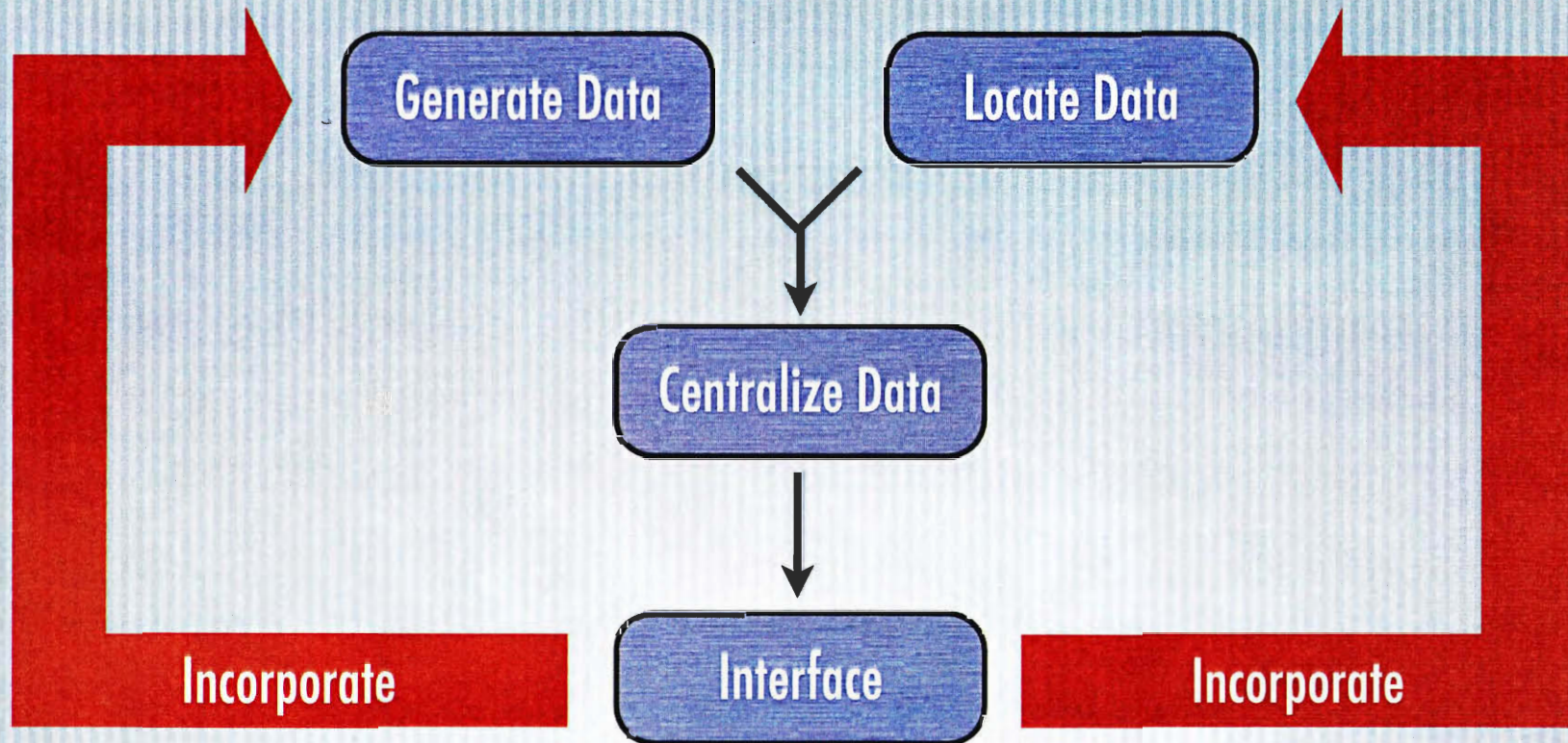
— [Organize resources.

— [Best Value Assessment Reports.

Using CK to save money

- [The State Government of Victoria conducted a GIS study in 1991.
- [Redlands, California used a GIS to analyze crime data.
- [Los Angeles, California.

How to Implement CK



Further Information

— [Fabio Carrera.

— <http://users.wpi.edu/~carrera>

— [City Knowledge report by the CK Team.

— Available upon request to gis05@wpi.edu