Effective Pilot Manpower Planning for Major US Airlines

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Agenda

- Business problem context
  - Definitions
  - Problem Description
  - Solution Approach
  - Value to airlines
Airline Operations Roadmap

Demand Forecasting → Pricing and Yield Mgt → Pax adjust. / re-scheduling → Pax monit. & control → Pax Recovery

Network Planning → Aircraft Scheduling → Aircraft adjust. / re-scheduling → Aircraft monit. & control → Aircraft Recovery

Manpower Planning → Manpower Training → Pairing Generation → Crew Assignment → Pairing adjustment / re-planning → Crew monit. & control → Crew Recovery

Crew Resource-Solver™ → Pairing-Solver™ → Ops-Solver™ → Crew-Solver™

Strategic “war room” → Tactical “war room” → Day of operations
Agenda

• Business problem context

• Definitions

  • Problem Description
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  • Value to airlines
Definitions

- Pilot Position => (Base, Equipment, Status)
  
  Crew Base (e.g. IAH, CLE, EWR, GUM)
  
  Equipment (e.g. B777, DC-10)
  
  Status: pilot’s seat on the cabin (CA, FO, SO)

- Pilot Pay Rate => f (position, longevity)

- Seniority Number: longevity of a pilot in the airline with respect to the other pilots
Definitions

• Business Plan Block Hours: Total number of pilots hours per position per bid period needed to cover scheduled flights
• System Bid Award: Process by which the airline adjust the number of pilots at each position and by which the pilots are allow to change their position positions
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Problem Description

System Bid Award

Positions offered
Pilot bids

- Pilots that need to be advanced without training
- Pilots that need to be trained and advanced
- Pilots to be furloughed
- Age 60 pilots with no award to be released
- Pilots who have chosen to retire
- Pilots that hold the same position

Open Positions
Pilots to be displaced

Manpower planning and training

Advance
Train
Release
Release
Decision is fixed
Hire
Advance

When?
Bid Effective Date: By this date all pilots must be advanced or released
Problem Description

- Business plan
- Block hours

Manpower Planning and Training

- Constraint
- Cost
Block Hours

Captain moving from 737 CA IAH to 757 CA EWR

Block Hours

Training Duration $\sim f(\text{current position, future position})$

Objective: Minimize percentage shortage

<table>
<thead>
<tr>
<th>Block Hrs</th>
<th>Shortage</th>
<th>%Shortage</th>
</tr>
</thead>
<tbody>
<tr>
<td>737 CAP IAH</td>
<td>70,000</td>
<td>1,000</td>
</tr>
<tr>
<td>DC10 F/O EWR</td>
<td>5,000</td>
<td>1,000</td>
</tr>
</tbody>
</table>
Block Hours
Problem Description

- Business plan block hours
- Pay protection costs

Manpower Planning and Training

Constraint Cost
Pay Protection

-One for all pay protection

<table>
<thead>
<tr>
<th>Current Position</th>
<th>Future Position</th>
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</thead>
<tbody>
<tr>
<td>1015 J. Jhonson</td>
<td>IAH, 727, CAP</td>
</tr>
<tr>
<td>1230 M. Summanth</td>
<td>EWR, 727, F/O</td>
</tr>
<tr>
<td>1312 K. Smith</td>
<td>CLE, 727, CAP</td>
</tr>
</tbody>
</table>

1312 - 1230 - 1015

=> 1312 pay protects 1230 for 2 months and 1015 for 1 month
Problem Description

- Business plan
  - block hours
- Pay protection costs
- Pilot
  - vacations

Manpower Planning and Training

Constraint

Cost
Pilot Vacations

• Airline estimates pilots needs and post 7-day vacation slots for bidding
• Pilots bid for vacations at the beginning of the year
• Airline award vacations base on seniority
• Training needs to be scheduled around vacations
Problem Description

- Business plan block hours
- Pay protection costs
- Pilot vacations
- Capacity of Training Resources
- Manpower Planning and Training
- Constraint
- Cost
# Capacity of Training Resources

- Predetermine curricula for each type of training (e.g. primary systems, re-qualification class)
- For each training day in the curricula different resources are required: Classrooms, Instructors, FTD (Flight Training Device), FSS (Flight Simulation Devices)
- Previous commitments, recurrent training

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<th>Day Template</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
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<tbody>
<tr>
<td>Calendar Day</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
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<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Device</td>
<td>class</td>
<td>FTD5</td>
<td>inflight</td>
<td>FTD5</td>
<td>class</td>
<td>FTD5</td>
<td>X</td>
<td>X</td>
<td>class</td>
<td>FTD5</td>
<td>class</td>
<td>FTD5</td>
<td>X</td>
<td>X</td>
<td>FTD8</td>
<td>FTD5</td>
<td>FTD8</td>
</tr>
<tr>
<td>Specific Instructor Qualification each training day</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- Do not exceed capacity of training devices
- Pilot days off
Problem Description

Manpower Planning and Training

- Business plan
- Pilot vacations
- Capacity of Training Resources
- Pay protection costs
- Release cost
- New hire cost

Constraint
Cost
Hiring and Furloughing

-Hiring as late as possible is desirable
  Reduces the payroll cost
  Estimated block hours need may change

-Furloughing as soon as possible is desirable
  Reduces the payroll cost
  Need to be released in seniority order
Problem Description

Manpower Planning and Training

- Business plan block hours
- Pay protection costs
- Release cost
- New hire cost
- Pilot vacations
- Capacity of Training Resources
- Pilot Groupings in Training Classes

Constraint
Cost
Pilot Grouping into Classes

- Preference to train pairs of Captains and First Officers
  Additional instructor events are avoided
  Quality of training
Problem Description

Manpower Planning and Training

- Business plan block hours
- Pay protection costs
- Release cost
- New hire cost
- Training cost
- Constraint

- Pilot vacations
- Capacity of Training Resources
- Pilot Groupings in Training Classes
M = Length of curricula (e.g. Primary Systems 757=>56 days)
F = Footprint (time spent in training)
L = Length of time to complete training for N students
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Solution Approach

Transition Planning

Crew Resource Database

Management and Monitoring

Training Scheduling
Implementation Complexity – Key data sources

- Crew Resource Database
  - Pilot Crew Records
  - FA Crew Records
  - Pilot Seniority
  - FA Seniority
  - Pilot Training
  - Training Scheduling
  - Pilot Training Qual/Rqmts
  - Business Plan Block Hours
  - Pilot Position Awards
  - Payroll
  - FA Training
  - Capability and Absence
  - HR
    - Staffing Info
  - External Interfaces

- Owned by ResourceSolver

- External Interfaces
Solution Approach

Key Input
- Block Hours
- Position Awards
- Training Capacity/Requirements

Solver
- Transition Planning

Output
- Staffing
  - Ability to meet business plan
- Transitions
  - Advancement
  - Hiring
  - Attrition
  - Training
Solution Approach

Key Input
- Transition Plan
- Training Resources
- Training Curricula

Solver
- Training Scheduling

Output
- Training Schedule
- Detailed Resource Utilization Plan
Transition Plan – Math Model -

• Hierarchical Problem:
  
  Determine minimum level of shortages
  
  Shortages in early bid periods are more “critical”
  
  Determine appropriate trade-off between shortages and dollar cost

• Inventory Model with sides constraints

• MIP problem (special branching directions)
  
  ~25,000 constraints
  
  ~15,000 variables
Training Scheduling

- This problem is solved by fleet
- Layout the classes minimizing length of time the pilots spend in training and considering feasible usage of resources
  
  $\Rightarrow$ Branch and bound rolling horizon algorithm (i.e. consider a subset of $n$ classes, solve and fix “$m$” classes)
Training Scheduling -Branch and Bound-

-A subset of classes is considered in each branch and bound tree

-Min and max start date for each class

Each node in each branch and bound tree represents a partial schedule through the current calendar day $t$

-From a node D a node D’ is reached scheduling a training day or a day-off for each class

-Cut branches by:

  Node elimination: Violation resource availability, Days-off constraints

  Lower Bound: The objective is to minimize the collective length of time pilots spend in training,

  Based on partial schedule and required training days remaining a lower bound is computed

-A depth first search approach is used to search the entire tree
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Value to airlines

- Significant Cost Savings
  - 2-4% reduction in time pilots are away at training
  - Up to 10% reduction in new hires
  - Reduction in pay protection costs
  - Reduction in block hour shortage
  - Estimated Cost Savings of $15,000,000 per year

- Increased Productivity
  - Provides what-if functionality for scenario planning
  - From 3 crew planners building a solution in 13 days to less than 1 hour
  - From 4 training schedulers building classes each month for a period of 3 days to few minutes

- Unified, cross-functional Solutions
  - Cross functional, enterprise-wide system through single, centralized database
    - Manpower planning
    - Training
    - Finance