Rostering Introduction

Developed by
Jeppesen Crew Academy

Practical Details

To ensure a good learning environment, we appreciate that:

- mobiles phones are turned off (or kept on silence)
- phone calls are taken outside the training room
- internet browsing, typing e-mails etc. is done on breaks

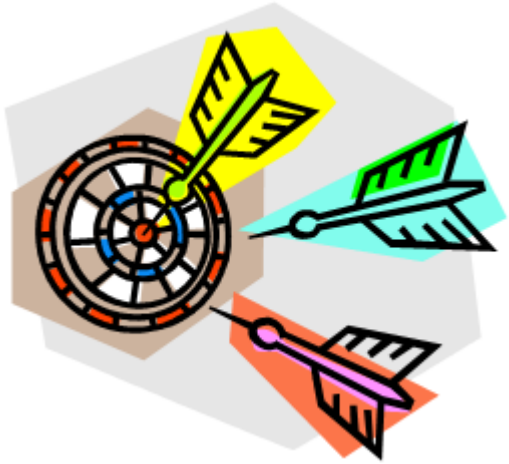
Practical information:

- course hours are 9:00 to 17:00
- restrooms are located outside of training room
- water and fruit are located in back

Course goals

Give an understanding of:

- planning concepts
- crew planning process
- crew rostering problem objective and complexity
- preferential bidding
- complicating factors.



Agenda Day 1

Planning process and concepts

Basic Crew Rostering problem

Lunch around 12:30

Quality and stability

Preferential bidding

Complicating factors

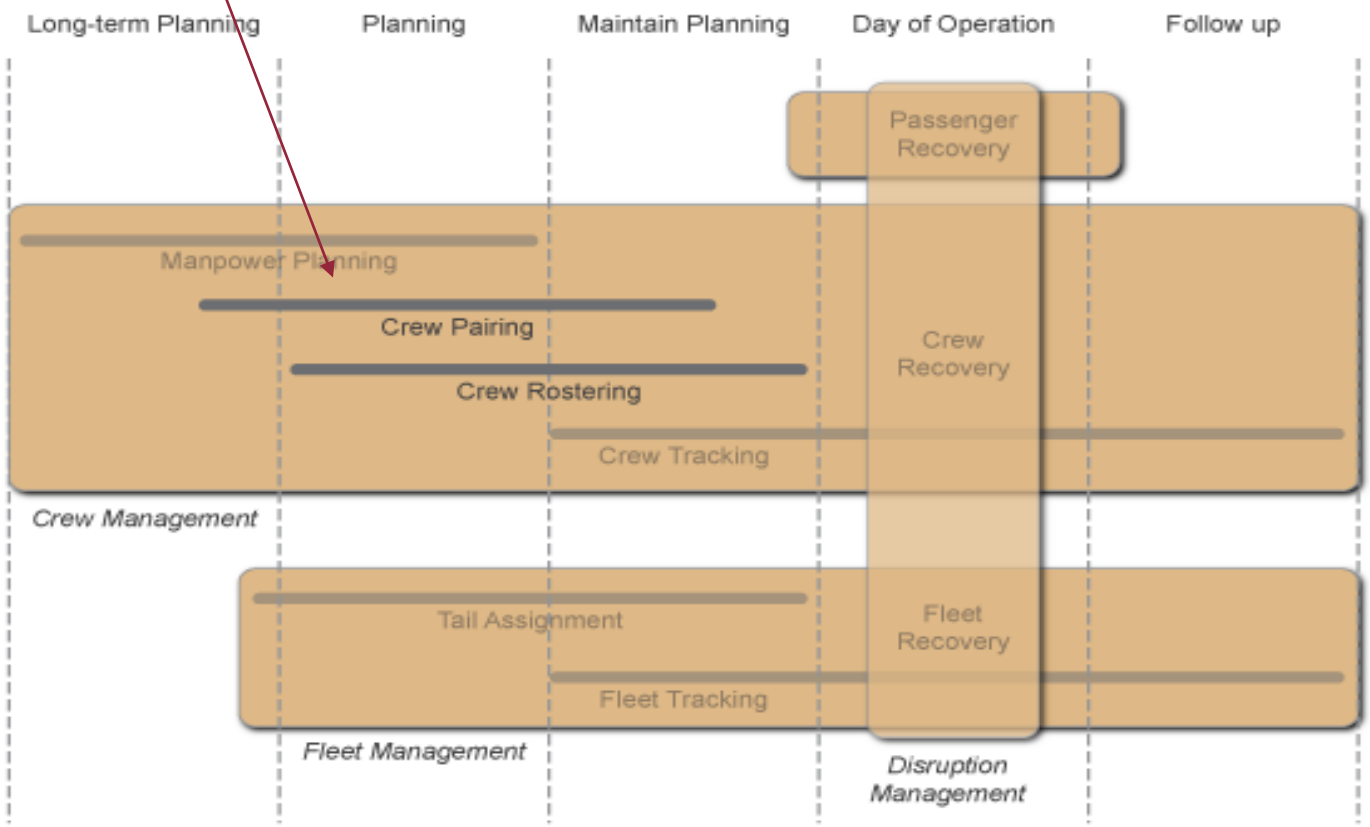
Course evaluation

Coffee breaks around 10:00 and 15:00

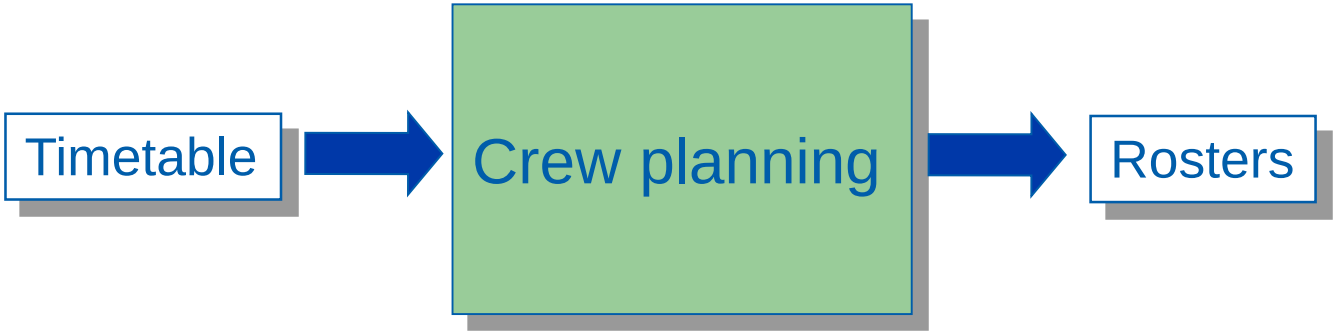
Planning process and concepts

Jeppesen products

Crew planning process



Crew planning problem



Due to complexity, the problem is divided into a number of smaller problems that are solved sequentially.

Timetable planning

Slots are distributed at biannual IATA conferences

Output: season timetables

```
10APR00-25MAY00 12345
SK 1771 1005 GOT-CPH 1040

10APR00-25MAY00      67
SK 1771 1015 GOT-CPH 1050

26MAY00-30OCT00 1234567
SK 1771 1010 GOT-CPH 1035

...
```

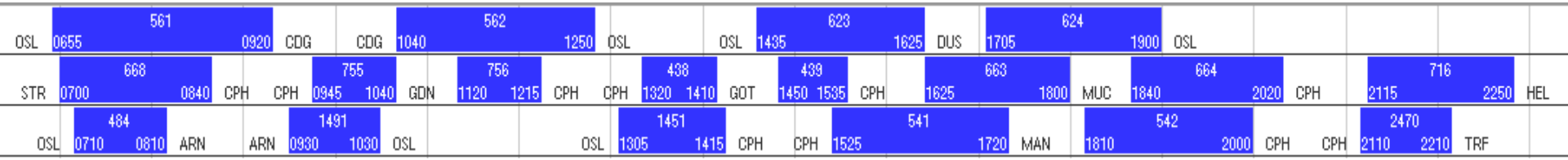
* IATA = International Air Transportation Society

Tail Assignment

- Assign larger airplanes to flights with more passengers.
- Define aircraft routing with respect to maintenance.

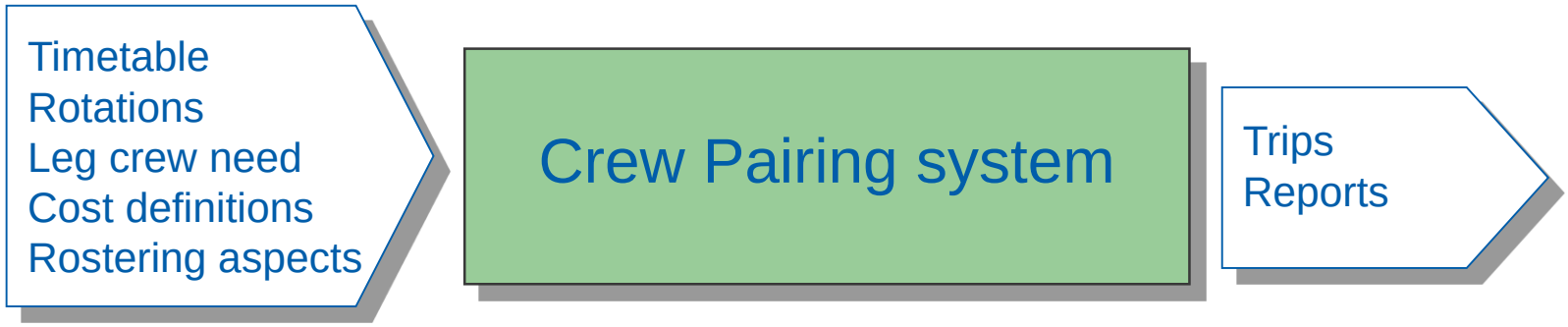
Tail Assignment – example

Rotations of three Boeing 736 on one day.



Crew Pairing

- Create anonymous flight sequences respecting flight regulations.
- Minimize cost, maximize quality of life and robustness.

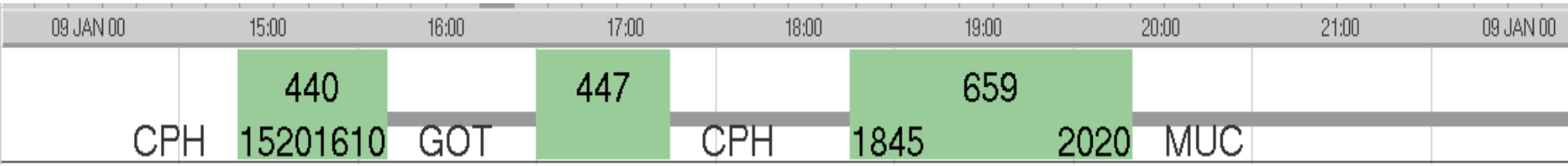


Crew Pairing planning is done between 3 and 8 weeks before day of operation.

Crew Pairing – example

A captain and a first officer are based in Copenhagen. They shall fly a two-day trip with a night-stop in Munich.

Monday's duty:



…and Tuesday's duty:

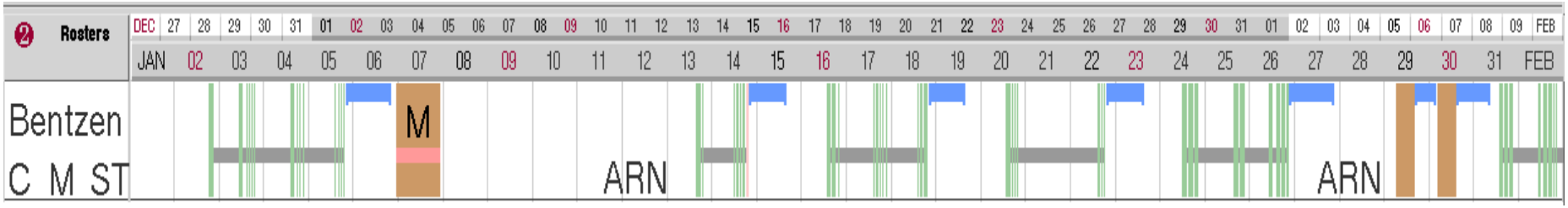
Crew Rostering

- Create detailed working plans for crew, including flights, ground duties, days off, vacation etc.
- Maximize fairness and satisfaction, minimize cost.

Crew Rostering planning is done between 1 and 6 weeks before day of operation.

Crew Rostering

The January roster for a captain includes flight duties, ground duties (e.g. simulators, medical checks) and days off.



Crew Tracking

- Maintain rosters after publication.
- Minimize costs and impact on published rosters.

Crew Tracking is done from roster publication to operation. The closer to operation, the more important on-line updates gets.

Planning concept - base

A home base is a station at which a crew member works.

A station can cover several airports
(e.g. PAR = CDG + ORY).

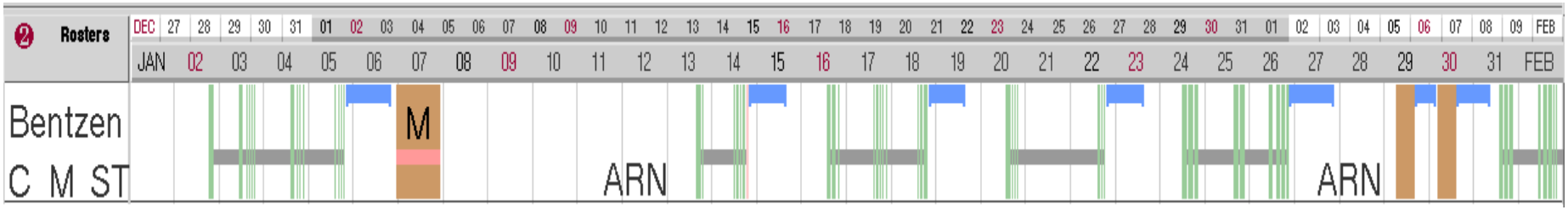
An airline can have several bases, but a crew member is always attached to one base only (the home base)

Example

SAS has three home bases: Copenhagen, Oslo and Stockholm

Planning concept - roster

A roster contains all activities to be performed by a crew member during a planning period (typically a month)



Planning concept - leg

The smallest (atomic) planning component is leg.

A leg is the operation between a departure station and the next arrival station. It has a unique combination of flight carrier, flight number and leg number per day.

Planning concept - duty

Duty is a sequence of legs constituting a day's work (i.e. work between required rest periods) for a crew member.

A duty usually begins with a briefing before the first leg and ends with a debriefing after the last leg.

Example

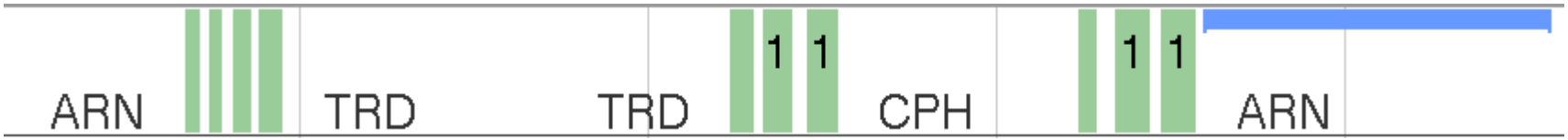
Duty beginning in WAW and ending in MUC.

Planning concept - trip

Trip is a sequence of duties beginning and ending at the same base.

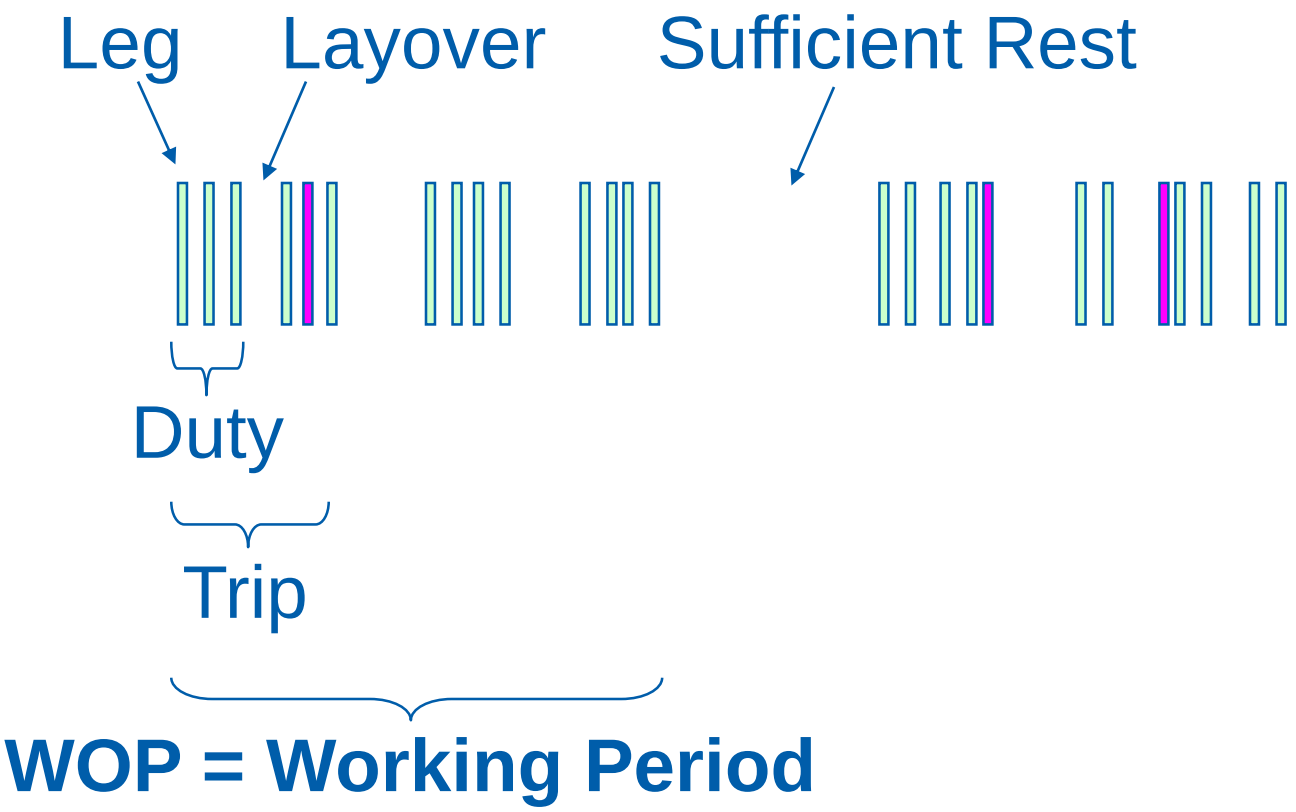
Example

Arlanda trip with three 1-day duties and layovers in Trondheim and Copenhagen



A trip always has a crew complement indicating the crew supposed to service the trip.

Planning Concepts - WOP



Planning concept - ground duty

Ground duty is a non-flight activity at base.

Reserve duties (where crew members are standby in case of disruptions such as illness or delays) are probably the most common ground duty.

Planning concept – on and off duty

Planning objects to be included in a roster

on-duty activities:

- trips
- ground duties (standby, simulator training etc).

off-duty activities:

- days off
- vacation.

Planning concept – personal activity

Personal activities are non-scheduled activities that may not be transferred from one crew member to another.

Example

Office duty, medical check, vacation, sick leave.

Planning concept – pre-assignment

Planners must usually take pre-assignments into consideration when constructing rosters.

Pre-assignments are activities assigned to crew members in previous planning steps.

Example

Vacation, training etc.

Planning concept – crew position

A non-personal activity needs crew carrying out various tasks. Therefore, crew is divided into crew positions.

The number of crew positions and crew position types vary from airline to airline.

Example

Flight deck crew: captain – first officer – second officer

Cabin crew: purser – assistant purser – flight attendant

Planning concept – crew complement

Each non-personal activity has a crew need (required crew complement), describing the required amount of crew in each crew position.

Example

A trip has crew complement 1/1/0//1/1/3.

This trip should be assigned to…

2 flight deck crew: 1 captain + 1 first officer

5 cabin crew: 1 purser + 1 assistant purser + 3 flight attendants

Problem types

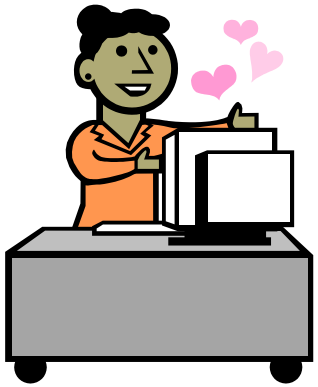
	Long-haul	Short-haul
Flight deck		
Cabin		

Exercise 1

Crew planning process
Planning concepts

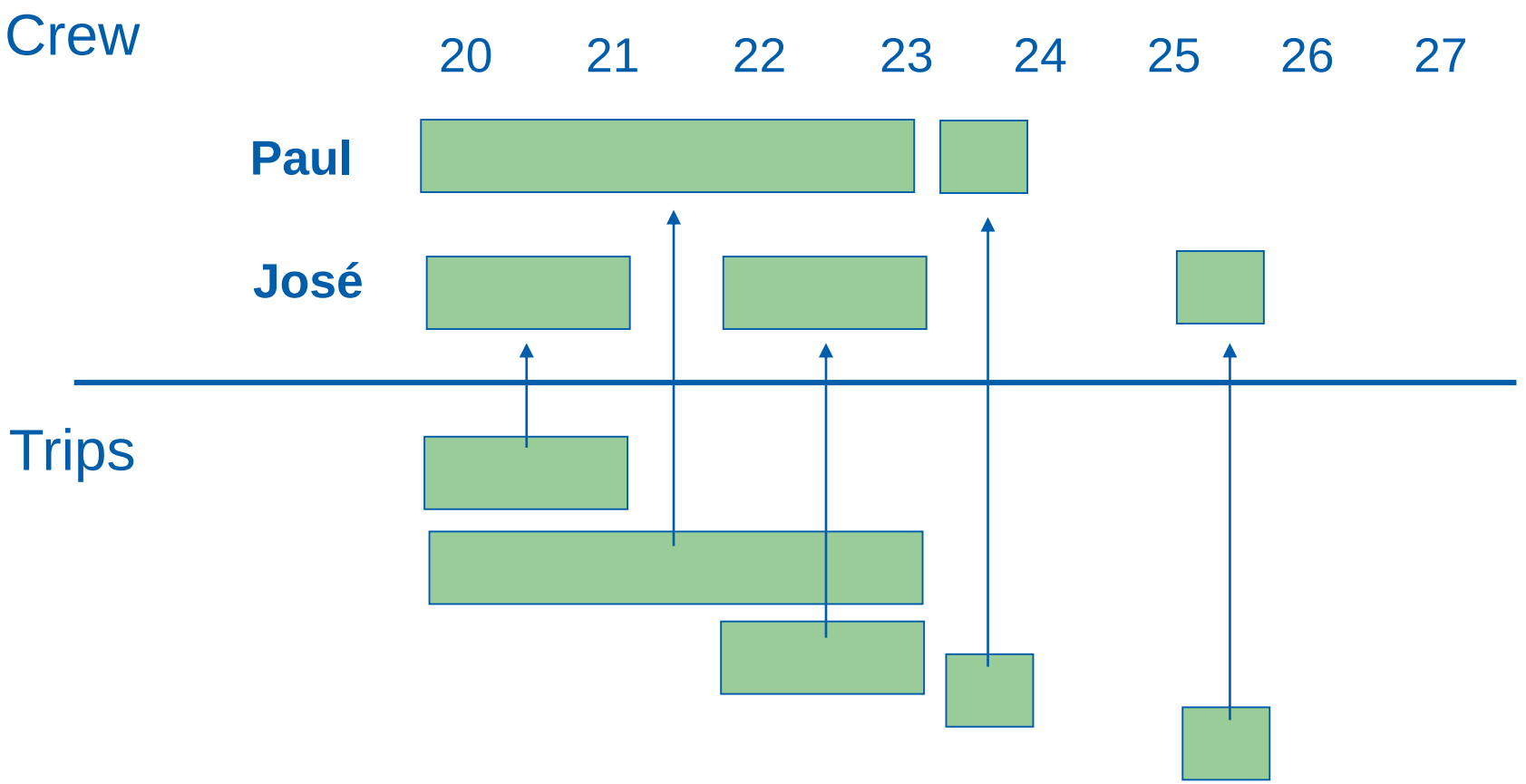
~10 mins

Exercise 1 summary



Basic Crew Rostering problem

Rostering is like solving a puzzle



Rules

Trips must be assigned according to rules.

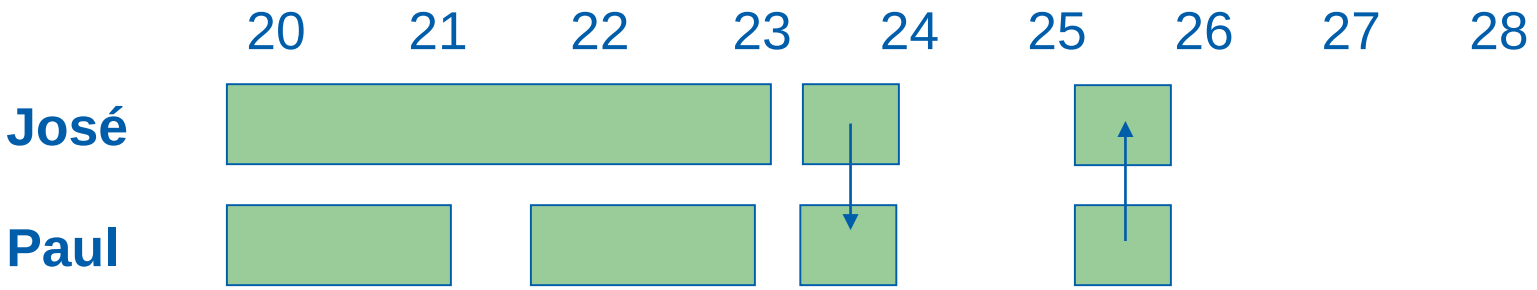
There are different kind of rules:

- authority
- union
- quality.

In Jeppesen Crew Rostering, rules are always enforced strictly.

Rosters not complying with rules are called illegal rosters.

The puzzle can be solved in different ways

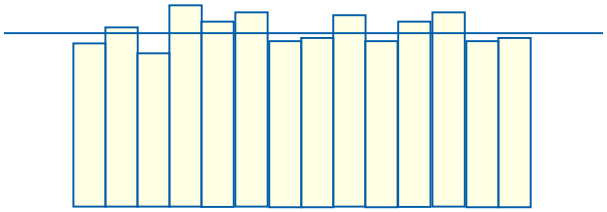


Objectives

- create only rosters complying with regulations, union rules
- cover production (flight duties, standbys etc.)
- maintain and develop crew qualification
- maximize bid satisfaction
- maximize fairness
- maximize crew quality of life
- minimize total costs
- ….

Conflicting objectives

Some objectives are potential conflicts, for example fairness and bid satisfaction.



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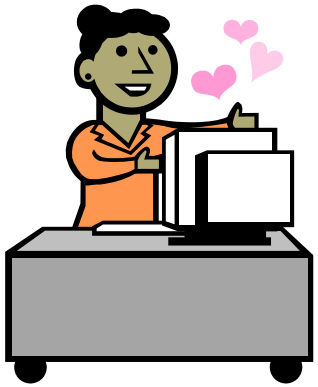
Finding the right balance between conflicting objectives is a non-trivial task.

Exercise 2
Basic Crew Rostering problem

~10 mins

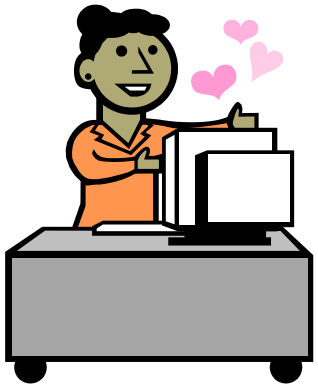
Exercise 2 summary



Exercise 3
Manual Rostering game

~20 mins

Exercise 3 summary

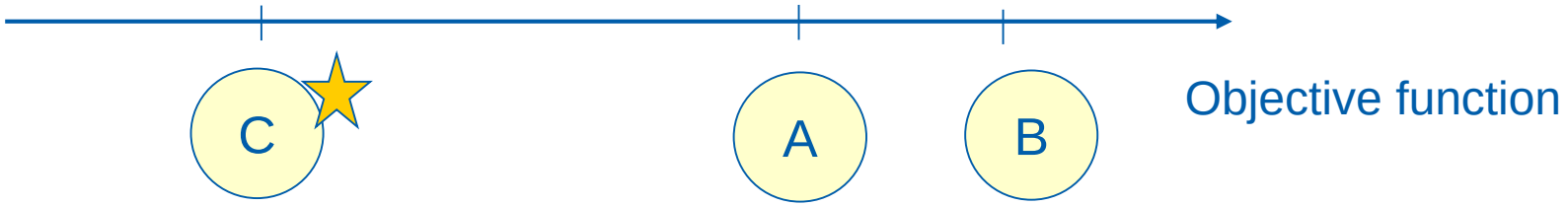


Quality and stability

Objective function

When you solve problems automatically, all crew rostering solutions should be uniquely ordered.

This is the only way to identify the best solution.



Solution A is better than solution B, but solution C is better than both and therefore the best.

Objective function

The objective function:

- guides the optimizer when generating solutions
- is modelled in Rave
- returns a value for every solution.

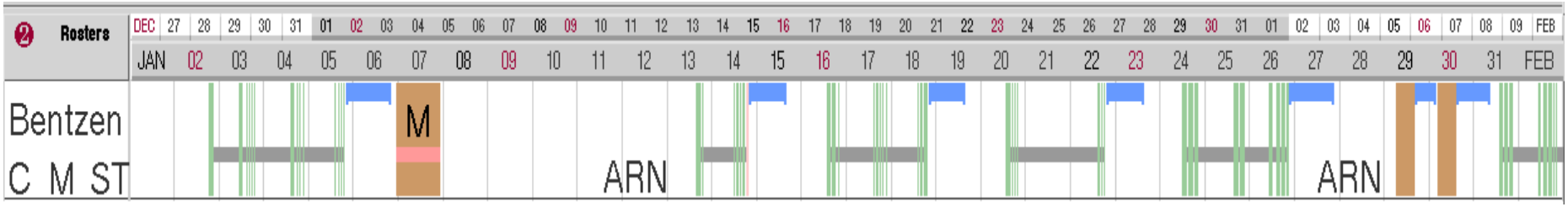
Objective function

The objective function contains two parts:

- real costs (e.g. overtime costs)
- penalties for lacking quality (e.g. lack of fairness).

The best solution is uniquely identified as the one with lowest value of the objective function.

Objective function – example

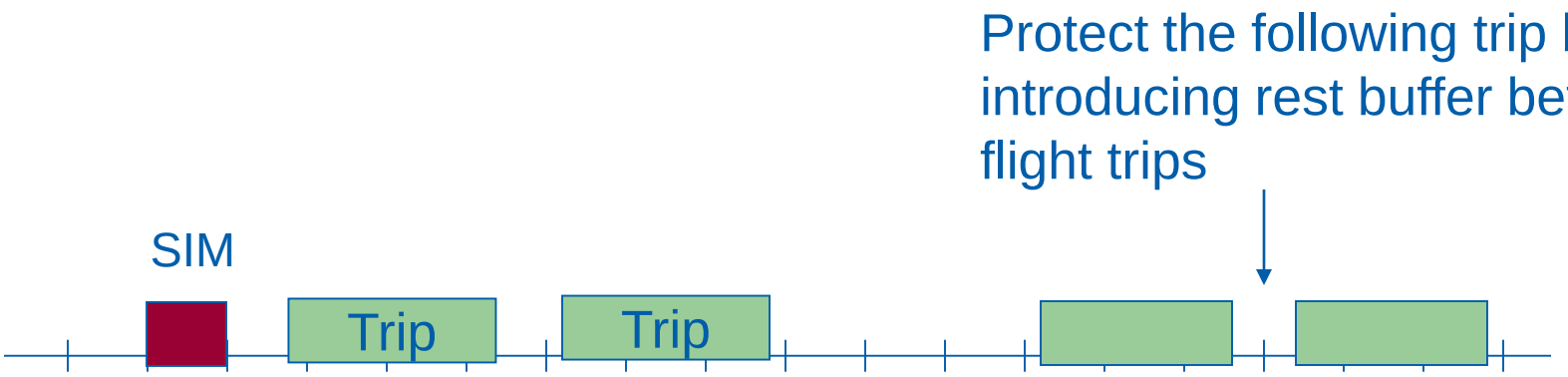


Given a certain objective function, the value of the objective function (often called **total cost**) for the roster above is:

Real costs	1,870 Jeppesen$
Penalties	4,652 Jeppesen$
Total costs	6,522 Jeppesen$

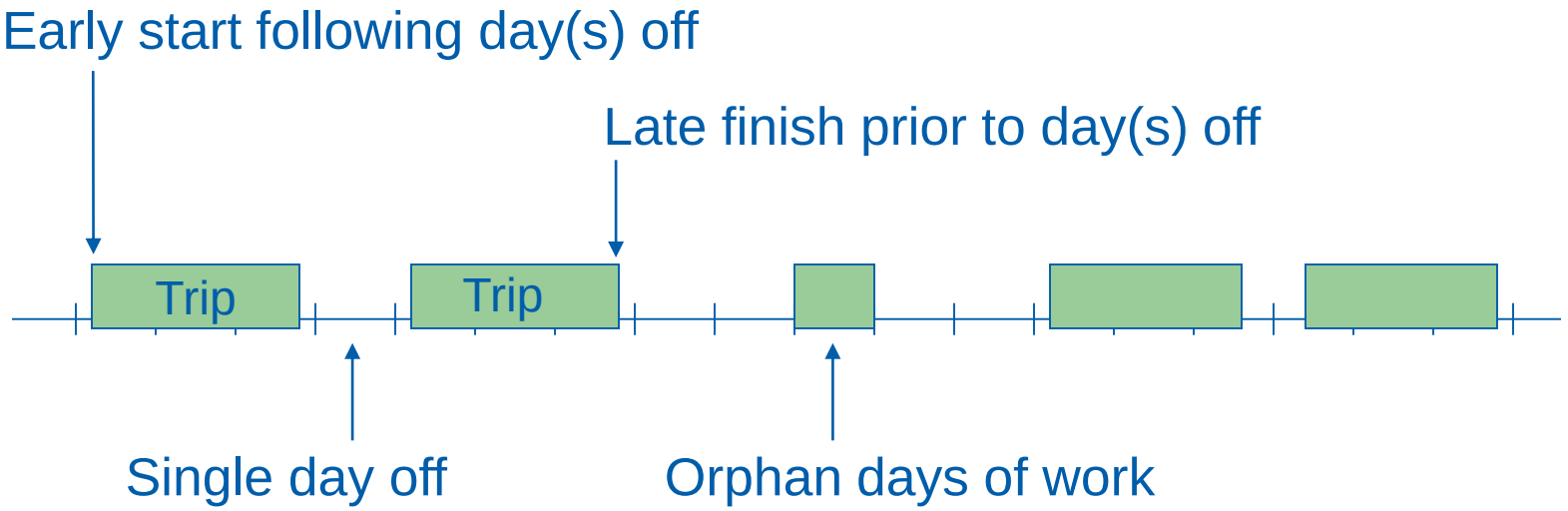
Objective function – stability

Make the roster less sensitive to delays and disturbances.



Social quality

Combinations of trips in a roster result in bad properties.



Quantifying quality

Defining penalties (and hereby quantifying quality) is always difficult, but often a very rewarding process.

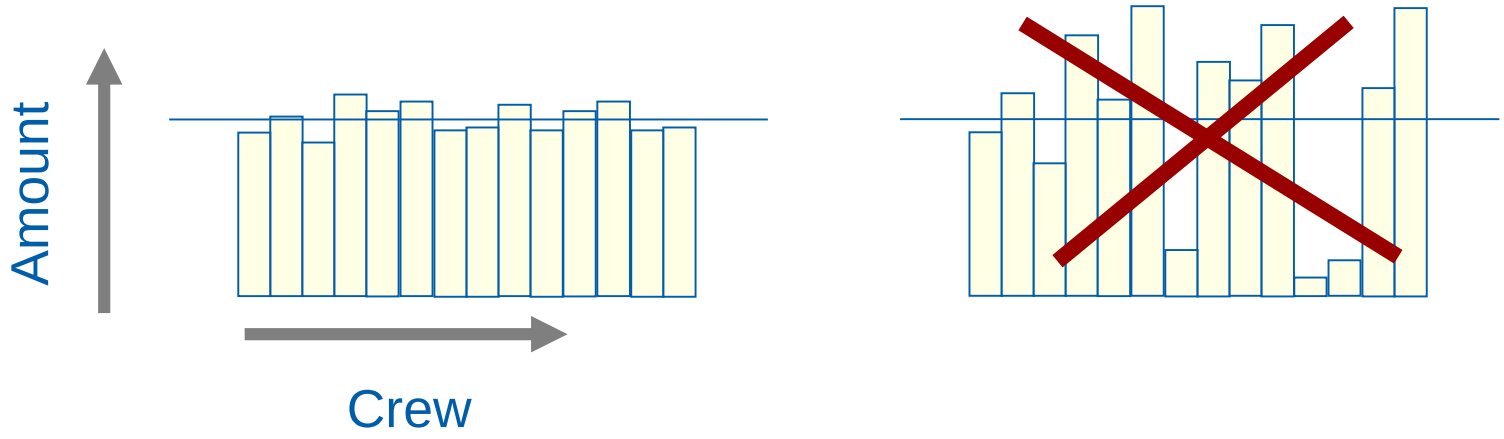
It forces planning departments to:

- prioritize quality issues
- decide how much quality is worth.

Fairness

Often there are certain attributes that must be distributed equally among crew members.

For example, duty time per month should be distributed fairly



Rules vs. cost function

If a rule may be violated in certain cases, this should be considered as a quality issue. A penalty should be given to be used as a backup when the rule is off.

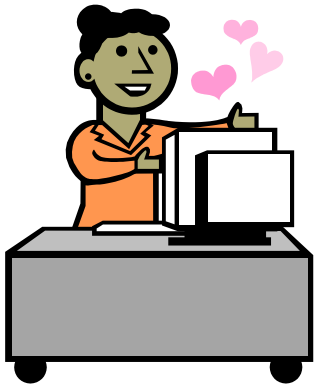
Example
Rule: “Do not allow more than 5 layovers in the same station per month.”

Penalty: “Every layover after the 3rd cost 1000.”

Exercise 4
Quality and stability

~20 mins

Exercise 4 summary



Preferential bidding

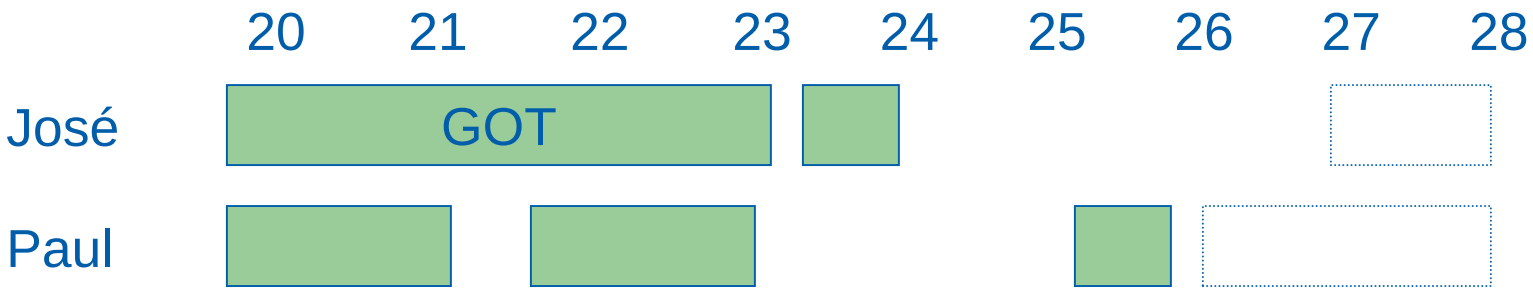
Preferential bidding

A bidding system enables crew to influence working hours, working tasks and time off.

- based on the fact that people have different needs and lifestyles
- if everybody wants the same things, PBS will not work.

Bidding – example

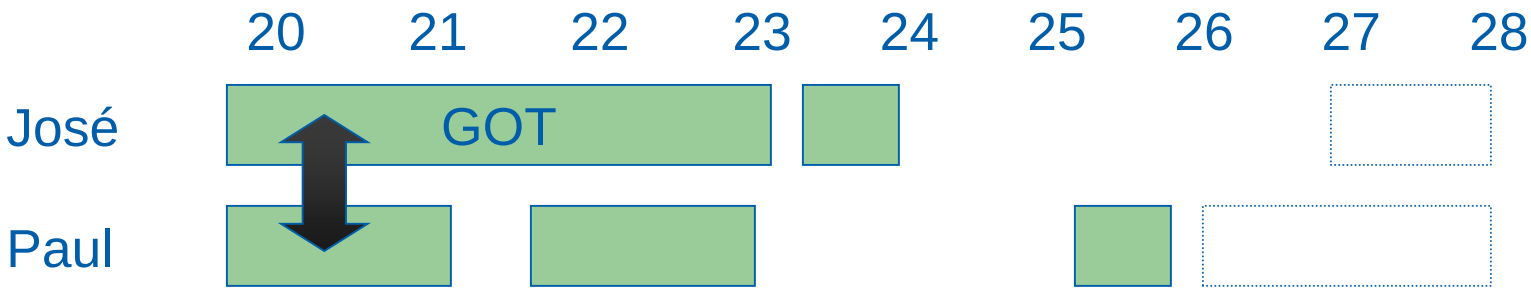
Captains José and Paul are planned to fly:



Bidding – example

José just had a child and therefore prefers short trips. Furthermore, it is his birthday on the 24th.

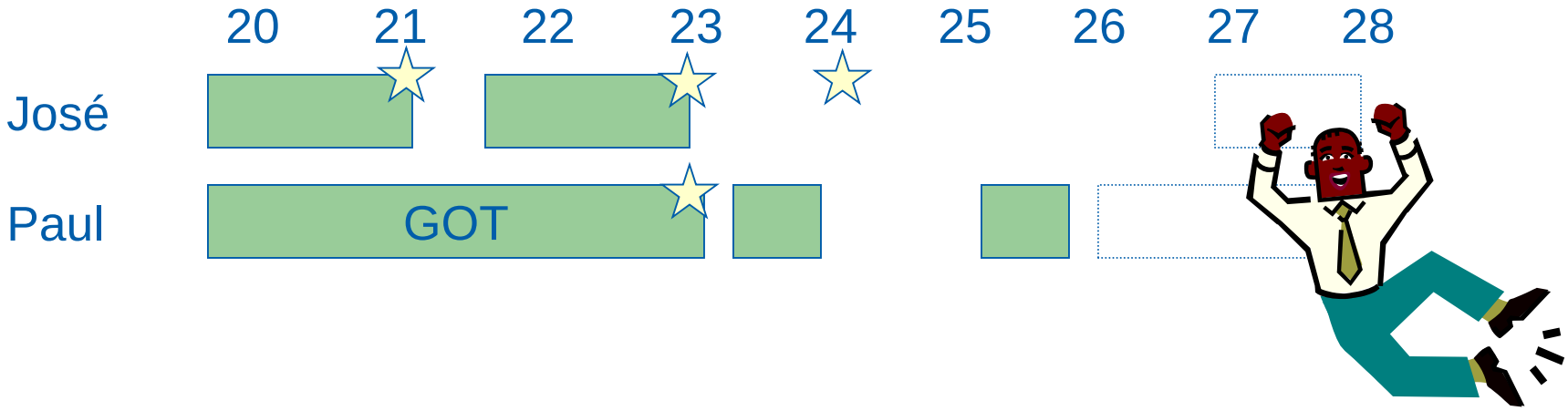
Paul is a bachelor living in Göteborg. He likes long trips.



...so we shift their schedules

Bidding – example

The result has the same overall stability and the same overall cost but it is better adapted to real life crew requests.



Bid types

Time-off bids

- ”I wish to be off the 17th”
- ”I wish to be off on Tuesdays”

Trip bids

- ”I wish to check-in before 8 am”
- ”I wish trips longer than 3 days”
- ”I wish trips shorter than 4 days with a layover in PAR and check-ins after 8 am”

Ground duty bids

- ”I would like my reserve block between the 20-28th”

Buddy bids

- ”I would like to fly with Hansen”

Bidding models

There are two main bidding models:

- bid ratio/reference roster
- strict seniority.

Strict seniority model

With strict seniority the system strives to maximize scheduled points for each individual in seniority order.

Bid ratio model

- strives for a fair distribution of bid fulfillment
- crew seniority may influence the bid fulfillment
- allows each crew member to decide exactly which bids that mean the most to him/her
- creates individual rosters based on individual bids.

In this course we work with the bid ratio model.

Bid ratio

Not all bids are granted:

Productivity
(Production not covered if everybody had this bid satisfied)

Attractive bid
(Limited number of certain properties)

Bad quality
(The bid generates a roster that is not robust)

Illegal bid
(The bid is illegal or impossible to combine with other bids)

Bid has low priority
(There are other combinations that are more advantageous)

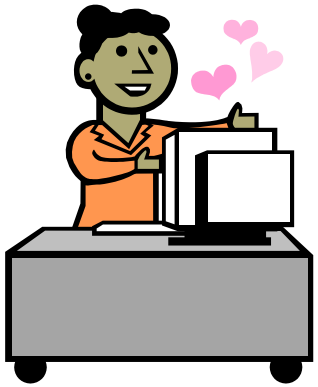
Impossible bid
(e.g. A night stop at a destination where there are no night stops)

Not realistic
(The roster would become unrealistic if the bid is granted)

Exercise 5
Preferential bidding

~30 mins

Exercise 5 summary



Complicating factors

Crew composition

Training

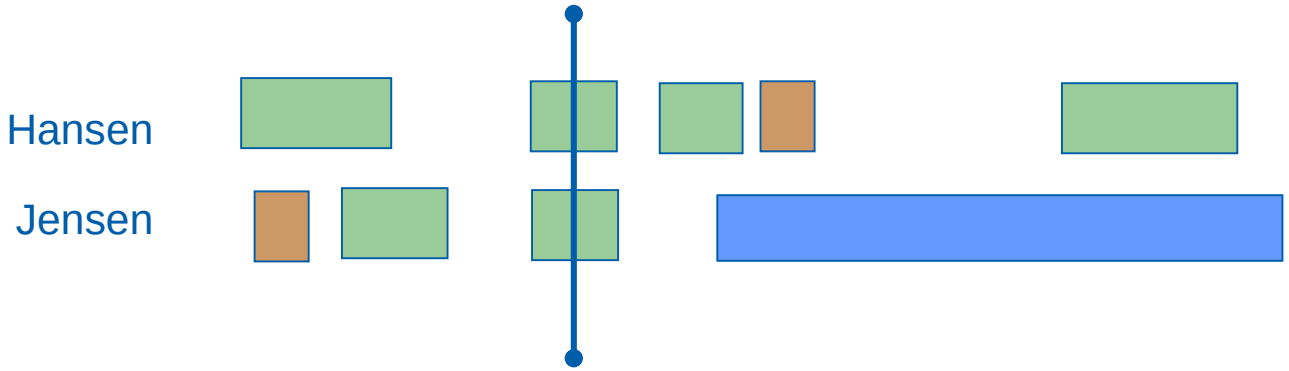
Recency – to maintain qualifications

Fly below/above rank

Crew composition

When checking ordinary rules (e.g. ”max duty time per month”) only one crew member at a time is considered.

Some rules can be enforced only by taking several crew members into account. These rules are called vertical constraints.



Training

Crew must go through different types of training:

- introduction training (new crew members)
- promotion training, e.g. first officer -> captain
- moving from one aircraft type to another
- approaching new or difficult airports
- yearly checks
- maintenance training after long absence.

Recency

The Jeppesen Crew Rostering system provides several mechanisms for maintaining qualifications:

Closer and closer expiry date

- fairness on e.g. aircraft type
- variation, quality penalties/rules
- penalty for getting too close to expiry date without getting a trip with qualifying attributes
- rule for getting really close to expiry date without getting a trip with qualifying attributes.

Fly above/below rank

Crew may fly positions above or below their rank to cover production:

- captains fly as first officers
- pursers fly as cabin attendants.

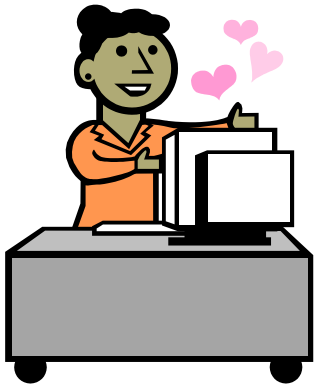
Usually only used during a transition period.

It increases the number of roster solutions significantly

Exercise 6
Complicating factors

~10 mins

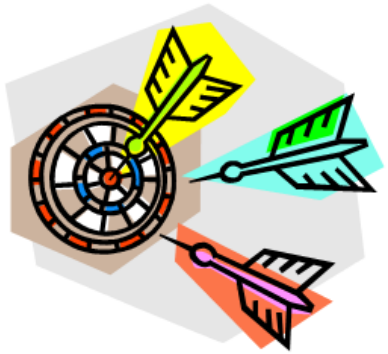
Exercise 6 summary



Course summary

You have learned about:

- Planning process
- Planning concepts
- Basic rostering problem
- Quality and stability
- Preferential bidding
- Complicating factors
  - vertical constraints
  - training …



Course Evaluation

Please take a few minutes to complete the evaluation form, it will help us improve the courses for you and your colleagues:

Special> Academy> Course Evaluation

Are the exercise definitions too vague (too real-life), would you like them to be more exact and straight forward?

Would you like to have even more info on slides (for self studying) or would you be stressed about the time constraint?

The end

This was Rostering Introduction

Welcome back to Jeppesen Crew Academy!

