

Material Handling Systems

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I. Transport Equipment – Cranes

I. Transport Equipment – Cranes

- Move loads over variable (horizontal and vertical) paths within a restricted area
- Used when there is insufficient (or intermittent) flow volume such that the use of a conveyor cannot be justified
- Provide
 - more flexibility in movement than conveyors
 - less flexibility in movement than industrial trucks
- Loads handled are **more varied** with respect to their shape and weight than those handled by a conveyor
- Most cranes utilize **hoists** for vertical movement

I. Transport Equipment – Cranes

1. Jib crane

- Horizontal boom (jib) supported from a stationary vertical support
- Hoist can move along the jib and can be used for lifting



I. Transport Equipment – Cranes

2. Bridge crane

- Bridge mounted on tracks that are located on opposite walls of the facility
- Enables three-dimensional handling



I. Transport Equipment – Cranes

3. Gantry crane (Liman/Kızak Vinci)

- Single leg, double leg, and mobile types
- Similar to a bridge crane except that it is floor supported at one or both ends instead of overhead (wall) supported
- Used to span a smaller portion of the work area as compared to a bridge crane
- The supports can be fixed in position or they can travel on runways



I. Transport Equipment – Cranes

4. Stacker crane

- Similar to a bridge crane except
 - instead of a hoist (zincir), it uses a mast(direk, gönder) with forks or a platform to handle unit loads
- Considered “fork trucks on a rail”
- Used for storing and retrieving unit loads in storage racks, especially in high-rise applications in which the racks are more than 15 meters
- Can be controlled remotely or by an operator in a cab on the mast
- Can be rack supported



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I. Transport Equipment – Industrial Trucks

I. Transport Equipment – Industrial Trucks

- *Industrial trucks* are trucks that are not licensed to travel on public roads
- *Commercial trucks* are licensed to travel on public roads.
- Industrial trucks are:
 - Used to move materials over variable (horizontal) paths with no restrictions on the area covered (i.e., unrestricted area)
 - Provide vertical movement if the truck has lifting capabilities
 - Used when there is insufficient (or intermittent) flow volume such that the use of a conveyor cannot be justified
 - Provide more flexibility in movement than conveyors and cranes

I. Transport Equipment – Industrial Trucks

1. *Pallet/Non-Pallet*
2. *Manual/Powered:*
3. *Walk/Ride:*
4. *Stack [lift]/No Stack:* Can the truck be used to lift loads for stacking purposes?
5. *Narrow Aisle:*
6. *Automated:*

I. Transport Equipment – Industrial Trucks

- **1. Hand truck**
- Non-Pallet + Walk + No Stack + Manual
- Simplest type of industrial truck



ULINE's complete line of Convertible Hand Trucks

ULINE

I. Transport Equipment – Industrial Trucks

2. Pallet jack/Pallet truck [manual/powered=pallet truck]

- Pallet + Walk + No Stack
- Front wheels are mounted inside the end of the forks and extend to the floor as the pallet is only lifted enough to clear the floor for subsequent travel





I. Transport Equipment – Industrial Trucks

3. Walkie stacker [manual/powered]

- Pallet + Walk + Stack
- Similar to a counterbalanced lift truck except the operator cannot ride on the truck



I. Transport Equipment – Industrial Trucks

5. Platform truck

- Non-Pallet + Powered + No Stack
- Platform used to provide support for *non-palletized* loads





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I. Transport Equipment – Industrial Trucks

6. Counterbalanced (CB) lift truck

- Pallet + Ride + Stack
- Sometimes referred to as a “fork truck” (but other attachments besides forks can be used)
- Weight of vehicle (and operator) behind the front wheels of truck counterbalances weight of the load (and weight of vehicle beyond front wheels);



- Front wheels act as fulcrum (destek noktası) or pivot point

I. Transport Equipment – Industrial Trucks

- *Workhorses* of material handling because of their flexibility:
 - indoor/outdoor operation over a variety of different surfaces;
 - variety of load capacities available;
 - variety of attachments available—
 - fork attachments can replace the forks (e.g., carton clamps) or
 - enhance the capabilities of the forks (e.g., blades for slipsheets)





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I. Transport Equipment – Industrial Trucks

7. Narrow-aisle (NA) straddle truck

- Similar to stand-up CB lift truck, except outrigger arms straddle a load and are used to support the load instead of the counterbalance of the truck
- Less expensive than stand-up CB lift truck and NA reach truck



BT vector



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I. Transport Equipment – Industrial Trucks

8. Narrow-aisle (NA) reach truck

- Similar to both stand-up CB lift truck and NA straddle truck
- Load rests on the outrigger arms during transport, but a scissors mechanism is used for reaching

I. Transport Equipment – Industrial Trucks

- Reaching capability enables the use of shorter outrigger arms (arms $> \frac{1}{2}$ load depth) as compared to NA straddle truck (arms = load depth)
- Counterbalance of the truck used to support the load when it extends beyond the outrigger arms
- T=136 **We were here...**





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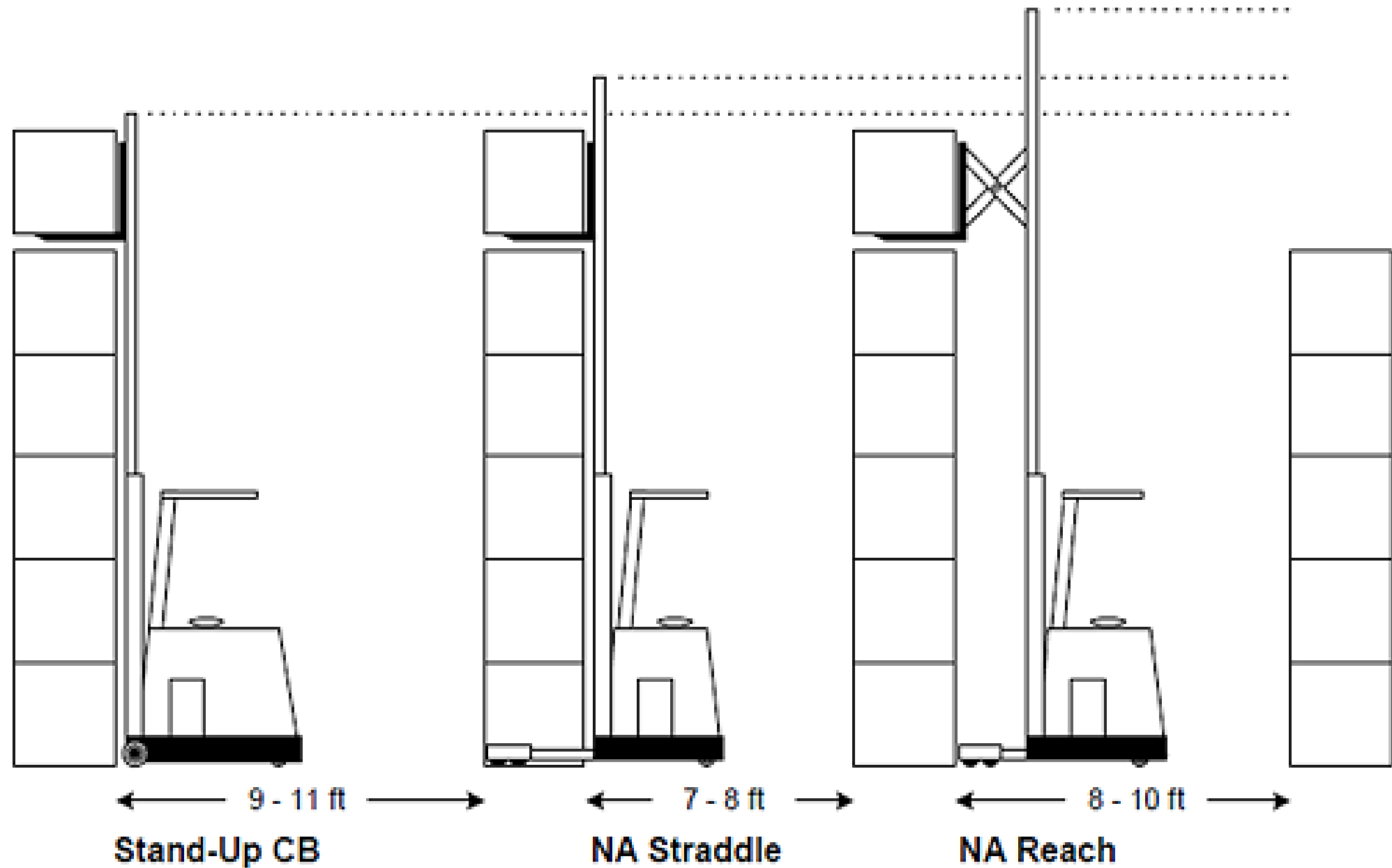


Figure 7. Narrow-aisle lift truck comparison.

I. Transport Equipment – Industrial Trucks

9. Turret (*kule*) truck

- Compared to other narrow-aisle trucks
 - Greater stacking height (40 ft. vs. 25 ft.),
 - but greater investment cost
- Does not rotate during stacking
 - Forks rotate to allow for side loading





I. Transport Equipment – Industrial Trucks

10. Order picker

- Similar to NA straddle truck,
 - except operator lifted with the load to allow for less-than-unit-load picking
- Typically has forks to allow the truck to be used for pallet stacking and to support a pallet during less-than-pallet-load picking

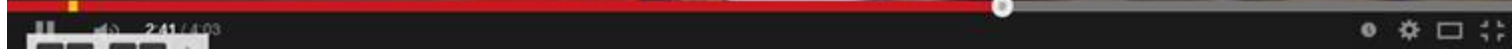


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Linde Man-Up Order Pickers: V10 2800mm & V10 6350mm



Linde Man-Up Order Pickers: V10 2800mm & V10 6350mm



I. Transport Equipment – Industrial Trucks

11. Sideloader

- Forks mounted perpendicular to direction of travel to allow for side loading
- Can be used to handle greater-than-pallet-size loads (e.g., bar stock)



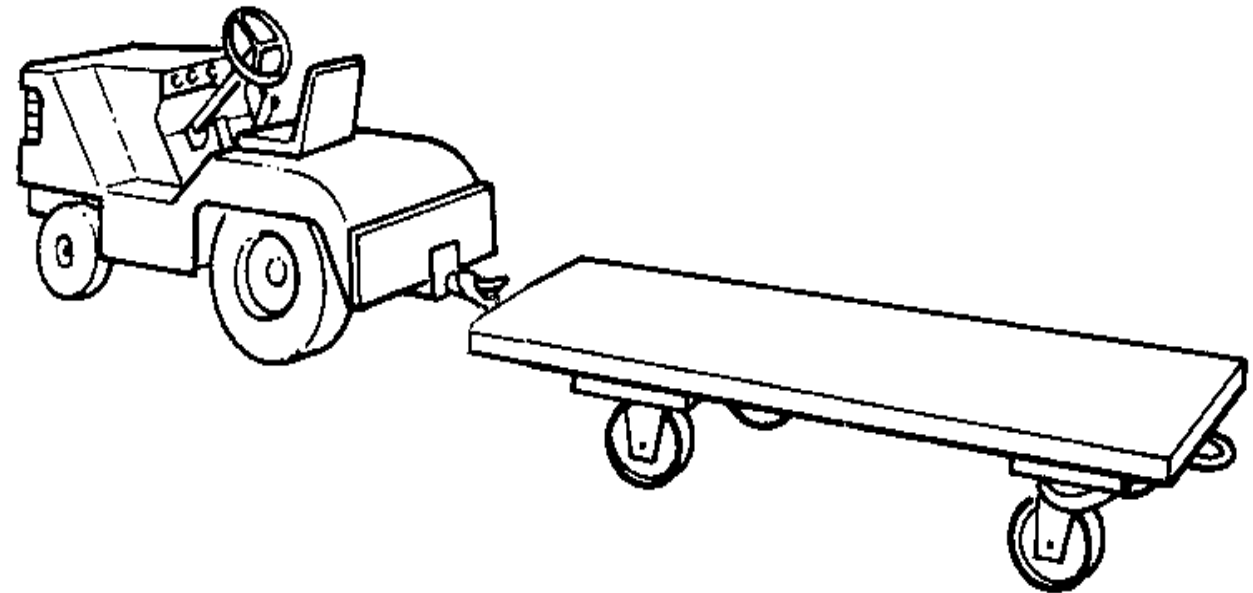
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I. Transport Equipment – Industrial Trucks

12. Tractor-trailer

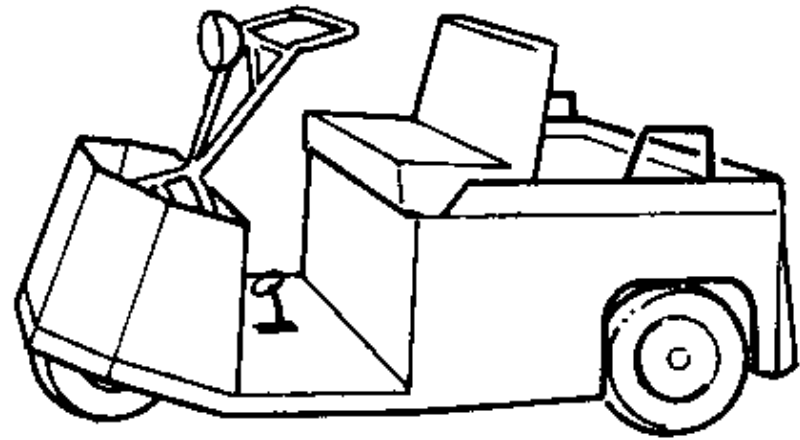
- Non-load-carrying tractor used to pull a train of trailers (i.e., dollies or floor hand trucks)
- Advantage: Enables a single operator to transport multiple floor hand trucks in a single move
- Disadvantage: Requires wide aisles or open spaces to operate
- Typically used at *airports for baggage handling*



I. Transport Equipment – Industrial Trucks

13. Personnel and burden carrier

- Non-load-carrying vehicle used to transport personnel within a facility (e.g., golf cart, bicycle, etc.)



I. Transport Equipment – Industrial Trucks

14. Automatic guided vehicle (AGV)

- AGVs do not require an operator
- Good for high labor cost, hazardous, or environmentally sensitive
- AGVs good for
 - low-to-medium volume
 - medium-to-long distance

random material flow operations (e.g., transport between work cells in a flexible manufacturing system (FMS) environment)

I. Transport Equipment – Industrial Trucks

- Two means of guidance can be used for AGV systems:
 - *Fixed path:*
 - Physical guidepath (e.g., wire, tape, paint) on the floor used for guidance
 - *Free-ranging:*
 - No physical guidepath, thus
 - easier to change vehicle path (in software),
 - but absolute position estimates (from, e.g., lasers) are needed

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**Fully automatic pallet
handling with AGV**
(automated guided vehicles)

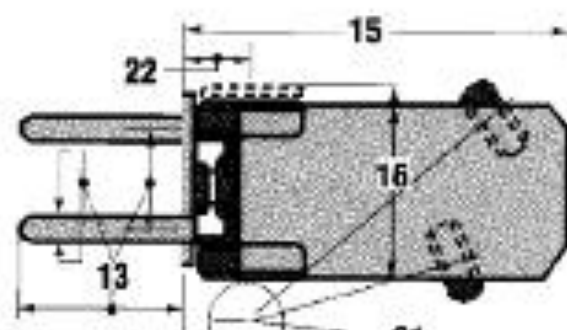
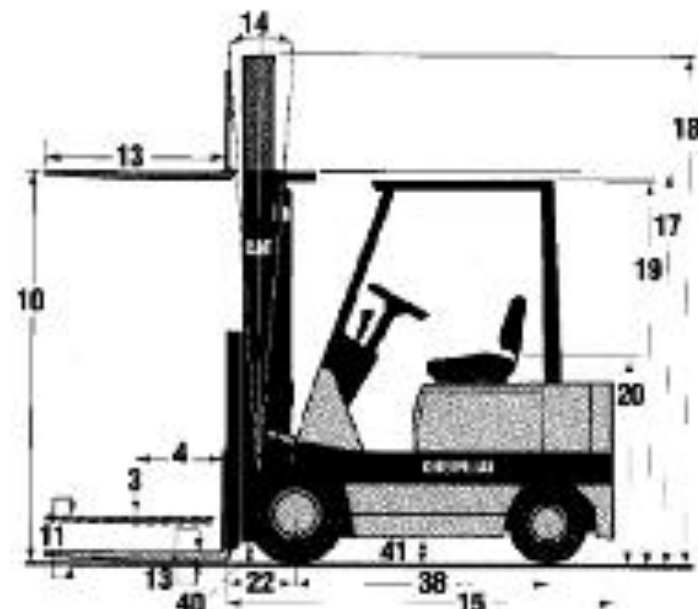
An Example – CB Lift Trucks

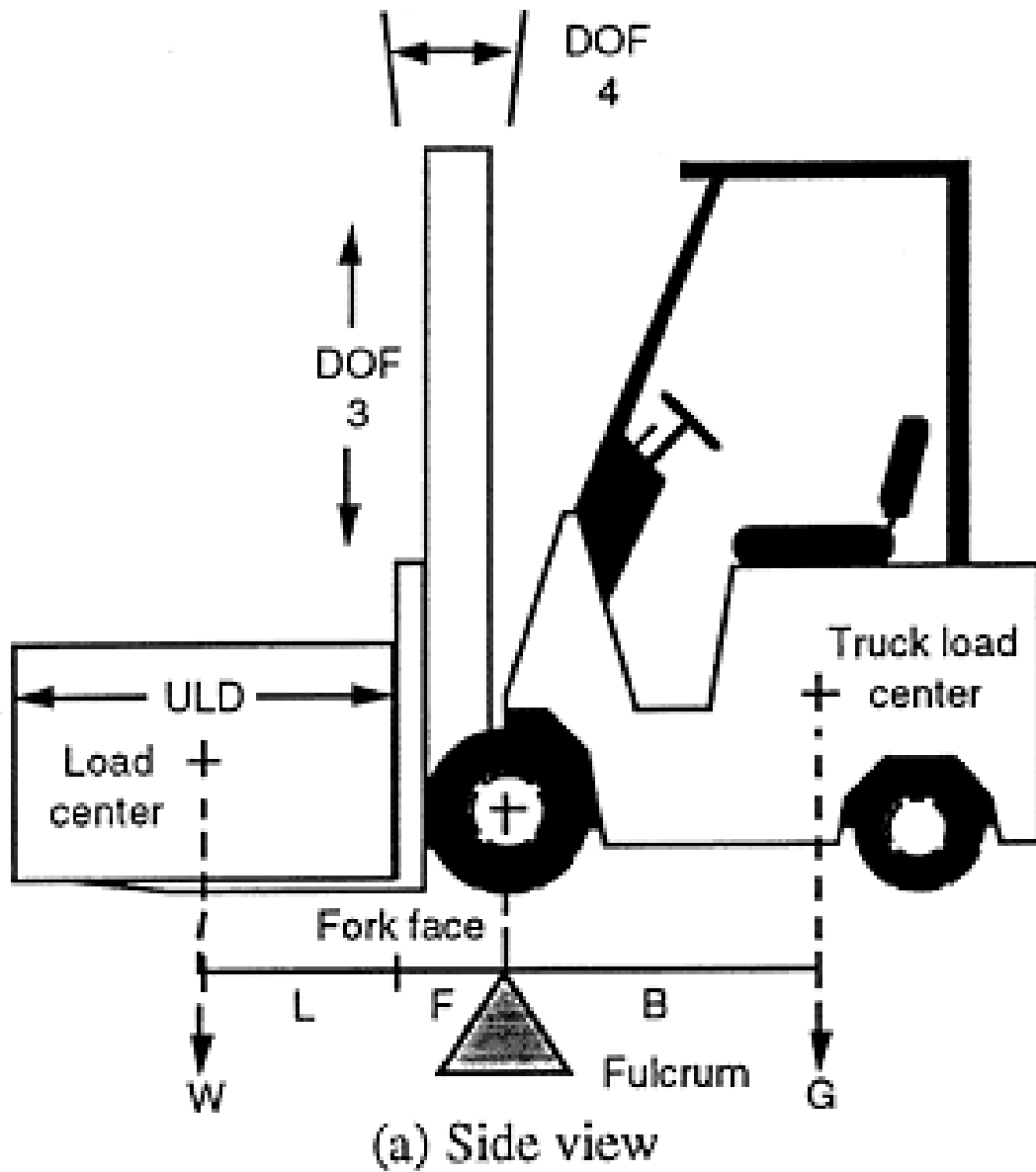
- Counterbalanced lift trucks (a.k.a. fork trucks) are the workhorses of material handling because of their flexibility:
 - Indoor/outdoor operation over a variety of different surfaces
 - Variety of load capacities available
 - Variety of attachments available;

SPECIFICATIONS

**Specify The Model EC15 For All Your
2000-3000 lb (1000-1500 kg) Capacity Material Handling Needs**

CHARACTERISTICS					
1	Manufacturer			Caterpillar	
2	Model			EC15	
3	Capacity	rated load	lb	kg	
				3000	1500
4	at load center	distance	in	mm	
				24	500
5	Power	electric, diesel, gasoline, LP gas			Electric
6	Steering control	pedestrian, stand-on, sit-down			sit-down
7	Tires	cushion, pneumatic			cushion
8	Wheels (x=driven)	number, front/rear			2x / 2
DIMENSIONS					
9	Lift with standard two-stage mast	maximum fork height with rated load		in	mm
		maximum fork height		in	mm
		free fork height		in	mm
10				157	4030
11				130	3300
12				4.1	105
13	Fork carriage	IFTA Class			II
14	Forks	thickness, width, length		in	mm
				1.5 x 4 x 36	34 x 102 x 920
15	Fork spacing	out-to-out, minimum/maximum		in	mm
				7.9/32.5	200/830
16	Tilt of mast	forward/back, degrees			5 / 10
17	Overall dimensions	length to fork face		in	mm
				73.2	1860
18		width	standard tires	in	mm
				37.2	945
		optional	in	mm	NA
19		height	with lowered mast	in	mm
				83	2110
20			with extended mast	in	mm
				178.5	4560
21			to top of overhead guard	in	mm
			83.7	2125	
22	seat height	in	mm		
		45.7	1160		
23	Minimum outside turning radius	in	mm		
		67	1700		
24	Load moment constant, from center of front axle to fork face	in	mm		
		14.2	360		





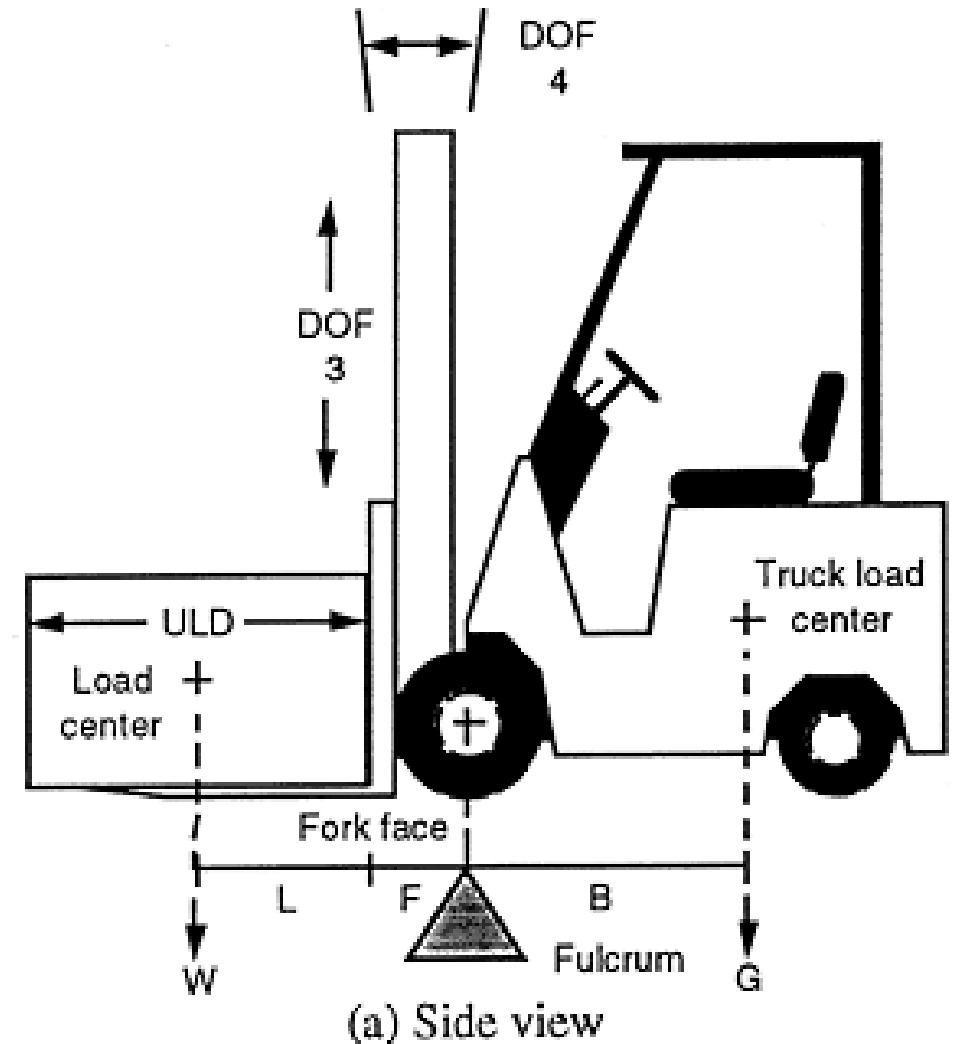
- A truck's **approximate load capacity W** is given by the following:

$$W(F + L) = GB = W_0(F + L_0)$$

- Where
 - **G** = empty truck weight
 - **B** = Front axle to truck-load center dist
 - **F** = Front axle to fork-face dist.
 - **ULD** = unit load depth
 - **L** = Actual load center, distance from fork face to load center of gravity
 $L = ULD/2$ if constant density rectangular shaped load.
 - **L_0** = rated load center (500mm)
 - **W_0** = rated load capacity *load capacity of the truck if the center of gravity of the load is 500mm away from the fork face.*

An Example – CB Lift Trucks

- What is the maximum permissible load weight if the load's center of gravity, L , is greater than $L=500\text{mm}$? (De-rating)
- **Example:** Assuming a constant density rectangular-shaped load, $ULD = 1250\text{ mm}$,
 $F = 250\text{ mm}$,
 $W_0 = 1500\text{ kg}$,



An Example – CB Lift Trucks

- What is the maximum permissible load weight if the load's center of gravity, L , is greater than $L=500\text{mm}$? (De-rating)

$$W(F + L) = W_0(F + L_0)$$

$$W(250 + 625) = 1500(250 + 500)$$

- **Example:** Assuming a constant density rectangular-shaped load,
 $ULD = 1250 \text{ mm}$,
 $F = 250 \text{ mm}$,
 $W_0 = 1500 \text{ kg}$,

$$W = 1285 \text{ kg}$$

An Example – CB Lift Trucks

- What if we add a counterbalance weight? How does the rated load capacity change?

An Example – CB Lift Trucks

- **Example:** Assume $F=250$ mm, $W_0 = 1500$ kg, and we add 250 kg to the back of the truck at a distance of 1500 mm from the front axle. Find **new rated load capacity**(W_0')? (Recall $L_0=500$)
- $W_0'(F + L_0) = W_0(F + L_0) + \Delta W L_\Delta$
- $W_0'(250 + 500) = 1500 (250 + 500) + (250)(1500)$
- $W_0' = 2000$ kg
- <https://www.youtube.com/watch?v=v7IlPLEzbo>

