



## **Teaching Guide**

**For**

## **Recycling Module**

**Illinois Transportation, Distribution and Logistics  
Math and Science Project**

**2008**

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## Acknowledgements

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Vicki Phillips, Rushville,-Industry High School, Rushville, IL

Matt Plater, Supt. of Schuyler-Industry Community Unit District #5

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## **Scenario Focus**

*Primary Career Pathway:* Logistics Planning and Management

*Occupation/Job Titles Related to this Scenario:* Logistics Manager, Logistics Analyst; Distribution Manager, Transportation Manager, Warehouse Manager, Recycling Coordinator

*Recommended Teaching Subject Areas:* Math, and Physics

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## **Scenario Problem Statement and Performance Elements**

Schuyler-Industry Community Unit District # 5 generates a considerable amount of paper wastes. This includes both paper wastes in the form of cardboard and classroom papers. The district also has considerable amount of plastics. These can be recycled. The purpose of this project is to develop a recycling program to be implemented district wide. Topics to consider are storage, the best company to use for the recycling and/or cost of transportation to a recycling center.

## **TDL Cluster Knowledge and Skills and Performance Elements**

- Determine storage needs.
- Select carriers for transportation mode/modes
- Determine the locations of facilities and services within logistics networks.
- Develop routes and schedules for transporting people/goods.

## **Illinois Learning Standards:**

### **Math**

- Solve problems involving scale drawings, models, maps, or blueprints. (H-7C.5)
- Solve problems involving multiple rates, measures, and conversion. (I-7C.6)
- Solve problems using indirect measurement by choosing appropriate technology, instruments, and/or formulas. (I-7C.1)

- Determine linear measures, perimeters, areas, surface areas, and volumes of similar figures using ratio of similitude.(I-7C.4)
- Calculate by appropriate method the length, width, height, perimeter, area, volume, surface area, angle measures, or sums of angle measures of common geometric figures, or combinations of common geometric figures.( I-7C.6)
- Solve problems involving multiple rates, measures, and conservation. (I-7C.7)
- Write equivalent forms of equations, inequalities and systems of equations.(I-8A.1)
- Evaluate published reports that are based on data by examining the design of the study, the appropriateness of data analysis, and the validity of conclusions.(I-10A.3)
- Make decisions based on data, including the relationships of correlation and causation. (I-10A.5)
- Construct, read, interpret, infer, predict, draw conclusions and evaluate data from various displays including histograms and scatter plots. (H-10A.1)
- Describe and apply properties of a polygon or a circle in a problem solving situation. (I-9A.1)
- Solve problems involving time, temperature, mass, speed, distance, density and monetary values. (H-7C.4)
- Solve simple problems involving rates and other derived measurements such as velocity and density. (H-7C.1)
- Apply formulas in a wide variety of theoretical and practical real work measurement.

**Language Arts:**

- Communicate information and ideas in narrative informative and persuasive writing with clarity and effectiveness.
- Deliver planned and impromptu oral presentations.

What I Want Students to Know	What I Want Students to be Able to Do
<ul style="list-style-type: none"> <li>• Definitions for logistics and distribution.</li> <li>• Understand the role of logistics and distribution in retail industry.</li> <li>• Relationship of cost of distribution to Customer Service</li> <li>• Career Opportunities in logistics and distribution</li> <li>• Major types of distribution channels</li> <li>• Major costs of distributions</li> <li>• Understand the factors concerning route planning for moving products to more than one location.</li> <li>• Knowledge of recyclable materials.</li> <li>• Knowledge of recycling programs.</li> </ul>	<ul style="list-style-type: none"> <li>• Determine most appropriate type of transportation for specific products.</li> <li>• Calculate cost of transportation for specific products.</li> <li>• Calculate cost of storing products at distribution center and/or storage facilities.</li> <li>• Read Maps and plan routes between two or more destinations.</li> <li>• Use internet to plan routes between two or more destinations.</li> <li>• Write a business report</li> <li>• Make a presentation with visuals.</li> </ul>

## Objectives:

- Learn about the role of logistics and distribution as it relates to recycling.
- Acquire the skills needed to develop a recycling plan.
  - Describe the major types of distribution channels for a recycling program.
  - Describe and calculate the major types of costs.
  - Read and interpret industry charts to determine transportation rates.
  - Read and interpret maps and estimate mileage between two locations.
  - Use computers to estimate mileage between two locations.
  - Identify and describe all possible routes between a location of origin and multiple locations to where you must travel and select the lowest cost route.
- Prepare a written business report.
- Deliver an oral presentation of the recycling plan.

## Measurement Criteria for an acceptable solution:

1. Carrier selected represented the most cost effective means for transporting or picking up recyclables.
2. Identified on map potential locations of recyclable materials.
3. Evaluate cost differences.
4. All calculations were correct using formulas, maps, and charts provided.
5. Business report included a cover letter, introduction stating the purpose of the report, documentation to support recommendations, a detailed explanation of costs, and tables, charts and spreadsheets to more clearly communicate recommended recycling plan.
6. Presentation presented the information with visual aids and/or handouts.
7. The presentation met the 7 requirements of effective business presentations:
  - Evidence of preparedness and practice
  - Started on time
  - Dressed appropriately
  - Showed enthusiasm and confidence
  - Maintained eye contact, showed friendliness and respect
  - Spoke slowly and distinctly without grammatical errors or slang
  - Welcomed questions and answered completely;
  - Accepted reactions without being defensive.

## Teacher Notes:

Students should have a good working knowledge of math and formulas. Additional content on transportation modes or routing, writing reports and making presentations may be necessary for some students. This can be done congruently with the scenario or prior to working on the scenario.

Please review the materials needed prior to starting the problem solving activity so that you can make copies or obtain items needed. Notify students of the date that presentations will be made. Give students the opportunity to make their own cause and effect connections as various consequences present it.

**Time Required to Complete Problem:** 15 hours

**Types of Materials included in this Module:**

1. Lesson plans for each topic with discussion questions and student activities.
2. Copy of student handouts with activities for duplication.
3. Copy of material describing problem for students.
4. Evaluation with measurement criteria and scoring guide.
5. Teacher materials to assist in evaluation of problem and possible solution steps.
6. Glossary of terms related to this module.

**Support Materials and Resources Necessary for Completion of Scenario:**

- United States Maps
- Computer access to internet and map programs
- Excel or similar spreadsheet software
- Handouts (see each lesson)
- Websites (see each lesson)
- TI-84 plus or TI-86 calculators

# Lesson 1

<b>TOPIC</b>	Overview of Logistics and Distribution	<b>TIME ESTIMATE</b>	1 hour (2 hour with optional activity)
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<b>OBJECTIVES</b>	
<ul style="list-style-type: none"> <li>• Students will be able to define logistics and distribution.</li> <li>• Students will be able to explain how products get from the source to the center.</li> </ul>	

<b>MATERIALS &amp; RESOURCES</b>	
<ul style="list-style-type: none"> <li>• Handout #1, Memo from Schuyler-Industry Community Unit District #5</li> <li>• Handout #2, Defining Logistics and Distribution</li> <li>• Handout #3, Lowest Cost of Distribution</li> <li>• Websites: <a href="http://www.sid5.com">www.sid5.com</a> <a href="http://www.earth.google.com">www.earth.google.com</a></li> </ul>	

<b>LESSON DESCRIPTION &amp; ACTIVITIES</b>		
<b>Steps</b>	<b>No. of Minutes</b>	<b>ACTIVITIES</b>
1	5	- Introduction to Project <ul style="list-style-type: none"> <li>• Distribute copies of Handout 1, the Memo from Schuyler Community Unit District #5.</li> <li>• Read with class and answer any immediate questions.</li> </ul>
2	30	- Distribute Handout 2, Defining Logistics and ask students to read. - After students have reviewed the readings, <ul style="list-style-type: none"> <li>• Ask students to define logistics.</li> <li>• Ask students to distinguish between recyclable and non-recyclable goods.</li> <li>• Ask the students to explain why recycling is important.</li> </ul>
3	20	- Distribute Handout 3, Lowest Cost of Distribution. - Discuss in small groups how it applies to recycling.

4	55	<b>Optional Activity:</b> Have students research on the computer how products are distributed from the supplier to the distribution center to the customer and develop a flowchart showing this process. - (Optional websites are: TBA )
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## Problem Statement

Schuyler-Industry Community Unit District #5 is located in Schuyler County in west-central Illinois. The district is composed of six distinct buildings: Washington Elementary School, 100 Buchanan; Webster Elementary, 310 North Monroe; Schuyler Middle School, 750 North Congress; Rushville-Industry High School, 730 North Congress; The District Board of Education Office, 740 Maple Ave all in Rushville Illinois and Industry Elementary, 306 East South Street in Industry Illinois.

The District would like to develop a district wide recycling program for fibers and plastics. This will include but not limited to developing a waste audit, temporary storage facilities for the recyclables and transportation of these recyclables to a recycling center or contracting a company to pick them up. It will also include the distribution of the recyclable containers, the emptying of the containers in a timely manner and the transportation to the temporary storage facility. It will be necessary to find and or design a suitable temporary storage facility.

You are being asked to recommend a plan for a recycling program that will meet the needs of the District.

## Defining Logistics

What is logistics?

Logistics refers to the planning and management of the physical movement or distribution of products and merchandise from the producer to the consumer. Producers are the companies who make the product. Consumers are people who use the product.



Logistics and distribution plays a critical role in the economy because products are usually produced in one part of the country or the world and have to be transported many miles to where consumers live. Producers and consumers depend on logistics and distribution companies and professionals to get products to the right place at the right time when consumers want to buy them. This can be very costly without good planning and management.

When defining logistics remember the 7 R Principles: Logistics is delivering the right product, in the right quantity and the right condition at the right place, at the right time, for the right customer, at the right cost.

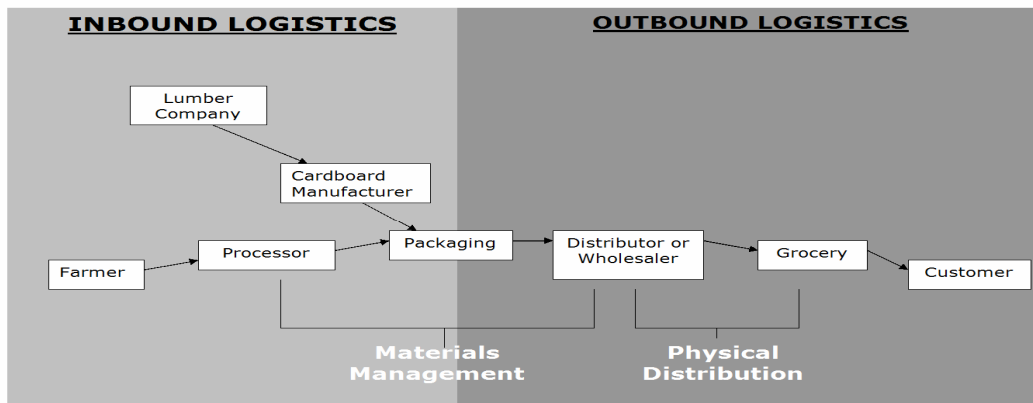
As shown in Figure 1.1, logistics management can be divided into two separate activities. Materials management involves the bringing of raw materials and supplies to where they are used to produce products and merchandise, usually a manufacturing company, and moving them through the company until they become finished products. Materials management is often referred to Inbound Logistics

Physical distribution management involves the movement of finished products and merchandise from the end of the production line to the consumer. This is also called Outbound Logistics.



Logistics and distribution professionals working for retail companies are involved in physical distribution activities. They are responsible for getting products and merchandise from the manufacturers or their wholesalers to stores and consumers.

**Figure 1.1 Flow Chart for Defining Logistics and Distribution**



### Activity

Discuss with your group the following and write your answers on a separate sheet of paper:

1. List the 7 R's in the 7R Principle.
2. How do food products that you buy in the grocery store get to you? How do raw materials get to the manufacturer? How do the finished products or merchandise get to the store?
3. What are some of the major decisions that have to be made in getting the finished product to the store?
4. Consider the Recycling Problem:



- a. How do the recyclables get to a center?
- b. What are some things we need to consider in getting recyclables to the center? (apply the 7 R Principle)
- c. When moving the items to the recycling centers, does this involve physical distribution management or materials management?

## Lowest Cost of Distribution

Logistics and distribution is very important in retail companies because it is a major factor in keeping customers satisfied and in controlling costs.

**Customer Service and Satisfaction.** One key to customer satisfaction is having the right product available to customers when they want to buy it. Customers get very frustrated when they go to a store to buy a product and they are told that the product is out of stock and will not be available until later in the week. High levels of service exist when products are available in the stores when customers want the products. High levels of service are measured by the percentage of products carried by a store that are in stock during a buying period.

**Costs of Distribution.** Retail companies must provide high levels of service at a reasonable cost of distribution. Companies can always have products available by maintaining high levels of inventory. They also can use the most expensive types of transportation such as air transport and special services like overnight delivery. But, this costs money, and must be included in the price of the product. Customers want products available at the lowest price. Retailers must keep distribution costs down to levels at or below their competitors.

**Managing Service and Cost.** Retail companies are always trying to manage the tradeoff between high levels of service and low costs of distribution. The key is finding a way to get the highest levels of service the lowest cost of distribution in comparison to major competitors.

## ACTIVITY

Discuss with your group the following:

1. Why is it important for retail companies to maintain high levels of service?
2. What can happen when customers find that products are out of stock?
3. Why is it important for retail companies to keep distribution costs low?
4. What would happen if retail stores had to raise prices to pay for higher distribution costs?

## Lesson 2

<b>TOPIC</b>	Solving the Distribution and Logistics Sample Problem	<b>TIME ESTIMATE</b>	1 hour
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### OBJECTIVES

- Students will be able to solve problem on distribution and logistics.
- Students will be able to present their solutions to the class.

### MATERIALS & RESOURCES

- Handout #4, How to Start a Recycling Program
- Handout #5, Developing a Waste Materials Audit Form
- Access to Computer

### LESSON DESCRIPTION & ACTIVITIES

Steps	No. of Minutes	ACTIVITIES
1	50	<ul style="list-style-type: none"> <li>- Distribute Handout 4, How to Start A Recycling Program to the class.</li> <li>- Allow time for students to read and complete the questions on the bottom of the page.</li> <li>- As a class discuss Handout 4 and answers to the questions.</li> </ul>
2	30	<ul style="list-style-type: none"> <li>- Distribute Handout 5 and go over the instructions with the students.</li> <li>- Why do we need the audit? What kind of information do we want to find out about recycling? Who should we contact to get the information?</li> <li>- Allow time for students to work their audit form.</li> </ul>
3	20	<ul style="list-style-type: none"> <li>- Discuss each of the waste material audit forms and decide on which form all groups will use.</li> </ul>

## Analyzing How to Start a Recycling Program.

There are a few key elements to starting any recycling program for a business, a school, an organization or just in your home.

1. **Decide what to recycle**—Evaluate how much space you have to sort and store materials and what items you tend to go through. Paper products are a safe bet to be recycled, and aluminum or steel cans are valuable. Other commonly accepted items include glass and plastic bottles.
2. **Find a vendor**—Check with your local recycling center, municipality and waste hauler to find out what kind of materials are accepted in your area. The green Earth 911 recycling locator at the top of the page can help.
3. **Decide on storage**—Washable plastic bins or trash cans are the best and cardboard boxes are good too. Be sure to rinse out the containers that held food to avoid critters.
4. **Educate participants**—If items are put in the wrong containers, it means more work for you and could mean materials might not be recycled. Let the people know what to do.
5. **Label bins**—Print up a sheet of special instructions, such as: remove caps, stomp on containers, break down cardboard boxes, bundle newspapers, etc.
6. **Maintain and monitor**—Keep the storage bins clean and dry and make sure materials don't pile up. A clean recycling area encourages other to keep it clean and uncluttered. Watch for critters from unwashed containers.
7. **Reward good behavior**—Praise your participants and share any monetary rewards from dropping off materials.

### Question for discussion:

1. What items will the district be able to recycle?  
Why?
2. How will you get the items to the nearest recycling center?
3. How will you store the recyclables in the classroom? On the grounds?
4. How do you intend to educate the teachers, students, and personnel in the district?

Develop a waste materials audit form.

In your groups you should develop an audit form to distributed district wide. We will then make a consensus to find a form all groups will use. Here is an example to start with.

Example Form Below

**Waste Material Audit Form**

MATERIALS	LOCATION	RECYCLED Y/N	DISPOSAL LBS/WEEK	DISPOSAL TONS/YR	COMMENTS
Computer Paper					
Ledger Paper					
Mixed Paper					
Corrugated					
Newspaper					
Magazines					
Glass Containers					
Aluminum Cans					
Steel Cans					
Scrap Metals					
Plastics					
Pallets					
Batteries					
others					
TOTALS					

## Lesson 3

<b>TOPIC</b>	Benefits of Recycling	<b>TIME ESTIMATE</b>	2 hours
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<b>OBJECTIVES</b>	
<ul style="list-style-type: none"> <li>• Students will understand the benefits of recycling.</li> <li>• Students will be able to teach others the importance of recycling.</li> </ul>	

<b>MATERIALS &amp; RESOURCES</b>	
<ul style="list-style-type: none"> <li>• Website  <a href="http://www.dep.state.pa.us/dep/deputate/airwaste/wm/RECYCLE/FACTS/benefits.htm">www.dep.state.pa.us/dep/deputate/airwaste/wm/RECYCLE/FACTS/benefits.htm</a> </li> <li>• Computer with internet access</li> </ul>	

<b>LESSON DESCRIPTION &amp; ACTIVITIES</b>		
<b>Steps</b>	<b>No. of Minutes</b>	<b>ACTIVITIES</b>
1	40	<ul style="list-style-type: none"> <li>- Brainstorm with the students—What do you think the benefits of recycling are?</li> <li>- Suggest the students do an internet search for answers to this question.</li> <li>- Refer students to the website listed above.</li> <li>- Allow time for students to read.</li> </ul>
2	15	<ul style="list-style-type: none"> <li>- Discuss in groups the benefits of a recycling program for Schuyler-Industry Community Unit District #5.</li> <li>- Share responses as a class.</li> </ul>



## Lesson 4

<b>TOPIC</b>	Understanding Distribution Centers	<b>TIME ESTIMATE</b>	2 hours
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### OBJECTIVES

- Students will be able to describe a distribution center and its role in handling and storage of recyclables.
- Students will be able to determine local and regional distribution costs.

### MATERIALS & RESOURCES

- Handout #6, "Two Major Costs of Distribution"
- Handout #7, "Handling and Storage at Distribution Centers"
- Handout #8, "Local and Regional Distribution Costs for Retail Companies"
- Access to Computers
- Calculators

### LESSON DESCRIPTION & ACTIVITIES

Steps	No. of Minutes	ACTIVITIES
1	30	<ul style="list-style-type: none"> <li>- Distribute Handout 6, Two Major Costs of Distribution and allow time for students to read.</li> <li>- As a class discuss the major points in the handout.</li> <li>- Go over the transportation cost formula and as a class work the example at the end of the handout.</li> </ul>
2	50	<ul style="list-style-type: none"> <li>- Distribute Handout 7, Handling and Storage at Distribution Centers, and allow time for students to read.</li> <li>- As a class discuss the major points in the handout.</li> <li>- Assign students to groups to work on activities at the end of Handout 7.</li> <li>- Check their work by selecting students to present their solutions on the board.</li> </ul>
3	30	<ul style="list-style-type: none"> <li>- Distribute Handout 8, Local and Regional Distribution Costs for Retail Companies and have students read.</li> <li>- As a class review the major costs and the formula for calculating these costs.</li> </ul>

		<p>- Assign activities at the end of Handout 8 for students to complete and go over their answers as a class.</p>
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## Two Major Costs of Distribution

The way that a business transports, stores and delivers its product to customers is critical to the ability to maintain and increase their profit. Outside of product costs, distribution expense is one of the largest cost of many businesses. This includes the cost of transporting, storing and delivering the product to the customer. There are two major types of distribution costs within a distribution channel—transportation and distribution center costs. Let's explore each type of cost.

### Transportation

Mode(s) of Transportation. Distribution planners must first decide on which mode or modes of transportation to use in distributing products. The major transportation modes are:

- Air—airplanes
- Motor—trucks, delivery vans, and cars
- Rail—trains, railroad cars
- Water—ships and barges
- Pipeline—liquid, gas, slurry
- Intermodal—combination of two or more modes

Distribution planners must select the lowest cost mode that also can get the products there on time (speed), on a consistent basis (reliability), to many different locations (location access), and without major damage (quality).

Motor transportation (e.g., trucks) is the most common mode of transportation that retailers use to distribute products from distribution centers to their stores.

Transportation Supplier/Vendor. After selecting the mode of transportation, distribution planners must then decide which suppliers or vendors will transport their products. They sometimes must decide whether to use their own transportation equipment and employees (in-house) or contract with another company (contract out to supplier).

They usually make this choice based on a comparison of cost, reliability, location access, and damage history. The final choice is usually made on cost. Costs are usually calculated based on number of units shipped per mile. Here is an example of a transportation cost formula.

**t** = Transportation costs

**n** = Number of units (e.g., cases, pounds)

**m** = Number of miles transported

**C** = Cost per unit per mile

$$t = n \times m \times c$$

## ACTIVITY

Use the transportation formula provided above to calculate the transportation costs for the following examples.

A distribution planner for a hardware store chain pays \$0.25 per mile for every case of bolts shipped from its distribution center to the company's stores. One store is located 53 miles from the distribution center. How much would it cost the company to ship 50 cases to this store?

## **Distribution Centers<sup>1</sup>**

A distribution center for a set of products is a warehouse or other specialized building with refrigeration or air conditioning which are supplied by transport, such as aircraft, truck, rail or ship, and then re-distributed to retailers or wholesalers. The food distribution system of the United States is dominated by distribution centers, which have helped to cut the cost of supplying food in the United States, and make food only a small part of the cost of living there.

Distribution centers are foundation of a retailing network. They allow a retail location to stock vast numbers of products without incurring an explosion in transportation costs. The way a typical distribution network operates is to have centers setup throughout a commercial market. Each center will then service a number of stores. Large distributions centers for companies such as Wal-Mart service 50-125 stores. Suppliers will ship truckloads of products to the distribution center. The distribution center will then store the product until needed by the retail location and ship the proper quantity.

Because a large retailer might sell tens of thousands of products from thousands of vendors, it would be impossibly inefficient to try to ship each product directly from each vendor to each store. Many retailers own and run their distribution networks, while smaller retailers may outsource this function to dedicated logistics firms that coordinated the distribution of products for a number of companies.

## **Scale**

Large distribution centers might receive and ship more than ten thousand truckloads each year, with an individual store receiving only a couple trucks per week up to 20, 30 or more per week. The distribution centers can range in size from less than 50,000 square feet up to the largest approaching 2 million square feet.

## **Storage**

Although the primary role of a distribution center is to receive large quantities of products and ship small quantities to individual stores, an important secondary role is storage. Many retailers have prioritized having as many items in stock at one time as possible. To conserve space, minimize inventory costs and maximize the variety they offer, the retail might only stock one or a few items of a particular product. This requires the ability to ship a replacement quickly once an item is sold. By keeping

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<sup>2</sup> Information in this Handout from [http://en.wikipedia.org/wiki/Distribution\\_center](http://en.wikipedia.org/wiki/Distribution_center)

product on hand in the distribution center, the retailer can ship a replacement almost immediately after a product is sold.

In addition to shipping quickly, preparing for busy shopping seasons requires retailers to stock up on product ahead of time. For many retailers, the Christmas shopping season is the busiest of the year. Ahead of this time, a distribution center might double the amount of inventory on hand and then draw this level down through the shopping season. This strategy is especially important for imported items. With lead times measured in weeks or months, stocking these products in a distribution center is often the only way to maintain in-stocks at the store. New seasons, holidays or special promotions may also prompt a retailer to store specific items prior to a large rollout or demand forecast.

## **Costs**

The most efficient method of distribution would be shipping a full truckload or railcar directly from the manufacturer to the retailer. After this, the next most efficient method would be to ship a full truckload to a distribution center, unload full pallets of products and immediately load the pallets onto trucks that are going to individual stores. Both of these methods can only be used on very high volume items. Most products cannot be delivered in this manner and pallets, or even individual boxes, must be broken down and divided.

Once a full pallet must be broken apart, the costs of handling the product can increase quickly. Many distribution centers use large sortation systems with miles of conveyor to move product through the facility and into a truck. They also may have automated equipment for de-palletizing and re-palletizing product. Some of the most sophisticated systems can convey product straight into storage racks and then convey out of the racks to trucks, all automatically. With a wide variety of product sizes and weights, these systems are designed to handle a specific range of products. Very large/small or heavy/light products require varying degrees of manual handling.

As the process of handling involves more steps and is more manual, the cost increases. Storing products instead of receiving and immediately shipping them, adds cost. Firms must determine where lost sales from not having product on the shelves are balanced by the increased handling and storage costs.

Products that cannot be handled by automatic equipment also add costs. Some of the largest products may require more than one person to manually unload and load these into trucks. This process can be very time consuming and costly, and must be offset by higher prices.

## **Distribution Center Organization**

All distribution centers have three main areas and may have additional specialized areas. The three main areas are the receiving dock, the storage area and the shipping dock. In small organizations it is possible for the receiving and shipping functions to occur side by side, but in large centers, separating these areas simplifies the process. Often a distribution center will have dedicated dock doors for each store in its shipping area. The receiving area can also be specialized based on the handling characteristics of freight being received, whether the product is going into storage or is going straight to a store or by the type of vehicle delivering the product.

Other departments that a distribution center may have include:

- Transportation - arranges and coordinates shipments in and out of the DC
- Repackaging - breaks open bulk packages and repackages assortments for individual stores
- Dedicated Product Departments - divisions can be based on handling characteristics or storage characteristics. For example, refrigerated and non-refrigerator

Distribution Centers also have a variety of supporting departments. These include human resources, maintenance/facilities operations, production control and accounting.

## **Distribution Jobs**

A distribution center will have a *General Manager* that manages the facility. This individual will then have a number of department managers that report directly to them. Each department is then composed of supervisors and warehouse workers. The jobs of a warehouse worker can include:

- Receiver - unloads trucks, either with or without equipment
- Pallet Mover - transports pallets with equipment from one area of a plant to another
- Stocker - puts product into racks, either on forklifts or by hand
- Order Picker - picks product from the racks to send to a store, either on forklifts or by hand
- Packer - repackaged product from bulk boxes into assortments for individual stores
- Shipper - loads trucks, either with equipment or by hand

In addition to these basic job functions, there are a number of other areas of employment in a DC. Inventory management, maintenance, training and housekeeping can all be dedicated job functions.

## **Handling and Storage at Distribution Centers**

Distribution planners must decide which warehouses or distribution centers to use within the distribution channel.

Distribution planners must always be looking for ways to lower handling and storage costs at distribution centers. In some cases, distribution planners for major retail companies hire other companies to provide warehousing services for some of their products.

Sometimes, this is done when their own distribution centers cannot handle the volume of in-bound and out-bound shipments.

One major factor in deciding which warehouse or distribution center to use is how much they charge to handle and store the products. Here are some major types of handling and storage costs:

- Unloading in-bound shipments from the producer or wholesaler
- Moving products into and out from short-term storage
- Maintaining control of inventory in the facility
- Moving products from short-term storage and loading for out-bound shipments

In most cases, these handling and short-term storage costs are combined into a total handling and storage cost. An example formula for handling and storage costs is:

$d$  = total handling and storage costs of a distribution center or warehouse  
 $n$  = number units handled and stored  
 $c$  = cost per unit handled and stored

$$d = n \times c$$

Use the formula to solve the following problem:

A distribution planner has 2500 cases of bolts to store for a big sale that is occurring next month. The warehouse charges \$0.49 per case handled and stored at the warehouse. How much will the planner have to pay to distribute the 2,500 cases through the warehouse?

## ACTIVITY

With your group, do the following:

1. Discuss why motor transportation is the most common mode of transportation used by retail companies to move products from distribution centers to their stores? Give two major reasons.



2. Use the transportation formula ( $t = n \times m \times c$ ) to calculate the transportation costs for the following examples.

A distribution planner for a wholesale distributor is selecting which trucking company to use to distribute holiday candy from their central warehouse to three distribution centers of a major retail customer. The round trip mileage from the wholesale distributor's warehouse and the retail distribution centers are:

Distribution Center 1 --- 132 miles

Distribution Center 2 --- 532 miles

Distribution Center 3 --- 432 miles

Advance Trucking charges \$0.25 per case per mile

Midwest Trucking charges \$0.28 per case per mile

How much money would the planner save by using the lowest cost trucking company?

3. Use the distribution center formula ( $d = n \times c$ ) to calculate the costs for the following:

3.1 A distribution planner for a paint store chain is calculating the total handling and storage costs she will have to pay to use a temporary storage warehouse to distribute 2,300 cases of paint for a special promotion. The warehouse charges \$0.66 per case handled and stored at the warehouse. How much will the planner have to pay to distribute the 2,300 cases through the warehouse?

3.2 If the planner is charged \$0.54 per case by another warehouse, how much money would be saved by choosing the lowest cost warehouse?

## Local and Regional Distribution Costs for Retail Companies

Logistics and distribution planners must control the total transportation and distribution center costs within a distribution channel such as the producer-retailer-consumer channel. As shown in Figure 3.1, there are four major sources of costs within this type of channel.

1. Producer distribution centers--costs for handling and storage.
2. Transportation costs for shipping from producer distribution centers to retailer distribution centers.
3. Retailer distribution centers—costs for handling and storage.
4. Transportation costs for shipping from retailer distribution centers to retail stores including cost of unloading at stores.

The major focus of many distribution planners working for retail companies is controlling the cost of local and regional distribution of products from their distribution centers to stores within a defined geographic area. These geographic areas are sometimes called service regions.

The total local or regional distribution costs for a geographic area or service region is a combination of total handling and storage costs at a distribution center and total transportation costs from the center to the stores. The formula for calculating these costs is

$$r = d + t$$

**r = total local/regional distribution costs**

**d = total handling and storage costs of a distribution center**

**t = total transportation costs**

This formula shows that planners can reduce their local or regional distribution costs by using three strategies:

- Use the lowest cost distribution centers that are closest to the stores being served.
- Use the lowest cost transportation supplier to transport products from distribution centers to stores.
- Plan the shortest routes from distribution centers to the stores to reduce the mileage charged by transportation suppliers

## ACTIVITY

With your group, do the following:

1. Discuss the three major strategies that distribution planners can use to reduce local/regional distribution costs.
2. Use the formula to calculate the local/regional distribution costs for the following example.

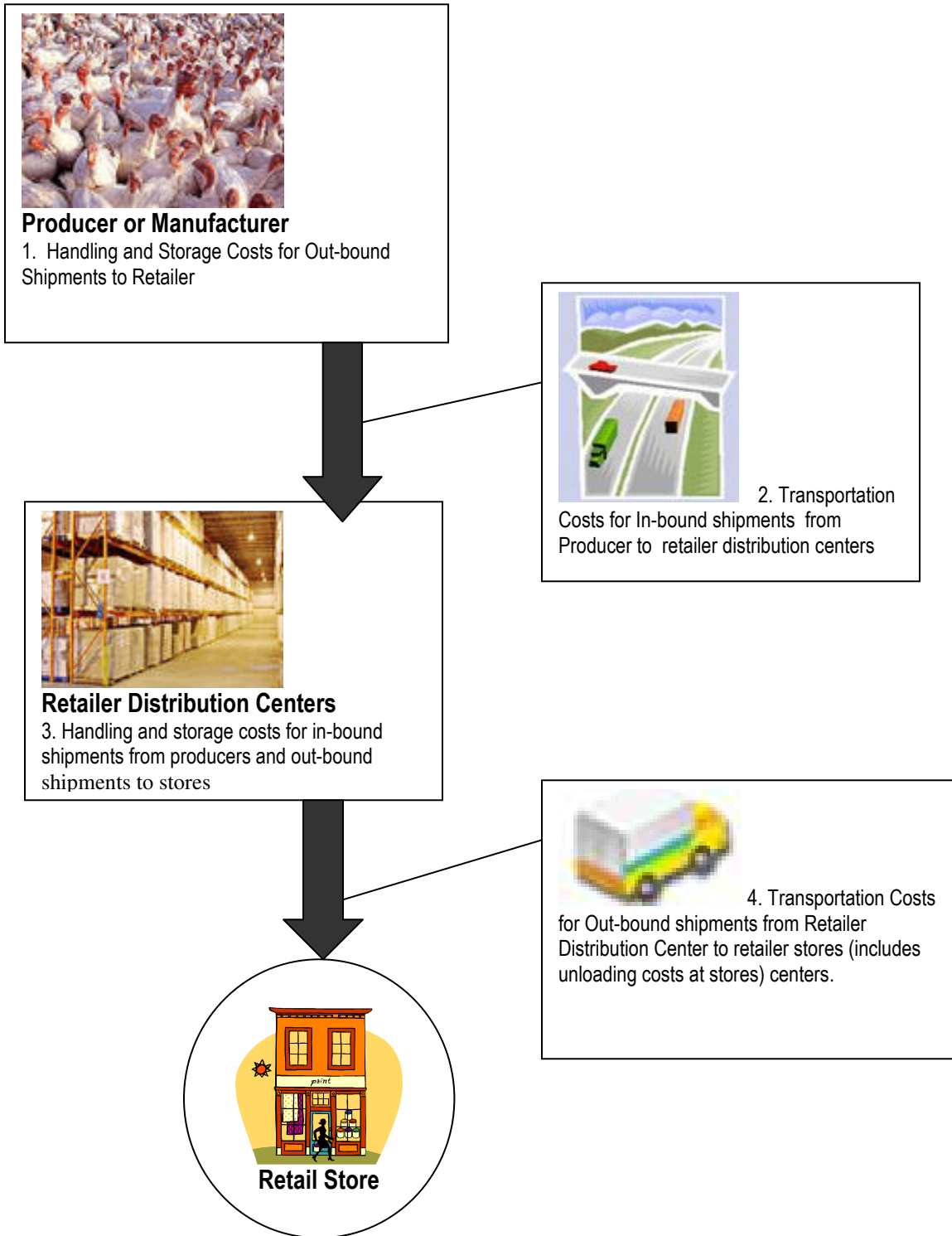
A distribution planner wants to calculate the total local distribution cost for distributing special promotion toys to her company's store in downtown Chicago. She wants to ship the toys from the company's regional distribution center, which is 23 miles away (round trip). She needs to make a delivery of 50 cases of toys each month for three months.

The regional distribution center charges \$0.25 per case shipped to the stores. The cost of shipping by truck to the stores is \$0.34 per case per mile (round trip).

What is the total distribution cost to distribute the toys over the three-month period?

**Figure 4.1**

**Distribution Costs for Producer-Retailer-Consumer Distribution Channel**



## Reading Charts to Select Suppliers

As discussed above, distribution planners can reduce transportation costs if the:

- Use the lowest cost distribution centers that are closest to the stores being served
- Use the lowest cost transportation supplier to ship from distribution centers to stores

It is not always that easy to do. In many cases, distribution planners must examine and compare the rates of multiple suppliers. Usually, this information is provided in complex charts that display different rates for different conditions such as number of total miles in a route. Distribution planners must be able to read and interpret charts containing cost information.

### ACTIVITY

Use the chart on the next page and answer the following questions.

1. What is the rate charged by Midwest Trucking to ship cases if the routes are between 3 and 4 miles?
2. What is the rate charged by Chicago Trucking if the routes are longer than 15 miles?
3. Which trucking company has the lowest rates for routes between 6 and 9 miles?
4. What would be the transportation costs for Advance Trucking to ship 50 cases of product with a route distance of 7 miles? How much could you save if you hired Midwest Trucking to do the same shipment?

**Figure 4.2 Transportation Rates by Distance of Route**  
**Route Distance Trucking Company**

Miles	Company A	Company B	Company C	Company D
<5	.34	.25	.30	
5-9.99	.34	.25	.37	
10-19.99	.34	.35	.37	
20<	.34	.45	.37	

rates = Dollar(\$) cost per case shipped

# Lesson 5

<b>TOPIC</b>	Maps and Routing	<b>TIME ESTIMATE</b>	2 hours
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<b>OBJECTIVES</b>
<ul style="list-style-type: none"> <li>• Students will be able to use software or Internet to read information from maps.</li> <li>• Students will be able to pinpoint locations on maps.</li> <li>• Students will be able to use maps to plan multiple routes.</li> </ul>

<b>MATERIALS &amp; RESOURCES</b>
<ul style="list-style-type: none"> <li>• Handout #9, Using Maps and Computers to Estimate Distance Between Locations</li> <li>• Handout #10, Route Planning</li> <li>• Copy of Handout 1 from Lesson 1</li> <li>• Copies of maps of United States</li> <li>• Access to Computers</li> <li>• Calculators</li> <li>• Websites: <a href="http://www.earth.google.com">http://www.earth.google.com</a> <a href="http://www.mapquest.com">http://www.mapquest.com</a></li> <li>• GIS/GPS Software for Teacher</li> </ul>

<b>LESSON DESCRIPTION &amp; ACTIVITIES</b>		
<b>Steps</b>	<b>No. of Minutes</b>	<b>ACTIVITIES</b>
1	5	- Discuss maps and their importance.
2	15	<ul style="list-style-type: none"> <li>- Distribute Handout 9, Using Maps and Computers to Estimate Distance Between Locations. Ask students to read the first part of the handout.</li> <li>- After students finish reading, distribute maps and ask them to look at maps for information on direction, scale and roads.</li> </ul>
3	15	- Ask students to pinpoint the recycling center on the map and answer the questions on Handout 9.

4	10	- Allow time for students to read the rest of Handout 9.
5	20	- Using computers, have students access mapquest.com and use it to estimate the distance from your school to the same location used in the map reading section. - Ask students to use mapquest.com to answer question on Handout 9.
6	30	- Discuss the importance of routing. - Distribute Handout 10, Route Planning and have students read and discuss the first part as a class. - With students working in groups, have them answer the first two questions of the activity on page 2 of Handout 10. - Allow time for them to report group results.
7	30	- Review Handout 1, Problem Statement, location of district and storage locations and recycling centers. - Allow time for students to work in groups to determine best routes from recycling center to district. - Read the rest of Handout 10 and complete the activities for determining multiple routes.

## Using Maps and Computers Estimate Distance Between Locations

### Using Maps to Estimate Distance Between Locations

As we discussed in Lesson 4, one major strategy for lowering local and regional distribution costs is to select the shortest routes between distribution centers and stores.

The first step in planning routes is to use maps to estimate the distance (i.e., number of miles) between locations. These locations are distribution centers and stores.

Look at the map provided for your project. Notice three types of information

- Direction—north, south, east, west
- Scale—miles to a standard measurement
- Roads—types and location
- Other Information—points of interest, retail centers

### ACTIVITY

With your group, answer the following questions

1. Which direction is the Recycling Center from RIHS? Is it east, west, north or south from the center?
2. How far would a truck have to travel to go from the Recycling Center to each of the district building if the truck used only major highways?
3. What is the route that would take the least amount of travel time and/or distance?

### Using Computers to Estimate Distance Between Locations

Most distribution planners no longer use maps to estimate mileage between locations. They use computer programs that are based on geographic information systems. One way to show how these systems work is to use publicly available computer software systems on the Internet. One popular Internet site--*mapquest.com* ---can provide you with an example of how these systems work.

With help from your teacher and students in your group, access and explore this site. Select "Driving Directions" to use it to estimate point to point distances between locations. Just enter addresses for the Recycling Center and the address of the pick up spots in the area.



## **ACTIVITY**

With your group, use *mapquest.com* to answer the following questions.

1. How far would a truck have to travel to go from the Recycling Center to the District Office 740 Maple Ave, Rushville, IL?
2. How far would a truck have to travel to go from the Industry Elementary at 306 East South Street in Industry, IL to the Recycling Center?
3. How far would a truck have to travel to go from Washington Elementary to the Recycling center?

## Route Planning

### Selecting Routes for Shortest Distances

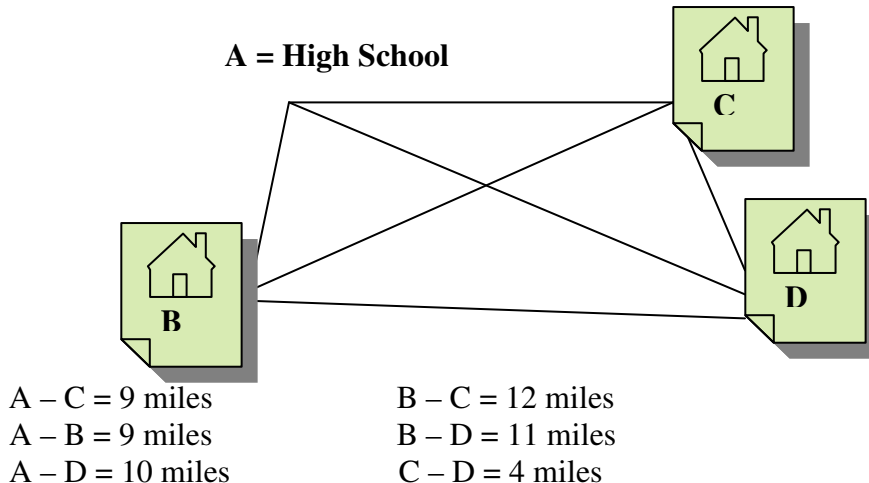
One of the most difficult tasks in distribution planning is selecting the shortest routes for trucks to take in distributing products from distribution centers to stores. In most cases, distribution planners can save money by having trucks deliver to more than one store in a single route.

One major key to route planning is making sure that you systematically explore every possible route and choose the route with the shortest total distance.

Let's illustrate the logic of route planning by thinking about decisions you make every day. As shown in Figure 4.1, you are at your high school and you have been asked to go pick up your three friends at their homes. To save time, you want to travel the shortest route that will get you to each house and then back to school. The location and distances between your high school and your friends' houses are shown on Figure 5.1.

**Figure 5.1**

#### Distances Between High School and Friends' Houses for 1 Best Route



#### Possible Routes: How many possible routes could you take?

You could simply brainstorm with your friends and try to come up with every possible route you can imagine. But, how do you know if you have thought of all possible routes. One way is to use a standard formula for calculating all possible permutations of the locations (your friend's houses) you need to travel to from the location of origin for your route (your high school).

Permutations are different orderings of a given set of objects or elements. In this case, these elements are locations of friends' houses. The formula is:

$$r = n!$$

**r = number of routes**

**n = number of locations(not including origin location)**

**! = factorial (product of all positive integers between 1 and number)**

Let's calculate how many different routes (permutations) you should be able to identify.

$$r = 3 \times 2 \times 1$$

$$r = 6$$

### ACTIVITY

1. What would be the number of possible routes if you had to go to four houses before returning to your school?

2. Shortest Route: Which is the shortest route?

How do you know you have selected the shortest route? One method is to list out every possible permutation, add the distances, and select the route with the shortest distance. Let's try the list method for identifying your shortest route. Follow the example on Route 1 and list out every possible route. Remember "A" is the location of your high school and must be the first and last location listed.

Route 1: A - B - C - D - A = 9 + 12 + 4 + 10 = 35 miles

Route 2: \_\_\_\_\_ miles

Route 3: \_\_\_\_\_ miles

Route 4: \_\_\_\_\_ miles

Route 5: \_\_\_\_\_ miles

Route 6: \_\_\_\_\_ miles

3. Now, imagine that your high school is Recycling Center and your friends' houses are the district buildings.

- a. Using a map or computer map program, chart the distances between each of the buildings and the recycling center.
- b. Determine the shortest route for distributing products between the recycling center and the district buildings. You may want to use a spreadsheet such as Excel to enter and calculate your data. You have just identified the shortest route for picking up recyclable products between a recycling center and district buildings! **r = n!**

But, we are not done. Read below for a more complex planning problem!

## Planning Multiple Routes for Shortest Distance

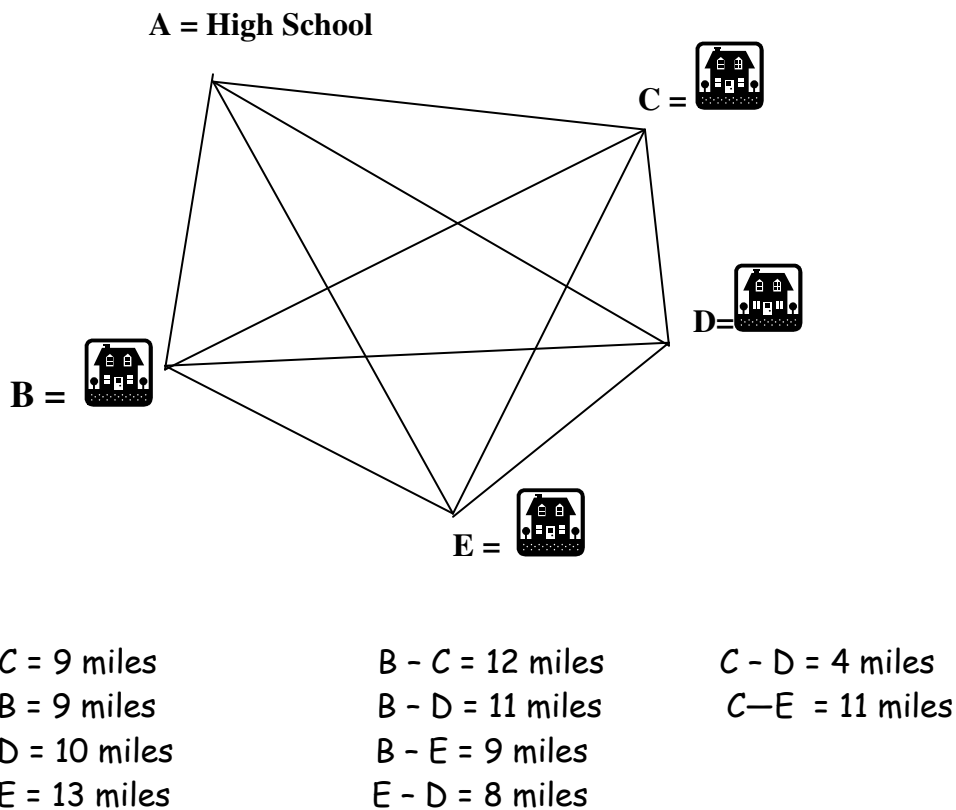
In some cases, distribution planners have to devise multiple routes for trucks so that these multiple routes add up to the shortest total distance. This is because trucks can only hold so many products and stores have limited storage capacity. As a result, planners must develop plans that involve multiple routes that only serve a few stores at a time.

The challenge is determining which stores should be grouped together for the shortest routes.

Let's go back to your route planning from your high school to your friend's houses. But, now look at Figure 5.2.

**Figure 5.2**

**Distances Between High School and Friends' Houses for 2 Best Routes**



Best Two Routes: What if I had to make two trips?

How many possible routes could I take if I could only get two friends in my car at the same time and had to make two trips to pick up four friends and take them back to school?

Again, you could simply brainstorm with your friends and try to come up with every possible combination of two routes you can imagine. But, how do you know if you have thought of all possible routes? Again, a formula can come be very helpful.

The formula is:

$$r = n!/p!$$

**r = number of possible routes**

**n = number of locations(not including origin location)**

**! = factorial (product of all positive integers between 1 and number)**

**p = number of locations (n) included in each route**

Let's calculate how different routes (permutations) you should be able to identify with four locations taking two at a time.

$$r = 24 / 2$$

$$r = 12$$

The next step is to select the two best routes that do not repeat locations. Use the list method to identify each of these routes and the total miles for each route. Then select the best two routes that do not involve the same friends.

<u>Route 1:</u>	=	<u>miles</u>
<u>Route 2:</u>	=	<u>miles</u>
<u>Route 3:</u>	=	<u>miles</u>
<u>Route 4:</u>	=	<u>miles</u>
<u>Route 5:</u>	=	<u>miles</u>
<u>Route 6:</u>	=	<u>miles</u>
<u>Route 7:</u>	=	<u>miles</u>
<u>Route 8:</u>	=	<u>miles</u>
<u>Route 9:</u>	=	<u>miles</u>
<u>Route 10:</u>	=	<u>miles</u>
<u>Route 11:</u>	=	<u>miles</u>
<u>Route 12:</u>	=	<u>miles</u>

## ACTIVITY

1. What would be the number of possible routes you could take if you had to pick up 6 friends and had to make 3 trips with 2 friends picked up in each route before returning to your school?
  
2. Again, imagine that your high school is a Recycling Center and your friends' houses are buildings in the district.
  - a. Chart the distances between each of the buildings and the recycling center.
  - b. Determine the shortest two routes serving two buildings in a single route. You may want to use a spreadsheet such as Excel to enter and calculate your data.

**Table 1**  
**Permutations for One Route (Three Friends Per Route)**  
(A = High School)

**First Stop Friend B (A-B-x-x-A)**

Route 1 --  $A-B-C-D-A = 9 + 12 + 4 + 10 = 35$   
Route 2 --  $A-B-D-C-A = 9 + 11 + 4 + 9 = 33$

**First Stop Friend C (A-C-x-x-A)**

Route 3 --  $A-C-B-D-A = 9 + 12 + 11 + 10 = 42$   
Route 4 --  $A-C-D-B-A = 9 + 4 + 11 + 9 = 33$

**First Stop Friend D (A-D-x-x-A)**

Route 5 --  $A-D-B-C-A = 10 + 11 + 12 + 9 = 42$   
Route 6 --  $A-D-C-B-A = 10 + 4 + 12 + 9 = 35$

**Table 2**  
**Permutations for Two Routes (Two Friends Per Route)**  
(A = High School)

**First Stop Friend B (A-B-x-A)**

Route 1:  $A-B-C-A = 9 + 12 + 9 = 30$   
Route 2:  $A-B-D-A = 9 + 11 + 10 = 30$   
Route 3:  $A-B-E-A = 9 + 9 + 13 = 31^*$

**First Stop Friend C (A-C-x-A)**

Route 4:  $A-C-B-A = 9 + 12 + 9 = 30$   
Route 5:  $A-C-D-A = 9 + 4 + 10 = 23^*$   
Route 6:  $A-C-E-A = 9 + 11 + 13 = 33$

**First Stop Friend D (A-D-x-A)**

Route 7:  $A-D-B-A = 10 + 11 + 9 = 30$   
Route 8:  $A-D-C-A = 10 + 4 + 9 = 23$   
Route 9:  $A-D-E-A = 10 + 8 + 13 = 31$

**First Stop Friend E (A-E-x-A)**

Route 10:  $A-E-B-A = 13 + 9 + 9 = 31$   
Route 11:  $A-E-C-A = 13 + 11 + 9 = 33$   
Route 12:  $A-E-D-A = 13 + 8 + 10 = 31$

## Lesson 6

<b>TOPIC</b>	Preparing and Presenting Reports	<b>TIME ESTIMATE</b>	3+ hours
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<b>OBJECTIVES</b>	
<ul style="list-style-type: none"> <li>• Students will be able to prepare reports.</li> <li>• Students will be able to make presentation of report.</li> </ul>	

<b>MATERIALS &amp; RESOURCES</b>	
<ul style="list-style-type: none"> <li>• Handout #11, "Rubric for Evaluating Student Presentation"</li> <li>• Handout #12, "Preparing the Plan"</li> <li>• Handout #13, Recycling Program Solution Checker</li> <li>• Copy of Handout 1 from Lesson 1, Problem Statement</li> <li>• Access to Computers</li> </ul>	

<b>LESSON DESCRIPTION &amp; ACTIVITIES</b>		
<b>Steps</b>	<b>No. of Minutes</b>	<b>ACTIVITIES</b>
1	5	- Review the Handout 1, Problem Statement and discuss any questions students may have.
2	10	- Distribute Handout 11, Rubric for Evaluating Student Presentation. - Discuss and answer any questions that students may have.
3	10	- Distribute Handout 12, Preparing the Plan. Have students read and complete information needed for the report.
4	60	- Distribute Handout 13, Recycling Program Solution Checker. Have students read and complete information needed for the report. - Allow time for student to work on preparing reports and presentations.
5	60	- Have students make presentations to the class. - Discuss the things students learned while working on the presentation.
6	50	- Conduct a class discussion on the various careers associated with TDL - Ask students to research and write about one job or position related to TDL that they find interesting. - Have students share their reports.



<b>Evaluating Student Presentations<sup>2</sup></b>					
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Total</b>
<b>Organization</b>	Audience cannot understand presentation because there is no sequence of information.	Audience has difficulty following presentation because student jumps around.	Student presents information in logical sequence which audience can follow.	Student presents information in logical, interesting sequence which audience can follow.	
<b>Subject Knowledge</b>	Student does not have grasp of information; student cannot answer questions about subject.	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student is at ease with expected answers to all questions, but fails to elaborate.	Student demonstrates full knowledge (more than required) by answering all class questions with explanations and elaboration.	
<b>Graphics</b>	Student uses superfluous graphics or no graphics	Student occasionally uses graphics that rarely support text and presentation.	Student's graphics relate to text and presentation.	Student's graphics explain and reinforce screen text and presentation.	
<b>Mechanics</b>	Student's presentation has four or more spelling errors and/or grammatical errors.	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	
<b>Eye Contact</b>	Student reads all of report with no eye contact.	Student occasionally uses eye contact, but still reads most of report.	Student maintains eye contact most of the time but frequently returns to notes.	Student maintains eye contact with audience, seldom returning to notes.	
<b>Elocution</b>	Student mumbles, incorrectly pronounces terms, and speaks too quietly for students in the back of class to hear.	Student's voice is low. Student incorrectly pronounces terms. Audience members have difficulty hearing presentation.	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear presentation.	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation.	
				<b>Total Points:</b>	

<sup>2</sup> Adapted from Evaluating Student Presentations, Information Technology Evaluation Services, NC Department of Public Instruction  
Recycling Module  
TDL Math Science Project 2008

## Planning a Presentation

### I. Decide on type of presentation your group will be doing.

- a. Poster board presentation
- b. Power-point presentation
- c. Other

### II. Material to include

- a. Graphics
- b. Calculations
- c. Problem Statement
- d. Steps in solution
- e. Solution Statement

### III. Gather all necessary materials

- a. Visual aides
- b. Media source

### IV. Presenting

- a. Practice your presentation
- b. Decide what the job will be for each member of the group during the presentation.

## New Recycling Program for Schuyler-Industry Community Unit District #5 Solution Checker

**STEP 1: Answer the questions below:**

- Did you take into account the location of the recycling center?
- How did you decide on the best routes from the recycling center to the district buildings?
- If yes, how did this effect your route planning? After answering the question, proceed to Step 2.

**STEP 2: Complete the table below:**

Route Description	# of Times Route is Repeated	Transpiration Option	Mileage for One Route	Total Mileage

**STEP 3: What is the total cost of your solution?**

# **Teacher**

## **Assessment Materials**

# FINAL EVALUATION

## **Problem Statement to be Solved:**

*You are to develop a district wide recycling program for Schuyler-Industry Community Unit District #5. You have been asked to find a recycling center in area. You will then need to choose a company to pick up the recyclable materials or develop a method of transporting the recyclables to the recycling center. You are to describe in detail your plan in a written business report which you will be asked to orally present at the next monthly School Board meeting for implementation in the 2008-2009 school year.*

## **Performance element and academic learning standards being assessed.**

- Select carriers for transportation mode/modes
- Determine the locations of recycling center or company to pick up recyclables.
- Develop routes and schedules for emptying recyclable containers and/or transporting items.

## **Mathematics**

- Apply formulas in a wide variety of theoretical and practical real work measurement.

## **Language Arts:**

- Interpret tables, graphs and maps in conjunction with related text.
- Communicate information and ideas in narrative informative and persuasive writing with clarity and effectiveness.
- Deliver planned and impromptu oral presentations.

## **Measurement Criteria that would describe an acceptable solution**

- Carrier selected represented the most cost effective means for transporting or picking up recyclables.
- Identified on map potential locations of recyclable materials.
- Evaluate cost differences.
- All calculations were correct using formulas, maps, and charts provided.
- Business report included a cover letter, introduction stating the purpose of the report, documentation to support recommendations, a detailed explanation of costs, and tables, charts and spreadsheets to more clearly communicate recommended recycling plan.
- Presentation presented the information with visual aids and/or handouts.
- The presentation met the 7 requirements of effective business presentations:
  - Evidence of preparedness and practice
  - Started on time
  - Dressed appropriately
  - Showed enthusiasm and confidence
  - Maintained eye contact, showed friendliness and respect

- Spoke slowly and distinctly without grammatical errors or slang
- Welcomed questions and answered completely;
- Accepted reactions without being defensive.

## **Provide a Suggested Scoring Guide or Rubric for Performance Response**

### **Suggested Scoring Guide**

#### **1. Solving the Problem—50 points**

- Carrier selected represented the most cost effective means for receiving recyclables on scheduled dates (10 points)
- Read map correctly in identifying potential locations and calculating best route. (10 points)
- Evaluate alternative locations of recycling centers and determine cost differences between pick up and delivery of recyclables. (15 points)
- All calculations were correct using formulas, maps, and charts provided. (20 points)

#### **2. Business Report—25 points**

#### **3. Presentation -20 points**

# **A P P E N D I X**

## **GLOSSARY of TERMS Related to this Scenario**

### **Distribution channel**

The complete sequence of producers, wholesaler, and retailers involved in bringing a product from the producer to the consumers

### **Distribution costs**

The direct costs for handling and storing products at distribution centers and transporting products from manufacturers to stores and consumers.

### **High levels of service**

A situation in which retail companies consistently have all of their products available in stores when customers want to buy them. High levels of service are measured by the percentage of products carried by a store that are in stock during a buying period (no stock outs).

### **Materials management**

The planning and management of the distribution of raw materials and supplies to where they are used to produce products and merchandise, usually a manufacturing facility, and moving them through the company until these materials become finished products.

### **Physical distribution management**

The planning and management of the distribution of finished products and merchandise from manufacturers or their wholesalers to stores and consumers.

### **Producers**

Those companies that convert raw materials into products and merchandise to be distributed and sold to the consumer. Producers are usually manufacturing companies.