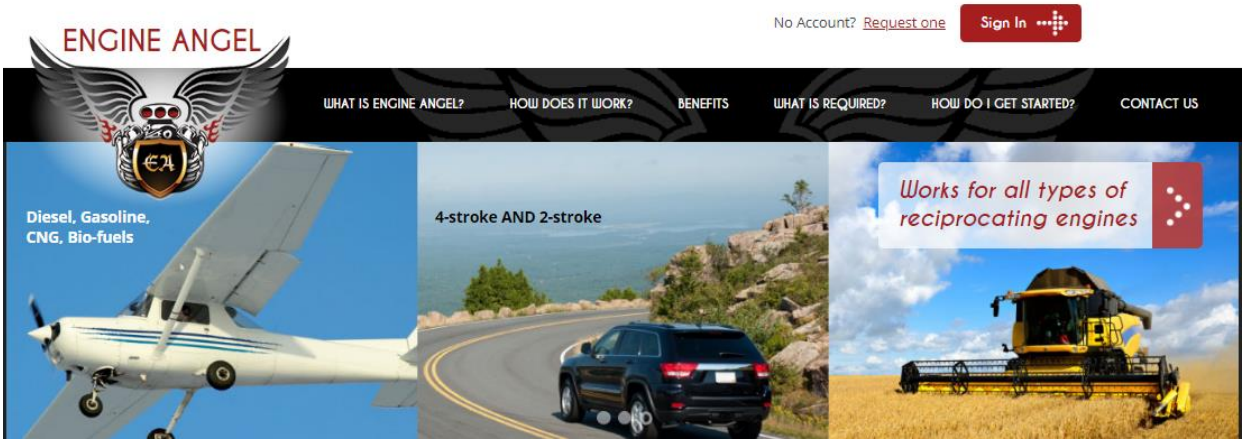
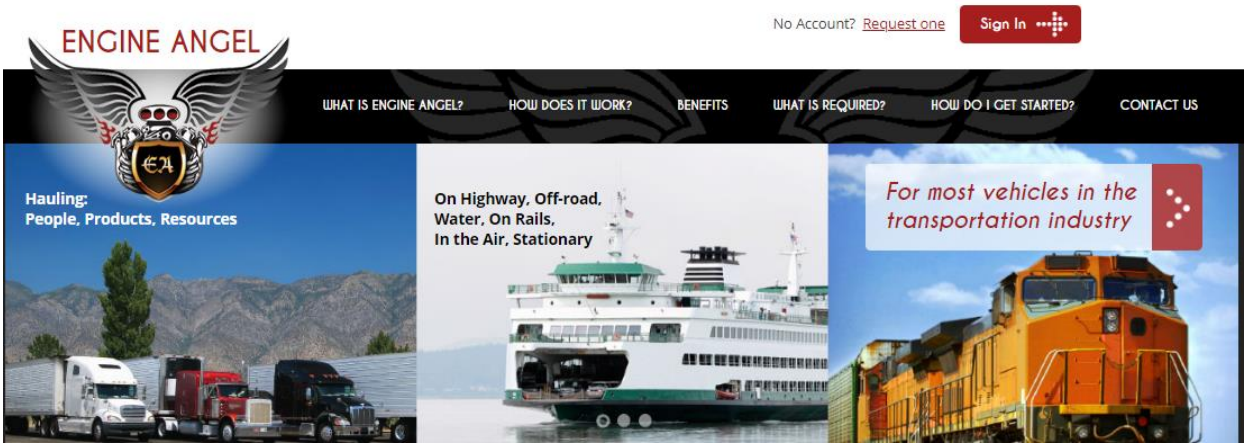
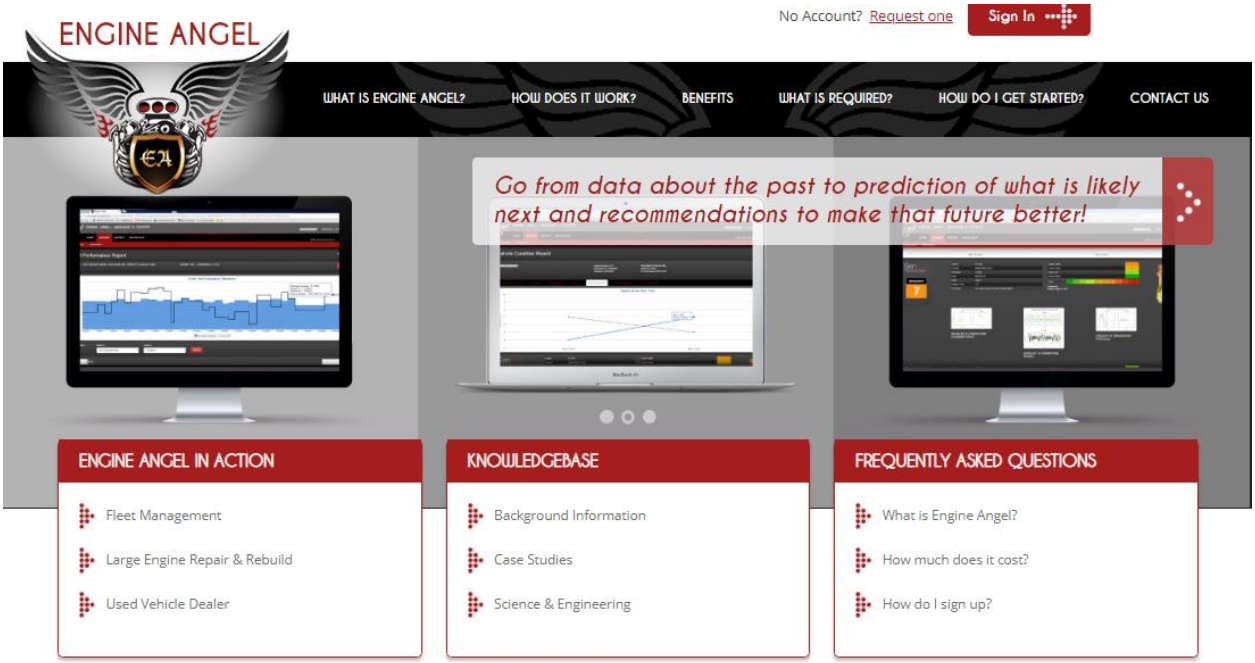
Engine Angel Operations Layer







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Engine Angel Documentation

Volume III. Operations Layer

2019-05-07

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Introduction

The documentation for Engine Angel is provided in 5 volumes”

1. The **Admin** Layer for the staff of Predictive Fleet Technologies are responsible for much data that is independent of any customer Fleets (equipment specifications, conversion standards, regulations, industry standards, Expert System rules, etc.
2. The Fleet **Cockpit** for managers, professional staff responsible for the policy and management of operational people to achieve the organizations goals (managers, analysts, clerical people)
3. **(This document):** The **Operations** people who implement the actions according to policies and guidelines of management resulting in organizational success.
4. The **Remote** functions are those processes that connect sensors and special purpose accumulators of ‘short-term’ histories of data and transmit, transform and integrate the data into the system’s databases to keep data about asset status and activities accurate and timely.
5. The **Scheduled** functions (data integration and analysis) are processes that monitor asset status data against preset threshold values to alert operations and staff personnel of abnormal situations that might need corrective action. In addition, the batch processes use the historical data and models to predict future statuses against the preset thresholds to again alert and, using Expert Systems, suggest corrective actions to avert problems.

The following diagram (flow chart) represents these functions and major flows of data through the system.

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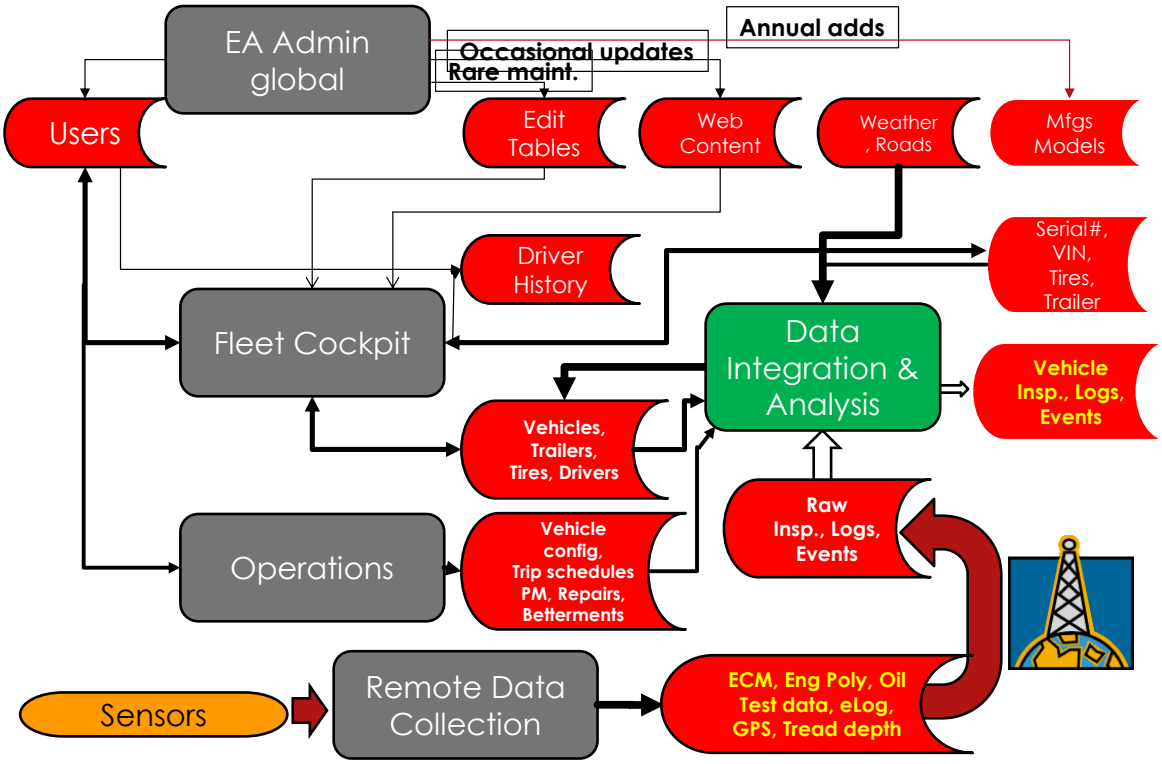

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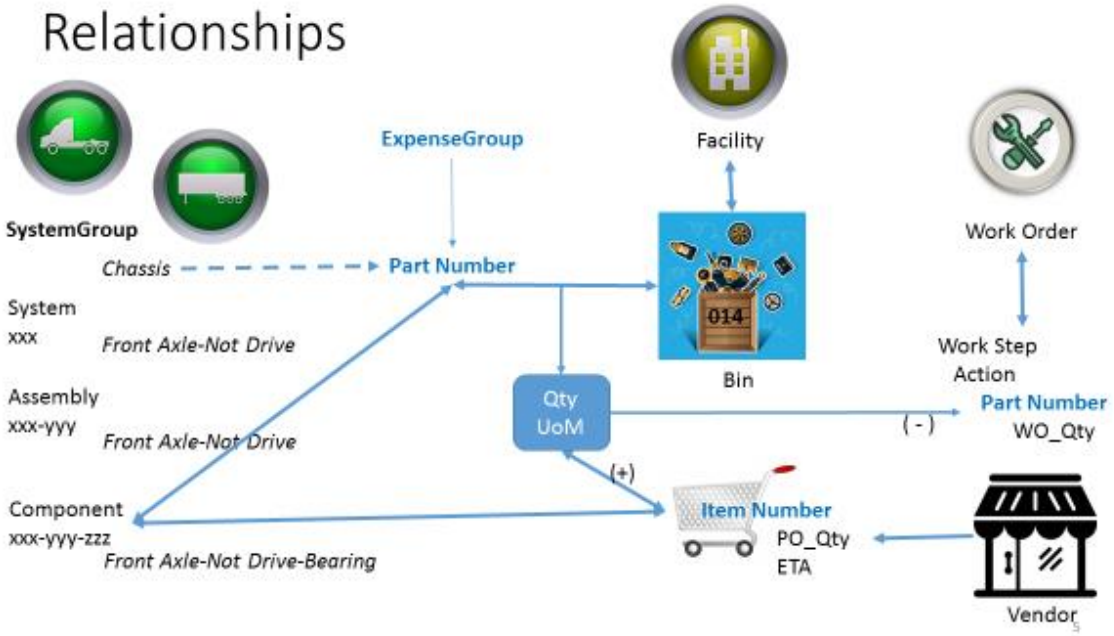
Operations Layer

Operations - Purpose

The Operations level provides a group of functions for collecting data from and supporting the people closest to revenue generation of the organization in their activities. The goal is to increase efficiency and safety of the shops, drivers, and clerks – the people who actually deliver value to customers. (The Cockpit is to support managers and supervisors to organize, schedule and dispatch work to be done safely and efficiently.)

Basic elements of the Operations Level include maintaining the assets of the Fleet and operating those assets safely and efficiently.

Inventory planning and management is fundamental for preventing delays (wasted time) and reducing costs. This design is compatible with the VMRS approach supported by the American Trucking Associations.



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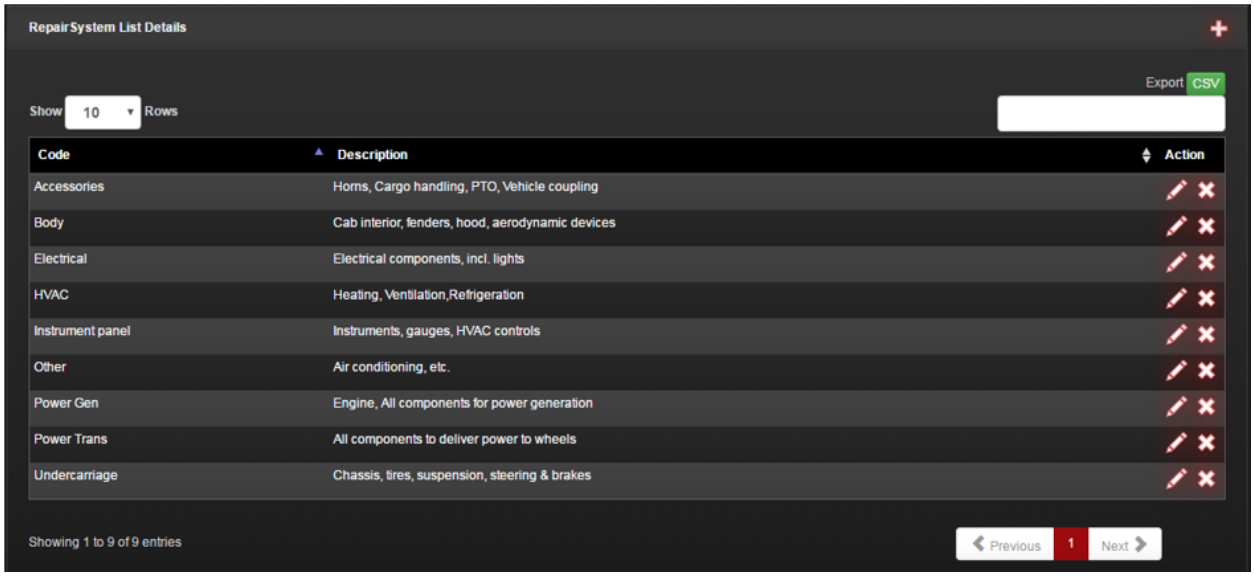
Operations - Structure

The Operations level data organizes the Vehicle and Trailer components by 'Repair System' maintained in the Admin Layer:

Repair System involved in Inspections, Maintenance and Repair activities, including Preventative Maintenance

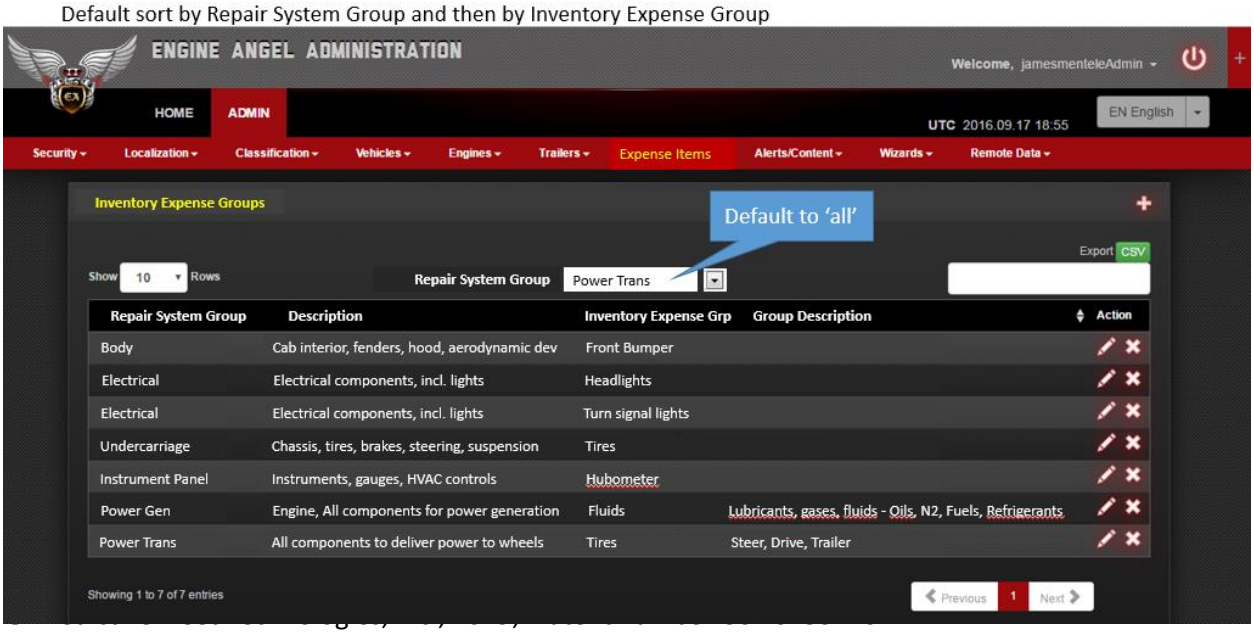
Admin Layer => Classification => CodeLists => Repair System

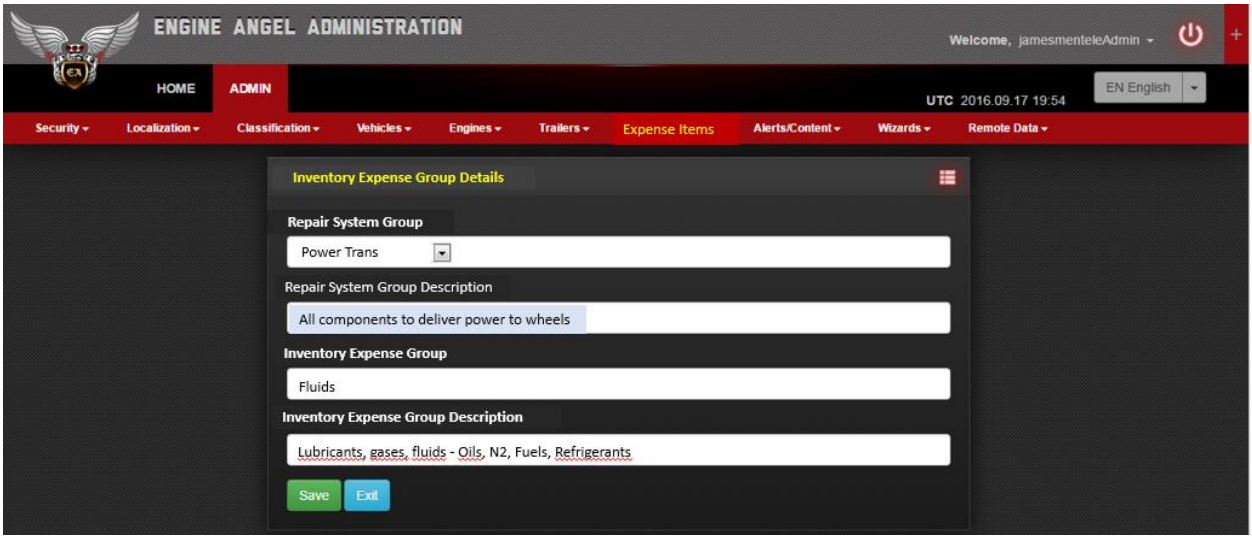
Admin Layer => Classification => CodeLists => Repair System



Inventoried Parts are grouped by Expense Item Groups and each Expense Item Group is assigned to a Repair System.

Default sort by Repair System Group and then by Inventory Expense Group





Menu Paths

- Admin
  - Classification => Code Lists
    - RepairSystem
  - Expense Items
    - Inventory Expense Groups
      - Expense Group Details
- Operations
  - Inventory
    - Parts Numbers
      - Part Number Details
    - Bins
      - Bin Details
    - Withdraw Reasons
      - Withdraw Reason Account
    - Bar Codes
      - Bar Code Details

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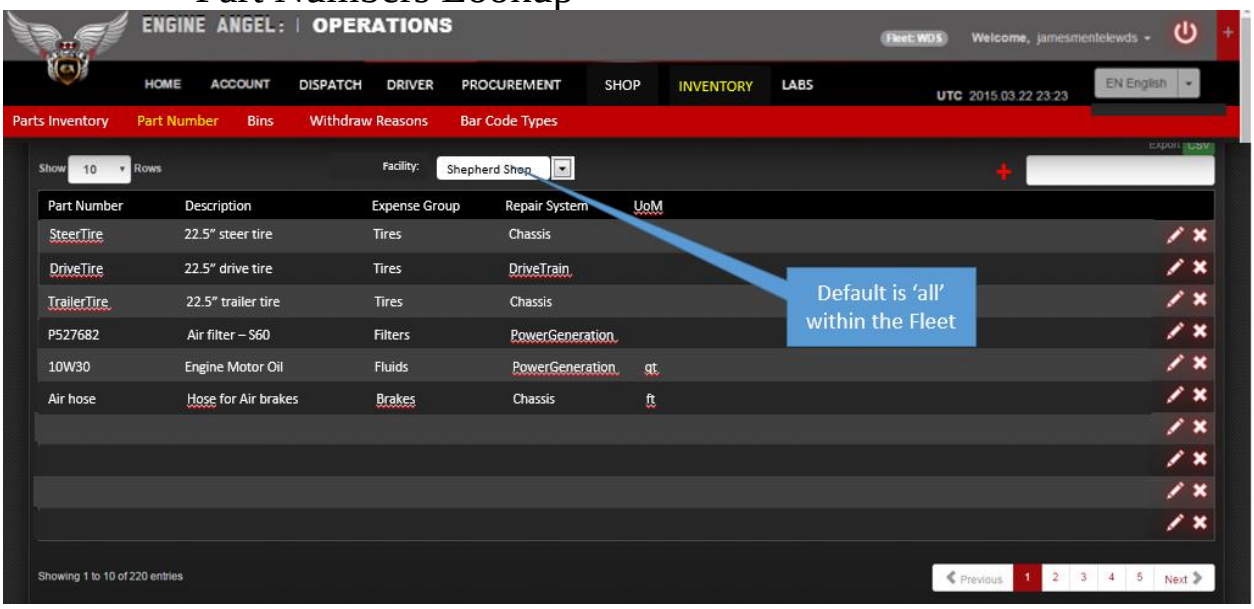
- Parts Inventory
    - Part Inventory Details
    - Move Inventory
    - Withdraw Inventory
    - Parts Inventory & POs
    - Receive PO Qty
- Procurement
    - Purchase Orders
        - PO Details
    - Vendors
        - Vendor Details

Parts Management

Codes Management: Part Numbers, Parts Inventory Masters, Bins, Withdraw Reasons

Part Numbers Lookup



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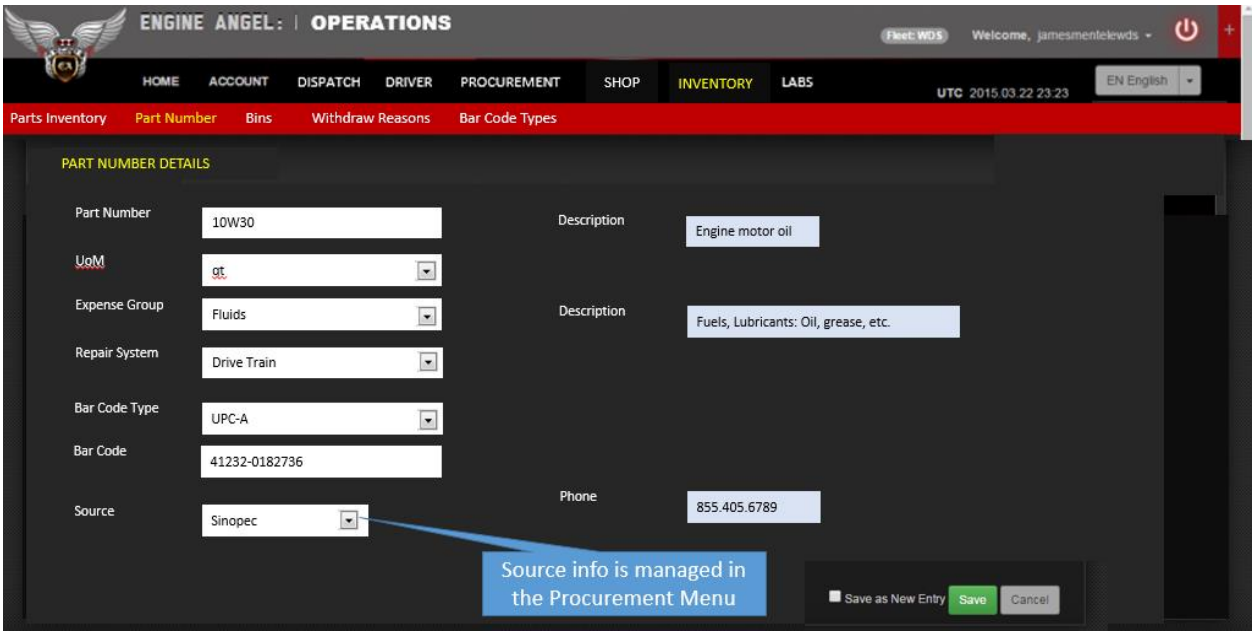
Part Number Details



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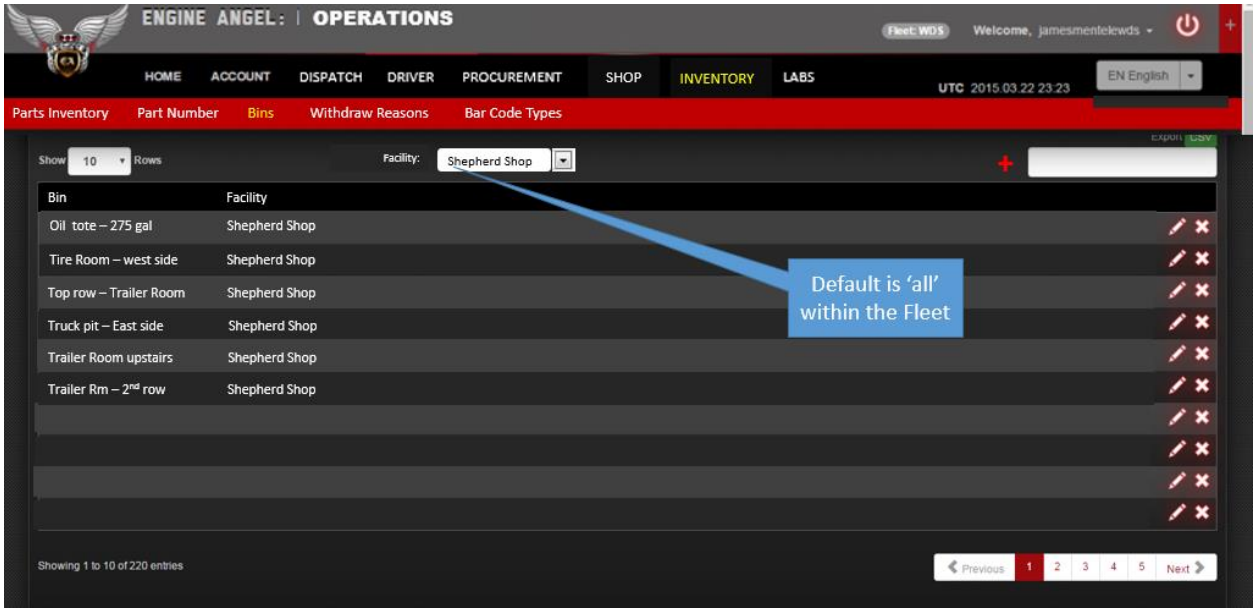
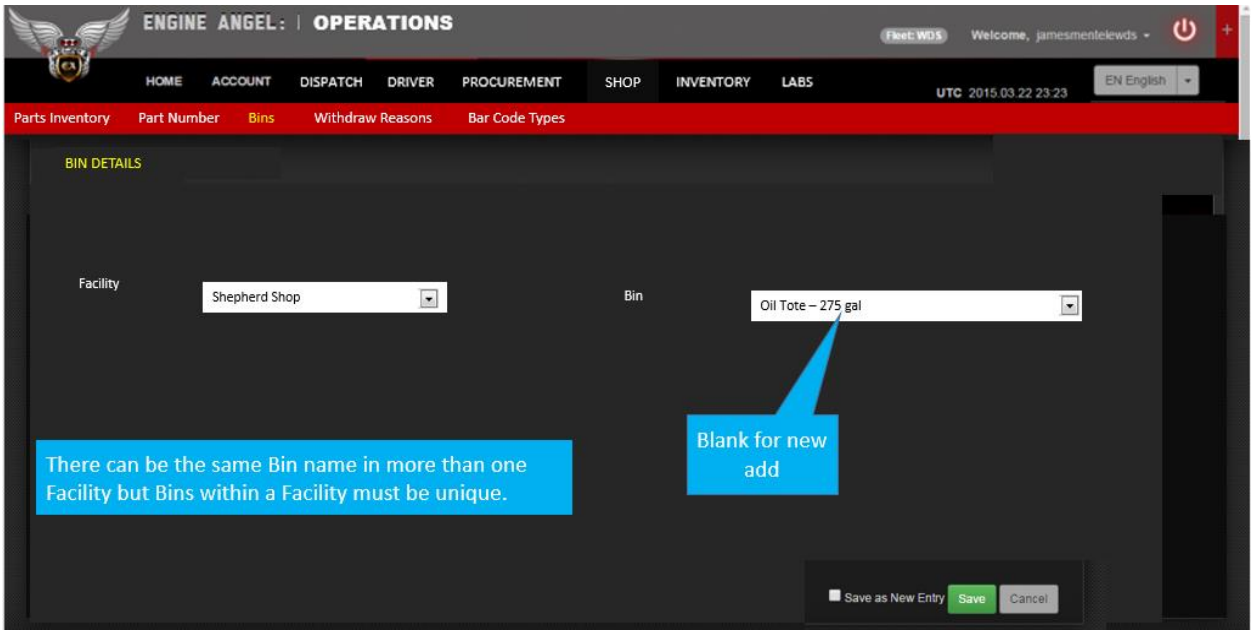
Bin Lookup



Bin Details



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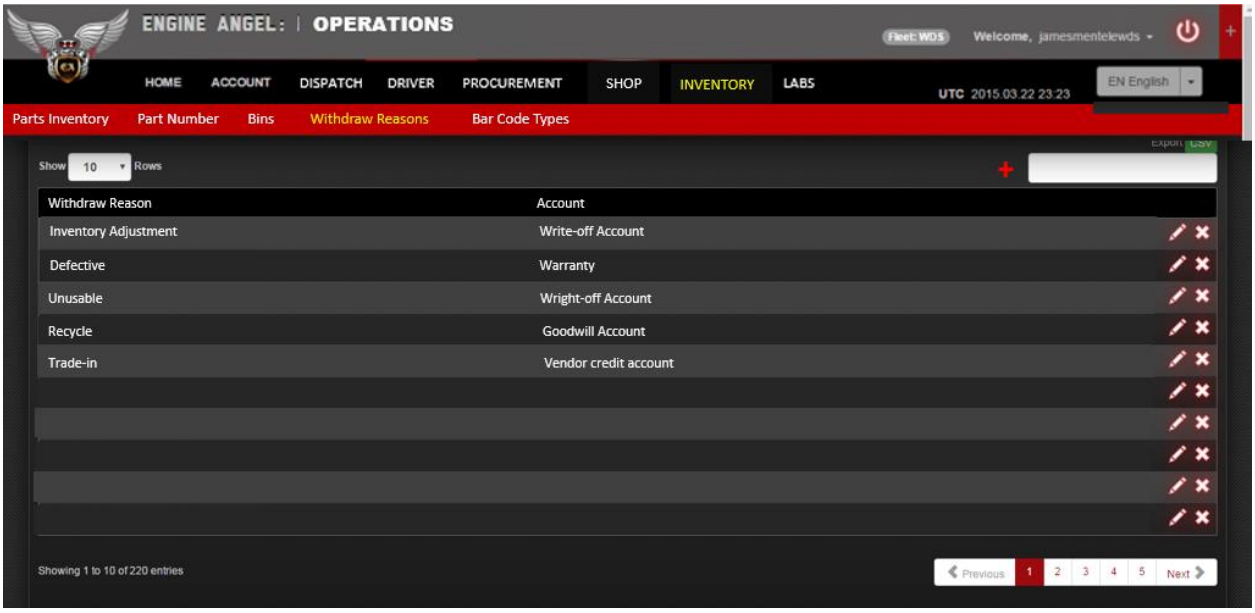
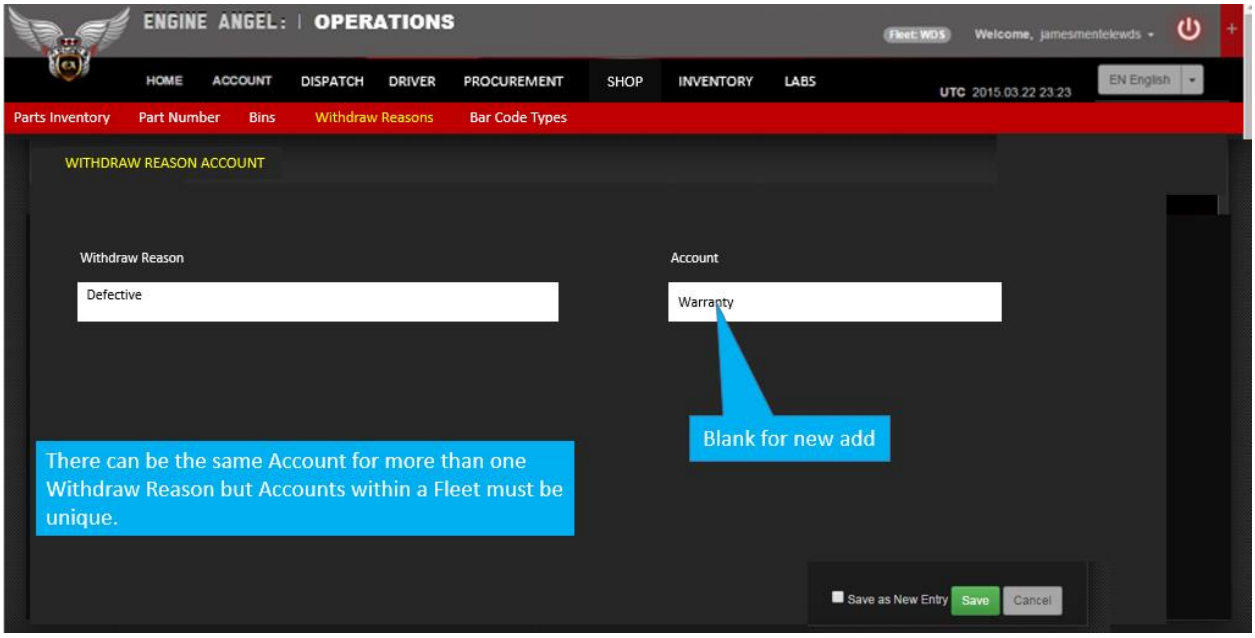
Withdraw Reasons



Withdraw Reason Details



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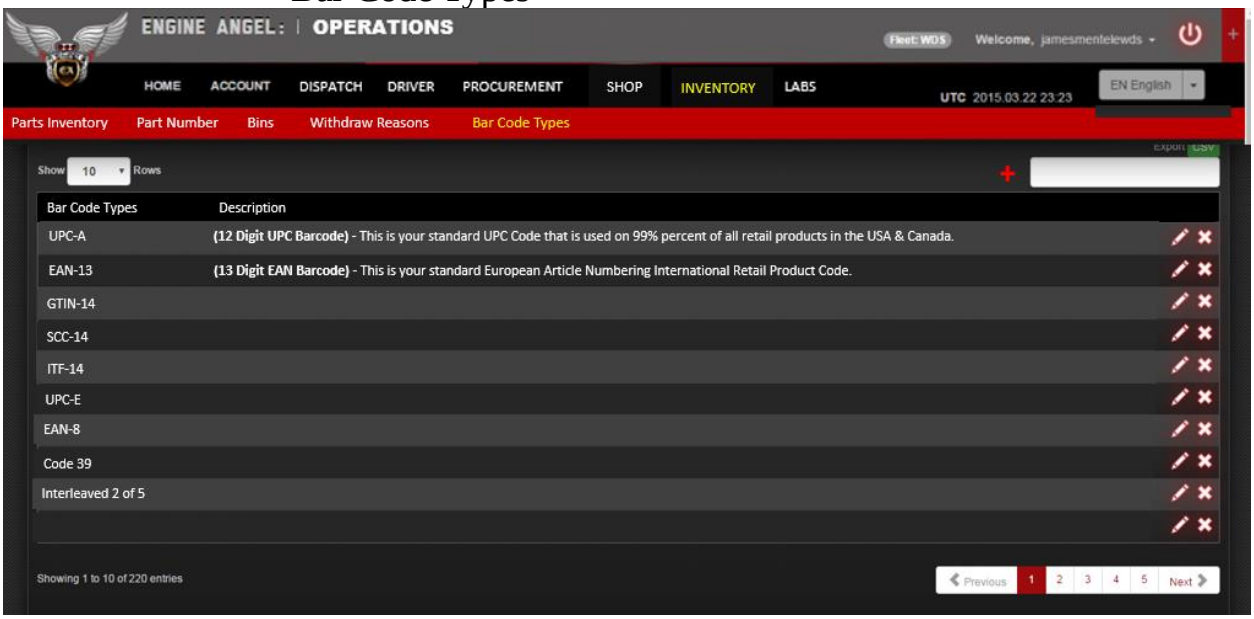
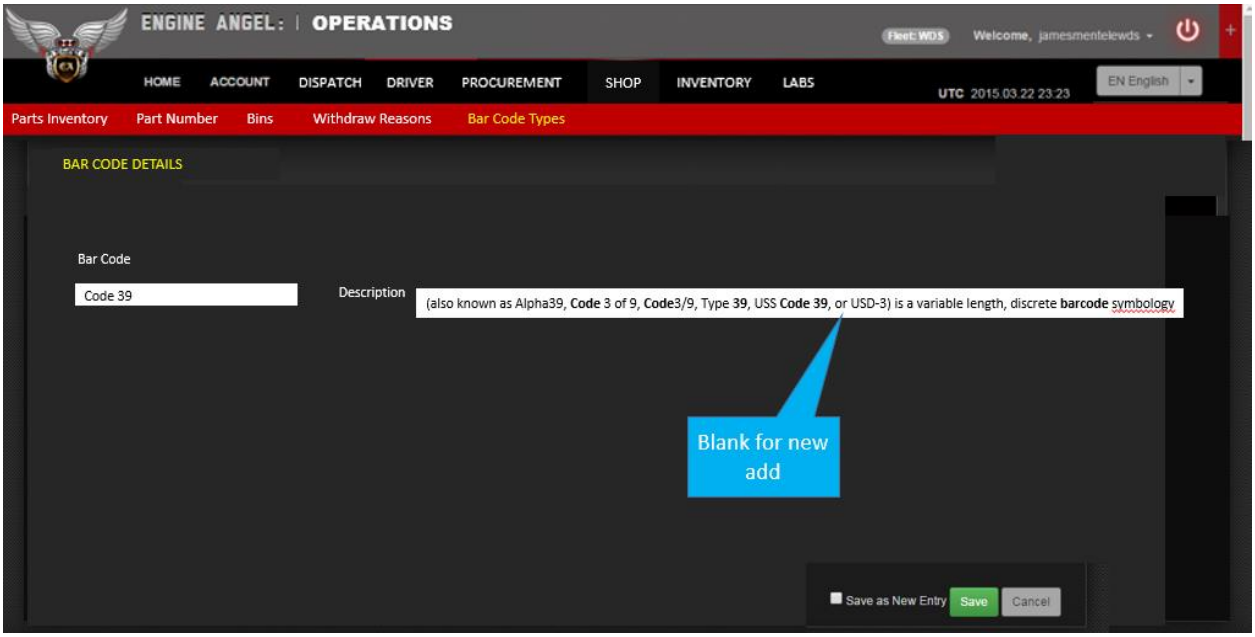
Bar Code Types



Bar Code Details



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Parts Inventory

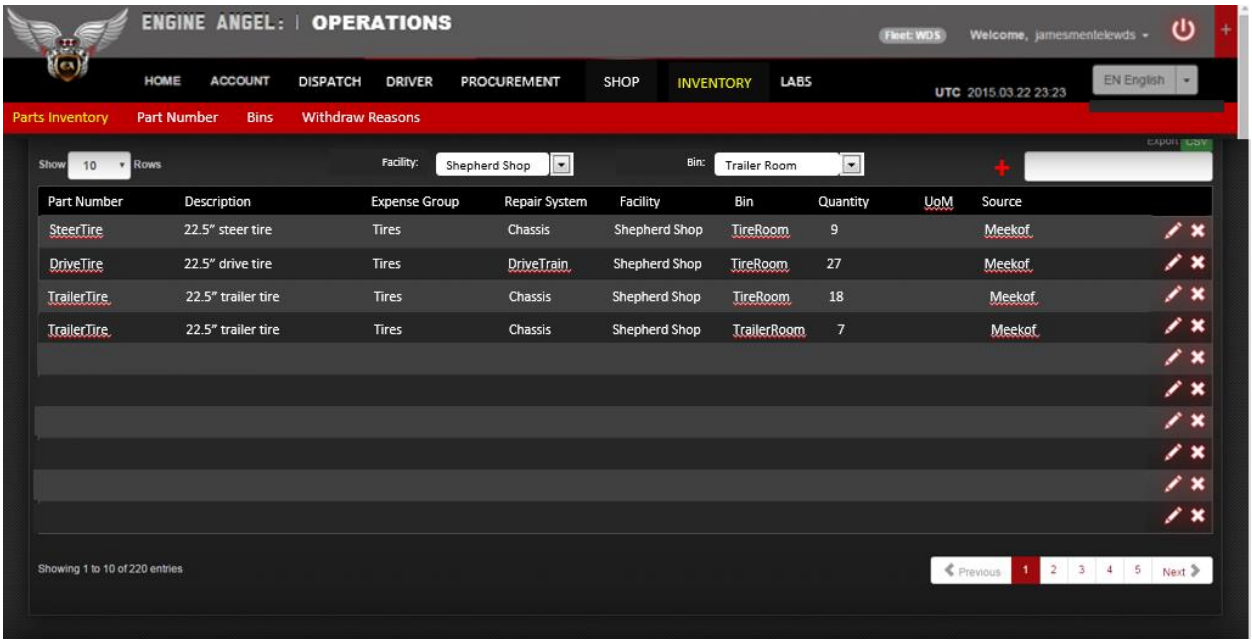
Inventory Status

Pending Usage

Moves

Withdrawals

Receive Purchase Orders



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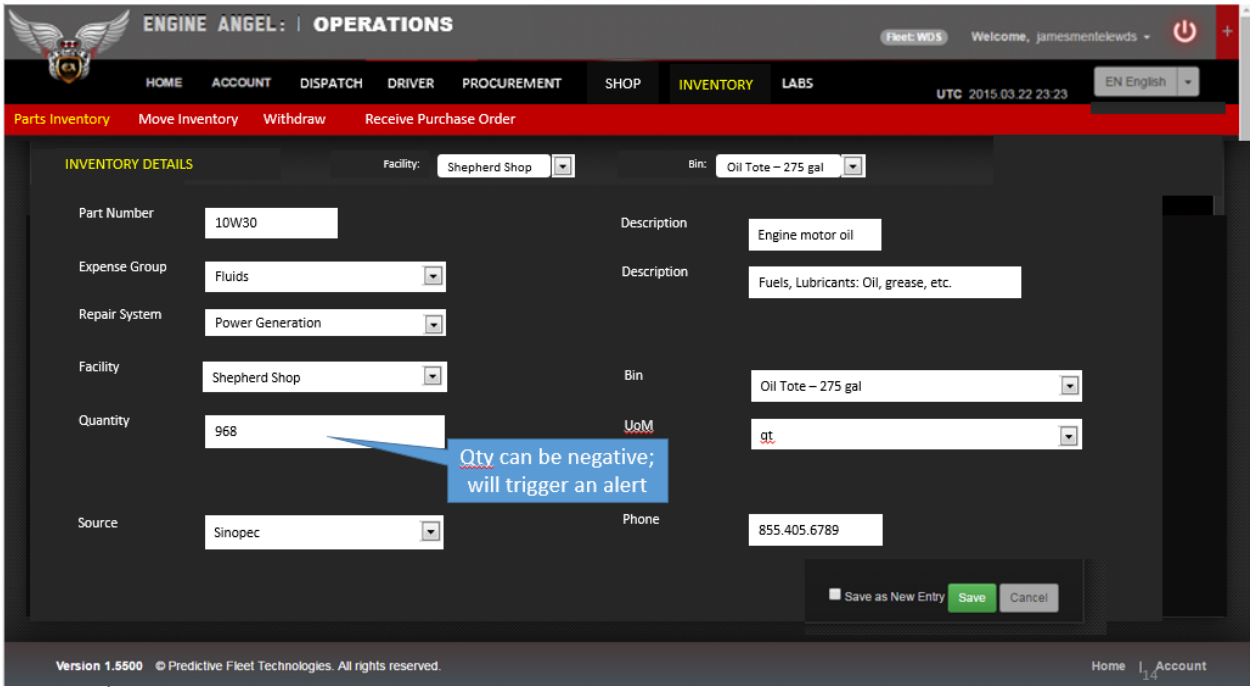
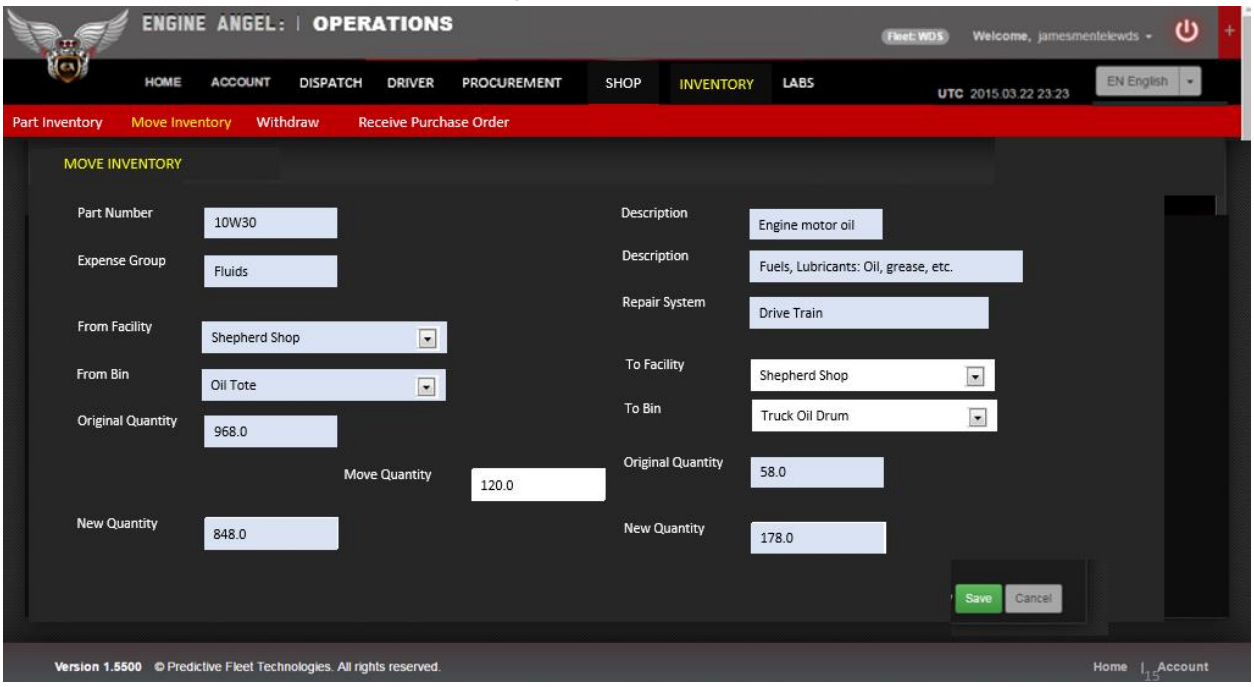
Inventory Details



Move Inventory



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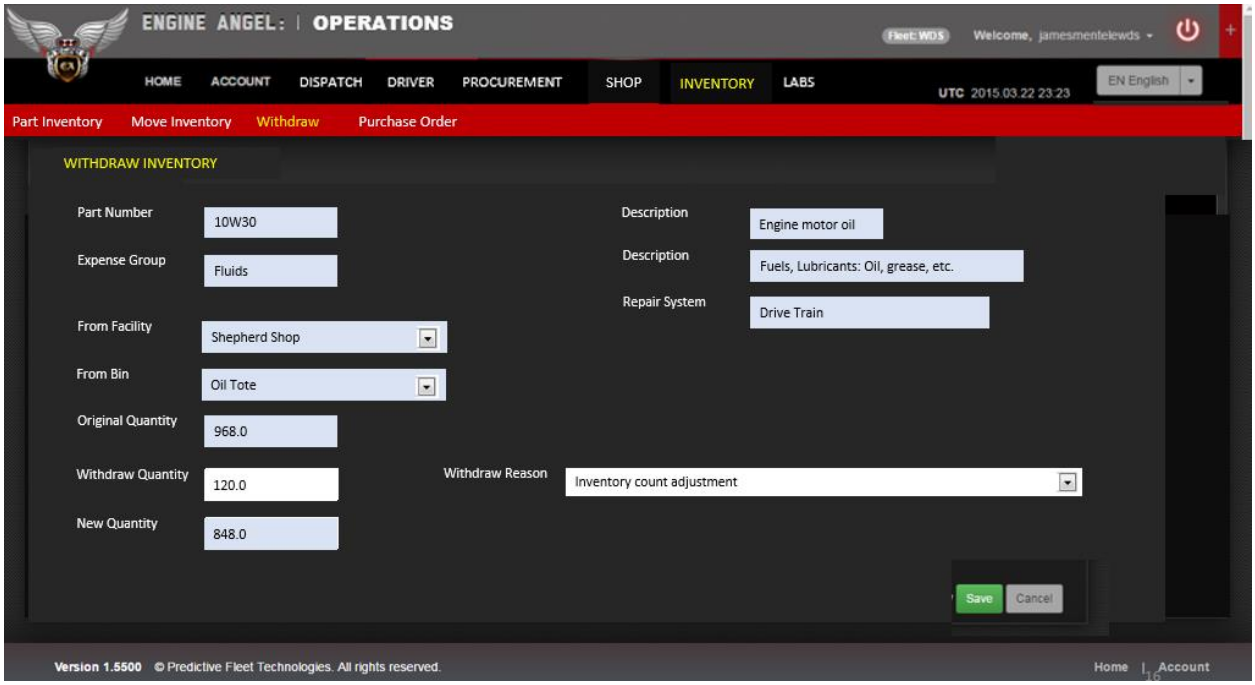
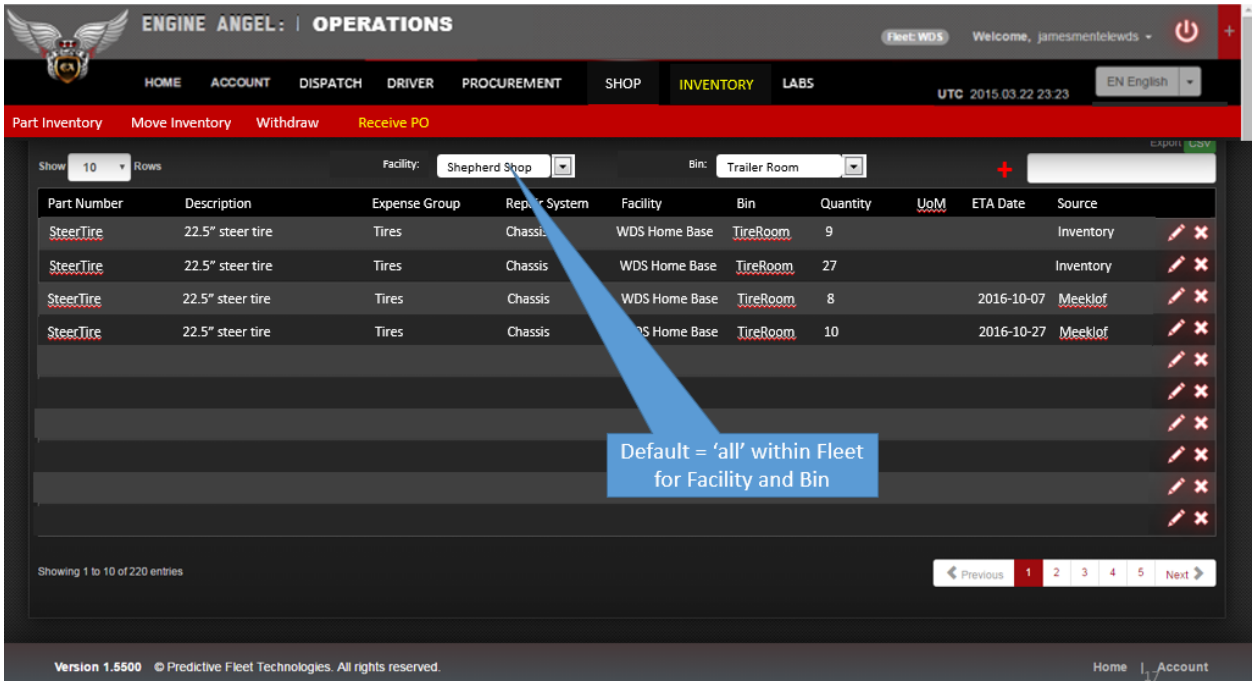


Receipts - PO

PO Lookup



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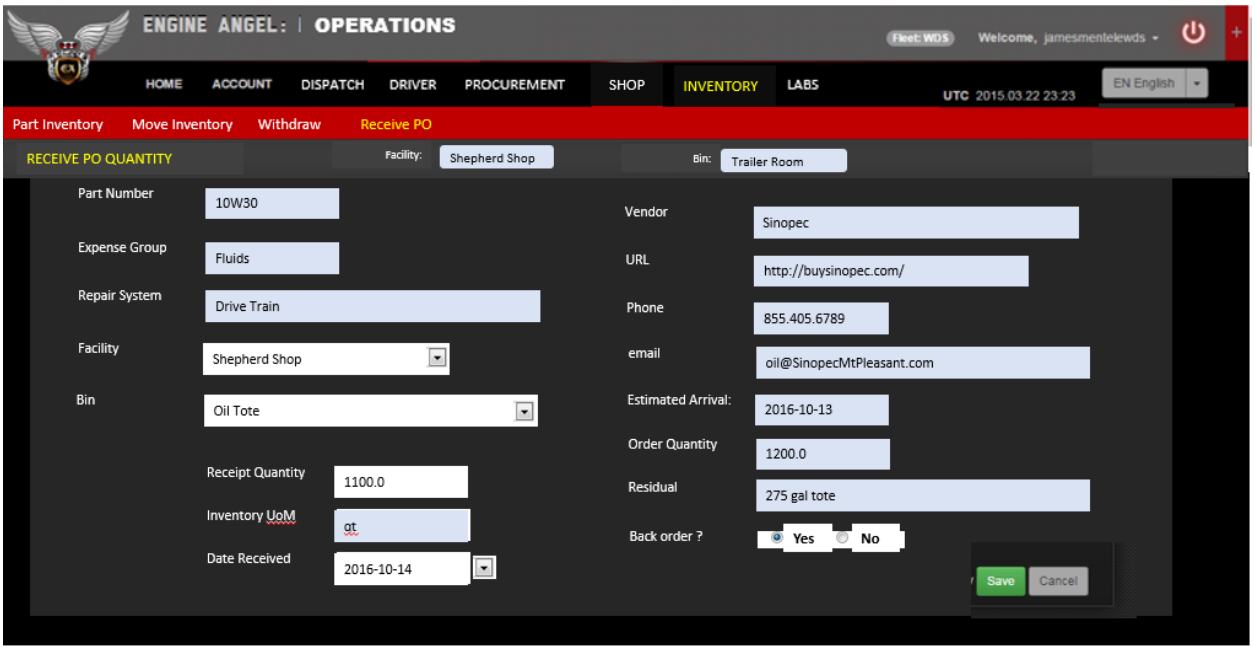
Inventory PO Receipt



Any back ordered Residual updates the 'Order line on the previous screen with the difference. No backorder or if Order Qty = Received Qty, Order line gets deleted. Only white fields can get entered; new inventory line is generated by receipt qty.

Procurement

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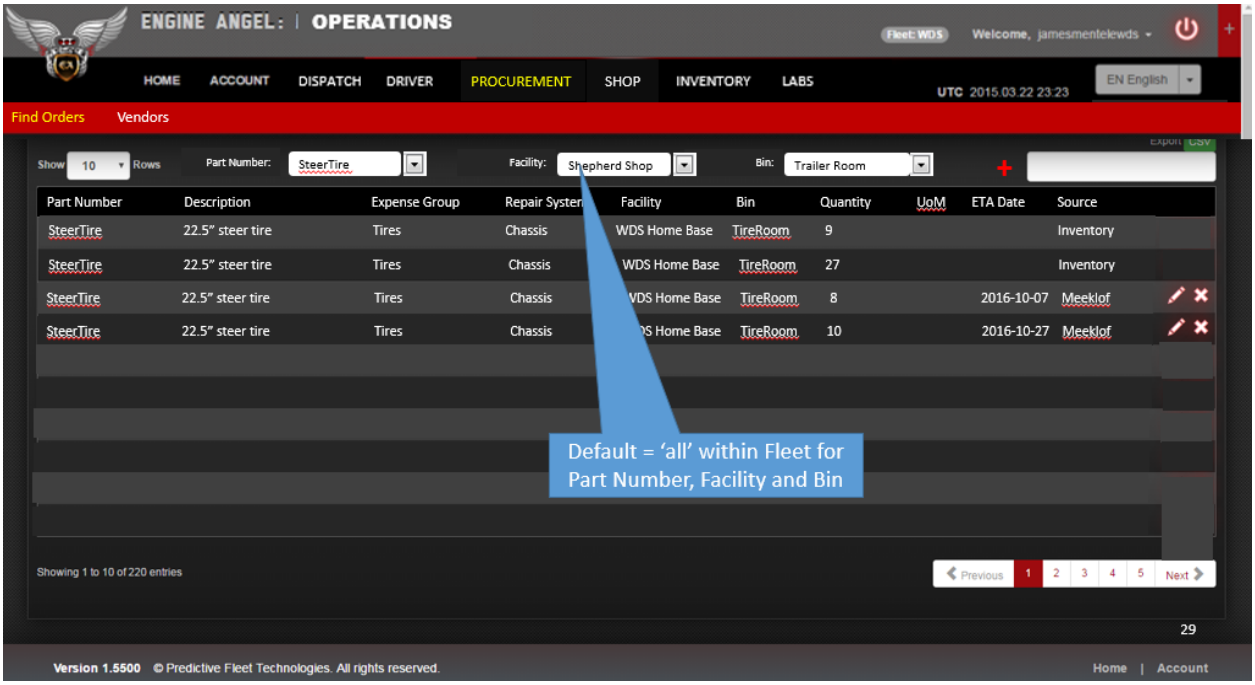
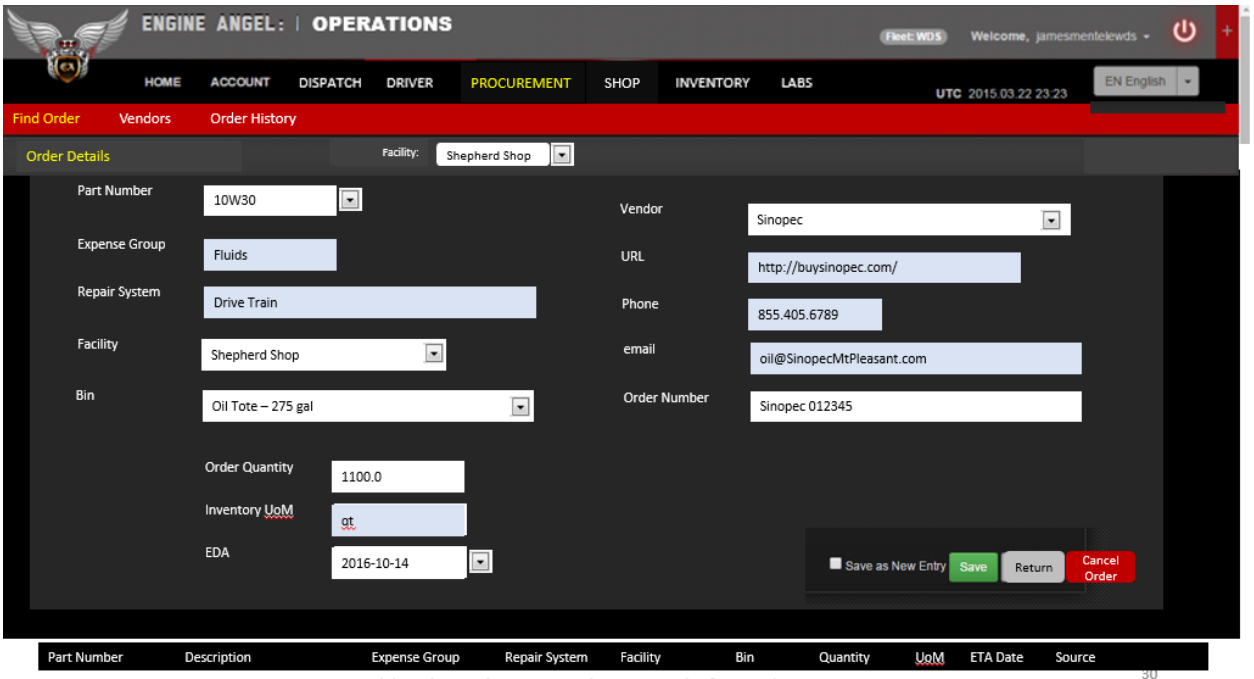
Orders



PO Details (Line Item)



Add order to increment inventory in future by PO

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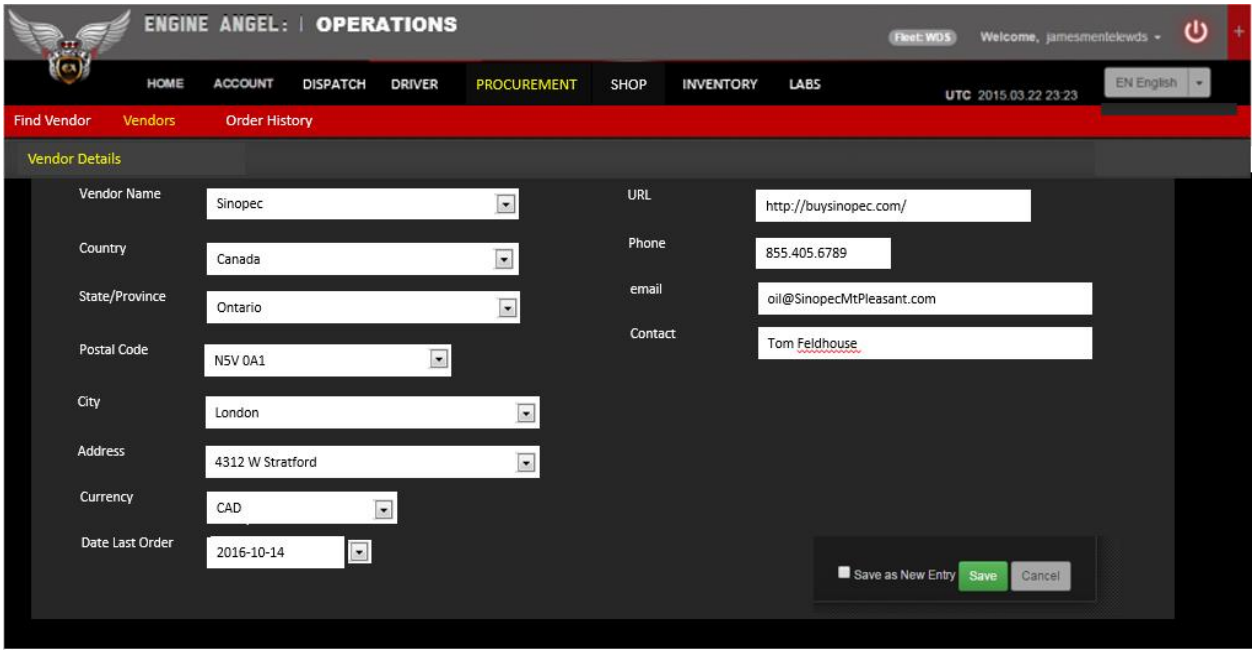
Vendor Management

Vendor Details



Shop

Work Order planning

Work Order Planning for the shop must be organized around time that the asset is at a place where the W.O. activity can be performed, often at a service shop. The time of an asset can be viewed as a time-sequence of asset statuses:

1. On Trip
    a. Moving (with engine running)
    b. Stopped, engine running (Stop lights, driver in berth, in queue)
    c. Stopped, engine off (Refuel, driver break, Load/unload, etc.)

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d. Out-of-Service (OoS) – Stopped due to Regulation violation

2. OoS due to a W.O. being performed (PM or Repair)
3. Available for dispatch

The future times over the next week or so are determined largely by Proposed and Released W.O.s, dispatch schedules, and forecasted work times.

The Work Order Templates approved for usage for the Fleet assets are provided and copied to the appropriate Assets in the Cockpit layer to comply with Fleet Management compliance and audit requirements.

A proposed set is available from the Admin Layer and include the following Scope:

- Vehicles (modified by Vocation)
  - Axles (bearings, steer, differential)
  - Tires (Steer, Drive, Trailer, Lift)
  - Brakes
  - Batteries
  - DPF
  - Differential Oil
  - License renewals
- Trailers (modified by Type)
  - Axles
  - Tires (Trailer, Lift)
  - Brakes
  - Batteries
  - License renewals
- Engines (modified by Technologies)
  - Engine Oil
  - Valve Lash
  - DEF Pump Filter
  - Injectors
  - Coolant
  - DPF filter
- Drivers (modified by limitations and extensions of license)
  - License renewals
  - Health exams
  - Drug & alcohol testing
  - Driver behaviors based on ECM trip data

Work Order History

Work Order reporting

Work Order functionality can be implemented at 2 different levels:

- High level with no details but a title, estimates of time OoS, technician time, and costs
- With a procedure specifying and observation recording of steps to be performed with expense part numbers proposed at each step.

Inspections

Annual Inspections

Vehicle & Trailer

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Pre- & Post-Trip Inspections

DVRS

Preventive Maintenance (PM)

Repair & Betterments

License (renewals)

Driver

Training

Experience

Certifications

Behaviors

Mechanics Workbench

Vehicle & Engine Details

EoL Calculations

Performance History (ECM data)

Maintenance & Repair History

Inspections History

OBD Codes

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Engine Polygraph History

Engine Oil Test Results

Diagnostics (Expert System)

Remote Data

ECM

ECM Synchronization

ECMDataSync

Engine Polygraph

EPReader

EPDataSync

EngPolygraph ETL to Engine Angel

Engine Oil Test Results

OilDataSync

Oil Test Results Synchronization

Telematics

Forecasting and Prediction

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We use the term forecasting when we estimate a future expectation based on a timeseries analysis of previous activity by the subject asset. The timeseries analysis may use seasonal factors for adjustments based on the geographic location of the home base of the asset.

We use the term prediction when we use external variables to calculate a future expectation based on equations obtained from calibration with facts from the past for that asset.

Methods

Exponential Smoothing

Regression

Seasonal Factors

Hazard Functions

Bathtub Curves

Processes

Each component that is as specified by a work order template and assigned to an asset has details associated with the lifecycle of the asset and the deterioration models that will be used to predict eventual end of life (EoL) dates that will be used to prioritize and schedule shop actions. Initial deterioration rates are largely derived from complement warranties. It can be modified by the vocation assigned to the asset of the component.

Overview

All components to be managed by work orders require initialization of needed deterioration equations at the time that the component is brought into service.

As the asset is used, compliments attached to the asset will have utilization factors assigned along with hazard factors associated with the duty during that utilization. The deterioration equation will convert those utilization and hazard factors to deterioration rates. Forecasted utilization will be applied to those rates to predict deterioration in the future.

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The future deterioration will be compared with the current component status and a threshold value that defines the EoL.

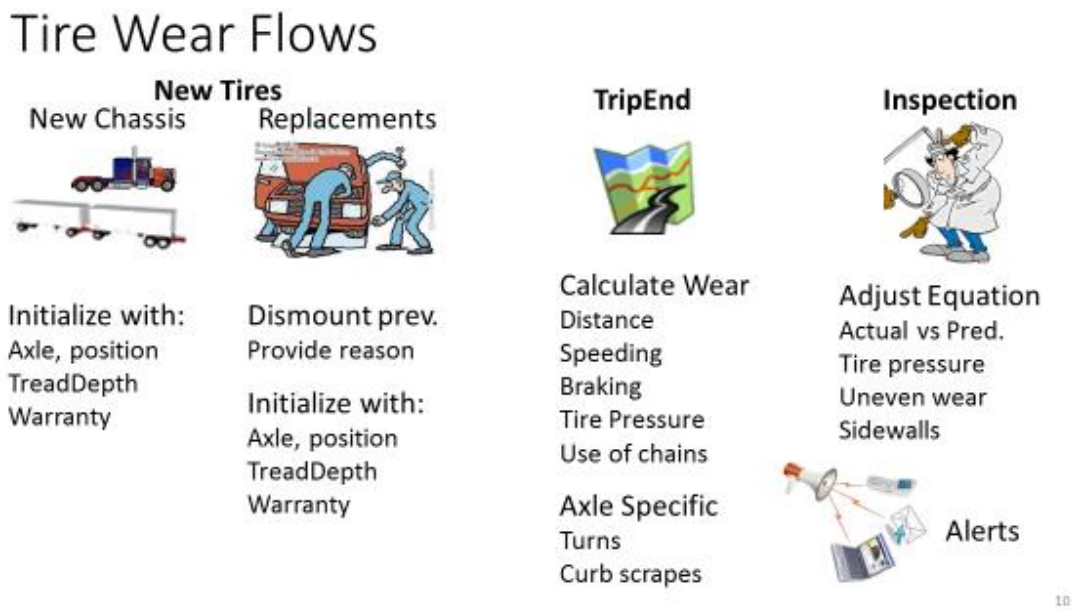
Actual utilization and hazard functions are extracted from the ECM and used to predict deterioration status at the end of the associated trip. Utilization data is also used to update the forecasted utilization rates.

Periodic preventive maintenance, possibly with replacement, can update the current component status.

Inspection results (e.g., tire tread depth) can be compared with predicted values for that time and differences used to update the deterioration parameters of the equations.

Periodically all end-of-life calculations for the components of an asset are compared against the end of the following week, and if one of the EoL calculations occurs prior to the end of next week, a process will be invoked to prepare a work order for that asset covering all components that are near their EoL. If an EoL calculation is prior to the end of next week, an urgent Alert will be sent out to the maintenance supervisor.

The following diagram illustrates those processes for each tire on an asset:



Forecasted Utilization

Deterioration Prediction

Initialization of parameters

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Seems Like Usage

Calculated End-of-Life (EoL)

Update Deterioration parameters

- Inspection vs. Prediction
- Resets after replacement/ repair

Alert generation

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