



## Teaching Guide

For

***CATERPILLAR PAVER MODULE***

# Transportation, Distribution and Logistics

# ACKNOWLEDGEMENTS

This curriculum project was completed under the direction of Dr. Fran Beaman, Project Director with assistance from Jerry Scranton, Jerry Ohare and Melissa Briscoe, Project Consultants.

The project staff would like to thank Herb Shields, HCS Consulting Inc. and former Logistics Manager for his work in the development of this module. Material for the problem was provided by Rick Roberts, Caterpillar, Peoria, IL.

The development of these materials was made possible through a grant from the Department of Commerce and Economics Opportunity to the Illinois Office of Educational Services.

# Project Overview

**About this Project** The materials provided in this document are designed for 9<sup>th</sup> and 10<sup>th</sup> grade for high school students. The materials are presented in a problem-based approach which heavily involves students in the teaching-learning process by giving them a real problem to research, discuss, and solve. Students learn about the role of various occupations within the Transportation, Logistics and Distribution industry and then are given a real-world problem which has been provided by Illinois industries. Through individual and team effort, the students acquire the skills needed to develop a distribution plan for promotion products and merchandise of a major retailer in their communities.

Your role in this effort is one of guide or mentor rather than one of lecturer. As with all learning, student success is directly related to how much they get involved in the problem... the more involvement... the more learning.

Each Scenario is designed as a separate set of learning activities. Each Scenario includes the following:

- **Objectives:** Each scenario begins with a set of learning objectives. This is the expected learning outcome of the module based on the readings and class discussion and activities.
- **Readings:** Each scenario starts with short introductory readings on the topic. These readings are designed to provide the basis for group discussion and problem-solving activities.
- **Activities:** Each scenario provides group activities that are designed to help students apply the concepts and skills needed in solving the problem.

The major goals of the project are to:

## Project Goals

- Provide an orientation to career opportunities in Transportation, Logistics and Distribution services.
- Provide sufficient knowledge and experience to students for them to decide whether they wish to explore these career opportunities further.
- Demonstrate integration of problem-solving, teamwork, computer and learning skills in authentic workplace applications.
- Demonstrate the application and integration of academic standards in authentic workplace applications.

More specific learning objectives are presented at the beginning of each scenario.

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# Scenario 1: Caterpillar Paver Project

## Scenario Focus:

**Primary Career Pathway:** Logistics Planning and Management

**Applies to People and/or Freight:** Freight

**Subject Areas:** Industrial Technology, Math, Communication

**Business/Industry/Government Partners:** *Caterpillar, Peoria, IL*

**Occupation/Job Titles Related to this Scenario:** Logistics Manager; Warehouse Manager; Supply Chain Manager, Buyer, Cost Analyst, Inventory Analyst

## Contact Information:

**Industry Rep:** Rick Roberts, 309-266-0175, [Roberts\\_rick1@cat.com](mailto:Roberts_rick1@cat.com)

**Developer:** Herb Shields, 847-498-9510, [hcsconsnb@aol.com](mailto:hcsconsnb@aol.com)

## Teacher Notes:

This module should help students understand what types of situations develop in the real world of manufacturers. It will also teach them the supply chain concept and should help them understand how important the process is in fulfilling society's daily needs. The text book referenced in the teacher notes on the student information sheets will give you plenty of additional information that you can use in class, time permitting.

Another important piece of learning in the module is the fact that the problem does not have one clear answer. Rather, it provides an opportunity for the student to think creatively in how to balance the warehouse, pricing, and inventory issues.

Given the need for creativity, it might be good to have the students work in teams to address the development of a recommended plan. In Cat's organization, this problem would be addressed by a team with inputs from many different functions within the business.

Students may have the impression from the media that all manufacturing has moved from the U.S.A. to China, India, etc. You may want to use Caterpillar as a good example of a global company, but with important manufacturing activity still in the U.S. A related point worth noting is that, even with a lot of manufacturing moving off-shore, the demand for logistics and supply chain people will continue to grow in the U.S.

## Problem to be Solved:

You are the Supply Chain Manager for Caterpillar's Paver Manufacturing Division located in Peoria, Illinois. Management has asked you to support increased production of Paver Model P-202. Paver P-202 requires a critical part – number 1A1- for each unit.

Production of P-202 is increasing from 45 units per day to 90 units per day over the next 12 months. You have three options to consider

1. Build a larger warehouse
2. Bring on a second supplier in China. 1A1 cost from this supplier is \$15.00. The current supplier located in Indiana has a price of \$25.00. Lead time from China is 9 weeks. Lead time from Indiana is 1 day. The Indiana supplier keeps a safety stock of 2 weeks supply. They can only increase production by 25%.

3. Change the material flow into the warehouse and manufacturing plant. This would include new ideas related to the flow of parts from your supplier(s) through the warehouse and into manufacturing. Kan Ban methodology is used. The Kan Ban tub capacity is 90 units of 1A1.

Your job is to come up with recommendations for management to consider.

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

### **Addressed:**

- Select modes of transportation
- Determine the location of facilities and services
- Develop routes and schedules
- Develop warehouse/storage solutions
- Develop documentation and information flow requirements and solutions

## **Illinois Learning Standards:**

### ***Mathematics***

- Work flexibly with fractions, decimals, and percents to solve number sentences and word problems. (G-6D)
- Construct, read, interpret, infer, predict, draw conclusions, and evaluate data from various displays... (G-10A)
- Select, use, and justify appropriate operations, methods, and tools to compute or estimate with real numbers. (H-6C)
- Solve problems that involve percents, including percent increase and decrease, regardless of the piece of information that is missing. (H-6D)
- Solve problems using simple matrix operations (addition, subtraction, scalar multiplication). (I-6B)
- Model and solve real problems using mathematical functions and relations. (J-8C)

### ***Language Arts:***

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

## **Objectives:**

- Understand the role of logistics and supply chain management in manufacturing.
- Understand the relationships between warehouse space and inventory investment.
- Understand the role of suppliers.
- Use cost analysis techniques to support a business decision.
- Prepare and present a report that includes the analysis, solutions and recommendations for this project.

What I want students to Know	What I want student to be Able to Do
<ul style="list-style-type: none"> <li>• Understand the logistics/supply chain process</li> <li>• Understand warehouse functions and design</li> <li>• Understand the role of suppliers</li> <li>• How to use cost analysis to improve decision making</li> <li>• How manufacturers manage inventory</li> <li>• Lead time and its impact on inventory</li> <li>• Issues around global sourcing</li> <li>• Kan Ban and other inventory techniques</li> </ul>	<ul style="list-style-type: none"> <li>• Diagram the supply chain process for a manufacturing facility</li> <li>• Develop a cost analysis for a purchasing decision</li> <li>• Diagram a typical warehouse</li> <li>• Explain the inventory options available for this problem</li> <li>• Write a project report</li> <li>• Make a presentation to the class on this report</li> </ul>

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

- Provided a recommendation from one of the three options with supporting documentation which included student understood the logistics/supply chain process, warehousing, purchasing and inventory concepts and cost factors.
- Recommendation provided evidence that all three options had been analyzed.
- Calculation of costs for the two suppliers was correct.
- Actively participated in determining recommendation and preparing report and presentation.
- 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 distribution 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.

**Time Required to Complete Problem:** less than 15 instructional hours

**Materials included in this Module:**

1. Instructional Plan for each topic with discussion questions and student activities
2. Copy of Student Information Sheets with Reading assignments and activities for Duplication
3. Copy of Material describing Problem for Student
4. Optional Interim Evaluation that Teacher may want to use to measure student progress
5. Final Evaluation with measurement criteria and scoring guide
6. Glossary of Terms Related to this Module

## **Support Materials and Resources that may be helpful in the Completion of Scenario:**

1. Teacher Reference book suggested: Contemporary Logistics by Murphy & Wood, Pearson Prentice Hall (ISBN 0-13-035280-2)
2. Internet Access to related TDL Websites such as:
3. Student access to computers with word processing and presentation software.
4. Module A, Preparing a Business Report—can be downloaded from the following website:
5. Module B, Preparing a Presentation—can be downloaded from the following website:
6. Glossary of terms for Transportation, Distribution and Logistics—can be downloaded from the following website:

# Summary of Instructional Plan

Topic	Resource	Student Activity	Teacher Notes
Logistics Supply chain process	Student Information Sheet 1	Activities suggested on Student Information Sheet 1	<u>Many want to read:</u> Contemporary Logistics Murphy & Wood Pearson Prentice Hall ISBN 0-13-035280-2  Chap 1 pg. 5-10 Chap 2 pg 36-44
Warehousing Functions and basic design criteria	Student Information Sheet 2	Activities suggested on Student Information Sheet 2	Contemporary Logistics Chapter 10
Analyzing a Logistics and Distribution Problem	Student Information Sheet 3	Activities listed on Student Information Sheet 3	Provide background information on Caterpillar  Distribute Student Copy of the Problem in Appendix
Purchasing-- Role of suppliers Global sourcing	Student Information Sheet 4	Activities listed on Student Information Sheet 4	Contemporary logistics Chapter 11 Chapter 12
Inventory management including Lead time and Kan Ban	Student Information Sheet 5	Activities listed on Student Information Sheet 5	Contemporary Logistics Chapter 9 Chapter 11 pgs.333-7
Project summary and report preparation	Student Information Sheet 6	Activities listed on Student Information Sheet 6	Depending on class size and available time, this phase of the module may be done by the students individually or in groups.
Interim Evaluation	Interim Evaluation Sheet 1	Describes four optional activities	Teacher can select one or all of activities to measure student progress during module.
Final Evaluation	Final Evaluation Sheet	Describes problem, TDL performance elements and IL Academic Learning Standards being evaluated.	Measurement Criteria, Scoring Guide and Optional Checklist are provided to provide guidance for evaluating student.

# Logistics/Supply Chain Process

## Reading Assignment

Have students read ***Student Information Sheet 1, Logistics/Supply Chain Process***

For additional information, instructor may want to read Chapter 1 pp. 5-110 and Chapter 2, pp. 36-44 of ***Contemporary Logistics*** text by Murphy & Wood.

## Logistics/Supply Chain Process

After students have reviewed the readings,

- Review definitions of Logistics and Logistics Activities.
- Ask for ideas about how the merchandise gets to the store and onto the shelf?
- Discuss the number of stores that are competing for the students' business--chains and local stores.

## Activity

Have students discuss and answer the following questions together or in their groups:



1. Discuss how a supply chain for a manufacturer differs from the supply chain for consumer products.
2. As a homework or outside assignment, have students visit a grocery or drug store, look at the shelves for one product category – i.e. soda, cereal, shampoo, etc.
  - Notice the variety of brands, sizes, products.
  - Discuss what the students learned at the store.
  - Point out that there are 23,000 products in the large retail chains of today.
  - How many brands or sizes of a specific product line did the students find?

## Warehousing and Distribution

### Reading Assignment

Have students read *Student Information Sheet 2, Warehouse Functions and Design Criteria*

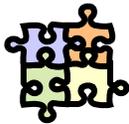
### Warehouse Functions and Design Criteria

For additional information, instructor may want to read Chapter 10 of *Contemporary Logistics* text by Murphy & Wood.

After students have reviewed the readings,

- Identify and describe an example of a warehouse they have seen.
- When or why would anyone ever need a warehouse?
- What kind of jobs do you think would be associated with a warehouse?

### Activity



Have students discuss and answer the following questions together or in their groups:

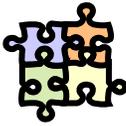
1. Discuss what information you would need to be able to design the new warehouse mentioned in the problem.
2. Research and discuss other warehouse options – renting space in a public facility, using the supplier's warehouse, etc. Contact a third party logistics (3PL) company to learn about the services offered by those firms.

## Analyzing a Logistics and Distribution Problem

### Analyzing a Logistics and Distribution Problem

- Provide background information on the Caterpillar Paver Manufacturing project and distribute a copy of the scenario.
- Have students read ***Student Information Sheet 3, Analyzing a Logistics and Distribution Problem.***
- Have students read the scenario.
- If available, have the class listen to the webcast from Caterpillar about this project.

### Activity



Ask your students to break into groups and develop questions they would like to ask a company representative.

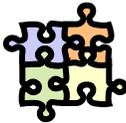
1. Read the scenario and make a list of what you know and what you don't know.
2. Look at your list of what you don't know and develop questions you need to get answers to from a company representative.
3. Review your questions with your teacher or other students to make sure they understand your question and how you could say it better.
  - **Visit the groups and give feedback on the content of their questions and their delivery.**
  - **Students should each be able to state one question clearly.**

### After Contact with the Company Representative

After the contact with the company representative, students will have more information.

Make sure that each group writes out their notes as soon as possible.

### Activity



Student group activities are the following.

1. Revise your work sheet and write down your revised list of what you know and what you don't know.
2. Set some priorities and determine what you need to get answered first.

# Purchasing

## Reading Assignment

Have the students read ***Student Information 4, Purchasing--Role of suppliers and Global sourcing.***

## Purchasing--Role of suppliers and Global sourcing.

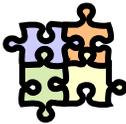
For additional information, instructor may want to read Chapter 11 and 12 of ***Contemporary Logistics*** text by Murphy & Wood.

As a review, ask students individually or as a class to:

Diagram the Caterpillar supply chain for the Paver P-202 model.

**The diagram should include the 2 suppliers, the Cat warehouse, and the Cat manufacturing plant. The possible second warehouse should also be included.**

## Activity



Ask students to do the following in their groups:

1. Do an internet research on costs associated with international transportation. Your teacher will provide you with a list of web sites.
2. Assuming that the additional costs of transportation to the Cat plant from China are 20%, decide how you might split the business for Part 1A1 between the two sources. Explain how you would deal with the inventory needed to support the 9 week lead time from the China supplier.
3. Optional: Make a list of 5 products found in your home that are labeled “made in the USA”. List 5 more products that are labeled as being manufactured somewhere outside of the US. Compile a list in class of all of the product types and discuss what you can learn from the findings.

## Inventory Management

### Reading Assignment

Have students read *Student Information Sheet 5, Inventory Management*

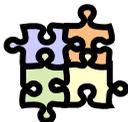
### Inventory Management

For additional information, instructor may want to read Chapter 19 and pp 333-337 of Chapter 11 of *Contemporary Logistics* text by Murphy & Wood.

Conduct class discussion on the following:

1. Give examples of items or materials that might be kept in inventory at your company under each of these classifications:
  - Raw materials
  - Work-in-process
  - Finished goods
  - Maintenance, repair, and operating supplies
2. Explain why companies need inventory to provide excellent customer service?
3. Discuss how inventory helps companies run their factories economically?
4. Why do companies want to keep a minimum inventory investment?
5. Explain why the goal of minimum inventory investment conflicts with the goals of excellent customer service and economical factory operation.

### Activity



Ask students to do the following in their groups:

1. Discuss how the lead time of 9 weeks from the supplier in China will impact Cat's inventory. Discuss ways that Cat may try and deal with this issue to minimize its inventory investment.
2. Explain how the higher production rate of 90 Pavers per day will affect the Kan Ban quantity. What changes will have to be made in the Kan Ban process?

# Preparing the Plan

## Preparing to develop the Plan

Have students read *Student Information Sheet 6, Project Summary*.

### Activity



Ask them to

- gather the information you have for your plan.
- Identify any missing pieces that you need to work on.
- Complete those pieces.

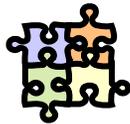
## Preparing the Report and Cover Letter

Study *Module A, Writing Business Reports and Cover Letter* if necessary.

Ask students to work as a team and do the following:

1. Identify and discuss the major types of information to be included in your plan. Discuss how to display your information in tables and charts.
2. Develop an outline of the key points that you want to cover in your report.
3. Develop the first draft of your cover letter and report
4. After review, complete the final copy of the cover letter and report.

### Activity



## Preparing the Presentation

Study *Module B, Preparing An Oral Presentation with Media* if necessary.

### Activity



Instructor: Will need to decide if this is a team activity or individual.

1. Using the key points from your outline, prepare your presentation and develop your notes and visual aids.
2. Practice your presentation and make improvement based on their suggestions.
3. Present your Report.

## ***Optional Interim Evaluation***

The following questions are activities can be used as part of the evaluation at the close of each of the 4 content topics of Supply Chain Process, Warehouse Functions, Purchasing and Inventory. The instructor may choose to use one or all as desired.

1. Describe the supply chain process and give an example from your own experience as a consumer or use a current event.
2. List the functions of a warehouse and explain why companies have warehouses.
3. Calculate the cost difference between the Indiana and China suppliers

**Answer: Indiana supplier  $\$25.00 \times 1800/\text{month} \times 12 = \$540,000$  annual cost**  
**China supplier  $\$15.00 \times 20\%$  (cost of ocean freight, duties, etc.) =  $\$3.00$**   
**Total cost from china  $\$15.00 + 3.00 = \$18.00/\text{unit}$**   
 **$\$18.00 \times 1800/\text{month} \times 12 = \$388,800$**

4. Calculate the carrying cost of a 9 week supply of Part 1A1.

**Answer: 9 week supply =  $90/\text{day} \times 5 \text{ days}/\text{wk.} \times 9 \text{ weeks} = 4050$  pieces in Inventory**  
**Inventory cost of 4050 pieces =  $\$18.00 \times 4050 = \$72,900$**   
**Carrying cost (assume 20%) =  $\$72.900 \times .20 = \$14,580$  per year**

# FINAL EVALUATION

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

You are the Supply Chain Manager for Caterpillar's Paver Manufacturing Division located in Peoria, Illinois. Management has asked you to support increased production of Paver Model P-202. Paver P-202 requires a critical part – number 1A1- for each unit.

Production of P-202 is increasing from 45 units per day to 90 units per day over the next 12 months. You have three options to consider

4. Build a larger warehouse
5. Bring on a second supplier in China. 1A1 cost from this supplier is \$15.00. The current supplier located in Indiana has a price of \$25.00. Lead time from China is 9 weeks. Lead time from Indiana is 1 day. The Indiana supplier keeps a safety stock of 2 weeks supply. They can only increase production by 25%.
6. Change the material flow into the warehouse and manufacturing plant. This would include new ideas related to the flow of parts from your supplier(s) through the warehouse and into manufacturing. Kan Ban methodology is used. The Kan Ban tub capacity is 90 units of 1A1.

Your job is to come up with recommendations for management to consider.

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

- Select modes of transportation
- Determine the location of facilities and services
- Develop routes and schedules
- Develop warehouse/storage solutions
- Develop documentation and information flow requirements and solutions

### ***Mathematics***

- Work flexibly with fractions, decimals, and percents to solve number sentences and word problems. (G-6D)
- Construct, read, interpret, infer, predict, draw conclusions, and evaluate data from various displays... (G-10A)
- Select, use, and justify appropriate operations, methods, and tools to compute or estimate with real numbers. (H-6C)
- Solve problems that involve percents, including percent increase and decrease, regardless of the piece of information that is missing. (H-6D)
- Solve problems using simple matrix operations (addition, subtraction, scalar multiplication). (I-6B)
- Model and solve real problems using mathematical functions and relations. (J-8C)

### ***Language Arts:***

- 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**

- Provided a recommendation from one of the three options with supporting documentation which included student understood the logistics/supply chain process, warehousing, purchasing and inventory concepts and cost factors.
- Recommendation provided evidence that all three options had been analyzed.
- Calculation of costs for the two suppliers was correct.
- Actively participated in determining recommendation and preparing report and presentation.
- 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 distribution 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.

### ***Suggested Scoring Guide:***

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

- Recommendation provided with supporting documentation and evidence of analysis. (30 points)
- All calculations were correct. (20 points)

#### **2. Participation in Solving Problem—10 points**

#### **3. Business Report—20 points**

#### **4. Presentation –20 points**

# Optional Checklist for Final Evaluation

The student's written report, cover letter and presentation met the following criteria.

Scenario Evaluation Criteria	Scenario Evaluation
1. Does the information in the report provide evidence that the required content was understood—specifically determining most efficient costs?	<input type="checkbox"/> YES <input type="checkbox"/> NO
2. Did the recommendation address one of the three options with supporting documentation?	<input type="checkbox"/> YES <input type="checkbox"/> NO
3. Did the recommendation provide evidence that all three options had been analyzed?	<input type="checkbox"/> YES <input type="checkbox"/> NO
4. Were all math calculations correct?	<input type="checkbox"/> YES <input type="checkbox"/> NO
5. Was the business report well organized, written clearly and include all the necessary information?	<input type="checkbox"/> YES <input type="checkbox"/> NO
6. Was there a well written informative cover letter accompanying the business report?	<input type="checkbox"/> YES <input type="checkbox"/> NO
7. Did the business report include the purpose, recommendations and supporting documentation?	<input type="checkbox"/> YES <input type="checkbox"/> NO
8. Was the business report professionally and accurately presented?	<input type="checkbox"/> YES <input type="checkbox"/> NO
9. Did the presentation include the purpose, major points and the recommendation?	<input type="checkbox"/> YES <input type="checkbox"/> NO
10. Did the presentation have supporting visuals, graphs, charts, etc. that were easily visible and readable?	<input type="checkbox"/> YES <input type="checkbox"/> NO
11. Did the student have the information ready in time for the meeting date?	<input type="checkbox"/> YES <input type="checkbox"/> NO
12. If assignment was done by team of students, did each member of the team contribute and fulfill their role and responsibility to the solution of the problem?	<input type="checkbox"/> YES <input type="checkbox"/> NO



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

## **Supporting Documents**

### ***Student Materials Glossary***



***STUDENT MATERIALS***

***FOR***

***CATERPILLAR PAVER MODULE***

# CATERPILLAR.

Peoria, IL 33333

## Interoffice Memorandum

**To:** Supply Chain Manager  
Caterpillar Paver Manufacturing Division

**From:** Rick Roberts, Manager

I need the support of your division to increase production of Paver Model P-202. I realize the Paver P-202 requires a critical part – number 1A1- for each unit. We will be increasing production of P-202 from 45 units per day to 90 units per day over the next 12 months. The management team needs your recommendation on which of the following three options we should pursue:

1. Build a larger warehouse
2. Bring on a second supplier in China. 1A1 cost from this supplier is \$15.00. The current supplier located in Indiana has a price of \$25.00. Lead time from China is 9 weeks. Lead time from Indiana is 1 day. The Indiana supplier keeps a safety stock of 2 weeks supply. They can only increase production by 25%.
3. Change the material flow into the warehouse and manufacturing plant. This would include new ideas related to the flow of parts from your supplier(s) through the warehouse and into manufacturing. Since we use the Kan Ban methodology, the Kan Ban tub capacity is 90 units of 1A1.

Once you have arrived at your recommendations, would you please prepare a written business report with details and present it at our next management team meeting.

If you have any questions, please let me know.

## Student Information Sheet 1 --Logistics/Supply Chain Process

**Logistics** is the part of the supply chain that plans, implements, and controls the efficient, effective forward and reverse flow of goods, services, and related information between the points of origin and the point of consumption in order to meet customer's requirements.

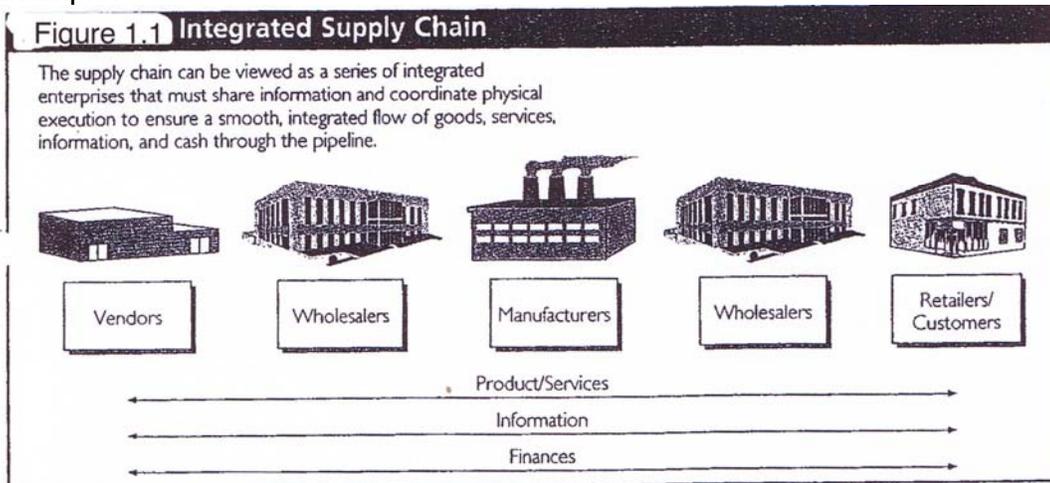
**Logistics Activities:** These are the functions of a business that are usually included in logistics.

- Traffic and transportation
- Production planning
- Purchasing
- Customer service
- Return goods handling
- Parts and service support
- Scrap disposal
- Warehousing and storage
- Packaging
- Materials handling
- Inventory control
- Order fulfillment
- Plant and warehouse site selection
- Demand forecasting

### Supply Chain

Definition: The functions and activities starting with suppliers through production and distribution to customers and end users that provide products, services, and information that add value for the customer.

Example:



### Supply chain enterprises

- Suppliers – companies that provide raw materials and components to manufacturers
- Manufacturers – companies that make an end product for consumers (i.e. Pepsi Cola) or for another company (i.e. Cummins Engine provides engines to Caterpillar)
- Distribution/Distributors – Warehouse facilities that may be owned by the manufacturer or public facilities that serve a variety of manufacturers. These facilities store and sort product for shipment to retailers or other companies.
- Retailers – Companies that sell products directly to the consumer – i.e. Wal Mart, Target, Walgreen's, etc.
- Consumers – End users of retail products

Supply Chain Attributes – Reason why most companies in today's economy are adopting supply chain management as part of their management approach.

- Inventory visibility – information about inventory levels is available to all enterprises from suppliers to retailers
- Pull system rather than push – companies produce inventory as needed throughout the supply chain rather than each enterprise make as much as they want and ship it to their customers
- Cost reduction – an efficient supply chain lowers costs of inventory, transportation, warehousing, etc.
- Real time information – computer systems are linked together so that information can be available instantly for better decision making
- Customer service – the objective of supply chain management is to deliver products to the consumer when they want them at the lowest possible cost
- Relationships – more effective business to business relationships lead to lower costs throughout the process.

### **ACTIVITY:**

1. Discuss how a supply chain for a manufacturer differs from the supply chain for consumer products.
2. Visit a grocery or drug store, look at the shelves for one product category – i.e. soda, cereal, shampoo, etc. Notice the variety of brands, sizes, products.

How many brands or sizes of a specific product line did you find?

## Student Information Sheet 2 --Warehouse Functions and Design Criteria

### WAREHOUSING AND DISTRIBUTION

Warehouses are buildings or sections within a building where the primary use of the space is to store inventory. You can think of your closet as a “warehouse” section of your home. Other home warehouses might be the basement or attic, the refrigerator, and the garage.

In the logistics world, a warehouse that is used to hold and sort material for distribution to customers, other companies, and other warehouses is called a “distribution center”. A large company that distributes products across the entire country might have a series of distribution centers servicing specific geographical territories or specific end markets.

The storage of goods is a big component of business. In 1999, the cost of running warehouses in the USA was \$75 billion. There was over 6 billion square feet of warehouse space in use.

#### ***WHY DO COMPANIES HAVE WAREHOUSES?***

The most basic reason that a company has a warehouse is to be able to deliver goods to its customers when and where the customer wants them. Think about a company like Kellogg’s making breakfast cereals in one plant in Michigan. It would be difficult and expensive for Kellogg’s to ship product directly from its factory to every store in the country. Companies like Kellogg’s use warehouses to move and store their products closer to the stores in each part of the country.

Here are the value added functions performed in a warehouse:

- Consolidation
- Product sorting and mixing
- Customer service
- Contingency protection

Consolidation is the function of bringing products together from different manufacturing sites or warehouses. The warehouse that serves a manufacturing plant will consolidate the material from many different suppliers at one site adjacent to the manufacturing line.

Product sorting and mixing will take different items from many sources and mix them together for each customer order. A good example is the catalog center for Sears or Penney’s. Your order is put together from the many items in the warehouse. You are shipped the correct quantity of each item that you order.

Customer service is the function of sending or providing each customer just what the customer wants, when they want it.

Contingency protection is provided by a warehouse through storage of merchandise that can be made available quickly when it is ordered by customers. If a company is going to advertise a “special offer” for one of its products on television or in the newspaper, it will ship extra product to the appropriate warehouse to cover the anticipated volume.

**WAREHOUSE DECISIONS**

When a company decides it needs a warehouse, there are several decisions it must make. First, it must decide if it wants to have its own facility or if it will rent space –either an entire building or space within a public facility. That decision is based on factors such as the amount of space needed, anticipated expenses to buy versus lease, the cost of financing, etc.

The investment in a private warehouse is evaluated like any other financial decision. If the return on the investment meets the organization’s criteria, the company will make the investment. A private warehouse does give the company control over operating and employee decisions. It does limit flexibility in that once the company has made the investment, exiting can be expensive.

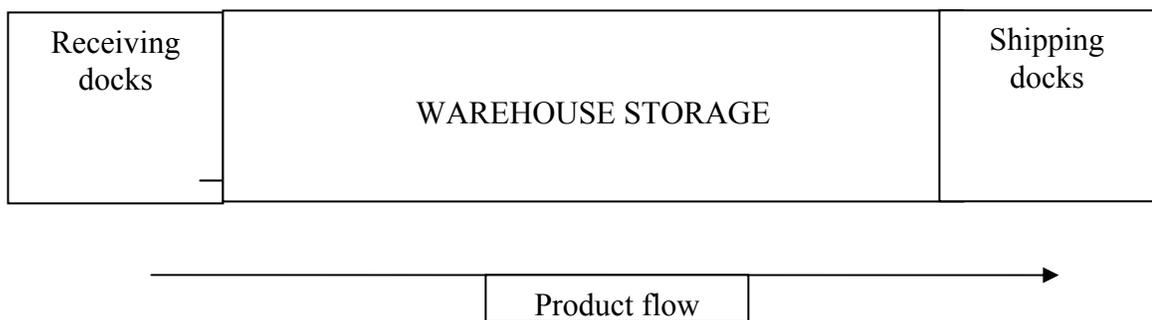
When a company leases space in a public facility, it has the option of contracting for a fixed amount of space for a fixed time period. This option can be used to negotiate the best possible terms. Typically, the smaller the space for the shorter time, the higher the lease costs per square foot.

Generally, for short term or variable amounts of space, there is a cost in, a monthly fee for space, then a cost to take material out. Since the great majority of products and materials are stored on pallets, the cost is usually stated as \$x/pallet.

**WAREHOUSE DESIGN**

There are some principles of design that affect the efficiency of a warehouse’s operations.

- One story buildings – this avoids the expense of elevators or special equipment needed in a multi-story building.
- Movement in straight lines – the ideal building has receiving docks at one end, storage areas in the middle with racks and aisles in the same direction and shipping at the opposite end through separate docks.



- Aisle space is minimized
- Maximum height of the building is used for storage
- Safety of workers and goods stored is considered throughout the facility.

### **WAREHOUSE ACTIVITIES**

- Unloading of goods and receiving
- Storage of goods in racks or assigned areas
- Picking and packing of orders
- Cycle counting and inventory control
- Cross docking
- Loading and shipping

All of these activities require people who can operate equipment such as fork lift trucks and understand the basics of computers, scanning, UPC's, and record keeping. As mentioned earlier, accuracy is an important performance factor in a modern warehouse operation.

Cycle counting and inventory control are functions within a warehouse that keep the records accurate. It is essential that the physical item and count in each location within the warehouse match exactly the item and count shown in the computer system that maintains inventory data. Cycle counting is usually performed on a weekly basis. A random sample of items are selected, then a cycle counting team of people go out into the warehouse, identify and count what is in the selected locations and compare their counts to the record in the computer. Discrepancies are investigated and corrections recorded immediately. Location accuracy of 99.5+% is typical in a modern warehouse.

Cross Docking occurs in warehouses where the material is moved directly from receiving into a sorting area for loading onto trucks to be shipped out again. The merchandise is never stored, it moves right through the facility. Companies such as UPS, Fed Ex, and Wal Mart use cross docking extensively.

Caterpillar's warehouse

Cat's warehouses are private facilities – owned by the company and used only for storage of its inventory. Here are some facts about private warehouses:

- Most company inventory held here
- Large investment
  - land, buildings, equipment
- Big expenses – fixed and variable
  - Labor, operating and administrative costs
  - Taxes, obligations and liabilities

Here are some things management must consider when operating a warehouse:

- Responsiveness
- Availability and cost of capital
- Management
- Employee competence and experience

- Control and visibility
- Flexibility
- Risks and liability

## **ACTIVITY**

1. Discuss what information you would need to be able to design the new warehouse mentioned in the problem.
  
2. Research and discuss other warehouse options – renting space in a public facility, using the supplier’s warehouse, etc. Contact a third party logistics (3PL) company to learn about the services offered by those firms.

## Student Information Sheet 3-- Analyzing a Logistics and Distribution Problem

Your teacher will hand out a short description of the problem to be solved. This is an actual problem that has occurred at sometime during the company's history. You are to analyze the problem and determine what questions or steps need to be addressed so that you can provide a recommended answer.

### Tips for Analyzing Problem Statements

Here are some tips in analyzing the problem.

- Read the problem statement very carefully. Read the statement sentence by sentence.
- Don't assume anything. Make sure that you can back up any assumption or conclusion about the problem by what is stated in writing.
- Don't be concerned if you do not have all the information you need. You can get more information by asking the Caterpillar representative and your teacher for the information you think you need to solve the problem.
- Don't be concerned that you do not know all the answers. As you work through this module you will learn the information you need to complete the activity.
- Don't be afraid to ask questions and tell people what you need to know. Good problem-solvers are people who are not afraid to learn new things and ask for assistance.

### Determining What You Know and What You Don't Know

Expert problem-solvers start their analysis of a problem by writing down what they already know and what they need to know to solve the problem. Once they identify what they don't know, they then develop questions and seek out people who can answer their questions and help them solve the problem.

As shown in Figure 1.3, one way to do this is to make a list using a two-column sheet of paper with one column for what you know and one column for what you don't know. For example, under the column for what you know, you could write down, "The plan is due in four weeks."

## ACTIVITY

With your group, develop the questions you will ask the company representative by doing the following:

1. Read the problem statement and make a list of what you know and what you don't know. Use Figure 1.3 to write down your group's list.

2. Look at your list of what you don't know and develop questions for Caterpillar that you can ask.
3. Practice asking your questions with other students. Be sure to state your question slowly and clearly and be prepared to restate your question if people do not understand what you are asking?
4. Make sure you listen carefully to all questions and answers. If you don't understand the answer, ask people to say it again or repeat what you don't understand.
5. Take notes on the answers. Don't try to write down everything that is said. Write down the major concept or idea that you can refer to later.

**Figure 1.3**  
**Problem Analysis Work Sheet**

<b>What I Know</b>	<b>What I Don't Know (Need to Ask)</b>

## Student Information Sheet 4-- Purchasing, Role of suppliers, Global Sourcing

### PURCHASING IN MANUFACTURING COMPANIES

All of us buy things in our day-to-day life that we need to eat, to wear, or to use. Our families on occasion make very large purchases – houses, cars, etc. Manufacturers also purchase materials and services that they need to run their business. The typical manufacturing company spends about 60% of its sales revenue on materials and services from other companies – its suppliers. Procurement is an important function within the logistics process. It is usually done by people whose job titles might include Buyer, Purchasing Manager, Buyer/Planner, and Senior buyer.

Caterpillar has a purchasing organization that is responsible for supplier relationships with all of its suppliers on a global basis. Purchasing is focused on these issues:

- Right supplier – purchasing leads a cross functional decision process to select the right supplier from the many companies that can make and sell a certain product or service. In this project purchasing is evaluating two sources, one in Indiana and one in China.
- Right cost – purchasing will solicit proposals from potential suppliers for items such as Part 1A1. In this case, the prices from each supplier vary significantly. Purchasing has to analyze the pricing and decide what is best for Caterpillar.
- Right time – materials have to be available when needed for production. It does no good to buy from a supplier who offers a very low price if they cannot deliver raw materials or parts on time.
- Right quantity – One supplier may not be able to supply the required quantity of material quickly enough to satisfy the demand. That is why Cat is looking at adding a second source for Part 1A1.
- Right quality – Purchasing must insure that any supplier can produce raw materials or components to the required specification. Again, low cost is not a good feature if the product is not of good quality.

Balancing these “Five Rights” is the responsibility of purchasing. In large organizations, like Cat, purchasing will involve other functions in the decision-making process such as engineering, Quality Assurance, and inventory management.

### ROLE OF SUPPLIERS

Suppliers are important to a manufacturing company because they furnish raw materials or components used to manufacture a product. In addition to simply providing products, suppliers will also provide assistance in:

- applying their product correctly to the product of the manufacturer

- engineering specifications for their products
- certificates of quality for each shipment
- managing the inventory level needed to support production (referred to as Vendor Managed Inventory)
- making and holding inventory for a customer
- industry information and price forecasts

Supplier personnel will communicate with Purchasing, Engineering, and Inventory Planning people often within their customer's organization.

## **GLOBAL SOURCING**

Companies such as Caterpillar have used suppliers from many different countries for many years. In the last 15-20 years with the introduction of the Internet and improved communications and transportation systems many more companies of all sizes are looking for potential suppliers around the world. Some products that have high labor content and are relatively easy to manufacture will always be sourced in countries with the lowest labor rates. This phenomenon gets a lot of attention in the media and does cause workers in some industries to lose jobs in the US and other developed nations, but it is a process that has been going on since the Industrial Revolution.

Global sourcing today is one reason that all of us, as consumers, enjoy the product choices that we have at prices that are affordable.

In this module, Cat has identified a second supplier for Part 1A1 in china. The price is \$15.00 versus \$25.00 from the supplier in Indiana. However there are additional costs that Cat Purchasing must evaluate when comparing prices between the two suppliers. These costs will include:

- Preparation and containers for ocean shipment
- Cost of ocean transportation
- Customs fees and duties
- Transportation cost from port of entry to Cat's plant
- Warehousing costs for extra inventory due to 9 week lead time

The total of costs associated with a global source can amount to 10-15% of the purchase price, so it is important for Cat to determine these costs in making their supplier evaluation.

## ACTIVITY

1. Do internet research on costs associated with international transportation. Your teacher will provide you with a list of web sites.
2. Assuming that the additional costs of transportation to the Cat plant from China are 20%, decide how you might split the business for Part 1A1 between the two sources. Explain how you would deal with the inventory needed to support the 9 week lead time from the China supplier.
3. Make a list of 5 products found in your home that are labeled “made in the USA”. List 5 more products that are labeled as being manufactured somewhere outside of the US. Compile a list in class of all of the product types and discuss what you can learn from the findings.

## Student Information Sheet 5-- INVENTORY MANAGEMENT LEAD TIME, KAN BAN

### *What is Inventory?*

**Inventory** is the word used to describe all the goods and materials kept on hand to perform work.

At home, you keep an inventory of food, personal care products, and cleaning supplies on hand. This enables you to cook, bathe, and clean the house without running to the store to buy needed items each day. It makes good sense to keep an inventory of these things in your home. It allows you to operate your home more efficiently.

In the same way, manufacturing companies keep an inventory of **stock** on hand that enables them to perform their work. Items that are used regularly are stored and used as needed, just like you store extra rice or detergent for your home.

The inventory kept by manufacturing companies usually falls under one of these classifications:

#### **1. Raw material**

Material that will be converted in the manufacturing process into components or finished products

##### ***Example***

*In a company that manufactures envelopes, paper is the main raw material kept in inventory.*

#### **2. Work in process**

All products in various stages of completion throughout the factory.

##### ***Example***

*At the envelope company, work in process would include envelopes that had been cut but not yet folded and glued.*

#### **3. Finished goods**

Completed products, ready to be sold to the customer.

##### ***Example***

*At the envelope company, finished goods are the completed envelopes, cut, folded, and printed, in boxes, ready to be shipped.*

#### **4. Maintenance, repair, and operating supplies**

Items such as spare parts, cleaning supplies, office supplies, that are used to support the manufacturing operation.

##### ***Example***

*Like most companies, the envelope manufacturer keeps many different kinds of supplies on hand for maintenance, repairs, and operating the plant. Some examples are cleaning fluids, nuts, bolts, and screws, and copier paper. None of these are directly related to manufacturing envelopes, but all are necessary to run a factory.*

### ***Why Do Companies Need Inventory?***

Companies are not very different from our homes. They need inventory on hand in order to operate more efficiently. Without an inventory of raw material needed to manufacture its products, a company would need to place an order with its suppliers each time it received a new order. This would be a very inefficient way to operate a company.

Good inventory control is needed in order to achieve three goals. The goals are all good, but sometimes are in conflict with each other. The three goals are:

#### **1. Excellent Customer Service**

Companies need inventory in order to supply customers with what they want, when they want it. Companies must keep extra inventory on hand in order to protect against running out of items that customers need.

#### **2. Economical Factory Operation**

Inventory allows factories to take advantage of the some cost-saving production techniques such as:

- allowing different operations to run at different rates and therefore be produced more efficiently
- longer production runs that reduce the number of set-ups and the unit cost of individual items
- taking advantage of quantity discounts from suppliers

#### **3. Minimum Inventory Investment**

This goal is often in conflict with the other two. While inventory is necessary, it costs money to carry inventory, or keep it in stock. That's why good inventory control is necessary. By using good inventory control principles, companies can keep the money invested in inventory to the minimum necessary to achieve excellent customer service and economical factory operation.

## ***Why Does Inventory Cost Money?***

### **Inventory Costs**

Carrying inventory is very expensive for companies. It may look as if inventory is just a lot of items sitting in cartons on shelves. It doesn't really cost anything to keep it there. But that is far from the truth. There are many different costs involved in carrying inventory. We will look at four of them.

1. **Item costs**

These are the costs involved with getting the item into inventory. For a manufacturer, this is the cost of production.

2. **Carrying costs**

These are the costs that are a result of keeping the inventory housed. This includes interest, taxes, warehousing, damage, and **obsolescence**.

3. **Ordering costs**

Every time an order is placed it costs the company money. It costs money to prepare and release a purchase order, follow up on it, receive the order, physically handle and inspect it.

Money can be saved in this area by placing fewer orders for larger quantities. However, that would increase the carrying costs that we discussed in # 2. Companies are always looking for the best balance between carrying costs and order costs.

4. **Stockout costs**

A **stockout** occurs when a customer places an order that cannot be filled on time because items are out of stock. This can result in the loss of a sale and even the loss of a customer. Stock-out costs cannot be completely calculated.

For all of these reasons, companies must be careful to manage their inventories well. It is important to find the best balance between carrying enough items in inventory to serve customers, and not carrying too much so that costs are minimized.

Carrying cost may total 20-25% of the value of the inventory. That would mean that if a company keeps \$1000 of obsolete material in inventory for an entire year, it has cost them \$200-250 to do so.

### **Inventory Turns**

One way that companies determine if they are keeping their inventory costs at a minimum is by calculating an **inventory turns** ratio. Inventory turns is the term used to describe how many times inventory cycles or "turns over" in a year. Companies are always looking for ways to raise the number of inventory turns per year because that means that inventory is moving faster, is being converted into cash sooner.

Annual inventory turns are calculated according to the following mathematical formula:

$$\text{Inventory turns} = \frac{\text{Annual cost of goods sold}}{\text{Average inventory in dollars}}$$

**Cost of goods sold (COGS)** is a financial term that puts a total dollar cost on producing a product. Cost of goods sold includes **direct costs** for labor and material directly related to manufacturing the product, as well as **overhead costs**, or costs that are necessary to keep a business running, but are not directly related to making the product.

**Average inventory** is another financial term that puts a dollar amount on the items carried in inventory by averaging the inventory over one year. Company accountants have several different ways to determine this number. One common way is to look at the month-end inventories for 12 consecutive months and average those numbers.

Company accountants determine both the cost of goods sold and the average inventory numbers.

#### **Example**

*If a company's annual cost of goods sold was \$2,000,000 and it kept \$1,000,000 in inventory, the equation would look like this:*

$$\text{Inventory turns} = \frac{\$2,000,000}{1,000,000} = 2$$

*This means that the company has two inventory turns per year, or is waiting six months to get its money back from inventory investment.*

*If the same company, through better inventory control, was able to reduce its average inventory to \$500,000 the equation would look like this:*

$$\text{Inventory turns} = \frac{\$2,000,000}{500,000} = 4$$

*This means that the company now has four inventory turns per year, or is waiting only three months to get its money back from inventory investment.*

There are a lot of costs in carrying inventory. With good inventory control, companies can reduce inventory costs and increase profits

## ***LEAD TIME***

Lead time is defined as the time it takes from when an order is placed until the part or raw material is ready for use. In this module, the lead time is one day from the Indiana supplier. That means that if Cat orders Part 1A1 today, it will be delivered tomorrow. The China supplier's lead time is 9 weeks. An order placed today will have parts delivered in 9 weeks.

Supplier lead time typically includes:

- Time to transmit our order to the supplier
- Supplier's total process time – the time for them to obtain raw materials, schedule production, produce the parts, inspect and pack the parts.
- Transit time from the supplier to your factory.

Lead time that we would use to tell a customer when to expect their order would typically include:

- Our time to process the customer order and schedule production
- Supplier lead time if we have to order materials
- Manufacturing time
- Inspection, packing time
- Transit time to the customer.

Companies have focused a lot of attention on reducing lead times throughout their process. Remember that inventory is used as a buffer to make sure materials are available when needed by customers. If we can reduce the lead time in our supply chain process, we can reduce the amount of inventory investment needed to support the business.

## ***KAN BAN***

Kan Ban is one of many just-in-time inventory techniques used by manufacturers to minimize their inventory. Kan Ban is focused on ordering a part in the same quantity, usually the number of parts used per day in the factory, and keeping only a 1 day supply on hand. In this module, Cat uses 45 pieces of Part 1A1 each day, so the Kan Ban quantity is 45. Cat uses a tub to bring 45 pieces at a time into the factory. Each day the warehouse takes another 45 pieces and gets a tub ready to be sent to the factory. The warehouse may be keeping a larger quantity, perhaps a week's supply on hand to protect against disrupting Cat's production schedule if the Indiana supplier has a delivery problem. We also know that the Indiana supplier keeps a two week supply (450 pieces) in their inventory.

Kan Ban works best when two conditions are met:

- Relatively few variations in product, for Cat that means few design changes to Paver P-202.
- Suppliers are located close to the factory. In Cat's case, the Indiana supplier meets this condition; obviously the China supplier does not.

## ACTIVITY

1. Discuss how the lead time of 9 weeks from the supplier in China will impact Cat's inventory. Discuss ways that Cat may try and deal with this issue to minimize its inventory investment.
2. Explain how the higher production rate of 90 Pavers per day will affect the Kan Ban quantity. What changes will have to be made in the Kan Ban process?

## **Student Information Sheet 6-- PROJECT SUMMARY**

### **Project summary**

Earlier in the instruction you were provided a copy of the problem to be solved. Your Manager wants you to prepare a report and presentation for the next Management team meeting.

There is no one correct answer to this problem. Like many real world situations, you have to understand each option that is available to Caterpillar management, balance them in your mind, and be able to explain your reasoning.

Options:

- Building a new warehouse.
- Adding a second supplier in China.
- Improving the material flow from supplier to warehouse to manufacturing plant.

Financial considerations:

- Cost of a new warehouse.
- Cost savings from China supplier
- Carrying cost of inventory.

Your final report should address all of these issues and include recommended actions for Cat management to consider. If you need assistance in completing this report or presentation, ask you teacher for support materials that describe how this is to be done.

### **Activity:**

1. Develop an outline of the key points that you want to cover in your report.
2. Review those with your teacher (and team if this is done in groups)
3. Write the report.
4. Prepare a presentation for the class using the key points from your outline.
5. Present your report.

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

### **Average inventory**

Financial term that puts a dollar amount on the items carried in inventory by averaging the inventory over one year.

### **Carrying costs**

These are the costs that are a result of keeping the inventory housed. This includes interest, taxes, warehousing, damage, and obsolescence.

### **Consumers**

End users of retail products

### **Cost of goods sold (COGS)**

A financial term that puts a total dollar cost on producing a product. Cost of goods sold includes direct costs for labor and material directly related to manufacturing the product, as well as overhead costs, or costs that are necessary to keep a business running, but are not directly related to making the product.

### **Cross Docking**

Where the material is moved directly from receiving into a sorting area for loading onto trucks to be shipped out again.

### **Customer service**

The function of sending or providing each customer just what the customer wants, when they want it.

### **Distribution/Distributors**

Warehouse facilities that may be owned by the manufacturer or public facilities that serve a variety of manufacturers. These facilities store and sort product for shipment to retailers or other companies.

### **Distribution Center**

A warehouse that is used to hold and sort material for distribution to customers, other companies, and other warehouses.

### **Distribution costs**

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

### **Finished goods**

Completed products, ready to be sold to the customer.

### **Inventory**

The word used to describe all the goods and materials kept on hand to perform work.

### **Inventory turns**

The term used to describe how many times inventory cycles or "turns over" in a year.

**Item costs**

These are the costs involved with getting the item into inventory. For a manufacturer, this is the cost of production.

**Kan Ban**

A just-in-time inventory technique used by manufacturers to minimize their inventory. It is ordering a part in the same quantity, usually the number of parts used per day in the factory, and keeping only a 1 day supply on hand.

**Lead time**

Time it takes from when an order is placed until the part or raw material is ready for use.

**Logistics**

Part of the supply chain that plans, implements, and controls the efficient, effective forward and reverse flow of goods, services, and related information between the points of origin and the point of consumption in order to meet customer's requirements.

**Manufacturers**

Companies that make an end product for consumers (i.e. Pepsi Cola) or for another company (i.e. Cummins Engine provides engines to Caterpillar)

**Raw material**

Material that will be converted in the manufacturing process into components or finished products

**Retailers**

Companies that sell products and merchandise directly to consumers.

**Stockout**

When a customer places an order that cannot be filled on time because items are out of stock.

**Supply Chain**

The functions and activities starting with suppliers through production and distribution to customers and end users that provide products, services, and information that add value for the customer.

**Suppliers**

Companies that provide raw materials and components to manufacturers

**Warehouses**

Buildings or sections within a building where the primary use of the space is to store inventory.

**Work in process**

All products in various stages of completion throughout the factory.