NCIT
The National Center for Intermodal Transportation

DEVELOPMENT OF AN INTERMODAL TRAINING PROGRAM FOR DISASTER RELIEF AGENCIES

FINAL REPORT

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1.0 Abstract

Natural disasters impact society on a broad level, often leading to both financial damage and the loss of human life. This project seeks to improve the design and operation of disaster relief chains by providing agencies with an intermodal transportation decision making and training tool, focusing on the use of air, rail, and trucks in providing aid (cargo and personnel) following a disaster. Building upon knowledge gained from a previous NCIT project regarding factors that impact choice of transportation modes in disaster relief, the product of the current project is an intermodal transportation training program for disaster relief agencies. The program, viewed as a Microsoft PowerPoint slideshow, allows users to investigate the benefits of intermodal transportation, allowing trainees to make informed transportation decision in disaster relief agencies.

2.0 Introduction

Several studies have made recommendations to improve the structure of humanitarian supply chains [1-4]. Studies have shown the existence of intermodal transportation in disaster relief though it may add complexity and delays to the supply chain [5]. Since relief cargos are distributed from resource staging centers to points of distribution and then to different destinations in different speeds, different modes of transportations are easily applied [6]. In the 2005 evacuation of New Orleans during Hurricane Katrina, there was a concerted effort to evacuate residents by means of multiple modes, including Amtrak trains, buses, aircraft, and ships [7], yet the transportation was still not sufficient to move all people out of the area.

The project team has completed a project that identifies the use of various transportation modes and technologies by disaster relief agencies. Results indicate that agencies primarily use single-mode transportation (truck) when delivering relief supplies [8]. The use of a single mode appears to be due to a lack of planning prior to disasters, as well as a lack of knowledge of other available modes. The selection of modes is based on numerous factors (e.g. cost, speed, capability) of the various modes. Multiple factors are considered jointly in making one decision. The impact of individual factors on the most effective mode has been clearly shown in the literature. For example, Rodrigue [9] developed guidelines for the most cost effective mode as a function of distance. In disaster relief situations, the availability of various modes and their routes becomes an additional consideration. For example, floods and earthquakes may make roadways unusable.

Based on the multiple factors and the uncertainty attributed to disaster relief, the process of choosing an effective and efficient transportation mode for supply and personnel delivery is complex. In the team's current study, it is clear that most disaster relief is transported using a single transportation mode. For disaster relief that is delivered internationally, however, multiple transportation modes are used. The use of multiple modes is done while also considering transfer cost and time [6]. If disaster relief on a regional or national scale were equipped with the knowledge of how to plan effective disaster relief chains, the negative impact of transfers, as well as other factors such as cost and distance, could be minimized.

3.0 Project Objectives

The main objective of this study was to develop a training program for disaster relief agencies. This was accomplished by collating information regarding intermodal transportation, the use of such transportation in disaster relief, and disaster relief chains. The project team collected information regarding mode usage, benefits of each mode, and cost and time estimates for various transportation options. The information was then used to present possible intermodal relief chains in a training program aimed at decision makers who design transportation systems for delivering relief supplies and personnel. Specific objectives for this project included (1) define how relief agencies train employees to make transportation decisions and (2) develop a training program to assist in personnel training.

4.0 Disaster Relief Training

4.1 Current Training Practices

Interviews were conducted with three disaster relief organizations to understand to what degree (if any) their employees are trained in selecting transportation modes. Based on the interviews, it is apparent that each of these organizations offers their employees some form of formal training but nothing with a focus on the selection of transportation modes. Most of the decisions about the transportation of supplies and volunteers are made by program directors or through previously established practices. Some of the key factors taken into consideration for their transportation mode selection include: road conditions, travel distances, and the supplies needing to be shipped.

Many disaster relief organizations utilize prepositioning and contractual agreements with shipping companies for effective allocation of supplies. One agency, for example, has agreements with US Foods and Cisco Foods to ship large quantities of food supplies from distribution centers located outside of disaster zones. This helps lower costs of transporting large trailer loads of supplies. In most cases these organizations exclusively use trucks (of varying sizes) and vans to transport personnel and supplies domestically. Another agency reported the use of boxed trucks, vans, and tractor trailers to ship much needed supplies to disaster victims across the nation.

4.2 Training Program

Screenshots from the training program are shown in Appendix A. The program itself is available as a Microsoft PowerPoint slideshow, as shown in Figure 1.

Figure 1. Training Program Title Slide

4.2.1 Content

The training program is divided into five major topics: Introduction, Emergency Supply Transportation, Transportation Modes, Single Mode Transportation Scenarios, and Intermodal Transportation Scenarios.

The program contains a written description of each topic, providing the user with details regarding the topic and its use in providing disaster relief supplies. Much of the information provided in the program is based on the project team's previous findings regarding transportation planning in disaster relief agencies [10].

Ten interactive scenarios were created based specifically for the program. Each scenario described a type of disaster (flood, hurricane, or wildfire), a disaster location, supply origin, and amount of supplies to be delivered. For example, scenario 1 reads "A flood in Iowa City, Iowa, damaged hundreds of homes and businesses. A small shipment of supplies will be needed from Denver, Colorado." Estimates for time and cost were calculated for each of the five most common single transportation modes: small truck, medium truck, large truck, rail, and air. For intermodal scenarios, estimates were provided for five common intermodal transportation combinations: large truck to small truck, large truck to medium truck, rail to medium truck, rail to large truck, and air to large truck. The time and cost estimates for each scenario were calculated using current mileage and usage rates.

4.2.2 Design

The design of the disaster relief training program incorporated an iterative process of developing an effective user interface for presenting, establishing, and reinforcing concepts of transportation modes used for disaster relief purposes. Initially several different methods for creating the training program were considered including: using pre-fabricated training templates, creating a training website, and constructing a macro-enabled PowerPoint slideshow. After sufficient investigation into each of these methods, it was decided that the training program would best be generated and distributed as a PowerPoint slideshow utilizing macros and user controls.

The format of the training program was established to give users intuitive navigation tools, informative concept highlights, and easy-to-use learning scenarios. Command buttons were placed at the bottom of each screen for the user to easily navigate through the program. Users may press the "Next" button to proceed through the program or press the "Previous" button to view information on prior screens. At any point during the training a user may exit the program by pressing the "Exit Training" button or by simply pressing the ESC key. In addition to the command buttons, a training index containing links to the different areas of the training program was placed on the right-hand side of each informational screen. These links can be used to navigate back and forth through the training program as users see fit.

The actual training information used in the program was broken into logical segments giving attention to important concepts though the use of bold and italicized font formats. Charts, listings, and clever images are also incorporated into the program to help illustrate key concepts. Once users navigate through the informational screens, they are presented with a series of disaster scenarios (floods, hurricanes, etc). A summary of each scenario is presented in the right-hand side of each scenario screen. Users are then given several transportation mode options. Each transportation option has a corresponding command button, which when pressed will display the cost and time of each option. After exploring the transportation options, the user presses the "Next" button emphasizing the suggested option(s) and presenting feedback as justification. The scenarios help reinforce concepts in selecting appropriate transportation options for single mode and intermodal cases.

4.3 Usability Evaluation

The usability evaluation consisted of two phases: expert heuristics evaluation and user testing. Results from each evaluation phase were used to modify the training program for improved usability. The final version of the program, which is shown in Appendix A and discussed in Section 5.2, incorporates the changes made as a result of the evaluation.

4.3.1 Expert Heuristics Evaluation Method

Nielsen's ten usability heuristics [10] were used to guide expert evaluation. The heuristics are shown in Table 1. Two research assistants in the human systems engineering lab served as experts to evaluate the interface. Results were generated in the form of a report that detailed usability issues qualitatively.

4.3.2 User Testing Method

Five university students were recruited as participants to test the usability of the program. An overview of the training program's purpose and content was given to the participants. Each participant was asked to imagine that they are a typical user for the program (e.g. that they work in a disaster relief agency). After completing the training program, users identified any usability problems within the interface. Time to complete the training and total functional errors were recorded for each participant. In addition,

participants completed a usability survey. The survey, shown in Appendix B, was used to collect participants' perceptions on the following aspects of the program:

- Simplicity: is the structure of the training simple for the user?
- Comfort: does the user feel comfortable using the training program?
- Control: does the user have a good control over the training?
- Readability: is the information in the training program easy to read?
- Consistency: consistency use of terms, icons
- Information adequacy: is there enough information to guide the training?
- Satisfaction: overall satisfaction with the interface.

Participants demonstrated an overall satisfaction towards the training program, with an average score of 4.2 (with 5 being the highest possible score). Among the 6 usability specifications, participants were most satisfied with the consistency of the training program (average score of 4.8), and least satisfied with the readability (average score of 3.8). Participants' additional comments covered the merits, drawbacks, and suggestion for improvement.

Table 1. Usability Heuristics for Expert Evaluation

Heuristic	**Evaluation Questions**
Visibility of system status	Is there a sign of the current status of training on each training page?
	Is there explicit feedback to users after certain actions?
Match between system and real world	When appropriate, some real world icons or metaphors could be used in the interfaces design
User control and freedom	Can users navigate through the training program easily?
Consistency and standards	Is the interface internally consistent?
	Is the interface externally consistent?
Error prevention	Are buttons designed to highlight primary selections?
Recognition rather than recall	Are quiz features based on multiple choice questions rather than fill in the blank?
Flexibility and efficiency of use	Are hotkeys and shortcuts available to the user?
Aesthetic and minimalist design	Is the interface clean and without redundant information?
	Is the color scheme appealing and fonts easy to read?
Help users recognize, diagnose, and recover from errors	Are error messages effectively used?
Help and documentation	Is there a method for users to obtain help?

5.0 Conclusions and Future Work

The training program developed during this project will provide disaster relief agencies with a low cost and accessible method to train employees on the selection of transportation for supply delivery. Relief agencies will be able to use the program to train personnel on developing effective relief chains, choosing transportation modes, and using intermodalism in the relief delivery process. The program will also be applicable to decision making within the agencies. When they are facing a transportation related decision, they will be able to use the program to aid in the decision making process and evaluate the potential outcome of their decision. This project will also contribute to the body of knowledge by presenting a coordinated view of disaster relief chain design and mode selection.

Future work includes testing the effectiveness of the program in terms of user learning and its practical impact on actual decisions made within relief agencies. Additional program modules can also be created to investigate other intermodal transportation opportunities. Finally, additional interactive scenarios that include other features such as staging locations can be added to expand the program.

6.0 References

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9. Rodrigue, J. (2006). *Intermodal Transportation.* Retrieved March 11, 2009, from Department of Global Studies & Geography, Hofstra University: http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c5en.html
10. Nielsen, J., 1994. Heuristic evaluation. In Nielsen, J., and Mack, R.L. (Eds.), *Usability Inspection Methods*, John Wiley & Sons, New York, NY.

APPENDIX A

Training Program Images

Intermodal Transportation in Disaster Relief: A Training Program

START

Exit Training

Program Contents

- Introduction
- Emergency Supply Transportation
- Transportation Modes:
  Trucks, Rail, Air
- Single Mode Transportation
- Intermodal Transportation

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Training Index

Introduction

The global increase in the number of natural or man-made disasters highlights the need for a better planning on part of disaster relief agencies.

Examples of these disasters are hurricanes, transportation accidents, tornadoes, floods, cyclones, earthquakes, droughts, snow storms, tsunamis, food shortages, war, wildfires, volcanic eruptions, and many others.

These emergencies cause organizations to face issues in transporting varying amounts of different supplies including food, clothing, medicine, medical supplies, and machinery from different points of origin to different destinations in the disaster areas. The transportation of supplies and relief personnel must be done **quickly and efficiently** to maximize the benefit to victims while minimizing the cost of relief agencies.

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Training Index

Introduction

In the event of one of these types of disasters, federal and local agencies are responsible for transporting emergency relief supplies such as water, food rations, blankets, clothing, generators and medicine and any other needed items to victims of the disaster.

The major concern is how emergency relief supplies can be transported to disaster victims in a timely manner in order to protect the health and sustain the lives of the victims.

Emergency relief supplies may need to reach millions of people or as little as a few hundred people in different locations in as little as three days time. **Therefore careful planning of the transportation of relief supplies is necessary to save lives.**

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Training Index

Introduction

During disaster relief, several organizations come together, each with their own objective, expertise, experience, training, and resources to help with a single disaster.

One way to help decrease chaos and confusion of relief workers and victims is for the agencies to be prepared for a wide variety of disaster scenarios, through the help of training programs. These agencies should assess existing disaster response plans and policies, and identify better transportation approaches to deliver supplies.

The supply chain of relief supplies is difficult to model due to the fact that many of these disasters are unpredictable and can occur on short notice. These disaster events involve destroyed or congested roadways, limited transportation resources, inaccessible air strips and other unknowns.

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Emergency Supply Transportation Planning

Transportation plays a key role in emergency planning and supply delivery. The movement of supplies is a vital component of any emergency response effort, shown in FEMA's All-Hazards Guide. Multiple modes of transportation are available to move supplies to and from areas where supplies are needed.

Therefore a major concern to relief agencies is which mode or combination of transportation modes is most efficient to move supplies into a disaster location.

By exploring a wide range of disaster transportation scenarios will help agencies quickly and effectively better identify better approaches for emergency transportation modes to respond during disaster events.

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Emergency Supply Transportation Planning

The type and quantity of humanitarian relief supplies required is typically determined by two factors:

(1) the type of disaster; and

(2) the type and quantity of supplies available.

Transportation of supplies involves making predetermined agreements and contracts of readily available and alternative means of transportation for prompt and safe delivery of supplies.

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Emergency Supply Transportation Planning

There are several strategies suggested for quick and efficient distribution during times of disaster.

Delivery of supplies depends on:

- *Location*
- *Time sensitivity*
- *Availability of local supply levels*

As part of disaster preparedness, sources of supplies should be identified, such as in national inventories in the case of a disaster, although excessive stockpiling of all supplies is not recommended due to incurring cost and shelf life of certain supplies.

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Emergency Supply Transportation Planning

Relief agencies should use established pre-disaster arrangements, relationships and contracts with transportation shippers/carriers (e.g. FedEx, Penske. etc.) to deliver supplies into a disaster area. Many companies and businesses offer free or reduced rates services to relief Agencies.

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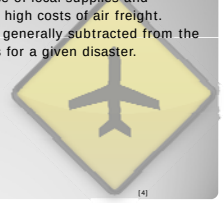
Emergency Supply Transportation Planning

The pre-positioning of relief supply inventory is one way to establish quick transportation of supplies. One suggestion is that agencies set up RSS (Receiving, Storing and Staging) warehouses in key locations or PODs for medical supplies in case of an emergency. The use of local supplies and inventories can help offset the high costs of air freight. Expenditures of air freight are generally subtracted from the total amount a donor allocates for a given disaster.



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Transportation Modes

Choosing a Transportation Mode

Here are the options we will explore:

- Trucks
  - Small, Medium, and Large
- Railroad
- Airplanes

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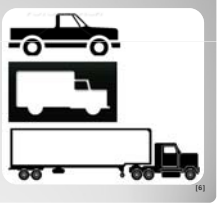
Transportation Modes

TRUCKS

Truck is the most commonly used mode of transportation. For this training program, truck is defined into three categories: small, medium, and large. Small trucks refer to pickup trucks and have the capacity of four pallets. Medium truck referring to22' -26' trucks commonly used to move 3-4 rooms of furniture; these trucks have a capacity of 20 pallets. Large trucks, 53' trailer trucks, have a capacity of 52 pallets.



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Transportation Modes

Truck Size	Advantages	Disadvantages
Small	Only includes fuel costs	Very limited capacity, Probable need for multiple vehicles
Medium	Only includes fuel costs	Limited capacity, Probable need for multiple vehicles
Large	Can carry a large capacity	Includes costs of driver fee, fuel surcharge, and insurance
All	Cost effective for moderate distances	If roads are damaged shipments may become unavailable

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Transportation Modes

RAILROAD

Rail transport is used for moving large quantities of items when time constraints are not demanding. Rail shipments are made using rail yard owned containers that store a maximum of 5400 cu ft per container. Rail containers are used in relief when immediate supply relief has been met, but continuous relief is still needed. Rail shipments offer cost effective results when shipping large quantities as the range of cu ft covered by the set cost does not vary; thus, the cost of a shipment via rail is not affected whether a full load or less.

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Transportation Modes

Railroad	
Advantages	Disadvantages
Cost effective for large shipments	Slow delivery speeds up to 7 days for cross country shipments
Effective for intermodal transportation	Limited access/drop-off points

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Transportation Modes

AIRPLANE

Air transportation is a very time efficient mode of transportation. For this training program, air shipments are assumed to be made by a major package carrier (e.g. UPS). These air shipments may be delivered as early as next day. One shipment carries the maximum capacity of 52 pallets of supplies; Lower capacity shipments provide for lower shipping costs

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Transportation Modes

Air	
Advantages	Disadvantages
Covers long distances in a short amount of time	Very high shipment costs
Useful in intermodal transportation	Access points are limited

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Single Mode Scenarios

Instructions

The following scenarios will help you investigate the advantages and disadvantages of each transportation mode. Each scenario provides information on the size of shipment for relief supplies, as well as the location of the disaster and the origin of the supplies. The following information should be considered when exploring scenario.

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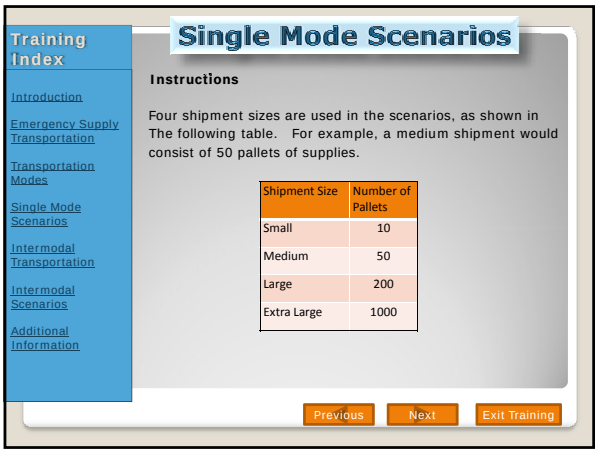
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Single Mode Scenarios
Instructions
Four shipment sizes are used in the scenarios, as shown in The following table. For example, a medium shipment would consist of 50 pallets of supplies.
Shipment Size | Number of Pallets
Small | 10
Medium | 50
Large | 200
Extra Large | 1000
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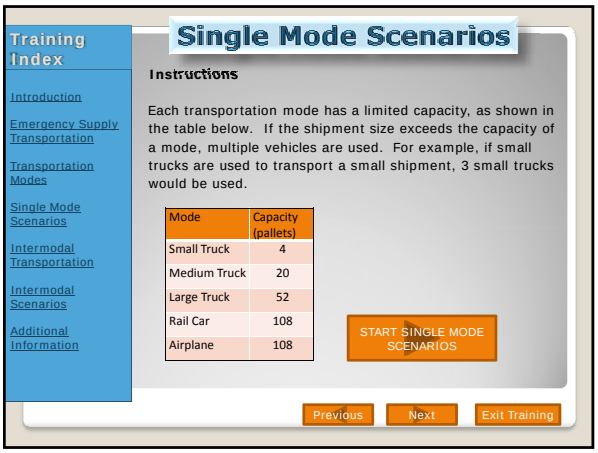
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Single Mode Scenarios
Instructions
Each transportation mode has a limited capacity, as shown in the table below. If the shipment size exceeds the capacity of a mode, multiple vehicles are used. For example, if small trucks are used to transport a small shipment, 3 small trucks would be used.
Mode | Capacity (pallets)
Small Truck | 4
Medium Truck | 20
Large Truck | 52
Rail Car | 108
Airplane | 108
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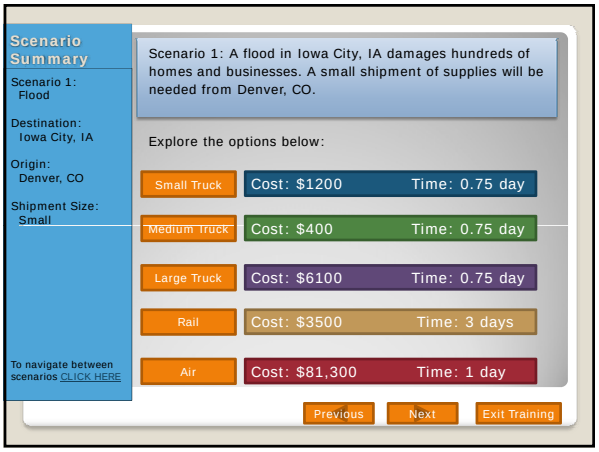
Scenario Summary
Scenario 1: Flood
Destination: Iowa City, IA
Origin: Denver, CO
Shipment Size: Small
To navigate between scenarios CLICK HERE
Scenario 1: A flood in Iowa City, IA damages hundreds of homes and businesses. A small shipment of supplies will be needed from Denver, CO.
Explore the options below:
Small Truck Cost: $1200 Time: 0.75 day
Medium Truck Cost: $400 Time: 0.75 day
Large Truck Cost: $6100 Time: 0.75 day
Rail Cost: $3500 Time: 3 days
Air Cost: $81,300 Time: 1 day
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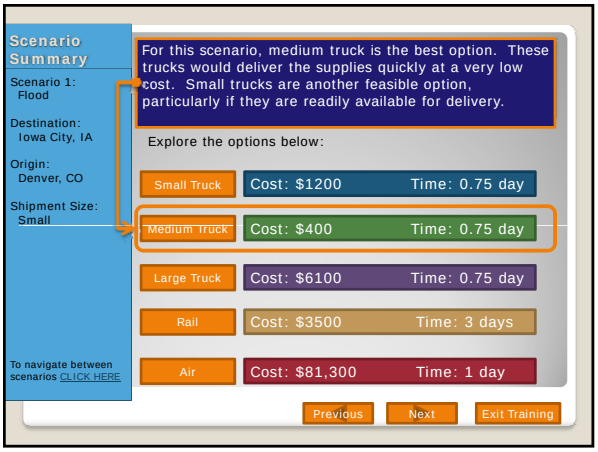
Scenario Summary
Scenario 1: Flood
Destination: Iowa City, IA
Origin: Denver, CO
Shipment Size: Small
To navigate between scenarios CLICK HERE
For this scenario, medium truck is the best option. These trucks would deliver the supplies quickly at a very low cost. Small trucks are another feasible option, particularly if they are readily available for delivery.
Explore the options below:
Small Truck Cost: $1200 Time: 0.75 day
Medium Truck Cost: $400 Time: 0.75 day
Large Truck Cost: $6100 Time: 0.75 day
Rail Cost: $3500 Time: 3 days
Air Cost: $81,300 Time: 1 day
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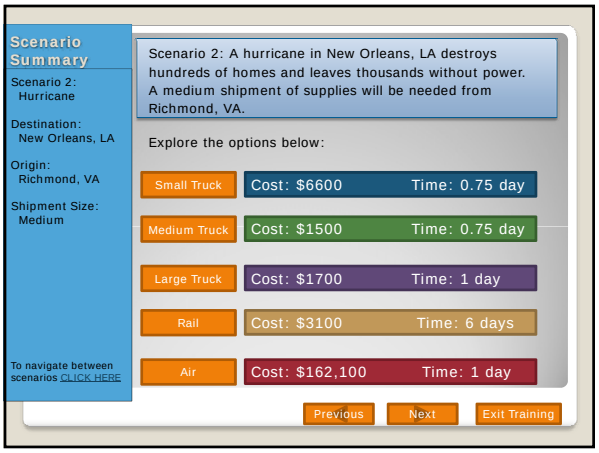
Scenario Summary
Scenario 2: Hurricane
Destination: New Orleans, LA
Origin: Richmond, VA
Shipment Size: Medium
To navigate between scenarios CLICK HERE
Scenario 2: A hurricane in New Orleans, LA destroys hundreds of homes and leaves thousands without power. A medium shipment of supplies will be needed from Richmond, VA.
Explore the options below:
Small Truck Cost: $6600 Time: 0.75 day
Medium Truck Cost: $1500 Time: 0.75 day
Large Truck Cost: $1700 Time: 1 day
Rail Cost: $3100 Time: 6 days
Air Cost: $162,100 Time: 1 day
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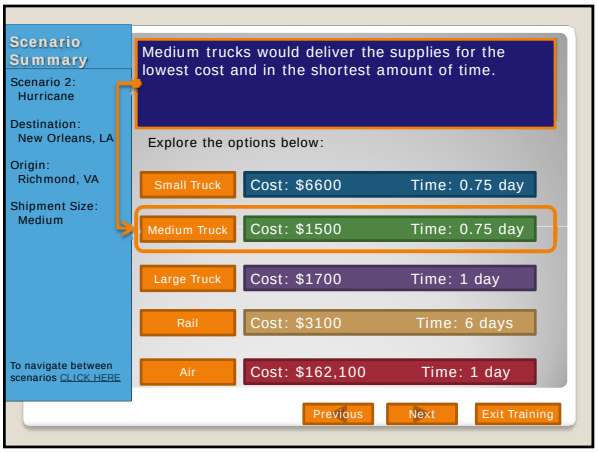
Scenario Summary
Scenario 2: Hurricane
Destination: New Orleans, LA
Origin: Richmond, VA
Shipment Size: Medium
To navigate between scenarios CLICK HERE
Medium trucks would deliver the supplies for the lowest cost and in the shortest amount of time.
Explore the options below:
Small Truck Cost: $6600 Time: 0.75 day
Medium Truck Cost: $1500 Time: 0.75 day
Large Truck Cost: $1700 Time: 1 day
Rail Cost: $3100 Time: 6 days
Air Cost: $162,100 Time: 1 day
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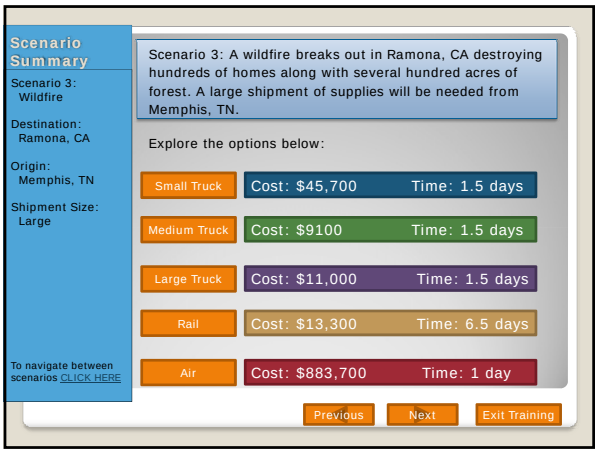
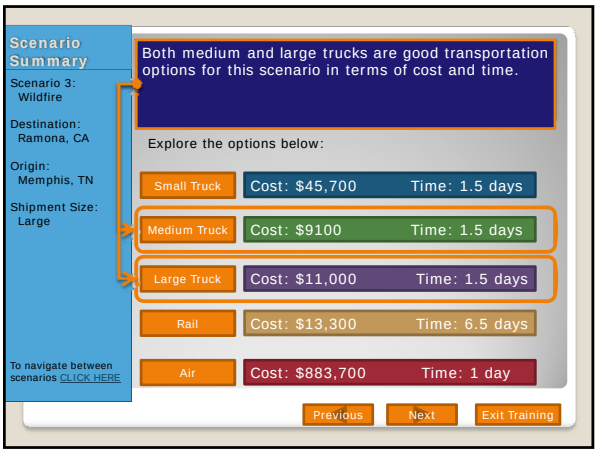

Scenario Summary
Scenario 3: Wildfire
Destination: Ramona, CA
Origin: Memphis, TN
Shipment Size: Large
To navigate between scenarios CLICK HERE
Scenario 3: A wildfire breaks out in Ramona, CA destroying hundreds of homes along with several hundred acres of forest. A large shipment of supplies will be needed from Memphis, TN.
Explore the options below:
Small Truck Cost: $45,700 Time: 1.5 days
Medium Truck Cost: $9100 Time: 1.5 days
Large Truck Cost: $11,000 Time: 1.5 days
Rail Cost: $13,300 Time: 6.5 days
Air Cost: $883,700 Time: 1 day
Previous Next Exit Training


Scenario Summary
Scenario 3: Wildfire
Destination: Ramona, CA
Origin: Memphis, TN
Shipment Size: Large
To navigate between scenarios CLICK HERE
Both medium and large trucks are good transportation options for this scenario in terms of cost and time.
Explore the options below:
Small Truck Cost: $45,700 Time: 1.5 days
Medium Truck Cost: $9100 Time: 1.5 days
Large Truck Cost: $11,000 Time: 1.5 days
Rail Cost: $13,300 Time: 6.5 days
Air Cost: $883,700 Time: 1 day
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Scenario Summary
Scenario 4: Hurricane
Destination: New Orleans, LA
Origin: Denver, CO
Shipment Size: Large
To navigate between scenarios CLICK HERE
Scenario 4: A hurricane in New Orleans, LA destroys hundreds of homes and leaves thousands without power. A large shipment of supplies will be needed from Denver, CO.
Explore the options below:
Small Truck Cost: $36,000 Time: 1.25 days
Medium Truck Cost: $7200 Time: 1.25 days
Large Truck Cost: $7800 Time: 1.25 days
Rail Cost: $8600 Time: 4.5 days
Air Cost: $763,400 Time: 1 day
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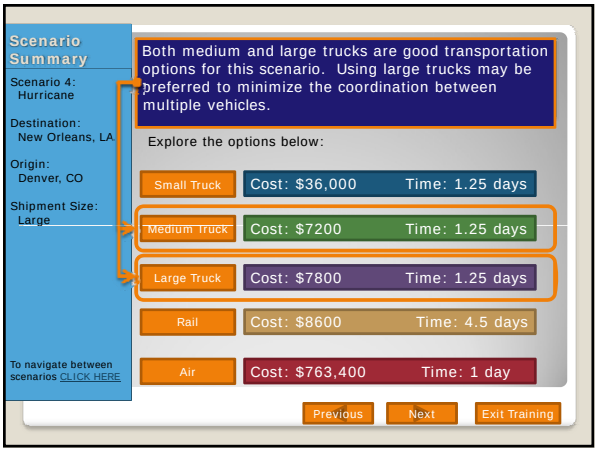
Scenario Summary
Scenario 4: Hurricane
Destination: New Orleans, LA
Origin: Denver, CO
Shipment Size: Large
To navigate between scenarios CLICK HERE
Both medium and large trucks are good transportation options for this scenario. Using large trucks may be preferred to minimize the coordination between multiple vehicles.
Explore the options below:
Small Truck Cost: $36,000 Time: 1.25 days
Medium Truck Cost: $7200 Time: 1.25 days
Large Truck Cost: $7800 Time: 1.25 days
Rail Cost: $8600 Time: 4.5 days
Air Cost: $763,400 Time: 1 day
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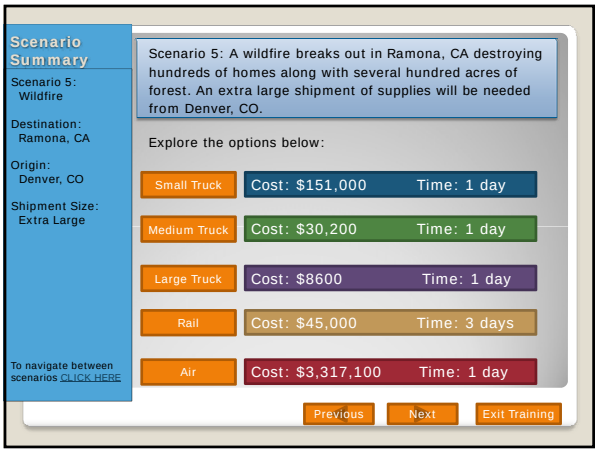
Scenario Summary
Scenario 5: Wildfire
Destination: Ramona, CA
Origin: Denver, CO
Shipment Size: Extra Large
To navigate between scenarios CLICK HERE
Scenario 5: A wildfire breaks out in Ramona, CA destroying hundreds of homes along with several hundred acres of forest. An extra large shipment of supplies will be needed from Denver, CO.
Explore the options below:
Small Truck Cost: $151,000 Time: 1 day
Medium Truck Cost: $30,200 Time: 1 day
Large Truck Cost: $8600 Time: 1 day
Rail Cost: $45,000 Time: 3 days
Air Cost: $3,317,100 Time: 1 day
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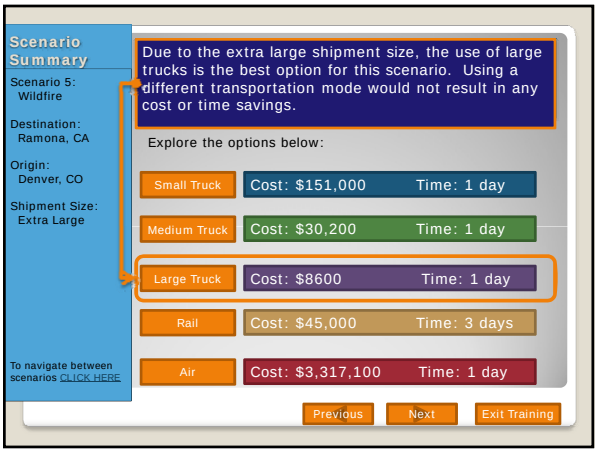
Scenario Summary
Scenario 5: Wildfire
Destination: Ramona, CA
Origin: Denver, CO
Shipment Size: Extra Large
To navigate between scenarios CLICK HERE
Due to the extra large shipment size, the use of large trucks is the best option for this scenario. Using a different transportation mode would not result in any cost or time savings.
Explore the options below:
Small Truck Cost: $151,000 Time: 1 day
Medium Truck Cost: $30,200 Time: 1 day
Large Truck Cost: $8600 Time: 1 day
Rail Cost: $45,000 Time: 3 days
Air Cost: $3,317,100 Time: 1 day
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Single Mode Summary

- In most situations, using ***trucks*** to deliver relief supplies will be the best option.
- Selecting the type of truck to use can include many factors beyond cost and time. For example, availability of vehicles, number of available drivers, and roadway conditions and congestion should also be taken into account.
- While using rail is often financially beneficial, it takes a ***long time for delivery***. However, rail remains a good option for the pre-positioning or staging of supplies if advanced warning of a disaster is provided.
- The use of air should be reserved for situations ***where time is critical and cost is not prohibitive***. Air is also necessary when providing international disaster relief.

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Intermodal Transportation

Intermodal transportation is the shipment of cargo and the movement of people involving more than one mode of transportation during a single journey.

In disaster relief, supplies are often distributed from resource staging centers to points of distribution and dispersed to site locations with varying time and cost requirements; therefore requiring different modes of transportation.

Transporting evacuees, volunteers, agency personal and other people involved in disaster relief also requires different modes of transportation.

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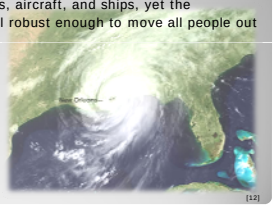
Intermodal Transportation

Intermodal transportation can play a key role in transporting people and cargo during disaster relief operations to reduce cost and shorten transportation time of relief supplies. During the 2005 evacuation of New Orleans during Hurricane Katrina, residents were evacuated by multiple modes, including trains, buses, aircraft, and ships, yet the transportation was still robust enough to move all people out of the affected area.



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Intermodal Transportation

The use of intermodal transportation is an important component to disaster relief transportation efforts, because the strength of each individual mode can be maximized for optimal use.

For example, railway can be utilized for long distance land transportation, since it has an advantage of having a relatively low cost. Air transport is especially useful when roadways are not available, with an added advantage of faster transport times.

Disaster relief agencies that utilize intermodal transportation are not restricted by the drawbacks of a selected transportation mode. Rather, they are able to combine the advantages of various modes to create an **effective transportation plan**.

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Intermodal Scenarios

Instructions

The following scenarios will help you investigate the advantages and disadvantages of using intermodal transportation to deliver relief supplies. Each scenario provides information on the size of shipment for relief supplies, as well as the location of the disaster and the origin of the supplies. You will also be given information on a transfer location. This is the city where supplies will be transferred from one mode of transportation to another.

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Intermodal Scenarios

Instructions

Five intermodal combinations are shown for each scenario. As an example, "Rail to Large Truck" would indicate that supplies would leave the origin using Rail, then be transferred to Large Truck at the transfer city in order to be delivered to the disaster location.

After you explore the intermodal transportation options, single mode options will also be provided. This will allow you to explore the use of a single mode for the entire scenario rather than multiple modes.

START INTERMODAL SCENARIOS

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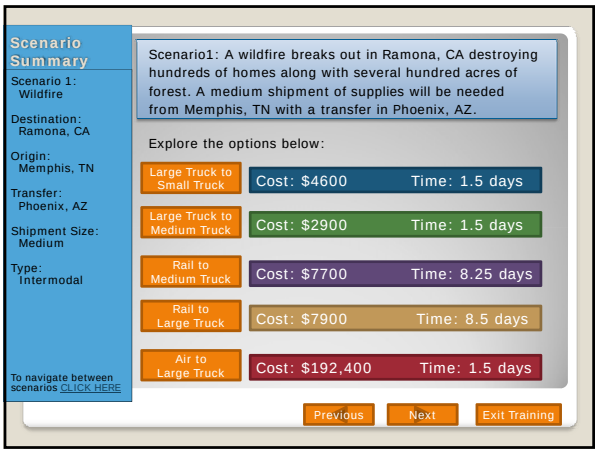
Scenario Summary
Scenario 1: Wildfire
Destination: Ramona, CA
Origin: Memphis, TN
Transfer: Phoenix, AZ
Shipment Size: Medium
Type: Intermodal
To navigate between scenarios CLICK HERE
Scenario1: A wildfire breaks out in Ramona, CA destroying hundreds of homes along with several hundred acres of forest. A medium shipment of supplies will be needed from Memphis, TN with a transfer in Phoenix, AZ.
Explore the options below:
Large Truck to Small Truck
Cost: $4600 Time: 1.5 days
Large Truck to Medium Truck
Cost: $2900 Time: 1.5 days
Rail to Medium Truck
Cost: $7700 Time: 8.25 days
Rail to Large Truck
Cost: $7900 Time: 8.5 days
Air to Large Truck
Cost: $192,400 Time: 1.5 days
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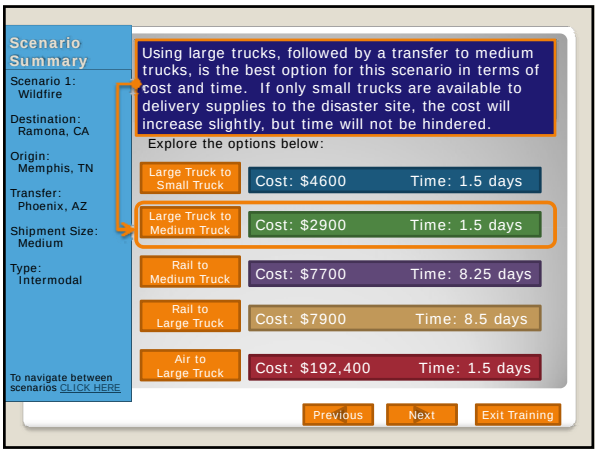
Scenario Summary
Scenario 1: Wildfire
Destination: Ramona, CA
Origin: Memphis, TN
Transfer: Phoenix, AZ
Shipment Size: Medium
Type: Intermodal
To navigate between scenarios CLICK HERE
Using large trucks, followed by a transfer to medium trucks, is the best option for this scenario in terms of cost and time. If only small trucks are available to delivery supplies to the disaster site, the cost will increase slightly, but time will not be hindered.
Explore the options below:
Large Truck to Small Truck
Cost: $4600 Time: 1.5 days
Large Truck to Medium Truck
Cost: $2900 Time: 1.5 days
Rail to Medium Truck
Cost: $7700 Time: 8.25 days
Rail to Large Truck
Cost: $7900 Time: 8.5 days
Air to Large Truck
Cost: $192,400 Time: 1.5 days
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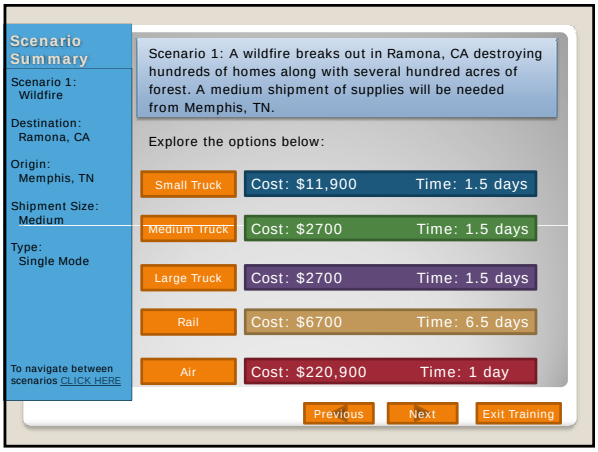
Scenario Summary
Scenario 1: Wildfire
Destination: Ramona, CA
Origin: Memphis, TN
Shipment Size: Medium
Type: Single Mode
To navigate between scenarios CLICK HERE
Scenario 1: A wildfire breaks out in Ramona, CA destroying hundreds of homes along with several hundred acres of forest. A medium shipment of supplies will be needed from Memphis, TN.
Explore the options below:
Small Truck
Cost: $11,900 Time: 1.5 days
Medium Truck
Cost: $2700 Time: 1.5 days
Large Truck
Cost: $2700 Time: 1.5 days
Rail
Cost: $6700 Time: 6.5 days
Air
Cost: $220,900 Time: 1 day
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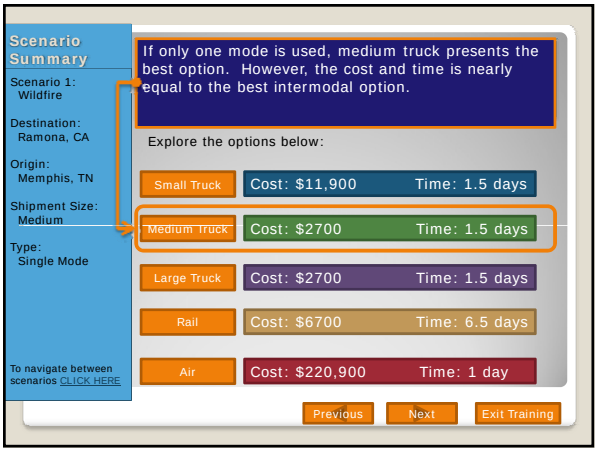
Scenario Summary
Scenario 1: Wildfire
Destination: Ramona, CA
Origin: Memphis, TN
Shipment Size: Medium
Type: Single Mode
To navigate between scenarios CLICK HERE
If only one mode is used, medium truck presents the best option. However, the cost and time is nearly equal to the best intermodal option.
Explore the options below:
Small Truck
Cost: $11,900 Time: 1.5 days
Medium Truck
Cost: $2700 Time: 1.5 days
Large Truck
Cost: $2700 Time: 1.5 days
Rail
Cost: $6700 Time: 6.5 days
Air
Cost: $220,900 Time: 1 day
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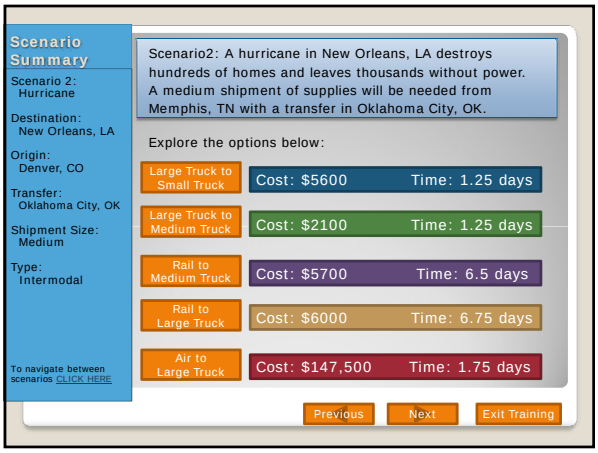
Scenario Summary
Scenario 2: Hurricane
Destination: New Orleans, LA
Origin: Denver, CO
Transfer: Oklahoma City, OK
Shipment Size: Medium
Type: Intermodal
To navigate between scenarios CLICK HERE
Scenario2: A hurricane in New Orleans, LA destroys hundreds of homes and leaves thousands without power. A medium shipment of supplies will be needed from Memphis, TN with a transfer in Oklahoma City, OK.
Explore the options below:
Large Truck to Small Truck
Cost: $5600 Time: 1.25 days
Large Truck to Medium Truck
Cost: $2100 Time: 1.25 days
Rail to Medium Truck
Cost: $5700 Time: 6.5 days
Rail to Large Truck
Cost: $6000 Time: 6.75 days
Air to Large Truck
Cost: $147,500 Time: 1.75 days
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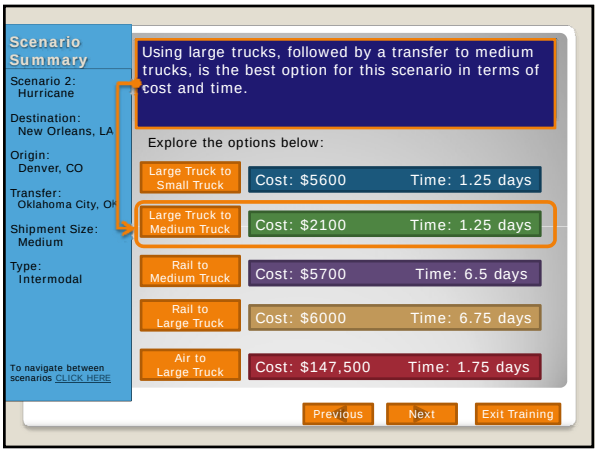
Scenario Summary
Scenario 2: Hurricane
Destination: New Orleans, LA
Origin: Denver, CO
Transfer: Oklahoma City, OK
Shipment Size: Medium
Type: Intermodal
To navigate between scenarios CLICK HERE
Using large trucks, followed by a transfer to medium trucks, is the best option for this scenario in terms of cost and time.
Explore the options below:
Large Truck to Small Truck
Cost: $5600 Time: 1.25 days
Large Truck to Medium Truck
Cost: $2100 Time: 1.25 days
Rail to Medium Truck
Cost: $5700 Time: 6.5 days
Rail to Large Truck
Cost: $6000 Time: 6.75 days
Air to Large Truck
Cost: $147,500 Time: 1.75 days
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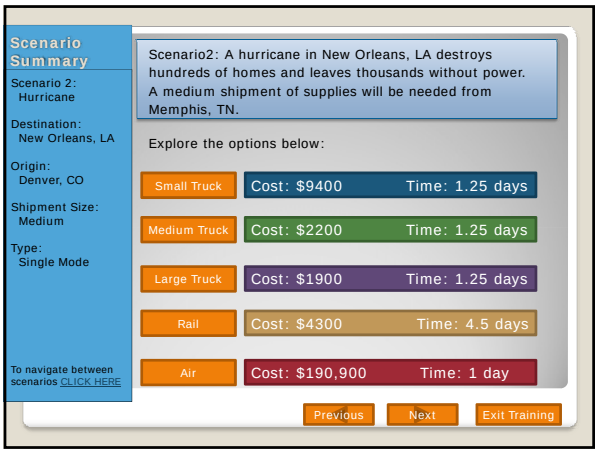
Scenario Summary
Scenario 2: Hurricane
Destination: New Orleans, LA
Origin: Denver, CO
Shipment Size: Medium
Type: Single Mode
To navigate between scenarios CLICK HERE
Scenario2: A hurricane in New Orleans, LA destroys hundreds of homes and leaves thousands without power. A medium shipment of supplies will be needed from Memphis, TN.
Explore the options below:
Small Truck Cost: $9400 Time: 1.25 days
Medium Truck Cost: $2200 Time: 1.25 days
Large Truck Cost: $1900 Time: 1.25 days
Rail Cost: $4300 Time: 4.5 days
Air Cost: $190,900 Time: 1 day
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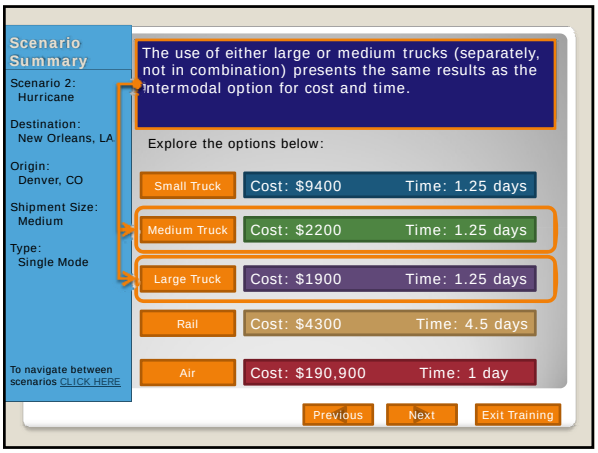
Scenario Summary
Scenario 2: Hurricane
Destination: New Orleans, LA
Origin: Denver, CO
Shipment Size: Medium
Type: Single Mode
To navigate between scenarios CLICK HERE
The use of either large or medium trucks (separately, not in combination) presents the same results as the intermodal option for cost and time.
Explore the options below:
Small Truck Cost: $9400 Time: 1.25 days
Medium Truck Cost: $2200 Time: 1.25 days
Large Truck Cost: $1900 Time: 1.25 days
Rail Cost: $4300 Time: 4.5 days
Air Cost: $190,900 Time: 1 day
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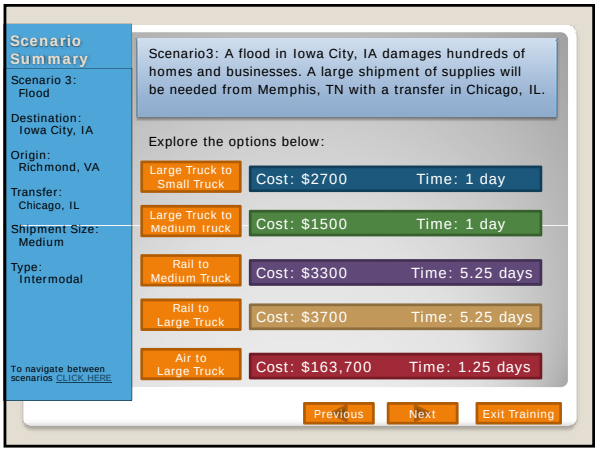
Scenario Summary
Scenario 3: Flood
Destination: Iowa City, IA
Origin: Richmond, VA
Transfer: Chicago, IL
Shipment Size: Medium
Type: Intermodal
To navigate between scenarios CLICK HERE
Scenario3: A flood in Iowa City, IA damages hundreds of homes and businesses. A large shipment of supplies will be needed from Memphis, TN with a transfer in Chicago, IL.
Explore the options below:
Large Truck to Small Truck Cost: $2700 Time: 1 day
Large Truck to Medium Truck Cost: $1500 Time: 1 day
Rail to Medium Truck Cost: $3300 Time: 5.25 days
Rail to Large Truck Cost: $3700 Time: 5.25 days
Air to Large Truck Cost: $163,700 Time: 1.25 days
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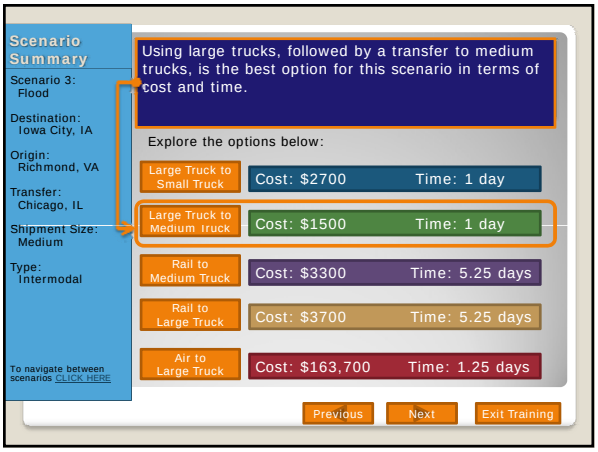
Scenario Summary
Scenario 3: Flood
Destination: Iowa City, IA
Origin: Richmond, VA
Transfer: Chicago, IL
Shipment Size: Medium
Type: Intermodal
To navigate between scenarios CLICK HERE
Using large trucks, followed by a transfer to medium trucks, is the best option for this scenario in terms of cost and time.
Explore the options below:
Large Truck to Small Truck Cost: $2700 Time: 1 day
Large Truck to Medium Truck Cost: $1500 Time: 1 day
Rail to Medium Truck Cost: $3300 Time: 5.25 days
Rail to Large Truck Cost: $3700 Time: 5.25 days
Air to Large Truck Cost: $163,700 Time: 1.25 days
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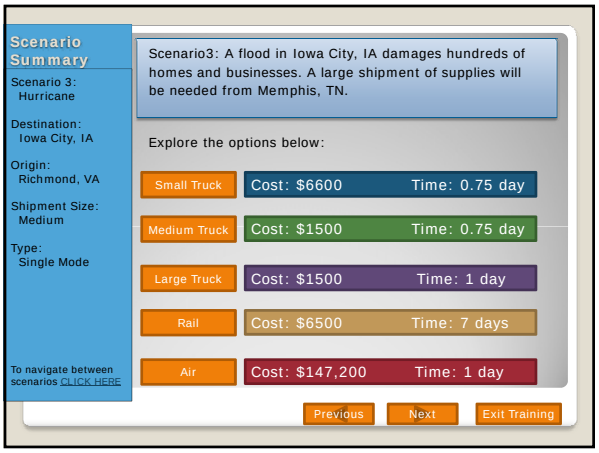
Scenario Summary
Scenario 3: Hurricane
Destination: Iowa City, IA
Origin: Richmond, VA
Shipment Size: Medium
Type: Single Mode
To navigate between scenarios CLICK HERE
Scenario3: A flood in Iowa City, IA damages hundreds of homes and businesses. A large shipment of supplies will be needed from Memphis, TN.
Explore the options below:
Small Truck Cost: $6600 Time: 0.75 day
Medium Truck Cost: $1500 Time: 0.75 day
Large Truck Cost: $1500 Time: 1 day
Rail Cost: $6500 Time: 7 days
Air Cost: $147,200 Time: 1 day
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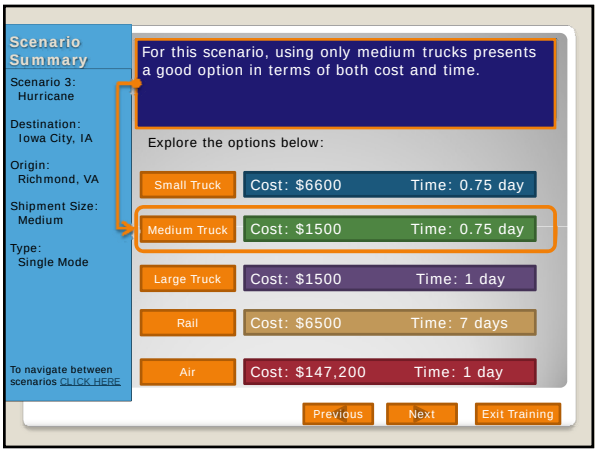
Scenario Summary
Scenario 3: Hurricane
Destination: Iowa City, IA
Origin: Richmond, VA
Shipment Size: Medium
Type: Single Mode
To navigate between scenarios CLICK HERE
For this scenario, using only medium trucks presents a good option in terms of both cost and time.
Explore the options below:
Small Truck Cost: $6600 Time: 0.75 day
Medium Truck Cost: $1500 Time: 0.75 day
Large Truck Cost: $1500 Time: 1 day
Rail Cost: $6500 Time: 7 days
Air Cost: $147,200 Time: 1 day
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Intermodal Summary

- Transferring supplies from a large truck to a smaller truck is a very common use of intermodal transportation. This option typically delivers the supplies in a ***short amount of time at a low cost***, and allows for the use of available trucks depending on the destination and origin locations.
- Using both rail and truck in the same delivery trip is very time-prohibitive. However, if advanced planning is possible, this type of intermodal transfer can ***save money*** in the long run for ***large shipments***.

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Intermodal Summary

- The use of air in intermodal transportation greatly increases overall transportation costs. However, if time is limited and cost is not prohibitive, the use of air along with truck provides a good option for providing disaster relief.
- In many situations, using intermodal transportation is equal to or superior than single mode options in terms of cost and time. Additional factors such as ***mode availability, route conditions, and convenience*** often provide an overwhelming advantage for the use of intermodal transportation for disaster relief.

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Program Overview

- Many factors should be considered when selecting a transportation mode for delivering relief supplies. These include cost, time, distance, road availability, mode availability, and convenience.
- Advance planning of transportation helps minimize cost and maximize efficiency.
- Intermodal transportation is the seamless use of more than one mode on a single delivery trip.
- There are many advantages to using multiple modes during delivery. ***In most situations, the use of multiple modes does not negatively impact cost or time***.

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Additional Information

- National Center for Intermodal Transportation
  http://ncit.msstate.edu/
- Research Report: The Role of Intermodal Transportation in Humanitarian Supply Chains
  http://ncit.msstate.edu/publications/reports/reports_58.html

Developed by faculty and students in Industrial & Systems Engineering, Mississippi State University

The development of this training program was made possible through a research grant Funded by the National Center for Intermodal Transportation (NCIT).

For more information, please contact:
Dr. Lesley Strawderman (strawderman@ise.msstate.edu) or
Dr. Burak Eksioglu (beksioglu@ise.msstate.edu).

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[6] http://comps.fotosearch.com/comp/UNC/UNC160/truck-pickup_~u14928883.jpg

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Single Route Scenarios

Select a scenario to explore:

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SCENARIO 3 SCENARIO 4
SCENARIO 5

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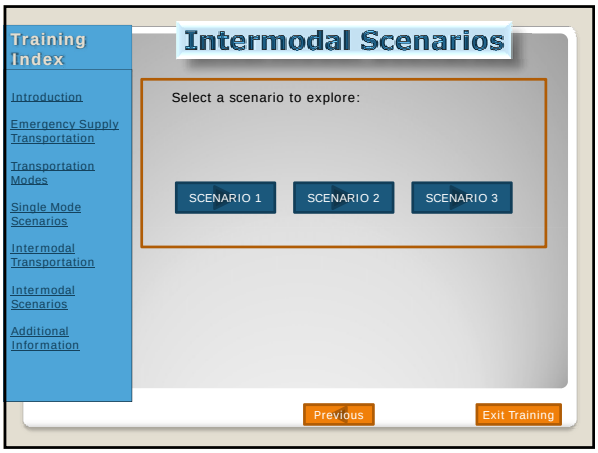
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Select a scenario to explore:
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Appendix B

Usability Survey

Usability Questions

For the following statements, please circle the number that most closely matches your answer regarding the training program you just completed. A "1" means **strongly disagree** and a "5" means **strongly agree.**

1. The structure of the training was simple to understand.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	*2*	*3*	*4*	*5*

2. I felt comfortable using the training program.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	*2*	*3*	*4*	*5*

3. While completing the training, I had good control over the training program.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	*2*	*3*	*4*	*5*

4. The information in the training program was easy to read.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	*2*	*3*	*4*	*5*

5. The use of terms and icons was consistent throughout the training program.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	*2*	*3*	*4*	*5*

6. I was given enough information to work through and complete the training.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	*2*	*3*	*4*	*5*

7. Overall, I am satisfied with the training program.

Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	*2*	*3*	*4*	*5*

Additional Usability Comments

8. If you have any additional comments regarding the **usability** of the training program, please include them here:

9. If you have any additional comments regarding the **design** of the training program, please include them here:

10. If you have any additional comments regarding the **appeal** of the training program, please include them here:

Content Questions

Thinking back to what you learned during the training program, please answer the following questions:

11. What is intermodal transportation?

12. What are some factors that should be considered when choosing a transportation mode for the delivery of disaster relief supplies?

13. List one common intermodal transportation mode combination that can be used to deliver supplies.

14. Does intermodal transportation save time and/or money in the delivery of supplies when compared to single mode transportation?