Geisinger, a large regional medical center, has been on the forefront of innovative solutions to clinical and operational issues. GMC has recognized the critical part their logistics/supply chain services play in enabling best-in-class care for its patients. This recognition led to the healthcare logistics study we are about to describe which focuses on improving the efficiency and effectiveness of the supply chain to produce a higher quality and more responsive delivery service. This was achieved through a joint effort of Efficiency Engineers, GMC staff and college interns.
The agenda for this presentation begins with an explanation of the problem, and then continues to describe and demonstrate the simulation model that was developed as a key tool for addressing the problem. I’ll then discuss future work opportunities and then we’ll have time for questions at the end.
In most hospital environments, the logistics is a quagmire of locally dispatched services with overlapping pathways. Geisinger Health Systems, a large regional health system covering 43 counties in Central PA, identified this problem. Their Supply Chain Services team during a LEAN event, discovered that there were over 18 different groups delivering everything from mail to meals to supplies to & from inpatient units. Not only was this an obviously over complicated request and delivery process and a waste of logistics resources, but it was also greatly impacting patient care on each and every inpatient unit.
To verify the logistics complexity impact, work sampling studies were performed in all Work Sampling of Inpatient Units

- Examined 18 units
- Covered all hours and all days of week
- 98% accuracy
- Total of 404 hours, 44,200 data points

Survey of Clinics

- What services utilized
- How many patients involved and when

Results showed that Nurses spend over 18% of their working day performing Non-Value Added activities, the majority of which are LOGISTICS related:

- Searching
- Retrieving
- Ordering

Informal storage points = increased inventory
SCS team wanted to see what the impact of the complexity of the logistics system really was and how best to service the PATIENT in better ways. Needed to fully understand the existing system, include all stakeholders from the beginning of the process.
Eliminate/reduce the silos of delivery and form a patient centered logistics system.....
Why can’t we get the logistics time/energy reduced by the nursing staff to gain time back with the patient?
The primary tool used for this project was a discrete event simulation model. In general, simulation modeling is a useful tool for performing any kind of process design and improvement project. It is valuable for observing both current and future state systems to analyze existing performance and predict future behavior. This allows for a much better chance of selecting the optimal solution, especially when dealing with a complex system with many interacting components.

From a change management perspective, simulation can quantify changes and improvements to help stakeholders visualize the benefits of those changes. Along with this also comes increased enthusiasm for the change as the potential benefits seem more concrete and justified.
The simulation model itself can be thought of in two parts.

The first part is the nodes and pathways which together make up the physical layout of the hospital. As supply chain and logistics staff move throughout the hospital network, this data controls where they go, how they get from one point to another, and how long it takes based on the distance travelled and potential congestion encountered based on location and time of day. Elevators are also incorporated into this data to control travel between floors and handle appropriate waiting times for elevator availability.

The second part of the model contains the supply chain departments that are travelling the highway system of the hospital. Typical departments would be Linen, Storeroom, Pharmacy, Patient Transport, Food, and Mail, among others. These departments are accessing the pathways, but there is also the additional elements of who, what, why, and how they are transporting. While it sounds complicated, part of the setup of the model involves identifying trip types for a department which essentially categorizes the department behavior. This will be explained in more detail later.
The hospital logistics model is comprised of two main pieces. There is a database that is used for setting up and storing a lot of the key data required to run the model, and there is the simulation model itself which contains a live connection to the database so that as the model runs it is accessing the database rather than loading or importing all the base data into the simulation file.

We’ll begin looking at the database and the pathway and trip type data first. Then we’ll switch to the simulation file to see how departments are modeled and what the output looks like.
From the main menu in the database, you can access the ‘General Data Setup’ area where the base data for the model is entered and maintained. There’s only time to briefly mention the components here, but they lay a very important foundation for the model. There is elevator data, including timing information for average wait times and floor travel times. There is a node listing, which identifies locations in the hospital network typically representing a starting or ending point for a delivery or pickup, or a decision point like an intersection or an elevator. Next is the department setup, which follows the nodes because we need to assign each department to a node so that the simulation knows where that department is physically located. We also have a resource listing, by department, to track how many resources are available by shift. Shifts are set up separately in the simulation as well. Then comes the distances, which is a very important piece. This defines the segments in the pathway by connecting two nodes. This also defines valid paths between two nodes by only allowing travel down defined segments, using the distance to calculate travel time based on a defined travel rate. The simulation also considers congestion based on time of day to represent slower travel through busy hallways during peak times. So each of the nodes is assigned a congestion factor which is used in a simple equation each time a travel time between two nodes is required.
Next we’ll take a closer look at the trip types by department, which was referenced earlier relating to the who, why, how, etc. of department behavior.

Each department can have multiple trip types defined which represent the behavior of the logistics transportation by the department. There are four characteristics that define a trip and they essentially represent who, what, why and how the trip is performed.

The Item Type is the WHO. This indicates if the transport is performed by supply chain staff or by a self-guided robot which were in use at the Geisinger facility. The Route Type is the WHAT. This indicates if the transport involves one or more stops along the trip and if those stops are fixed or variable locations. The Trip Behavior is the WHY or the purpose of the trip. Is something being picked up, delivered, and even exchange, or collecting something like trash until a container is full. The Destination Method is HOW a destination is chosen. The destination can be fixed, scheduled, or based on a percentage/probability of choosing from a list of destinations.

The trip types are defined early on in the model development because the required trip types will dictate what data is necessary for each department. So the database...
also contains a data requirements guide that will generate a list of needed data based on the defined trip types for a department.
Another important piece of data defined in the database is the destination option. For non-fixed destinations, the simulation needs either schedules or a listing of locations with usage percentages by department. The schedules can be used to control the timing of trips as well as their destinations. The location lists with percentages end up in distributions that the simulations accesses whenever it needs to select a destination.

There is a lot more important data set up and maintained in the database, but for the sake of time we will switch to the simulation and demonstrate how it models the pathways and departments.
In the simulation model, the node pathway network is modeled using one set of generic node objects and all the distance and routing data is obtained as the model runs directly from the database. So even if there are 100 nodes and 8 elevators, the model only contains one node and one elevator, which greatly simplifies the setup of a new model and improves the performance of the simulation by keeping the file size smaller and the number of physical components at a minimum.

The departments are created in separate sub-windows accessed through the buttons on the main simulation screen. The department sub-windows control the behavior of the logistics duties for the department. This includes the usage of resources, the timing of transport trips, the logic used for selecting destinations and following schedules and the timing for pre and post-trip processing. This is the data that is defined based on the trip type configurations for the department.

The departments are setup in the simulation in such a way that they can be turned on and off using a custom menu, making it easy for the user to run a single department or a customized set of departments rather than all at once.

As the model runs, the main screen of the simulation shows overall pathway usage such as the number of currently active carts or transporters and a breakdown of
where they are located. This includes carts that are in-transit, at elevators, or at a destination in the logistics trip.
At the completion of a run, there are three types of standard results that are generated by the simulation. This data can then be loaded into the spreadsheet for analysis and summarization by a number of pre-defined model reports.

The results include a detailed trip log that shows data like the total trip time and number of stops in the trip which can give us overall statistics about average trip times by trip type and department. Also included are resource utilization results that show the percentage of time that each type of resource spends working. Lastly, there is a node log that records every time a node is passed through or stopped at by department. With this data, you can identify the most commonly used pathways and routes and see which departments have the most common ground and are therefore good candidates to examine closer for process improvement.
Now, we’ll look at some examples of the reports available by loading the simulation results into the database.

From the detailed trip log, there is a report that will compare the simulation data to actual department summary data for use in validating the model against reality. This is an important first step when setting up a new model to make sure that the system is behaving accurately before trusting the model results for altered versions of the system. There is also a report to compare the current simulation run to a previous run for assessing the impact of potential process improvements on a validated model. Similarly, resource results can be compared to both actual resource utilization and previous model runs. The results reports are grouped by department and trip type and the data is separated for weekdays and weekends due to significantly varied department workloads based on the day of the week.
Looking at the simulation node log, the database generates some very interesting reports that do not only summarize node usage by department, but can compare between departments the percentage of matching nodes. This helps to identify the popular node paths and reveal departments travelling the most similar pathways, which in turn can guide process improvements efforts toward department consolidation that is the most natural and least disruptive. Ultimately, that is exactly what we are trying to get out of this model – the identification of key departments with the most potential for “leaning” in the form of increased efficiency and less waste.
Moving forward, once departments have been identified for consolidation, or desiloing, the model can be used to evaluate the impact of combined logistics trips and combined resources. We can then quantify the reduction of waste and improved quality in the form of logistics responsiveness to departmental needs. To date, Geisinger has used this model to justify significant changes to some of the supply chain and logistics departments. The model was helpful in allowing key players to envision the benefits that were possible and to break down the resistance to change that so often stands in the way of process improvement.

Model Uses

- Focused Lean/PI teams to
  - De-Silo hospital logistics where appropriate to improve efficiencies
  - To reduce waste and improve quality in areas found to be most critical

*(All based on results of simulation analysis)*
Specific results which have been achieved include: COC concept, initial silo consolidation with increased delivery cycles and NO additional staff.

Initial Results

- Realized need for logistics coordinator on each unit – concierge of care concept developed and under pilot
- Consolidated Linen and stockroom runs and are piloting mail
- Have increased delivery cycle from 1/day to 3/day with *no additional staffing*
Continuing to utilize model and wisdom received from first wins, we expect to continue to fold in more silos, determine the best method of dispatch within the walls of the hospital and then to roll the concepts out to the other hospital sites within Geisinger.
Thank you for your time and interest in this study of healthcare logistics. Please do not hesitate to contact us at any time for additional questions and follow up.