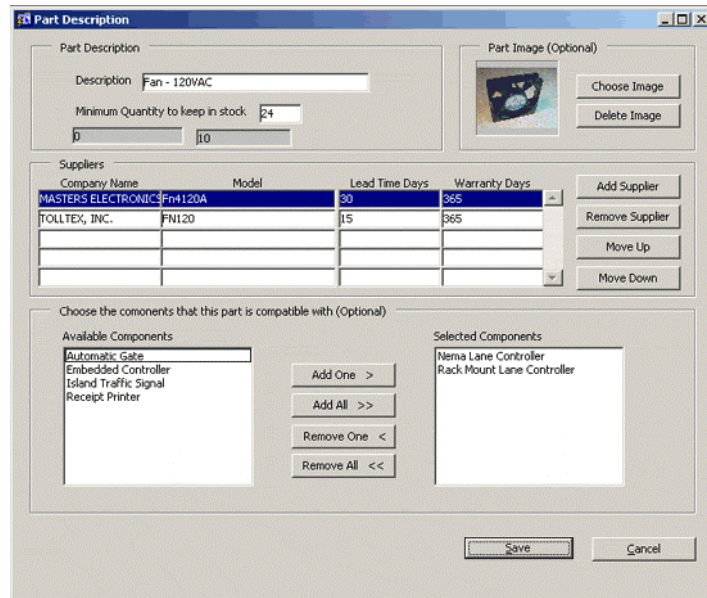


Maintenance Subsystem

Development Project

Tolltex is developing a Maintenance Online Management (MOMs) subsystem designed for use with Toll Collection systems. The goal is to produce a baseline "core" product that can be modified to meet specific maintenance requirements of a toll facility. The core system is being built to include common features that would be needed as part of a typical MOMs system. It features a graphic user interface and is table-driven to allow major application-specific settings to be made without program changes.



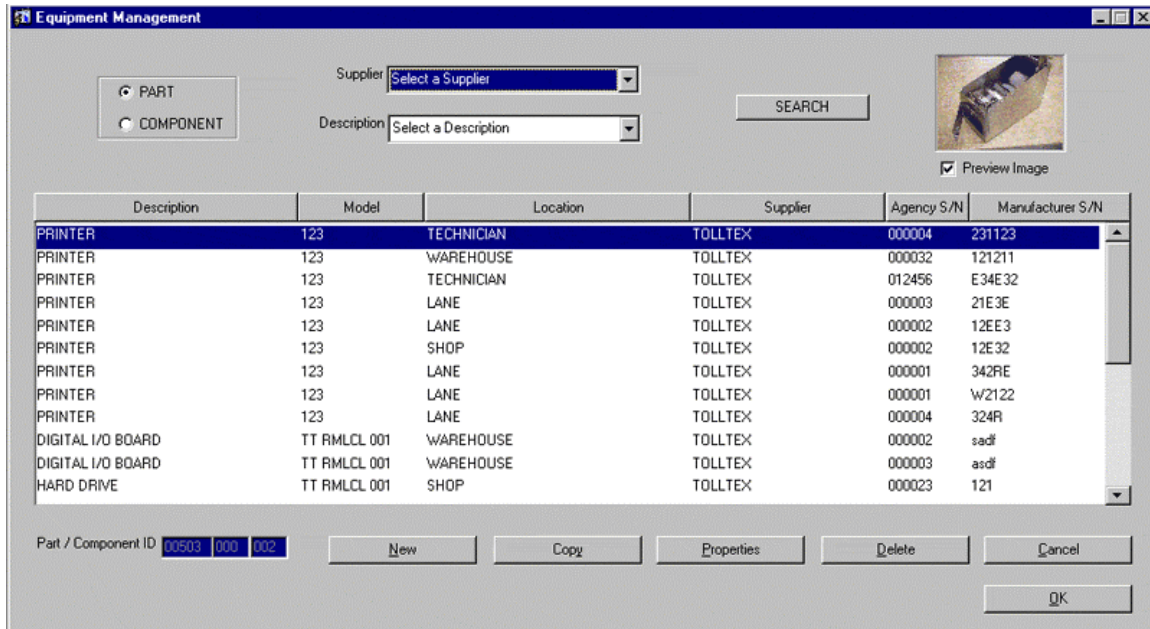
The system is based on the Oracle relational database management system for deployment under a Windows NT operating system.

The design is based on a modular set of functions including Supplier Information, Parts and Component Descriptions, Equipment Inventory, Consumable Inventory, Diagnostic Messages, Lane Event Messages, Custom Reporting, and, Work Order Generation/Assignment/Management. The system is designed to accept diagnostic and event messages in real time and includes a client/server architecture built using TCP/IP Ethernet. If real time messages are not available, data could be obtained by other methods such as file transfers, or other physical data links to the operating toll system.

Overview:

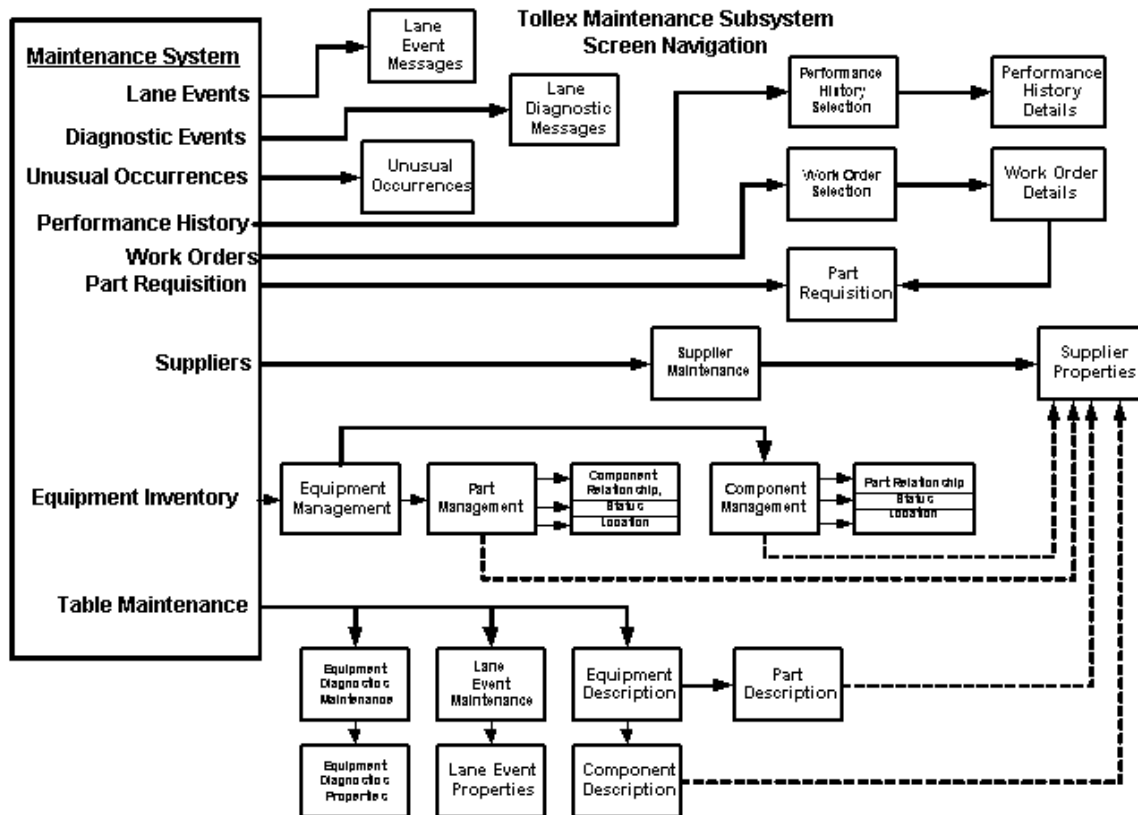
This internal development project is focused on designing and developing a baseline core Maintenance Online Management system (MOMs) that includes common features needed to support the maintenance of a toll collection system. The design is based on separate modules that can operate together or separately. The system

foundation is the Oracle relational database that includes approximately 15 functionally designed tables to address the storage and management of data. These include lane events, maintenance diagnostic events, equipment inventory, spare parts, supplier data, part/component compatibility, work orders, work order responses (MTTR), and consumable supplies. Storage and display of photo-images of equipment is also available. The system administration portion includes tables for lane configuration, system usage, user IDs/passwords and user roles that limit system access to authorized users only.



The screen shown above is used to display a list of all parts and components available in the system. From this screen, it's possible to link to another screen to add new items, display/change the properties of an item, or delete an item. Searches can be made to only list certain items by description or supplier. If an image of the item is available and the "Preview Image" box is checked, a small thumbnail picture is displayed. If the user clicks on the thumbnail, a full size image is displayed. For consistency, the same screen layout is used for both parts and components. Radio buttons determine which are displayed. A component is considered a complete assembly such as a lane controller, traffic light, or automatic gate. Both the manufacturer's serial number and the toll agency's serial number are displayed as well as model and the location where the part is located. Locations can be added and can be warehouses, service vans, shop, or the plaza/lane where the equipment is installed. Date of installation is also stored.

The illustration below shows the organization of the system and the various functional modules. The hierarchy of modules corresponds to pull-down Windows menus that are used to access the various sections of the system.



Description of Main Modules:

The following descriptions correspond to the main functional modules listed in the above illustration.

- Lane Events** - A display feature that allows database queries to be made against the Lane Event table. Lane Events are considered normal changes in the operational state of a lane. For example, lane open, lane close, new collector ID or non-revenue ID lists being sent, new lane configuration settings, new toll schedules, and other changes in the operational condition of a lane. It's purpose is to allow a technician to determine the operating state of a lane before a failure occurred or after a repair has been made to correct a failure.
- Diagnostic Events** - A display feature that allows database queries to be made against the Diagnostic Event table. Diagnostic Events are related to individual devices in the lane and their current operating status. For example, a failure of a loop detector would be reported via a message. These diagnostic messages are typically generated by the toll system's lane controllers and they form the basis of generating Work Orders within the Tolltex system as well as to store maintenance-related data for other uses. The format and descriptive meanings of the messages is an area that will require customization according to the messages generated by the actual toll collection system. The Diagnostic Event table will

store messages according to date, time, plaza, lane, and other key fields needed by the system. The purpose of this screen is to allow technicians to determine any device failures and/or recoveries that have occurred in a lane.

- **Unusual Occurrences** - A display feature that allows database queries to be made against the Unusual Occurrence table (UO). These UOs pertain to unusual events that occur in the lanes. For example, an invalid collector ID, or ETC account ID could be considered unusual occurrences. Use of this portion of the system depends upon the system requirements. This area of the system that will need to be customized to the actual operation of the facility. Its purpose is to provide technicians with additional information about the events taking place in the toll system.
- **Performance History** - Tracks the performance of equipment used within the system. This area includes Mean Time to Repair (MTTR) information. Its purpose is to track failures and report on the time needed to repair failures.
- **Work Orders** - Automatically generates work orders based on diagnostic event messages and allows work orders to be assigned to specific individuals for management of maintenance activities and staff. The table definition of the diagnostic event messages includes the number of times a specific device must fail before a work order is generated. This eliminates the creation of meaningless work orders for sporadic failures of non-critical devices. For example, if a loop detector fails to detect a single vehicle but then correctly detects the next vehicle, it may not be necessary to generate a work order for that single failure event. In this example, determining the number of failures of a device before a work order is generated is performed by entering a single value in a field on the Diagnostic Event definition screen. If a device is critical, this value could be set to a value of "1" which would generate a work order upon the detection of a single device failure.

This portion of the system also allows for entry of comments and resolution measures needed to correct a problem related to a work order. It also allows different priorities to be set for work orders and provides for a means to open or close work orders. Manual work orders can also be generated to address cases of extra preventative maintenance or other special maintenance needs. If parts are needed for a work order, the system allows parts to be "checked-out" of inventory and assigned to the person assigned to the work order. Queries can be made against the work order table by plaza, lane, status, and other key fields.

- **Part Requisition** - Manages the disbursement of parts and components to technicians for use in making repairs. Stock is identified by location, which can include any number of multiple warehouses, service vans, repair shops, or any other location where equipment is stored. Location also extends to the plaza/lane where the equipment is installed. Therefore, it's possible to search for a specific item by any location. Each item also includes a status, which can be "available", "damaged", "on-hold" or others as needed by the operation. Serial numbers

further identify the item. Movement of parts within the system operates on a "parts basket" concept. A screen displays a list of available parts, and the parts manager highlights the item and clicks on a "Move to Basket" button which assigns the part to the technician who needs the part to address a work order. An equipment audit by work order number is also maintained so that parts associated with a work order can be tracked. This portion of the system also includes a means to return any failed parts that were replaced as part of the work performed to correct a problem. This "closed loop" design allows for items to be managed whether they are in stock (at any location), in a technician's possession, on hold, installed, in the shop, at the manufacturer's shop for warranty repair, or so damaged that they were disposed of.

- **Suppliers** - Manages information about each supplier including contact information including company name, name of contact person, company address, telephone number(s), fax number(s), and email address.
- **Equipment Inventory** - Allows for the management of all parts and components within the system. Its primary use is to "check-in" equipment that is received from suppliers. Screens allow parts to be entered into inventory stock by location, serial number, and part/component ID. If an item is a component such as a lane controller, the system will allow information about the individual parts within the lane controller to be entered as well. For example, the serial numbers of each printed circuit board, power supply, or other part within the lane controller component can be recorded and associated with that lane controller. This allows tracking of all components as well as their associated parts. However, the system does not require entering data for each part of a component. The feature is available if the user is interested in managing both components and their associated parts. If this level of detail is not needed, then only information about the component would be entered.

The inventory portion of the system also allows for managing consumables such as receipt printer paper, traffic light bulbs, or other items that are ordered in bulk and do not have an individual serial number.

- **Table Maintenance** - This portion addresses the database set-up information used by the system. It contains information about the messages, part descriptions, component descriptions, consumable item descriptions, and the relationships between suppliers and the parts/components that they supply. A powerful feature of setting up a part or component in the system is that multiple suppliers of a single item can be identified. Therefore, if a part such as a loop detector is procured from more than one supplier, a list of suppliers can be associated with that part. The screen used to set-up multiple suppliers is shown at the top of this page. Delivery lead-times are also recorded for the part to assist in determining the preference of a primary supplier. Suppliers are easily added to the list by clicking on the "Add Supplier" button. That action will display a pull-down list of suppliers from which the selection is made by clicking on a supplier in the list. The order of preference is easily adjusted by clicking on either the "Move Up" or



"Move Down" buttons. The system considers the entry at the top of the supplier list to be the primary supplier. Note that it's possible to associate compatibility of an individual part with more than one component. In the sample screen, the cooling fan is compatible with both the NEMA lane controller and the Rackmount lane controller components. Selection is easily made by highlighting the component in the "Available Components" list and then clicking on the "Add One" button. No typing is needed.

The sections of the system described above form the base-line core of a maintenance subsystem. Since each toll collection system has its own unique methods of operation, it will be necessary to examine the specific requirements and customize the system to meet the needs of the toll operation.
