Health and Humanitarian Logistics Conference

Poster and Abstract Guide

Georgia Institute of Technology

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Poster 1

A Logistics Model for Delivery of Prioritized Items in a Humanitarian Relief Effort

Yen-Hung Lin (University at Buffalo), Rajan Batta (University at Buffalo), Peter Rogerson (University at Buffalo), Alan Blatt (Center for Transportation Injury Research, CUBRC), Marie Flanigan (Center for Transportation Injury Research, CUBRC)

In this work, a new logistics model is proposed for delivery of prioritized items in disaster humanitarian relief operations. The type of humanitarian relief problem of interest is an earthquake with extended damage, prioritized items for delivery, and an extensive time period over which supplies need to be delivered. It considers multi-items, multi-vehicles, multi-periods, soft time windows, and a split delivery strategy scenario, and is formulated as a multi-objective tour-based integer programming model. To effectively solve this model we need to limit the number of available tours. A heuristic approach is introduced for this purpose that is developed by decomposing the original problem. Meanwhile, the multi-objective problem is converted to a single-objective problem by the weighted sum method. We first consider a humanitarian relief logistics problem with all supplies emanating from a central depot. A case study will be presented to illustrate the potential applicability of our model to this type of supply strategy. Then we will present our ongoing work of extending to the situation where temporary depots can be set up to improve the efficiency of the disaster relief effort, and demand can be fulfilled by either temporary depots or the central depot. The mathematical model will be proposed to locating temporary depots, allocating demand points, and transporting resources (e.g., supplies and vehicles) from the central depot to temporary depots. A heuristic-based framework of the methodology to solve the logistics problem with this kind of supply strategy will be presented. We will optimize the number and the placement of these temporary depots, and use the revised new logistics model and its associated algorithm for delivery to demand points associated with each selected temporary depot.

Poster 2

Integrated Logistics Model for Emergency Disaster Relief Operations

Abbas Afshar (University of Maryland), Ali Haghani (University of Maryland)

The goal of this research is to develop a comprehensive model that describes the integrated logistics operations in response to natural disasters. We propose a mathematical model that controls the flow of several relief commodities from the sources through the supply chain and until they are delivered to the hands of recipients. The structure of the network is in compliance with FEMA's complex logistics structure. The proposed model not only considers details such as vehicle routing and pick up or delivery schedules; but also considers finding the optimal location for several layers of temporary facilities as well as considering several capacity constraints for each facility and the transportation system. Such an integrated model provides the opportunity for a centralized operation plan that can eliminate delays and assign the limited resources to the best possible use.

A set of numerical experiments is designed to test the proposed formulation and evaluate the properties of the optimization problem. The numerical analysis shows the capabilities of the model to handle the large-scale relief operations with adequate details. However, the problem size and difficulty grows rapidly with adding the equity constraints and extending the length of the operations. In these cases, it is suggested to find fast solution algorithms and heuristics methods in future research.

Poster 3

Likelihood Ratio Methods for Spatiotemporal Healthcare Surveillance

Sung Won Han (Georgia Institute of Technology), Kwok-Leung Tsui (Georgia Institute of Technology), Wei Jiang (Hong Kong University of Science and Technology), William H. Woodall (Virginia Tech)

For healthcare surveillance, the timely detection of a rate increase in disease incidence or mortality is very important. The incidence data are often count data which consist of spatial information on the location of incidences. Prospective spatiotemporal surveillance methods are used to detect the clusters of the regions.

In this poster, we present spatiotemporal methods for disease surveillance based on likelihood ratio statistics. By investigating CUSUM and other LR-based approaches for engineering SPC (Statistical Process Control), we develop a general framework for existing methods by including many operators such as summation or maximum in terms of outbreak position, coverage, or time period. We also show that CUSUM and other popular likelihood ratio statistics are special cases under such a general framework. We propose new spatiotemporal surveillance methods based on likelihood ratio statistics over windows of tests.

We compared the performance of these spatiotemporal surveillance methods by simulation. For the performance measure, CED (conditional expected delay) with the control of ARL0 (average run length under in-control) is used under different assumptions on change position, coverage, and magnitude. Similar to the Shiryayev-Roberts procedure, taking summation for spatiotemporal surveillance may outperform the procedure which takes the maximum over all time windows of the LR statistics. In addition, when the outbreak coverage is known, the methods with an appropriate radius that matches the actual outbreak coverage are often better than those under- or over-scanned. Finally, the likelihood ratio statistic with summation operator over spatial windows and maximum operator over temporal windows provides better performance than other methods. In addition to our simulation study, the various LR statistics were illustrated in a real case of male thyroid cancer data in New Mexico.

Poster 4

Vehicle Routing for the Food Rescue Programs

Canan Gunes (Tepper School of Business Carnegie Mellon University), Willem-Jan van Hoeve (Tepper School of Business Carnegie Mellon University), Sridhar Tayur (Tepper School of Business Carnegie Mellon University)

Food banks are non-profit organizations that collect food from several organizations and distribute it through agencies to people in need. There are more than 200 food banks around the U.S.A. Although food banks occasionally purchase some items, they mostly rely on donations. One important supply channel of food banks is the food rescue program that is implemented in many food banks in the U.S.A. According to this program, trucks of the food banks pickup ready-to-serve food from several restaurants, hotels, and schools and along their way they distribute it to the agencies, where people in need are served. From a theoretical perspective, the food rescue program involves an important vehicle routing problem, the One-Commodity Pick-up and Delivery Vehicle Routing Problem (PDVRP), which did not receive much attention in the literature. In this study we first present a thorough study on the state-of-the-art solution methods for the PDVRP utilizing technologies IP, ILOG Scheduler, ILOG CP Optimizer and ILOG Dispatcher. We then describe our efforts to implement an Excel-based tool for food

banks that is easy to use and that will help them in designing their schedules for the food rescue program relatively efficiently.

Our case study for the food rescue program of Greater Pittsburgh Community Food Bank shows that the exact methods i.e., IP, ILOG Scheduler, ILOG CP Optimizer can solve relatively small instances while Dispatcher, which implements several simple heuristics, provides solutions of good quality very quickly for large-scale problems. Incorporation of these heuristics into the Excel-based tool is part of the ongoing work.

Poster 5

Redesigning the Emergency Relief Supply Chains

Dina Ribbink (University of Maryland, R.H. Smith School of Business), Koray Ozpolat (University of Maryland, R.H. Smith School of Business), Robert Windle (University of Maryland, R.H. Smith School of Business)

In the past decade, global media coverage about catastrophes that affect millions of people have increased. The cry for help is often met by donations and an outpouring of support from governments and individuals alike; the response to the earthquake in Haiti being a recent example. However, the underlying logistics of providing this aid is rarely covered unless the supply chain fails to perform and the suffering increases. Emergency relief aid organizations face very uncertain demand patterns but general expectations are that they should have enough provisions and inventory in storage to provide for even large-scale emergencies.

This paper empirically studies both forecasting and supply chain redesign as means to address the issue of rapid responses to emergencies. The United States Agency for International Development (USAID) provided unique data about its emergency food aid shipments over a period of about eleven years. Although the geographic distribution of food aid delivery can be predicted to a degree, the scale of emergency food needs cannot be forecasted using past data alone. Overall, global sourcing offers significant benefits. Matching the USAID shipment data with Food and Agriculture Organization's (FAO)local food commodity prices, we find that sourcing location decisions should be based on the type of commodity as well as the geographic location and economic situation of the recipient country. Pre-positioning food supplies closer to the recipient countries and reducing SKU variability through standardization at relief agency warehouses are additional means to improve the efficiency and effectiveness of humanitarian relief chains.

Poster 6

Using Metrics of Culture to Inform Whole-of-Government Approaches to International Engagement

William McDaniel (Johns Hopkins University/Applied Physics Lab)

There are currently few means to measure or predict the effectiveness of whole-of-government approaches to international engagement. This research seeks to tie relevant metrics to actions taken by the U.S. Government to influence other nations. The work is also expected to enhance U.S. understanding of the motivations of other governments as they use different means for international engagement. If successful, this research could lead to the development of explanatory models of the influence of U.S. policies on cultural dimensions of specific countries.

The intent of this work is to explore a wide variety of metrics of culture. Most of the academic research in this area stems from the seminal work of Hofstede, who used the results of employee surveys from IBM's worldwide operations from the late 1960s and early 1970s to propose a set of four (later expanded to five) metrics of cultural distance.

Among other approaches, Craig, Douglas and Bennett attempted to measure the Americanization of other countries by using proxy metrics for Appadurai's global flows [5]. Appadurai is a sociologist who proposed five global flows (or "scapes") that affect interacting societies: Mediascapes, Ethnoscapes, Ideoscapes, Technoscapes and Financscapes. Bryant, using models of national power collected across three different eras, defined seven categories of national power: Military, Economic, Resource, Technological, Diplomatic, Movie and Social, and proposed metrics associated with each category.

Using data collected from various government and non-government organizations representing or related to the flows or categories of power described above, initial data exploration and mining is being performed. Undirected methods to aggregate the data show expected groupings along economic and geographic terms, from undeveloped countries to Western economic powers. Directed methods, using Pew Research survey data on attitudes about the US as a target, demonstrate health and humanitarian relationships with significant policy implications.

Poster 7

World Food Programme Supply Chain Improvements

James Wade (Georgia Institute of Technology), Joy Peak (Georgia Institute of Technology), Ozlem Ergun (Georgia Institute of Technology), Elhadj Bah (Georgia Institute of Technology), Manuel Jimenez (Georgia Institute of Technology)

The World Food Programme (WFP) is the largest humanitarian logistics provider in the world and the food aid branch of the United Nations. Our poster details work between Georgia Tech and WFP in the areas of supply chain optimization, supply chain simulation, inventory management and pre-positioning. We show that inventory management tools can increase efficiency and that pre-positioning can be used to improve long term relief operations on a global scale. We also exhibit ongoing projects to simulate and optimize detailed regional operations in the horn of Africa.

Poster 8

Making Combination Vaccines More Affordable to Low Income Countries

Ruben Proano (Rochester Institute of Technology (RIT)), Sheldon Jacobson (University of Illinois)

New combination vaccines have become the choice of preference for immunizing children in high and middle-income countries. However, these new vaccines are prohibitively expensive to poorer countries, causing them to rely on older, less-expensive vaccines. This product divergence decreases economies of scale for the purchase of vaccines and eliminates the financial incentive for manufacturers to maintain production of less-expensive vaccines or even to develop new vaccines for diseases affecting developing countries. This paper treats combination vaccines as bundles of antigens that can be priced as a single item. Such bundles are used to formulate an optimization problem that determines the combination vaccine allocation between vaccine producers and different countries under a price discrimination agreement. The objective of the optimization problem is to satisfy countries' antigen demand at the lowest possible price, while providing a reasonable profit for the vaccine producers. The optimization problem results in a mixed-integer non-linear programming problem that simultaneously maximizes the aggregated manufacturing profits and the aggregated customer surplus, and hence, maximizing the total social surplus. Moreover, the concept of price equilibrium is applied through a heuristic that selects problem solutions, which maximize total social surplus by balancing the trade-offs between the producers' profits and customer surplus.

Poster 9

Balancing nutritional benefit and profitability of community food gardens in South Africa.

Nadia Viljoen (Council for Scientific and Industrial Research (CSIR)), Carin De Kock (University of Pretoria), Gerda Trollip (University of Pretoria)

Food security is a key concern among the impoverished communities of South Africa. Surveys have indicated that micronutrient deficiencies abound in these communities, detrimentally affecting child development and overall health. Many of these deficiencies are attributed to a lack of fresh fruits and vegetables in the average community member's diet.

Community food gardens have been widely utilised in South Africa over the last two decades, with varying levels of success. Various subsistence farming methods have been employed by a number of organisations, resulting in a myriad of â€œbest practiceâ€ models. The final outcome of the project will be a generic planning support tool that can be implemented across a number of different best practice models.

Currently, the tool employs a two-phased stochastic, multi-objective linear program to determine a periodic planting and harvesting schedule for a financially self-sustaining community food garden. The first phase selects a short-list of appropriate vegetables, while the second phase develops the planting and harvesting schedules. The model takes into account growing seasons, harvesting seasons and the need for crop rotation. Inputs into the model include:

1. The aggregate community nutrient requirement that must be satisfied by produce from the garden;
2. Operating costs emanating from labour, irrigation, fertilization and buying seeds and seedlings
3. Market prices and nutritional density of a variety of vegetables suited to the climate and soil conditions

A hypothetical case was designed and solved to verify and validate the model. Following its success, Heartbeat (an organisation supporting Orphaned and Vulnerable Children in impoverished communities), has agreed to implement the tool at their Nelmapius food garden just outside Pretoria in the Gauteng province. The purpose of the pilot is to determine the potential impact the implementation of this planning tool can have in community food gardens. Preliminary results will be made available.

Poster 10

Solving the Inventory Slack Routing Problem for Medication Distribution Planning

Adam Montjoy (University of Maryland), Jeffrey Herrmann (University of Maryland)

The inventory slack routing problem (ISRP) addresses a critical issue in emergency preparedness. Public health officials must plan the logistics for distributing medication to points of dispensing (PODs), which will give medication to the public in case of a bioterrorist attack such as anthrax. Unlike other vehicle routing problems, which use a cost objective function, the objective in the ISRP is to maximize the slack in the deliveries so that sites can continue operating without interruption and hedge against uncertainty. This problem can also be expanded to include emergencies where relief supplies need quick and equal distribution to many different centers for immediate use.

Our approach separates the problem into two subproblems: (1) the â€œrouting problem" assigns sites to routes for each vehicle, and (2) the â€œscheduling problem" determines when the vehicles should start these routes and how much material should be delivered on each trip. It is important to develop techniques that can be implemented within widely-accessible software, such as common spreadsheet program, so that their use is beneficial to all public health planners. The routing problem has been solved by a body of heuristics, as well as an adaptive large neighborhood search. The scheduling problem has been solved with an improvement algorithm that carefully allocates inventory to maximize slack.

These approaches have been applied to a large body of instances that have qualities of various real-world scenarios. These results have been compared to an upper bound. Future work on this project includes solving the ISRP using an exact integer programming approach. This research is a part of a larger body of work related to creating tools for clinic and public emergency preparedness.

Poster 11

Strategic Planning for Disaster Recovery with Stochastic Last Mile Distribution

Carleton Coffrin (Brown University), Pascal Van Hentenryck (Brown University), Russell Bent (Los Alamos National Laboratory)

This work considers the single commodity allocation problem (SCAP) for disaster recovery, a fundamental problem faced by all populated areas. SCAPs are complex stochastic optimization problems that combine resource allocation, warehouse routing, and parallel fleet routing. Moreover, these problems must be solved under tight runtime constraints to be practical in real-world disaster situations. This poster presents the specification of SCAPs and introduces a novel multi-stage hybrid-optimization algorithm that utilizes the strengths of mixed integer programming, constraint programming, and large neighborhood search. The algorithm is validated on hurricane disaster scenarios generated by Los Alamos National Laboratory using state-of-the-art disaster simulation tools and is deployed to aid federal organizations in the United States.

Poster 12

Restoring Infrastructure Systems: An Integrated Network Design and Scheduling Problem

Burak Cavdaroglu (Rensselaer Polytechnic University), Sarah G. Nurre (Rensselaer Polytechnic University), John E. Mitchell (Rensselaer Polytechnic University), Thomas C. Sharkey (Rensselaer Polytechnic University), William A. Wallace (Rensselaer Polytechnic University)

We consider a new class of integrated network design and scheduling problems, with important applications in the restoration of services provided by civil infrastructure systems after an extreme event. Critical services such as power, telecommunications, water, and transportation are provided by these infrastructure systems. The restoration of these services is necessary for the society to recover from the extreme event and in delivering humanitarian relief to this affected area since these relief efforts may rely on infrastructure systems. For example, emergency responders will be traveling on the road network in order to assist with the disaster response activities.

The class of integrated network design and scheduling problems considered by this work focuses on a set of selected arcs to install into an existing network (i.e., network design decisions) and then scheduling these arcs on a set of work groups. Unlike previous network design problems, the network must be operating at intermediate points in time (for example, providing services) so that the scheduling decisions associated with the design decisions have a significant impact on the objective of the problem. The operations of the network at intermediate points in time will be evaluated by determining the amount of unmet demand in the network. Our overall objective is to minimize the cumulative amount of (weighted) unmet demand over a set of time periods.

We discuss heuristic and exact methods to solve this class of problems. The heuristics combine ideas from the field of network flows and scheduling while the exact method integrates integer and constraint programming techniques. Our methods are tested on a realistic data set representing the (disrupted) infrastructure systems of lower Manhattan in New York City. These results demonstrate that our methods are capable of providing solutions to decision-makers in real-time.

Poster 13

Vaccine Vial Size Optimization for Immunization Campaigns

Aswin Dhamodharan (Rochester Institute of Technology (RIT)), Dr Ruben Proano (Department of Industrial and Systems Engineering, RIT), Dr Seshavadhani Kumar (School of Mathematical Sciences, RIT)

Vaccines are perishable products stored in vials with a specified expiry period. The expiry period corresponds to the length of time for which vaccine doses stored in a vial can be safely used to immunize children since the time of opening (puncturing) of the vial. Vaccines are products with limited supply. The overall vaccine wastage rate in developing countries has been observed to be 50% by WHO and UNICEF. Hence there is a need to recommend inventory policies and an optimal vial size to be used to minimize vaccine wastage. During immunization campaigns, vaccine expiration occurs when not enough children in need of vaccination are found during the expiry period of an open vaccine vial, resulting in discarding of the remaining doses in the vial. Storing only one dose of vaccine in a vial could prevent the expiration from happening. However, doing so increases production and handling costs for the immunization campaign. This study aims to determine the optimal number of vaccine doses to be stored in a vial such that total cost associated with an immunization campaign is minimized. This is done by solving two sub-problems; the first problem considers the perishable content of an open vaccine vial as inventory to capture the wastage due to expiry and the wastage cost associated with it. The second problem deals with the vaccine vial reordering policy and positive lead-time. Poisson process is assumed to generate demand. An approximate expected cost function for the entire problem is obtained using policies from the literature and is evaluated using Mathematica for given set of parameters. A Mixed Integer Program is formulated to simulate the problem and compute average cost for the same set of parameters and is compared with the expected cost obtained from the approximate cost function mentioned above.

Poster 14

A Capacitated Nonprofit Supply Chain with Unreliable Storage and Transportation

Gemma Berenguer (University of California, Berkeley), Zuo-Jun Max Shen (University of California, Berkeley)

Our research is motivated by a humanitarian nonprofit organization that provides aid in the form of food, medical supplies or water to a region composed of a set of villages. The organization faces challenges such as limited capacities, unreliable operations, demand variability, and high cost of stock-outs. We study the design and operation of a supply chain that takes into account such characteristics. Specifically, we propose a capacitated supply chain design model that captures the unreliable aspects of the supply chain and determines the number and locations of the warehouses, assignments of villages to the warehouses, and the reorder quantity for each warehouse. The model is a nonlinear mixed-integer program that considers costs and equity as objective functions. We reformulate the model as an equivalent second-order conic mixed-integer program (SOCMIP) that can be solved efficiently. We discuss the impacts of supply uncertainty on supply chain design decisions and provide some managerial insights.

Poster 15

Reproductive Health Supplies in Emergency Settings

Mary Yetter (CARE), Maaike van Min (Mari Stopes International), Louise Lee Jones (Mari Stopes International)

(1) Background/Significance

The Reproductive Health Access Information and Services Initiative is a joint program developed by Marie Stopes International and the Mailman School of Public Health, Columbia University. RAISE is working to improve access to reproductive health services in Africa, Latin America and South East Asia.

(2) Hypothesis or Intervention/Activity Tested

We believe that many of the challenges faced by organizations trying to support the provision of reproductive health services in conflict affected settings are common and that common solutions can be found. With little empirical data to support this theory we decided to examine the supply chain for three different projects supporting the provision of reproductive health services.

(3) Methodology

We conducted a desk based review of the availability of RH supplies in emergencies. Focusing on the role of key humanitarian and reproductive health actors, including WFP, WHO, UNHCR and UNFPA as well as larger NGOs. We also conducted rapid assessments with three RAISE partners who are providing reproductive health services in conflict affected areas. Beginning in May 2009, a logistical consultant visited DRC, South Sudan and Uganda to conduct a rapid assessment of the RH supplies situation and to troubleshoot problems where possible. Semi structured interviews were held with project staff at the three sites, include logisticians, country directors and reproductive health coordinators. Also interviewed were relevant staff from the Ministry of Health, UN agencies and other NGOs operating in the area.

(5) Findings

Reproductive health supplies were not, or not sufficiently, available in many of the family planning service delivery points visited. Some themes emerged from the three sites. Common challenges faced included the lack of support to NGOs in ensuring RH supplies reach potential client at the health centre. Barriers exist at national, UN and NGO level. All NGOs visited wanted to improve the supply chain.

Poster 16

Engineering-Economic Justification for Rebuilding Haiti from Scratch

Kas Salawu (Centers for Disease Control and Prevention)

It is clear that after the January 12, 2010, 7.0 magnitude earthquake in Port-au-Prince, Haiti, and its aftershocks, rebuilding the city as it used to be is not advisable. It would not be wise to recreate the fragile housing on the hillsides nor to construct buildings without enforcing codes that were ignored before. To rebuild the city from scratch, the massive amount of rubble on the ground now needs to be relocated outside the city. Keeping in mind that the epicenter of the quake was located only 6.2 miles below the surface, more stringent codes for earthquake-proof structures need to be imposed and enforced. The horrific natural disaster exacerbated the poverty of Haiti and its residents hence external help would be the only hope to reconstruct a viable city, if it is worth rebuilding. While economists sort out issues such as debt forgiveness and politicians canvass for huge, multilateral international aid, recovery funds earmarked for reconstruction should be kept off the hands of a relatively inexperienced Haitian government and be funneled through the Inter-American Development Bank. The logistics of post-disaster operations need the attention of world class systems engineers and town planners not former municipal administrators. Suggestions to plan the new city based on traffic flow will also be displayed, as would the cost estimates for infrastructures necessary to sustain no more than two million residents. Safeguards should also be provided against intermittent hurricanes. This poster will display the engineering-economic justification to rebuild the city as well as show examples of the seismic shock absorption structures that should be built. As commonly inserted in Istanbul, Turkey, elastomeric pads in the foundations of buildings will isolate the structures from horizontal and vertical movements imparted to the foundation by say an 8.0 magnitude earthquake.

Poster 17

Understanding Disaster Resilience in Savannah, GA

Ann Carpenter (Georgia Tech Research Institute), Leigh McCook (Georgia Tech Research Institute), Mark Hodges (Georgia Tech Research Institute), Claudia Huff (Georgia Tech Research Institute)

The proposed poster will detail the results of a one-year study of community resilience in Savannah, GA funded by the U.S. Department of Homeland Security's Southeast Region Research Initiative. Objectives were to better understand the factors that contribute to community resilience, begin to map the resilience of Savannah, and develop recommendations for the region while building partnerships between researchers, residents, agencies, nonprofits, and other stakeholders. Methods included a survey of community residents and businesses to understand structures of support network, and facilitated discussions for more depth of qualitative information. Initial results indicated Savannah has strong leadership in surviving and recovering from disasters, but that its resilience has not been tested. The project underscored the need to foster community resilience in high-risk communities and in vulnerable populations.

Poster 18

A Pediatric Intensive Care Unit Rounding Process Lean Transformation

Tuba Yilmaz (Georgia Institute of Technology), Monica Villarreal (Georgia Institute of Technology), Pinar Keskinocak (Georgia Institute of Technology), Atul Vats (Children's Healthcare of Atlanta), Kristin Goin (Children's Healthcare of Atlanta)

The Pediatric Intensive Care Unit (PICU) at Children's Healthcare of Atlanta at Egleston expanded the number of beds, size of the unit, and physician resources in 2008 to meet the needs of a growing pediatric population. Multiple unit changes created challenges for an effective and efficient provider workflow. A team of attending physicians and internal consultants at Children's conducted a workflow analysis with the objective to improve the morning rounding process with the following goals: to provide patient-centered care, to improve communication with stakeholders; to optimize resources required to provide timely, quality care; and to develop teaching, research, and education opportunities. Lean methods and scenario analysis were used to develop recommendations for a new, standardized rounding model for the PICU and were implemented in December 2009. Joint work between Georgia Tech and Children's focused on post-implementation analysis to measure the impact of the changes made on the rounding process. Georgia Tech students conducted post-implementation time and motion studies of the new process and used statistical analysis to compare and measure the results. Findings include: A significant reduction in rounding duration (157 to 121 mins, p=0.01), more timely care delivery (patient rounded on by 10:00 a.m. increased from 42 to 97%), improved staff satisfaction related to communication, physician identification, and coordination of the rounding process (13 of 16 Zoomerang survey questions showed significant improvement), improved resident satisfaction, enhanced patient satisfaction, increased didactic teaching, and optimized resources (attending man hours per daily morning rounds decreased from 7.85 to 4.03). The Children's and Georgia Tech collaboration helped to verify that a lean rounding process focusing on essential components could be more efficient, while improving care delivery and satisfaction.

Poster 19

Simulation of Container Performance in the Vaccine Cold Chain

Trustin Clear (Georgia Institute of Technology), William Rouse (Georgia Institute of Technology)

The purpose of the work is to better understand how insulated shipping containers interact with the vaccine and biological material cold chains, and how enhanced container performance creates value in these systems. This understanding will inform future container designs by showing where resources can be allocated most efficiently, and will provide evidence to encourage the adoption of improved designs.

The work focuses on insulated container performance, but evaluates this performance in the context of a distribution network for vaccines and biological materials, which in turn is considered as part of efforts to improve health care outcomes. The primary application of the containers under study is improvement of vaccine and medical service delivery in remote areas.

A model of container performance has been constructed using discrete event simulation. This model simulates conditions experienced by cargo as its container traverses transportation links. The model allows a number of container parameters to be specified, tracks the response of cargo to conditions, and supports the construction of arbitrary distribution networks. Simulations can be conducted under static conditions, or can incorporate run-to-run variability in parameters. The core model is being extended to include specific cost and value estimates as the work proceeds.

The simulation model was used to duplicate World Health Organization Performance, Quality, and Safety tests for insulated shipping containers, validating its accuracy under static conditions. The model was also used to simulate variable external temperature, showing that improvements in insulation performance produce enhanced cargo outcomes over a larger range of transit lengths when variable conditions are considered.

The simulation model will be expanded to account for more sources of value, and will soon be used to analyze data from field trials of prototype containers, but is already providing insights into the system under consideration.

Poster 20

On The Need To Reformulate Humanitarian Logistics Modeling

Jose Holguin-Veras (Rensselaer Polytechnic Institute), Noel Perez (Rensselaer Polytechnic Institute), Miguel Jaller (Rensselaer Polytechnic Institute), Lisa Destro (Rensselaer Polytechnic Institute), Tricia Wachtendorf (University of Delaware)

This poster presents a number of not so well understood differences between commercial and humanitarian logistics, and suggests a number of improvements to humanitarian logistic modeling to ensure that the analytical formulations provide a meaningful depiction of the system being modeled. Although humanitarian and commercial supply chains may seem similar on the surface, they are different in terms of: (1) objectives being pursued, (2) nature of the commodity flow to be transported, (3) decision making structure, (4) knowledge of demand, (5) state of supporting systems, and (6) periodicity and volume of activities. The lack of proper consideration of deprivation costs and the phenomenon of material convergence are identified as the most pressing areas in need of improvement.

In the case of material convergence, the poster presents recent econometric evidence suggests that the amount of material convergence to a disaster site depends on the proximity to wealthy areas and to other socio-demographic factors. Since the material convergence flow frequently has negative impacts on the logistical response “as it distracts resources from more critical tasks” emergency responders should be prepared to deal with it.

In the case of deprivation costs, it is recommended to consider these costs explicitly in the analytical models, as part of objective functions that capture social costs. It is also suggested the use of economic valuation techniques to estimate these costs. Using basic formulations and numerical examples, the authors show that when humanitarian logistic strategies do not consider deprivation costs, human suffering is not minimized, far from it. Furthermore, it is demonstrated that traditional methods based on pre-defined levels of service and penalties for unmet demands are arbitrary in nature, lead to high social costs, and are likely to lead to either unfeasible or suboptimal solutions.

Poster 21

A Simulation-Based Analysis of Different Mitigation Strategies for H1N1

Hamed Yarmand (North Carolina State University), Julie Ivy (North Carolina State University), Stephan Roberts (North Carolina State University)

In this research, we have conducted a cost-effectiveness analysis to examine the relative importance of vaccination and self-isolation, two common measures for controlling the spread of infectious diseases, with respect to the current H1N1 outbreak. We have developed a continuous-time simulation model for the spread of H1N1 which allows for three types of interventions: antiviral prophylaxis and treatment, vaccination, and self-isolation and mandatory quarantine. We have used the North Carolina State University undergraduate students as our target population.

We have developed an optimization model with two decision variables: vaccination fraction and self-isolation fraction among infectives. By considering the relative marginal costs associated with each of these decision variables, we have a linear objective function representing the total relative cost for each control policy. We have also considered upper bound constraints for two of the most critical performance measures: maximum number of individuals under treatment (which is related to surge capacity), and percentage of infected individuals. We have used the Arena simulation software and have conducted grid search to obtain insight into the model and to find "good" feasible solutions.

Our target population has been the NCSU undergraduate students. We have taken advantage of the cooperation of the NCSU health center in this research. Using the estimated model parameters from the target population and literature, our results show that vaccination is much more effective in controlling the disease spread than self-isolation. Even when the relative cost of vaccination is much higher than self-isolation, the disease cannot be controlled (i.e. constraints cannot be satisfied) without a minimum level of vaccination. While vaccination decreases number of both susceptibles and infectives (with a delay), self-isolation only affects the number of infectives.

This research has been funded by the CDC NC PEERC.

Poster 22

Sequential Resource Allocation and Routing for Last-Mile Humanitarian Relief

Hugh Medal (University of Arkansas), Manuel Rossetti (University of Arkansas), Edward Pohl (University of Arkansas)

In the response to a sudden-onset disaster, the first three phases are assessment, procurement, and distribution. In the assessment phase, the quantity and location of demand is estimated. This information is then used in the procurement phase as goods are transported to a local distribution center or staging area. In the distribution phase, goods are transported from the distribution center to the disaster victims.

In this work we study the routing of goods from a distribution center to geographically dispersed points (customers) whose demand quantities are uncertain. Estimates of all demand quantities are known by the response team before they begin the route but the exact demand quantity for a customer is revealed only upon arrival at that customer. Thus, the team must decide what order to visit customers and how much inventory to allocate to each customer after observing their demand. We model this problem as an inventory routing problem with sequential inventory allocation.

While similar problems have been studied in a commercial setting, the profit-maximizing objectives used may not be suitable for the humanitarian sector. In this work we study the use of equitable objective functions for this problem. In particular, we seek to maximize the expected minimum fill rate among customers as well as minimize the maximum customer arrival time. It has been shown in previous work that in this problem the route sequence affects the fill rate objective. Thus, our two objectives interact.

We use our model to examine several difficult tradeoffs that must be made in the distribution of goods for disaster relief. We also measure the value of demand information, indicating the value of communication and assessment. Because efficiency is also an important consideration in disaster relief, we measure the increase in travel distance that results from using these equity-based objective functions.

Poster 23

The Evaluation and Design of the World Health Organization Emergency Health Kit

Evan Saltzman (Georgia Institute of Technology), Seonghye Jeon (Georgia Institute of Technology), Samina Jamil (Georgia Institute of Technology), Jessica Nance (Georgia Institute of Technology)

Context:

To facilitate a swift and efficient response to a humanitarian disaster, the World Health Organization (WHO) first developed in 1990 a standardized, pre-packed kit of critical medicines and medical supplies that could be kept in readiness and shipped promptly. A comprehensive and systematic evaluation of the contents of the WHO kit has not been undertaken and is essential to maximizing the humanitarian benefit of a relief effort.

Objectives:

An optimization model is developed to provide a scientific method for evaluating the performance of the WHO kit in emergency relief efforts and for proposing improvements to increase the humanitarian benefit of the kit.

Research Design and Methods:

Two linear programming models are developed: a kit evaluation model and a kit design model. The former model assesses the performance of the current contents of the kit, measured in disability adjusted life years (DALYs) saved and the percentage of sick individuals treated. By contrast, the second model selects the contents of the kit to maximize its performance. Practical considerations such as kit capacity and patient demand are included in the models.

Results:

The current WHO kit (as of 2006) provides the necessary medicines and medical supplies to treat a large portion of the diseases following a disaster with ample resources remaining. However, there are several diseases for which resources are inadequate, particularly diarrhoeal diseases. This result suggests that significant improvements can be made to the WHO kit. The kit design model provides a reallocation of the current contents of the kit that can achieve an increase of approximately thirty-nine percent more DALYs saved as compared to the current kit.

Conclusions:

The results of this study suggest several promising strategies for the WHO to pursue in improving the performance of the health kit.

Poster 24

Determining Inventory Levels to Support Emergency Food Distribution Using News Vendor Model

Selina Begum (Clemson University), William Ferrell (Clemson University)

It has been always a challenge for companies to establish an appropriate inventory level. The same is true for the emergency logistics planners. Emergency situations like natural disasters do not allow organizations much time to prepare. The onset of an incident is the trigger point in which resources have to be mobilized and distributed to the affected population/area. Unfortunately, the earthquake in Haiti serves as a tragic reminder of the magnitude of problems and how tightly they are integrated. For example, using limited distribution to deliver only water might not be the best solution for a region or it might only be a solution for the first 48 hours. Our research is attempting to address these issues with simple models that can be used by relief agencies to help make better decisions. This poster will illustrate a portion of the work that focuses on determining the amount of inventory using news vendor model and an Excel based analysis. A demand model is generated using an empirical distribution and then is converted into a standard distribution to find the order quantity. As time passes, the demand information is updated with new information. There are significant consequences if the organization falls short of providing any of a number of items that are essential for human existence because anarchy becomes the rule as humans become desperate. We formulate the model in such a way that organizations can compute the quantity to deliver as a function of shortage; that is, as a function of one ingredient that creates anarchy by unsatisfied people. It is important to understand that this is but one component in a more comprehensive look at the integrated problem and should not be considered as a stand-alone solution to this problem.

Poster 25

Filter Pure: Point-of-use water purification in Haiti relief efforts

Tracy Hawkins (Filter Pure), Amanda Mejia (Georgia Institute of Technology), Akhil Bhandari (Georgia Institute of Technology), William Britt (Engineers Without Borders)

Filter Pure: Point of use water purification in Haiti relief efforts

The recent humanitarian crisis in Haiti is an example of the need for long-term solutions for clean water in developing nations. Before the earthquake, Haiti, a country known for violence and poverty, little infrastructure, and a poor government was already in a grave situation. After the earthquake, Haiti is faced with a disaster of almost unimaginable proportions that is demanding innovative solutions for providing relief, particularly with providing clean drinking water.

This poster describes the efforts of Filter Pure, Inc., a non-profit, 501(c) 3 organization, in distributing their point-of-use water purification systems in Haiti. The poster also describes general information about Filter Pure, including details about the filtration system and the economics of providing these systems.

Haiti

As the humanitarian disaster unfolded in Haiti, the organization was called to provide their water purification device for distribution in the disaster area. At the time of preparing this Abstract, Filter Pure's efforts are ongoing. FilterPure with their Haiti distributor, Pure Water for Haiti, was able to increase production and distribute the systems to various organizations including the Red Cross and Save the Children. This poster will describe the challenges of increasing production and developing logistical support to deliver filters to appropriate distribution centers.

The Filter Pure System

The technology of the water filter is simple, effective, and, sustainable. The device is a round-bottom ceramic pot made from a mixture of clay and colloidal silver. The FilterPure filter removes up to 99.99% of pathogenic bacteria and oocytes while retaining healthy, naturally-occurring minerals. This poster describes the filter system and the previous testing results on the effectiveness of the filter.

Economics

Also included is a discussion on the pricing analyses for the systems and the social returns on investments made into Filter Pure.

Poster 26

Gift in Kind (GIK): Opportunities and Challenges

Md. Moinul Islam (Georgia Institute of Technology), Dr. John H. Vande Vate (Georgia Institute of Technology)

Currently, most NGOs receive significant donations in kind, known as Gifts in Kind (GIK), especially from the corporate/business donors. While these gifts can be a blessing, they can also pose serious challenges for the NGOs that accept them. Sadly, this is especially true in times of crisis when donors are most strongly motivated to give.

According to the Giving USA - 2008 annual report, corporate donations amounted to $ 15.69 billion in 2007 or approximately 5 % of the $306 billion total giving in the United States. A 2006 Business Week survey of two hundred S&P 500 companies suggests that roughly 65% of total corporate donations is in the form of in-kind donations, consisting of donations of products, services and employee time. The vast majority of these contributions are in-kind contributions of products.

In-Kind donations vary widely ranging from medicines and medical supplies to food, from construction materials to books, shoes, apparel, etc. Many NGOs are poorly equipped to manage the logistical costs and challenges associated with moving, storing and delivering GIK contributions. More subtly, the sporadic nature and sometimes questionable relevance of some GIK gifts poses serious strategic challenges for NGOs: Even when the gifts are of marginal relevance to the organization's mission, accepting them helps increase the NGOs perceived size and capacity and so helps to attract future donations. Rejecting such gifts helps keep the organization focused on its core mission, but runs the risk of alienating a large and influential donor.

Here, we present a brief account of the challenges and opportunities for NGOs and their donors to best incorporate GIK into a larger strategy for addressing various social and humanitarian needs.

Poster 27

Improving Patient Flow and Service at DeKalb Medical's Maternity Center

Jacqueline Griffin (Georgia Institute of Technology), Shuangjun Xia (Georgia Institute of Tecnology), Pinar Keskinocak (Georgia Institute of Technology)

The success of the healthcare system in the United States is highly dependent on efficiency. Therefore, all hospital units must strive to increase efficiency while maintaining high service levels and patient satisfaction. To study the tradeoffs in efficiency and patient satisfaction, a simulation model is created for an obstetric hospital. A realistic model of the patient flow in the unit is achieved with the incorporation of patient classification, blocking effects, time dependant arrival and departure patterns, and statistically supported distributions for length of stay (LOS). In a case study, the model is applied to Dekalb Medical's Women's Center, in Atlanta, GA, analyzing the hospital's readiness for changes to patient mix and patient volume. Additionally, a thorough analysis of the reallocation of beds in the unit is performed to ensure that blocking is minimized and patients are able to receive care as soon as necessary.

Poster 28

A Methodology to Increase Effectiveness in Disaster Response Planning Through Implementation of Parametric System-of-Systems Design for Robust Real-Time Decision Support

Stephanie Mma (Georgia Institute of Technology), Dr. Dimitri Mavris (Georgia Institute of Technology)

As emergency response analysts begin to implement an all-hazards approach in mitigation and preparedness response phases, a need arises for parametric design from a system-of-systems perspective in emergency response planning. While international organizations and foreign responses were studied during the literature review, the focus of the research remains on U.S. emergency response planning, at federal and state levels. At state and national levels, the system-of-systems perspective becomes much more complex than at a community level and would benefit from the proposed methodology.

In the aerospace systems design field, parametric design is emerging as a method for advanced aircraft system-of-systems design. Parametric design methodology brings system knowledge forward for complex systems which may not have any historical data available to use in planning stages. This will enable designers to consider the effect of a constrained group of system alternatives. With a parametric tradeoff environment correctly modeled to represent the behavior of an emergency response system, trade-off studies will be conducted on a range of settings within response disciplines. Coupled with a relevant and descriptive set of system performance metrics, capability gap analysis can be done. The trade-off environment will enable different system design alternatives to be evaluated, so that quantitative improvement or the effectiveness of the alternatives can be determined.

The current proof of concept developed by a student team in the Aerospace Systems Design Laboratory at Georgia Tech represents a complex reactive response system using joint probability distributions based on activity reports generated by MarOpsSim, a high fidelity complex software system used by the Coast Guard to evaluate quantitative changes made to their Deepwater Initiative Program.

Current research is ongoing, and is currently in the methodology definition phase. The proof-of-concept will be notionally applied to the emergency response system and a more thorough case study will be conducted.

Poster 29

Emergency Evacuation Transportation Planning Under Uncertainty: A Robust Optimization Approach

Aharon Ben-Tal (Faculty of Industrial Engineering and Management, Technion - Israel Institute of Technology), Byung Do Chung (Department of Industrial and Manufacturing Engineering, The Pennsylvania State University), Supreet Reddy Mandala (Department of Industrial and Manufacturing Engineering, The Pennsylvania State University), Andreas Thorsen (Department of Industrial and Manufacturing Engineering, The Pennsylvania State University), Tao Yao (Department of Industrial and Manufacturing Engineering, The Pennsylvania State University)

Emergency evacuation transportation problem presents challenges because of the inherent uncertainty and the complexity of the transportation systems. Traditional approaches dealing with uncertainty (e.g., stochastic and dynamic programming) usually require the probability distribution information for the underlying uncertain data, consider soft constraints that may be violated in extreme events, and suffer from the â€œcurse of dimensionalityâ€ problem.

The main purpose of this research is to explore the potential of robust optimization (RO) as a general computational approach to manage uncertainty, feasibility, and tractability for emergency evacuation transportation problems. RO will not assume the availability of a probability distribution. Moreover, the RO approach guarantees feasibility through the use of prescribed uncertainty sets and can be made computationally tractable through appropriate reformulations.

In this research, we develop an evacuation model by considering a system optimum dynamic traffic assignment problem (SO-DTA). The framework is a linear programming (LP) formulation based on the Cell Transmission Model (CTM). We present a tractable Affinely Adjustable Robust Counterpart (AARC) which is less conservative than static RO. Results using AARC are promising and compared to solutions of the nominal methods and Monte Carlo sampling methods. New insights include that 1) a robust solution may improve both feasibility and performance due to high infeasibility costs (an essential component for evacuation transportation management); and 2) an integration of social behavior research, robust optimization, and transportation modeling will improve the generation, communication, and potential use of uncertain data in evacuation management. Extended work on robust network design for disaster preparedness will be presented.

Poster 30

Integrating Multiple Phases of Disaster Debris Management

Kael Stilp (Georgia Institute of Technology), Antonio Carbajal (Georgia Institute of Technology), Ozlem Ergun (Georgia Institute of Technology), Pinar Keskinocak (Georgia Institute of Technology), Monica Villarreal (Georgia Institute of Technology)

Debris is the waste generated during a disaster such as a hurricane and is handled in three primary phases afterwards. Immediately following such an event debris blocks roadways which are essential for the execution of emergency relief to the affected region. During this time localized entities must determine the order in which roadways are cleared of debris. The decision of which roadways to clear must be made daily, or more frequently, over the course of about a week, so which roadways are cleared in early days can impact the effectiveness of clearing roadways on future days. These decisions greatly determine the order in which communities have access to emergency aid, so they must balance opening the roads that service the most in need with breadth in partially opening up many communities in a fair manner. The second phase is the removal of debris from from the affected region, which begins roughly one week following the event and continues until completed. Contractors are given divisions of the region with which they are to collect the debris and then deposit to a designated holding area. Key issues during this period involve properly dividing the region among contractors so that their proportional profit margins are similar while completion time is minimized. The third phase is where the sorting is done and the debris is taken to their final disposal locations. This phase can be time consuming and cause environmental problems for local communities. We use mathematical model to analyze each stage to assist with determining effective strategies and possibly lead to interactive tools during a real event. We present a proposed method for analyzing how sorting debris prior to the third phase can reduce its negative impact, and at what cost that would be to the first two phases objectives.

Poster 31

CARE Disaster Relief Demand Estimation and Emergency Procurement Project

Natasha Jain (Georgia Institute of Technology), Raahi Kapadia (Georgia Institute of Technology), Jessica Cort (Georgia Institute of Technology), Matthew Knepper (Georgia Institute of Technology), Ozlem Ergun (Georgia Institute of Technology)

CARE USA is a nonprofit organization that provides disaster relief around the world. In order to efficiently respond to disasters, CARE has developed an Emergency Preparedness Plan (EPP) for each of its Country Offices. EPPs provide estimates on how many people are affected by commonly occurring disasters in countries. Some of the problems associated with the EPPs are that they don't contain statistical analysis, historic data, and lack consistency.

Our team created a "Demand Estimation" tool to supplement EPPs, and estimate people affected and supplies needed during disasters. The back end of this tool contains 100 years worth of disaster data gathered from EM-DAT (Emergency Events Database). This data was adjusted for population growth and disaster frequency trends. It was fit to a statistical distribution, which is a hybrid of the geometric and discrete empirical distribution. The â€œhybridâ€ distribution was tested and it was concluded that this distribution best estimated number of people affected in disasters.

The second component of this project was the development of an "Emergency Procurement" tool. This tool will provide CARE with suggested relief supply order quantities after considering local, regional and global vendors in addition to items stored in warehouse facilities. These suggestions are based on a minimum cost solution that considers the cost of relief supplies, transportation, and a penalty cost for unmet demand. The system considers demand in two phases. Phase I demand represents the items needed immediately; Phase II demand represents items that are needed for the remainder of the response effort.

Poster 32

A Integrated Disease Spread Simulation with Location-Allocation Decisions

Sean Carr (North Carolina State University)

In the event of an outbreak of communicable disease, we may need to vaccinate or give antiviral medication to the still susceptible or infected populations, respectively. If there is a threat of the disease spreading, we may also want to plan the frequency of these interventions, knowing that we have limited production capacity of medication and limited budget for intervention activities. In this research, we have created a simulation of the deterministic, compartmental SEIR model using C++. However, this disease spread model is a batched population model, with subgroups for age and spatial location. In this way, we use age-specific parameters for the rate of infection, interactions between geographic regions due to employment patterns.

As the disease progresses, we choose specific points in time to open clinics. We open these clinics in locations that minimize the total cost of transportation for the public while keeping the waiting time at each clinic below a specified threshold. This is done using a location-allocation model solved with the current infectious population level.

With a limited budget and medication production capacity, our decision becomes to determine the frequency at which we should open clinics to make the best use of our resources and minimize the peak infection, assuming a fixed interval between clinic dates. The problem is put in the context of an H1N1 outbreak occurring in Wake County, North Carolina. A major contribution of this work is a simulation framework that ties together disease spread and facility location models as well as plans the opening of treatment clinics when resources are constrained.

Poster 33

Understanding the Risks of Progressive Disease - A Case Study on Mortality Risk for Breast Cancer Patients

Shengfan Zhang (North Carolina State University), Julie Ivy (North Carolina State University), Kathleen Diehl (University of Michigan, Ann Arbor), Bonnie Yankaskas (University of North Carolina, Chapel Hill)

For most studies regarding decision making and cost-effectiveness analyses for progressive diseases, it is important to understand and characterize how the disease progresses and what the final outcomes will be for various stages of disease.

We model breast cancer progression and focus on the estimation of mortality probabilities for white and African American. Breast cancer is the second leading cause of cancer death in women. Breast cancer risk changes with age; and older patients, when they have two or more comorbidities, may be at greater risk of dying. Our goal is to calculate the probability of dying from breast cancer as well as dying from a specific comorbidity as a function of patient age, race, breast density (a breast cancer risk factor) and cancer stages at detection. We use Carolina Mammography Registry (CMR) data, which is a population-based screening registry, for the survival analysis. Data including patient demographics, cancer information and vital status is collected from CMR.

A Cumulative Incidence function with confidence interval estimation is used to calculate the mortality probabilities. We propose methods for incorporating both left and right censoring in our survival analysis. Left censoring refers to situations in which the true start time of the disease at a specific stage is unknown. It is only observed at diagnosis. Right censoring occurs when mortality for a patient is not observed either at the end of study time or when the patient withdraws from the registry. The adjustment to the survival time is essential for quantifying the true mortality probabilities for breast cancer patients. This study quantifies the risks for breast cancer patients in the presence of competing risks, and the methods could be applied to other progressive systems.

Poster 34

Catch-Up Scheduling for Childhood and Adult Vaccination

Hannah Smalley (Georgia Institute of Technology), Faramroze Engineer (University of Newcastle), Pinar Keskinocak (Georgia Institute of Technology), Larry Pickering (Centers for Disease Control and Prevention)

A significant portion of adults and children do not receive their recommended vaccines at the appropriate times. To help ensure coverage against vaccine-preventable diseases for adults and children, Georgia Institute of Technology and the Centers for Disease Control and Prevention (CDC) combined efforts to develop decision support tools for creating catch-up schedules for childhood and adult immunization in the United States. The childhood scheduler has been available for download since June, 2008: http://www.cdc.gov/vaccines/recs/scheduler/catchup.htm.

Additionally, in collaboration with the Canadian Paediatric Society, the tool was modified for childhood immunization in Canada.

During childhood, an individual's vaccination status may be verified often (e.g. upon starting school at different levels). However, as adults, this verification is likely much less frequent, but adequate vaccinations are just as important as during childhood. The recommendations for adult immunizations in the United States are affected in many cases by medical condition, work atmosphere, and lifestyle. The vaccination scheduler for adults in the United States became available to the public in January, 2010 at http://www.cdc.gov/vaccines/recs/Scheduler/AdultScheduler.htm. This tool creates schedules for future vaccinations that are recommended based on vaccination history and the answers to a questionnaire.

In Canada, the recommended immunization schedules for children vary by province of residence. If a child is up-to-date on the recommended immunizations in one province but then relocates to another, they may need additional vaccinations to adhere to the recommendations of the new province. The vaccination scheduler provides vaccine recommendations for children in Canada based on vaccination history and province of residence. This tool is still in the testing phase and is anticipated to become available to the public in 2010.

The vaccination schedulers developed each involve an interface and a scheduler. Based on user input into the interface, the scheduler creates an optimized schedule through the use of a dynamic programming algorithm.

Poster 35

Two Queue or Not Two Queue: Evaluating Integration of HIV Clinics in Zambia

Ariel Garcia (Georgia Institute of Technology), Bettina Gardner (Georgia Institute of Technology), Mallory Soldner (Georgia Institute of Technology), Kezban Yagci (Georgia Institute of Technology), Julie Swann (Georgia Institute of Technology)

Many HIV clinics in Africa are considering integrating with outpatient departments (OPD) in order to share limited healthcare resources. In southern Zambia, the non-governmental organization CIDRZ is currently in the initial phase of integration in a network of over 60 clinics run by the Ministry of Health. Recent data from one such integration showed that the waiting times significantly increased for both HIV and OPD patients, despite the fact that the theory suggested that the wait times for the slower patient types should improve. Patient wait time is an important metric for clinics serving HIV/AIDS patients because it affects the quality of care. Long wait times discourage patients from returning for regular check-ups and adhering to anti-retroviral treatment (ART), which can lower the efficacy of ART and can lead to the mutation of the HIV virus into drug-resistant strains. Our research directly relates to the health policy debate over the pros and cons of vertical versus horizontal healthcare delivery programs, as related to patient retention, adherence to treatment, and quality of care measures.

Our objective is twofold: (i) to empirically test the impact of integration on waiting times at the clinic for which we have data, and (ii) to classify other clinics based on key dimensions depending on whether integration can reduce or increase waiting times. We follow a simulation-based approach for both objectives. We simulate clinic operations pre- and post-integration and study strategies to reduce waiting times after integration. In addition, we examine factors in the system that can lead to integration resulting in longer queues for both types of patients in order to recommend which clinics should be integrated. We found that contrary to conventional queuing theory, the wait times increased significantly for both types of patients, and investigated reasons and remedies for the increased wait times.

Poster 36

Assessing the Suitability of Water Treatment Systems for Emergency Aid Deployment

Kevin Caravati (Georgia Tech Research Institute), Joseph Goodman (Georgia Tech Research Institute), Molly Nelson (Georgia Tech Research Institute)

The GE Foundation is currently sponsoring the Georgia Tech Research Institute (GTRI) and the Emory Center for Global Safe Water to research the application of water treatment systems in emergency aid applications and to conduct a side by side system performance trial. One of the systems to be tested is GE's own Homespring system. The purpose of this research is to assist the product screening and selection process of the GE Foundation and other aid organizations operating in emergency situations. Currently GTRI is ordering and receiving a range of these systems for the system testing with the intent of evaluating critical deployment characteristics such as installation, commissioning, operation, maintenance and operations.

The initial literature review revealed limited previous research and established methodology for evaluating water filtration systems for emergency aid. Therefore, GTRI is first developing a robust methodology for evaluation that can be uniformly applied to all of the systems tested. A preliminary score sheet has been drawn up, providing space to rate the installation, commission, operation, maintenance, winterization, and end-of-life of the system based on subcategories that each receive numerical scores. One system has been tested according to this evaluation method thus far; this experience helped the research team refine the evaluation method to make it more effective in testing more systems in coming weeks and months. Once the evaluation method is finalized and being applied to the systems being tested, GTRI hopes to generate a uniform, meaningful set of data that will help those working in disaster-relief situations determine the system best suited to their situation. Additionally, the test results and experience will be shared with the original equipment manufacturers to provide assistance with future product development.

Poster 37

Stochastic Alert Threshold Model Development for North Carolina Health Alert Network

Emine Yaylali (North Carolina State University), Julie Ivy (North Carolina State University)

North Carolina Health Alert Network (NC HAN) is an 24/7 alert system which provides critical health information to key health officials and care providers in North Carolina in response to public health threats, namely communicable disease, bioterrorism or other types of threats. We model North Carolina public "health" with respect to the level of potential threat as a tiered finite, discrete-time partially observable Markov decision process (POMDP). We incorporate decision makers to the model at two dependent levels: State (North Carolina) and local (county level). These levels represent the public health system in North Carolina where there is one State Health Department and 85 autonomous local health departments. We represent the various characteristics of different types of threats by model parameters such as the disease occurrence and spread probabilities. We develop a core model and formulation which can be customized for different types of threats.

As a base case, we model a communicable disease event and solve the two-state model for a short planning horizon using the value iteration technique. The optimal actions in local and North Carolina level are determined as well as expected operating cost for each decision epoch.

We seek an optimal alert threshold policy in order to minimize total expected system operating cost over a finite time. Under uncertain nature of threat, an alert threshold policy will provide the decision maker threshold values at both levels, North Carolina and local, for issuing alerts. The decision maker attempts to prevent the system from issuing a false alert or failing to issue a true threat in time. Providing such balance in the system will increase the credibility and efficiency of the system while improving immediate response and care in the event of a public health emergency.

Poster 38

Emergency Shelter Location and Allocation during Extreme Weather Events

Sara Ghorbani (Rutgers), Melike Baykal-Gursoy (Rutgers), Pooyan Kazemian (Rutgers), Endre Boros (Rutgers), Nina Fefferman (Rutgers)

Extreme weather events have challenged our emergency response capabilities in recent years. Unfortunately, studies indicate that the number of such events is increasing over time. The humanitarian and economical consequences of these events can be catastrophic, especially if compounded by a lack of preparedness. In such cases, an effective emergency plan moves people to shelters with controlled environments and contains provisions for healthcare needs. In this research, we will design an evacuation plan for the case of a heat wave event in the Newark, New Jersey area.

We present a stochastic optimization model which assigns vulnerable populations to health care centers based on their health issues. We categorize people into three groups depending on their having; cardiovascular, respiratory, or dehydration problems. The demand for health care is random so is the mortality due to the lack of treatment.

Our objective function is to minimize the increase in the mortality rate in case of an extreme heat event. We utilize the GIS-based data and the available demographic information of the Newark area into the model.

The set of health centers that can provide the appropriate health care treatment is determined. The optimization is performed by simultaneously locating the optimal health centers and assigning people to the appropriate center with regard to the distance and available capacity in the system.

Poster 39

A Simulation Model of Public Health Response to Pertussis Events

Travis Worth (North Carolina State University), Reha Uzsoy (North Carolina State University), Javad Taheri (North Carolina State University), Jean-Marie Malliard (North Carolina Department of Health and Human Services - Divison of Public Health), Erika Samoff (NC Center for Public Health Preparedness NC Institute for Public Health)

We present a discrete-event simulation model of the response of the North Carolina public health system to pertussis events, with particular emphasis on the role of the North Carolina PHIN (Public Health Information Network) alerting systems. We take a comprehensive view of public health actions related to a pertussis event, beginning with detection of an individual patient, confirmation of the case by physician and results, contact tracing and medication of contacts by local health departments. We explicitly model the information transfer between actors through all those involved with identifying and stopping an outbreak, and examine the effect of different alerting strategies on the number of confirmed cases and secondary infections. The effect of time delays associated with resources such as laboratories and contact tracing personnel are examined, as well as the effect of tailoring the outbreak to a particular situation (e.g. a public school setting). Upon fine tuning the model, it would hopefully be expanded to monitoring what effects would occur with patients moving between different regions of the surrounding area.

This research is being supported by the CDC NC PERCC.

Poster 40

A Heuristic Approach to Scheduling Food Bank Collection and Delivery Tasks

Luther Brock (North Carolina A&T State University), Lauren Davis (North Carolina A&T State University), Julie Ivy (North Carolina State University), LaStella Miles (North Carolina State University)

The goal of this project is to determine a transportation schedule that enables both the collection of Wal-Mart donations and the dispatch of food items to food delivery locations for pickup by charitable agencies. The charitable agencies are located within rural counties of the Northwest North Carolina Food Bank service area. We first identify feasible pick-up points (Food Delivery Points) to serve as satellite locations for the rural agencies that are co-located with collection points. We then assign an agency to each FDP based on a maximum travel distance constraint imposed by unrefrigerated food spoilage concerns. Lastly, we identify a weekly transportation schedule covering 28 donation pickup locations with simultaneous distribution to the FDPs considering constraints on operator workday, collection frequency, and fleet capacity. We formulate the co-location and agency assignment problem as a set covering problem. A multi-period vehicle routing problem is developed to determine the optimal weekly transportation schedule that minimizes the total travel time subject to the constraints on collection and delivery frequency. We ensure that delivered products are not co-mingled with collected products by enforcing a “first delivery” option on any truck scheduled to visit an FDP site. Our model identifies the minimum number of trucks required per day to satisfy the aforementioned transportation requests. From this model, the NWNC Foodbank can determine if additional leased vehicles are required to implement rural delivery.

Poster 41

Design and Implementation of a Basic Laboratory Information System

Ruban Monu (Georgia Institute of Technology), Dr. Santosh Vempala (Georgia Institute of Technology), Mark DeZalia (Centers for Disease Control and Prevention), Dr. John Nkengasong (Centers for Disease Control and Prevention)

The Basic Laboratory Information System (BLIS) is a joint initiative of the Georgia Institute of Technology, the CDC and participating countries. A majority of clinical laboratories in Africa that are being funded and overseen by the CDC have been using paper logs and manual entries for keeping track of test samples and results. These methods make it difficult to efficiently manage critical disease and infection related data and perform further analysis on them. Moreover, a significant proportion of errors have been observed to be clerical errors. The overall objective of the BLIS project is to provide a robust, customizable, and easy-to-use system that keeps track of test samples, results, lab workflow and reports. It is meant to be an effective and sustainable alternative to manual logs and paper-based approaches. The system is designed to work in low-resource laboratories with limited IT equipment and across sites with good, intermittent or no internet availability. A preliminary prototype was designed, developed and evaluated in collaboration with laboratories from Botswana, Cameroon, Ghana, Nigeria, Tanzania, and Uganda. The next step is a pilot phase with implementation and deployment being carried out in 10 laboratories located in Cameroon, Ghana, Tanzania, and Uganda. With varied practices and workflows being followed across the different laboratories in these countries, BLIS has been developed to enable each laboratory or country to customize and configure the system in a way that suits them best.

Poster 42

V2V: A System for Blood Unit Tracking, Prediction, and Allocation

Stephen Tyler (Georgia Institute of Technology), Santosh Vempala (Georgia Institute of Technology), John Pitman (Center for Disease Control and Prevention), Rob Wilkinson (Blood Transfusion Service of Namibia), Bright Mulenga (Zambia National Blood Transfusion Service of Namibia), Bright Mulenga (Zambia National Blood Transfusion Service)

Vein-Â-2-Â-Vein (V2V) is a joint initiative among the Georgia Institute of Technology, the Center for Disease Control and Prevention, and the blood transfusion services of Namibia and Zambia. This system arose from the need to better monitor and track blood units as they are donated and distributed. Due to the shortage of available blood units, it is important to ensure they are allocated efficiently. Based on past usage data, V2V is able to estimate how many blood units will be used within a given time period by each health care facility. These predictions allow officials to better allocate how available blood units should be distributed. V2V allows for visualization of collection and prediction data using graphs and tables. Past blood unit data can be imported into V2V and exported from V2V through Excel spreadsheet files. V2V is implemented as a rich internet application (RIA) using Ext JS, a popular web application framework. A major hurdle during development was to accommodate for the lack of a reliable internet connection at deployment locations in Namibia and Zambia. This issue was resolved using Google Gears, which allows blood unit data to be viewed and updated while working offline. This was accomplished by having a copy of the master database stored locally on the client's computer. Methods of synchronizing blood unit data between the master database and the clients' copies were explored and implemented. Future work will include improving prediction, spreading adoption, and adding other desired functionality requested by our partners.

Poster 43

LifeNet: A System for Disaster Communications

Hrushikesh Mehendale (Georgia Institute of Technology), Ashwin Paranjpe (Georgia Institute of Technology), Santosh Vempala (Georgia Institute of Technology)

In disaster relief operations, timeliness of aid is as important as the aid itself. As was evident from the experience of Haiti, inadequate infrastructure and a near complete failure in telephone and Internet communications, greatly complicated relief efforts. Even in today's world of high-speed broadband connectivity, there is no technology solution that provides reliable connectivity in disaster-affected areas. Existing approaches have had only limited success due to their dependence on infrastructure, lack of flexibility and usability, and high cost.

Our system, LifeNet, has the potential to provide large-scale and instant low-cost deployments of WiFi based ad hoc networks in disaster-affected areas. Relief volunteers, paramedics, etc. can connect to the network through their laptops, mobile phones or routers

after installing LifeNet's open-source software. LifeNet does not require infrastructure such as towers or base stations and hence is an ideal solution for disaster communications. It is designed to be extremely usable (download and click). Users can be mobile and can also share Internet access, when available, with other users.

LifeNet provides a global view of the entire network. This feature helps support a variety of sustainable and customized applications including tracking, resource-need matching and efficiently routing critical needs such as medical supplies. We have partnered with the TeNeT group of IIT Madras and the Federal Aviation Authority for evaluation. Preliminary tests conducted with FAA found the coverage, performance and usability of LifeNet to be quite satisfactory.

Poster 44

Bridging the Relevancy Gap: An innovation-design methodology for value engineering in redesigning vaccine cold chain transport containers

Michael F. C. Moreland (SEEDR L3C), Victoria M. Gammino (US Centers for Disease Control & Prevention), Sue Gerber (US Centers for Disease Control & Prevention), Scott Wellman (SEEDR L3C)

The authors developed a design methodology for global-development value innovation through the redesign of the long-range cold box and short-range vaccine carrier, as defined by the WHO Performance Quality Safety (PQS) guidelines. The authors' critical-point analysis of the vaccine cold chain revealed these containers have the lowest function-to-cost proposition and greatest dependence on end-users.Â

The objective was to maximize the containers' function-to-cost value by empowering the design process to overcome common challenges in global deployment, such as linguistic and cultural diversity, variations in user education and training levels, limited program resources, and a range of terrain and climate conditions.

The methodology integrated a sequence of design and engineering best practices modified to bridge the "œrelevancy gap"□ among engineers, designers, and users. It focused on introducing new technologies and user-experience strategies to conform with global supply chain product requirements. It included a baseline audit, design-element teardown, a series of multidisciplinary, cross-sectoral expert forums, literature review, container performance data collection, a survey of sixty-one end users from twenty-two countries identified through snowball sampling, field interviews, and a simulation of the economic and public-health impact of design variations.

The process revealed previously uncontextualized behavioral patterns and failure points, connected the designers to a global sample of users, and facilitated user input and simulation and survey data to drive decision making.

The authors integrated the resulting body of work with the WHO PQS guidelines to form a framework for parameterizing the engineering and optimizing the function variables. The results revealed opportunities for poka-yoke behavior-shaping elements, and potential methods for orthogonal system integration.

The authors are using the framework to create a prototype field-test protocol and explore opportunities to redesign other PQS products.

Poster 45

Modeling Influenza Pandemic, Intervention Strategies, and Preparedness

Ali Ekici (Georgia Institute of Technology), Pinar Keskinocak (Georgia Institute of Technology), Julie Swann (Georgia Institute of Technology), Pengyi Shi (Georgia Institute of Technology), Carlo Davila (Georgia Institute of Technology)

The 2009 H1N1 influenza pandemic raised in the Spring 2009 and attacked the whole world with two waves. Evidence suggests that an efficient and rapid response will be crucial for mitigating morbidity, mortality, and costs to society. To aid with planning, we model the spread of pandemic influenza, both geographically and over time, using an agent-based simulation approach. We use the spread model to evaluate intervention strategies and the impact of seasonal effects and/or viral mutations on the course of a pandemic influenza. We showed that two waves of attack in an outbreak is possible under the effect of seasonality and/or viral mutations. We integrate the spread model with optimization of the supply chain response (e.g., locating facilities for a food distribution network, supply chain disruptions). In addition, we study the effect of timing and length of the quarantine or school closings on the disease spread.

Poster 46

Incorporating Behavior to Improve Performance in Humanitarian and Health Care Systems with Self-routing Users

Özlem Ergun, Jessica L. Heier Stamm*, and Julie Swann (Georgia Institute of Technology)

We study network problems motivated by humanitarian and public health scenarios. In these problems, decentralized users choose to visit one facility among those opened by a centralized planner to obtain supplies or services. Individuals seek to optimize their own objectives, which include travel time, congestion, and the perception of congestion. The perception of facility congestion can differ based on the quality of the facility or stigma associated with receiving treatment or services.

Classical optimization approaches assume the existence of a centralized planner with control over the entire system, but many examples of decentralized systems exist in practice. This is particularly true in humanitarian scenarios in which there is damaged infrastructure, multiple agencies and individuals acting with different and conflicting objectives, limited opportunity to plan, and limited resources. In such systems, individuals make decisions to optimize local objectives but these choices impact the entire system. Decentralized systems can thus perform poorly in comparison to their centralized counterparts. However, centralization is often impractical or costly to implement.

We quantify the impact of decentralization on system performance in networks where individuals choose among facilities to receive services. We integrate optimization and game theory to develop models that account for individual behavior, present algorithms for solving the models, and use the model output to develop strategies to mitigate the effects of decentralization. Applications of this framework include the distribution of goods or relief items in an emergency, the allocation and use of medicine and supplies during an influenza pandemic, and the dispensation of antiretroviral treatments for HIV in health clinics in Africa.