

Entities:

- Orders (quantity)
- Equipment
- Material (minStock, maxStock)
- MaterialDemand (starttime, endtime, quantity)

Conditions:

- Order is executable on each machine.
- Order has different sizes.
- Order running time is depending of the material and the equipment.
- Gaps between orders are possible if there is no demand.
- Gaps between orders are possible when there is a equipment setup time.
- Parallel orders with same material on different equipment's are possible.

Target:

- Calculate start and endtime for an order.
- Start and endtime is precisely one minute (maximum five minutes if runtime is to long).
- Satisfy only the demand of a material.
- Good result in 5 minutes.
- No exceed min or max stock.

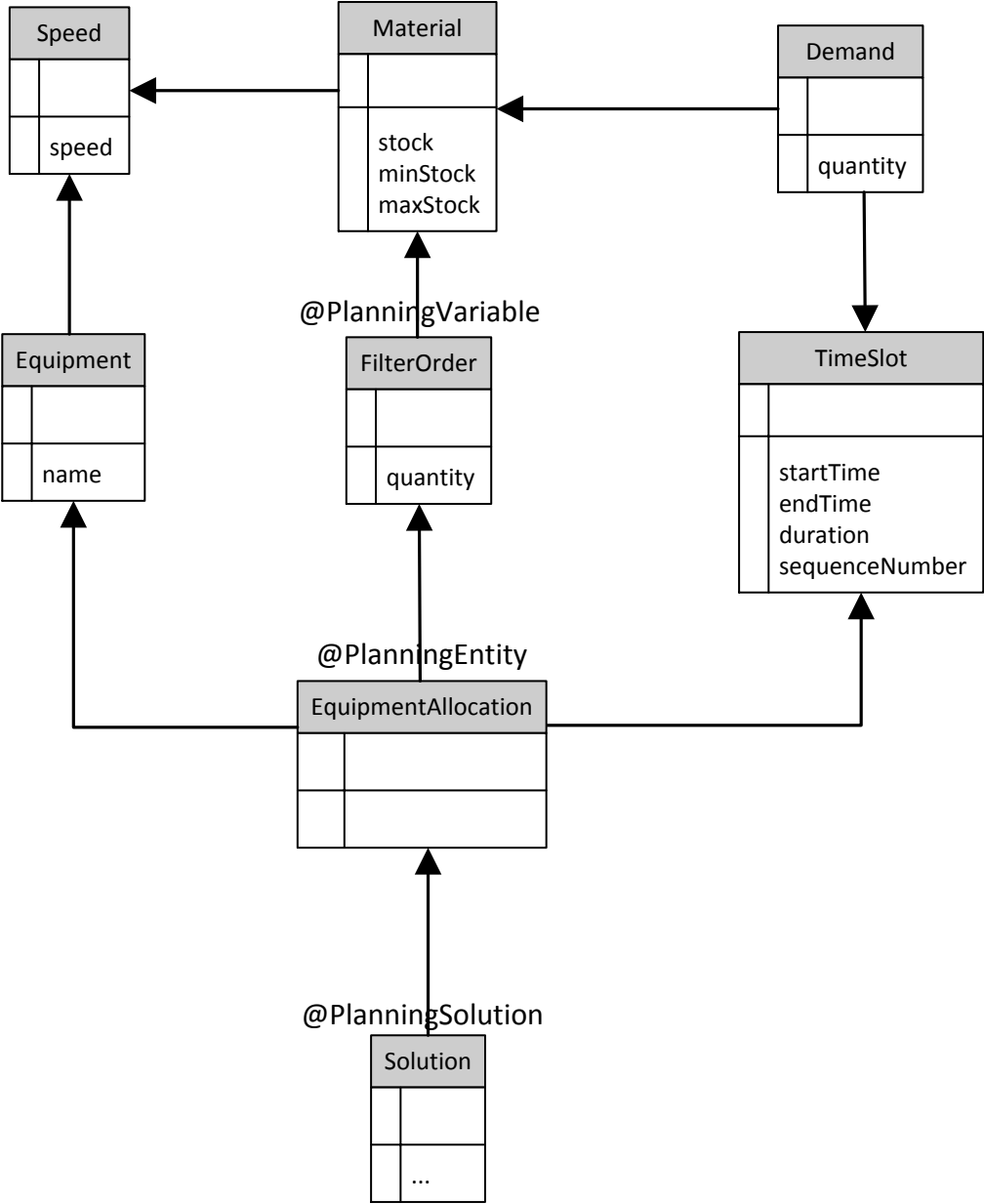
Plan data:

- Plan for 24 hours.
- Plan 35 orders (normal order time is 2 hours).
- Plan 5 demands with different materials (7 orders per demand).
- Plan 3 equipment's.

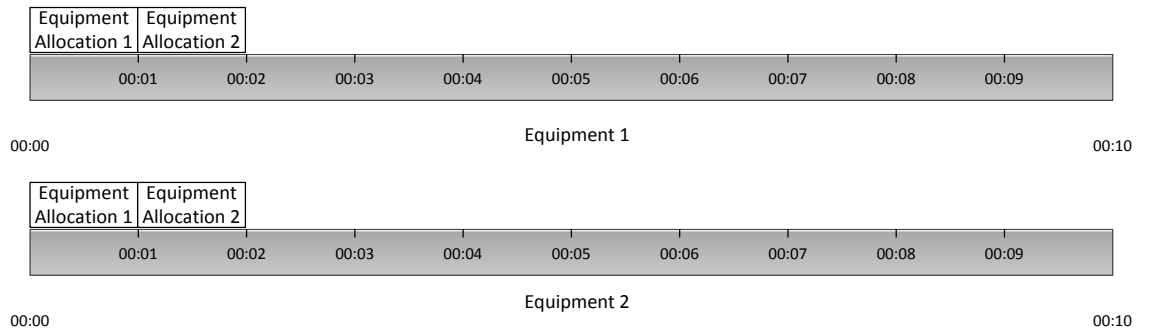
Problem:

- No result in 5 minutes.
- Concept with timeslots has to many possible order positions.
- No restrictions are possible to find the best solution.

Domain model



1. Implement different timeslots on each equipment to find start and endtime.

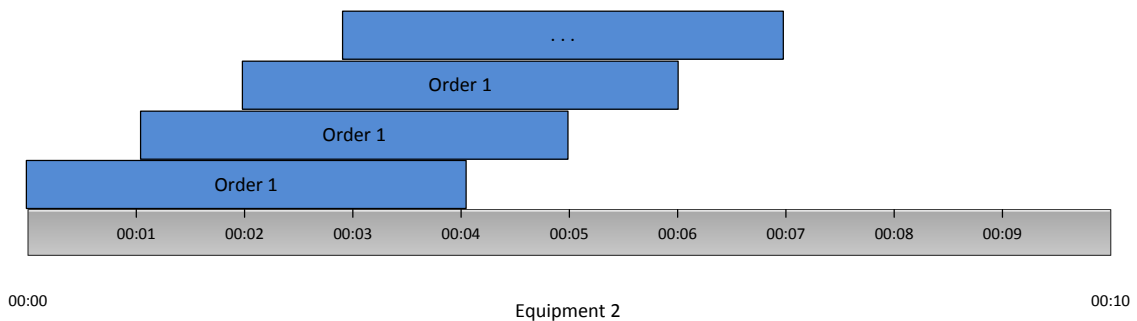
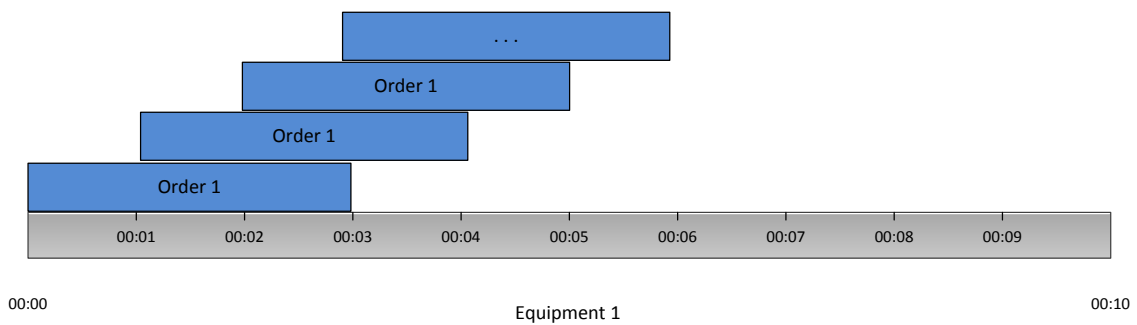


2. Use a pillar swap to define to possible order positions (before solving phase).

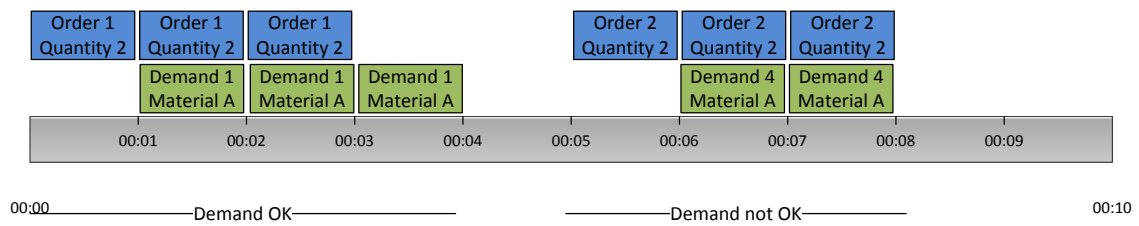
Example show, that equipment 1 is faster than equipment 2.

Example:

- 1 order (with 2 hours)
- 1 equipment
- 24 hours planning time with 1 timeslot per minute
- Possible order positions = $22 * 60 = 1320$ (on one equipment)
- Possible order positions = $1320 * 3 = 3960$ (on three equipment)
- Possible order positions = $3960 * 35 = 138.600$ (all orders on all equipment)



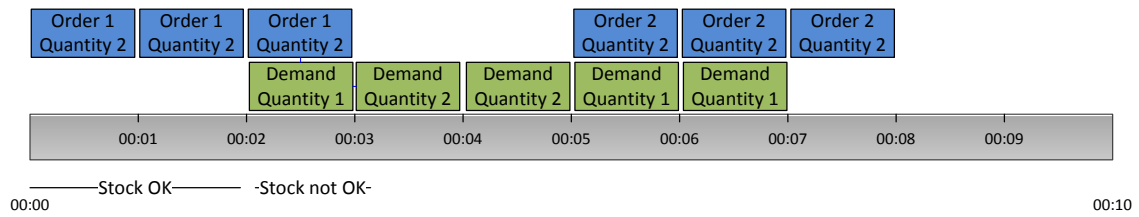
3. The concept to check the material demand.



- The first block is ok, because it is more produced than consumed (demand).
- The second block is not ok, because it is more consumed (demand) than produced.

4. The concept to check the min and max stock.

Example max stock.



Example max stock:

Start stock: = 5

Max stock: = 10

Formula: Start stock – Summe(Demand) + Summe(Order Quantity)

Timeslot 1 $5 + 2 - 0 \geq 10$ => OK

Timeslot 2 $5 + 4 - 0 \geq 10$ => OK

Timeslot 3 $5 + 6 - 1 \geq 10$ => HardConstraint

5. Performance workaround with pillar swap

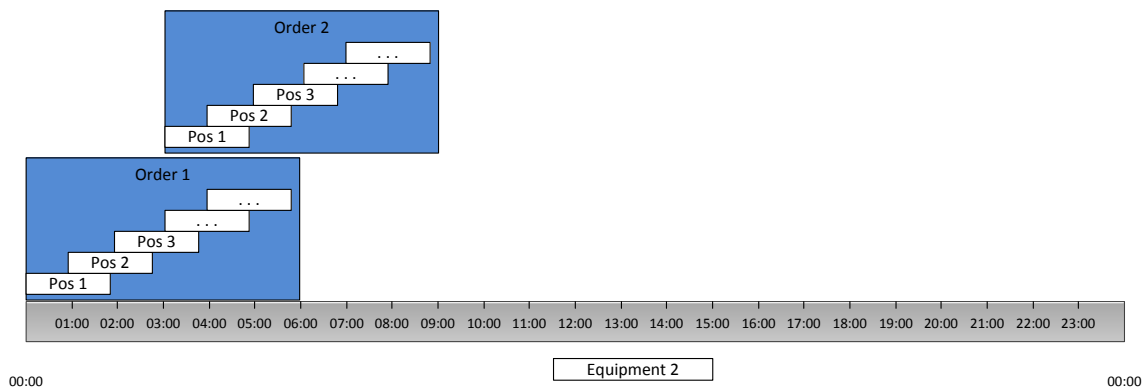
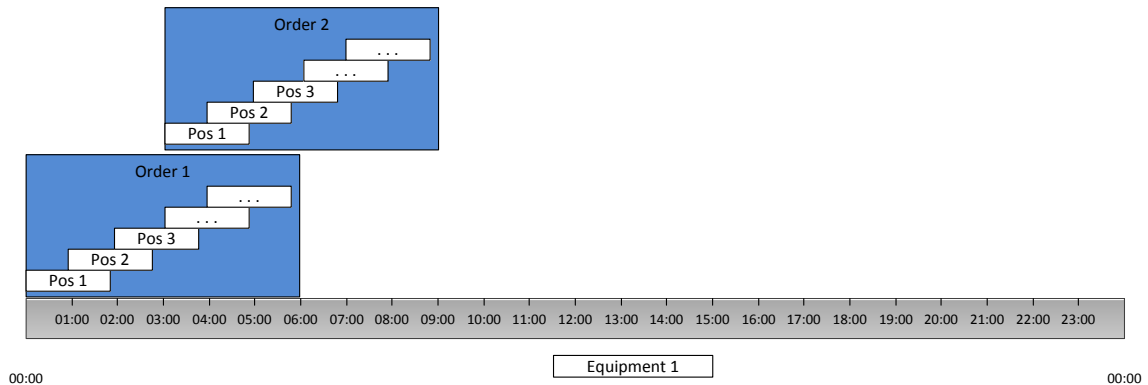
Build time windows for the possible execute time for an order with the same size.

When the order is smaller or bigger than the normal order size, plan them at the end of the equipment time.

This concept has the problem that order 1 and order 2 cannot start at 00:00 on equipment 1 and equipment 2.

For the stock of a material it may very well to planner small and big orders on each position of the equipment.

Order Id	Earliest starttime	Latest endtime
1	01.01.2013 00:00	02.01.2013 06:00
2	02.01.2013 03:00	03.01.2013 09:00
3	03.01.2013 06:00	04.01.2013 12:00
4	04.01.2013 09:00	05.01.2013 15:00
5	05.01.2013 12:00	06.01.2013 18:00
6	06.01.2013 15:00	07.01.2013 21:00
7	07.01.2013 18:00	09.01.2013 00:00

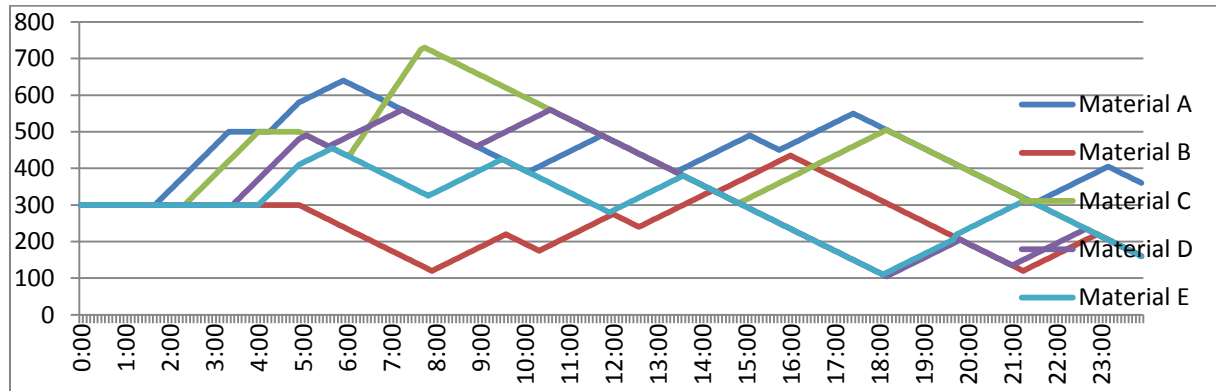


Example stock trend

Start Stock: 300

Min-Stock: 100

Max-Stock: 900



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FOrder id=0 q=200 [Equipment-2] 01.02.2014 01:45:00 01.02.2014 03:25:00
FOrder id=1 q=200 [Equipment-3] 01.02.2014 04:20:00 01.02.2014 06:00:00
FOrder id=2 q=200 [Equipment-2] 01.02.2014 10:10:00 01.02.2014 11:50:00
FOrder id=3 q=200 [Equipment-1] 01.02.2014 13:30:00 01.02.2014 15:10:00
FOrder id=4 q=200 [Equipment-1] 01.02.2014 15:50:00 01.02.2014 17:30:00
FOrder id=5 q=200 [Equipment-3]
FOrder id=6 q=200 [Equipment-1] 01.02.2014 21:35:00 01.02.2014 23:15:00
FOrder id=10 q=200 [Equipment-3]
FOrder id=11 q=200 [Equipment-2] 01.02.2014 08:00:00 01.02.2014 09:40:00
FOrder id=12 q=200 [Equipment-1] 01.02.2014 10:25:00 01.02.2014 12:05:00
FOrder id=13 q=200 [Equipment-2] 01.02.2014 12:40:00 01.02.2014 14:20:00
FOrder id=14 q=200 [Equipment-3] 01.02.2014 14:25:00 01.02.2014 16:05:00
FOrder id=15 q=200 [Equipment-3]
FOrder id=16 q=200 [Equipment-2] 01.02.2014 21:20:00 01.02.2014 23:00:00
FOrder id=20 q=200 [Equipment-3] 01.02.2014 02:25:00 01.02.2014 04:05:00
FOrder id=21 q=200 [Equipment-1] 01.02.2014 06:10:00 01.02.2014 07:50:00
FOrder id=22 q=200 [Equipment-3] 01.02.2014 06:05:00 01.02.2014 07:45:00
FOrder id=23 q=200 [Equipment-3]
FOrder id=24 q=200 [Equipment-2] 01.02.2014 14:55:00 01.02.2014 16:35:00
FOrder id=25 q=200 [Equipment-2] 01.02.2014 16:35:00 01.02.2014 18:15:00
FOrder id=26 q=200 [Equipment-3]
FOrder id=30 q=200 [Equipment-2] 01.02.2014 03:30:00 01.02.2014 05:10:00
FOrder id=31 q=200 [Equipment-2] 01.02.2014 05:40:00 01.02.2014 07:20:00
FOrder id=32 q=200 [Equipment-3] 01.02.2014 09:00:00 01.02.2014 10:40:00
FOrder id=33 q=200 [Equipment-3]
FOrder id=34 q=200 [Equipment-3]
FOrder id=35 q=200 [Equipment-2] 01.02.2014 18:15:00 01.02.2014 19:55:00
FOrder id=36 q=200 [Equipment-3] 01.02.2014 21:05:00 01.02.2014 22:45:00
FOrder id=40 q=200 [Equipment-1] 01.02.2014 04:05:00 01.02.2014 05:45:00
FOrder id=41 q=200 [Equipment-3]
FOrder id=42 q=200 [Equipment-1] 01.02.2014 07:55:00 01.02.2014 09:35:00
FOrder id=43 q=200 [Equipment-3] 01.02.2014 12:00:00 01.02.2014 13:40:00
FOrder id=44 q=200 [Equipment-3]
FOrder id=45 q=200 [Equipment-1] 01.02.2014 19:45:00 01.02.2014 21:25:00
FOrder id=46 q=200 [Equipment-3] 01.02.2014 18:10:00 01.02.2014 19:50:00

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