Proceedings of the 2016 Winter Simulation Conference
T. M. K. Roeder, P. I. Frazier, R. Szechtman, E. Zhou, T. Huschka, and S. E. Chick, eds.

A SIMULATION-OPTIMIZATION FRAMEWORK FOR MANPOWER MODELING AND FORECASTING

Aristotelis E. Thanos, Brian Dingman, Srinivas Bollapragada, and Xing Wang

GE Global Research
1 Research Cir.
Niskayuna, NY, 12309, USA

ABSTRACT

In this work we design a simulation optimization framework for satisfying the terms of a service level agreement with manufacturing companies where technicians need to be available to respond in a timely manner to machine repair requests. The task of determining technicians' skill and location coverage for every service area drives variance from target technician utilization, service response times and travel expense. Technicians can be assigned to alternative shifts and might have various skill levels for different type of repair requests (modalities) and the frequency, type and location of requests is highly uncertain. The aforementioned challenges can be addressed with the use of a robust simulation optimization framework that will be able to analyze and optimize future technician target mix for modality specific forecast of service requests by region and test alternative assignment algorithms to optimize service level and minimize costs.

1 PROBLEM DESCRIPTION

The goal of this work is to create a standalone app that a sub-regional manager responsible for technicians or a region manager (larger area) would use to 1) simulate future repair demand and identify the proper workforce configuration (number of technicians and their skill levels, and 2) provide the ability to select the logic type or setup experiments to test alternative assignment logic or technician configurations.
Definitions:

- Job and technician skill level: Different demand types that require specific technician capabilities to repair. The highest level would be modality, this identifies the type of machine to be repaired. Then within a modality the technicians have a skill level 1,2 or 3.
- Assignment logic:
    - By distance - Check for the closest technician trained in that modality that has the required skill level for the repair request.
    - By preference - Sites where machines reside have preferred technician criteria.
- Repair requests: Distribution of requests per modality per type of request (required minimum technician skill level), per day of the week, per hour.
- Training : Technicians are trained on specific modalities where they increase their skill level. While in training a technician is unavailable to respond to repair requests.
- Retirement : Technicians can retire at a date in the future where they are removed from the system.

2 AGENT BASED SIMULATION MODEL

An agent based model is used to simulate Site / Machine level behavior and technician behavior over an extended future time line. Machine level failure and planned repair probabilities are created based on a

combination of historical patterns and part failure predictions. Technicians are modeled as agents with modality and skill level capabilities that are used in selection of the technician to respond to a repair event. Technician schedule contains shift information available and unavailable days & hours, training schedules and retirement probability by month into the future.

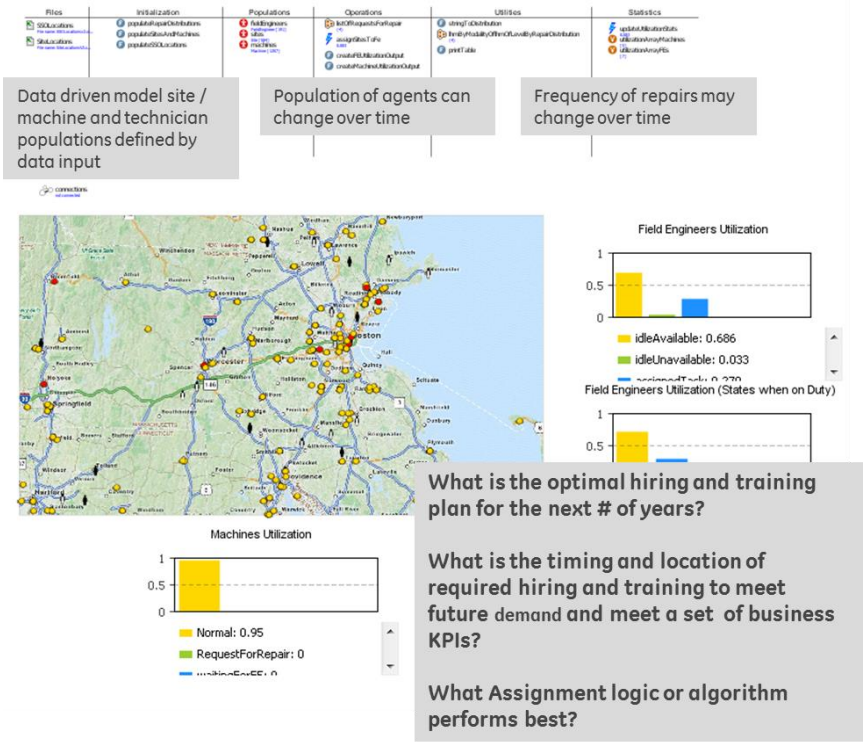

Figure 1. Agent Based Simulation Model for Manpower Forecasting

3 SIMULATION – OPTIMIZATION FRAMEWORK

A plain integer optimization model is used to determine the optimal number of technicians needed to satisfy the desired service level agreement while minimizing the total cost. This model is being solved in Matlab using the Gurobi Optimizer solver for the aggregate expected number of repair requests for the entire duration of the period of interest (approximately a calendar year). The technician number and configuration is then validated from multiple replications of runs of the simulation model which may provide additional constraints to the optimization model in case of multiple occurrences of infeasibility (note that the optimization problem was solved for the aggregate and expected demand throughout the 1-year period. Apart from the aforementioned "outer loop" optimization there exists an optimization model within the simulation that can determine the expected optimal shifts for each technician in order to further minimize costs and response times.

4 BENEFITS

The designed robust simulation optimization framework is capable of analyzing and optimizing future technician target mix for modality specific forecast of service requests by region and testing alternative assignment algorithms to optimize service level and minimize costs. For the validation of the framework, the model has been run and compared against real historical GE data.