Optimization of Surgical Supply Inventory and Kitting

By
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B.S. in Operations Research, The United States Military Academy, 2003

Submitted to the MIT Sloan School of Management and the Engineering System Division in
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and
Master of Science in Engineering Systems

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Massachusetts Institute of Technology

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Abstract

This project centered on inventory optimization for operative custom surgical packs and soft good supplies for Massachusetts General Hospital (MGH), a 947-bed medical center. Custom surgical packs are used in every surgical case and delivered to the hospital by a vendor who manufactures them off site. These large packs contain unwrapped surgical items (drapes, gown, sutures, etc.) delivered to each operating room prior to the start of surgery. Once a surgical pack is opened, the items inside are consumed or wasted. MGH uses the custom packs to reduce the amount of time warehouse associates spend picking individual items and to reduce preparation time in the operating rooms prior to the patient arriving. To augment the custom packs, individually packaged and sterilized items (called soft goods) are requested by the surgeon for each case. Specific case information, surgeon's preferences for materials, and patient needs dictate these soft good supply requirements. Soft goods are ordered from separate vendors and together with the custom packs comprise a surgeon's preference card.

The hospital orders custom packs and soft goods with the intent to keep three days of supply on hand or to fill shelf space, whichever is greater. This situation triggers bloated and redundant inventory stores throughout MGH. Despite the sub-optimality of this policy, no analysis had informed hospital leadership of the correct levels of inventory or the best ways to cover preference cards.

To solve these challenges, we formalized an optimization model that minimized the purchasing and holding costs of custom packs and soft goods while satisfying the supply requirements of all preference cards. As an input, the model used all current pack configurations and new pack configurations born from the overlaps of current surgical packs. Base stock reductions are achievable through covering "sibling" procedures with the new combined pack configurations and picking displaced items as soft goods. The model results revealed a modular pack structure as the most cost effective method to cover all preference cards. The new modular pack structure prescribed replacing 14 of the 65 current packs with 16 smaller packs to reduce overall value of inventory on hand. Currently, we estimate that this work will save the hospital in excess of $1.3M annually by reducing inventory on the shelf and lowering associated holding costs through risk pooling.

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I would be remiss if I didn't also thank my MIT team for their continued support on this project. Specifically, thanks goes to Retsef Levi[7] for his continued support of the MIT-MGH relationship and the individual focus he gave my project. His passion for healthcare and coaching abilities guided me along at the most difficult times. David Simchi-Levi's[8] supply chain knowledge and expertise helped me to fully understand the implications of my recommendations on MGH's supply system. Finally, none of my recommendations would be possible without Cecilia Zenteno[9]. She mentored me and helped develop the model on which I optimized MGH's supply requirements.

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Chapter 1: Introduction

1.1 Background

With insurance companies willing to pay less for procedures, a traditional means to increase bottom line figures at hospitals has been to increase hospital capacity and utilization rates to squeeze every possible dollar out of available resources. Currently, hospitals are paid based on billings to diagnosis-related groups (or DRGs). DRGs pay a lump sum of money based on the classification of a procedure performed. With ever increasing demands placed on healthcare resources, a corresponding demand on the supply needs of the hospital follows. Hospitals need to be ever-mindful of supply expenditures and money tied up in inventory of the shelf. The cost of supply directly detracts from DRG lump sum payments, affecting the hospital's bottom line.

1.2 Massachusetts General Hospital

Massachusetts General Hospital (MGH) is the third-oldest general hospital in the United States. Situated in Boston's West End, MGH is New England's largest hospital with 947 beds. The surgical ward at MGH hosts 36,000 operations per year in 70 operating rooms (of which about 56 are active on a daily basis).[10] In 2012, MGH received accolades as the #1 hospital according to US News and World Report. MGH has a stellar record of innovation. The first demonstrated use of inhaled anesthetic occurred in the hospital's Ether dome in 1846. Since then, MGH continues to lead in education and research while affiliated with Harvard Medical School. For the last five years, MGH and MIT have fostered a collaborative relationship between the Leaders for Global Operations (LGO) Program and the Perioperative Services Group to provide continuous improvement opportunities to the hospital and research opportunities for students.

1.3 Surgical Supply

In the summer of 2011, MGH opened the Lunder building. Lunder provides state of the art emergency and surgical spaces and connects to the buildings that house the existing operating rooms (ORs) in the White, Gray, Blake, and Jackson buildings (see figure 1). These other buildings are now collectively referred to as the legacy buildings. The design of having two surgical clusters relatively distant from one another, Lunder and legacy, complicates supply stocking and delivery. To make matters more complex, in conjunction with the opening of new surgical spaces in the Lunder building, the hospital evolved its

[10] *Hospital Overview*. Retrieved January 31, 2013, from www.massgeneral.org: http://www.massgeneral.org/about/overview.aspx

supply processes. Under the old system, nurses assigned to each case scrambled around before surgery to retrieve the necessary supplies and instruments needed. With the opening of Lunder, MGH allocated dedicated space for centralized sterilization and warehousing of surgical supplies to serve both the Lunder and legacy ORs. Instead of using highly skilled nurses to retrieve supplies, the hospital could now employ a staff to pick surgical supplies from a central inventory pool for delivery to operating rooms. Along with a change in location of the surgical inventory came a change to the kitting of supplies. The previous system employed nurses and associates to retrieve individual items. A new system employed since 2011 uses surgical kits fabricated by a vendor and delivered to MGH in bundles to the warehouse. These bundles, called custom surgical packs (CSPs), contain the majority of supplies needed for standard categories of surgeries. The CSPs help save the time of the highly skilled nurses by eliminating the need to open the packages of many surgical supply items. CSPs make supply retrieval and OR preparation easier through consolidating and wrapping surgical goods in one bag instead of individual bags. As an added bonus, CSPs reduce the chance of picking the wrong individual items, known as soft goods. The hospital pays a premium for the CSPs, however, hoping to offset the costs by saving money in nurse overhead and supply picking.

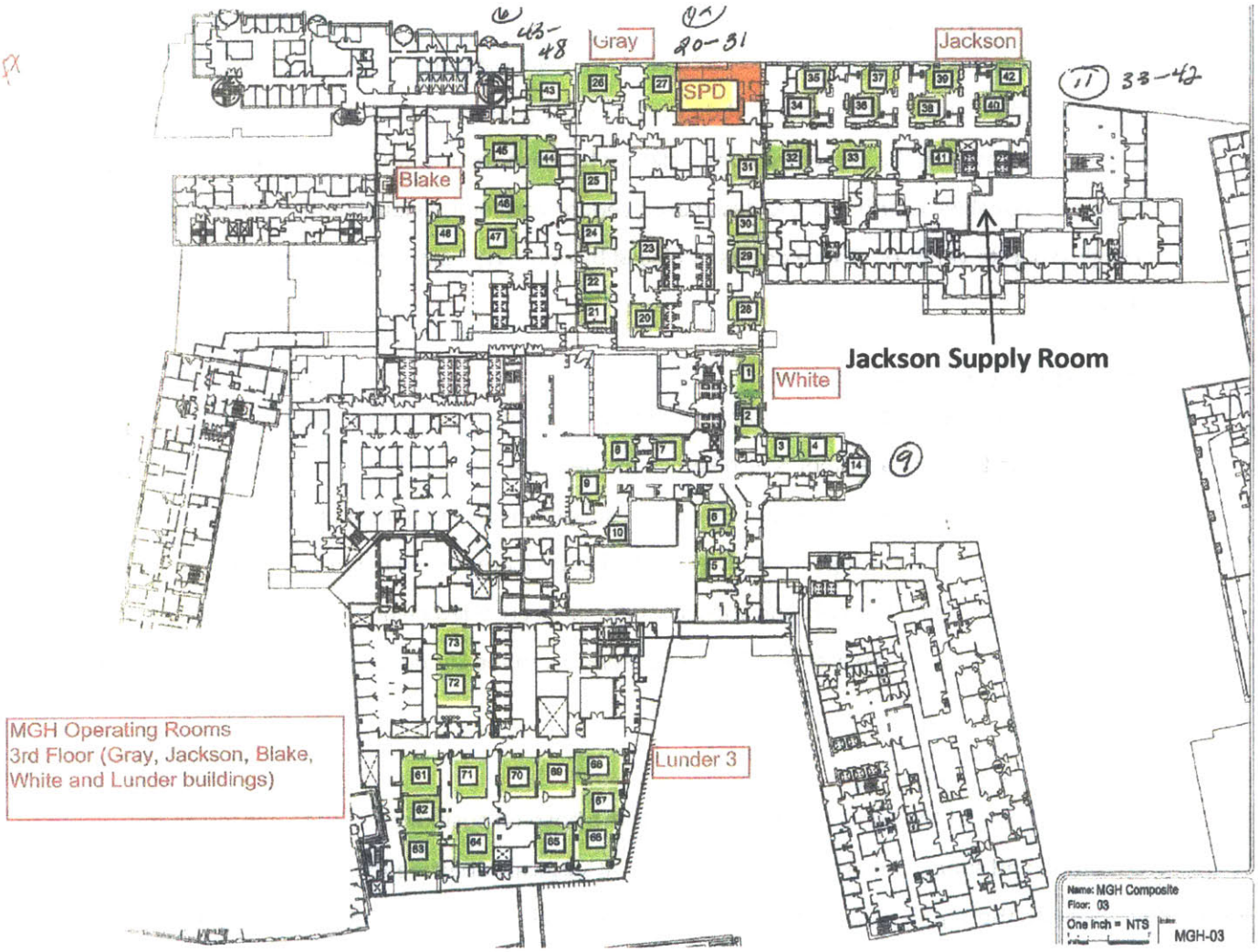


Figure 1: 3rd Floor OR Schematic (All Buildings)

1.4 Supply Fulfillment Process

The MGH supply fulfillment process has changed rapidly since the opening of the Lunder building in the summer of 2011. The perioperative supply process is diagrammed below and made up of four major components: the supply ordering process, the stockroom process, the supply request process, and the surgery process.

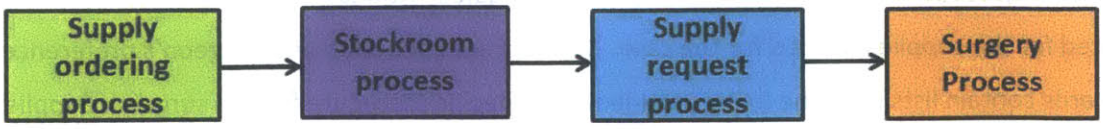


Figure 2: Supply Fulfillment Processes

1.4.1 Supply Ordering Process

The supply ordering process starts each weekday when an associate scours the shelves of the warehouse and identifies the items that do not meet the prescribed base stock (order up to) quantities. The term "par level" is the preferred nomenclature for base stock at MGH. An order is placed for customer surgical packs through the designated vendor and for individual items, called soft goods, through separate vendors. These orders, if placed by noon, typically arrive the next business day around 2 P.M.

1.4.2 Stockroom Process

Once an order arrives, the associates at the hospital stock the main supply warehouse in the Lunder basement. The Lunder basement is also known as the Central Sterile Processing and Supply Department or CSPS-not to be confused with the CSPs-custom surgical packs. Other supply rooms (the Jackson supply room for one) in the legacy buildings of the hospital are resupplied from the Lunder warehouse. In turn, many OR supply cabinets and specialty item carts are filled nightly from supplies delivered to the Jackson supply room. This waterfall of supplies stems from the Lunder warehouse to the extremities of the hospital.

1.4.3 Supply Request Process

With the opening of the Lunder building in 2011, the hospital positioned itself to centralize the sterilization and supply departments that service all surgical departments. The new space allowed MGH to reevaluate the supply request process for each surgical case. Every surgical procedure at MGH requires a unique set of supplies based on surgeon's preferences, patient needs, and potential emergencies that arise during the surgery. In order to simplify the on-time delivery of supplies, the hospital adopted a centralized warehouse system as the prime means to deliver the necessary supplies for each case. A complete supply list for a surgery contains soft goods, a custom surgical pack, and instruments. Some standby soft goods are generally requested for each case and kept separate in case of emergency. A supply list for a sample case, called a preference card, is shown in appendix 1.

The supply request process starts when a surgery is scheduled. At this time, a request is automatically generated for the supplies needed for the case. Supplies are annotated on a surgeon's preference card. These cards contain lists of all the items pertinent to a specific procedure for one surgeon. Supplies are gathered in the warehouse and placed on a cart for delivery to the OR the night before surgery is performed. Associates fill the carts with about 75% of the necessary items in the warehouse. The remaining 25% of items marry up with the carts at specialty locations (clean cores or operating room

cabinets) throughout the hospital closer to the ORs. The rationale for this process is that the surgical departments entrust more responsibility to trained OR specialists to pick specialty items. These items may be very specialized and require extra attention in the picking process to ensure the correct item is picked. For example, an orthopedic surgeon often won't know the exact size knee implant until he/she evaluates the anatomy of the patient during surgery. This delayed specialization during surgery necessitates that implants reside close to the ORs for quick delivery. These are all reasons for picking the remaining 25% of items outside the central warehouse. For this reason, not all legacy supply systems have become extinct and centralized. Outside of implants which are delivered in surgery, all items eventually make it on a case cart and to the OR prior to the start of surgery.

A key component of the supply list for each case cart is the custom surgical pack (CSP). CSPs are used in every surgical case and delivered to the hospital warehouse by a vendor who produces them at its facility. These large packs contain unwrapped and sterile surgical items (drapes, gown, sutures, etc) picked for transport and placed on a cart in the warehouse prior to the start of surgery. Once a surgical pack is opened during surgery, the items inside are consumed or wasted, as the items are not individually wrapped for reuse. Custom surgical packs deliver goods that tend to be standard for a given procedure. The hospital currently uses 65 CSPs for various procedures. MGH uses the CSPs to reduce the amount of time warehouse associates spend picking individual items and also to reduce preparation time in the operating rooms prior to the patient arriving. A nurse's time is very valuable, and operating room turnover time is crucial to the hospital's profitability. Because of these pressures, it benefits the staff to have as few items to unwrap as possible while preparing the room for surgery. The timed saved opening sterilized wrapping on individual items led to the current CSP system.

The CSPs do not contain the exact mix of supplies needed for each surgical case type. To augment the CSPs, individually packaged and sterilized items (called soft goods) are delivered to the surgeon for each case on the same cart. Specific case information, surgeon's preferences for materials, and patient needs dictate these soft good supply requirements. The specific requirements for each case and each surgeon are specified through preference cards. The preference card requirements are filled by a combination of CSPs and soft goods. Figure 3 shows the regions where instruments and supplies are picked for each case prior to arrival at the operating room. We only considered the CSPs and soft goods in our analysis, as instruments are reusable tools. The standby items mentioned previously are encompassed in the soft goods on a preference card.

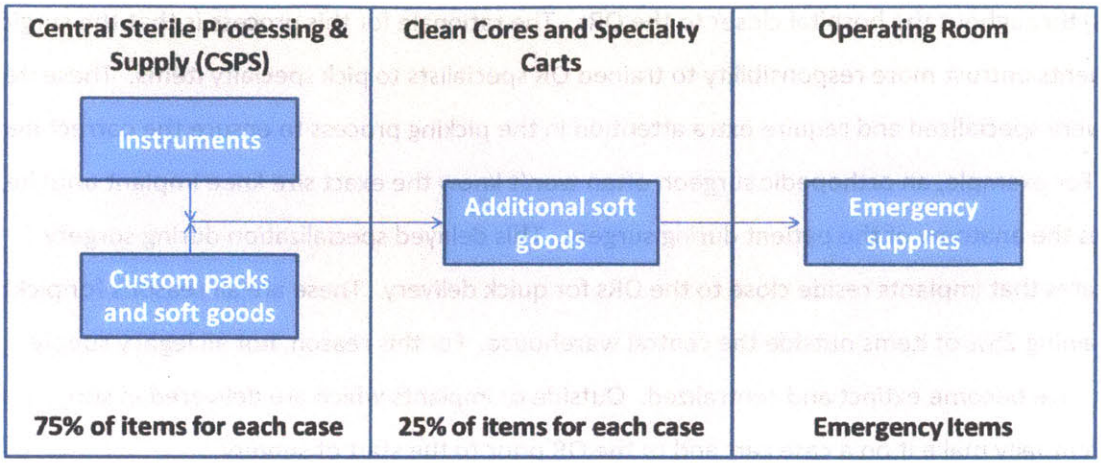


Figure 3: Supply Fulfillment Locations

1.4.4 Surgery Process

The final step in the supply process is the surgery itself. At this point, the supplies are consumed. Supplies from CSPs are consumed or thrown away at the end of surgery. Soft goods arrive on the case carts in an individually wrapped and sterilized fashion. In principle, these goods can be returned to the warehouse if unopened during a case; although, sometimes the staff disposes of or damages the soft goods by mistake. Restocking serviceable soft goods sent back to the CSPS in Lunder can be a timely process for an associate in the warehouse.

1.5 Supply Fulfillment Challenges

This project focuses on solving some of the problems found in the aforementioned processes. Specific problems within each process are highlighted in table 1. Discovering these challenges and the subsequent inquiry into their root causes is based on data analysis, supply usage observations, and key stakeholder interviews.

The ordering process has three main issues. First, employees place orders for supplies while mistakenly disregarding orders already in the pipeline. Additionally, soft good par levels don't reflect the advent of the new custom surgical pack (CSP) fulfillment system. Little coordination has been done to reconcile soft good par levels now that many surgeries are now supplied with most of the needed materials via the CSP. Soft goods and CSPs are not ordered in a coordinated way. Each class of supply is ordered ignoring the existence of the other, adding to the lack of system-wide cost consciousness. Finally, the current CSP composition doesn't consider the impact on inventory levels. To address these issues, my project will 1) advocate a new ordering timeline so associates always know the inventory position when

ordering 2)optimize the costs of ordering, holding, and picking soft goods and CSPs and 3)prescribe new par levels and compositions for CSPs.

The stock room process causes redundancy issues and the bloating of inventory levels. Keeping stock in multiple locations is an artifact of the legacy system, and also a sign that trust has not been given completely to the centralized supply process. In an emergency, surgical staff wants to take only a few steps to find an item. Due to time constraints, this project did not tackle the problem of too many inventory locations throughout MGH, but recognizes it as a key area of improvement for future projects.

The supply request process has issues that stem from a lack of standardization. Currently, there is a lack of standardization of preference cards for identical surgeries. For example, due to individual preferences, one surgeon might request sixteen unique soft goods in addition to the custom pack for a gastric bypass surgery, while another might request three for the same type of procedure. Some surgeons might also request different amounts of the same soft good. Surgeons do not have standard preference cards for nearly identical procedures. Surgeons also tend to over-request the quantity of items needed for each case to err on the side of caution. CSPs are not surgeon specific, but procedure oriented. The hospital orders CSPs and soft goods with the intent to keep three days of supply on hand or to fill shelf space, whichever is greater. This policy triggers inflated inventory levels throughout MGH that are not congruent with the actual demand realized. Conservatism promotes stocking more inventory than needed. The hospital can typically order a supply and have it delivered the next day, but three days of supply acts as an additional buffer to prevent shortages. Despite the sub-optimality of this policy, no analysis had informed hospital leadership of the correct levels of inventory or the best ways to cover preference cards. In this project, I tackled the right-sizing of par levels, but left the standardization of preference cards for future work.

Finally, the surgery system in the OR causes issues with tracking supply usage. Suppose a surgeon requests ten sutures for a case, but ends up needing fifteen for a specific patient. Problems arise when staff remove an extra handful of sutures from the OR supply cabinet to make up the difference. Sometimes this handful contains the five sutures needed. Other times, the nurse may grab seven sutures instead of the five needed. The extra two sutures are sometimes returned to the Lunder basement instead of to the OR room cabinet stock, creating the illusion that the surgeon did not actually use all ten sutures requested. In actuality, the surgeon used fifteen, but careless accountability can make it seem that only eight were used because two sets were returned. To alleviate this problem, the hospital will install a bar coding system to track every supply to the patient in the coming months.

Issue	Addressed in this project	Left for future work
Ordering without regarding pipeline stock	✓	
Lack of coordination between soft good and CSP channels of supply when setting par levels and ordering	✓	
Inaccurate CSP base stock (par) levels and suboptimal CSP composition	✓	
Redundancy of inventory (too many inventory locations)		✓
Lack of preference card standardization		✓
Over-requesting of supplies for surgery		✓
Supply tracking during surgery		✓

Table 1: Process Issues

1.6 Project Focus & Approach

This project is the first attempt to rigorously model all of the costs involved in MGH's supply system and design a new approach to robustly minimize those costs while respecting the service levels required at the Perioperative Services Group. The objective of reducing the overall purchasing, holding, and picking costs of CSPs and soft goods can best be achieved by the following: 1) modularizing the pack configurations and covering multiple preference cards with new pack configurations that help to reduce overall variability and safety stock in the system 2) evaluating and redesigning the supply delivery schedule and 3)analyzing and reconfiguring the contents of current CSPs to eliminate waste.

In order to solve the challenges of inefficient supply fulfillment, we formalized an optimization model intending to minimize the total purchasing costs and holding costs of custom packs and soft goods while satisfying the supply requirements of all preference cards. Taking the surgeon's preference cards as an input, we designed a model that finds the best (least costly) way to fulfill the needs using CSPs and soft goods. Specifically, the model optimizes the CSP configurations and CSP and soft good inventory levels required to maintain a very high likelihood of meeting requirements. In particular, there was no guarantee the current configuration of the hospital's CSP structure was optimal. To provide alternatives to the current system, we seeded an optimization model with potential new CSP configurations. The model would use new pack configurations to see if the hospital could gain some efficiencies by supplying

procedures that previously used different packs with the same pack. The financial savings incurred is in the reduction of the safety stock created through inventory pooling as the relative variance of CSP demand decreases by combining the demand of several CSPs into one. As an input, the model used all current pack configurations and new pack configurations we fabricated from the overlaps of current packs that shared similar items. For instance, two packs which overlapped to a large extent led to the creation of a new pack that contained the common items.

We conducted additional efforts to model and reduce the cost of the entire supply system by analyzing the sequencing of ordering and supply receipt. Finally, we conducted analysis on the validity of small sub-packs inside the CSPs, called circulator packs. These packs existed due to the uncoordinated CSP and soft good ordering processes. Originally, circulator packs were meant to carry items typically used during initial patient preparation and OR room setup. These separate bags helped the nursing staff to identify setup supplies early and separate them. The circulator packs carried an extra processing surcharge of 7%. We looked for ways to pick these items as soft goods and remove the costly circulator packs altogether, thereby eliminating the superfluous surcharge.

1.7 Results

The optimization model results revealed a modular pack structure as the most cost effective method to cover all preference cards. The new modular pack structure prescribed replacing fourteen of the current CSPs with sixteen smaller CSPs to reduce the overall value of inventory on hand. The model prescribes new base stock levels for all surgical packs and soft goods. Future work should be conducted to perfect the inventory levels and locations of all soft goods. Solving this problem has the potential to bring in greater financial savings than modularizing custom packs based on the sheer volume of soft goods purchased. Additionally, we propose shifting the ordering timeline to help reduce the need for buffer stock by receiving supplies earlier in the day, thereby decreasing the safety stock required to cover the daily demand. Finally, we propose removing the circulator packs. The financial impact of these changes conservatively estimates the hospital will save $1.36 million annually.

Chapter 2: Supply Chain

2.1 Supply Chain Design

An associate in the Lunder warehouse (known as the Central Sterile Processing and Supply Department or CSPS) places orders daily from Monday through Friday. Thursday's order must account for forecasted weekend demand. As long as an order is placed by noon, the items will arrive the next day to the warehouse loading dock between 2-5 P.M. Every day, some key supply locations throughout the hospital will retrieve needed items from the main supply in the Lunder CSPS. In addition, certain operating room specialists have the ability to place purchase order requests for specialty items under their purview. These items go through the same purchase order and validation process and get delivered along with the bulk of other supplies. Figure 4 details the chronology of the ordering and case-picking processes. This figure depicts the arrival of supply and the timing of when associates pick inventory off the shelves for the next day's cases using colors as a guide.

The hospital orders from a list of 2,000 items each year, some used multiple times a day and some used only once per year. Each morning an associate scans the shelves for a dearth of inventory and annotates discrepancies where inventory levels and par levels mismatch. At the end of his survey, he sits down with a representative from the vendor to discuss the day's orders. The ordering associate and vendor tend to massage the numbers and discuss if items really need to be ordered with disregard to the actual par level on the shelf. These hunches take into account orders from previous days that have not arrived.

The hospital starts picking supplies for the next day's surgical cases around noon. Due to the arrival of orders, the inventory on the shelf on Monday has to be plentiful enough to cover all of Tuesday's cases and some of Wednesday's cases. As an example, on a Monday an order is placed. Due to the timing of the order, that inventory is not typically available for picking until late Tuesday based on its arrival and stocking to the shelves on Tuesday afternoon. Thus, on Monday, the inventory levels on the shelves must account for the total case volume on Tuesday and Wednesday, since these cases are picked before the Monday's shipment has been fully stocked. Figure 5 describes this inventory use schedule in more detail.

At the onset of this project, MGH used a version of a base stock model to account for restocking their shelves. MGH set par levels to dictate how much supply should be kept on the shelf. Generally, these par levels directed the order-up-to points for all items in the supply catalog. Appropriate par levels were set with the intent to carry three days of supply. MGH materials managers and the vendor loosely analyzed historical demand to arrive at the correct figures for these levels. Par levels exist for every

item in every location throughout the hospital. The current ordering process often relies on remembering the order quantities from previous days when placing the current day's order. This practice necessitates a revision of the ordering timeline so the associate does not need to rely on his memory.

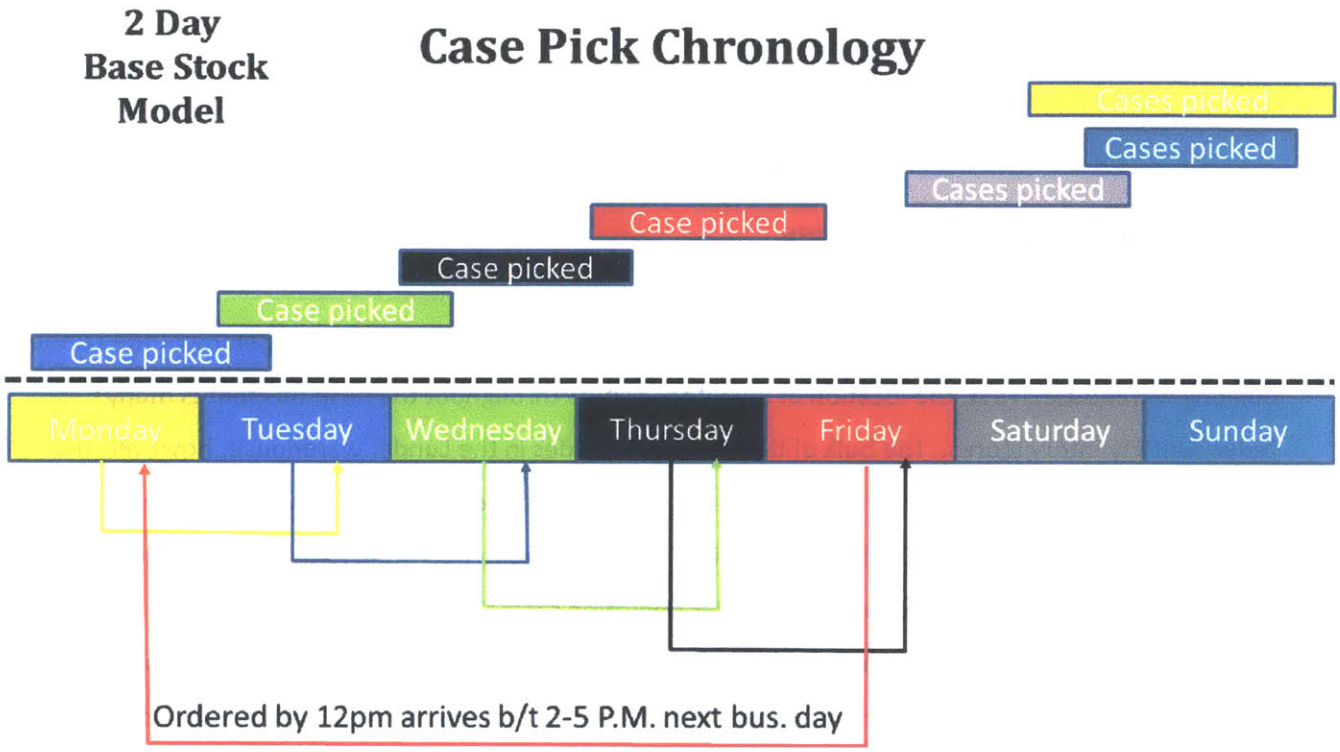


Figure 4: Resupply and Case Pick Chronology.
"Case picked" bar highlights the timeline for retrieval of the supplies for the day with the same color

Order placed on	Ordered stock first available for picking	Inventory on hand on order day must cover cases on
M	W	Tu, W,
Tu	Th	W, Th
W	F	Th, F
Th	Sa	F, Sa, Su, M
F	Tu	M,Tu

Figure 5: Inventory Use Schedule

2.2 Supply Network Challenges

Redundant Inventory

The MGH supply chain design has some significant challenges posed by the recent opening of the Lunder building warehouse. First, the location of inventory depots throughout the hospital creates many redundant inventory stores. The bulk of the inventory resides in the Lunder warehouse; however, the hospital maintains over 70 other inventory locations closer to the operating rooms. This is a legacy of the old system. The Jackson Supply room services the older legacy operating rooms in the White and Ellison buildings with additional supplies. Newer operating rooms in the Lunder building have special supply areas called clean cores that exist to provide supply closer to the point of use. Clean cores resides central to a cluster of operating rooms that share a common hallway. Additionally, each individual operating room has various supplies. Finally, many surgical services have specialty carts that carry items unique to one surgical service. Examples of these specialty areas include the implant room for orthopedic surgery and the cardiovascular cart for heart procedures which might carry heart valves and other cardio-specific equipment. Despite the push to centralize the supply chain, little thought has been given to reevaluating and consolidating the locations where inventory is stored throughout the hospital. The feeder supply of many of these room and specialty carts comes from the Lunder warehouse; however, a few select locations retain the ability to order their own supplies without respect to the overall usage of the entire network. Figure 6 depicts a schematic of the OR layout for the 3rd floor operating rooms. Each OR maintains its own local room-stock and the clean core maintains stock of many items. Stock locations are highlighted with a red circle in figure 6. Similar setups exist in the White, Gray, and Blake buildings in figure 1.

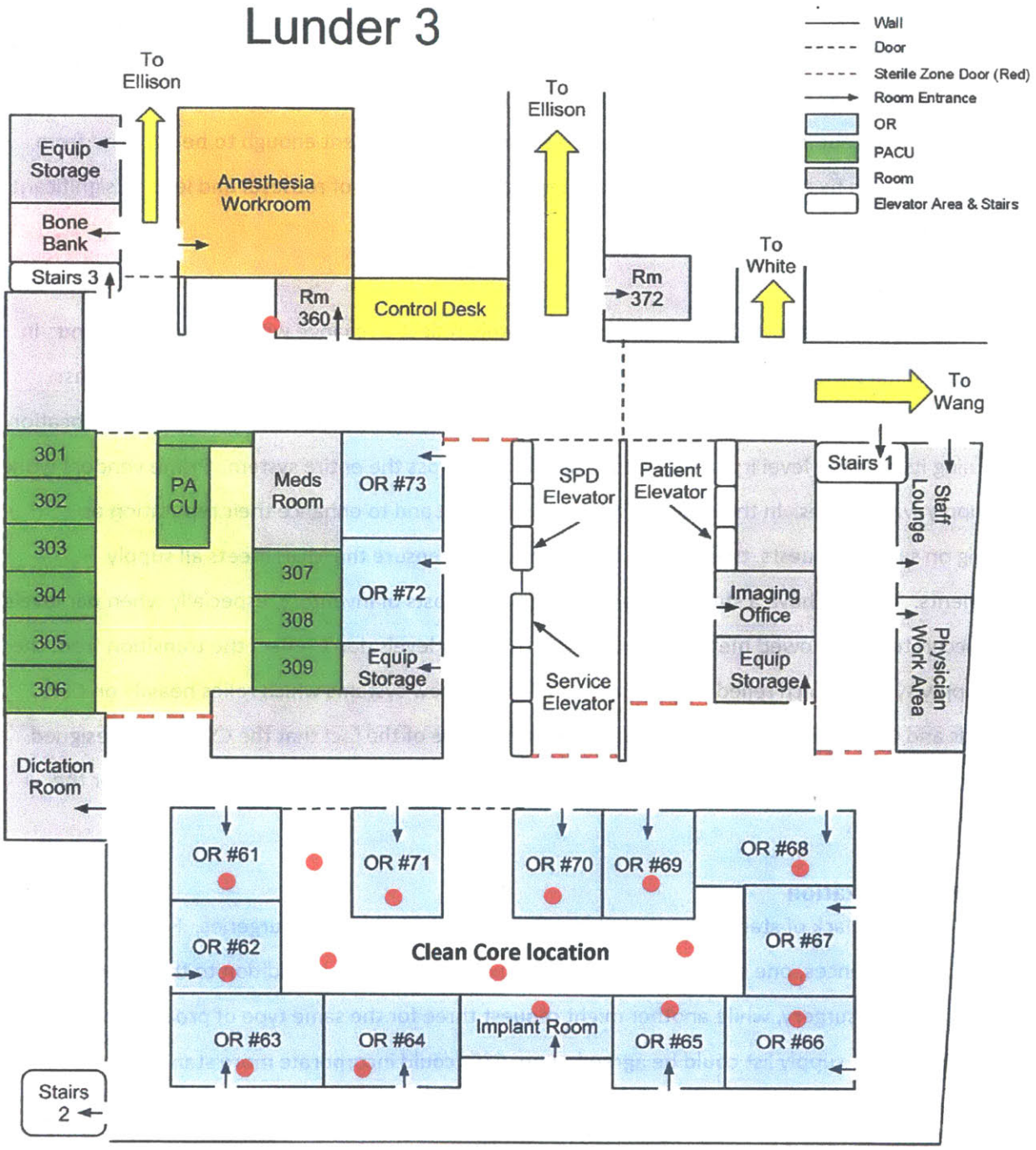


Figure 6: Lunder 3 OR Schematic

Legacy Systems

Before the opening of the Lunder building, nursing staff accumulated and opened the supplies necessary for each case. This required supplies to reside close to the point of use in the operating rooms. Because old habits die hard, nurses and surgeons don't fully trust the centralized supply system to work when a surgeon requires an expedited item. Nurses do not feel comfortable completely relying on the central

warehouse for the totality of their supply needs. While some commonly needed items should probably be kept close to the point of use in the rooms, the inertia to move away from previous methods to the new system causes some of the over-stocking of redundant inventory locations. Determining which supplies should be kept in room stores and which supplies are not urgent enough to be supplied from central locations can fix some of the trust issues regarding immediacy of retrieval and lead to significant reduction in the total inventory level.

Inaccurate Par Levels

The prescribed par (or base stock) levels do not accurately reflect or change with historical demand. In setting up hospital policy, it was determined that three days of supply was needed to buffer against stock-outs. Dated analysis determined 3-day par levels across the hospital, with each individual location determining its own par level irrespective to supply usage across the entire system. Prime vendors work in the supply warehouses. In their own best financial interest and to enhance their reputation as delivering on supply requests, they help to order amounts to ensure the MGH meets all supply requirements. This can have a staggering effect on holding costs of inventory, especially when par levels are not accurate nor followed meticulously. Additionally, par levels don't reflect the transition from the legacy supply system which relied only on soft goods to the new systems which relies heavily on CSPs. Soft goods and CSPs maintain their own par levels irrespective of the fact that the CSPs were designed to replace soft good inventories. In many instances, the soft good par levels did not adjust after the introduction of CSPs.

Lack of Standardization

Currently, there is a lack of standardization of preference cards for identical surgeries. For example, due to individual preferences, one surgeon might request sixteen soft goods in addition to the custom pack for a gastric bypass surgery, while another might request three for the same type of procedure. If a standard procedural supply list could be agreed upon, CSPs could incorporate more standard items and ordering based on historical demand could reduce the variability and lead to reductions in inventory.

Over-Requesting

A tendency exists to over-request items for procedures. A few reasons contribute to this phenomenon:

1. Surgeons err on the side of caution when requesting supplies. A surgeon might remember the one case he/she required ten sutures to close a patient. Instead of requesting the typical amount needed, say four, the surgeon will request ten and return the extras to the warehouse post-surgery. This can create problems when accounting for the inventory position when ordering. Items not on warehouse

shelves only to return later create the illusion of higher demand and empty shelves which leads to over-ordering.

2. Surgeons and clinical staffs do not actively manage their preference cards to identify overlaps between CSP items and soft goods. As long as surgical supplies arrive on time, the staffs do not care the origin of supplies or if excess materials show up. Surgical staffs care about defective products and shortages which might affect patient care.

3. Standby (or back up items) that are rarely used are ordered each time instead of being pooled among surgeries.

Poor Tracking Mechanisms and Supply Accountability

Supply usage is not tracked per patient. The hospital records what is requested for each surgical case. Once inside the operating room; however, supplies pulled from any room or carts are not linked to the patient unless they are high value items that are directly billed to the patient, like implants. Extra unopened soft goods are frequently returned to the warehouse for restocking. This unnecessary travel of items can cause damage to unopened items and increases the risk of contamination of the sterile soft goods in the warehouse. Frequently, in attempts to expedite room changeovers after surgery, some unopened soft goods may inadvertently be swept into waste bins.

Fluid Surgery Schedule

The surgery schedule at the hospital begins to take shape the week before cases start when surgeons schedule into assigned blocks. By 48 hours prior, the perioperative group schedules most surgeries into operating rooms and begins staffing for anesthesiologists and nurses. 24 hours in advance of surgery, organizers finalize room assignments and runners stage supplies for the next day's cases on carts. Despite these efforts, the unpredictable nature of emergency surgery and non-elective (wait list) additions require the hospital to carry inventory to guard against demand spikes for items. The fluid surgery schedule creates another challenge to minimizing inventory levels that is not addressed in this project.

Summary

All of the aforementioned problems in the supply chain system lead to overstocking of CSPs and soft goods at redundant inventory locations in each OR, the clean cores, and the main supply rooms. Holding costs incurred from maintaining excess inventory occur due to over-ordering, lack of visibility on the overlap of soft goods and CSP items on preference cards, inaccurate par levels, poor tracking mechanisms, and the clinical staff's penchant to want to retrieve item expeditiously in emergencies.

The total amount spent on inventory is the major problem that I aimed to solve in this project. An optimal plan to cover preference cards would help to reduce some of the waste while the hospital irons out it central supply processes and work flows.

2.3 Inventory Drivers

MGH's supply system centers on fulfilling the needs for surgeries by first filling the warehouse shelves to the par levels set for CSPs and soft goods. The par levels (set to three day's demand) and the timing of deliveries are the key drivers for the amount of inventory on the shelves. Suppose the daily demand for a surgeon's preference card is normally distributed, then the base stock level (par level) on the shelf in the warehouse should be the expected demand over the delivery lead time and review period—not an arbitrary 3 day par level set by the vendor. Due to the variability in the demand random variable for each preference card, safety stock is carried as a buffer. The safety stock is given by a safety factor based on MGH's desired service level multiplied by the standard deviation of demand over the lead time and review period. Equation 1 below formalizes this idea (B is the base stock (order up-to par) level, μ is the average demand, R is the length of the review period, L is the length of the lead time, z_α is a safety factor, and σ is the standard deviation of demand.)[11] The $(\mu\ (R + L))$ term represents the cycle stock, while $z_\alpha \sigma \sqrt{R + L}$ represents the safety stock.

$$B = \mu(R + L) + z_\alpha \sigma \sqrt{R + L} \qquad (1)$$

Using this equation as guide, we can effectively see that any reductions in lead time (L) or variability in demand (σ) lead to reduced inventory levels. Although we don't explicitly use this equation in calculating base stock levels later on (we use empirical data and the schedule in figure 5), the intuition holds and informs us on the levers to pull to reduce inventory levels. Pooling together the demand for similar CSPs through CSP modularization can reduce the standard deviation of demand and help to reduce the safety stock. This can have quite a large effect taken together with the correlation of many surgeries at the hospital. If preference card demand random variables are negatively correlated, the hospital could carry even less safety stock of CSP if it knows those preference cards relying on the same CSP will not be picked on the same day. The following relationships exist when dealing with random variables of preference card demand and their variances:

1. $Var(X + Y) = Var(X) + Var(Y) + 2*Cov(X,Y)$
2. $Var(aX) = a^2\ Var(X)$
3. $Cov(aX,bY) = a*b*Cov(X,Y)$

[11] Equation presented during MIT class ESD.267J Supply Chain Planning

They will be needed later when determining the safety stock levels for CSPs and items under pooling schemes. The following section detail the ways we propose to reduce inventory by shortening lead times and reducing variability.

2.4 Inventory Reduction

Delivery Rescheduling

Under the current supply delivery scheme, the associate placing orders will not see the delivery of an order placed on Monday until after he has to place the order on Tuesday. It is our recommendation to make tracking the inventory position easier, MGH should change the delivery schedule. By pushing the delivery timeline earlier in the day, the associate will not have to recall the amount of stock ordered on a previous day; instead, he will just take notice of the physical inventory on the shelf. If the order isn't placed until after delivery of supplies and re-stocking of returns, a more accurate order based on need will result. Figure 7 is a depiction of the current ordering and delivery timeline contrasted with a desired future state. A new system will prevent the associate from the over-ordering associated with not accounting for returns from operating rooms or the previous day's order prior to placing the current day's order. Under the new system, an order placed at noon will arrive in the overnight hours. Effectively, this change can reduce MGH's resupply timeline from a 3-day model to a 2-day model. This change could also pave the way for a just-in time (JIT) model delivery schedule in the future. Eventually, this system could lead to a predictive schedule based on the next day's cases, with the safety stock acting as a buffer for emergent cases.

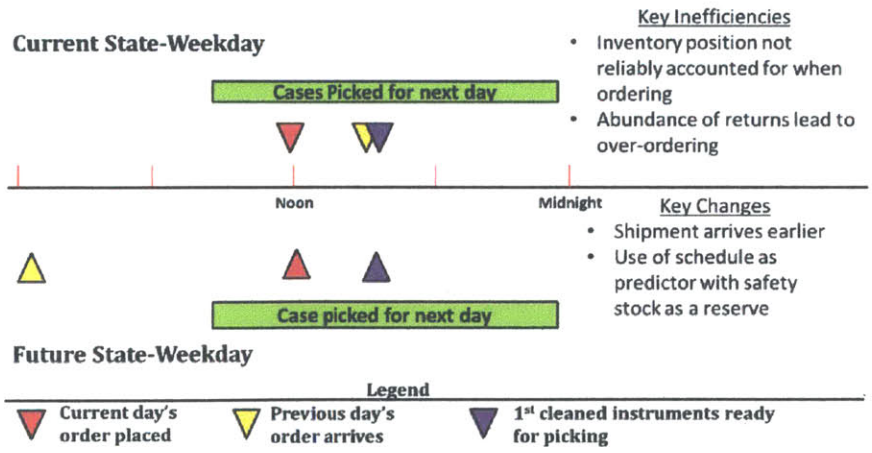


Figure 7: Proposed New Replenishment Schedule

CSP Composition and Pooling

By slightly altering CSP composition, it is possible to combine multiple packs that are highly similar and pool their demand. Aggregation at this level reduces variability and the required safety stock of the new pack when compared to the original parent packs. Reduction in safety stock directly leads to a reduction in holding costs of inventory—equating to money back in the pockets of MGH. Any displaced items can be picked up as soft goods. The effective savings of pooling demand might greatly outweigh the picking of a few individual items per case. Our optimization model discussed in the next chapter revolves around finding the best way to alter CSP composition and modularize them to pool demand and reduce variability.

Chapter 3: Optimization Model Formulation

3.1 Model Goals and Tradeoffs

To understand how to best redesign CSP composition and right-size supply par levels, we developed an optimization model to minimize inventory costs. The goal of our model is minimizing total purchasing and inventory holding costs while satisfying demand as specified by each surgeon's preference card and historical surgical volume. We used picking cost as a constraint. It was our determination that as long as the picking costs didn't increase over 15% of the current levels by changing pack composition, the hospital would move forward with this scheme. The model trades off assigning the CSPs (current and new compositions developed through our analysis) with soft goods to meet the needs of each preference card. Soft goods are labor intensive to pick, while CSPs cost more money for the convenience they offer. The model balances the key tradeoffs in purchasing and carrying inventory and ensuring the adequacy of supplies to prevent stocking out of key items needed in surgery.

3.2 Model Decisions

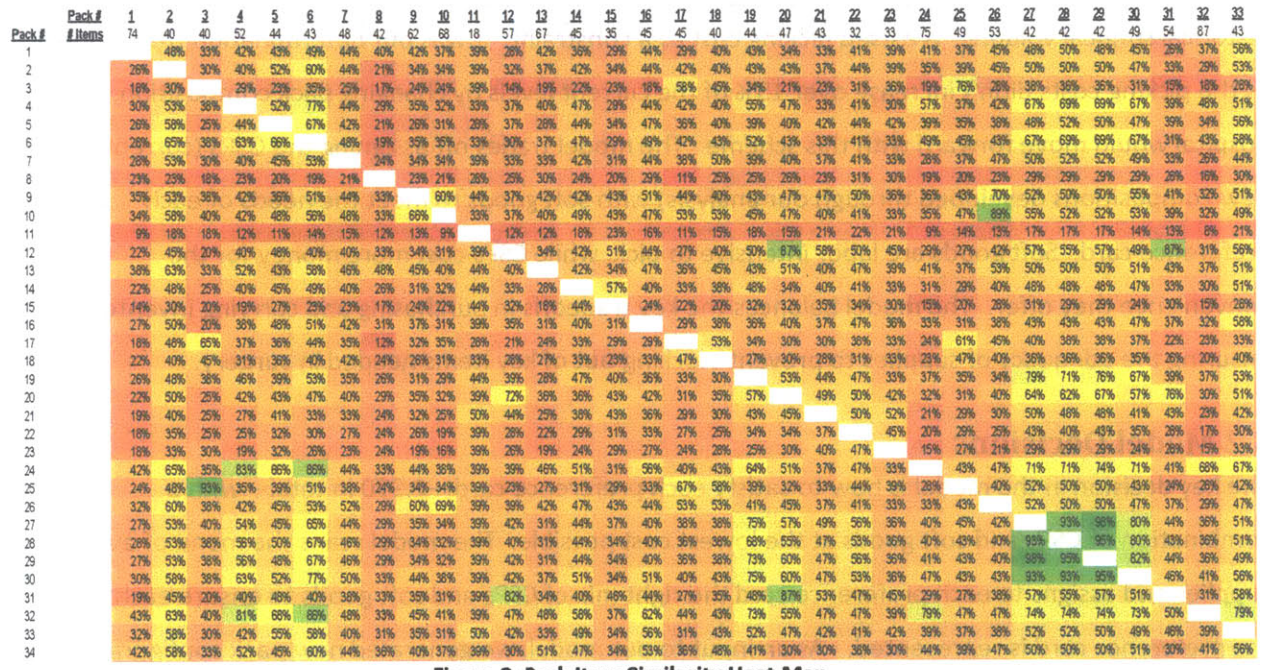
The key decision in the model is how to satisfy each preference card—2,970 in total—with a combination of CSPs and soft goods at the lowest cost possible. The model scans the menu of available supplies and assigns to each preference card the right mix of CSPs and soft goods to ensure each item on the preference card is represented. As an input to our model, we generated new pack configurations and let the model choose the best scheme to supply ORs. Developing new pack configurations by combining highly similar packs has the consequence of displacing some items from CSPs. The model weighs the tradeoffs of the increase in holding costs of individual items with the savings achieved through reduction in safety stock by combining CSPs in our new configurations. Some soft goods might see an uptick in base stock levels due to displacement from current packs as a consequence of CSP consolidation around common items.

3.3 Model Inputs

New Pack Generation

To investigate the benefits of risk pooling among highly similar CSPs, we generated new packs as an input to the model. New packs born from packs with high overlaps became candidates to help reduce inventory through risk pooling and aggregation of demand. The model accounts for the increase in soft good spending as a result of items displaced from the current packs under this pack consolidation scheme. As a starting point, we set the threshold of overlaps to 75% and analyzed the current packs based on the items shared between pack pairs. Figure 8 depicts a portion of the heat map generated to

highlight pack clustering with high overlaps. Colors change from red to yellow to green as the overlap between packs increase. This chart is read as following: the pack denoted in the row is x % included in pack denoted in the column. For example, pack #25 is 93% included in pack #3. The second row denotes the number of items found in each pack.



Pack #	Pack # Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
		74	40	40	52	44	43	48	42	62	68	18	57	67	45	35	45	45	40	44	47	43	32	33	75	49	53	42	42	42	49	54	87	43
1			48%	33%	42%	43%	49%	44%	40%	42%	37%	39%	28%	42%	36%	29%	44%	29%	40%	43%	34%	33%	41%	39%	41%	37%	45%	48%	50%	48%	45%	28%	37%	56%
2		28%		30%	40%	52%	60%	44%	21%	34%	34%	39%	32%	37%	42%	34%	44%	42%	40%	43%	43%	37%	44%	39%	35%	39%	45%	50%	50%	50%	47%	33%	29%	53%
3		16%	30%		29%	23%	35%	25%	17%	24%	24%	39%	14%	19%	22%	23%	18%	58%	45%	34%	21%	23%	31%	36%	19%	76%	28%	38%	36%	36%	31%	15%	18%	26%
4		30%	53%	38%		52%	77%	44%	29%	35%	32%	33%	37%	40%	47%	29%	44%	42%	40%	55%	47%	33%	41%	30%	57%	37%	42%	67%	69%	69%	67%	39%	48%	51%
5		28%	58%	25%	44%		67%	42%	21%	26%	31%	28%	37%	28%	44%	34%	47%	36%	40%	39%	40%	42%	44%	42%	39%	35%	38%	48%	52%	50%	47%	39%	34%	56%
6		28%	65%	38%	63%	66%		48%	19%	35%	35%	33%	30%	37%	47%	29%	48%	42%	43%	52%	43%	33%	41%	33%	49%	45%	43%	67%	69%	69%	67%	31%	43%	58%
7		28%	53%	30%	40%	45%	53%		24%	34%	34%	39%	33%	33%	42%	31%	44%	38%	50%	39%	40%	37%	41%	33%	28%	37%	47%	50%	52%	52%	49%	33%	26%	44%
8		23%	23%	18%	23%	20%	19%	21%		23%	21%	28%	25%	30%	24%	20%	29%	11%	25%	25%	26%	23%	31%	30%	19%	20%	23%	29%	29%	29%	29%	26%	16%	30%
9		35%	53%	38%	42%	36%	51%	44%	33%		60%	44%	37%	42%	42%	43%	51%	44%	40%	43%	47%	47%	50%	36%	36%	43%	70%	52%	50%	50%	55%	41%	32%	51%
10		34%	58%	40%	42%	48%	56%	48%	33%	66%		33%	37%	40%	49%	43%	47%	53%	53%	45%	47%	40%	41%	33%	35%	47%	89%	55%	52%	52%	53%	39%	32%	49%
11		9%	18%	18%	12%	11%	14%	15%	12%	13%	9%		12%	12%	18%	23%	16%	11%	15%	18%	15%	21%	22%	21%	9%	14%	13%	17%	17%	17%	14%	13%	8%	21%
12		22%	45%	20%	40%	46%	40%	40%	33%	34%	31%	39%		34%	42%	51%	44%	27%	40%	50%	67%	58%	50%	45%	29%	27%	42%	57%	55%	57%	49%	87%	31%	56%
13		38%	63%	33%	52%	43%	58%	46%	48%	45%	40%	44%	40%		42%	34%	47%	36%	45%	43%	51%	40%	47%	39%	41%	37%	53%	50%	50%	50%	51%	43%	37%	51%
14		22%	48%	25%	40%	45%	49%	40%	26%	31%	32%	44%	33%	28%		57%	40%	33%	36%	46%	34%	40%	41%	33%	31%	29%	40%	46%	48%	46%	47%	33%	30%	51%
15		14%	30%	20%	19%	27%	23%	23%	17%	24%	22%	44%	32%	16%	44%		24%	22%	20%	32%	32%	35%	34%	30%	15%	20%	26%	31%	29%	29%	24%	30%	15%	28%
16		27%	50%	20%	36%	48%	51%	42%	31%	37%	31%	39%	35%	31%	40%	31%		29%	38%	36%	40%	37%	47%	36%	33%	31%	38%	43%	43%	43%	47%	37%	32%	58%
17		18%	48%	65%	37%	36%	44%	35%	12%	32%	35%	28%	21%	24%	33%	29%	29%		53%	34%	30%	30%	36%	33%	24%	61%	45%	40%	36%	36%	37%	22%	23%	33%
18		22%	40%	45%	31%	36%	40%	42%	24%	26%	31%	33%	26%	27%	33%	23%	33%	47%		27%	30%	28%	31%	33%	23%	47%	40%	36%	36%	36%	35%	26%	20%	40%
19		26%	48%	38%	46%	39%	53%	35%	26%	31%	29%	44%	39%	28%	47%	40%	36%	33%	30%		53%	44%	47%	33%	37%	35%	34%	79%	71%	76%	67%	39%	37%	53%
20		22%	50%	25%	42%	43%	47%	40%	29%	35%	32%	39%	72%	36%	36%	43%	42%	31%	35%	57%		49%	50%	42%	32%	31%	40%	64%	62%	67%	57%	76%	30%	51%
21		19%	40%	25%	27%	41%	33%	33%	24%	32%	25%	50%	44%	29%	38%	43%	36%	29%	30%	43%	45%		50%	52%	21%	29%	30%	50%	48%	48%	41%	43%	23%	42%
22		16%	35%	25%	25%	32%	30%	27%	24%	26%	19%	39%	26%	22%	29%	31%	33%	27%	25%	34%	34%	37%		45%	20%	29%	25%	43%	40%	43%	35%	26%	17%	30%
23		18%	33%	30%	19%	32%	26%	23%	24%	19%	16%	39%	26%	19%	24%	29%	27%	24%	28%	25%	30%	40%	47%		15%	27%	21%	29%	29%	29%	24%	26%	15%	33%
24		42%	65%	35%	83%	66%	86%	44%	33%	44%	38%	39%	39%	46%	51%	31%	56%	40%	43%	64%	51%	37%	47%	33%		43%	47%	71%	71%	74%	71%	41%	68%	67%
25		24%	48%	93%	35%	39%	51%	38%	24%	34%	34%	39%	23%	27%	31%	29%	33%	67%	58%	39%	32%	33%	44%	39%	28%		40%	52%	50%	50%	43%	24%	26%	42%
26		32%	60%	38%	42%	45%	53%	52%	29%	60%	69%	39%	39%	42%	47%	43%	44%	53%	53%	41%	45%	37%	41%	33%	33%	43%		52%	50%	50%	47%	37%	29%	47%
27		27%	53%	40%	54%	45%	65%	44%	29%	35%	34%	39%	42%	31%	44%	37%	40%	38%	38%	75%	57%	49%	56%	36%	40%	45%	42%		93%	96%	80%	44%	36%	51%
28		28%	53%	38%	58%	50%	67%	46%	29%	34%	32%	39%	40%	31%	44%	34%	40%	36%	38%	68%	55%	47%	53%	36%	40%	43%	40%	93%		95%	80%	43%	36%	51%
29		27%	53%	38%	56%	48%	67%	46%	29%	34%	32%	39%	42%	31%	44%	34%	40%	36%	38%	73%	60%	47%	56%	36%	41%	43%	40%	98%	95%		82%	44%	36%	49%
30		30%	58%	38%	63%	52%	77%	50%	33%	44%	38%	39%	42%	37%	51%	34%	51%	40%	43%	75%	60%	47%	53%	36%	47%	43%	43%	93%	93%	95%		46%	41%	56%
31		19%	45%	20%	40%	48%	40%	36%	33%	35%	31%	39%	82%	34%	40%	46%	44%	27%	35%	48%	87%	53%	47%	45%	29%	27%	38%	57%	55%	57%	51%		31%	58%
32		43%	63%	40%	81%	68%	86%	48%	33%	45%	41%	39%	47%	48%	58%	37%	62%	44%	43%	73%	55%	47%	47%	39%	79%	47%	47%	74%	74%	74%	73%	50%		79%
33		32%	58%	30%	42%	55%	58%	40%	31%	35%	31%	50%	42%	33%	49%	34%	56%	31%	43%	52%	47%	42%	41%	42%	39%	37%	38%	52%	52%	50%	49%	46%	39%	
34		42%	58%	33%	52%	45%	60%	44%	36%	40%	37%	39%	30%	51%	47%	34%	53%	36%	48%	41%	30%	30%	36%	30%	44%	39%	47%	50%	50%	50%	51%	30%	41%	56%

Figure 8: Pack Item Similarity Heat Map

For each two-way intersection above the threshold of 75% (green numbers), we generated 4 new pack inputs to my model. These inputs were 1) the union (total list of supplies in the two packs) of each pack, 2) the intersection (shared supplies), 3-4) each complement (the unique items to each pack). The Venn diagram in figure 9 depicts new pack inputs generated from the current pack pairs that exceeded the commonality threshold of 75%. The optimization model determined which of the 169 new pack configurations would most optimally cover preference cards. There is an odd number of new packs due to some 3-way and 4-way pack consolidations conducted on special cases with extremely high overlaps.

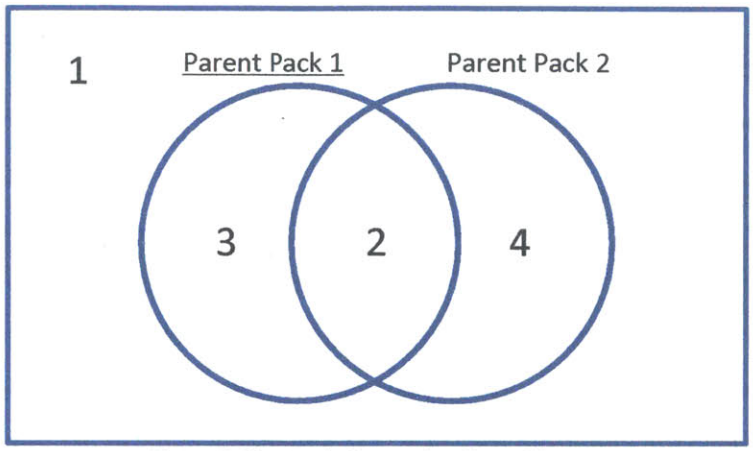


Figure 9: New Pack Generation Venn Diagram

Complete analysis of all the overlaps revealed the network structure depicted in figure 10 among the current CSPs at the 75% threshold. The numbers on the lines indicate the percent of inclusion from a pack on the left/top to the pack on the right/bottom. If two numbers exist on a line, the first indicates the relationship from the left (top) pack to the right (bottom), while the second number indicates the percentage inclusion in the reverse direction.

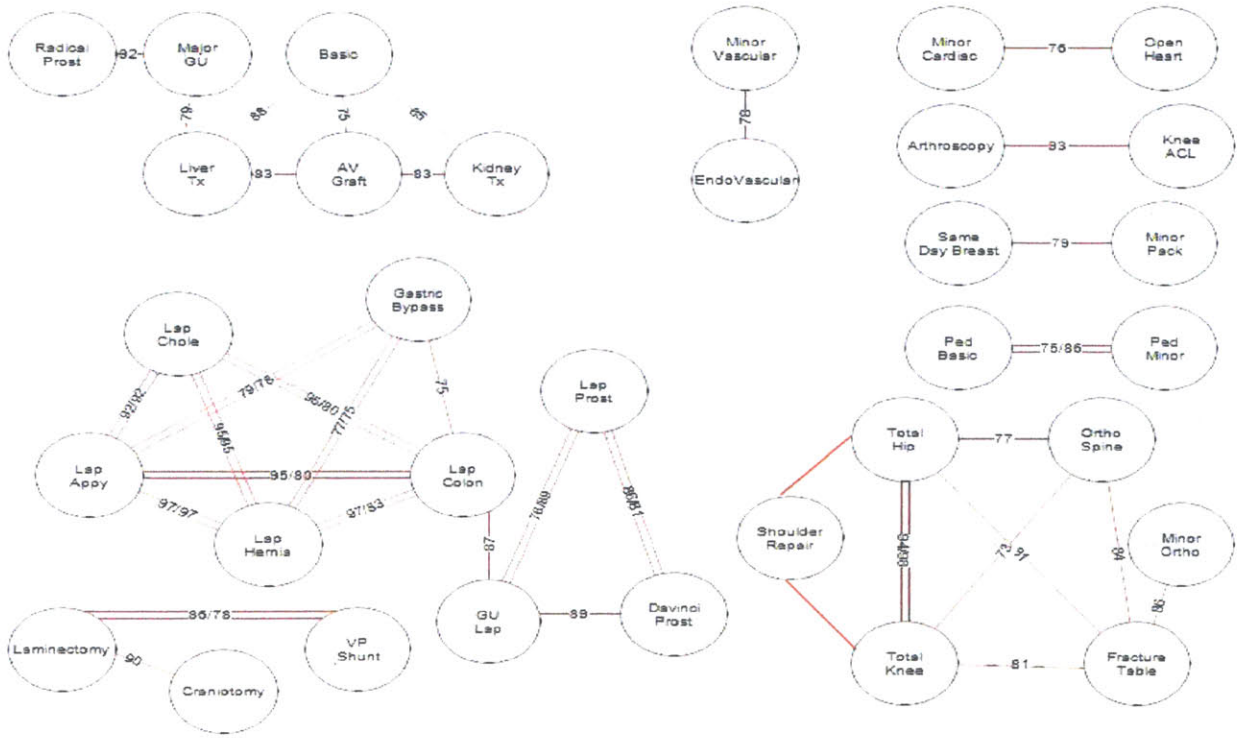


Figure 10: Pack Network Relationships

Costs

Our model took into account the purchasing, holding, and picking costs of each pack. CSP purchase costs included the value of all the items in the pack plus a standard markup applied to the value of the items in the packs to account for processing, sterilization, and delivery. The exact value of the markup is not listed for proprietary reasons. Soft goods were purchased at the price given by the hospital contracted agreement with vendors. The holding costs of inventory were defined as 40% per dollar investment per year of the overall value of the CSP or soft good based on the average inventory of each item on the shelf. Finally, we assumed a picking costs of each item based on the time it would take an hourly associate to retrieve the item from the shelf. We assumed 2 minutes per item with a labor rate of $15 per hour.

Demand

We considered the preference cards used by surgeons in the time period from January to June of 2012 in our analysis. Every time a preference card was requested in this window, it counted towards the demand total for that card. Due to the block scheduling practices of MGH, the demand for each preference card is not independent. For these reasons, we needed a model that accounted for the covariance of preference card demand. For example, if two elective procedures serviced by the same CSP are perfectly negatively correlated, the hospital can carry less of the stock of the CSP that serves these procedures because it knows it will never have to perform both procedures on the same day. As an input, our model records the covariance between each pair of preference cards for each day of the week. Conservatively, the model uses the maximum covariance as an input. By using the maximum covariance value, we ensure the hospital errs on the side of caution. For example, if two packs have a high covariance, MGH would need to carry more safety stock on the days those surgeries are performed. In order to calculate the various demand parameters for each preference card, we took the daily demand and extrapolated it out to one full year. This was necessary because our holding cost is calculated as an annual rate. The standard deviation inputs to the model are the preference card standard deviation of daily demand.

3.4 Optimization Model

Our optimization model aims to minimize the key terms that comprise total inventory cost in the surgical department at MGH by balancing key cost levers. The goal of the optimization model is to find the best way to cover all the items requested on a surgeon's preference card from those included in the CSPs and soft goods while minimizing total cost to MGH. We consolidated the items from the CSP used on each card on file at the hospital (2970 total cards) and added the associated soft goods items to create a master item list for each preference card. The optimization model must meet all the supply requirements in lowest cost way possible by assigning CSPs and soft goods to each card. The model minimizes the following four key components of cost: annual purchasing cost of CSPs, annual purchasing costs of soft goods, annual holding cost of CSPs, and annual holding costs of soft goods. The model will choose the most cost efficient way to fulfill all necessary supply requirements. Figure 11 shows the minimization optimization model. All parameters are explained hereafter:

<u>Variables</u>

$$y_{pc} = \begin{bmatrix} 1 & CSP\ (p)\ covers\ prefercence\ card\ (c) \\ 0 & otherwise \end{bmatrix}$$

$$p_{ic} = \begin{bmatrix} 1 & item\ i\ picked\ as\ soft\ good\ for\ preference\ card\ (c) \\ 0 & otherwise \end{bmatrix}$$

$$t_{pc_1c_2} = \begin{bmatrix} 1 & CSP\ (p)\ covers\ prefernce\ card\ c1\ \&\ c2 \\ 0 & otherwise \end{bmatrix}$$

$$r_{ic_1c_2} = \begin{bmatrix} 1 & items\ i\ is\ picked\ as\ a\ soft\ good\ pack\ for\ preference\ card\ c1\ \&\ c2 \\ 0 & otherwise \end{bmatrix}$$

<u>Parameters</u>

μ_c = average demand for card (c) per annum

h_{1p} = holding cost rate of a pack (p)

h_{2i} = holding cost rate of a soft good (i)

W = wage cost of picking 1 item as soft good

σ^2_c = variance of preference card daily demand

b_{ic} = # of units of item (i) required for pref card (c)

q_{ip} = # of units of item (i) in CSP (p)

d_i = purchasing cost of item (i)

d_p = purchasing cost of CSP (p)

k = safety stock factor (z_α)

L= current labor cost per service

Model

minimize

$$\sum_p \sum_c d_p \mu_c y_{pc} + \sum_i \sum_c d_i b_{ic} \mu_c p_{ic} + \sum_p h_{1p} k \sqrt{2\left(\sum_c \sigma_c^2 y_{pc} + 2 \sum_{c_1<c_2} \sigma_{c_1 c_2} t_{pc_1 c_2}\right)} + \sum_i h_{2i} k \sqrt{2\left(\sum_c \sigma_c^2 b_{ic}^2 p_{ic} + 2 \sum_{c_1<c_2} \sigma_{c_1 c_2} b_{ic_1} b_{ic_2} r_{ic_1 c_2}\right)}$$

Subject to:

$\sum_p q_{ip} y_{pc} \geq b_{ic}(1 - p_{ic})$ $\quad \forall\, c, i$ C.1

$t_{pc_1c_2} \geq y_{pc_1} + y_{pc_2} - 1$ $\quad \forall\, p, c_1, c_2$ C.2

$t_{pc_1c_2} \leq y_{pc_1}$ $\quad \forall\, p, c_1, c_2$ C.3

$t_{pc_1c_2} \leq y_{pc_2}$ $\quad \forall\, p, c_1, c_2$ C.4

$W \sum_c \sum_i p_{ic} \mu_c \leq 1.15L$ C.5

$y_{pc},\ p_{ic}, t_{pc_1c_2}, r_{ic_1c_2} \in \{0,1\}$ $\quad \forall\, i, c,\ p, c_1, c_2$ C.6

Figure 11: Optimization Model

3.5 Model Explanation

Each piece of the optimization model will be explained in greater detail. Table 2 describes what each term contributes to the overall model. Detailed explanations of each term are listed below the table.

Term	Meaning
$\sum_p \sum_c d_p \mu_c y_{pc}$	**Purchasing Costs of Packs**
$\sum_i \sum_c d_i b_{ic} \mu_c p_{ic}$	**Purchasing Cost of Soft Goods**
$\sum_p h_{1p} k \sqrt{2\left(\sum_c \sigma_c^2 y_{pc} + 2 \sum_{c_1<c_2} \sigma_{c_1 c_2} t_{pc_1 c_2}\right)}$	**Holding Costs of Packs**
$\sum_i h_{2i} k \sqrt{2\left(\sum_c \sigma_c^2 b_{ic}^2 p_{ic} + 2 \sum_{c_1<c_2} \sigma_{c_1 c_2} b_{ic_1} b_{ic_2} r_{ic_1 c_2}\right)}$	**Holding Cost of Soft Goods**

Table 2: Optimization Model Term Explanation

Purchasing cost of packs (CSPs)

The purchasing cost of each CSP is computed by fixing a CSP(p) and summing the cost of the pack (d_p) multiplied by the average yearly usage of the preference card (μ_c) multiplied by a binary variable if the pack covers the given card (y_{pc}). The cost of the pack is calculated by adding the value of the items in the pack and applying a standard markup required by the vendor as a charge for sterilization, handling, and delivery. This is conducted for each pack to get the total purchasing costs for CSPs for the year.

Purchasing costs of soft goods

A similar computation computes the annual cost of purchasing soft goods. The cost for the soft goods on one preference card (c) is computed by fixing a soft good item (i) and multiplying the cost of that item (d_i) by the number of that item requested on a preference card (b_{ic}) by the average yearly usage of a preference card (μ_c) by a binary variable if the item is picked as a soft good for that card (p_{ic}). This is conducted for each item to get the total purchasing costs of soft goods annually.

Holding costs of CSPs

The holding cost formula relates to the previous discussions regarding risk pooling. CSPs assigned to multiple preference cards pool the risk and reduce variability associated with those packs, thereby reducing overall holding costs of inventory. For this calculation, fix a pack and multiply the inventory holding cost of the pack (h_1) by the safety factor given by the hospital's service level (~99%). This value is multiplied by the standard deviation of the pooled demand given by the quantity underneath the radical. The pooled demand is calculated by summing the variance of a preference card times a binary

variable if that preference card is covered by the pack in question. To this, we add a covariance term to include two-way interaction between preference cards. We multiply all of this by 2 since the review period and lead time is two days. In equation 1, the demand for different items is assumed to independent. Block scheduling practices at the hospital render this assumption invalid; therefore, we include a covariance term given by 2 times the maximum covariance of two preference cards (σ_{c1c2}) times a binary variable if a pack covers both preference cards (t_{pc1c2}). This whole process is conducted for each pack to arrive at the total holding cost of CSPs.

Holding costs of soft goods

An analogous computation exists for the holding costs of soft goods. Instead of fixing a pack, we fix an item. The difference in this calculation occurs because multiple of the same item might be requested on each preference card, while each pack will only be requested once on a preference card. The following relationship exists when manipulating random variables X and Y:

4. $\mathrm{Var}(X + Y) = \mathrm{Var}(X) + \mathrm{Var}(Y) + 2*\mathrm{Cov}(X,Y)$
5. $\mathrm{Var}(aX) = a^2\,\mathrm{Var}(X)$
6. $\mathrm{Cov}(aX,bY) = a*b*\mathrm{Cov}(X,Y)$

Because we are summing the demand for an item (i) that in turn is summing the demand for preference cards (c) that include the item in question, we can substitute 2 and 3 into 1 where appropriate to obtain the term for holding costs for soft goods.

Constraints

The constraints in this model ensure coverage of all items requested on each preference card. Constraint #1 ensures that for each CSP, the items in on the packing list times a binary variable to determine if that pack is used on a preference card is greater than or equal to supply requirement unless the p_{ic} variable (denoting the item will be picked as a soft good) is turned on. Constraints 2-4 are logical constraints that ensure that the t_{pc1c2} variable is turned on if and only if the pack covers both card c_1 and c_2 at the same time. Constraint 5 ensures the labor costs of picking items can't increase by more than 15%. Instead of including picking cost in the overall cost objective function, a constraint is included to prevent picking cost by surgical service to increase more than 15%. This percentage was deemed the number at which the hospital would hire additional associates to handle an increased case-pick workload. Finally, constraint 6 is a binary constraint on the decision variables.

Complexity of the model

The complexity of this optimization model necessitated some simplifications in order for it to run in a timely manner using current optimization software. The number of variables grew quickly to over 6 million when incorporating all preference cards and items. The optimization software could not handle the complexity arising from the integral, non-linear, and non-convex properties of the objective function. In order to pare down the complexity, we analyzed the preference cards by running the model by surgical service. The hospital's surgical services include Burns, Cardiovascular, General Surgery, Gynecology, Neurology, Oral & Maxi-facial, Orthopedics, Pediatrics, Plastics, Surgical Oncology, Thoracic, Urology, and Vascular. In addition, to alleviate the solving challenges due to non-linear portions of the objective function, we approximated the piece of the objective function underneath the radical in the holding cost terms with a piecewise linear function. We decided to approximate the square root function with three pieces. Due to the concavity of the square root function, we ran an optimization problem to choose the breakpoints that would minimize the maximum residual between the two functions with an upper bound of 100. We chose the upper bound based on analysis of items and packs, understanding the data showed 100 as the maximum quantity underneath the radical. Shown on the chart in figure 12, the maximum residual (r_i) occurs where the derivative of the square root function is the same as the slope of the line segment connecting the break points (m_i) in the piecewise linear function. In this case r_i is evaluated at $\tilde{x}_i$ subject to $f'(\tilde{x}_i) = m_i$. This yields the following relationship where the derivative of the function $\sqrt{x}$ is evaluated at equal $\tilde{x}_i$: $\frac{1}{2}\tilde{x}_i^{\frac{-1}{2}} = m_i$ and $\tilde{x}_i = \frac{1}{4m_i^2}$. Now we have a relationship that we can use to evaluate where to place our optimal breakpoints, denoted as a_i. Evaluating the value of the residuals at the square root function at $\tilde{x}_i$ minus the value of the line segment at $\tilde{x}_i$ yields the following:

$$r_i = \frac{1}{2m_i} - \left[f(a_i) + m_i\left(\frac{1}{4m_i^2} - a_i\right)\right]$$

This equation can be simplified to the following:

$$r_i = \frac{1}{4m_i} - f(a_i) + a_i m_i$$

and substituting $\frac{\sqrt{a_{i+1}}-\sqrt{a_i}}{a_{i+1}-a_i}$ for m_i yields the following:

$$r_i = \frac{a_{i+1} - a_i}{4\left(\sqrt{a_{i+1}} - \sqrt{a_i}\right)} - \sqrt{a_i} + a_i\left(\frac{\sqrt{a_{i+1}} - \sqrt{a_i}}{a_{i+1} - a_i}\right)$$

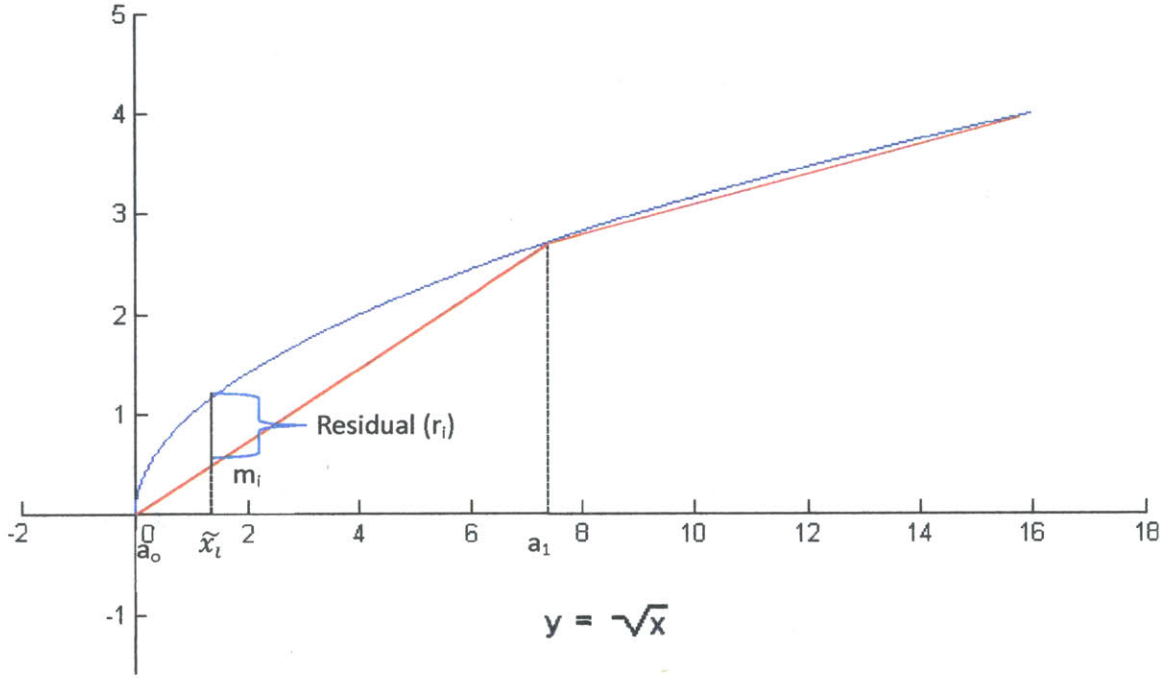


Figure 12: Piecewise Linear Approximation Formulation

Now we can solve the following optimization problem to smartly choose breakpoints:

$$\underset{\{a_i\}_{i=0}^{n}}{\text{Min}} \quad z$$

$$\text{s.t.} \quad z \geq r_i \quad \forall\, i$$
$$a_0 = 0$$
$$a_n = 100$$
$$r_i = \frac{a_{i+1} - a_i}{4\left(\sqrt{a_{i+1}} - \sqrt{a_i}\right)} - \sqrt{a_i} + a_i\left(\frac{\sqrt{a_{i+1}} - \sqrt{a_i}}{a_{i+1} - a_i}\right)$$

Our optimal breakpoints were a_i=2.8, 25 and 100. Plotted on the graph in figure 13 is the square root function and the piecewise linear function we used under each radical to help simplify the problem.

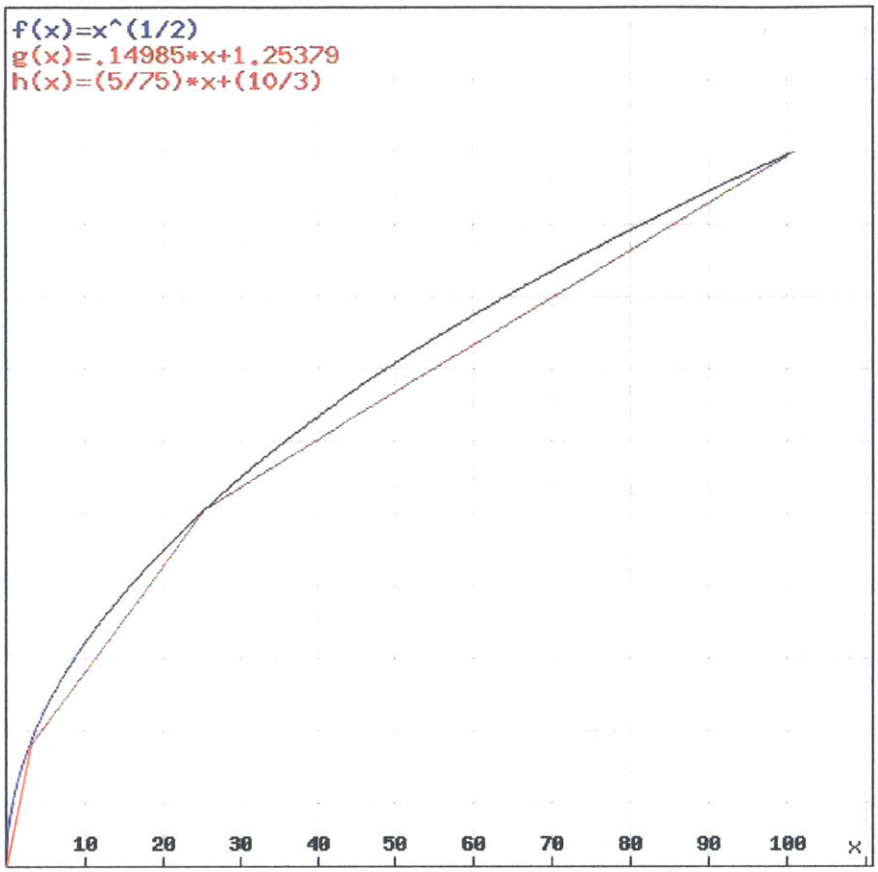


Figure 13: Piecewise Linear Approximation Results

In every instance in the objective function where a square root is calculated, a piecewise linear function as shown above in figure 13 is substituted in to replace the radical. To incorporate the piecewise linear approximation into the objective functions, we used CPLEX's piecewise linear function modeling features. With these added model simplifications, the model ran quickly on the Diablo and Daredevil servers at MIT. Overall running time varied by the complexity of the surgical service being solved. The model solved some of the smaller surgical services with fewer preference cards in less than one minute. The larger services (ortho, general surgery) took approximately 5 minutes to solve. The model converged to a solution quickly, with a majority of the running time used to fine tune the optimal solution. This simplification removed the non-linear portion of the objective function. The resulting objective function is the following:

$$\min \sum_{p}\sum_{c} d_p \mu_c y_{pc} + \sum_{i}\sum_{c} d_i b_{ic} \mu_c p_{ic} + \sum_{p} h_{1p} k z_p + \sum_{i} h_{2i} k f_i$$

s.t. (more constraints added to account for the piecewise linear approximations of our square root functions)

$\sum_p q_{ip} y_{pc} \geq b_{ic}(1 - p_{ic})$ $\forall c, i$ C.1

$t_{pc_1c_2} \geq y_{pc_1} + y_{pc_2} - 1$ $\forall p, c_1, c_2$ C.2

$t_{pc_1c_2} \leq y_{pc_1}$ $\forall p, c_1, c_2$ C.3

$t_{pc_1c_2} \leq y_{pc_2}$ $\forall p, c_1, c_2$ C.4

$W \sum_c \sum_i p_{ic} \mu_c \leq 1.15L$ C.5

$y_{pc}, p_{ic}, t_{pc_1c_2}, r_{ic_1c_2} \in \{0,1\}$ $\forall i, c, p, c_1, c_2$ C.6

Original constraints

$x_p = 2\left(\sum_c \sigma c^2 y_{pc} + 2\sum_{c_1<c_2} \sigma_{c_1c_2} t_{pc_1c_2}\right)$ $\forall p$ C.7

$x_p = \sum_{s=0}^{3} \lambda_{p,s} a_s$ $\forall p$ C.8

$z_p = \sum_{s=0}^{3} \lambda_{p,s} f(a_s)$ $\forall p$ C.9

$\sum_{s=0}^{3} \lambda_{p,s} = 1$ $\forall p$ C.10

$\lambda_{p,0} \leq v_{p,1}$ $\forall p$ C.11

$\lambda_{p,s} \leq v_{p,s} + v_{p,s+1}$ $\forall s \in \{1,2\}$ $\forall p$ C.12

$\lambda_{p,3} \leq v_{p,3}$ $\forall p$ C.13

$\sum_{s=0}^{3} v_{p,s} = 1$ $\forall p$ C.14

$\lambda_{p,s} \geq 0$ $\forall s, p$ C.15

$v_{p,s} \in \{0,1\}$ $\forall s, p$ C.16

Piecewise constraints CSPs

$g_i = 2\left(\sum_c \sigma c^2 {b_{ic}}^2 p_{ic} + 2\sum_{c_1<c_2} \sigma_{c_1c_2} b_{ic_1} b_{ic_2} r_{ic_1c_2}\right)$ $\forall i$ C.17

$g_i = \sum_{s=0}^{3} \delta_{i,s} a_s$ $\forall i$ C.18

$f_i = \sum_{s=0}^{3} \delta_{i,s} f(a_s)$ $\forall i$ C.19

$\sum_{s=0}^{3} \delta_{i,s} = 1$ $\forall i$ C.20

$\delta_{i,0} \leq w_{i,1}$ $\forall i$ C.21

Piecewise constraints soft goods

$$\delta_{i,s} \leq w_{i,s} + w_{i,s+1} \quad \forall s \in \{1,2\} \quad \forall i \qquad \text{C.22}$$

$$\delta_{i,3} \leq w_{i,3} \quad \forall i \qquad \text{C.23}$$

$$\sum_{s=0}^{3} w_{i,s} = 1 \quad \forall i \qquad \text{C.24}$$

$$\delta_{i,s} \geq 0 \qquad \forall s, i \qquad \text{C.25}$$

$$w_{i,s} \in \{0,1\} \qquad \forall s, i \qquad \text{C.26}$$

Piecewise constraints soft goods

In this model, the a_s represent the breakpoints of 0, 2.8, 25, and 100 in our piecewise linear approximations. The new auxiliary variables (λ, ν, δ, w) exist to approximate the square root functions as we described above.[12]

[12] Mixed Integer Linear Programming Formulation Techniques by Juan Pablo Vielma, Assistant Professor, Sloan School of Management

Chapter 4: Results

4.1 Modular Pack Configuration

As discussed previously, the model was run by surgical service to reduce complexity. This simplification did not have a large effect on overall results as very few of the pack overlaps at the 75% threshold included packs used by more than one surgical service. The results show a modular pack structure as the most financially optimal. Instead of assigning one CSP to each case, some cases are now served by two smaller CSPs. Looking at a specific example may help to shed light on the resulting preference card coverage scheme. Let's look at one example where the two original custom packs exceeded the 75% threshold overlap-the Arthroscopy and Knee ACL repair packs. In this situation, the Arthroscopy pack was 93% included in the Knee ACL pack based on an item by item comparison (neglecting quantity of each item in the pack). When the four newly generated packs (see *3.3 Pack Generation*) were input into the model, it returned a result that prescribed the original Arthroscopy pack be replaced on all preference cards that requested it with two smaller packs. These packs were 1) the pack that included the intersection of items from the Arthroscopy and Knee ACL and 2) the complement that included the unique items to the legacy Arthroscopy pack. In a similar manner, the Knee ACL pack would be covered by two smaller packs. These packs were 1)the same intersection pack that covered the Arthroscopy pack and 2) the opposite complement pack that included items unique to only the legacy Knee ACL pack. Every case that requested a Knee ACL pack should now receive these two smaller packs. The key savings here exists in holding less safety stock of the intersection pack that holds a majority of the value of the inventory that services both cases. This modularization of replacing two packs with three smaller packs occurred in four instances shown below. In each of these cases, the modularization worked without requiring any additional soft goods to be picked to fulfill the original packing lists on the original packs.

	Pack A	Pack B
1	Arthroscopy	Knee ACL
2	VP Shunt	Laminectomy
3	Endovascular	Minor Vascular
4	Fracture Table	Minor Ortho

Table 3: Modular Pack Pairings

Two other special modularization case results do not fit this pattern. First, a set of three laparoscopic packs existed that were so similar that one pack could replace them all. These three packs are listed

below. In this instance, pack A and B required three displaced items to be picked as soft goods, while pack C required five displaced items to be picked as soft goods.

Pack A	Pack B	Pack C
Lap Appendectomy	Lap Hernia	Lap Cholecystectomy

Table 4: Modular Pack 3-way Consolidation

The overall cost savings of servicing procedures using these packs with one pack, outweighed the costs of ordering, holding, and picking these displaced soft goods. The other special case existed with the relationship of the Orthopedic Spine, Total Hip Replacement, and Total Knee Replacement packs. These three packs would be replaced where each pack would receive the intersection of the Total Knee Replacement and Ortho Spine. The Total Knee Replacement and Total Hip Replacement would be replaced by just the hip complement of the interaction of the Total Hip Replacement and Ortho Spine pairing, while the Ortho Spine pack would receive the opposite complement. Figure 14 below describes the new pack structure exhibited in this special case. Originally, the optimization model advocated for 3 additional packs (1 to each scenario) that would include a few items in each (2, 4, and 4 respectively). Due to the hospital's desires to limit pack modularization to replace current packs with at most two modular packs, these items will be picked as soft goods.

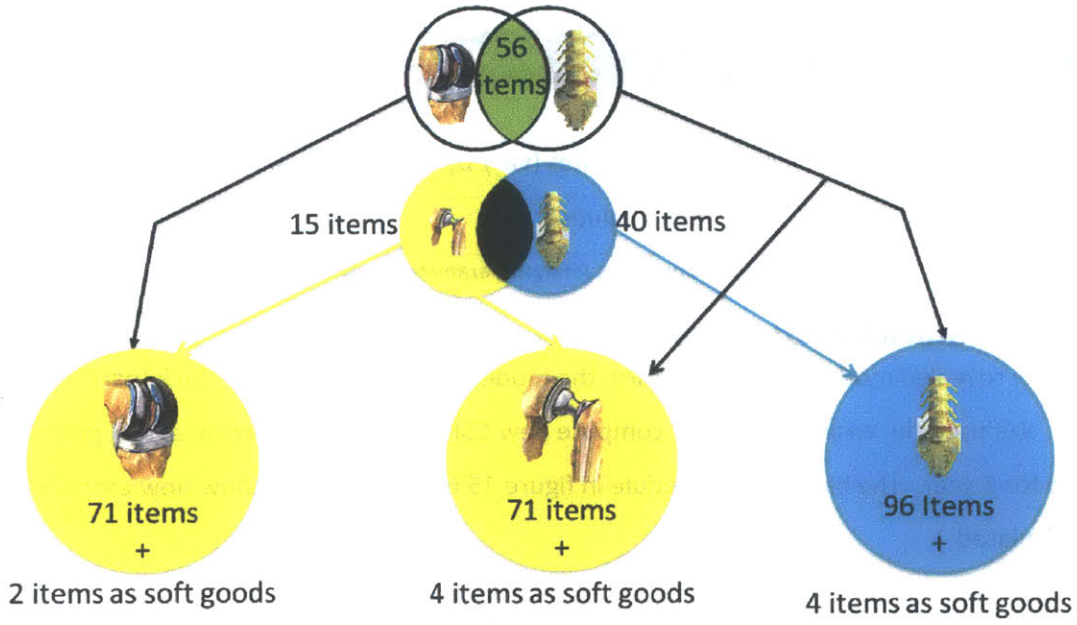


Figure 14: Hip-Knee-Ortho Spine Consolidation

A summary of the transition of current packs to new modular packs can be seen in the appendix 3. In total, only 14 of the packs required the change to the modular structure, while 51 remained unchanged. The exact item listing for each new modular pack as compared with the old packs is listed in appendix 3.

4.2 Model Robustness

Reconfiguring fourteen of the current CSPs helps the hospital to save money under the current conditions. In order to test the robustness of the model results, we looked at different scenarios where the demand and cost structures changed. Varying the demand for preference cards, the labor rates for associates in the warehouse, and the markup of the CSPs could all have impacts on the optimal solution. After conducting a robustness analysis under select conditions, the optimal pack reconfiguration scheme did not change—implying that MGH can be very confident this solution will hold given changing conditions in the future. Based on hospital space constraints, it was determined that in an extreme scenario, hospital demand could go up five percent if utilization rates increased and more space became available. To test robustness, we varied the preference card demand up and down five percent. We also tested the effects of changes in picking costs. We varied the labor picking rate up and down by five dollars per hour. Finally, the vendor markup percentages, if varied, could have an impact on the reliance on CSPs. To test our model, we varied the current CSP vendors handling surcharge by seven percentage points. The following chart details the sensitivity analysis performed to test model robustness:

Parameter	Current rate	Analyzed rates
Labor wage	$15/hr	+/- $5/hr
Preference card demand	Actual usages rates (vary by preference card)	+/- 5%
Vendor CSP markup %	Proprietary values	+/- 7%

Table 5: Robustness Analysis Parameter Sensitivity

4.3 CSP Base Stock Calculations

With the new revealed modular pack structure, the model computed new base stock (par) levels for each pack. We used the empirical data to compute new CSP base stocks based on actual preference card usage for 1 year. The base stock schedule in figure 15 is a reference to show how each day's base stock is calculated.

Ordering Day	Base Stock Level Aggregates Demand on:
M	Tu, W,
Tu	W, Th
W	Th, F
Th	F, Sa, Su, M
F	M,Tu

Figure 15: Base Stock Schedule

Based on the arrival of shipments, each daily base stock value must buffer against the daily demand for a different period. In general, due to the nature of deliveries, a base stock value for a weekday must cover up until the next full day after delivery. For example, the order placed on Monday will typically arrive Tuesday afternoon. By the time the shelves have been stocked with this order, the case pick function for Wednesday's cases will be 50% complete. Therefore, Monday's base stock level must cover the full volume of cases for Tuesday and Wednesday because one can't expect to see Monday's delivery on case carts until afternoon cases on Wednesday. The exception to this rule is the Thursday order. Friday's order will not be delivered over the weekend; therefore, Thursday's order must cover all cases until Monday afternoon.

In order to calculate a new base stock level for each CSP, I created an empirical distribution for the demand of each CSP for each day of the week. For each weekday throughout 2012, I calculated the required base stock based on demand according to figure 15. For Monday, this would be equivalent to the sum of the cases using that CSP on Tuesday and Wednesday. For Tuesday, this would be equivalent to the sum of the cases using that CSP on Wednesday and Thursday. This pattern continues for each weekday except Thursday-which aggregates the case demand for Friday, Saturday, Sunday, and Monday. I pulled the 95^{th} percentile of each weekday's base stock level for each CSP and recorded it. Finally, I took the maximum base stock level of these five values (one for each weekday for each CSP) and recorded it as the base stock level at the 95% service level for each pack. This method is conservative because even at a service level of 95%, custom packs can be recreated from soft goods in dire straits. This analysis uncovered the hospital was over-ordering on 34 out of 51 of the original legacy packs (66%) that were not modularized. The financial savings of this analysis was two-fold via: 1)reducing the base stock inventory levels of legacy packs and 2)reducing base stocks of the new modular packs. Many of the parent packs that the modular packs arose from were also over-ordered. The combination of removing these packs and pooling their demand in the new modular scheme further

compounded the inventory savings. Specific base stock levels for each new pack are listed in appendix 2.

4.4 Soft Good Base Stock Calculations

In the same manner, base stock calculations could be performed for all soft goods. Due to the redundancy of inventory locations for soft goods throughout MGH, significant differences exist from the computed base stock levels to those actually kept in the hospital. Unfortunately, the accuracy of the database of locations for all soft good needs refinement before exact analysis can compute the financial savings. To simplify matters, I took an initial look into soft goods ordered by the unit of measure of 'each' to uncover an estimate for the magnitude of inventory savings in this cohort of supplies.

4.5 Financial Impact

CSP Savings

The financial savings in revamping the CSPs is a function of a one-time inventory reduction to more accurate base stock levels for all CSPs and the annual holding cost reduction due to CSP modularization. At a holding cost rate of 40%, I calculated holding costs savings by multiplying the dollar value of each CSP by the average inventory on the shelf and the holding cost rate. The following table describes the savings incurred from making the recommended base stock and modularization changes. This table includes the one time savings from reduction in inventory and the recurring savings annually from pack modularization.

First Year Modular Pack System Savings		
Modular Packs Initial Inventory Reduction	$	47,652
Annual Holding Cost Savings	$	19,061
Year 1 CSP Savings	$	66,713

Table 6: First Year Modular Pack Savings

The total value of the annual holding costs savings at a discounted rate of 8%[13] in perpetuity is given by the formula $P = \frac{n}{r}$ where P is the present value of an annuity with the n being the principal and r being the discount rate. The lifetime value of savings is the following:

[13] 8% cost of capital is standard in the healthcare industry

Lifetime Modular Pack System Savings		
Modular Packs Initial Inventory Reduction	$	47,652
Lifetime holding cost savings at 8% cost of capital	$	238,260
Total Savings	$	285,912

Table 7: Lifetime Modular Pack Savings

Soft Good Savings

To calculate an estimate of the savings by resetting par levels for soft goods, one needs a clear understanding of the usage of items. Because items are often requested on preference cards and returned, it's very difficult to get an accurate tracking of soft goods used per case. Additionally, many items pulled from room stock cabinets never get traced or recorded as expended on a case. When I investigated the base stock level for many items I found errors in the hospital database that prevent reliable reporting of financial savings. Two key errors existed. First, a few cases existed where items were physically located in carts throughout MGH, but base stock levels weren't recorded on the database identifying the locations for these items. Second, some items existed on preference cards and were requested by surgeons, but could not be found on the master database. In order to get a general sense for the magnitude of savings, I began by analyzing only the items purchased on the individual level. Although the hospital needs to clean the database before accurate accounting can take place, it is still beneficial to know a rough magnitude of inventory savings. When looking just at soft good individual items (not those purchase by the case, box, vial, roll, etc), the inventory savings at a 40% holding cost rate is shown below. This is based on aggregating the par levels for each item throughout the hospital and comparing it with my recommended base stock levels dictated by usage. A much more comprehensive analysis can be conducted once the hospital transitions to new system called PIMMS phase II which will allow for point-of-use recording of individual items used in each case in the operating room.

First Year Individual Soft Good Savings Estimates		
Soft Good Initial Inventory Reduction	$	72,559
Annual Holding Cost Savings	$	149,511
Total Savings	**$**	**222,070**

Table 8: First Year Individual Soft Good Savings Estimate

Using the same cost of capital as the CSPs (8%), I can compute the total lifetime savings estimate for individual softs goods.

Lifetime Individual Soft Good Savings Estimates		
Soft Good Initial Inventory Reduction	$	72,559
Lifetime Soft Good Holding Cost Savings (8% cost of capital)	$	1,868,883
Total Savings	**$**	**1,941,442**

Table 9: Lifetime Individual Soft Good Savings Estimate

Due to the previously noted challenges with understanding actual usage of individual goods at the hospital, this estimate is conservative. It only accounts for individually purchased soft goods, not those purchased in cases or boxes. Once more reliable systems document individual usage and the hospital cleans the database for recording base stock levels, this figure will be clearer.

Circulator Pack Savings

In discussion with the hospital's vendor about the delivery schedule, we uncovered a segment of CSPs that included a sub-pack inside the larger pack. These packs, called circulator packs or procedural-based delivery systems, existed in roughly 50% of the surgical packs. In general, circulator packs items are separated inside the CSP in a small plastic bag to allow the nurses to quickly retrieve them while setting up a room for surgery. The pricing scheme dictated that any pack with a circulator pack inside receive an extra 7% markup to account for handling charges for the sub-pack. The vendor claimed these items were already sterile and did not need to go through the sterilization process like the rest of the CSPs items, hence the extra pack to prevent damage. Although the items serve a need, the hospital did not see the clinical need to have a separate pack for these setup items within their already bulky CSPs. Many of the circulator pack items exist on shelves in the operating rooms. By removing circulator packs, the vendor estimates the savings shown below along with my calculation for lifetime savings based on an 8% cost of capital:

Circulator Pack Removal Savings		
Annual circulator pack reduction	$	1,190,000
Lifetime circulator pack savings (8% cost of capital)	$	14,875,000
Total Savings	**$**	**14,875,000**

Table 10: Circulator Pack Removal Savings

Although the circulator packs were not analyzed as part of the optimization, the financial benefits of removing these items was a positive discovery that occurred while analyzing the supply system.

Total Savings

The numbers for total savings are a conservative estimate due to the conservative nature of the soft good savings.

Total Project Savings		
Lifetime Modular Pack System Savings	$	285,912
Lifetime Soft Good Savings	$	1,941,442
Lifetime circulator pack savings	$	14,875,000
Total Savings	**$**	**17,102,354**

Table 11: Total Project Savings

Chapter 5: Conclusions and Recommendations

The main take away from this project is the advocation for a modular pack structure to allow for risk pooling across CSPs and a restructuring of the delivery schedule to carry less days of inventory. Replacing fourteen current CSPs with sixteen new CSPs allows for multiple procedures to draw from the same CSP pool, thereby aggregating demand and reducing the variability of demand. In order to achieve the desired results, MGH must communicate pack changes to their vendors. New base stock levels will ensure the hospital orders to the desired par levels. Appendix 2 contains information regarding exact par levels under a 2-day base stock model. The vendors own the responsibility to make the new pack configurations and supply them on schedule. Appendix 3 contains the exact make-up of the new CSPs. The new modular structure saves money and should improve efficiency of the overall supply system. Added benefits include a possible reduction in the warehouse space allocated for CSPs.

Chapter 6: Future opportunities

Inventory Location Refinement and Soft Good Optimization

With the knowledge gained from the project, MGH should pursue future projects to enhance their supply chain operations. It is evident that the redundant inventory locations are partially due to the legacy systems for supplying operating rooms. Nurses used to pick supplies for cases, and the proximity of supplies to operating rooms was of utmost importance. Despite the centralized nature of the supply system, a complete shift to the Lunder CSPS warehouse for all supply needs has yet to start. Reevaluating the locations of many supplies and the associated par levels has great promise to help with efficiency and reducing cost. A full evaluation of locations will help the hospital determine which items should go in CSPs, where to station emergency supplies, and how to prevent return supplies. This evaluation may help to answer key questions like if sutures should become local supplies to each operating room or supplied in CSPs. It will also help MGH to take full advantage of the centralized supply system envisioned when the Lunder building opened in 2011. Although this project optimized over all CSPs and soft goods, further analysis could reveal the best locations to store specific soft goods. In conjunction with a complete audit of the hospital's database, the hospital could drastically reduce soft good base stock levels and find the ideal locations for urgent items. Centralizing these items closer to ORs could allow their removal from CSPs or the central supply warehouse.

Anesthesia Optimization

In the same manner as the CSPs and soft goods, the anesthesia supply room carts need an overhaul. While visiting one surgery, one doctor remarked the she had to pick her own drug supplies individually for each case. A standard kitting or inventory location analysis of the anesthesia department's drugs could fix base stock levels and free the time of highly paid doctors to do their hired duties instead of collecting supplies from a stock room.

Standardization of Preference Cards by Procedure

With the knowledge gained from this project, MGH should pursue standardization of procedural preference cards. Under the current setup, surgeons dictate requirements for surgeries based on patient needs and personal preferences. Surgeons request different amounts of soft goods for nearly identical procedures. Use the following gastric bypass procedures as an example. The following chart depicts the items requested by the four surgeons at MGH that conducted this procedure in 2012. Notice that each surgeon requests different amounts of each item. A policy in which hospital leadership dictates the standard supply list for each type of procedure would allow for more kitting of common

items, reductions of inventory of soft goods, and increased financial savings. This would require meetings with surgical services to get consensus on procedural standards.

Gastric Bypass Surgery Preference Card Item Requests				
	Surgeon #1	Surgeon #2	Surgeon #3	Surgeon #4
Card Requests	8	36	12	24
APPLICATOR COTTON 6IN TP STRL	0	0	1	0
CAP SEAL ASMBL W/ ACCY	0	0	1	0
CLOSURE STERISTRIP 1/2X4IN SKIN STRIP REINF WHITE BX/50EA	0	1	0	0
CLOSURE STERISTRIP 1/4X4IN SKIN STRIP REINF WHITE	1	0	0	0
CONTAINER SPECIMEN 120CC CLIKSEAL BLSTR PK STRL	0	1	0	0
DRAIN PENROSE 1/4X18IN LATEX FREE TUBE STRL SIL	0	1	0	1
DRAIN PENROSE 18X1/4IN LATEX RADIOPQ STRL	1	0	0	0
DRESSING TEGADERM 2.375X2 3/4IN FILM TRNSP FRM STYL STRL	4	0	1	0
ENDO DEVICE STITCH SUTURING BX/3EA	0	0	1	0
FILTER PAPER STRL	0	1	0	0
GLOVE PROC SZ 8.0 LATEX STRL PWDR FREE BEAD CUF LDP POLYMR	1	0	1	0
GOWN LG STRL FABRIC REINFORCED CS/20EA	1	0	0	0
LABEL STERILE KT 1.9 X 0.6 MM BOX/100	0	0	0	1
LAPSAC SURGICAL TISSUE POUCH C-LSP-10-8	0	0	1	0
MGH OR ONLY KIT GASTRIC BYPASS	1	1	1	1
NEEDLE SURGICAL 150MM LAPSCP PNEUMOPERITONEAL DISP STRL	0	0	1	0
PAPER FILTER 4X11CM	1	0	1	1
PREP SKIN 26ML CHLORAPREP ORANGE TINT GLUC ISPRPYL ALC 2%	1	1	0	0
SCALPEL HARMONIC 5MMX36CM W/ ERGONOMIC HNDL CRV ACE	1	0	0	0
SCISSORS REPOSABLE METZENBAUM 31MM PK/10	0	0	1	1
SEALER/DIVIDER LIGASURE 5MM BX/6EA	0	0	1	0
SHEAR ENDOSCOPIC 5MMX36CM W/ UNIPOLAR CAUT RATCH HNDL DISP	1	0	0	0
SOLUTION IV 0.9% 1500ML IRG NACL	0	0	1	1
SOLUTION SCRUB 26ML SURG SKIN PREP IOD ISPRPYL ALC PREFLL	0	0	2	2
STAPLER GIA 45X2.0MM ENDOSCOPIC ROTIC OPEN LOADING GRAY	3	3	0	1
STAPLER GIA 45X3.5MM ENDOSCOPIC ROTIC OPEN LOADING BLUE	1	0	0	0
STAPLER GIA 60X2.5MM ENDO ROTIC OPEN LOADING	4	3	0	0
STAPLER GIA 60X2.5MM OPEN 1USE LOADING UNIT STR WHITE	0	0	0	3
STAPLER GIA 60X3.5MM ENDOSCOPIC ROTIC OPEN LOADING BLUE	1	0	0	0
STAPLER GIA 60X3.5MM OPEN 1USE LOADING UNIT STR BLUE	0	0	0	1
SUTURE ENDOSTITCH 2-0 48IN PLYSRB UD	3	4	2	4
SUTURE ETHILON 3-0 FS-1 18IN MF BLACK	0	0	1	0
SUTURE VICRYL 0-0 45CM COAT BR VIOLET 3 X 18IN TIES	1	1	1	1
SUTURE VICRYL 4-0 PS-2 18IN COAT BR UD	3	2	2	2
SYRINGE W/O 30ML NEEDLE STRL DISP W/ LUER SLP TP PLASTIC	0	0	1	1
TRAY CATHETER 16FR FOLEY W/ URINE MTR COAT	1	0	0	0
TROCAR BLADELESS 5X100MM OBTRTR STBL SLV DISP ENDOPATH	0	0	1	0
TROCAR ENDOPATH 11X100MM BLADELESS BLNT STBL SLV DISP XCEL	1	0	0	0
TROCAR ENDOPATH 12X100MM BLADELESS BLNT STBL SLV DISP XCEL	0	0	1	0
TROCAR ENDOPATH 12X100MM BLADELESS STBL SLV XCEL	0	1	0	0
TROCAR ENDOPATH 5X100MM BLADELESS STBL SLV XCEL	0	0	3	1
TUBE INSUFFLATION UHI2 HIGH FLOW DISPOSABLE BX/10	0	1	0	0
TUBE SUCTION HIGH FLOW DISPOSABLE BX/20	0	0	0	1
Grand Total	**31**	**21**	**26**	**23**

Table 12: Gastric Bypass Surgery Preference Card Item Requests

Glossary of terms

Case cart: a metal container that delivers custom surgical packs, requested soft goods, and surgical instruments to each operating room prior to the start of a case

Central Sterilize Processing and Supply (CSPS): the warehouse location in the Lunder building basement that supplies 75% of the surgical supplies and 100% of surgical instruments for the 36,000 cases completed each year at MGH.

Circulator pack: a small sub-pack within a custom surgical pack that includes items typically used in the setup of an operating room prior to the start of surgery

Custom Surgical Pack (CSP): a bundle of unwrapped sterile surgical items supplied by a vendor to the hospital. Each CSP is specific to a class of procedures

CSPs on a Shelf

Preference card: a list of supplies requested by a surgeon for a case that includes custom surgical packs (CSPs), soft goods, standby items, and instruments.

Soft good: an individually wrapped and sterile item requested for a surgery in addition to custom surgical packs

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Appendix 1: Sample Preference Card

All items on the equipment in house. Additional equipment

MGH Orthopaedic Department

CSPS Pick List Form # 982531 Page: 1 of 3

Surgery Date: 7/6/2012 OR: 73 Time: 07:45

[redacted] Service: ORTHOPAEDIC SURGERY

MD:

Additional MD(s): MD Service:

[redacted]

Primary Procedure: LUMBAR POSTERIOR FUSION Additional Procedure(s): LUMBAR LAMINECTOMY 3 OR MORE LEVELS

Picklist: LUMBAR POSTERIOR FUSION

CSPS SUPPLY CART 1-17								
Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 002 C	GLOVE BIOGEL M SIZE 8 1/2 LATEX	30585	38462	2			Y	
CT 003 C	GLOVE PERRY WHITE SIZE 8 1/2 LATEX	5711106	162163	2			Y	
CT 006 D	COVER OVERHEAD REINFORCED POLY TABLE 80X90 CS/12EA	9385	206679	1			U	
CT 008 C	PREP SKIN 26ML CHLORAPREP ORANGE TINT GLUC ISPRPYL ALC 2%	260815	132484	2			U	
CT 008 D	DRESSING KERLIX 4 1/2INX4.1YD GZ 6 PLY SFT STRL	6715	32993	1			U	
CT 009 D	DRESSING TELFA 3.0X8IN NONADH W/ CONTCT LAYR STRL	1238	12287	1			U	
CT 010 D	SUCTION YANKR STRL RIGD W/O CTRL VNT BULB TP REG CAP	8888505016	28789	1		Y	U	
CT 010 D	TAPE PATCH 4X7IN MICROFM STRL	1562	28770	1			U	
CT 011 B	BOVIE EXTENDER INSULATED	E1455-6	41215	1			U	
CT 011 B	BOVIE TIP INSULATED	E1455	41214	1			U	
CT 011 D	MARKER SKIN SURG STRL W/ RULR FINE PT	1400-100	8029	1			U	
CT 011 D	SYRINGE W/O 30ML NEEDLE STRL DISP W/ LUER SLP TP PLASTIC	309651	37180	1			U	
CT 011 D	TRAP SPECIMEN 40CC STERL CS/50EA	8884724500	34845	1			U	

CSPS SUPPLY CART 18-60								
Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 018 C	STERI STRIP 1/4" (CLOSURE STERI 1/4X4IN STRIP WOUND SKIN STR	R1546	33030	1		Y	U	
CT 028 C	DRAPE C ARM 44X77IN XRAY W/ STRAP	9951-20	4497	1		Y	U	
CT 028 D	DRAPE MICROSCOPE 54X120IN F/ ZEISS LENS	4850120GL	40446	1			U	
CT 036 D	SPONGE NEURO PATTIE 1/2 X 1/2	1000	12363	1		Y	U	
CT 053 A	BRUSH SURGICAL SCRB CHLORAHEXIDINE GLUC 4% W/ NL CLN	371073	45043	1			U	
CT 060 C	COVER CAMERA OR STERILE CS/10EA	LT-C01	361881	1			U	

CSPS SUPPLY CART 61-93								
Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 078 B	MGH OR ONLY KIT ORTHO SPINE 631	PO13BKMG	365445	1			U	

CSPS Pick List **Form # 982531** **Page:** 2 of 3

Surgery Date: 7/6/2012 **OR:** 73 **Time:** 07:45

[redacted] **Service:** ORTHOPAEDIC SURGERY

Additional MD(s): **MD Service:**

[redacted]

Primary Procedure: LUMBAR POSTERIOR FUSION **Additional Procedure(s):** LUMBAR LAMINECTOMY 3 OR MORE LEVELS

CSPS SUPPLY CART 61-93

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
		A						

CSPS Suture Cart 1-5

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 002 C	SUTURE VICRYL 0-0 UR-6 27IN COAT BR VIOLET	J603H	74454	2			U	
CT 006 E	SUTURE MONOCRYL 3-0 PS-1 27IN MF UD	Y936H	18120	1			U	

CSPS INSTRUMENTS

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 094 C 1	Basic Ortho Kit		0	1			U	
CT 094 E 1	Lambotte Osteotome Set		0	1			U	
CT 095 D 2	Universal Spine Instruments		0	1			U	
CT 097 D 3	Legend Electric Drill (Orth)		0	1			U	
CT 098 D 1	Cha Curette (Orth)		0	1			U	
CT 118 D 1	Acromed Pedicle Marker Bone Marker (Orth)		0	1			U	
CT 128 E 2	Dural Repair Kit		0	1		Y	U	
CT 129 D 1	Universal Spine Kerrison and Pituitary Rongeurs		0	1			U	
CT 129 D 2	Universal Spine Black Handle Instruments		0	1			U	
CT 133 A 1	Depuy Spine Expedium Core 5.5 Instrument Set # 1		0	1			U	
CT 133 A 1	Depuy Spine Expedium Core 5.5 Instrument Set # 2		0	1			U	
CT 133 A 2	Depuy Spine Expedium Core Implant 5.5 Case (Cns)		0	1			U	
CT 138 E 3	Depuy Spine Acromed Rod Cutter		0	1		Y	U	
CT 169 B 1	SPD Basin Single	27425	0	1			U	
CT 170 B 1	SPD Basin Major	27424	0	1			U	
CT127	Bipolar Forcep, Bayonet Insulated, Blunt 7 1/4		0	1			U	
LL SPD	SPD Cord Malis Neuro	27458	0	1			U	
LL SPD	SPD Retractor Weitlaner Blunt 4"	27591	0	1			U	
LL SPD	SPD Tray Mayo	27680	0	1			U	
LUNDER3	Acromed Rod Bender (Orth)		0	1		Y	U	

Additional MD(s):	**MD Service:**

Primary Procedure: LUMBAR POSTERIOR FUSION	**Additional Procedure(s):** LUMBAR LAMINECTOMY 3 OR MORE LEVELS

LUNDER 3 NORTHWEST CORE

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 001 B	BUR BONE 3MMX14CM CUT DISSCT MATCH HD LEGEND	14MH30	79243	1			U	

OR JACKSON SUPPLY EXTERIOR

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 052 D	ADHESIVE SKIN 0.5ML TOPICAL DERMABOND HI VISCOSITY	DHV12	35453	1			U	

GEN SURG CLOSET 3

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
CT 001 A	ANGIOCATH 14 G X 5 1/4 (CATHETER IV 14GAX5 1/4IN LATEX FREE	382269	373	1			N	

NON CSPS INSTRUMENT LOCATIONS

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
Trauma	Balfour Retractor Deep (Trau)		0	1			U	

UNKNOWN LOCATION: SUPPLIES

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
	SUTURE VICRYL 2-0 CP-1 36IN COAT BR VIOLET	J472H	29459	2			U	

UNKNOWN LOCATION: INSTRUMENTS

Compartment	Item Description	Catalog #	PS #	Qty	Picked	Stand By	Latex	Std. Comments
	Legend Attatchment AA14DK (Dr.Cha)		0	1			U	

Appendix 2: New Base Stock Levels

Pack #	Pack	Service	New Base stock (Par)	Old Base stock (Par)
1	BURN PREP DRESSING CHANGE CS/5EA'	Burn	5	20
2	'ENT NECK ACCESSORY CS/3EA'	Thor	2	6
3	'PACK OPEN HEART DRAPE CS/10EA'	Card	15	18
4	'PACK TRASPHENOIDAL DRAPE CS/10EA'	N/A	4	5
5	'PUL PERCUTANEOUS ULTRASONIC'	UROL	4	6
6	' ENT TRAY CS/6EA'	Thor	8	12
7	' KIT AMP'	Vasc	7	10
8	' KIT ARTHROSCOPY CS/2EA'	Ortho	0	18
9	' KIT AV GRAFT'	Trans	8	10
10	' KIT BASIC GYN CS/2EA'	GYN	6	8
11	' KIT CAROTID'	Neur	2	3
12	' KIT CRANIOTOMY'	Neur	18	18
13	' KIT DAVINCI PROSTATECTOMY'	UROL	2	5
14	' KIT ENDOVASCULAR'	VASC	0	6
15	' KIT FOOT'	Ortho	12	12
16	' KIT FRACTURE TABLE CS/2EA'	Ortho	0	12
17	' KIT GASTRIC BYPASS'	GENS	4	6
18	' KIT GYN LAP CS/3EA'	GYN	12	18
19	' KIT KIDNEY TRANSPLANT'	TRANS	3	4
20	' KIT KNEE ACL'	Ortho	0	8
21	' KIT LAMINECTOMY'	NEUR	0	12
22	' KIT LAP APPY CS/2EA'	GENS	0	8
23	' KIT LAP HERNIA CS/2EA'	GENS	0	20
24	' KIT LAPAROSCOPIC COLON'	GENS	7	8
25	' KIT LAPAROSCOPIC PROSTATECTOMY CS/2EA'	UROL	4	6
26	' KIT LIVER TRANSPLANT'	TRANS	3	6
27	' KIT MINOR CARDIAC 631'	Card	2	7
28	' KIT MINOR ORTHO'	Ortho	0	42
29	' KIT OPEN HEART'	Card	15	18
30	' KIT ORTHO SPINE 631'	Ortho	0	12
31	' KIT RADICAL PROSTATECTOMY CS/2EA'	UROL	3	4
32	' KIT SHOULDER REPAIR'	Ortho	7	10
33	' KIT TOTAL HIP REPLACEMENT'	Ortho	0	15
34	' KIT TOTAL KNEE REPLACEMENT 631'	Ortho	0	18
35	' KIT URO GYN CS/2EA'	Gyn	5	4
36	' KIT VP SHUNT'	Neur	0	6
37	' MAJOR GU CS/3EA'	UROL	8	6
38	' MEDIASTINOSCOPY CS/5EA'	Thor	6	10
39	' MICRO PLASTIC PACK CS/3EA'	Plastic	3	12

40	' ORAL PLASTIC FACIAL CS/3EA'	Plastic	14	20
41	' ORTHO PEDI CS/7EA'	Ortho	0	14
42	' PACK BASIC PACK CS/2EA'	GENS	55	58
43	' PACK BURN'	Burn	10	8
44	' PACK CABG ADD ON CS/5EA'	Card	8	20
45	' PACK CYSTO CS/4EA'	UROL	24	20
46	' PACK DRAPE LAPAROTOMY'		0	-
47	' PACK DRAPE LITHOTOMY'		0	-
48	' PACK ESOPHAGEALTRACHEAL CS/6EA'	Thor	3	10
49	' PACK GU LAPAROSCOPY'	UROL	5	4
50	' PACK HERNIA SAME DAY CS/5EA'	GENS	8	8
51	' PACK LAP CHOLE CS/4EA'	GENS	0	21
52	' PACK MAJOR VASCULAR'	Vasc	3	3
53	' PACK MINOR VASCULAR CS/3EA'	Vasc	0	12
54	' PACK PEDIATRIC BASIC CS/5EA'	Pedi	5	10
55	' PACK PEDIATRIC MINOR CS/8EA'	Pedi	16	16
56	' PACK RECONSTRUCTION CS/3EA'	Plastic	16	20
57	' PACK SAME DAY BREAST CS/3EA'	SONC	24	18
58	' PACK SAME DAY HAND CS/3EA'	Ortho	13	10
59	' PACK SAME DAY HYSTEROSCOPY CS/2EA'	GYN	13	12
60	' PACK SAME DAY MINOR CS/8EA'	Burn	3	16
61	' PACK SAME DAY VENOUS ABLATION PK CS/2EA'	VASC	2	6
62	' PACK THORACOSCOPY CS/5EA'	Thor	13	15
63	' PACK THYROIDECTOMY CS/5EA'	GENS	13	16
64	' PERCUTANEOUS PROCEDURE'	VASC	8	20
65	' TRANS HYPOPHYSECTOMY'	Neur	5	3
66	'inter8&20' Arthroscopy&Knee ACL	Ortho	18	-
68	'diff 8\20' Arth/ACL	Ortho	16	-
69	'diff 20\8' ACL/Arth	Ortho	4	-
102	'inter14&53' Endovascular&Minor Vascular	Vasc	10	-
104	'diff 14\53' Endo/Minor Vascular	Vasc	3	-
105	'diff 53\14' Minor Vascular/Endo	Vasc	10	-
106	'inter16&28' Fracture Table & Minor Ortho	Ortho	32	-
108	'diff 16\28' Fracture Table/Minor Ortho	Ortho	5	-
109	'diff 28\16' Minor Ortho/Fracture Table	Ortho	29	-
134	'inter21&36' Laminectomy&VP Shunt	Neur	15	-
136	'diff 21\36' Laminectomy/VP Shunt	Neur	13	-
137	'diff 36\21' VP Shunt/Laminectomy	Neur	5	-
180	'diff 30\33' Ortho Spine/ Total Hip	Ortho	13	-
181	'diff 33\30' Total Hip/ Ortho Spine	Ortho	25	-
182	'inter30&34' Ortho Spine & Total Knee	Ortho	33	-
209	inter3' 22-23-51 Lap Appy & Lap Hernia & Lap Chole	Gens	24	-

Appendix 3: Pack Transition Guide

	Old Pack	New Pack	New Pack
Arthroscopy pack	Arthroscopy	Arth & ACL	Arth/ACL
BANDAGE COBAN 4INX5YD LATEX FREE SELF ADHESIVE STRL ELAST	1	0	1
BANDAGE ELASTIC 4INX5YD LATEX FREE ACE STRL W/ CLIP	1	1	0
BASIN,RING,5500CC,7QT,BLUE,NS	1	1	0
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.5	0.5	0
CLOSURE STERISTRIP 1/2X4IN SKIN STRIP REINF WHITE BX/50EA	2	2	0
CNTNR,SPECIMEN,4.5-OZ CAPACITY SCREW LID,NS	1	1	0
COVER CAMERA OR STERILE CS/10EA	1	1	0
COVER,BACK TABLE,55X75IN,FAN- FOLD,NS	1	1	0
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1	0
DRAPE,THREE QUARTER SHEET, 60X76IN,NS	1	1	0
DRAPE,U,60X72IN,FAN FOLDED,NS	2	2	0
DRESSING KERLIX 4 1/2INX4.1YD GZ 6 PLY SFT STRL	1	1	0
DRESSING PAD 5.0X9IN ABDOMINALTENDERSORB STRL	2	2	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	1	1	0
GOWN IMPERVIOUS XL CS/18EA	1	1	0
GOWN SMART BI XL XLONG CS/14EA	2	2	0
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	1	0
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1	0
LBL,LACTATED RINGERS,STD SIZE, WHITE W/BLACK	4	2	2
LBL,ORTHO,SHEET OF 26,STD SIZE WHI W/BLK INK,	1	1	0
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	1	0
NDL CNTR,20CT,MAG/FOAM,10#'S, POP N COUNT,NS	1	0	1
NEEDLE DISP SPINAL 18X3 1/2	1	1	0
NEEDLE HYPODERMIC 20GAX1 1/2IN LATEX FREE REG BVL REG WALL	1	1	0
NLC USE SJ0144ECT55,(030110), BOX,CORRUGATE,2	0.5	0	0.5
PITCHER,GRAD,1200CC,W/HANDLE, RAD STABLE,NS	1	1	0
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1	0
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1	0
STOCKINETTE ORTHOPEDIC LG 12X48IN IMPERV STRL SYNTH	1	1	0
SYRINGE 35CC W/O NEEDLE LL LUER LOCK	1	1	0
TBG,SUCTION,NON-CONDUCTIVE, 6MMX12FT,CLR,BAND	2	0	2
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	1	2
TRAY,ORGANIZER,5X4X2IN,BLUE, NS	3	3	0
TRAY,STYROFOAM,3/4X14X20IN,NS	1	1	0

TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	10	10	0
WRAP,CSR,12X12IN,BIO-SHIELD,NS	1	1	0
WRAP,CSR,30X30IN,BIO-SHIELD II NS	1	1	0

Items to be picked: None

	Old Pack	New Pack	New Pack
Knee ACL	Knee ACL	Arth&ACL	ACL/Arth
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	2	0	2
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	3	0	3
BLADE SURGICAL SZ 20 SCLPL STRL DISP CARBN STL RIB BACK	1	0	1
BANDAGE ELASTIC 4INX5YD LATEX FREE ACE STRL W/ CLIP	1	1	0
BANDAGE ESMARK 6.0X9FT LATEX FREE STRL	1	0	1
COVER CAMERA OR STERILE CS/10EA	1	1	0
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	0	1
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	0	1
DRAPE EXTREMITY W/ABC AND NON SLIP CS/8EA	1	0	1
DRESSING KERLIX 4 1/2INX4.1YD GZ 6 PLY SFT STRL	1	1	0
GOWN IMPERVIOUS XL CS/18EA	1	1	0
GOWN SMART BI XL XLONG CS/14EA	2	2	0
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
NEEDLE HYPODERMIC 20GAX1 1/2IN LATEX FREE REG BVL REG WALL	1	1	0
NEEDLE DISP SPINAL 18X3 1/2	1	1	0
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1	0
DRESSING PAD 5.0X9IN ABDOMINALTENDERSORB STRL	2	2	0
STOCKINETTE ORTHOPEDIC LG 12X48IN IMPERV STRL SYNTH	1	1	0
SYRINGE 35CC W/O NEEDLE LL LUER LOCK	1	1	0
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	0	1
CLOSURE STERISTRIP 1/2X4IN SKIN STRIP REINF WHITE BX/50EA	2	2	0
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	0	1
BASIN,RING,5500CC,7QT,BLUE,NS	1	1	0
BNDG,SELF-ADHERENT,6INX5YD, LATEX FREE,NS	2	0	2
BOX,CORRUGATE,24X20.0625X 14.5625IN OD,GAS,NS	0.5	0	0.5
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.5	0.5	0
CNTNR,SPECIMEN,4.5-OZ CAPACITY SCREW LID,NS	1	1	0
COVER,BACK TABLE,55X75IN,FAN- FOLD,NS	1	1	0
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1	0
DRAPE,THREE QUARTER SHEET, 60X76IN,NS	1	1	0
DRAPE,U,60X72IN,FAN FOLDED,NS	2	2	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	1	1
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	1	0
LBL,LACTATED RINGERS,STD SIZE, WHITE W/BLACK	2	2	0
LBL,ORTHO,SHEET OF 26,STD SIZE WHI W/BLK INK,	1	1	0
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	1	0
NDL CNTR,10-20 COUNT,FOAM BLOCK W/MAGNET,NS	1	0	1

PITCHER,GRAD,1200CC,W/HANDLE, RAD STABLE,NS	1	1	0
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1	0
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	0	1
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1	0
TRAY,9X5X2,1/2 DEEP,BLUE,NS	1	1	0
TRAY,ORGANIZER,5X4X2IN,BLUE, NS	3	3	0
TRAY,STYROFOAM,3/4X14X20IN,NS	1	1	0
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	10	10	0
WRAP,CSR,12X12IN,BIO-SHIELD,NS	1	1	0
WRAP,CSR,30X30IN,BIO-SHIELD II NS	1	1	0

Items to be picked: None

	Old	New	New
Fracture Table	FT	FT&MO	FT/MO
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	2	2	0
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	2	2	0
COVER CAMERA OR STERILE CS/10EA	1	0	1
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1	0
DRAPE TIBURON LARGE SHEET 72X85 CS/30EA	1	0	1
DRESSING TEGADERM 4.0X4 3/4IN FILM TRNSP FRM STYL STRL	1	0	1
DRESSING GZ 1.0X8IN PETRO PATCH STRL NON ADHESIVE FOIL PK	1	0	1
GOWN SMART BI XL XLONG CS/14EA	3	3	0
TIP SUCTION 10FR FRZR STRL W/ CTRL VNT OBTRTR DISP	1	1	0
SUCTION YANKR LATEX FREE STRL SUCT BULB TP CTRL	1	1	0
SOLUTION SCRUB 26ML SURG SKIN PREP IOD ISPRPYL ALC PREFLL	2	0	2
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
COUNTER NEEDLE 40 COUNT CS/64	1	0	1
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1	0
DRESSING PAD 5.0X9IN ABDOMINALTENDERSORB STRL	2	2	0
STAPLER SKIN 35MM FIX HD WD DISP STRL PROX	1	1	0
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	1	0
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1	0
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1	0
BOX,CORRUGATE,24X20.0625X 14.5625IN OD,GAS,NS	0.33	0	0.3333
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.33	0.333	0
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1	0
COVER,BACK TABLE,65X90IN,BOOK FOLD,HVY DTY,NS	2	2	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	1	1	0
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	1	0
LBL,CONSUMER COMMODITY ORM-D, BLUE W/WHITE IN	0.33	0	0.3333
LBL,LACTATED RINGERS,STD SIZE, WHITE W/BLACK	2	2	0
LBL,ORTHO,SHEET OF 26,STD SIZE WHI W/BLK INK,	1	1	0
LBL,SHEET OF 9,BLANK,NS	2	2	0
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	1	0
PITCHER,GRAD,1200CC,W/HANDLE, RAD STABLE,NS	1	1	0
POUCH,STERILIZATION,26X24IN, 5MIL,W/ANTIBLOCK	1	0	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	1	0
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1	0
SPNG,LAP,8X36IN,PRE-WASHED, 4PLY,X-RAY,TAPE L	1	0	1

TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	1	1	0
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3	0
TRAY,MAYO,12-3/4X19IN,NS	1	0	1
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	10	10	0

Items to be picked: None

	Old	New	New
Minor Ortho	MO	FT&MO	MO/FT
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	2	2	0
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	2	2	0
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	0	1
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1	0
DRAPE IOBAN LG 23X17IN INCISE ANTIMICROB STRL CS/4BX/10EA	1	0	1
DRAPE INST 7.0X11IN POUCH 2 COMPRT STRL PLASTIC CLR	1	0	1
DRESSING WOUND GAUZE XEROFORM PETROLATUM 1X8IN	1	0	1
GOWN SMART BI XL XLONG CS/14EA	3	3	0
TIP SUCTION 10FR FRZR STRL W/ CTRL VNT OBTRTR DISP	1	1	0
SUCTION YANKR LATEX FREE STRL SUCT BULB TP CTRL	1	1	0
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	0	1
NEEDLE HYPODERMIC 20GAX1 1/2IN LATEX FREE REG BVL REG WALL	1	0	1
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1	0
DRESSING PAD 5.0X9IN ABDOMINALTENDERSORB STRL	2	2	0
STAPLER SKIN 35MM FIX HD WD DISP STRL PROX	1	1	0
SYRINGE DISP 10CC LUER LOK	1	0	1
SYRINGE 35CC W/O NEEDLE LL LUER LOCK	1	0	1
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	1	0
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1	0
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1	0
BASIN,RING,5500CC,7QT,BLUE,NS	1	0	1
BOX,CORRUGATE,23-5/8X19-11/16X 16-3/8,NS	0.5	0	0.5
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.5	0.333	0.1667
COVER,BACK TABLE,55X75IN,FAN- FOLD,NS	1	0	1
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	2	1	1
COVER,BACK TABLE,65X90IN,BOOK FOLD,HVY DTY,NS	3	2	1
DRAPE,SPLIT SHEET,77X120IN,FAN FOLDED,TIBURON	1	0	1
DRAPE,U,60X72IN,FAN FOLDED,NS	1	0	1
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	1	1
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	2	1	1
LBL,LACTATED RINGERS,STD SIZE, WHITE W/BLACK	2	2	0
LBL,ORTHO,SHEET OF 26,STD SIZE WHI W/BLK INK,	1	1	0
LBL,SHEET OF 9,BLANK,NS	2	2	0
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	1	0
PITCHER,GRAD,1200CC,W/HANDLE, RAD STABLE,NS	1	1	0
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	0	1

PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	1	0
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	1	1	0
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3	0
TRAY,ORGANIZER,5X4X2IN,BLUE, NS	3	0	3
TRAY,STYROFOAM,3/4X14X20IN,NS	1	0	1
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	10	10	0

Items to be picked: None

	Old	New	New
Ortho Spine	OS	OS/Hip	OS&Knee
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	2	0	2
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	2	1	1
WAX BONE 2 1/2GR LATEX FREE SURG SUTURE	1	1	0
CONTAINER SPECIMEN 120CC CLIKSEAL BLSTR PK STRL	1	1	0
COVER CAMERA OR STERILE CS/10EA	1	0	1
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	0	1
DRAPE ENDOSCOPY GENERAL CS/12EA	1	1	0
DRAPE EQUIPMENT 35X43IN FLUOROSCOPE STRL 2 ADHESIVE STRIP	1	1	0
DRAPE IOBAN LG 23X17IN INCISE ANTIMICROB STRL CS/4BX/10EA	1	0	1
DRAPE INST 7.0X11IN POUCH 2 COMPRT STRL PLASTIC CLR	1	0	1
DRESSING FILM 6.0X8IN MOIST VAPOR PERM ORIG FRM STRL TRNSP	1	1	0
DRESSING GZ 1.0X8IN PETRO PATCH STRL NON ADHESIVE FOIL PK	1	0	1
EDGE COATED EXTENDED BOVIE BLADE	1	0	0
GOWN SMART BI XL XLONG CS/14EA	3	0	3
TIP SUCTION 10FR FRZR STRL W/ CTRL VNT OBTRTR DISP	2	1	0
SUCTION YANKR LATEX FREE STRL SUCT BULB TP CTRL	1	1	0
TIP SUCTION FRZR STRL W/ CTRL VNT OBTRTR DISP FR	1	0	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	0	1
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	0	1
NEEDLE HYPODERMIC 20GAX1 1/2IN LATEX FREE REG BVL REG WALL	1	1	0
NEEDLE HYPODERMIC 22GAX1 1/2IN LATEX FREE REG BVL REG WALL	1	1	0
NEEDLE DISP SPINAL 18X3 1/2	2	2	0
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	0	1
DRESSING PAD 5.0X9IN ABDOMINALTENDERSORB STRL	2	0	2
STAPLER SKIN 35MM FIX HD WD DISP STRL PROX	1	0	1
SUTURE VICRYL 0-0 CT-1 18IN COAT BR VIOLET	2	2	0
SUTURE VICRYL 2-0 CT-1 18IN COAT BR VIOLET	2	2	0
SYRINGE DISP 10CC LUER LOK	1	1	0
SYRINGE DISP 20CC LUER LOK	2	2	0
SYRINGE 35CC W/O NEEDLE LL LUER LOCK	1	1	0
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	0	1
CLOSURE STERISTRIP 1/2X4IN SKIN STRIP REINF WHITE BX/50EA	2	2	0
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	0	1
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	0	1
BOX,CORRUGATE,20.0625X16X 12.9375IN OD,GAS,NS	1	1	0
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	0	1
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	1	0.5	0.5
COVER,BACK TABLE,55X75IN,FAN- FOLD,NS	1	1	0
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	2	0	2

COVER,BACK TABLE,65X90IN,BOOK FOLD,HVY DTY,NS	3	0	2
DRAPE,SHEET,77X98IN,NS	1	0	0
DRAPE,THREE QUARTER SHEET, 60X76IN,NS	2	2	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	0	2
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	0	1
LBL,LACTATED RINGERS,STD SIZE, WHITE W/BLACK	2	0	2
LBL,ORTHO,SHEET OF 26,STD SIZE WHI W/BLK INK,	1	0	1
LBL,SHEET OF 9,BLANK,NS	2	2	0
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	0	1
PITCHER,GRAD,1200CC,W/HANDLE, RAD STABLE,NS	1	0	1
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	0	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	0	1
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	0	1
SPNG,PEANUT,3/8IN,XR,5/PK FOAM HOLDER,NS	1	1	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	2	1	1
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	0	3
TRAY,MAYO,12-3/4X19IN,NS	1	0	1
TRAY,ORGANIZER,5X4X2IN,BLUE, NS	4	1	3
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	20	9	11

Items to be picked: EDGE COATED EXTENDED BOVIE BLADE, TIP SUCTION 10FR FRZR STRL W/ CTRL VNT OBTRTR DISP, COVER,BACK TABLE,65X90IN,BOOK FOLD,HVY DTY,NS, DRAPE,SHEET,77X98IN,NS

Total Knee	Old Knee	New Hip/OS	New OS&Knee
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	4	2	2
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	0	1
CONTAINER SPECIMEN LG 16OZ STRL	2	1	0
COVER CAMERA OR STERILE CS/10EA	1	0	1
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	1	0
COVER OVERHEAD REINFORCED POLY TABLE 80X90 CS/12EA	1	1	0
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	0	1
DRAPE CASSETTE 21X36IN XRAY DISP	1	1	0
DRAPE HIP W/POUCH CS/5EA	1	1	0
DRAPE IOBAN LG 23X17IN INCISE ANTIMICROB STRL CS/4BX/10EA	2	1	1
DRAPE TIBURON LARGE SHEET 72X85 CS/30EA	1	0	0
DRAPE INST 7.0X11IN POUCH 2 COMPRT STRL PLASTIC CLR	1	0	1
DRESSING GZ 1.0X8IN PETRO PATCH STRL NON ADHESIVE FOIL PK	1	0	1
GOWN SMART BI XL XLONG CS/14EA	3	0	3
SUCTION YANKR STRL RIGD W/O CTRL VNT BULB TP REG CAP	1	1	0
TIP SUCTION FRZR STRL W/ CTRL VNT OBTRTR DISP FR	1	0	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	0	1
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	0	1
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	0	1
DRESSING PAD 5.0X9IN ABDOMINALTENDERSORB STRL	2	0	2
STAPLER SKIN 35MM FIX HD WD DISP STRL PROX	1	0	1
STOCKINETTE ORTHOPEDIC LG 12X48IN IMPERV STRL SYNTH	1	1	0
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	0	1
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	0	1
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	1	0
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	0	1
BNDG,SELF-ADHERENT,6INX5YD, LATEX FREE,NS	1	1	0
BOX,CORRUGATE,24X20.0625X17 OUTER,GAS,NS	0.5	0.5	0
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	0	1
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.5	0	0.5
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	2	0	2
COVER,BACK TABLE,65X90IN,BOOK FOLD,HVY DTY,NS	2	0	2
DRAPE,U,60X72IN,FAN FOLDED,NS	1	1	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	0	2
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	0	1
LBL,LACTATED RINGERS,STD SIZE, WHITE W/BLACK	2	0	2
LBL,ORTHO,SHEET OF 26,STD SIZE WHI W/BLK INK,	1	0	1
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	0	1
PITCHER,GRAD,1200CC,W/HANDLE, RAD STABLE,NS	1	0	1

POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	0	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	0	1
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	0	1
SPNG,LAP,8X36IN,PRE-WASHED, 4PLY,X-RAY,TAPE L	2	2	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	1	0	1
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	0	3
TRAY,MAYO,12-3/4X19IN,NS	1	0	1
TRAY,ORGANIZER,5X4X2IN,BLUE, NS	3	0	3
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	11	0	11

Items to be picked: CONTAINER SPECIMEN LG 16OZ STRL, DRAPE TIBURON LARGE SHEET 72X85 CS/30EA

	Old	New	New
Total Hip	Total Hip	Hip/OS	OS&Kne e
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	4	2	2
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	0	1
CONTAINER SPECIMEN LG 16OZ STRL	1	1	0
COVER CAMERA OR STERILE CS/10EA	1	0	1
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	1	0
COVER OVERHEAD REINFORCED POLY TABLE 80X90 CS/12EA	1	1	0
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	0	1
DRAPE CASSETTE 21X36IN XRAY DISP	1	1	0
DRAPE HIP W/POUCH CS/5EA	1	1	0
DRAPE IOBAN LG 23X17IN INCISE ANTIMICROB STRL CS/4BX/10EA	2	1	1
DRAPE INST 7.0X11IN POUCH 2 COMPRT STRL PLASTIC CLR	1	0	1
DRESSING GZ 1.0X8IN PETRO PATCH STRL NON ADHESIVE FOIL PK	1	0	1
EDGE COATED EXTENDED BOVIE BLADE	1	0	0
GOWN SMART BI XL XLONG CS/14EA	3	0	3
TIP SUCTION 10FR FRZR STRL W/ CTRL VNT OBTRTR DISP	1	0	0
SUCTION YANKR STRL RIGD W/O CTRL VNT BULB TP REG CAP	1	1	0
TIP SUCTION FRZR STRL W/ CTRL VNT OBTRTR DISP FR	1	0	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	0	1
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	0	1
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	0	1
DRESSING PAD 5.0X9IN ABDOMINALTENDERSORB STRL	2	0	2
STAPLER SKIN 35MM FIX HD WD DISP STRL PROX	1	0	1
STOCKINETTE ORTHOPEDIC LG 12X48IN IMPERV STRL SYNTH	1	1	0
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	0	1
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	0	1
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	1	0
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	0	1
BNDG,SELF-ADHERENT,6INX5YD, LATEX FREE,NS	1	1	0
BOX,CORRUGATE,24X20.0625X17 OUTER,GAS,NS	0.5	0.5	0
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	0	1
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.5	0	0.5
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	2	0	2
COVER,BACK TABLE,65X90IN,BOOK FOLD,HVY DTY,NS	3	0	2
DRAPE,SHEET,77X98IN,NS	1	0	0
DRAPE,U,60X72IN,FAN FOLDED,NS	1	1	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	0	2
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	0	1
LBL,LACTATED RINGERS,STD SIZE, WHITE W/BLACK	2	0	2
LBL,ORTHO,SHEET OF 26,STD SIZE WHI W/BLK INK,	1	0	1

MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	0	1
PITCHER,GRAD,1200CC,W/HANDLE, RAD STABLE,NS	1	0	1
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	0	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	0	1
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	0	1
SPNG,LAP,8X36IN,PRE-WASHED, 4PLY,X-RAY,TAPE L	2	2	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	1	0	1
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	0	3
TRAY,MAYO,12-3/4X19IN,NS	1	0	1
TRAY,ORGANIZER,5X4X2IN,BLUE, NS	3	0	3
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	11	0	11

Items to be picked: -COVER,BACK TABLE,65X90IN,BOOK FOLD,HVY DTY,NS, - TIP SUCTION 10FR FRZR STRL W/ CTRL VNT OBTRTR DISP, -EDGE COATED EXTENDED BOVIE BLADE, -DRAPE,SHEET,77X98IN,NS

	Old	New	New
ENDOVASCULAR	Endo	Endo&Minor Vascular	Endo/Minor Vascular
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	2	1	1
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1	0
BAG,SUTURE,12X18IN,2IN,2.0MIL, CLEAR,W/ADH,NS	1	1	0
BAG,ZIPLOCK,3X5IN,2.0MIL	1	0	1
BASIN,RING,5500CC,7QT,BLUE,NS	2	2	0
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	2	2	0
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BOWL,SPONGE,16 OZ,500CC,BLUE, NS	4	3	1
BOX,CORRUGATE,24X20.0625X 14.5625IN OD,GAS,NS	1	0.5	0.5
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	1	0.5	0.5
CLIP APPLIER MED LIG HEMOCLIP PLUS TI BLUE	1	1	0
CLIP LIGATING SM LIGCLP X SS	1	1	0
CLOSURE STERISTRIP 1/4X4IN SKIN STRIP REINF WHITE	2	0	2
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	1	0
COVER,BACK TABLE,50X90IN,BOOK FOLD,NS,ST=A837	1	0	1
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1	0
DOMEBAG,26IN DEEP,CLEAR, LATEX FREE,NS	1	0	1
DRAPE,106X147-1/4IN,2-SHEET, TIBURON,NS	1	0	1
DRESSING TEGADERM 4.0X4 3/4IN FILM TRNSP FRM STYL STRL	2	0	2
DRESSING TELFA 3.0X8IN NONADH W/ CONTCT LAYR STRL	2	0	2
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	2	0
GOWN SURGICAL XLARGE REINF W/ TOWL STRL DISP ASTOUND	3	3	0
HEMOSTAT,ABSORBABLE,2X14IN,XR, SURGICEL,ST	1	1	0
HLDR,TBG,3X3",PAD,W/ADJ VELCRO STRIP,NS,ST EQ	2	0	2
INSERT SURGICAL 33MM LATEX CLMP ATRAUMATIC VASC HYDRAJAW SIL	4	4	0
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1	0
LBL,CONSUMER COMMODITY ORM-D, BLUE W/WHITE IN	1	0	1
LBL,SHEET OF 23,ASSORTED,STD SZ,WHI W/BLK INK	1	0	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
NEEDLE PERCUTANEOUS 19GAX7CM ACCESS SINGLE WALL WITH BASEPLA	1	0	1
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1	0
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	2	1	1
PITCHER,1200CC CAPACITY, GRADUATED,W/HANDLE,S	1	1	0
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1	0
SHEET HALF 44INX58IN STRL DISP CS/20EA	1	0	1

SOLUTION STERISTRIP 2/3CC SKIN PREP BENZ TINCT ADHESIVE VIAL	2	0	2
SPONGE DISSECTOR 3/8IN PEANUT STRL W/ FM HOLD	1	0	1
STOPCOCK HIGH FLO 4 WAY	1	0	1
SUCTION YANKR STRL RIGD W/O CTRL VNT BULB TP REG CAP	1	1	0
SUT BOOT,YELLOW W/BLUE FOAM, 5PR/PK,NS	1	1	0
SUTURE MONOCRYL 4-0 PC-5 18IN MF UD	2	0	2
SUTURE PROLENE 5-0 C-1 24IN MF BLUE DA	4	2	2
SUTURE PROLENE 6-0 C-1 30IN MF BLUE DA	1	1	0
SUTURE SILK 2-0 24IN BR BLACK TIES	1	1	0
SUTURE SILK 3-0 24IN BR BLACK TIES BX/36EA	1	1	0
SUTURE SILK SIZE:3-0 NEEDLE:SH LENGTH:18IN SILK BRAIDED BLAC	1	1	0
SUTURE VICRYL 2-0 CT-1 18IN COAT BR VIOLET	2	2	0
SUTURE VICRYL 3-0 SH 18IN COAT BR VIOLET	2	2	0
SYRINGE 35CC W/O NEEDLE LL LUER LOCK	2	0	2
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	1	0
SYRINGE DISP 20CC LUER LOK	2	0	2
SYRINGE NONSAFETY 3CC 22X1.5 CS/8BX/100	1	1	0
SYRINGE W/O 30ML NEEDLE STRL DISP W/ LUER SLP TP PLASTIC	3	2	1
TAPE SILCRUSH LOOP 12IN SILICON BX/10	2	2	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	2	2	0
TIP SUCTION 8FR FRZR STRL W/ CTRL VNT OBTRTR DISP	1	1	0
TOWEL NONABSORBENT ADHESIVE 17X26 CS/120EA	6	4	2
TRAY,1-COMPARTMENT,10X8-1/4X2, NS	1	0	1
TRAY,9X11,RECTANGULAR,FULL DEEP,BLUE NS	1	0	1
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3	0
TUBING ADULT 60IN PRESS MONITOR LINE CS/25EA	2	0	2
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	8	3	5
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASHED,STEAM	6	6	0
WRAP,POLYBACK,54X72IN,BLUE,NS	1	1	0

Items to be picked: None

Minor Vascular	Old Minor Vascular	New Endo&MV	New MV/Endo
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	1	0
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1	0
BAG,SUTURE,12X18IN,2IN,2.0MIL, CLEAR,W/ADH,NS	1	1	0
BASIN,RING,5500CC,7QT,BLUE,NS	2	2	0
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	2	2	0
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BOWL,SPONGE,16 OZ,500CC,BLUE, NS	3	3	0
BOX,CORRUGATE,24X20.0625X 14.5625IN OD,GAS,NS	0.5	0.5	0
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.5	0.5	0
CLIP APPLIER MED LIG HEMOCLIP PLUS TI BLUE	1	1	0
CLIP LIGATING SM LIGCLP X SS	1	1	0
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	1	0
COVER,BACK TABLE,44X75IN,BOOK FOLD,NS,ST=A837	1	0	1
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	2	0
GOWN SURGICAL XLARGE REINF W/ TOWL STRL DISP ASTOUND	3	3	0
HEMOSTAT,ABSORBABLE,2X14IN,XR, SURGICEL,ST	1	1	0
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	0	1
INSERT SURGICAL 33MM LATEX CLMP ATRAUMATIC VASC HYDRAJAW SIL	4	4	0
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1	0
LBL,SHEET OF 14,ASSORTED,1.25X .375,WHI/BLK I	1	0	1
LBL,SHEET OF 24,ASSORTED,STD SZ,WHI W/BLK INK	1	0	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	0	1
NEEDLE HYPODERMIC 25GAX5/8IN LATEX FREE REG BVL REG WALL	1	0	1
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1	0
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1	0
PITCHER,1200CC CAPACITY, GRADUATED,W/HANDLE,S	1	1	0
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1	0
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	3	0	3
SPNG,PEANUT,3/8IN,XR,5/PK FOAM HOLDER,NS	1	0	1
SUCTION YANKR STRL RIGD W/O CTRL VNT BULB TP REG CAP	1	1	0
SUT BOOT,YELLOW W/BLUE FOAM, 5PR/PK,NS	1	1	0
SUTURE PROLENE 5-0 C-1 24IN MF BLUE DA	2	2	0
SUTURE PROLENE 6-0 C-1 18IN MF BLUE DA	1	0	1

SUTURE PROLENE 6-0 C-1 30IN MF BLUE DA	2	1	1
SUTURE PROLENE 7-0 BV-1 24IN MF BLUE DA	1	0	1
SUTURE SILK 0-0 24IN BR BLACK TIES	1	0	1
SUTURE SILK 2-0 24IN BR BLACK TIES	1	1	0
SUTURE SILK 3-0 24IN BR BLACK TIES BX/36EA	2	1	1
SUTURE SILK SIZE:3-0 NEEDLE:SH LENGTH:18IN SILK BRAIDED BLAC	1	1	0
SUTURE VICRYL 2-0 CT-1 18IN COAT BR VIOLET	2	2	0
SUTURE VICRYL 3-0 SH 18IN COAT BR VIOLET	2	2	0
SYR,2-OZ,CATHETER TIP,VENTED, ST,NS=301037LF	1	0	1
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	1	1	0
SYRINGE NONSAFETY 3CC 22X1.5 CS/8BX/100	1	1	0
SYRINGE W/O 30ML NEEDLE STRL DISP W/ LUER SLP TP PLASTIC	2	2	0
TAPE SILCRUSH LOOP 12IN SILICON BX/10	2	2	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	2	2	0
TIP SUCTION 8FR FRZR STRL W/ CTRL VNT OBTRTR DISP	1	1	0
TOWEL NONABSORBENT ADHESIVE 17X26 CS/120EA	4	4	0
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3	0
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	3	3	0
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASHED,STEAM	8	6	2
WRAP,POLYBACK,54X72IN,BLUE,NS	1	1	0

Items to be picked: None

	Old	New	New
Laminectomy	Lam	Lam&VP	Lam/VP
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	2	1	1
WAX BONE 2 1/2GR LATEX FREE SURG SUTURE	1	1	0
CATHETER POLY INTROCAN 18X1 3/4 CS/4BX/50EA	2	2	0
CORD CAUTERY 12FT BIPLR DISP LONG	1	0	1
COVER TABLE 80X90IN LATEX FREE SURG OVERHEAD	3	3	0
COVER CAMERA OR STERILE CS/10EA	1	1	0
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1	0
DRAPE IOBAN LG 23X17IN INCISE ANTIMICROB STRL CS/4BX/10EA	1	1	0
DRAPE SURGICAL SPINE UNIVERSAL CS/7EA	1	0	1
DRESSING TELFA 3.0X8IN NONADH W/ CONTCT LAYR STRL	1	1	0
DRESSING GZ 1.0X8IN PETRO PATCH STRL NON ADHESIVE FOIL PK	1	1	0
GOWN SURGICAL XLARGE REINF W/ TOWL STRL DISP ASTOUND	3	3	0
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	1	0
NEEDLE HYPODERMIC 25GAX1 1/2IN LATEX FREE REG BVL REG WALL	1	1	0
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	2	1	1
SPONGE NEUROLOGICAL 1/4X1/4IN XRAY DETECT STRL	1	0	1
SPONGE NEUROLOGICAL 1/2X1/2IN STRL DBL STRUNG XRAY DETECT	1	0	1
SUTURE VICRYL 0-0 CT-1 18IN COAT BR VIOLET	2	0	2
SUTURE VICRYL 3-0 SH 18IN COAT BR VIOLET	2	2	0
SUTURE VICRYL 2-0 CT-1 18IN COAT BR VIOLET	2	2	0
SYRINGE DISP 10CC LUER LOK	3	3	0
SYRINGE W/O 30ML NEEDLE STRL DISP W/ LUER SLP TP PLASTIC	1	0	1
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	2	2	0
SYRINGE 10CC CONTROL W/ LOOP	1	1	0
TAPE ADHESIVE 2INX10YD LATEX FREE HYPOALLERG MICROPORE WHITE	1	1	0
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1	0
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	2	1	1
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1	0
BAG,SUTURE,12X18IN,2IN,2.0MIL, CLEAR,W/ADH,NS	1	1	0
BASIN,RING,5500CC,7QT,BLUE,NS	4	4	0
BOWL,SPONGE,16 OZ,500CC,BLUE, NS	3	3	0
BOX,CORRUGATE,24X16X17.25IN OD,GAS,NS	1	0	1
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	1	1	0
CNTNR,SPECIMEN,4.5-OZ CAPACITY SCREW LID,NS	1	1	0
COVER,BACK TABLE,44X75IN,BOOK FOLD,NS,ST=A837	1	1	0

COVER,BACK TABLE,80X110, UNFOLDED,HEAVY DUTY,	1	1	0
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	3	2	1
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	1	0
LBL,SHEET OF 32,ASSORTED,STD SZ,WHI W/BLK INK	1	1	0
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	1	0
PITCHER,1200CC CAPACITY, GRADUATED,W/HANDLE,S	1	1	0
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	2	1	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	1	0
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	2	2	0
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3	0
TRAY,MAYO,12-3/4X19IN,NS	1	0	1
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	16	16	0

Items to be picked: None

	Old	New	New
VP Shunt	VP	Lam&VP	VP/Lam
BLADE SURGICAL SZ 10 SCLPL STRL DISP CARBN STL RIB BACK	2	1	1
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	1	0
WAX BONE 2 1/2GR LATEX FREE SURG SUTURE	1	1	0
CATHETER POLY INTROCAN 18X1 3/4 CS/4BX/50EA	2	2	0
COVER TABLE 80X90IN LATEX FREE SURG OVERHEAD	3	3	0
COVER CAMERA OR STERILE CS/10EA	1	1	0
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1	0
SHEET BREAST/CHEST CS/12EA	1	0	1
DRAPE IOBAN LG 23X17IN INCISE ANTIMICROB STRL CS/4BX/10EA	2	1	1
DRAPE W/ 47X51IN U SLOT APER W/ ADHESIVE SPLT PLASTIC CLR	1	0	1
DRESSING TELFA 3.0X8IN NONADH W/ CONTCT LAYR STRL	1	1	0
DRESSING GZ 1.0X8IN PETRO PATCH STRL NON ADHESIVE FOIL PK	1	1	0
GOWN SURGICAL XLARGE REINF W/ TOWL STRL DISP ASTOUND	3	3	0
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1	0
COUNTER NEEDLE MAG FM BLOC 40TO70 COUNT	1	1	0
NEEDLE HYPODERMIC 25GAX1 1/2IN LATEX FREE REG BVL REG WALL	1	1	0
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1	0
DRAPE IRG 19X23IN POUCH W/ ADHESIVE APER STRL PLASTIC CLR	1	0	1
STAPLER SKIN 35MM FIX HD WD DISP STRL PROX	1	0	1
SUTURE VICRYL 3-0 SH 18IN COAT BR VIOLET	2	2	0
SUTURE SILK 2-0 24IN BR BLACK TIES	1	0	1
SUTURE VICRYL 0 REEL 54IN COATED VIOLET BRAIDED BX/12EA	1	0	1
SUTURE VICRYL 2-0 CT-1 18IN COAT BR VIOLET	2	2	0
SYRINGE DISP 10CC LUER LOK	3	3	0
SYRINGE DISP 3CC LUER LOK CS/4BX/200EA	1	0	1
SYRINGE BULB 60CC LATEX IRG CTRL FEE STRL	2	2	0
SYRINGE 10CC CONTROL W/ LOOP	1	1	0
TAPE ADHESIVE 2INX10YD LATEX FREE HYPOALLERG MICROPORE WHITE	1	1	0
TUBE CONNECTING 3/16X72IN SUCT MED PVC STRL	2	0	2
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1	0
BAG,10X12,CLEAR PE,0.0045IN THICK,NS	1	0	1
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	1	0
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1	0
BAG,SUTURE,12X18IN,2IN,2.0MIL, CLEAR,W/ADH,NS	1	1	0
BASIN,RING,5500CC,7QT,BLUE,NS	4	4	0
BOWL,SPONGE,16 OZ,500CC,BLUE, NS	5	3	2
BOX,CORRUGATE,24X16X14.8125IN OD,GAS,NS	1	0	1
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1	0

CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	1	1	0
CNTNR,SPECIMEN,4.5-OZ CAPACITY SCREW LID,NS	1	1	0
COVER,BACK TABLE,44X75IN,BOOK FOLD,NS,ST=A837	1	1	0
COVER,BACK TABLE,80X110, UNFOLDED,HEAVY DUTY,	1	1	0
DRAPE,BAR SHEET,106X61-3/4IN, ARMBOARD COVERS	1	0	1
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	2	2	0
HNDL,LITE COVER,FLEXIBLE,GRN, 1PIECE,NS	1	1	0
LBL,SHEET OF 32,ASSORTED,STD SZ,WHI W/BLK INK	1	1	0
MRKR,UTILITY,REGULAR TIP,NS *NOT FOR USE ON S	1	1	0
PITCHER,1200CC CAPACITY, GRADUATED,W/HANDLE,S	1	1	0
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1	0
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	1	0
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1	0
TBG,SUCTION,6MMX20FT,SERRATED, BANDED,NS,ST E	2	2	0
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3	0
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	16	16	0
WRAP,CSR,12X12IN,BIO-SHIELD,NS	2	0	2
WRAP,CSR,30X30IN,BIO-SHIELD II NS	1	0	1

Items to be picked: None

	Old	New
Lap Appy	Lap Appy	Appy&Hernia&Chole
APPLICATOR COTTON 6IN FIBER TP WOOD	2	2
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	1
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1
BAG,SUTURE,12X18IN,2IN,2.0MIL, CLEAR,W/ADH,NS	1	1
BASIN,RING,5500CC,7QT,BLUE,NS	1	1
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	1
BOWL,SPONGE,16 OZ,500CC,BLUE, NS	3	3
BOX,CORRUGATE,27.875X19.875X 18.875IN OD,NS *	0.333	0.333
CAP,SCOPE WARMER SEAL,ST	1	0
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.333	0.25
CLOSURE STERISTRIP 1/4X4IN SKIN STRIP REINF WHITE	2	2
CNTNR,SPECIMEN,4.5-OZ CAPACITY SCREW LID,NS	1	0
COVER LIGHT HANDLE PLASTIC FLEXIBLE STERILE GREEN	1	1
COVER,BACK TABLE,55X75IN,FAN- FOLD,NS	1	0
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1
DRAPE,LAPAROTOMY,147X150IN,W/ ARMBRD CVR,12X1	1	1
DRAPE,THREE QUARTER SHEET, 60X76IN,NS	1	1
DRESSING TEGADERM 2.375X2 3/4IN FILM TRNSP FRM STYL STRL	4	4
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	1	1
GOWN IMPERVIOUS XL CS/18EA	3	3
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1
LBL,SHEET OF 14,ASSORTED,STD SZ,WHI W/BLK INK	1	1
LBL,SHEET OF 9,BLANK,NS	1	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	1
NDL CNTR,10-20 COUNT,FOAM BLOCK W/MAGNET,NS	1	1
NEEDLE HYPODERMIC 22GAX1 1/2IN LATEX FREE REG BVL REG WALL	2	2
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1
PITCHER,1200CC CAPACITY, GRADUATED,W/HANDLE,S	1	1
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	1
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1
SUTURE VICRYL 0-0 UR-6 27IN COAT BR VIOLET	1	1
SYRINGE DISP 10CC LUER LOK	2	2
TOWEL NONABSORBENT ADHESIVE 17X26 CS/120EA	4	4
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3

TUBING INSUFFLATION 10FT W/ MAXI-GRIP CONNECTOR CS/10EA	1	1
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	8	8

Items to be picked:

1. CAP,SCOPE WARMER SEAL,ST
2. CNTNR,SPECIMEN,4.5-OZ CAPACITY SCREW LID,NS
3. COVER,BACK TABLE,55X75IN,FAN- FOLD,NS

	Old	New
Lap Hernia	Lap Hernia	Appy&Hernia&Chole
APPLICATOR COTTON 6IN FIBER TP WOOD	2	2
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	1
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1
BAG,SUTURE,12X18IN,2IN,2.0MIL, CLEAR,W/ADH,NS	1	1
BASIN,RING,5500CC,7QT,BLUE,NS	1	1
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	1
BOWL,SPONGE,16 OZ,500CC,BLUE, NS	3	3
BOX,CORRUGATE,27.875X19.875X 18.875IN OD,NS *	0.333	0.333
CAP,SCOPE WARMER SEAL,ST	1	0
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.333	0.25
CLOSURE STERISTRIP 1/4X4IN SKIN STRIP REINF WHITE	2	2
COVER LIGHT HANDLE PLASTIC FLEXIBLE STERILE GREEN	1	1
COVER,BACK TABLE,55X75IN,FAN- FOLD,NS	1	0
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1
DRAPE,LAPAROTOMY,147X150IN,W/ ARMBRD CVR,12X1	1	1
DRAPE,THREE QUARTER SHEET, 60X76IN,NS	1	1
DRESSING TEGADERM 2.375X2 3/4IN FILM TRNSP FRM STYL STRL	4	4
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	1	1
GOWN IMPERVIOUS XL CS/18EA	3	3
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1
LBL,SHEET OF 14,ASSORTED,STD SZ,WHI W/BLK INK	1	1
LBL,SHEET OF 9,BLANK,NS	1	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	1
NDL CNTR,10-20 COUNT,FOAM BLOCK W/MAGNET,NS	1	1
NEEDLE HYPODERMIC 22GAX1 1/2IN LATEX FREE REG BVL REG WALL	2	2
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1
PITCHER,1200CC CAPACITY, GRADUATED,W/HANDLE,S	1	1
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	1
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1
SUTURE VICRYL 0-0 UR-6 27IN COAT BR VIOLET	1	1
SYRINGE DISP 10CC LUER LOK	2	2
TABLE COVER 44X90 CS/22EA	1	0
TOWEL NONABSORBENT ADHESIVE 17X26 CS/120EA	4	4

TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3
TUBING INSUFFLATION 10FT W/ MAXI-GRIP CONNECTOR CS/10EA	1	1
TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	8	8

Items to be picked:

1. CAP,SCOPE WARMER SEAL,ST
2. COVER,BACK TABLE,55X75IN,FAN- FOLD,NS
3. TABLE COVER 44X90 CS/22EA

	Old	New
Lap Chole	Lap Chole	Appy&Hernia&Chole
APPLICATOR COTTON 6IN FIBER TP WOOD	2	2
BAG,7X10IN,2MIL,PE,CLEAR,FLAT, NS	1	1
BAG,GLASSINE,2-3/4X3-3/4IN, FLAP	1	1
BAG,SUTURE,12X18IN,2IN,2.0MIL, CLEAR,W/ADH,NS	1	1
BASIN,RING,5500CC,7QT,BLUE,NS	1	1
BLADE SURGICAL SZ 11 SCLPL STRL DISP CARBN STL RIB BACK	1	1
BLADE SURGICAL SZ 15 SCLPL STRL DISP CARBN STL RIB BACK	1	1
BOWL,SPONGE,16 OZ,500CC,BLUE, NS	3	3
BOX,CORRUGATE,27.875X19.875X 18.875IN OD,NS *	0.3333	0.333
CHECKLIST MAIN OR/SDSU HANDOFF TOOL,SCRUB TO	1	1
CHIPBOARD,17X15IN,(CHARLOTTE ONLY),NS	0.25	0.25
CLIP LIGATING MED LG 5.5MM LIGCLP X TI	2	0
CLOSURE STERISTRIP 1/4X4IN SKIN STRIP REINF WHITE	2	2
COVER LIGHT HANDLE PLASTIC FLEXIBLE STERILE GREEN	1	1
COVER,BACK TABLE,65X90IN, UNFOLDED,HEAVY DUTY	1	1
DRAPE,LAPAROTOMY,147X150IN,W/ ARMBRD CVR,12X1	1	1
DRAPE,THREE QUARTER SHEET, 60X76IN,NS	1	1
DRESSING TEGADERM 2.375X2 3/4IN FILM TRNSP FRM STYL STRL	4	4
GAUZE,XR, 3-1/2X4IN,32PLY,10/PK,NS	1	1
GOWN IMPERVIOUS XL CS/18EA	3	3
LABEL STERILE 1 1/2X1/2IN KT G CUST 20 PER SHT	1	1
LBL,SHEET OF 14,ASSORTED,STD SZ,WHI W/BLK INK	1	1
LBL,SHEET OF 9,BLANK,NS	1	1
MARKER SKIN SURG STRL W/ RULR FINE PT	1	1
MAYO STAND COVER REINFORCED POLY 23IN CS/30EA	1	1
NDL CNTR,10-20 COUNT,FOAM BLOCK W/MAGNET,NS	1	1
NEEDLE HYPODERMIC 22GAX1 1/2IN LATEX FREE REG BVL REG WALL	2	2
PAD CLEANER 5.0X5.0CM POLISHER TP CAUT	1	1
PEN ELECTROSURG HANDSWITCH STRL W/HOLSTER	1	1
PITCHER,1200CC CAPACITY, GRADUATED,W/HANDLE,S	1	1
POUCH,STERILIZATION,28X32IN, 5MIL,W/ANTIBLOCK	1	1
PROTECTOR,TRAY,FOAM,22INX28INX 1/16IN,NS	1	1
RULER,6IN,FLEXIBLE,CARDINAL,NS	1	1
SUTURE VICRYL 0-0 UR-6 27IN COAT BR VIOLET	1	1
SYRINGE DISP 10CC LUER LOK	2	2
TABLE COVER 44X90 CS/22EA	1	0
TOWEL NONABSORBENT ADHESIVE 17X26 CS/120EA	4	4
TRAY,9X5X2,1/2 DEEP,BLUE,NS	3	3
TUBING INSUFFLATION 10FT W/ MAXI-GRIP CONNECTOR CS/10EA	1	1

TWL,COTTON,17X26IN,+/-1,UNIV, PREWASH,STEAM P	8	8
WRAP,CSR,12X12IN,BIO-SHIELD,NS	2	0

Items to be picked:

1. 2 x CLIP LIGATING MED LG 5.5MM LIGCLP X TI
2. TABLE COVER 44X90 CS/22EA
3. 2 x WRAP,CSR,12X12IN,BIO-SHIELD,NS

Appendix 4: CSP Base Stock Savings

	Pack	Service	New Basestock	Old Basestock	Price		Savings	Holding Cost New	Holding Cost Old
1	BURN PREP DRESSING CHANGE CS/5EA'	Burn	5	20	92.66	$	1,389.90	185.32	741.28
2	'ENT NECK ACCESSORY CS/3EA'	Thor	2	6	58.56	$	234.24	46.85	140.54
3	'PACK OPEN HEART DRAPE CS/10EA'	Card	15	18	18.75	$	56.26	112.52	135.02
4	'PACK TRASPHENOIDAL DRAPE CS/10EA'	N/A	4	5	31.35	$	31.35	50.16	62.70
5	'PUL PERCUTANEOUS ULTRASONIC'	UROL	4	6	106.01	$	212.02	169.62	254.42
6	' ENT TRAY CS/6EA'	Thor	8	12	9.82	$	39.27	31.41	47.12
7	' KIT AMP'	Vasc	7	10	61.67	$	185.01	172.68	246.68
8	' KIT ARTHROSCOPY CS/2EA'	Ortho	0	18	98.04	$	1,764.72	0.00	705.89
9	' KIT AV GRAFT'	Trans	8	10	97.79	$	195.58	312.93	391.16
10	' KIT BASIC GYN CS/2EA'	GYN	6	8	91.17	$	182.34	218.81	291.74
11	' KIT CAROTID'	Neur	2	3	254.07	$	254.07	203.26	304.88
12	' KIT CRANIOTOMY'	Neur	18	18	248.04	$	-	1785.89	1785.89
13	' KIT DAVINCI PROSTATECTOMY'	UROL	2	5	693.17	$	2,079.51	554.54	1386.34
14	' KIT ENDOVASCULAR'	VASC	0	6	445.34	$	2,672.04	0.00	1068.82
15	' KIT FOOT'	Ortho	12	12	87.18	$	-	418.46	418.46
16	' KIT FRACTURE TABLE CS/2EA'	Ortho	0	12	114.17	$	1,370.04	0.00	548.02
17	' KIT GASTRIC BYPASS'	GENS	4	6	1293.38	$	2,586.76	2069.41	3104.11
18	' KIT GYN LAP CS/3EA'	GYN	12	18	96.21	$	577.26	461.81	692.71
19	' KIT KIDNEY TRANSPLANT'	TRANS	3	4	345.79	$	345.79	414.95	553.26
20	' KIT KNEE ACL'	Ortho	0	8	134.01	$	1,072.08	0.00	428.83
21	' KIT LAMINECTOMY'	NEUR	0	12	209.75	$	2,517.00	0.00	1006.80
22	' KIT LAP APPY CS/2EA'	GENS	0	8	646.60	$	5,172.80	0.00	2069.12
23	' KIT LAP HERNIA CS/2EA'	GENS	0	20	173.38	$	3,467.60	0.00	1387.04
24	' KIT LAPAROSCOPIC COLON'	GENS	7	8	293.35	$	293.35	821.38	938.72
25	' KIT LAPAROSCOPIC PROSTATECTOMY CS/2EA'	UROL	4	6	728.80	$	1,457.60	1166.08	1749.12
26	' KIT LIVER TRANSPLANT'	TRANS	3	6	1082.48	$	3,247.44	1298.98	2597.95
27	' KIT MINOR CARDIAC 631'	Card	2	7	158.58	$	792.90	126.86	444.02
28	' KIT MINOR ORTHO'	Ortho	0	42	118.99	$	4,997.58	0.00	1999.03
29	' KIT OPEN HEART'	Card	15	18	461.29	$	1,383.87	2767.74	3321.29
30	' KIT ORTHO SPINE 631'	Ortho	0	12	247.91	$	2,974.92	0.00	1189.97
31	' KIT RADICAL PROSTATECTOMY CS/2EA'	UROL	3	4	317.49	$	317.49	380.99	507.98
32	' KIT SHOULDER REPAIR'	Ortho	7	10	182.53	$	547.59	511.08	730.12
33	' KIT TOTAL HIP REPLACEMENT'	Ortho	0	15	149.28	$	2,239.20	0.00	895.68
34	' KIT TOTAL KNEE REPLACEMENT 631'	Ortho	0	18	206.56	$	3,718.08	0.00	1487.23
35	' KIT URO GYN CS/2EA'	Gyn	5	4	95.07	$	(95.07)	190.14	152.11
36	' KIT VP SHUNT'	Neur	0	6	179.04	$	1,074.24	0.00	429.70
37	' MAJOR GU CS/3EA'	UROL	8	6	60.75	$	(121.49)	194.39	145.79
38	' MEDIASTINOSCOPY CS/5EA'	Thor	6	10	48.30	$	193.22	115.93	193.22
39	' MICRO PLASTIC PACK CS/3EA'	Plastic	3	12	610.89	$	5,498.01	733.07	2932.27
40	' ORAL PLASTIC FACIAL CS/3EA'	Plastic	14	20	62.20	$	373.20	348.32	497.60
41	' ORTHO PEDI CS/7EA'	Ortho	0	14	28.60	$	400.40	0.00	160.16
42	' PACK BASIC PACK CS/2EA'	GENS	55	58	98.98	$	296.94	2177.56	2296.34
43	' PACK BURN'	Burn	10	8	161.59	$	(323.18)	646.36	517.09
44	' PACK CABG ADD ON CS/5EA'	Card	8	20	217.15	$	2,605.80	694.88	1737.20
45	' PACK CYSTO CS/4EA'	UROL	24	20	26.04	$	(104.16)	249.98	208.32
46	' PACK DRAPE LAPAROTOMY'		0		0.00	$	-	0.00	0.00
47	' PACK DRAPE LITHOTOMY'		0		0.00	$	-	0.00	0.00
48	' PACK ESOPHAGEALTRACHEAL CS/6EA'	Thor	3	10	57.99	$	405.93	69.59	231.96
49	' PACK GU LAPAROSCOPY'	UROL	5	4	397.14	$	(397.14)	794.28	635.42
50	' PACK HERNIA SAME DAY CS/5EA'	GENS	8	8	36.53	$	-	116.89	116.89
51	' PACK LAP CHOLE CS/4EA'	GENS	0	21	71.10	$	1,493.00	0.00	597.20
52	' PACK MAJOR VASCULAR'	Vasc	3	3	666.09	$	-	799.31	799.31
53	' PACK MINOR VASCULAR CS/3EA'	Vasc	0	12	262.75	$	3,153.00	0.00	1261.20
54	' PACK PEDIATRIC BASIC CS/5EA'	Pedi	5	10	46.92	$	234.60	93.84	187.68
55	' PACK PEDIATRIC MINOR CS/8EA'	Pedi	16	16	38.44	$	-	246.02	246.02
56	' PACK RECONSTRUCTION CS/3EA'	Plastic	16	20	67.37	$	269.48	431.17	538.96
57	' PACK SAME DAY BREAST CS/3EA'	SONC	24	18	56.20	$	(337.20)	539.52	404.64
58	' PACK SAME DAY HAND CS/3EA'	Ortho	13	10	47.32	$	(141.96)	246.06	189.28
59	' PACK SAME DAY HYSTEROSCOPY CS/2EA'	GYN	13	12	37.48	$	(37.48)	194.90	179.90
60	' PACK SAME DAY MINOR CS/8EA'	Burn	3	16	23.10	$	300.30	27.72	147.84
61	' PACK SAME DAY VENOUS ABLATION PK CS/2EA'	VASC	2	6	64.28	$	257.12	51.42	154.27
62	' PACK THORACOSCOPY CS/5EA'	Thor	13	15	83.98	$	167.96	436.70	503.88
63	' PACK THYROIDECTOMY CS/5EA'	GENS	13	16	31.81	$	95.42	165.40	203.57
64	' PERCUTANEOUS PROCEDURE'	VASC	8	20	59.74	$	716.88	191.17	477.92
65	' TRANS HYPOPHYSECTOMY'	Neur	5	3	145.21	$	(290.42)	290.42	174.25
66	'inter8&20'	Ortho	18		49.42	$	(889.49)	355.80	0.00
68	'diff 8\20'	Ortho	16		5.86	$	(93.73)	37.49	0.00
69	'diff 20\8'	Ortho	4		29.13	$	(116.52)	46.61	0.00
102	'inter14&53'	Vasc	10		289.83	$	(2,898.32)	1159.33	0.00
103	'union14&53'	Vasc	0		396.69	$	-	0.00	0.00
104	'diff 14\53'	Vasc	3		72.48	$	(217.45)	86.98	0.00
105	'diff 53\14'	Vasc	10		34.37	$	(343.73)	137.49	0.00
106	'inter16&28'	Ortho	32		51.40	$	(1,644.95)	657.98	0.00
108	'diff 16\28'	Ortho	5		22.69	$	(113.46)	45.39	0.00
109	'diff 28\16'	Ortho	29		30.56	$	(886.10)	354.44	0.00
134	'inter21&36'	Neur	15		122.79	$	(1,841.85)	736.74	0.00
136	'diff 21\36'	Neur	13		47.38	$	(615.93)	246.37	0.00
137	'diff 36\21'	Neur	5		46.97	$	(234.86)	93.94	0.00
180	'diff 30\33'	Ortho	13		88.32	$	(1,148.16)	459.26	0.00
181	'diff 33\30'	Ortho	25		45.75	$	(1,143.86)	457.54	0.00
182	'inter30&34'	Ortho	33		68.76	$	(2,269.08)	907.63	0.00
192	'diff 33\34'	Ortho	26		11.73	$	(305.09)	122.04	0.00
193	'diff 34\33'	Ortho	16		5.68	$	(90.81)	36.33	0.00
209	inter3' 22-23-51	Gens	24		64.90	$	(1,557.68)	623.07	0.00

One time Savings	Holding Cost Dif
$ 47,652	$ 19,061
	In Perp at 8%
	$ 238,260

Total Savings

$ 285,912

Appendix 5: Optimization Code

```
param nitems > 0;  # = nonlysoftg + nonlypackg + nbothsandp + nexcesssoft
param ncards > 0;
param npacks > 0;

set ITEMS := 1..nitems;
set PACKS := 1..npacks;
set CARDS := 1..ncards;

set ICPAIRS within {ITEMS, CARDS};
set COVPAIRS within {CARDS, CARDS};

set OnlyPACKITEMS := 2063..2306;

set excessITEMS := 2307..2602;

param mu {CARDS} >= 0;
param sigma {CARDS} >=0;
param covariance {CARDS, CARDS};

param intrate > 0;
param markup > 0;
param w > 0;
param safetyfactor > 0;
param b {ICPAIRS} default 0;
param q {ITEMS,PACKS} default 0;
param cost_cardinal {ITEMS} > 0;                                    # cost of an item when put into
packs (cardinal = pack provider)
param cost_owens {i in ITEMS} > 0;                                  # cost of an item when bought
as soft goods (owens = soft goods provider)
param cost_pack {p in PACKS} = (sum {i in ITEMS} q[i,p]*cost_cardinal[i])*(1+markup);
param h1 {p in PACKS} = cost_pack[p] * intrate;
param h2 {i in (ITEMS diff OnlyPACKITEMS)} = cost_owens[i] * intrate;
param pickcost > 0;


param slopes{ls in 1..numberofpieces} <= if ls = 1 then 1000 else slopes[ls-1];
param bkpts{ls in 1..numberofpieces-1} > if ls = 1 then 0 else bkpts[ls-1];

var y {PACKS,CARDS} binary;
var picked {ICPAIRS} binary;

var y_cov {PACKS, COVPAIRS} binary;
var picked_cov {ITEMS, COVPAIRS} binary;

var laborcost >= 0;
var sscostpacks >= 0;
```

```
var sscostsoft >= 0;

var ordercostpacks >= 0;
var ordercostitems >= 0;

var xp{PACKS} >= 0;
var xi{ITEMS} >= 0;

#minimize totalcost: w*sum {c in CARDS,i in ITEMS} picked[i,c]*mu[c] + sum {p in PACKS} safetyfactor *
h1[p] * <<{ls in 1..numberofpieces-1} bkpts[ls]; {ls in 1..numberofpieces} slopes[ls]>> xp[p] +
sum {i in ITEMS} safetyfactor * h2[i] * <<{ls in 1..numberofpieces-1} bkpts[ls]; {ls in 1..numberofpieces}
slopes[ls]>> xi[i] + sum {i in ITEMS,c in CARDS} cost_cardinal[i] * mu[c] * (b[i,c] - sum {p in PACKS} q[i,p] *
y[p,c] + s[i,c]);

minimize totalcost: sscostpacks + sscostsoft + ordercostpacks + ordercostitems;

subject to labor: laborcost = w*sum {(i,c) in ICPAIRS} picked[i,c]*mu[c];
subject to safetypack: sscostpacks =  sum {p in PACKS} safetyfactor * h1[p] * <<{ls in 1..numberofpieces-
1} bkpts[ls]; {ls in 1..numberofpieces} slopes[ls]>> xp[p];
subject to safetysoft: sscostsoft = sum {i in (ITEMS diff OnlyPACKITEMS)} safetyfactor * h2[i] * <<{ls in
1..numberofpieces-1} bkpts[ls]; {ls in 1..numberofpieces} slopes[ls]>> xi[i];
subject to ocpacks: ordercostpacks = sum {p in PACKS, c in CARDS} cost_pack[p] * mu[c] * y[p,c];
subject to ocitems: ordercostitems = sum {(i,c) in ICPAIRS} cost_owens[i] * b[i,c] * mu[c] * picked[i,c];

subject to coverage{(i,c) in ICPAIRS: i not in excessITEMS}: sum {p in PACKS} q[i,p] * y[p,c] >= b[i,c] * ( 1 -
picked[i,c]);

subject to cov_packs1{p in PACKS, (c1,c2) in COVPAIRS}: y_cov[p,c1,c2] >= y[p,c1] + y[p,c2] - 1;
subject to cov_packs2{p in PACKS, (c1,c2) in COVPAIRS}: y_cov[p,c1,c2] <= y[p,c1];
subject to cov_packs3{p in PACKS, (c1,c2) in COVPAIRS}: y_cov[p,c1,c2] <= y[p,c2];

subject to cov_items{i in ITEMS, (c1,c2) in COVPAIRS: (i,c1) in ICPAIRS and (i,c2) in ICPAIRS}:
picked_cov[i,c1,c2] >= picked[i,c1] + picked[i,c2] - 1;

subject to pw1{p in PACKS}: xp[p] = sum {c in CARDS} sigma[c]^2 * y[p,c] + 2 * sum{(c1,c2) in COVPAIRS}
covariance[c1, c2] * y_cov[p,c1,c2];
subject to pw2{i in ITEMS}: xi[i] = sum {c in CARDS: (i,c) in ICPAIRS} sigma[c]^2  * b[i,c]^2 * picked[i,c] + 2
* sum{(c1,c2) in COVPAIRS: (i,c1) in ICPAIRS and (i,c2) in ICPAIRS} b[i,c1] * b[i,c2] * covariance[c1, c2] *
picked_cov[i,c1,c2];

# ORTHO PEDI PACK CONSTRAINT
 subject to orthopedi{c in CARDS}: y[10,c] = 0;
```

Appendix 6: Base-Stock Model Basics[14]

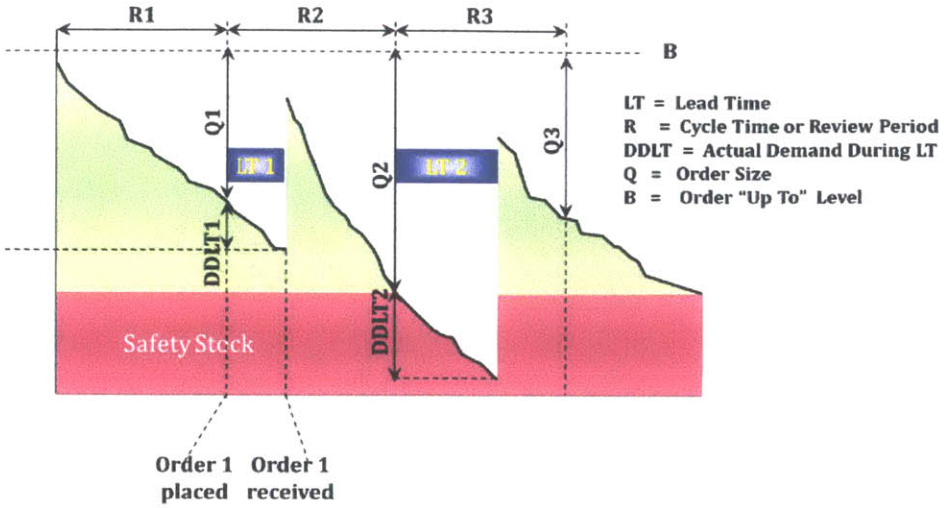

Figure 16: Generic Base Stock Replenishment Model

[14] Picture adapted from David Simchi-Levi's supply chain slides for MIT class ESD.267J