Some of this material is covered in the Sustainable Supply Chain overview, and we will skip much of the chapter.

- The role of Transportation in the Supply Chain
- Factors affecting transportation decisions
- Modes of transportation and their performance characteristics
- Trade-offs in transportation design
- Tailored transportation
- The role of IT in transportation
- Risk management in transportation
- Making transportation decisions in practice
The Role of Transportation in the Supply Chain

- To move the product through the chain to the end consumer
- Some fun facts
  - US: freight transport activities account for 10% of GDP
    - It is estimated that JIT inventory policies and other efficiencies have been able to reduce this from historical rates of around ~15%
  - Germany: per www.bmvbs.de
    - The German freight logistics sector is currently the largest in Europe.
    - (In) 2005 …estimated to be around 170 billion euros. …7% of German GDP
    - the freight logistics sector comes third after retail trade and the automotive industry, with an estimated 2.5 million employees, (and is)… growing at a disproportionately high rate
    - “Interconnection of infrastructure, information and organization is a pre-condition for Germany to master the challenges ….At the same time Germany must face the challenges of making freight transport more environmentally-, climate- and resource- friendly”
Factors (and Parties) Affecting Transportation Decisions

From earlier, we know that there may be three separate parties involved. All of them have factors to consider:

1. Carrier (party that moves or transports the product)
   - Vehicle-related costs, Fixed operating costs, Trip-related costs
   - Often incurs huge investments (new fleets, etc…)

2. Shipper (party that requires the movement of the product between two points in the supply chain)
   - May need to balance Transportation costs with Inventory and Facility costs

3. Consignee (party that receives the shipment)
   - May have certain responsiveness needs

We should also consider:

4. The owners of the infrastructure (Ports, highways, railroads)
5. Government and/or bodies that set worldwide transportation policy
Transportation Modes

- Trucks
  - TL
  - LTL
- Rail
- Air
- Water
- Pipeline (highly limited by geography and product)
- Package Carriers (still using trucks, but the focus is on delivery of a few packages)
Truckload (TL) vs. Less than Truckload (LTL)

**TL**
Cheaper than LTL for large shipments
Average haul = 274 miles
Great for large loads
Low fixed and variable costs
Major Issues (especially when economies of scale are missing)
  - Utilization
  - Consistent service
  - Backhauls

**LTL**
Typically used for smaller shipments
Average haul = 646 miles
Higher fixed costs (terminals/consolidation centers) but low variable costs
Major issues:
  - Location of consolidation facilities
  - Utilization can still be an issue
  - Vehicle routing, other IT complexities
  - Customer service
Rail

◆ Cheapest of the land-based modes
  – Uses less fuel, so also greener
◆ Average US haul, load= 720 miles, 80 tons
◆ Key issues:
  – Scheduling to minimize delays / improve service
  – Off-track delays (at pickup and delivery end)
  – Yard operations
  – Variability of delivery times
  – Ownership of rail network in the US is highly fragmented
  – Rail does not and cannot reach everywhere
Air

◆ Fastest mode, often used for global transit of expensive items
  – Use is growing (14% per year in US, see usage in Europe in graph below)

◆ Key issues:
  – Complex: Location/number of hubs, Location of fleet bases/crew bases, Schedule optimization, Fleet + Crew assignment, yield management….
  – Expensive, EXPENSIVE, EXPENSIVE
  – Most energy/emissions intensive

(1) Underestimated: freight transport at Paris Charles-de-Gaulle and Paris Orly is incomplete.
(2) 2008.
Source: Eurostat (tt00011)
Package Carriers

- Companies like DHL, FedEx, UPS, USPS, that carry small packages ranging from letters to shipments of about 150 pounds
- Expensive
- Rapid and reliable delivery
- Small and time-sensitive shipments
- Preferred mode for e-businesses (e.g., Amazon)
- Consolidation of shipments (especially important for package carriers that use air as a primary method of transport)
  - Interestingly, a lot of package carriers have, through their own need for such networks, expanded into being full service 3PLs (DHL is world’s largest)
Water

- Ocean, inland waterway system, coastal waters
  - Limited to certain geographic areas
- Very large loads at very low cost
  - Lowest energy/emission intensity per tonne-km, though some concern about port pollution
- Slowest
  - Also subject to bottlenecks at Ports
- Dominant in overseas trade (autos, grain, apparel, etc.)
- Book example of successful usage: IKEA
  » As per 2008: 250 stores in 24 countries, sales: 21+ billion euro
  » Internationally sourced goods
  » IKEA makes very strong use of water and other low cost transport
Pipeline

- High fixed cost
- Primarily for crude petroleum, refined petroleum products, natural gas
- Best for large and predictable demand
- Would be used for getting crude oil to a port or refinery, but not for getting refined gasoline to a gasoline station
Intermodal

- Use of more than one mode of transportation to move a shipment to its destination
  - rail/truck, water/rail/truck or water/truck
- Grown considerably with increased use of containers
- Increased global trade has also increased use of intermodal transportation
- More convenient for shippers (one entity can provide the complete service)
- Key issue involves the exchange of information to facilitate transfer between different transport modes
Design Options for a Transportation Network

- What are the transportation options? On what basis do we design our network?
- Consider the tradeoffs:
  - Transportation cost vs. inventory cost
    » Choice of transportation mode: A mode with higher transportation costs may be justifiable if it results in significantly lower inventories or is necessary to maintain strategic level of responsiveness
    » Physical inventory aggregation
  - Transportation cost vs. responsiveness: temporal aggregation
- We won’t cover all the networks in the book, i.e. “milk runs” etc.
  - Instead we will look at a transportation LP (SRH students- we don’t even do this!)
Tailored Transportation

- The use of different transportation networks and/or modes based on customer and product characteristics

- Factors affecting tailoring:
  - Customer distance and density
  - Customer size
  - Product demand and value

- Some examples:
  - GAP primarily imports from its contract manufacturers worldwide by cargo ship. However, for some high-margin or otherwise key products, they may use some air freight for mid-season replenishment.
  - Keeco, LLC supplies home furnishings. They primarily use trucking to deliver goods from their warehouse to retail stores, but occasionally they will use parcel delivery for small replenishment orders instead of sending out a mostly empty truck.
The complexity of transportation decisions demands use of IT systems
- Especially crucial with intermodal transportation, need for cross-enterprise collaboration

Information Technology can assist in many ways:
- Identification of optimal routes by minimizing costs subject to delivery constraints (such as LPs)
- Optimal fleet utilization
- GPS applications
- Finding backhaul opportunities [www.coyotelogistics.com](http://www.coyotelogistics.com)
Risk Management in Transportation

Three main risks to be considered in transportation are:

- Risk that the shipment is delayed
- Risk of disruptions
  - When the International Longshore & Warehouse Union strike/lockout closed 29 West Coast ports for 10 days in 2003, one study estimated it cost the U.S. economy $19.4 billion (that’s almost $2 billion per day!)
  - 2011 Tsunami: not only impacting auto manufacturers on the Island, but so are the dealers/repair shops
- Risk of hazardous material issues, theft, terrorism (the dirty secret about dirty bombs….)

Risk mitigation strategies:

- Decrease the probability of disruptions
- Alternative routings
- In case of hazardous materials the use of modified containers, low-risk transportation models, modification of physical and chemical properties can prove to be effective
Making Transportation Decisions in Practice

◆ Align transportation strategy with competitive strategy
  – Does your transportation strategy balance responsiveness vs. efficiency?
  – Does it consider sustainability?

◆ Evaluate both in-house and outsourced transportation options

◆ Design a transportation network that can handle e-commerce, if that is part of your business plan

◆ Use technology to improve transportation performance

◆ Design flexibility into the transportation network
Summary of Chapter 13’s Learning Objectives

1. What is the role of transportation in a supply chain?
2. What are some of the factors and parties that need to be considered?
3. What are the strengths and weaknesses of different modes of transportation?
4. What are the trade-offs in transportation network design?