NEW YORK CITY DEPARTMENT OF TRANSPORTATION

Traffic Information Management System (TIMS)

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ABSTRACT

The New York City Department of Transportation (NYCDOT) routinely collects high volumes of traffic data, serving diverse project and analytical needs. To standardize the methodology of identifying, requesting, collecting, validating and analyzing this data, NYCDOT developed the Traffic Information Management System (TIMS).

The initial version of TIMS was designed as an interactive, map-based web application to provide a simplified workflow for both NYCDOT and non-NYCDOT users to query, display and download point data such as Automatic Traffic Recorder (ATRs), Vehicle Classification, Turning Movement, Bicycle, Pedestrian and Spot Speed counts. The TIMS suite also provides a defined procedure to authorized users to request, collect and validate traffic counts, financial officers to ensure funding availability as well as a simplified method of responding to Freedom of Information Law (FOIL) requests. NYCDOT successfully launched the initial version of TIMS in April 2012.

Phase II of TIMS is currently extending the existing application by:

- Enhancing the application based on user feedback;
- Allowing the application to accessed from both desktop and mobile devices;
- Streamlining the traffic count request workflow;
- Adding new traffic count types; (corridor and link speeds)
- Development of Protocols for Accessing other datasets; and,
- Implementing new advanced functionalities to enhance the users experience.

TIMS has provided NYCDOT with an advanced application for managing and maintaining all traffic count data used by the department within a secure hosted environment.
INTRODUCTION

The New York City Department of Transportation (NYCDOT) routinely collects high volumes of traffic data: Automatic Traffic Recorders (ATR); Bicycle (Segment and Intersection); Pedestrian (Segment and Intersection); Turning Movement; Vehicle Classification; and, Spot Speeds. This traffic count data serves many diverse project and analytical needs, as well as allowing NYCDOT to meet Freedom of Information Law (FOIL) requests.

Historically, this data was collected by many divisions within NYCDOT on an “as-needed” basis for a particular project or study, either by internal staff or consultants. This caused the data to be collected in inconsistent formats making post-processing and comparisons difficult. Data was also stored in numerous locations across the NYCDOT, both electronically and on paper, making it difficult and time-consuming for staff to identify available count data for use on future projects and studies, with the inevitable duplication of data collection efforts and increased costs.

To eliminate these inefficiencies, NYCDOT proposed developing a secure application that would implement a standardized methodology for requesting, approving and collecting traffic data based on extensive research with users. This strategy is improving data accuracy while reducing the time from data collection to data analysis; eliminated the collection of duplicate data; automatically calculates standard sets of statistics for the collected data; helps reduce time consuming searches for traffic data; and simplifies responding to FOIL requests. All while cataloging the data within a centralized data warehouse that could be accessed by staff across NYCDOT.

This application, the Traffic Information Management System (TIMS), was developed by NYCDOT with support from STV, Inc. and Cambridge Systematics, Inc. (CS) as an interactive, map-based web application to provide a simplified workflow for both NYCDOT and non-NYCDOT users to query, display and download traffic data within the data warehouse.

DESIGN AND DEVELOPMENT APPROACH

As with any application development that will cause changes across a large agency, it is vital that the users become a part of the development effort. The final application must address their needs, through streamlining existing workflows and simplifying basic tasks to allow them to concentrate on high-value functions. For TIMS, this was achieved through the use of extensive requirement gathering combined was an agile development methodology that focused on iterative development, a user-centered design, and application usability. It was strongly felt that adopting the perspective of the users would create a system that they would see as beneficial from a data and time perspective.

Detailed Requirements Gathering

To correctly design the TIMS application, the project team needed a thorough understanding of traffic engineering, existing business processes, workflows, problems, bottlenecks and limitations. While a basic understanding of the traffic count workflow could be obtained by a review of existing documents, it did not allow of a complete understanding of the intricate details. For example, at a high level, a traffic count request goes through four stages:
In reality each of these stages, the request workflow is sub-divided into a number of smaller processes:- a traffic count is initiated and refined; quotes are obtained from contractors; collection schedules are adjusted; data is parsed for validity and adjusted for purpose. Thus, the basic workflow is quickly broken down into finer levels of detail:

While some of this detail is included in the published documentation, a lot is not, with the workflows sub-processes being developed over potentially many years by the users (i.e., the domain experts).

To gather this fine level of detail, the project team conducted a number of requirements gathering meetings with all of the stakeholders in the project:- executives; end users; domain experts; contractors; sister agencies and support staff. All of the meetings were documented, individual requirements determined, follow-up meetings held to resolve conflicting requirements, and finally a concise Requirements Report developed that described what functionality would be included in the application, and any technical, functional and non-functional restrictions on the application.

**Agile Development Methodology**

The Requirements Report describes the required functionality. It does not, and should not, detail how the functionality should be implemented. Based on industry best practices and the development teams prior experience, it was decided that TIMS would be developed using an agile methodology based on the core principles of incremental and iterative development, user-centered design and usability. This approach:

- Decomposed the project into smaller, more manageable pieces.
- Made progress transparent, easily measurable, and more predictable.
Exposed risk (technological, architectural, and organizational) early, when there is more time to address it.

Enforced continuous testing, resulting in a higher quality application with fewer defects.

Enabled NYCDOT staff to see and test functionality early and on a regular basis throughout the development process, providing continuous validation that the application met the functional requirements.

Encouraged in a consistent and high level of communication among the project team, and the stakeholders.

The core principles are described below.

**Incremental and iterative development** (IID) means that the lifecycle of the project is subdivided into a series of iterations, each of which adds new features and functions as the system evolves and expands. Each iteration combines activities such as requirements analysis, design, programming, and testing, and serves as an opportunity for the project team to re-examine and re-direct the work to ensure that the goals of the project (including staying on schedule and on budget) are achieved. With each iteration a more stable, integrated, and validated product is developed. Larman illustrates this approach in the diagram below.

![Project Lifecycle Diagram](image)

**Figure 3 - Incremental and Iterative Development Project Lifecycle**

After the release of each TIMS Iteration, users were provided the opportunity to use the implemented functionality to provide feedback and suggestions on how to improve the application, resulting in an application that better meets their needs.

**User-centered design** is a philosophy in which the needs, wants, and capabilities of the end user of the software product are given extensive attention through the software design and development process. User-centered design tries to structure the information architecture and user interface of an application so that the application is tailored to the way that end-users want to do their jobs, rather than forcing users to work according to the way the application is organized.
Usability requires ongoing and active customer engagement. In the early stages of the project, usability was achieved through the use of screen mockups, or wireframes, that enabled users to respond to concrete user interface and information design choices.

In the development stage, end users were engaged in refining requirements, viewing product demonstrations, and participating in hands-on testing at each and every iteration. The feedback and direction from the users as each incremental functionality that was delivered was critical to the success of the project, with changes to functionality and workflows identified by the users improving the overall usability of the application.

APPLICATION

The application was developed over the course of approximately 18 months and 10 iterations, starting with the basic application framework and database design, moving through the implementation of functionality related to each of the traffic count data types, and finally integration with NYCDOT infrastructure.

Technology

To develop an application that is responsive and user-friendly that could be deployed within NYCDOT’s network, a Microsoft and Adobe solution was chosen. Specifically:

- Microsoft Windows Server 2008 Application server running Internet Information Services to host the web application and the server components.
Microsoft SQL Server 2008 R2 in which all of the data was stored, including spatial data using the Open Geospatial Consortium (OGC) standard.

Adobe Flex 4 with ActionScript to implement the client application allowing for a rich internet application (RIA) with intrinsic cross-browser compatibility.

**User Interface**

To simplify the display and filtering of data, the application was implemented with a GIS map-based user interface that used a standardized method for data display, filtering and

*Map.* The contents of the maps were generated by overlaying basemaps layers maintained by NYCDOT and third-parties, OGC-compatible map services hosted by NYCDOT and traffic data displays dynamically rendered from the database. This resulted in a seamless merging of the map data from the multiple sources where the user is unaware, rightly so, of the data origin.

*Data Filtering.* Traffic data can be filtered based on spatial location and attribute values to quickly identify relevant counts, which are then displayed on the map and tabular form.

Users can drill-down into the data displayed on the map and table to view individual traffic count requests and count locations.

*User Authentication.* To restrict access to areas with sensitive data and to implement the detailed workflows, roles-based user authentication was implemented allowing the functionality within
the application to be automatically customized based on the user login. Additionally, through the use of individual user accounts, messages, or notifications, are automatically sent within the application to user notifying of pending items (e.g., requests to QA staff to approve a submitted request).

**Count Request Workflow.** The application implements the detailed traffic count request workflow defined in the requirements, walking the users through the required steps. During the process, the users receive notifications whenever the status of the request changes to keep them appraised of progress.

![Figure 6 - TIMS Traffic Count Request Dialog](image)

**Data Handling.** Whenever raw count data is uploaded into the application, to comply with FOIL, an exact copy of the Microsoft Excel file is stored within the database. This file is then parsed to allow it to be associated with the original request based on type, dates and location.
Data Review and Analysis. Prior to TIMS, the review and analysis was a manual, labor-intensive process. Now TIMS automatically calculates a number of traffic engineering statistics including AM, MD and PM peak hours, and aggregates data into 15 minute and 1 hour time intervals. Together with the ability chart the data over a user-defined time interval, users can quickly and efficiently review any count data, making edits as necessary.

Freedom of Information Law (FOIL). Members of the general public can make a FOIL request to NYCDOT to obtain copies of the original raw count data. Prior to TIMS, this was a time-consuming effort as individual counts that meet the request had to be researched and identified. Now authorized TIMS users can quickly filter the counts based on location and attributes and package the count files together to be sent to the requestor. TIMS tags each count with the FOIL request identifier so data usage can be tracked.

ROLLOUT

After completion of the development and extensive testing, the application was launched in the spring of 2012, with coordinated kick-off presentation and user training. Initially the database was populated with 3 years of historical traffic count data (approximately 6,000 counts), and the user base consisted of 95 authorized users (70 internal NYCDOT, 5 other NYC agencies, and 20 consultants).

As an indication of the success and usage of the application, as of October 2013, the database had expanded to over 16,400 individual counts (7,866 ATR, 1,435 Bicycle, 1,710 Pedestrian,
3,062 Spot Speeds, 2,111 Turning Movements, and 307 24-Hour Vehicle Classifications), while the user base had grown to include 359 authorized users (222 internal NYCDOT, 44 other NYC agencies and 93 consultants).

**ENHANCEMENTS**

Based on user reaction, comments and feedback to the existing application, NYCDOT has embarked on Phase II of the project that will:

- Address user comments generated during the use of the Phase I implementation.
  - Allow more accurate count locations on segments.
  - Add count locations to existing traffic count requests.
  - Relocate existing count locations.
  - Group multiple traffic count requests of different types into a single super-request.

- Improve traffic count request functionality:
  - Allow more accurate count locations on segments.
  - Add count locations to existing traffic count requests.
  - Relocate existing count locations.
  - Group multiple traffic count requests of different types into a single super-request.

- Enhance the existing workflows:
  - Streamline the traffic count request approval process based on requested and selected collector.
  - Integrate the consultant quote process into the workflow.

- Incorporate additional traffic datasets – GPS logger speed runs and crashes.
- Allow access from mobile devices such as Apple iPads and Google tablets, requiring the client application to be redeveloped using HTML5 and Javascript.

The Phase II implementation uses a similar agile development methodology as that described for Phase I. This work was started in the fall of 2012 and is expected to be completed by early 2014. As an example of the updated client application, the redeveloped Traffic Count Details tab running on an Apple iPad is shown in Figure 8.
CONCLUSION

The TIMS project has provided NYCDOT with an advanced application for managing and maintaining all traffic count data used by the department within a secure hosted environment. By combining a focused project team, good stakeholder involvement, detailed requirements gathering and an agile development methodology, the TIMS application meets agencies and
users’ needs while providing a cost and time savings to NYCDOT numerous other sister agencies through efficient data sharing, eliminating duplication of data collection, streamlining and standardizing workflows, improving data accuracy, and increased level of communication and cooperation between staff.

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REFERENCES