Management of Packing Activities in Multimodal Transport Including Air Traffic

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Packing activities

- Tasks
  - Loading / unloading
  - Preparation, picking
  - Short term scheduling
- Packing
  - 1D / 2D / 3D packing problems
  - Which sectors ?
  - A niche business!
  - Which optimisation techniques?
- Net-WMS European project

Problem definition

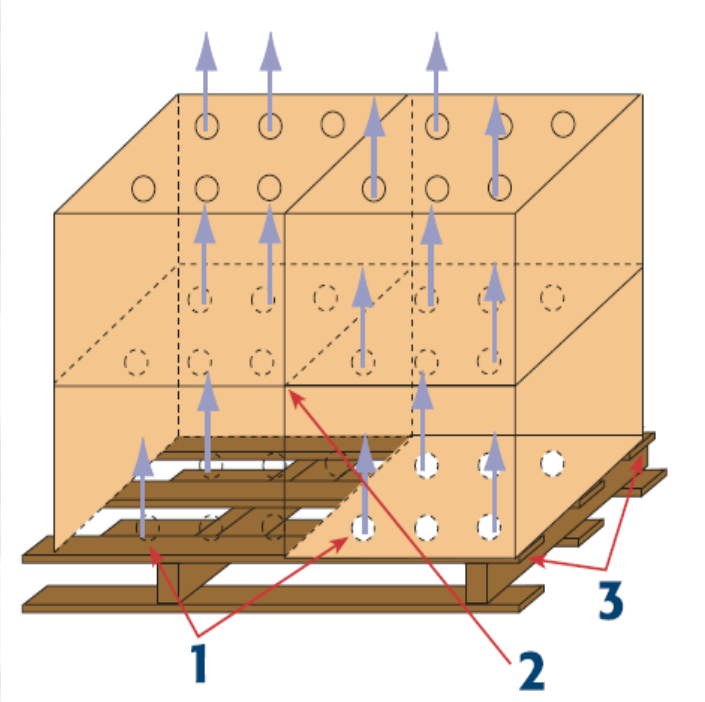
- A set of boxes to pack
  - Cartons, pallets
- A set of containers
  - Pallets, containers, trucks
  - Surfaces, yards
- Constraints
  - Stackable items, heavy items, incompatibles items, ...
- Objectives
  - Feasible solution, Optimal solution, Quality solution

Objectives

- **Objective 1 : Optimal selection of the containers to pack all boxes**
  - {Ci, Qi}
  - **Knapsack problem**
- **Objective 2 : Minimise the number of containers to pack all boxes**
  - {C, Q}
  - **Bin packing problem**
- **Objective 3 : Feasible solution**
  - Assignment of containers to wagons
  - Vehicle loading plan

Example of constraints

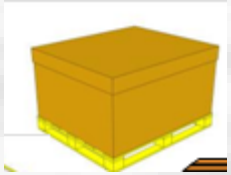
- Chilled products
  - Piles of cartons
- Fresh fruits
  1. Carton alignment for unrestricted air flow
  2. Strength of cartons in the corners
  3. Corners of the cartons supported

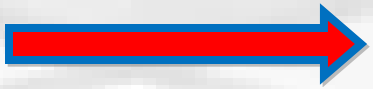


Constraints – cold chain

- Ensure total weight of cargo, container, chassis and truck are within legal limits.
- Set unit at optimal carrying temperature.
- Assure weight is distributed evenly in container for maximum stability.
- Never stack product to the ceiling of the container.
  - Allow a minimum of 4 inches (100mm) between the top of the cargo and the ceiling.

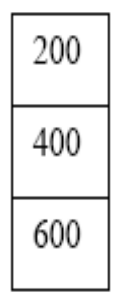
Packing in a warehouse



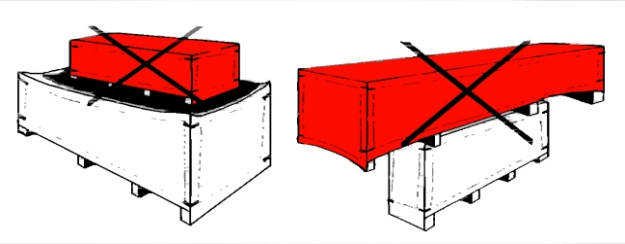


Constraints

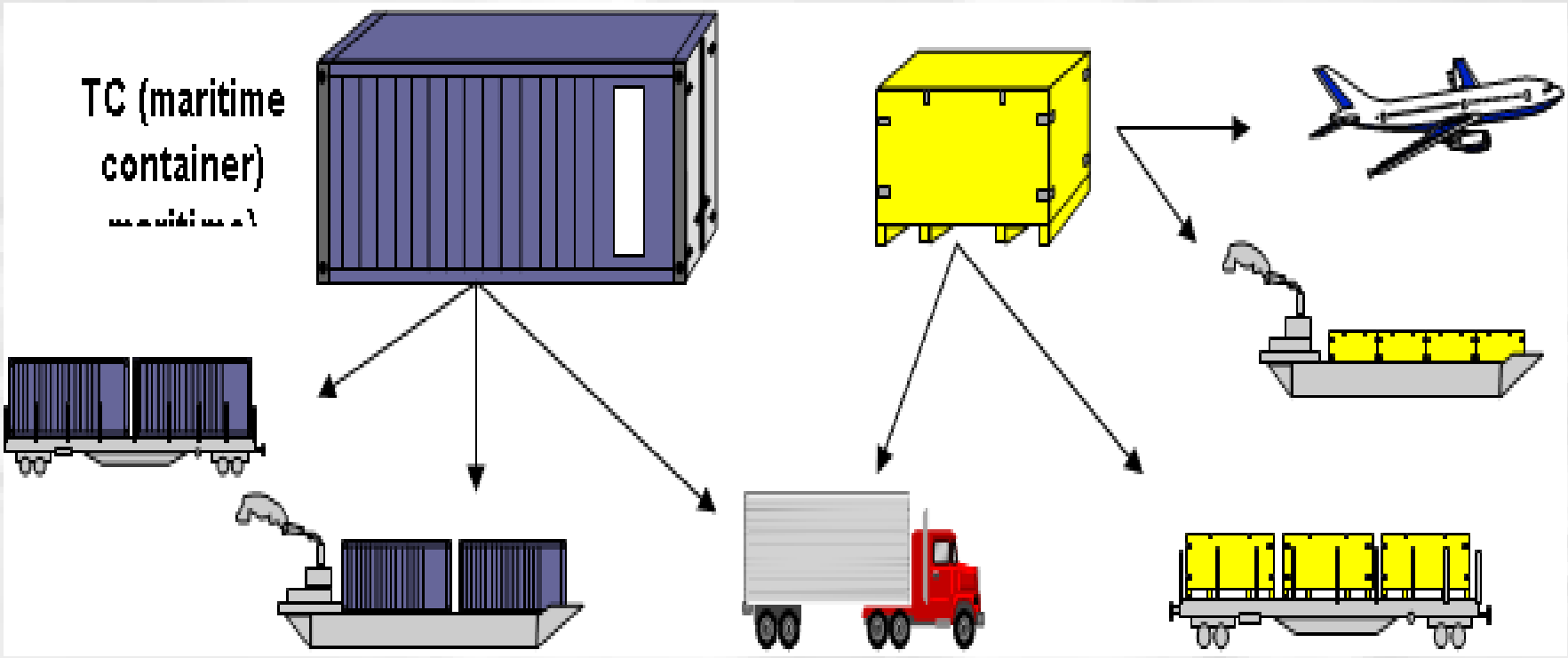
- All boxes must be stacked in decreasing order of weights.



- A group of boxes can be placed below another box if and only if the overhang is less than 10 cm.



Multimodal transport



Solvers

- Pallet Loading
- Pallet / containers
- Vehicle loading
- Area organisation

Solvers

- Weight equilibrium constraints
- Loading / unloading sequences
- Quality of solutions

Air Freight

- **Air freight is similar to that for sea freight**
- **Air cargo containers**
- **Distance constraints**
  - Air circulation, maintain cooling
- **Special handling practices**
  - Dangerous products
  - Pharmaceutical products
  - Air cargo theft
- **Manifest**
  - Detailed loading plan
- **Online packing optimisation tools**

Technologies

- Rule programming
- Constraint Programming
- Mathematical Programming
- Heuristics

Conclusion

- Several problem formulations
- 1 problem = 1 tool
- Right optimisation technology
- Combination of technologies : **CP + MP + H**
- Composition of solvers
- Handling large instances
- Online packing
- Quality of solutions