Senior Design Project Pre-proposal
Intercity Transport Capacity & POP Planning Division; AT&T Network Services

Sponsor Description

AT&T Inc. is a worldwide communications corporation, leading globally as the largest IP-service provider and locally in the US as the largest provider of wireless, local, and long distance phone services. Its merger with SBC and future merger with BellSouth, which will result in complete ownership of Cingular Wireless, are pushing it further into the lead in all of its services. These services include residential and business services (Internet, Local and Long Distance Phone, Wireless Phone). The company reports revenue for 2005 summing to $117.4 billion (combination of AT&T, BellSouth, and Cingular).

The division we will be working with is AT&T's Intercity Transport division. The Intercity Transport division handles all of the cross-country fiber and cable networks. Their annual costs for this year are expected to be about $400 million. This is more than twice their costs for last year, and it is a number they expect to double again in 2007.

Because of its impending merger with BellSouth, AT&T is anticipating a major increase in demand for internet and local and long distance voice services. The intercity transport materials primarily consist of large bays and smaller circuit packs scattered in facilities across the country. Those components, of which there are over 300 SKUs, are mostly stored in a warehouse in Edison, New Jersey. Components coming from NEC are stored in a separate warehouse in Compton, California, and components with lower demands are kept in Amsterdam, New York. The Edison warehouse is about 60,000 square feet, of which a little more than half is devoted to intercity transport. The Amsterdam warehouse has another 50,000 square feet of space. These warehouses have a total inventory value of about $50 million.

Problem Description

Expediting fees for installation make up a large cost component for AT&T. Sometimes installation has to be expedited in order to meet deadlines for capacity increases, and this can involve having the installation vendor send larger teams to do the installation, send the teams out early, or have to send teams out multiple times. In these cases, the installation vendor charges a percentage increase over their normal fees. Most expedite orders involve components to augment the capacity in an existing system; a few involve expediting an entire system. The average installation expediting fee per order is $2,000, but can be as high as $10,000 if an entire system is being expedited.

Expediting installation can happen for a number of reasons:

- Materials get lost in transit.
- Equipment is recalled, causing a delay in sending the final materials.
- Material order is changed at last minute, and the final materials arrive later than planned.
- Materials are stocked-out in warehouse and have to be ordered from manufacturer. Upon arrival, they have to be expedited to meet the installation deadlines.

About 60% of these expedition cases are caused by material stockouts at the warehouse.

AT&T's goal is to supply 95% of the components from their own warehouses. However, there are exceptions in the system. Some items, such as the larger Siemens DWDM systems, are sent straight from manufacturer to installation vendor because their size makes stocking them in the warehouse unreasonable. The following issues present a challenge to their goal of supplying the majority of items from their warehouses:

- Their department was downsized from a forecasting team to a single person in charge of inventory ordering.
- Demand for network installation is dramatically picking up.
- Currently they do not have an organized ordering system.
- They typically experience stockouts on 20-30 different SKUs at any given time.

Our senior design team will develop an inventory management system for AT&T that will allow them to make better forecasting and ordering decisions. Presently, they do a rough forecast of demand for components over a yearly time-frame. Then, an employee periodically checks their database to see the warehouse stock levels and decides the order quantities, factoring in the manufacturing lead time and expected demand for the next few months. These order quantities are based on calculations done in Excel spreadsheets. With the current increase and expected increase in demand, this ordering method has become inefficient, and a more systematic method is needed. That system should minimize the total warehousing costs by considering these objectives:

- minimizing stockouts
- reducing holding costs
- preventing an accumulation of obsolete stock

Deliverable

We will provide AT&T with an Enterprise Software Package which will be directly tied to the warehouse inventory databases, NISE and DBOR. This package will contain the following features:

- Simple, easy to learn and use graphical user-interface.
- A list of SKUs which currently are at low or need-to-order levels.
- Searchable and sortable inventory of SKUs, with ordering recommendations for each.
- Dynamic structure to allow easy addition and deletion of SKUs for new and obsolete parts.
- Forecasting algorithms for ordering built in and computed live with the most current data available.
- Flexibility of forecasting model that supports huge upturns in demand.
- E-Mail or other type of notification alerts to order can be activated.
- If deemed necessary, software set up to be accessed and modified remotely through a secure connection such as a .NET interface.

Potential Value

The expected increase in demand over the next two years puts ever-increasing strains on their existing network capacities. Without this project, AT&T is likely to experience more stockouts, resulting in greater customer dissatisfaction, and not meet its growth goals.

Up through third quarter of this year, 12,200 orders had been placed. Assuming constant volume that approximates to 16,000 orders this year. About 25% of these orders need expedited installation, and with an expediting fee of $2,000 per order, the total cost for this year will be $8M. Since warehouse stockouts result in about 60% of these expedited installation orders, this makes stockouts a $4.8M problem in 2006. Given their total budget of $400M, stockout-related costs represent 1.2% of their total expenditure. Our proposed 10% reduction in stockouts would result in a savings of about $480,000 to AT&T intercity transportation division.

These costs continue to increase as demand for the network grows. The intercity transport division was considering hiring more employees solely for the purpose of managing the forecasting and ordering through their current system. However, that would increase their personnel budget by 5-10%, so it has not been allowed. Our deliverable will be able to be used by the existing employees and will save them time since they will only have to query a single program to determine their ordering schedule, instead of sorting through spreadsheets of data and estimating the order timing and quantities. Hiring additional employees should be unnecessary.

1 Sponsor Description

BlueLinx Holdings, Inc. (NYSE: BXC) is a leading distributor of building products in North America. Their core specialty is coordinating warehousing and transportation of more than 10,000 products from over 750 suppliers to more than 11,700 customers nationwide. BlueLinx's primary customer base consists of building materials dealers, industrial users of building products, manufactured housing builders, and home improvement centers.

BlueLinx was created in March 2004 after Georgia Pacific Corporation's distribution operations were sold to ABP Distribution Holdings. Subsequent mergers resulted in the formation of BlueLinx and its present standing. At the end of the Fiscal Year 2005, BlueLinx reported Net Sales of $5.6 billion, 52% of which comes directly from sales made through BlueLinx warehouses. BlueLinx currently runs over 60 warehouse locations, with 900 trucks and 1,200 trailers across the United States to service its operations.

The warehousing and distribution system was last reviewed in the early 1990's when BlueLinx contracted professional consultants to restructure their distribution network. This study recommended the current warehouse and transportation network that includes annual expenses of $73.7 million in outbound transportation. This study does not allow for continuous optimization, and it has become outdated as BlueLinx has developed and grown since 1990. In addition, the original solution does not take into account changes in customer or product mix or the option of closing existing centers and opening new ones. Finally, the existing model does not project what changes need to be made in the future for anticipated changes in the demand of products. Since the profitability and value of BlueLinx's distribution centers are dependent on population growth and development, a new, more detailed system analysis needs to be developed to re-optimize BlueLinx's warehousing and distribution operations. Such an updated system will allow BlueLinx to continually evaluate their operations in order to save substantial costs while maintaining efficient service levels.

2 Problem Description

2.1 Forecasting

The optimization of BlueLinx's outbound logistics over the next ten years is highly dependent upon the future demand of BlueLinx products. Demand is affected by factors such as population growth, demographic changes, new housing development, interest rates, economic conditions, and manufacturing trends. In addition to these factors, the demand of each product is also affected by product source locations and shifts in the types of products distributed.

A regression analysis will be performed using past data to determine the relationship between each of the factors discussed above and BlueLinx's sales per product. Using reputable forecasts for the significant factors, we will then develop a forecasting model that predicts future demand for each BlueLinx product in each county over the next ten years. The resulting demand data will be included in our optimization model to determine how BlueLinx's outbound logistics network should change over time.

2.2 Optimization

Future demand, determined by our forecasting model, simply cannot be known with certainty, and the decision variables described in this section depend on this random factor. Rather than make deterministic decisions that will affect BlueLinx's outbound logistics network for the next ten years, we will develop a dynamic stochastic optimization model that BlueLinx can use in future years to adjust and re-optimize their outbound logistics network.

2.2.1 County Allocations

We will determine which geographic region each distribution center should serve. County allocations will be made by minimizing the outbound transportation costs between distribution centers and regions. When making allocations, we will also ensure that each center meets its counties' demands.

2.2.2 Product Specialization

BlueLinx distribution centers vary in the products that they hold. A center that houses a wide variety of products may incur high inventory costs for products that it does not sell, while a highly specialized center may lose potential sales of products that it does not carry. To capture these sales while decreasing unnecessary inventory, we will determine an optimal combination of products that each center should house.

2.2.3 Facility Openings and Closings

BlueLinx can save operating costs by closing centers in low growth or over-served areas. They can also increase sales by opening new centers in areas of high growth or where demand is currently under-served. We will make recommendations to close existing centers that prove to be unprofitable and open new ones that will turn a profit. The model will also include a breakeven analysis to determine when BueLinx should outsource its warehousing capabilities to a third-party versus opening a new distribution center in a given area.

3 Project Deliverables

3.1 Forecasting Tool

The forecasting tool will use current data on the significant predictive factors to update the forecast of BlueLinx's product demand over time. These factors are dynamic, so this tool will be able to provide a more accurate forecast for future years.

3.2 Decision Support Tools

Our goal is to deliver two optimization models to BlueLinx. The first provides a comprehensive solution to the problem whereby all of the necessary changes to the operation are made today and last for the planning horizon. A second model will be designed to run periodically, taking into account unforeseen changes and allowing more flexible decisions to be made in the short term. Both models are inexorably linked to the forecasting tool, which will provide important demand information needed to drive the model's decisions.

Currently, BlueLinx possesses an integrated platform of CAPS and CPLEX software but does not understand its capabilities and limitations. Provided that the CPLEX license is capable of free-standing work, we will develop our models on campus before implementing at BlueLinx. Otherwise, we will persuade BlueLinx to purchase a new CPLEX license or determine alternative methods to deliver our solution.

4 Estimated Value

Because our project consists of a national distribution network redesign, we believe that the results of our project will create substantial value to BlueLinx. Since our project focuses on several areas of the distribution network, value will be added by the interaction of the different aspects of the network. Potential areas to reduce costs include transportation costs, inventory costs, and facility costs; in addition to reducing costs, their may be opportunities to increase revenue due to expanding the network to meet more demand.

Currently, BlueLinx spends $78 million in transportation and $32 million in non-labor related facility costs annually. Our project is expected to yield a 5% savings, or $5.5 million. These savings were estimated from preliminary network strategy work that has been done by BlueLinx for three of its sales regions.

1. Client Background

InterContinental Hotels Group (IHG) owns, manages, leases, and franchises seven internationally recognized hotel brands. The two oldest brands include Holiday Inn and Holiday Inn Express, with average ages of 25-30 years and 8 years, respectively. There are approximately 1,002 Holiday Inn hotels and 1,461 Holiday Inn Express hotels in the Americas region. These two hotel brands comprise 85% of IHG's franchise licenses in the United States On average, a hotel costs $5 million to build ($50,000 per room/key with 100 keys per hotel), and generates $1,500,000 per year in gross room revenue. IHG revenues are generated by royalties paid by franchise owners; the current royalty rate paid by IHG's franchise owners is 5% of gross room revenues for the Holiday Inn brand and 6% of gross room revenues for the Holiday Inn Express brand.

In order to improve performance processes for its hotel brands, IHG employs the Hotel Performance Support (HPS) group. This group determines how improvements in product quality can increase future cash flows for IHG. Product quality includes the appearance, cleanliness and condition of physical components of the hotel. Common components addressed include interior floor/wall covering and furniture/fixtures, as well as exterior site design/landscaping and building material/roofing. IHG measures customer perception of product quality from the results of random guest surveys. (Refer to Appendix A.)

Based on standards established by the HPS group, franchise hotels are required to make improvements on the properties periodically. Such changes occur approximately every ten years when franchise License Agreements are brought up for renewal. During this time, Product Improvement Plan (PIP) teams assess the properties and make suggestions for quality improvements. A field consultant is employed to communicate these proposed improvements to each of the hotel owners. Once a PIP plan is agreed upon by both parties, the PIP document will become part of the newly executed License Agreement with IHG.

2. Problem Description

The problem is the field consultants' inability to give individual franchisees concrete proof of return on investment as a result of product quality improvement. This proof would be helpful because franchisees do not see the benefit of bearing the renovation costs other than for the greater good of IHG. Therefore, the PIP process typically turns into a negotiation between IHG upper management and the franchisee; PIP plans are frequently reduced in dollar value as a result of these discussions. Consequently, quality levels remain below standards and negatively impact IHG. More specifically, gross room revenues decline, brand image suffers, and new franchise sales drop.

3. Design Strategy

Our group will provide field consultants with a sales tool designed to do the following:

- Based on franchisee data, show the cash flows over a number of years for a suggested PIP plan, including incentives and penalties from IHG.

  - Incentives are designed to eliminate the perception that the franchisee is solely bearing the burden of these improvements. For example, an incentive plan can reduce royalty fees, subsidize repairs, or provide rebates for renovation.
  - Penalties are designed to discourage deviation from the agreed upon PIP plan.
- Create a pro forma financial model to analyze the cash flows and determine the Return on Investment. This model is a presentation to the customer, breaking down the costs and benefits using charts, graphs, and financials.

4. Value-Add

Our field consultant tool:

- Determines the Return on Investment for any proposed PIP plan.

  Understanding the Return on Investment allows IHG to implement an effective incentive program. Such a program could demonstrate to a franchisee that IHG is willing to financially contribute to renovations and repairs. This outreach from IHG will encourage the franchisee to invest in these needed improvements.

- Creates a pro forma financial model to be introduced to the franchisee.

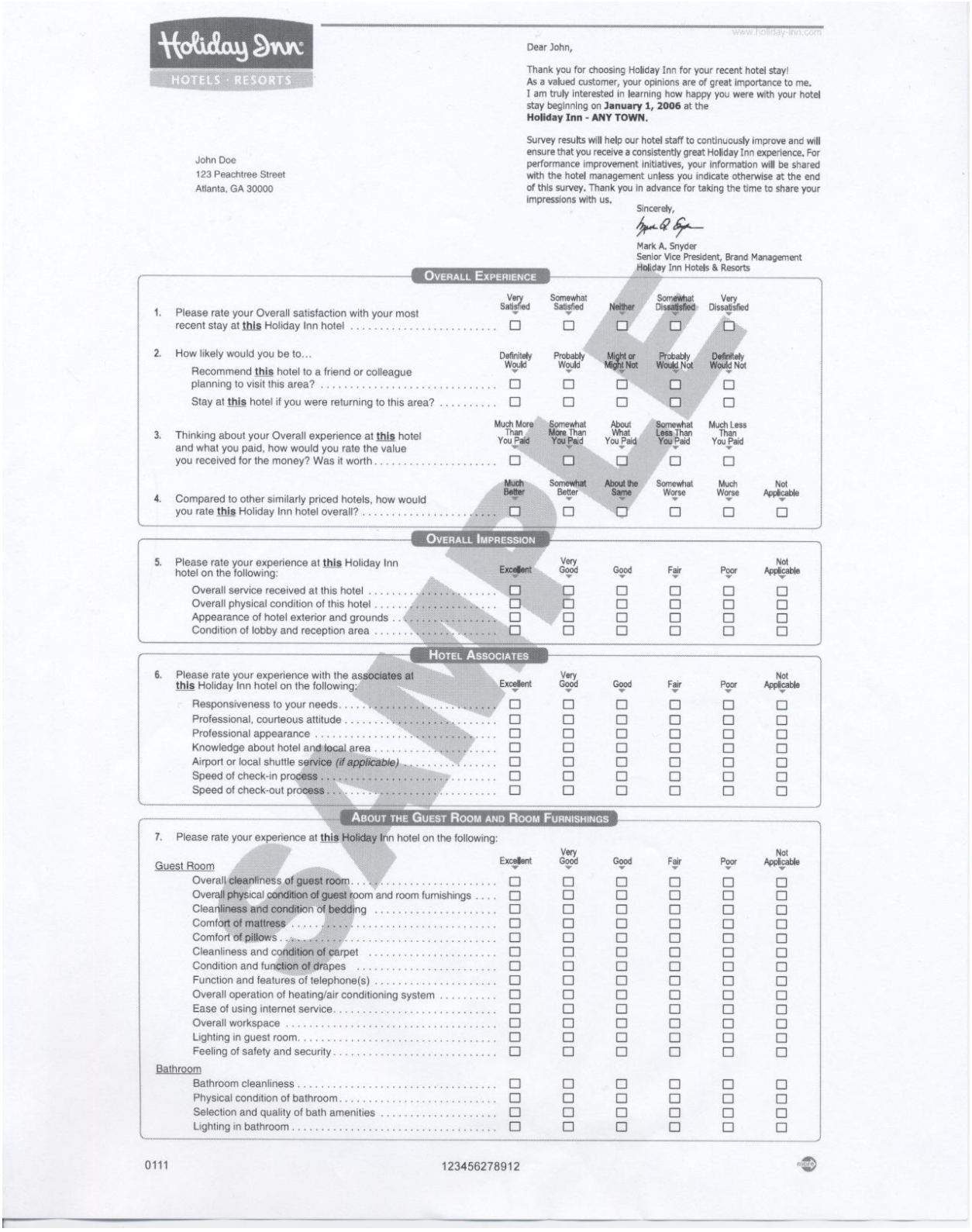
  This model provides financial evidence of an increase in revenue for the franchisee. Therefore, the model helps the effectiveness of field consultants in supporting the proposed PIP changes and reduces the time required for negotiations between IHG field consultants and franchisees.

- Facilitates transition of PIP plans into License Agreements.

  With additions such as the incentive program, IHG can more easily convince franchisees to agree to the proposed PIP plans as they are. More importantly, IHG is able to enforce PIP plans outlined in License Agreements by including specific penalties that will result if renovations and repairs are not made to IHG's preferred level of quality.

If more franchisees engage in renovations and repairs according to the proposed PIP plan, overall brand image and quality will improve. Furthermore, increases in franchise revenue as a result of product quality improvement will lead to increased revenue for IHG as a whole.

Appendix A



Holiday Inn
HOTELS · RESORTS

www.holiday-inn.com

Dear John,

Thank you for choosing Holiday Inn for your recent hotel stay!
As a valued customer, your opinions are of great importance to me. I am truly interested in learning how happy you were with your hotel stay beginning on **January 1, 2006** at the **Holiday Inn - ANY TOWN.**

Survey results will help our hotel staff to continuously improve and will ensure that you receive a consistently great Holiday Inn experience. For performance improvement initiatives, your information will be shared with the hotel management unless you indicate otherwise at the end of this survey. Thank you in advance for taking the time to share your impressions with us.

John Doe
123 Peachtree Street
Atlanta, GA 30000

Sincerely,

Mark A. Snyder
Senior Vice President, Brand Management
Holiday Inn Hotels & Resorts

OVERALL EXPERIENCE

	Very Satisfied	Somewhat Satisfied	Neither	Somewhat Dissatisfied	Very Dissatisfied
1. Please rate your Overall satisfaction with your most recent stay at **this** Holiday Inn hotel	☐	☐	☐	☐	☐

2. How likely would you be to...	Definitely Would	Probably Would	Might or Might Not	Probably Would Not	Definitely Would Not
Recommend **this** hotel to a friend or colleague planning to visit this area?	☐	☐	☐	☐	☐
Stay at **this** hotel if you were returning to this area?	☐	☐	☐	☐	☐

3. Thinking about your Overall experience at **this** hotel and what you paid, how would you rate the value you received for the money? Was it worth	Much More Than You Paid	Somewhat More Than You Paid	About What You Paid	Somewhat Less Than You Paid	Much Less Than You Paid
	☐	☐	☐	☐	☐

4. Compared to other similarly priced hotels, how would you rate **this** Holiday Inn hotel overall?	Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse	Not Applicable
	☐	☐	☐	☐	☐	☐

OVERALL IMPRESSION

5. Please rate your experience at **this** Holiday Inn hotel on the following:	Excellent	Very Good	Good	Fair	Poor	Not Applicable
Overall service received at this hotel	☐	☐	☐	☐	☐	☐
Overall physical condition of this hotel	☐	☐	☐	☐	☐	☐
Appearance of hotel exterior and grounds	☐	☐	☐	☐	☐	☐
Condition of lobby and reception area	☐	☐	☐	☐	☐	☐

HOTEL ASSOCIATES

6. Please rate your experience with the associates at **this** Holiday Inn hotel on the following:	Excellent	Very Good	Good	Fair	Poor	Not Applicable
Responsiveness to your needs	☐	☐	☐	☐	☐	☐
Professional, courteous attitude	☐	☐	☐	☐	☐	☐
Professional appearance	☐	☐	☐	☐	☐	☐
Knowledge about hotel and local area	☐	☐	☐	☐	☐	☐
Airport or local shuttle service *(if applicable)*	☐	☐	☐	☐	☐	☐
Speed of check-in process	☐	☐	☐	☐	☐	☐
Speed of check-out process	☐	☐	☐	☐	☐	☐

ABOUT THE GUEST ROOM AND ROOM FURNISHINGS

7. Please rate your experience at **this** Holiday Inn hotel on the following:	Excellent	Very Good	Good	Fair	Poor	Not Applicable
Guest Room						
Overall cleanliness of guest room	☐	☐	☐	☐	☐	☐
Overall physical condition of guest room and room furnishings	☐	☐	☐	☐	☐	☐
Cleanliness and condition of bedding	☐	☐	☐	☐	☐	☐
Comfort of mattress	☐	☐	☐	☐	☐	☐
Comfort of pillows	☐	☐	☐	☐	☐	☐
Cleanliness and condition of carpet	☐	☐	☐	☐	☐	☐
Condition and function of drapes	☐	☐	☐	☐	☐	☐
Function and features of telephone(s)	☐	☐	☐	☐	☐	☐
Overall operation of heating/air conditioning system	☐	☐	☐	☐	☐	☐
Ease of using internet service	☐	☐	☐	☐	☐	☐
Overall workspace	☐	☐	☐	☐	☐	☐
Lighting in guest room	☐	☐	☐	☐	☐	☐
Feeling of safety and security	☐	☐	☐	☐	☐	☐
Bathroom						
Bathroom cleanliness	☐	☐	☐	☐	☐	☐
Physical condition of bathroom	☐	☐	☐	☐	☐	☐
Selection and quality of bath amenities	☐	☐	☐	☐	☐	☐
Lighting in bathroom	☐	☐	☐	☐	☐	☐

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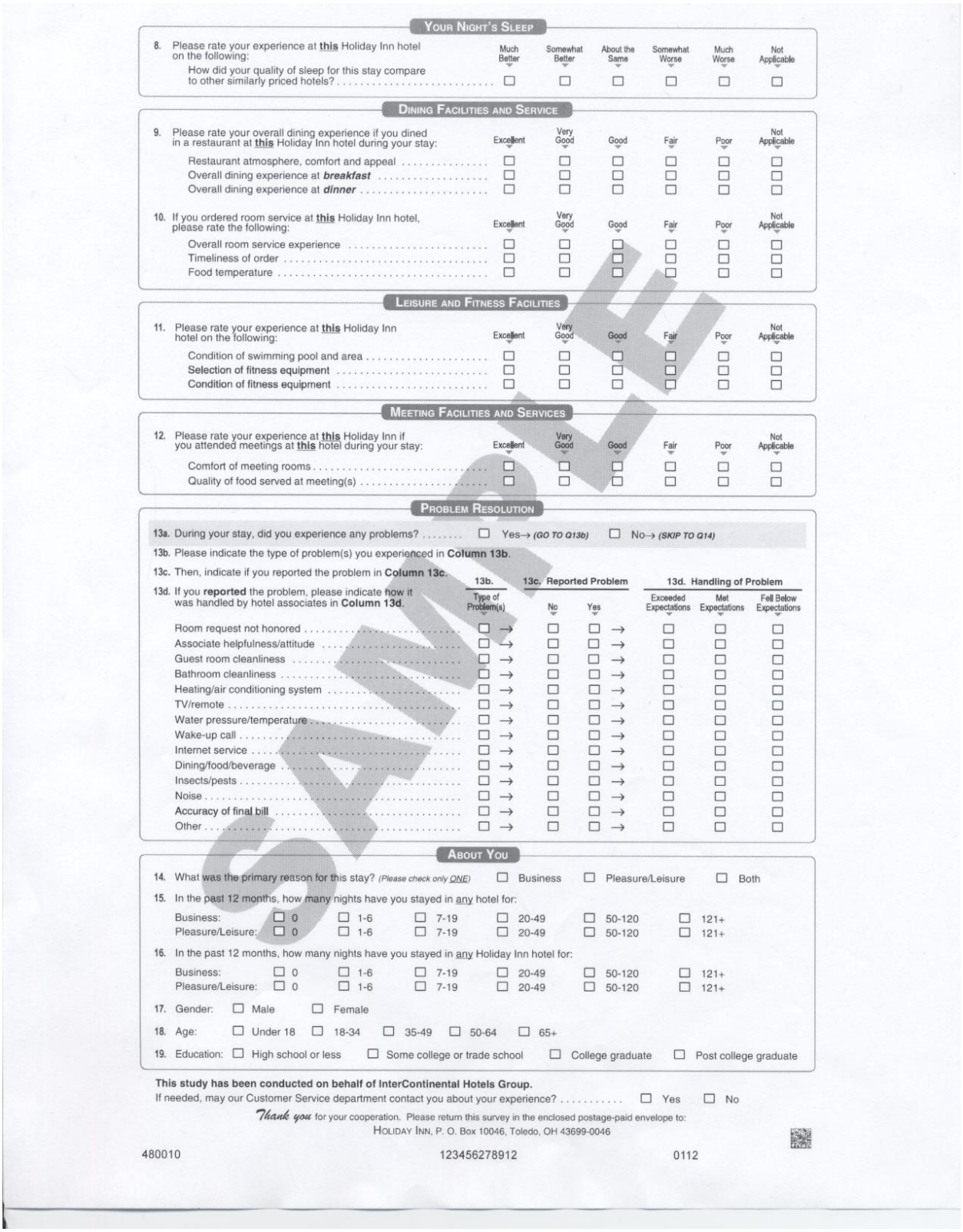
SAMPLE



YOUR NIGHT'S SLEEP

8. Please rate your experience at **this** Holiday Inn hotel on the following:	Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse	Not Applicable
How did your quality of sleep for this stay compare to other similarly priced hotels?	☐	☐	☐	☐	☐	☐

DINING FACILITIES AND SERVICE

9. Please rate your overall dining experience if you dined in a restaurant at **this** Holiday Inn hotel during your stay:	Excellent	Very Good	Good	Fair	Poor	Not Applicable
Restaurant atmosphere, comfort and appeal	☐	☐	☐	☐	☐	☐
Overall dining experience at ***breakfast***	☐	☐	☐	☐	☐	☐
Overall dining experience at ***dinner***	☐	☐	☐	☐	☐	☐

10. If you ordered room service at **this** Holiday Inn hotel, please rate the following:	Excellent	Very Good	Good	Fair	Poor	Not Applicable
Overall room service experience	☐	☐	☐	☐	☐	☐
Timeliness of order	☐	☐	☐	☐	☐	☐
Food temperature	☐	☐	☐	☐	☐	☐

LEISURE AND FITNESS FACILITIES

11. Please rate your experience at **this** Holiday Inn hotel on the following:	Excellent	Very Good	Good	Fair	Poor	Not Applicable
Condition of swimming pool and area	☐	☐	☐	☐	☐	☐
Selection of fitness equipment	☐	☐	☐	☐	☐	☐
Condition of fitness equipment	☐	☐	☐	☐	☐	☐

MEETING FACILITIES AND SERVICES

12. Please rate your experience at **this** Holiday Inn if you attended meetings at **this** hotel during your stay:	Excellent	Very Good	Good	Fair	Poor	Not Applicable
Comfort of meeting rooms	☐	☐	☐	☐	☐	☐
Quality of food served at meeting(s)	☐	☐	☐	☐	☐	☐

PROBLEM RESOLUTION

13a. During your stay, did you experience any problems? ☐ Yes→ *(GO TO Q13b)* ☐ No→ *(SKIP TO Q14)*

13b. Please indicate the type of problem(s) you experienced in **Column 13b**.

13c. Then, indicate if you reported the problem in **Column 13c**.

13d. If you **reported** the problem, please indicate how it was handled by hotel associates in **Column 13d**.

	13b. Type of Problem(s)	13c. Reported Problem: No	13c. Reported Problem: Yes	13d. Handling of Problem: Exceeded Expectations	13d. Handling of Problem: Met Expectations	13d. Handling of Problem: Fell Below Expectations
Room request not honored	☐ →	☐	☐ →	☐	☐	☐
Associate helpfulness/attitude	☐ →	☐	☐ →	☐	☐	☐
Guest room cleanliness	☐ →	☐	☐ →	☐	☐	☐
Bathroom cleanliness	☐ →	☐	☐ →	☐	☐	☐
Heating/air conditioning system	☐ →	☐	☐ →	☐	☐	☐
TV/remote	☐ →	☐	☐ →	☐	☐	☐
Water pressure/temperature	☐ →	☐	☐ →	☐	☐	☐
Wake-up call	☐ →	☐	☐ →	☐	☐	☐
Internet service	☐ →	☐	☐ →	☐	☐	☐
Dining/food/beverage	☐ →	☐	☐ →	☐	☐	☐
Insects/pests	☐ →	☐	☐ →	☐	☐	☐
Noise	☐ →	☐	☐ →	☐	☐	☐
Accuracy of final bill	☐ →	☐	☐ →	☐	☐	☐
Other	☐ →	☐	☐ →	☐	☐	☐

ABOUT YOU

14. What was the primary reason for this stay? *(Please check only ONE)* ☐ Business ☐ Pleasure/Leisure ☐ Both

15. In the past 12 months, how many nights have you stayed in any hotel for:

Business:	☐ 0	☐ 1-6	☐ 7-19	☐ 20-49	☐ 50-120	☐ 121+
Pleasure/Leisure:	☐ 0	☐ 1-6	☐ 7-19	☐ 20-49	☐ 50-120	☐ 121+

16. In the past 12 months, how many nights have you stayed in any Holiday Inn hotel for:

Business:	☐ 0	☐ 1-6	☐ 7-19	☐ 20-49	☐ 50-120	☐ 121+
Pleasure/Leisure:	☐ 0	☐ 1-6	☐ 7-19	☐ 20-49	☐ 50-120	☐ 121+

17. Gender: ☐ Male ☐ Female

18. Age: ☐ Under 18 ☐ 18-34 ☐ 35-49 ☐ 50-64 ☐ 65+

19. Education: ☐ High school or less ☐ Some college or trade school ☐ College graduate ☐ Post college graduate

This study has been conducted on behalf of InterContinental Hotels Group.

If needed, may our Customer Service department contact you about your experience? ☐ Yes ☐ No

Thank you for your cooperation. Please return this survey in the enclosed postage-paid envelope to:

HOLIDAY INN, P. O. Box 10046, Toledo, OH 43699-0046

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Sponsor Description

Matador Distributing, LLC is the sole distributor of Red Bull Energy Drink for the north Georgia and southeast Tennessee region. They currently employ over 100 people who sell and deliver 1.2 million cases of Red Bull (8 separate SKUs) to over 7,000 customers annually. They operate out of four distribution centers; however, the Kennesaw, GA (6,600 square feet) and Suwanee, GA (5,600 square feet) centers provide the bulk of Matador's service. The other two distribution centers are located in Ringgold, GA and Macon, GA and serve the Chattanooga and Macon metro areas, respectively. Matador's distribution network consists of more than 45 separate routes utilizing 44 leased 4-bay trucks, 6 company cars, and 2 dry van trucks to deliver pallet sized shipments to Club Stores (Sam's Club, Costco, etc.). Matador Distributing, LLC adds approximately 50 customers per month and they anticipate selling 25% more product next year.

Matador Distributing, LLC is subsidiary of James Edwards and Companies, Inc..

Structure and Operations

Matador Distributing, LLC distributes Red Bull to grocery stores, convenience stores, bars, restaurants, club stores, drug stores, vending machines, workplaces, sub-wholesalers, and college campuses. Because of the large variety of customers, Matador Distributing, LLC must adapt its selling and delivery strategy to suit the needs of their client base.

Key Account Managers handle any sale that will affect a group of accounts. The groups assigned to a Key Account Manager include, but are not limited to, convenience stores, grocery stores, NTOP (non-traditional on premise), military, vending, drug stores, sub-wholesalers, wholesalers, colleges, or ethnic markets. These managers drive company cars and make visits at determined intervals to their specific groups. They talk to decision makers, pitch new products, and attain new space and displays for Red Bull.

District Sales Managers oversee a team of 6-9 Account Managers and insure that the customers are all being serviced to the best of the company's abilities. They also occasionally approach the managers of some of the customers under their Account Managers in order to get new displays or shelf space.

Account Managers will physically deliver to stores but also do some selling. Account Managers are expected to make one stop each day to try to gain customers. Their successes are rewarded through a bonus program.

Project Description

Current Routing Network

Currently, Matador Distributing, LLC uses a sweep method to route their trucks and new locations are added onto the closest geographic route. Customers are assigned to one of the four DC's based on proximity and then they are clustered somewhat arbitrarily before they are added to a region.

Matador has four different customer types that are all routed independently of one another. For example, Red Bull for one of their on-premise customers would not be on the same truck as pallets of Red Bull for a wholesaler.

On-Premise – Bars and Restaurants
Grocery Stores (Pre-sell) – All grocery stores in the Metro area call in orders beforehand
Club Stores (Pre-sell) – Pallet deliveries
General Customers (Driver-sell) – In driver-sell, the driver loads up his truck to visit the same customers weekly. The amount of Red Bull on the truck is based on historical demand. The driver makes a sale at each stop and writes an invoice on the spot.

Improve Current Routes

This project will seek to improve Matador's current routes in order to reduce total transportation costs and increase opportunities for new sales. The enhanced routes will take into consideration:

- Appropriate time windows for delivery to specific locations.
- Truck capacity constraints.
- The rate at which new customers are added to routes.
- The diversity of Matador's customer base and benefits involved with combining different customers on the same routes.
- Customer proximity to distribution centers (Note: Kennesaw location will be relocating in early 2007).
- Equal distribution of routes to Account Managers (drivers)

Value

Matador's management team has estimated that they could save 10% of their transportation costs by evaluating the current routes and suggesting improvements. The management team does not currently have the resources to explore this project.

To estimate the potential value for this project, two days from one route were analyzed. The routes deliver strictly to QuickTrip and RaceTrack gas stations in North Atlanta. These routes were chosen not only because they were very typical of the routes that Matador provided us with; they were also chosen because QuickTrip and RaceTrack do not have specific time windows for delivery. Both operate on a 24 hour schedule and there are very few times when they cannot accept deliveries. Pictured in Appendix A are the routes as were included in the data from Matador. Upon mapping out these routes in MapPoint, they seem to be counterintuitive. At multiple points in the route, the driver is backtracking across much of his territory. Appendix B shows the routes in Appendix A but with slight adjustments that an Account Manager might make when driving the route – the same customers are visited each day, but in a much more efficient order (as provided by MapPoint).

Appendix C shows the routes we would recommend they run on these two days. These routes split the customers based on geography alone – whether in the northern or southern part of the territory and what major highways they are closest to. Using this logic alone and MapPoint software (the software Matador is currently using), savings to the company were anywhere between $736,459.43 (assuming the route order received in the data is correct) and $80,700.75 (assuming Matador is currently running more logical routes). The calculation of these savings can be found in Appendix D.

These estimated values do not account for any savings that would result if we were to consolidate routes, reallocate sales roles, find a more effective way to add new clients and thus expand sales, or the time Matador will save by having routes designed around their new warehouse on Peachtree Industrial, as opposed to their current routes, based out of the warehouse in Kennesaw.

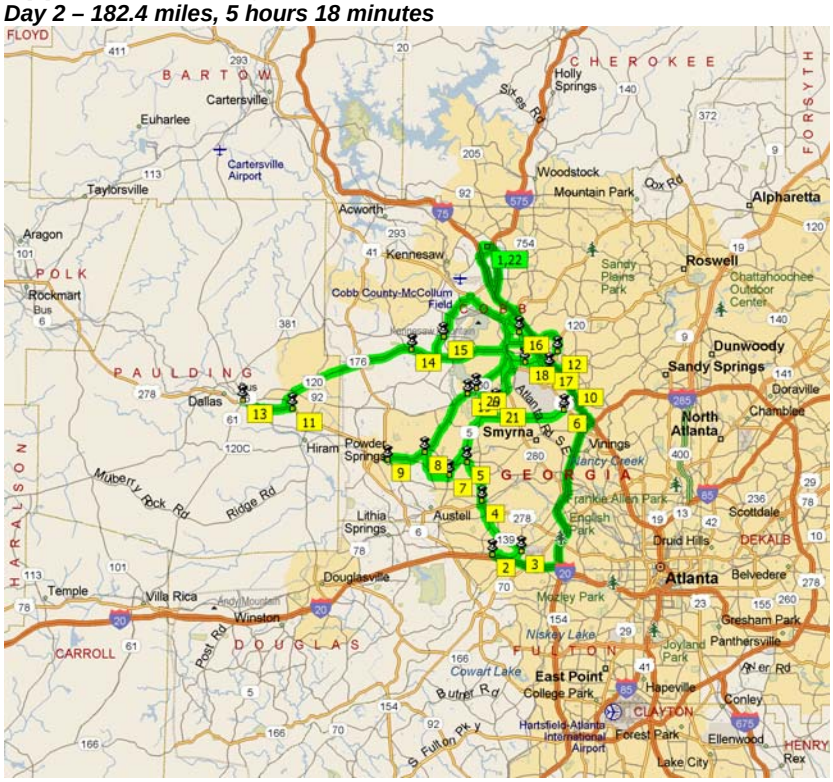
Develop Sustainability Tool

A tool will be developed to assist Matador in efficiently adding new clients to the current routes. This tool will:

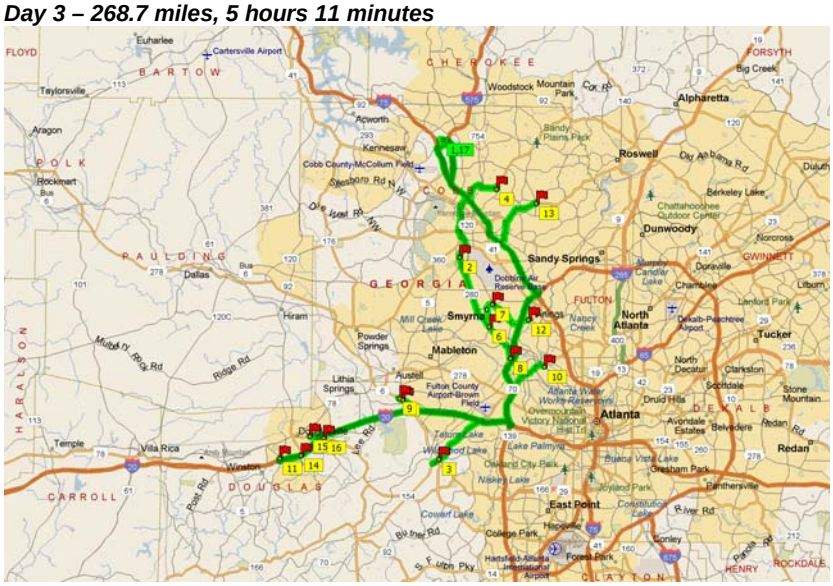
- Take in as input parameters: customer type, account number, customer name, address, city, state, expected demand
- Output the route number, day and stop number for the new customer.
- Appear in the form of an easy-to-use GUI to the client.
- Let the company know when to reevaluate the different hierarchical levels of their network (for example, they will be able to tell when they need to change the assignment of a customer to a DC as opposed to the assignment of a customer to an Account Manager).

Appendix A – Original Routes

Day 2 – 182.4 miles, 5 hours 18 minutes

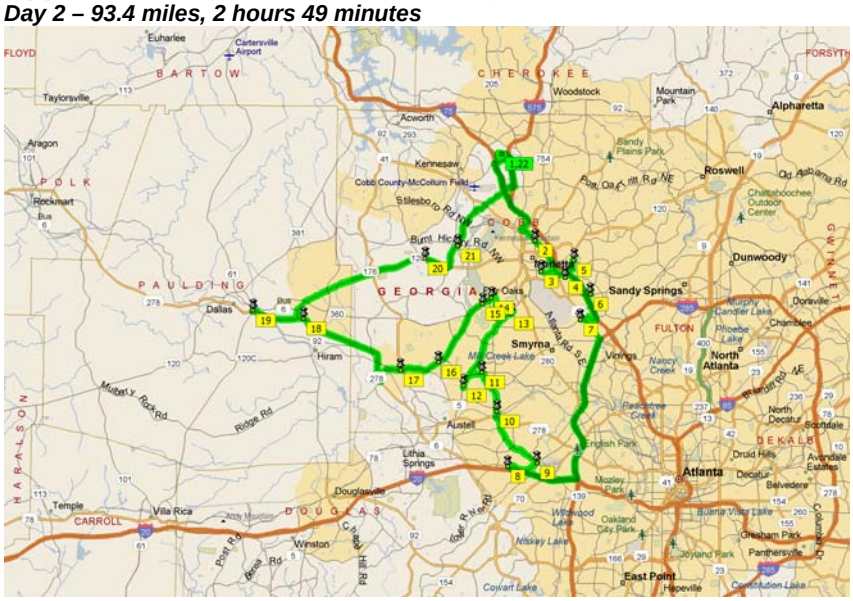


Day 3 – 268.7 miles, 5 hours 11 minutes

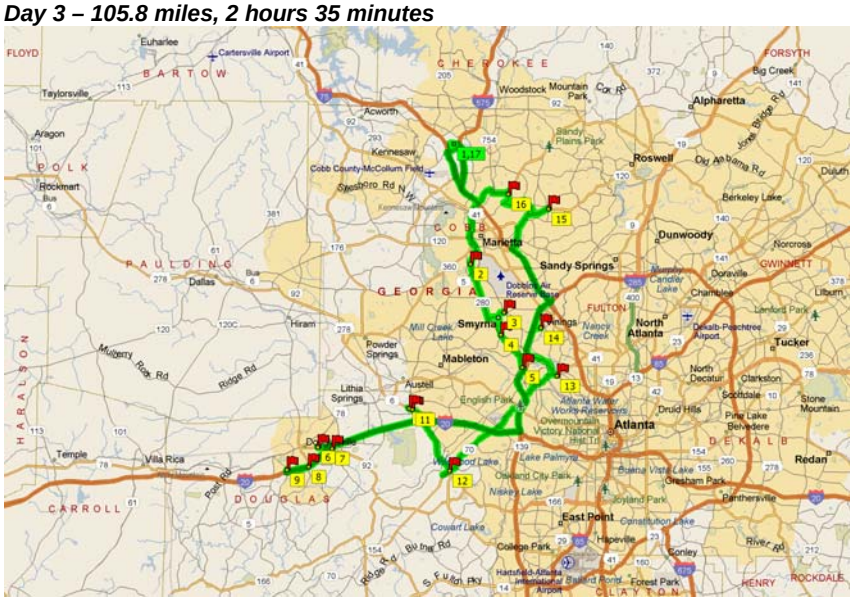


Appendix B – Routes Likely Run by Account Managers

Day 2 – 93.4 miles, 2 hours 49 minutes

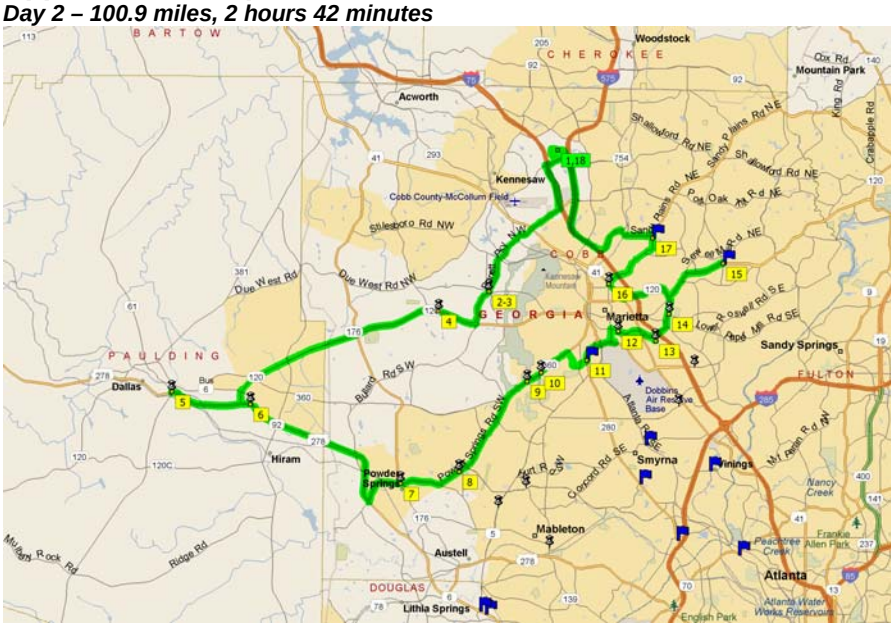


Day 3 – 105.8 miles, 2 hours 35 minutes

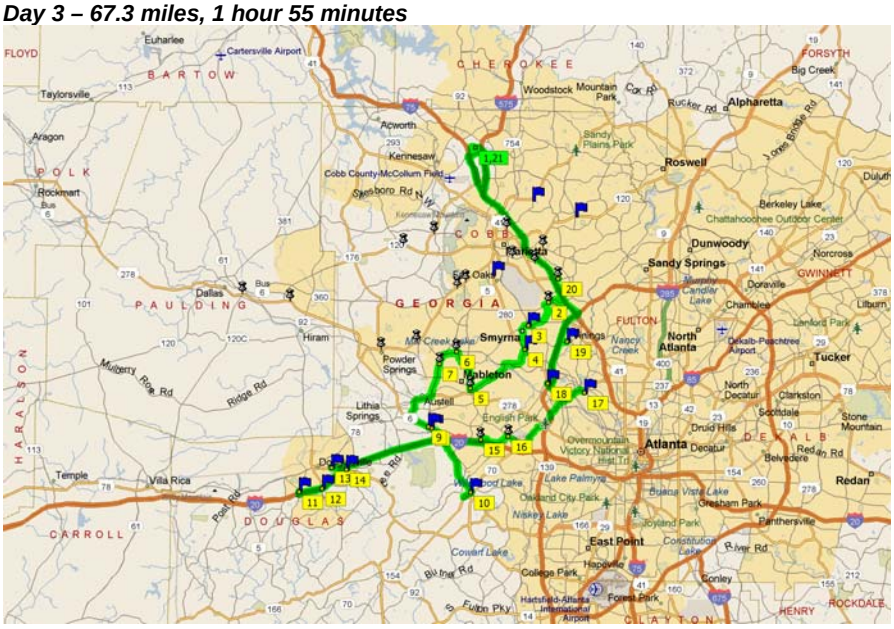


Appendix C - Proposed Alternative Routes

Day 2 – 100.9 miles, 2 hours 42 minutes



Day 3 – 67.3 miles, 1 hour 55 minutes



Appendix D – Cost Savings

Table D-1: Original Matador Routes

Line No.	Item	Day 2	Day 3	Total
(a)	(b)	(c)	(d)	(e)
	Mileage			
1	Original Miles[1]	182.4	268.7	451.1
2	Optimized Miles[2]	100.9	67.3	168.2
3	**Savings**	**81.5**	**201.4**	**282.9**
	Costs[3]			
7	Costs - Original	$81.17	$119.57	$200.74
8	Costs - Optimized	$44.90	$29.95	$74.85
9	**Cost Savings**	**$36.27**	**$89.62**	**$125.89**
10	2-Day Savings	$125.89		
11	Weekly Savings[4]	$314.73		
12	Annual Savings[5]	$16,365.77		
13	**Company Savings[6]**	**$736,459.43**		

NOTES:
1. Using Routes in Appendix B
2. Using Routes in Appendix C
3. Cost is mileage x 44.5 cents per mile (Gas, Depreciation, and Vehicle Maintenance Cost, Estimated by Matador)
4. Based on a 5-Day Week
5. Based on 52 Weeks per Year
6. Annual Savings x 45 Routes

Table D-2: Likely Matador Routes

Line No.	Item	Day 2	Day 3	Total
(a)	(b)	(c)	(d)	(e)
	Mileage			
1	Original Miles[1]	93.4	105.8	199.2
2	Optimized Miles[2]	100.9	67.3	168.2
3	**Savings**	**-7.5**	**38.5**	**31**
	Costs[3]			
7	Costs - Original	$41.56	$47.08	$88.64
8	Costs - Optimized	$44.90	$29.95	$74.85
9	**Cost Savings**	**-$3.34**	**$17.13**	**$13.80**
10	2-Day Savings	$13.80		
11	Weekly Savings[4]	$34.49		
12	Annual Savings[5]	$1,793.35		
13	**Company Savings[6]**	**$80,700.75**		

NOTES:
1. Using Routes in Appendix B
2. Using Routes in Appendix C
3. Cost is mileage x 44.5 cents per mile (Gas, Depreciation, and Vehicle Maintenance Cost, Estimated by Matador)
4. Based on a 5-Day Week
5. Based on 52 Weeks per Year
6. Annual Savings x 45 Routes

Maintenance Shop Network Design and Analysis
For
Norfolk Southern

About Norfolk Southern

Operating over 21,000 miles of rail routes and 12 major hubs to serve 1,143 customer facilities in the Eastern US and Canada, Norfolk Southern is one of two major Eastern railroads. The corporation currently operates a fleet of approximately 3,700 locomotive engines and schedules over 2,000 trips each day. Each locomotive in this fleet is required by the Federal Railroad Administration to receive routine maintenance every 92 days. To meet this requirement, Norfolk Southern maintains a network of maintenance shops[1] that also supports the fleet for unscheduled repairs.

The maintenance shops primarily consist of five System Shops and six Division Shops. The five System Shops are large facilities (35,000-100,000 ft^2) capable of most repairs short of locomotive overhaul.[2] The six Division shops have small capacities and are limited to completing the routine 92 day maintenance requirements and some minor repairs.

The rail management software Norfolk Southern currently uses will flag a locomotive when it reaches 86[3] days since its last routine maintenance. The software then plans a route that leads the locomotive through a facility to receive maintenance. The facility to which the engine is routed is determined by estimating which location will be able to repair or service the unit in the least amount of down time. This is determined by considering the capacity of the nearest shops to complete maintenance and the current number of engines requiring service at each of those shops. If it is not possible to route an engine to a maintenance shop while pulling a load, the fuel and extra time traveling to and from the facility must be considered. For unscheduled failures, the time required to transport the engine to the facility must also be considered, but the options are limited by the repair capabilities of the shops. Since the system can schedule assignments to route locomotives through maintenance facilities with a 4-6 day advance notice to receive routine maintenance, the larger problem is the event of unscheduled failures.

Problems with the Current Maintenance Shop Network

The locations of the maintenance shops have largely been determined by circumstance (preexisting facilities acquired through railroad mergers), or operational needs from decades ago. Referring to the system map appended, there is an Eastern bias to the System Shop locations that means any unit suffering major failures on the western end of the rail system must be towed hundreds of miles over several days to receive repair.

Even though the current system routes trains for maintenance based on minimizing out of service time, the configuration of the maintenance shop network was not developed with these considerations in mind. Also, the current network does not consider flow density of engines throughout the system or any possible geographic trends in unscheduled failures or maintenance flag events.

Another aspect of rail operations complicating the maintenance routing is that approximately 1,100 engines in the fleet are considered yard and local locomotives. This means that they are assigned to one of thirteen divisions and operate only within those limits. If failure requiring repair in a facility outside of that division occurs, the unit must be towed to the appropriate facility and then towed back after repairs are completed.

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[1] System map with facility locations appended
[2] System Shop capacities appended, Division Shop capacities are approximately 3-5 units released per day
[3] Actual day on which locomotive is flagged varies somewhat depending on model and duty assignment.

Maintenance Shop Network Design and Analysis
For
Norfolk Southern

Project Plan

The goal of this project is to maximize the productivity of the rail fleet by minimizing locomotive out of service time. The group will:

- Analyze the geographic distribution of unscheduled failures and the network flow density of units that have hit the 86 day flag to determine whether any patterns exist. If so, identify probable locations for maintenance facilities outside of the 12 major rail hubs (probable locations recommended by NS).
- Simulate the entire Norfolk Southern rail system, recording unpaid (engines not transporting cargo or units being towed) travel time, fuel relevant distance traveled to and from maintenance facilities, and dwell time at the facility before, during and after repairs are completed.
- Alter the simulation to represent different configurations of the system regarding facility location, capacity and capability. Record differences in total out of service time plus other costs resulting from maintenance events—these alternate configurations will be limited by the analysis in the first bullet and by amount of capital available to NS to keep the number of required simulations reasonable
- Estimate the initial capital investment required to implement each alternate network configuration and the actual annual monetary savings from any out of service time reductions in each configuration. Write a mixed integer program to determine network configuration that minimizes operating costs but will yield a positive return on investment within specified time limits (3, 5, and 7 years)

Project Deliverables

The project should leave Norfolk Southern with:

- An optimal shop network configuration including shop location, capability and capacity
- A year by year spending strategy to achieve the network configuration

Potential Value Added

Over the last several years Norfolk Southern has purchased locomotives each year to meet growing demand, and to replace old units. Though replacing old units is unavoidable, if the productivity of the current fleet is increased sufficiently, it could reduce the number of new locomotives required to meet increasing demand. Mr. Graab estimates that an entire year (8,760 hours) of locomotive out of service time removed from the system annually would add the productivity of one additional locomotive. Or more concretely, this time reduction would eliminate the need for one additional locomotive purchase to meet expanding demand. To be conservative consider that 8,760*1.5 hours eliminates the need for one additional locomotive for the next years purchase.

Current routine maintenance (RM) average out of service time including travel to and from facility is 52 hours and current unscheduled failures (U) average is 12 hours. If the average down time for RM is reduced by 2 hours and downtime for U is reduced by 1 hour, then 36,992 hours can be saved annually:

14,796 RM Events per year * 2 Hours + 7400 U Events[4] per year * 1 Hour = **36,992 Hours**

[4] Average of two unscheduled repairs per locomotive per year

If 13,140 hours corresponds to one fewer locomotive required then 2.8 purchases can be negated. Rounding down to 2 locomotives not purchased saves NS the initial average purchase price of $1.3 million for each locomotive, and an average of $100,000 in annual maintenance that will not be required. Accounting a 10% (NS uses this rate) potential return on capital that can be realized from not investing in those locomotives, then over 5 years preventing two locomotive purchases saves approximately:

$1{,}300{,}000*2*(1.1)^5 + 100{,}000*2[(1.1)^5 + (1.1)^4 + (1.1)^3 + (1.1)^2 + 1.1] = \$5.53$ million

Also, according to NS, there are always trains waiting on locomotives to pull them. Increasing the availability of locomotives can reduce this wait time and reduce delivery times, creating better customer relations. Faster delivery times can also give NS better bidding power for new contracts and attract new business.

Maintenance Shop Network Design and Analysis
For
Norfolk Southern

Appendix

1: The following system map shows the locations of maintenance facilities.

2: Table detailing Shop capacities

Shop	Capacity (released Units per day)
Bellevue, OH	19.2
Chattanooga, TN	54.4
Enola, PA	25.6
Schaffer's Crossing, VA	54.4
Conway, PA	33.6

3: Lease rates per day for various hp categories

Horsepower Category	Customer provides fuel	Fuel provided by NS
1000-1750 (Gp 1)	**$395.04**	**$890.29**
2000-2999 (Gp 2)	**$461.18**	**$1,124.75**
3000-3500 (Gp 3)	**$699.30**	**$1,563.77**
3600-4000 (Gp 4 & 5)	**$807.82**	**$1,721.28**
4100-5000 (Gp 6)	**$905.00**	**$2,035.71**

4. Average purchase price and annual maintenance costs for locomotives

Loco Model		Units	Horse Power	Ave Weight	Ave Age	Equivalent Repl Cost	Annual Maint.
SYS AVE		3611	3357	345,260	16.4	$ 1,385,749	104715.333

Sponsor Description

Founded in 1986, Office Depot is the leading supplier in office products and services, and an industry leader in every distribution channel including stores, direct mail, contract delivery, Internet, and business-to-business electronic commerce. Fiscal year-to-date revenues are $14.89 billion, with profits of $4.39 billion. As of September 30, 2006, there were 1,121 Office Depot stores operating in 49 U.S. states and Canada.

Office Depot has 30 distribution centers across the United States, with the largest single-building facility in Buford, Georgia. This 550,000 square foot distribution center services 190 retail stores throughout Georgia, Florida, Alabama, North and South Carolina, Tennessee, Louisiana, Mississippi, and Virginia, and houses approximately 23,000 SKUs. Approximately $1.1 billion (at cost) of office products move through this distribution center each year.

Problem Description

Office Depot operates two types of distribution centers, the Customer Service Center (CSC) and Cross Dock (XD), which are distinct in their physical locations, operations and clientele that they serve. The CSC warehouses inventory for both Internet and business-to-business transactions, while the XD operations include the staging of inventory to be shipped to the regional Office Depot retail stores, as well as processing technical and high value orders. The Buford DC is the only Office Depot facility that houses both the XD and CSC operations in one center.

This project focuses on the Buford XD operations since it has been underperforming in comparison to the other eight Office Depot Cross Docks, as well as in comparison to the expected production based on the facility's historical performance. This facility operates 24 hours, 6 days a week, and has approximately $900 million in product flow through per year. Each morning, warehouse managers obtain the daily receiving schedule, and have all orders received by 3:00PM shipped out that day. The XD is divided into a staging area and Batch Cage. The staging area is divided into small 30' x 5' lanes assigned to each retail store. Once inventory is received from the incoming trailers into the XD, electronics and high dollar items are stocked in the Batch Cage (batch), while all other items are immediately staged for shipment (flow-through). Based on product size, flow-through items are then sent to Repack (smallest items), Small Carton Sort (medium sized items), or FOMB[1] (largest items) to be repacked and consolidated into the lanes for delivery. Currently, 197 total employees (not including transportation, maintenance, management, or clerical support) work on the XD, and are broken down by position as follows:

- Receiving – 10 *(PTE[2] 0 / FTE[3] 10)*
- Batch Cage – 65 *(PTE 26 / FTE 39)*

[1] Freight Outbound Merchandise Billed
[2] Part-Time Employee
[3] Full-Time Employee

- Repack – 22 *(PTE 11 / FTE 11)*
- Small Carton Sort Module – 33 *(PTE 18 / FTE 15)*
- FOMB Lane Distribution – 26 *(PTE 6 / FTE 20)*
- Label Apply – 23 *(PTE 11 / FTE 12)*
- Loading – 18 *(PTE 5 / FTE 13)*

Two primary performance measures of the XD facilities are throughput rate (number of standard packs, or single selling units, processed per employee per hour), as well as overtime hours logged. Compared to the average throughput rate of all other Cross Docks, the Buford XD has been underperforming in recent years. It averaged 6.50 standard packs per hour less than the average in 2004, 8.30 in 2005, and 8.85 in 2006 YTD. The XD also consistently logs overtime hours that exceed the 5% factored into budget.

We have identified three possible causes for the facility's underperformance:

1. Warehouse managers do not have accurate forecasts to determine the labor hours required to process inventory.
2. Staffing does not react to the fluctuating volume of received inventory and orders.
3. There are no standards for individual labor performance, and therefore managers can't effectively hold employees accountable for low productivity.

Solution Strategy

The goal of our project is to develop a framework through which more efficient staffing methods can be implemented. This framework will consist of:

- **Engineering Labor Standards:** These standards will be based on time studies conducted by Office Depot and additional time studies to account for the unique behavior of this facility. Implementing these standards will provide accountability measures for individual performance of the XD staff.
- **Labor Forecasting Tool:** This tool will be based on historical demand data. Upon analyzing the data for seasonality and trends, a volume forecast will be generated weekly and will be related to the engineering labor standards, providing an estimate of the number of labor hours that need to be scheduled. This will allow management to schedule (or place on call) necessary part time and temporary labor for an upcoming week.
- **Daily Planning Tool:** This tool will be utilized by warehouse management each morning upon receipt of the daily inbound volume to assist in allocating part time hours. Managers will input the number of standard packs to be processed by their department that day and will be given a schedule of labor hours required to complete production.

These implementations will result in a more effective staffing system in which managers can allocate labor hours more efficiently, and employees can be held accountable for productivity. This translates to a lower percentage of overtime hours, higher system productivity and, ultimately, a reduction in labor costs.

SENIOR DESIGN PRE-PROPOSAL

PROJECT BACKGROUND

Project Open Hand, a not-for-profit service organization founded in 1988, was originally established to provide comfort food to victims with severe cases of HIV/AIDs. In 2000, Project Open Hand expanded this mission to serve senior citizens and other homebound residents based on doctor recommended need. They have also launched a for-profit program called Good Measure Meals, which targets individuals with specific dietary needs. Project Open Hand produces, packages, and delivers all prepared meals six days per week. Approximately 22,500 meals are delivered each week, with Project Open Hand reaching their 10 millionth meal served in 2005.

UPS Industrial Engineering will be a co-sponsor on this project and provide previous experience in analysis of Project Open Hand and other relevant support. They will also provide guidance on the feasibility of suggested recommendations.

PROCESS OVERVIEW

The daily process of Project Open Hand consists of the production, packaging, and distribution of meals to clients. This process can vary daily, depending on the day of the week. The standard schedules at Project Open Hand are shown below.

Monday – Friday Schedule:

Time	Activity	Workforce
6 AM- 9 AM	Cooler bag packing	Volunteers and Staff
8 AM- noon	Meal cooking	Staff Only
9 AM- noon	Meal packaging	Volunteers and Staff
1 PM- 4 PM	Meal packaging	Volunteers and Staff
4:30 PM- 7 PM	Meal packaging	Volunteers and Staff
9:30 AM- 1 PM	Deliver meals	Volunteers and Staff

Saturday Schedule:

Time	Activity	Workforce
7:30 AM- 9 AM	Cooler bag prepping/packing	Volunteers and Staff
9:30 AM- 1 PM	Meal packaging	Volunteers and Staff
9:30 AM- 1 PM	Deliver meals	Volunteers and Staff

Sunday Schedule:

Time	Activity	Workforce
9 AM- Noon	Meal packaging	Volunteers and Staff
Noon- 3 PM	Meal packaging	Volunteers and Staff

Activity Descriptions:

1. Cooler Bag Packing: Volunteers and employees pack meals into insulated cooler bags that drivers will be delivering later in the morning. (See Figure 1)
2. Meal Cooking: Different meals are prepared in bulk by employees. These meals are delivered to clients the next day. Until delivery, they are stored in the on-site coolers.
3. Meal Packaging: Volunteers and employees individually package each meal. (See Figure 2)
4. Deliver Meals: Volunteers and employees use detailed driving directions to deliver meals to the home-bound clients.
5. Cooler Bag Prepping and Packing: Since no delivery takes place on Sunday, volunteers prepare for double delivery on Saturday. They also help set up the cooler bags and pack the meals that the Saturday drivers will begin delivering.

Notes:

1. Food is ordered in bulk every two days. It is stored in the inventory area at the front of the building and in the refrigerator space. (See Figure 3)

2. Routes are determined each day based on the schedule of clients on the calendar.

3. Staff helps to prepare, package, and deliver meals. In the event that volunteers cancel at the last minute, employee schedules can be re-arranged to deliver meals.

PROJECT OBJECTIVE

The yearly budget of Project Open Hand is $7.2 million. The top three expenditures are salaries ($2.9million/year), food ($2.4million/year), and employee benefits ($300,000.00/year). The project will focus on cutting costs through an improved routing system, which will reduce the number of miles driven and consolidate current routes. (See Appendix) This dispatching system will allow Project Open Hand to use driving time more effectively, since the highest cost for the company is salaries.

Dispatch

Project Open Hand currently uses a part-manual, part-automated software program utilizing MapQuest, MapPoint, and driver experience to formulate routes used to deliver meals. Staff members and volunteers drive routes for two different services – Good Measure meals and normal meals. Based on the findings of a UPS study, many routes run parallel, adding more travel time than necessary to the delivery process. Consolidation of delivery routes and a setup of auxiliary sites outside of the perimeter will be cost-effective, reduce the number of miles driven, and increase the number of participating volunteers. This project will consolidate both meal services and implement mapping software to formulate the most effective routes for all meal recipients.

Auxiliary Distribution Sites

Currently, the company owns six refrigerated vans for transportation of meals. We hope to utilize these vans in setting up strategically located auxiliary sites. These locations will serve as points from which volunteers can pick up meals to be delivered. The sites will be determined by analysis of the current demand for service outside of the perimeter. (See Figure 4)

Objectives:

1. Decrease driving time for volunteers, consequently increasing the number of available volunteer participating since there is greater ease of travel outside of the perimeter.
2. Reduce the number of miles driven by Project Open Hand staff who are reimbursed for their miles driven ($0.36/mile, average of 1,000 miles per vehicle per month, 30 vehicles). Volunteers are not reimbursed for their gas or miles driven while delivering meals.
3. Decrease maintenance cost of the eleven Project Open Hand vehicles by consolidating routes. Current cost for the vehicle maintenance is $1,584 per month. Current cost on gas money is $3,000 per month.

Process:

1. Vans with packaged meals prepared for delivery will drive to pre-determined auxiliary sites.
2. Volunteer drivers will travel to these auxiliary sites to pick up packaged meals to deliver to clients.
3. Meals will be delivered and the cooler bags will be returned to the auxiliary site.

PROJECT DELIVERABLE

Routing Program and Auxiliary Distribution Sites:

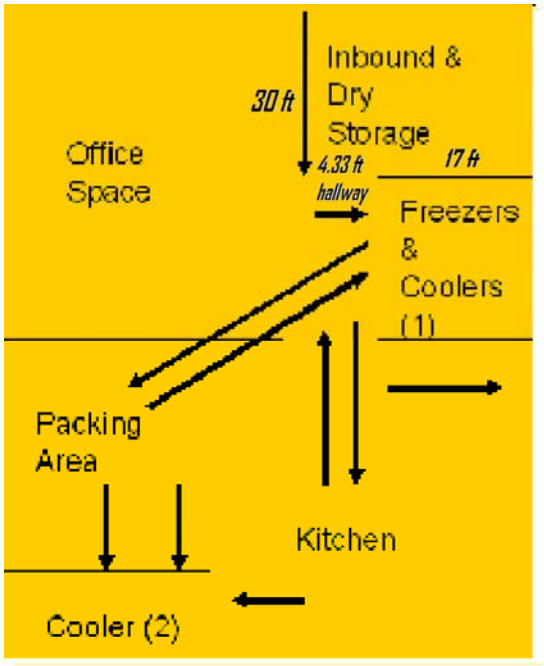
This will be designed as a dynamic daily routing program. This program will use current locations of delivery to determine optimal routing system and the possible areas that need an auxiliary distribution site. It will update routes as needed with respect to changes in client demand.

PROJECT CONSTRAINTS

- No capital expenditure feasible
- Limited Volunteer Hours
  - 525 Volunteers/Week
  - 1,575 Volunteer Hours/Week
- Limited inventory and cooler storage space
  - 12,000 square feet (See Appendix)

APPENDIX

Current Layout of Project Open Hand



One Day Sample Routing Data

	Number of Routes	Number of Stops	Estimated Miles	Estimated Time (Hours)	Number of Clients
Regular Clients	78	805	1460	180	1385
Good Measure Clients	6	68	585	22.5	600

*Regular Clients are delivered to daily
*Good Measure Clients are delivered to twice a week

FIGURE 1

FIGURE 2

FIGURE 3

FIGURE 4

Figure 1: Packaged prepared meals on tiered racks to be placed in cooler bags and delivered to clients.

Figure 2: Food packaging assembly line

Figure 3: Inbound and Dry Storage Area (non-perishable food pallet loads)

Figure 4: Routing map that is posted on the wall of Project Open Hand

I. Sponsor Description

Working to protect public health and safety, the Centers for Disease Control employs nearly 15,000 people with an estimated annual budget of $8.8 billion. The CDC provides information to enhance health decisions through partnerships with state departments and other organizations. The Atlanta based CDC focuses on developing and applying disease prevention and control, environmental health, occupational safety and health, health promotion, and educational activities.

The Entomology Branch is a department within the Division of Parasitic Diseases that studies novel interventions, conducts surveillance, and develops diagnostic methods for parasitic diseases that are transmitted in soil, food, water, and by arthropod vectors. The branch conducts both domestic surveillance and insecticide resistance studies for mosquitoes and bedbugs and is responsible for providing answers specifically for the vector-borne diseases, such as malaria. Their goal is to use conventional and novel interventions to reduce or eliminate these populations.

II. Background Information

Malaria is widespread in tropical and subtropical regions, including parts of the Americas, Asia, and Africa. Without a vaccine, preventative drugs are an option to reduce the risk of infection; however, these prophylactic drug treatments are usually too expensive for most people living in endemic areas. The parasite's primary (definitive) hosts and malaria transmission vectors are female mosquitoes of the *Anopheles* genus.

Sterile Insect Technique is a method of biological control, whereby large numbers of factory produced, sexually sterile male insects are released into an infested area. If a sterile male successfully mates with a wild female, no offspring will be produced and thus the chain of reproduction and infection for that female will be broken. This technique is commonly referred to as "birth control" for insects. Repeated release of sterile insects can eventually eradicate a population of mosquitoes.

III. Problem Description

The International Atomic Energy Agency (IAEA), Sudan national government, and CDC have collaborated to build a mosquito production facility in Sudan's capital Khartoum, located in the northern part of the country. This facility will test the release of sterile mosquitoes into an area where a single species of mosquito transmits malaria to a high proportion of human population. The selected test release location is in vicinity of the city of Merowe, Sudan.

This problem involves designing a cost-effective production and distribution system for the mass-rearing and releasing of sterile male mosquitoes at this test release site.

a. Production

The existing model is the CDC's production system, which yields approximately 5,000 mosquitoes per day. Production of mosquitoes involves four successive biological stages: eggs, larvae, pupae, and adults (respectively).

To begin production, a base colonization of adult mosquitoes will already exist. An estimated 20% of the adult females lay 80 eggs each per day, with an egg to larvae survival rate of 80%. In approximately eight days, larvae develop into pupae and the pupae are then manually separated from the larvae. The separated pupae are transferred to a water system where they will take another 36 hours to grow into adults, with a pupa to adult survival rate of 95%. Once fully developed, about 4/5 of the adult males are separated to be sexually sterilized and released while the females and remaining 1/5 males are recycled through the system to reproduce. The current non-automated production system requires approximately 30 man hours per 7,000 – 10,000 mosquitoes produced.

The proposed continuous production system will need to produce millions of mosquitoes per day, far more than any existing mosquito production system in place in the world today. This system will be automated, thus requiring far fewer man hours per mosquito produced than the current manual system. Two main factors of interest in the production process are: (1) the optimal biological stage for the mosquitoes to be sterilized and released (during the pupae or adult stage), and (2) the amount of production that must be used for broodstock vs. release. The proposed production system can be seen in Appendix A.

b. Distribution

The distribution of the mosquitoes is the most critical aspect of the project's success. The two key components of distribution are transport and release, though in the interest of the project, the problem will likely be solved backwards starting with the release of the mosquitoes.

i.) Release

Defining release locations and optimal release numbers to eradicate the mosquito population will create a basis on which to build the rest of the results. The release locations will depend on existing mosquito population densities in Merowe as well as implicated factors such as weather, climate, irrigation methods, and seasonality. The potential release area will cover approximately 192 km^2 of irrigated land, however actual release area may be smaller, as it will be determined by mosquito population densities. An existing dam and surrounding desert in Merowe will provide a natural barrier to prevent migration from the release area.

One possible method of release is to target isolated pockets in areas of high density. The alternative is a rolling barrier, where a rotating "wall" of sterile mosquitoes would sweep over the entire area. Both methods would be compared to determine which is most effective in reducing population density of mosquitoes in the release area.

ii.) Transport

Transporting the mosquitoes from the production facility in Khartoum to the desired release areas in Merowe (which are located roughly 320 *km* apart) must be both cost-effective and time-efficient, due to the short lifespan of mosquitoes. Executing the various releases will involve complications, as methods of transportation will be limited in parts of Sudan due to the lack of reliable roads. Possible methods of transportation include ground, air, rail or boat. Costs and benefits for each transportation method must be examined to identify the ideal transportation mode for this situation.

IV. Project Deliverables

a.) Release Strategy

A simulation model will explore the feasible methods to release sterile mosquitoes into the natural mosquito population. Based on the release method, the time needed to eradicate the existing population will be compared. Transportation logistics will be integrated into our model, as release locations must be accessible by available transportation methods. The deciding factors for the best method are cost of transportation from Khartoum to the release site in Merowe and time to complete the elimination program. The recommended method is dependent upon financial resources, as posed by the International Atomic Energy (IAEA), Sudan national government, and CDC, as well as desired duration of the elimination program.

b.) Biological Stage to Release Mosquitoes

The biological stage to release sterile mosquitoes will be determined by simulating the production process to identify the most cost effective means of obtaining the necessary daily mosquito production rate. The desired production rate corresponds directly to the recommended amount of sterile mosquitoes to release per day.

c.) Daily Production and Release Rates

The mosquito population density of the area varies throughout the year, so the recommended daily production and release rates will provide a dynamic solution based on when the project is implemented. These rates will include a recommendation to either release the same amount of mosquitoes over the course of the program or to vary the release amounts as the population fluctuates, as well as a corresponding strategy for the recommendation.

d.) Production Facility Location

While Khartoum has initially been selected as the site for the production facility, it may be more cost effective to build the facility near Merowe. Changes in costs would include construction, transportation, and an additional irradiator for Merowe. After release locations and production rates have been decided independently of facility location, comparing the costs of the two transportation routes and overall construction costs will allow us to recommend the better facility location.

V. Estimated Value

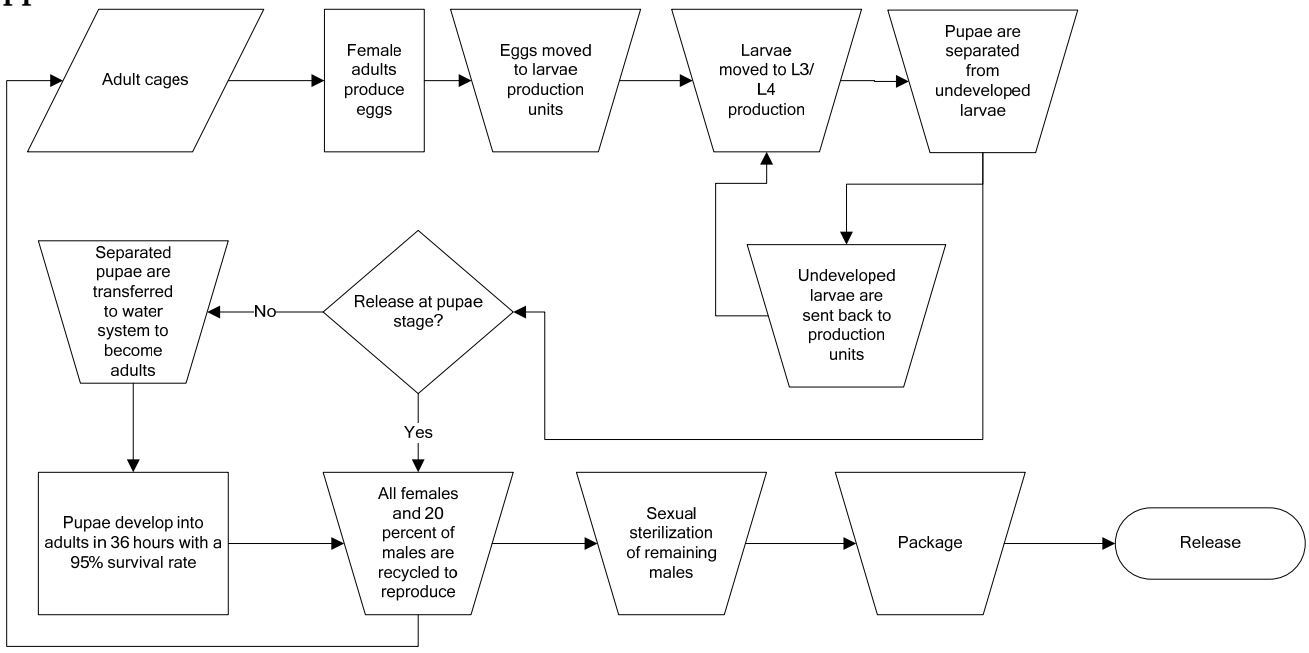
Estimating the potential value of the project monetarily proves difficult. Though there have been several studies focusing on direct costs, such as the treatment or prevention of malaria, the indirect costs, such as reduced productivity or work performance, and the externalities, such as potential value lost from trade, tourism, and investment, many of these figures are inconsistent. However, sources agree that the cost of the disease to households, communities, and national economies is significant. The true value of the project will be hard to realize until it is actually implemented in a malaria-infected area; the project focuses on feasibility and practicality.

Another hurdle in predicting value is the lack of data from previous sterile mosquito releases. Production costs of a general SIT facility, however, are available. An estimate of the construction costs of a production facility which would produce an estimated billion mosquitoes per week is approximately US $ 11 million with a weekly operating cost of $405 per one million mosquitoes produced, which includes both fixed and variable costs. However, construction costs may be much lower as they will depend on the recommended daily production rates. Fixed costs include repayment on capital costs, administrative and permanent employees, communications, utilities, research and development, base stock of insects, waste insects not needed for release, and insurance. Variable costs include rearing diet, fixed term employees, and quality control.

In a 1987 African study involving four countries, the cost of one case of malaria was estimated at US $9.84; US $1.83 was spent on direct medical expenses and the remainder on indirect costs accrued from foregone income associated with lost work days from illness and death. In Sudan alone, 48,000 deaths each year are attributed to the disease. One study comparing countries with malaria to those without estimated a macroeconomic effect of a 1.3% drop in annual Gross Domestic Product per capita. The Central Intelligence Agency estimated Sudan's GDP in 2006 to be $97.47 billion. The economic downturn over the last 35 years has caused their GDP to be 32% lower than it would have been in the absence of malaria. Aside from economic effects of malaria, one must consider the value of human life, the suffering of those infected, and the lack of aid to prevent and cure the disease ridden in financially unstable countries; all of which cannot be measured in dollars or percents.

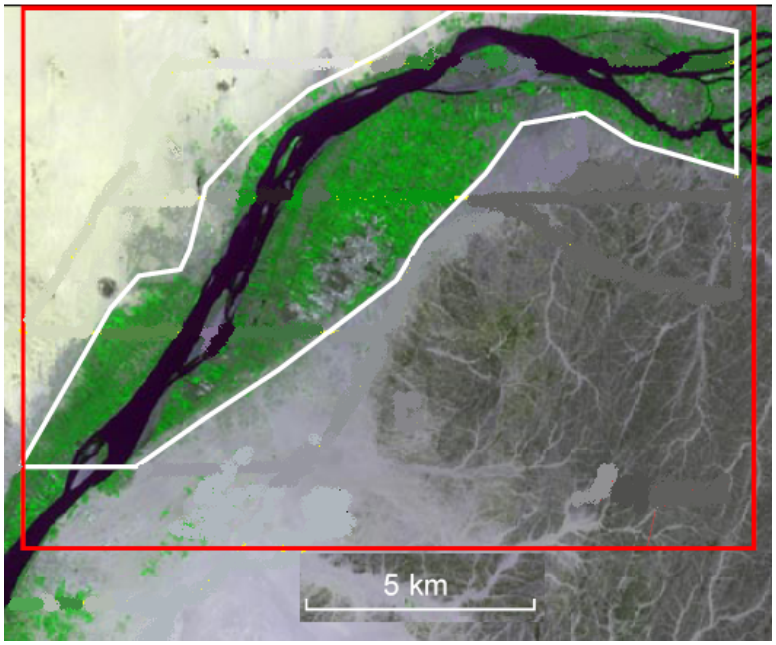
Our project will minimize costs of SIT control of mosquitoes in Sudan, providing cost figures or duration estimates for the production and release program given several variables (such as the density of existing mosquito populations, weather, seasonality, etc.) that would influence the cost and methods of SIT implementation.

Appendix A



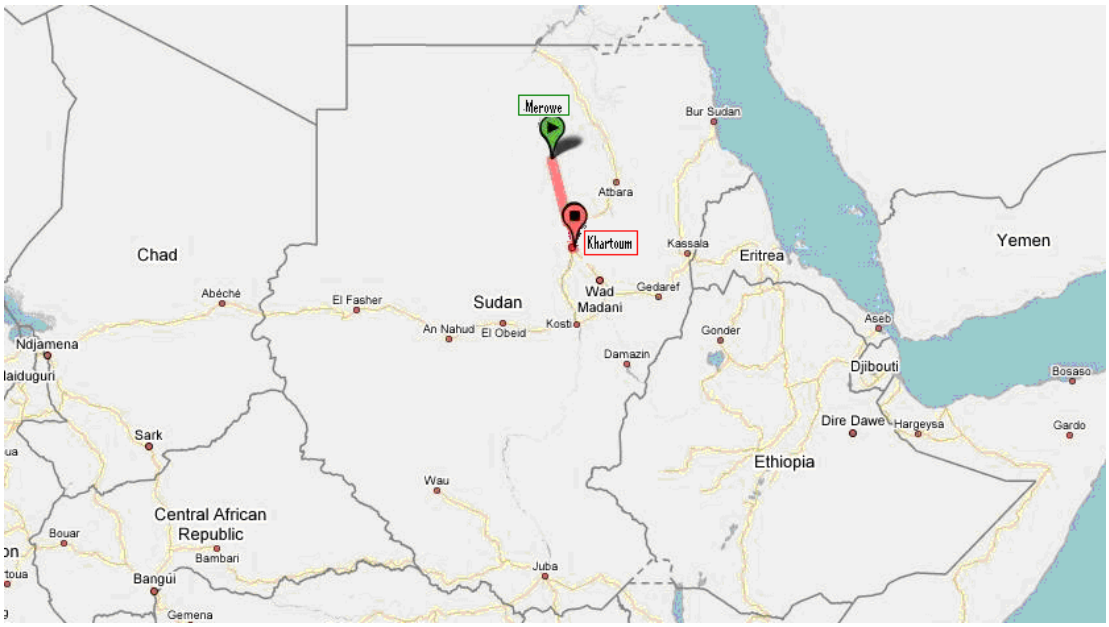
Mosquito Production System – Proposed process flow of the two possible biological stages released in the field

Appendix B



Release area in Merowe, Sudan - Green indicates land that is irrigated (i.e. more prone to mosquito habitation)

Appendix C



Location of production facility (Khartoum) relative to the release site (Merowe)

Appendix D

Available transportation in Sudan

Company Description

SunTrust Banks, Inc. is one of the largest banking ventures in the United States with assets exceeding $186.4 billion. Atlanta based, SunTrust consists of over 1691 retail branches along with 2543 ATMs that serve Alabama, Arkansas, Florida, Georgia, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia, and the District of Columbia.

SunTrust provides services in retail and commercial banking, trust services, mortgage banking, credit cards, mutual funds, insurance, equipment leasing, asset management, and securities underwriting and dealing. They have played crucial roles in the startup of corporations such as Coca-Cola and assist institutions and affluent individuals in wealth management with assets under advisement totaling over $249.9 billion.

SunTrust continues to grow and gain popularity with new acquisitions. In 2004, SunTrust acquired Memphis based National Commerce Financial, which elevated it to the seventh largest bank in the United States. Predominantly located in the southeastern United States, SunTrust is looking to expand into other regions of the country.

Problem Description

The Federal Reserve requires that all banks hold at least 10% of their total transaction deposits. SunTrust frequently exceeds this requirement, preventing them from investing this excess Cash on Hand in other profitable opportunities. Each day, some branches have excess cash and some have a need for cash. Currently, the branches that have a need for cash place their orders from a cash vault rather than getting it from a branch with excess cash, which inflates the total Cash on Hand for the bank.

SunTrust uses Brinks armored vehicles to transport all of its cash. Brinks use static routes that service each branch independently of all others. On a daily basis, SunTrust stores an average of $325MM in its Brinks vaults, which contributes to an unnecessarily high Cash on Hand position. By keeping this excess Cash on Hand, SunTrust is not able to invest it in other profitable opportunities.

The senior design team proposes to create a dynamic routing model for Atlanta’s 211 branches based on a mapping tool and daily forecasted and actual Cash on Hand amounts for each branch. This will allow the branches to exchange cash by using the armored trucks as mobile vaults, it will reduce unnecessary usage of armored vehicles, and it will reduce the potential for bank robberies by changing the routes daily. Once the Atlanta-based model has been completed, we will expand the model to be applied across the entire SunTrust enterprise.

Deliverable

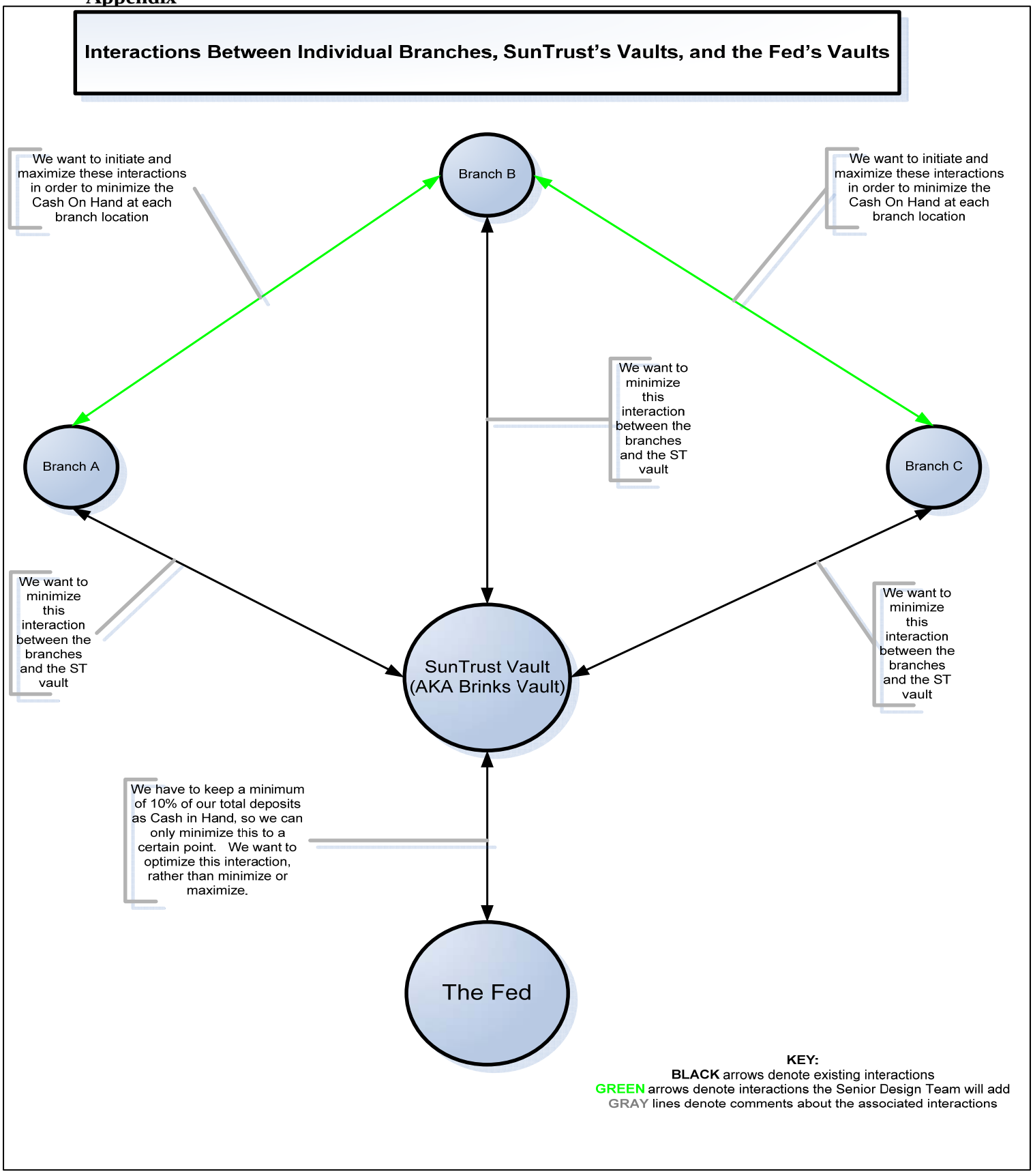
We will provide SunTrust with a routing optimization application for Atlanta that takes into account both a mapping tool and Cash on Hand for each branch. This model will allow SunTrust branches to share money with each other, thereby reducing Cash on Hand. The team will then apply the same model across all of SunTrust.

Value-Add

Allowing branches to share cash will reduce the Cash on Hand at SunTrust vaults and provide more investment opportunity. For example, on August 1, SunTrust Branch A had an excess of $64,000 and Branch B needed an additional $79,000. Under the current system, the excess at Branch A would not be used to fill the need at Branch B. With our proposed application, Branch B would receive $64,000 from Branch A and only $15,000 from the vault, reducing the amount needed in the vault for that day by $64,000. With similar examples across SunTrust's 211 branches in Atlanta, there is a large potential excess each day. SunTrust would be able to invest this excess cash at a minimum rate of 5.25% with the Federal Reserve.

Additionally, this project will have a smaller impact on armored vehicle expense, provide a security benefit by lowering vault inventory, and provide a security benefit to both Brinks trucks and the branches by changing the routes daily.

Appendix


Interactions Between Individual Branches, SunTrust's Vaults, and the Fed's Vaults
We want to initiate and maximize these interactions in order to minimize the Cash On Hand at each branch location
Branch B
We want to initiate and maximize these interactions in order to minimize the Cash On Hand at each branch location
We want to minimize this interaction between the branches and the ST vault
Branch A
Branch C
We want to minimize this interaction between the branches and the ST vault
We want to minimize this interaction between the branches and the ST vault
SunTrust Vault (AKA Brinks Vault)
We have to keep a minimum of 10% of our total deposits as Cash in Hand, so we can only minimize this to a certain point. We want to optimize this interaction, rather than minimize or maximize.
The Fed
KEY:
BLACK arrows denote existing interactions
GREEN arrows denote interactions the Senior Design Team will add
GRAY lines denote comments about the associated interactions