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Capacity Planning and Production Scheduling for Aircraft Painting Operations

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Boeing

Boeing painting operations

- New aircraft assigned to hangars for painting based on expert knowledge and heuristic scheduling
- Painting can occur in house or be outsourced



Research questions

- Does Boeing have sufficient painting capacity to meet future demand?
- What is the future demand for airplanes?
- What is the optimal schedule for painting aircraft to minimize costs given demand?
- How does uncertainty (in painting times, future demand) impact the optimal schedule and decision about capacity?

Optimal schedule to minimize cost

- Time frame: 1 month increments (20 years total)
- Minimize cost
 - Cost of painting airplanes in house
 - Cost of outsourcing airplanes to be painted
 - Cost of being late
- Decision variables: assign each plane to a hangar for painting at each time (assignment problem)

Constraints

- 5 different models of planes; each model has a different painting time
- Hangars can only paint certain models of planes
- Setup times can vary with hangar
- Job cannot be assigned until plane is released for painting
- Per-day tardiness penalty for planes that are finished late
- All jobs must be assigned to a hangar
- Each hangar can only paint one plane at a time

Input data

- Monthly demand data from demand forecasting model
- 22 hangars: 12 in house and 10 outsource
- Cost as a function of painting time
 - \$6,000 per day (material and labor)
 - \$50,000 daily penalty cost for being late

Model	Setup and painting days
737	3 or 4
747	6
767	5
777	6 or 7
787	5 or 6

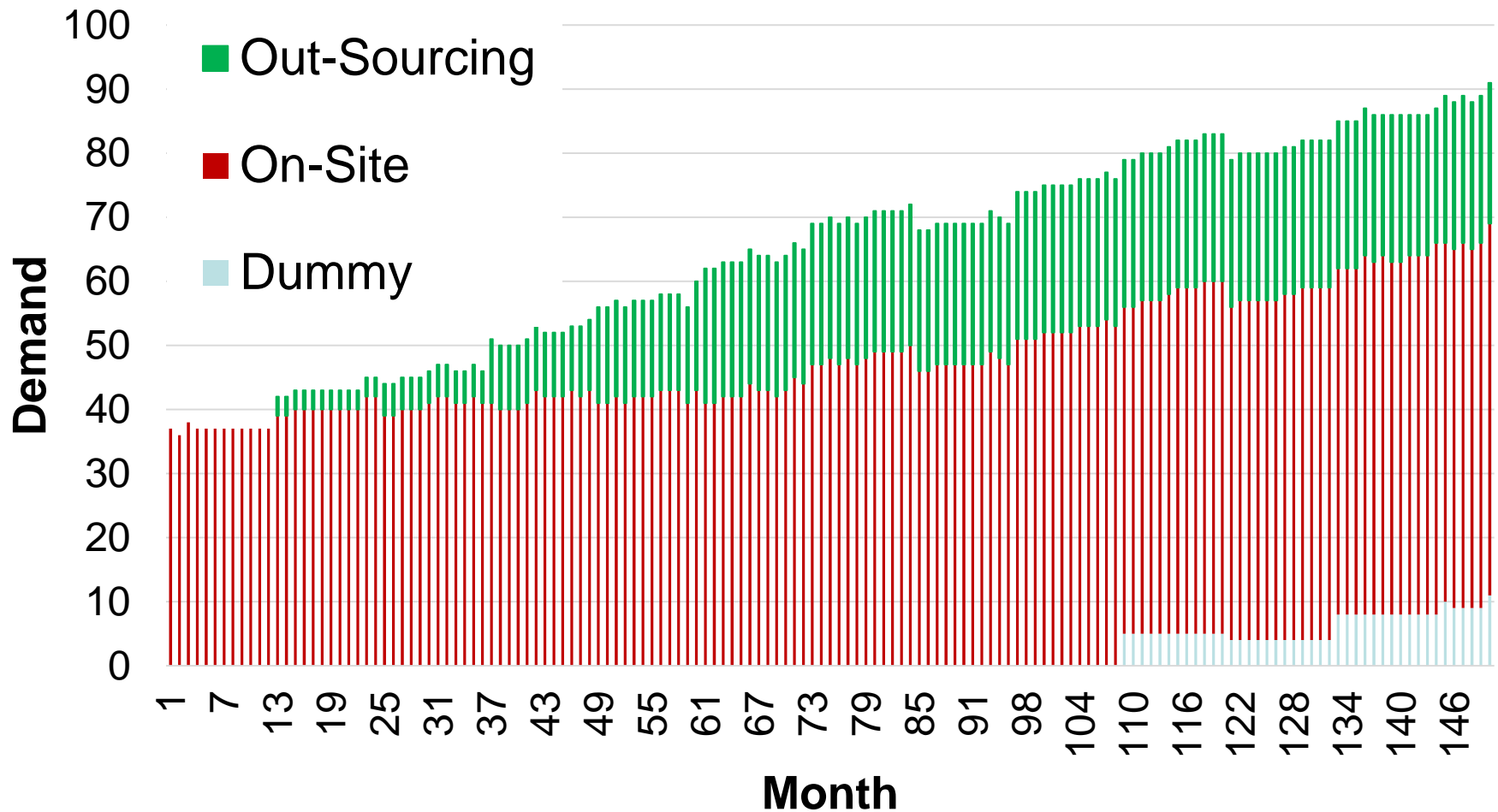
Optimal Solution for Month 1

37 total airplanes

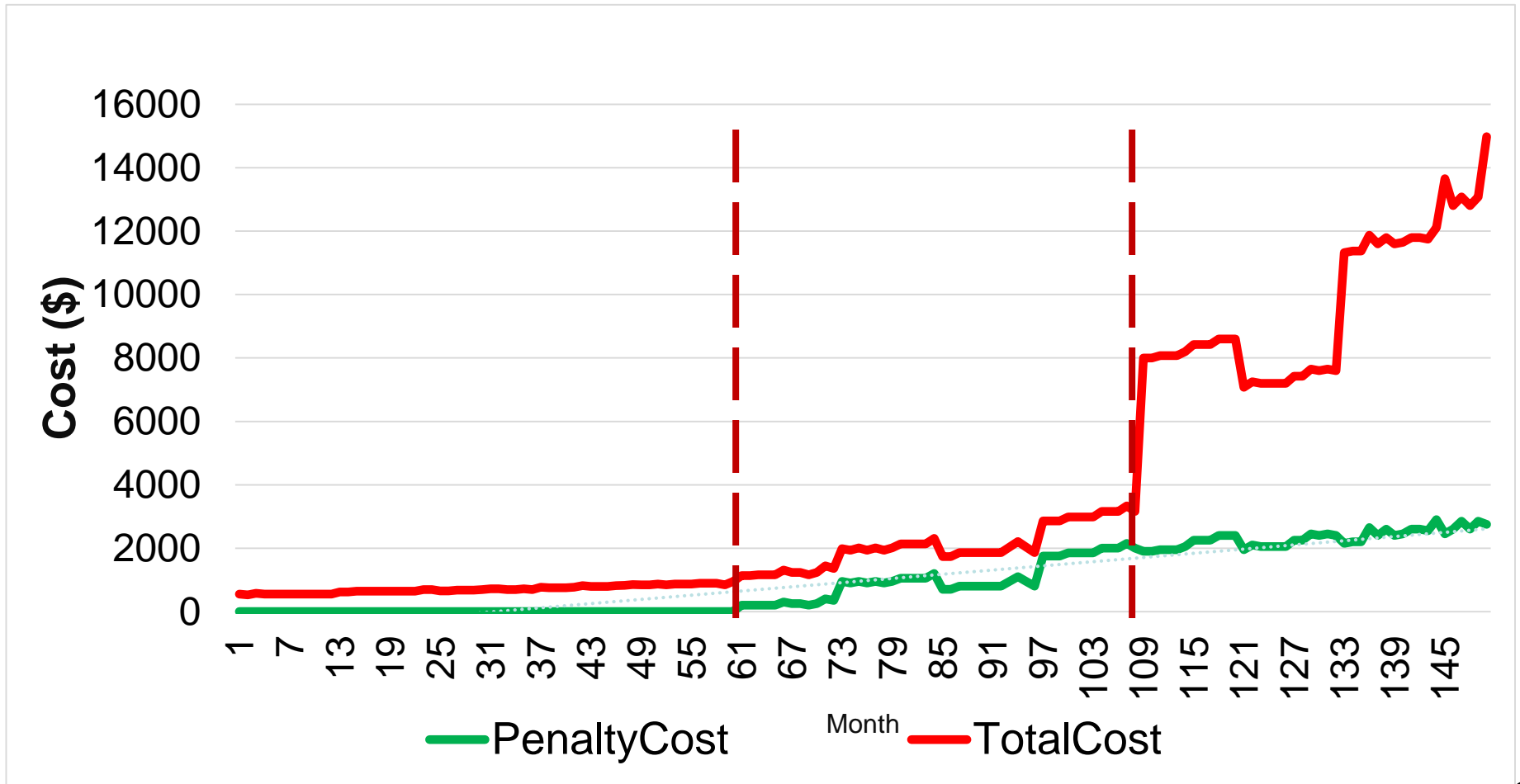
Table 2. Schedule Gantt Chart for month 1

	Time																				
Hangar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
1						32						33						737			
2																			747		
3		31							30											767	
4	34											37							777		
5					36							35							787		
6										29											
7		6			16			26			5			27							
8		7			8			13			12			22							
9	2		14				1			24			25								
10	3		10				18			20			15								
11		9				17			19				23								
12				11			21			28			4								

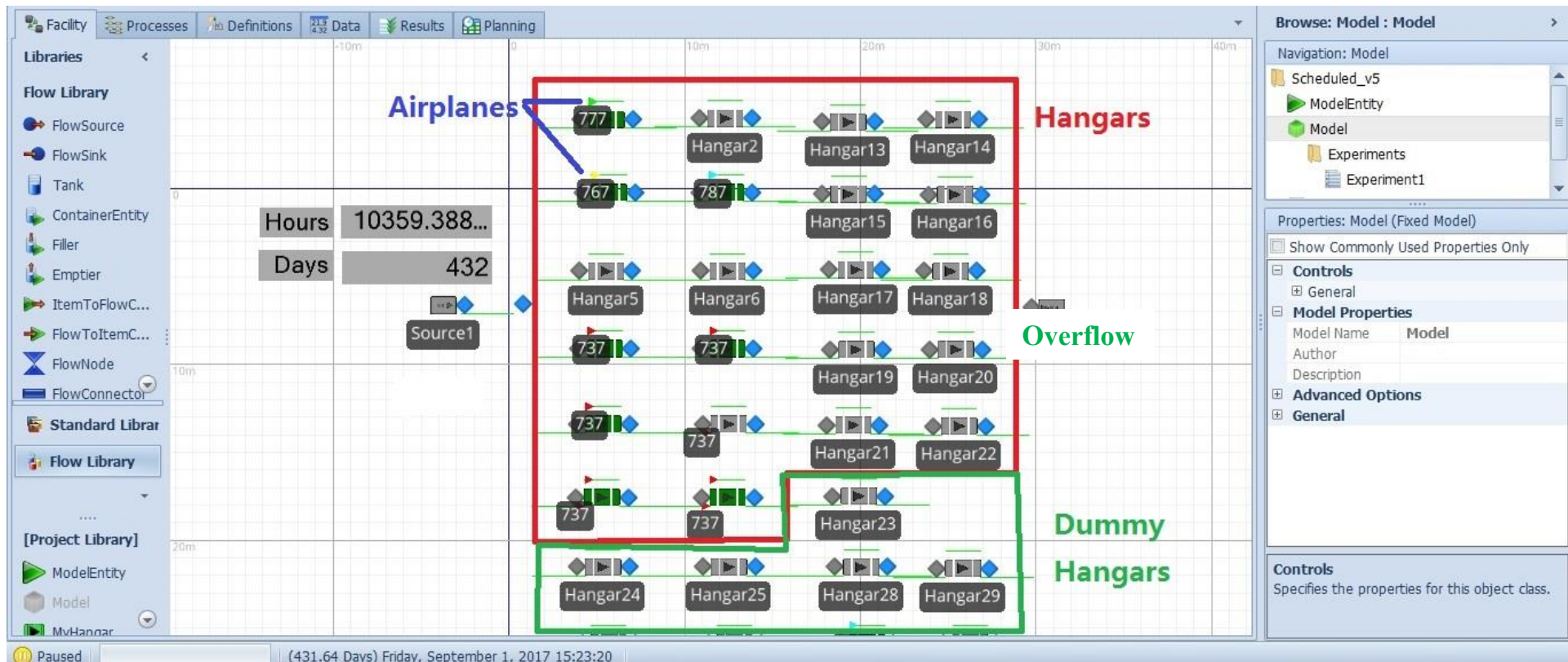
Painting assignment



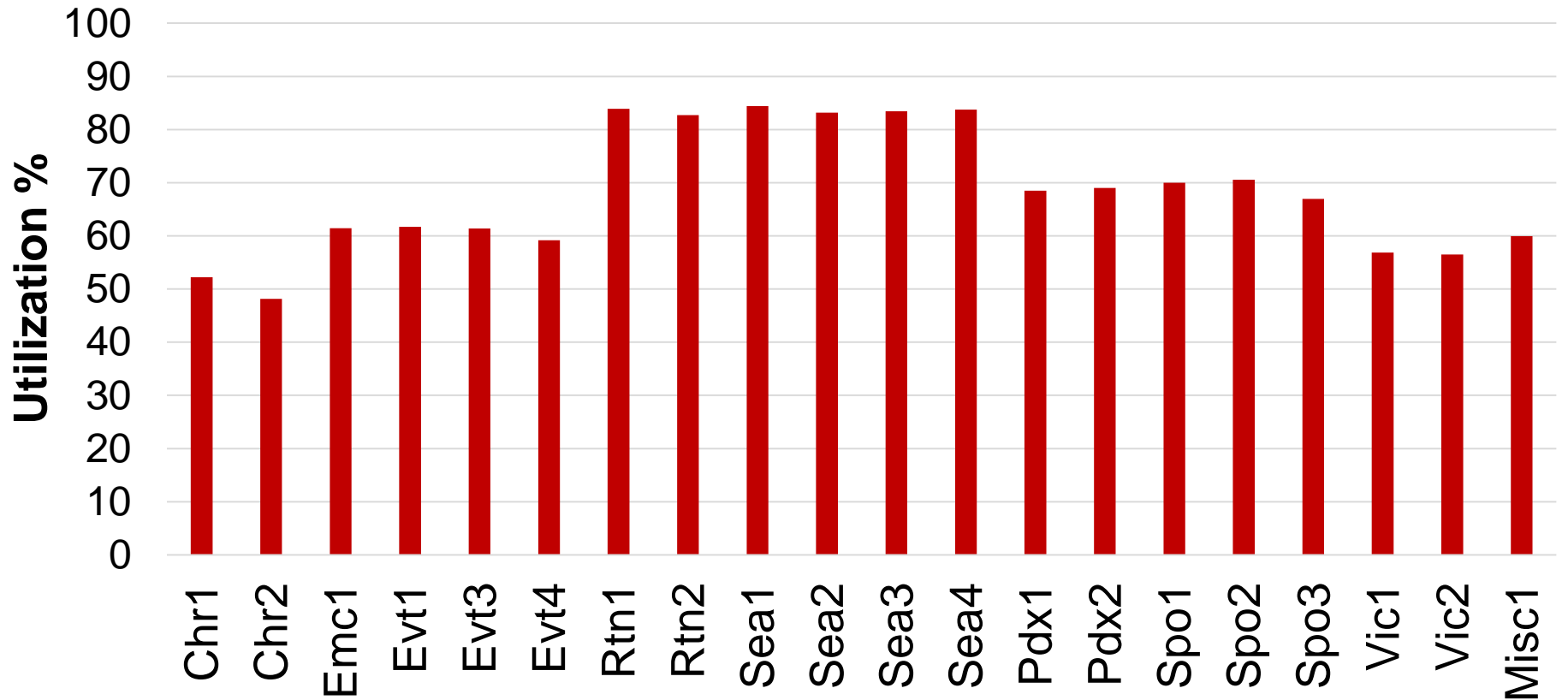
Cost per month



Simulation with random release dates and painting times



Average hangar utilization



Key conclusions

- Planes can be painted in house for years 0-2
- Delays start occurring in year 5
- Capacity exceeded in year 6
- Significant delays beginning in year 7

Due to demand uncertainty, capacity could be exceeded much earlier or later!

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