POEM®

Programming in Operational and Expressive Models

Management and Optimization

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ENGINEST
delivering intelligence

Step by Step … to Success

- Foundation: June 2000, Spin-off from INRIA
- Profile: Planning and Scheduling Specialist
- Founders: 3 PhD brothers
- Offices: Nancy and Beijing
- Technology: NCL (Natural Constraint Language)
- Products: POEM®, PlanSuite™, POEM APS
- Market: Management & Optimization
- Strategy: A Product, Simpler and Smarter

- Mathematical Description Language
- Modeling and Solving

The NCL Natural Constraint Language

$$
\begin{aligned}
&Ti1 \in [150.0, 240.0], \quad To1 \in [250.0, 490.0], \quad Ti2 \in [150.0, 190.0],\\
&To2 \in [210.0, 340.0], \quad FE1 \in [2.941, 10.0], \quad FE2 \in [3.158, 10.0],\\
&Fi1 \geqslant 0.0,\ Fi2 \geqslant 0.0, \quad FB12 \geqslant 0.0,\ FB21 \geqslant 0.0, \quad Fo1 \geqslant 0.0,\ Fo2 \geqslant 0.0,\\
&T11 = 500.0 - To1, \quad T12 = 250.0 - Ti1, \quad T21 = 350.0 - To2, \quad T22 = 200.0 - Ti2,\\
&Fi1 + Fi2 = 10.0, \quad Fo2 + FB12 = FE2, \quad Fo1 + FB21 = FE1, \quad Fi1 + FB12 = FE1,\\
&Fi2 + FB21 = FE2,
\end{aligned}
$$

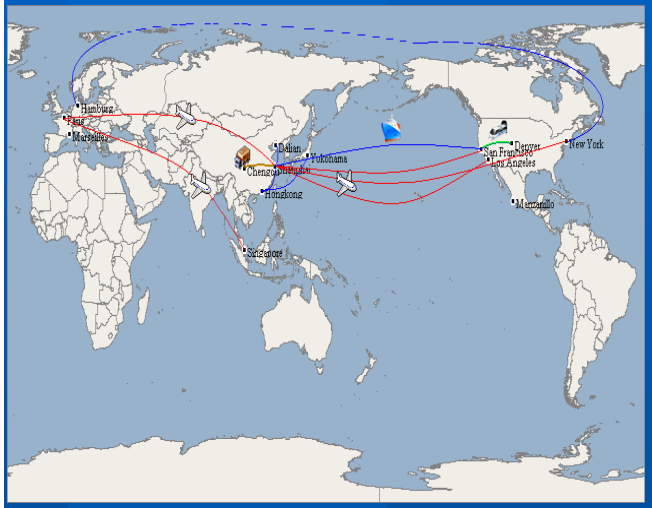
$$
\begin{aligned}
&FE2 \times (To2 - Ti2) = 600.0, \quad FE1 \times (To1 - Ti1) = 1000.0,\\
&150.0 \times Fi1 + To2 \times FB12 - Ti1 \times FE1 = 0.0, \quad 150.0 \times Fi2 + To1 \times FB21 - Ti2 \times FE2 = 0.0,
\end{aligned}
$$

$$
\begin{aligned}
\min \quad & 1300 \times \exp(0.6 \times \log(20000 \times 6 / (4 \times \sqrt{T11 \times T12} + (T11+T12)))) +\\
& 1300 \times \exp(0.6 \times \log(12000 \times 6 / (4 \times \sqrt{T21 \times T22} + (T21+T22)))) .
\end{aligned}
$$

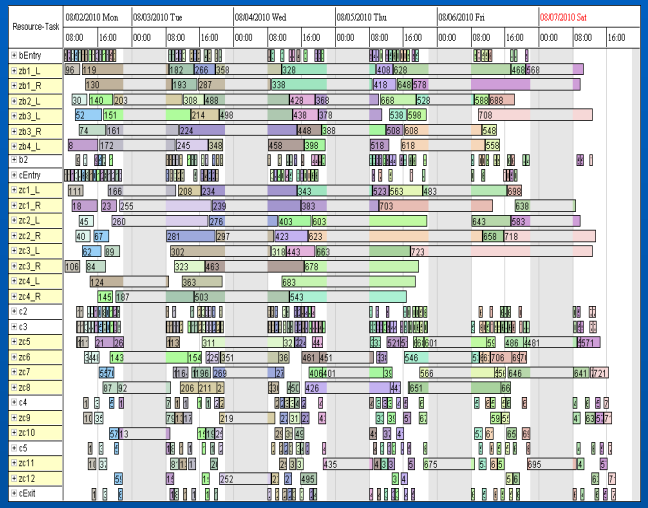
View & Interaction

Simpler • Smarter • Swifter

Map



Gantt chart

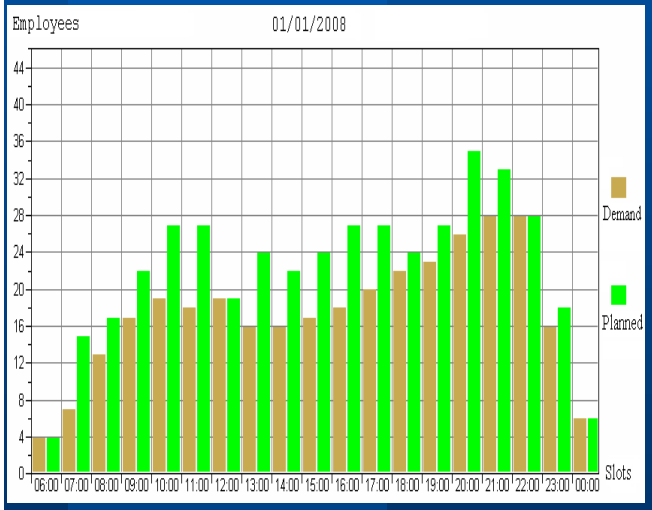


Table

派工计划表

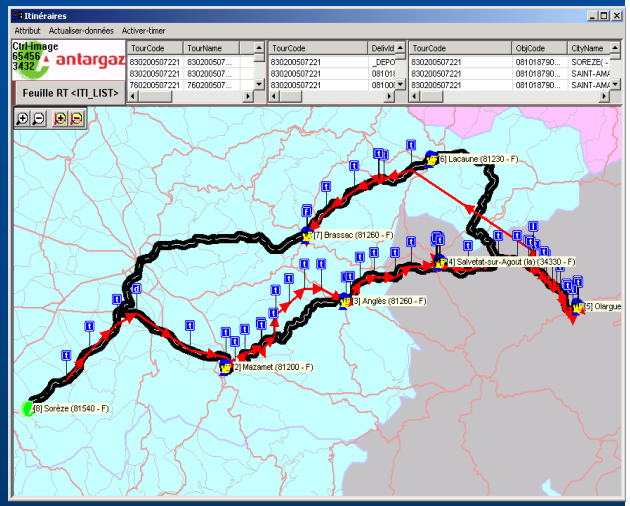
	订单编号	产品编号	时间安排	计划完成时间	延期(天)
1	07060003	PART23	2007-08-06 11:34 - 2007-08-09 22:01	2007-08-10 09:11	否
2	07060007	PART1	2007-08-06 08:00 - 2007-08-07 09:55	2007-08-07 08:30	否
3	07060010	PART28	2007-08-07 19:36 - 2007-08-23 17:32	2007-08-24 00:27	否
4	07060013	PART16	2007-08-06 08:00 - 2007-08-22 08:00	2007-08-29 02:42	否
5	07060023	PART5	2007-08-06 08:00 - 2007-08-08 18:10	2007-08-10 20:30	否
6	07060025	PART29	2007-08-22 08:01 - 2007-09-26 08:33	2007-09-29 17:03	否
7	07060027	PART22	2007-08-06 08:00 - 2007-08-07 12:21	2007-08-08 02:03	否
8	07060036	PART3	2007-08-06 08:00 - 2007-08-21 10:40	2007-08-27 02:40	否
9	07060043	PART20	2007-08-06 09:01 - 2007-08-07 22:33	2007-08-08 04:41	否
10	07060044	PART21	2007-08-06 08:00 - 2007-08-06 23:31	2007-08-07 18:11	否
11	07060046	PART41	2007-08-23 14:33 - 2007-09-06 19:44	2007-09-11 13:57	否
12	07060065	PART12	2007-08-17 17:11 - 2007-08-30 10:01	2007-09-02 05:30	否
13	07060073	PART15	2007-08-06 08:00 - 2007-10-03 21:06	2007-11-07 16:30	否
14	07060080	PART10	2007-08-07 09:56 - 2007-08-23 19:30	2007-08-26 03:00	否

Histogram



Process simulation

Interaction



State of The Art

Linear Programming (Canonical Form)

$$\begin{aligned} \text{maximize} \quad & c^T x \\ \text{subject to} \quad & Ax \leqslant b \\ \text{and} \quad & x \geqslant 0 \end{aligned}$$

Efficient

Numeric

Linear Model

Not The Only Choice

Programming in First-Order Logic
Example: Crew Scheduling

$$\text{Pairing} \quad \text{PAIRING},$$

$$\bigcup_{i \in \text{Pairing}} \text{LegPairing}_i = \text{LEG},$$

$$\min \sum_{i \in \text{Pairing}} \text{costPairing}_i$$

Quantifier Logic

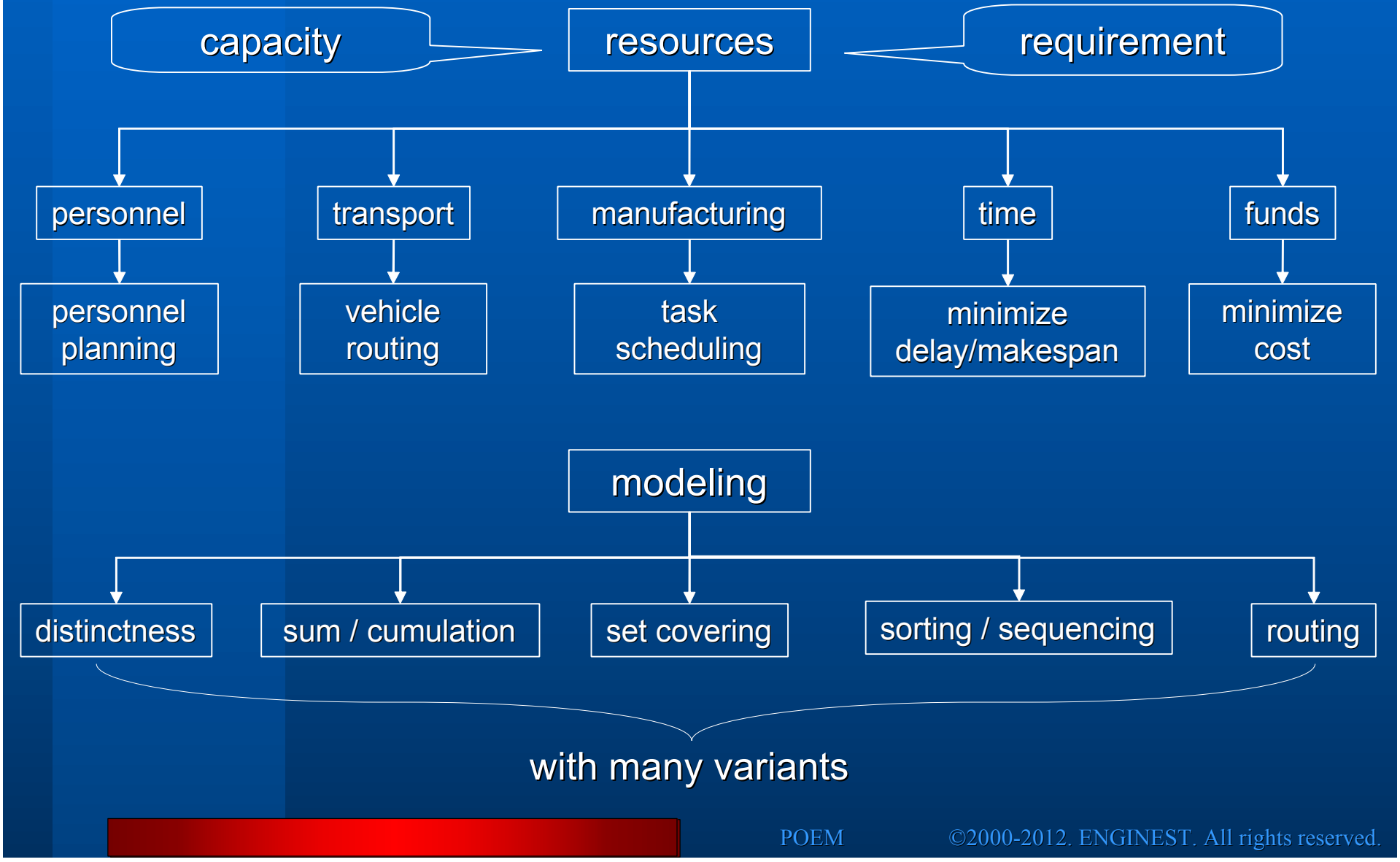
Set Programming

Logical Function

Object Oriented

Can Be The Best

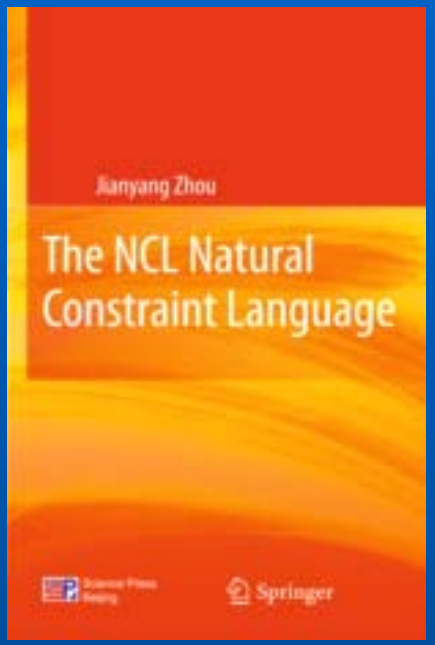
Resource Optimization

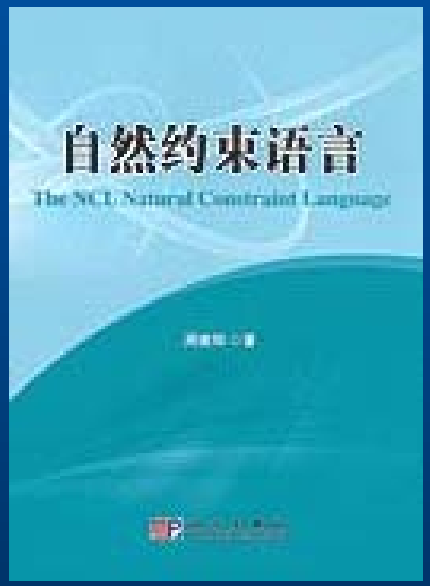


Publications

Books

- J. Zhou: The NCL Natural Constraint Language. Springer, ISBN 978-3-642-23844-4 (2012).
- J. Zhou: The NCL Natural Constraint Language. Science Press Beijing, ISBN 978-7-03-031784-1 (2012).
- 周建阳:《自然约束语言》. 科学出版社, ISBN 978-7-03-024973-9 (2009).



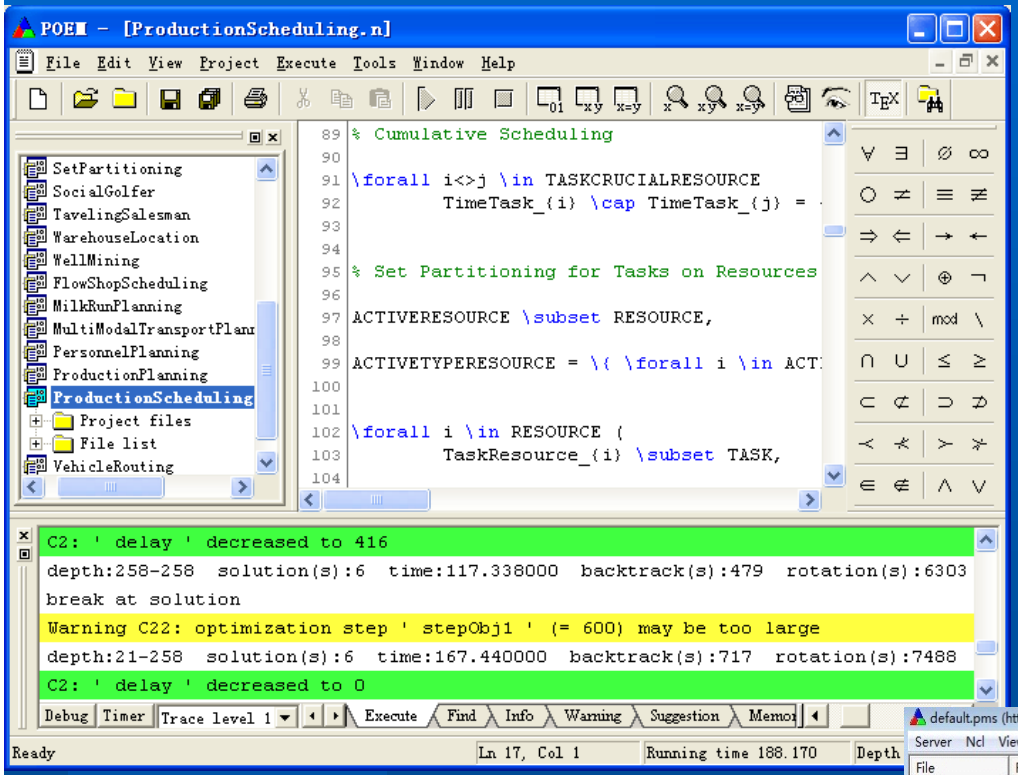


Journal Papers

- J. Zhou: Introduction to the constraint language NCL. Journal of Logic Programming. 45 (1-3): 71-103 (2000).
- J. Zhou: A Permutation-Based Approach for Solving the Job-Shop Problem. Constraints 2(2): 185-213 (1997).

The POEM Platform

Simpler • Smarter • Swifter



POEM® Solution Builder

Logic + Optimization + Heuristic Rules + View

Integration

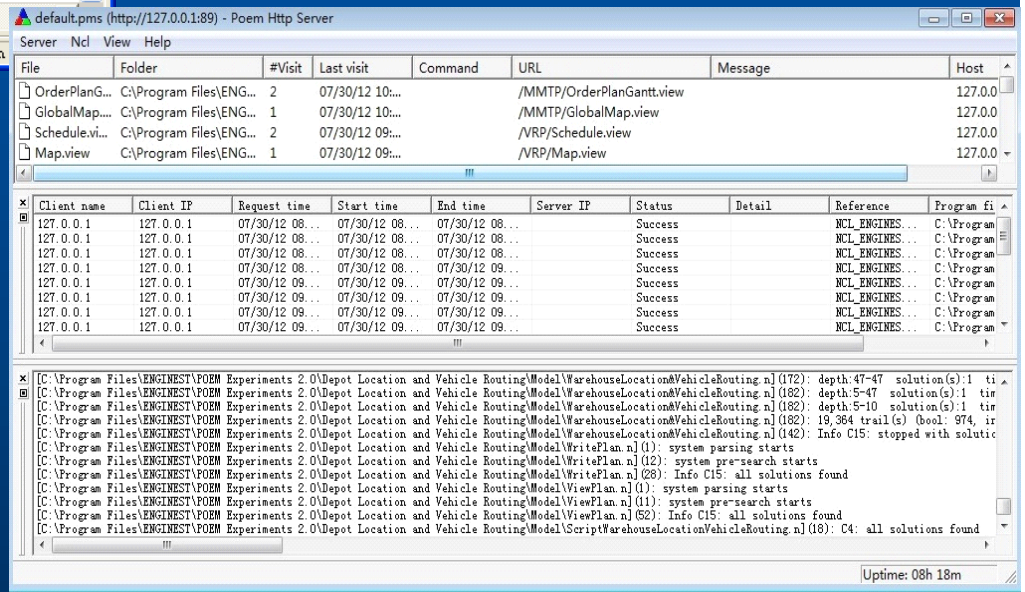
- PoemServer: Application Server
- ComPoem: Optimization Component
- PomeView: Visualization Component

NCL

- Mathematical Description Language
- Modeling, Solving, Optimization

PoemView

- Visualization: Gantt chart, Map, etc.
- What If Interaction



Applications

- Logistics
- Manufacturing
- Airline Companies
- Human Resources
- High-Speed Trains…

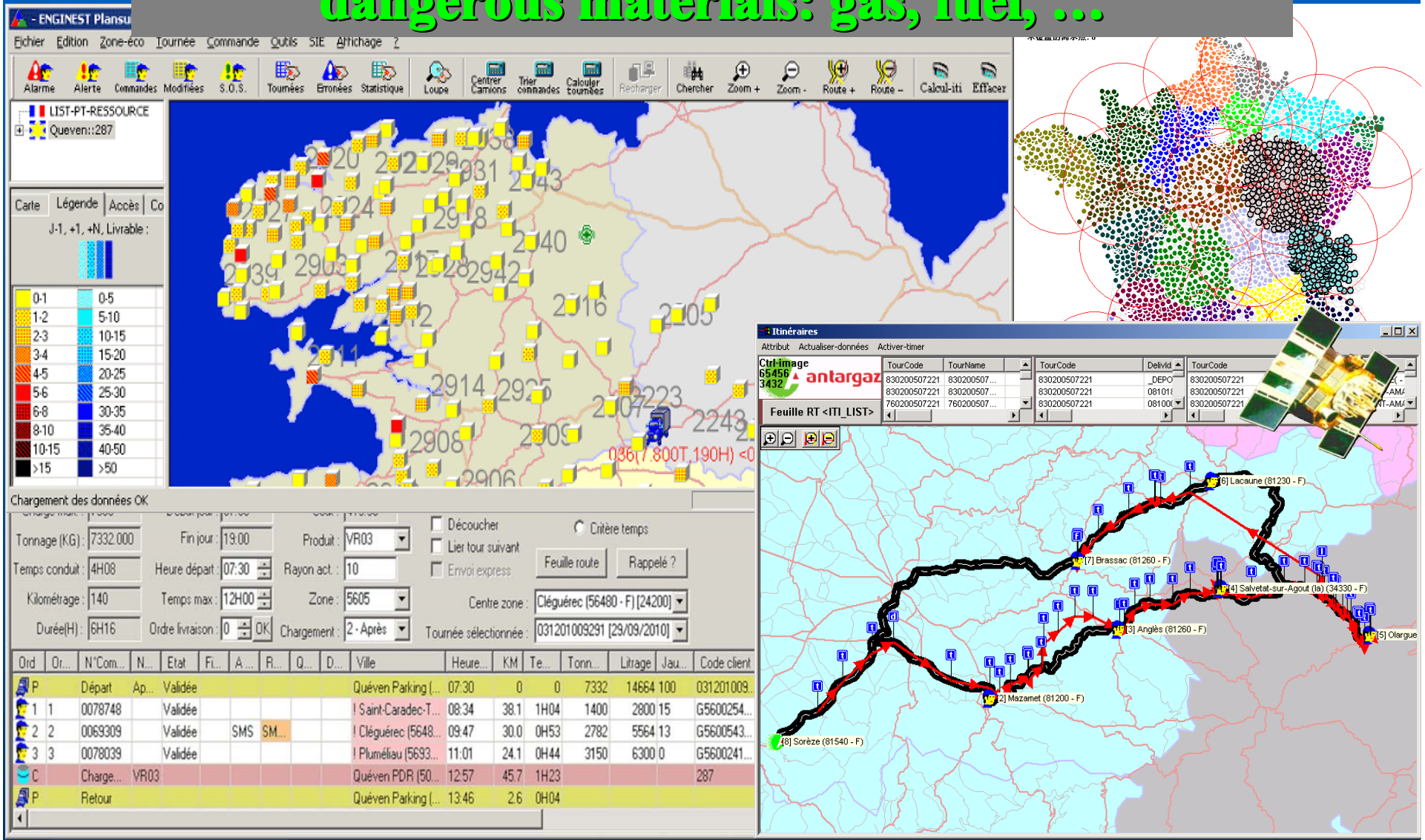
Licensing

- Application license: for end-users and software integrators
- Development license: for software developers
- Academic license: for universities and institutes

PlanSuite: Distribution Planning

Simpler • Smarter • Swifter

Optimizing depots location and distribution of dangerous materials: gas, fuel, …



Vehicle Routing (Benchmarking)

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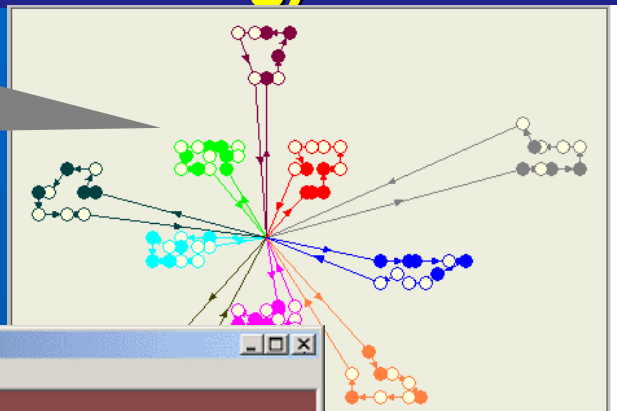
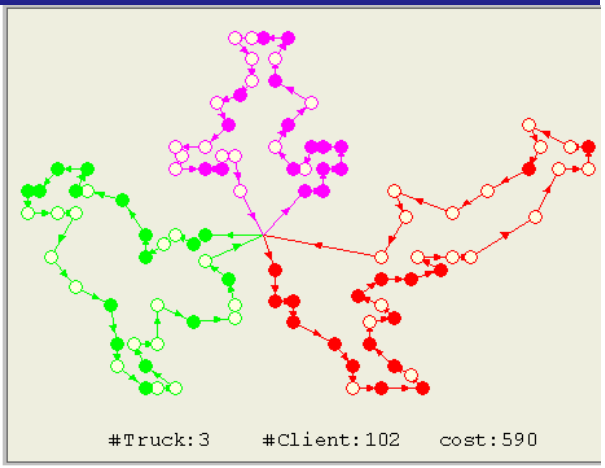
Optimal Solution
to Solomon Problems



:106 cost:829



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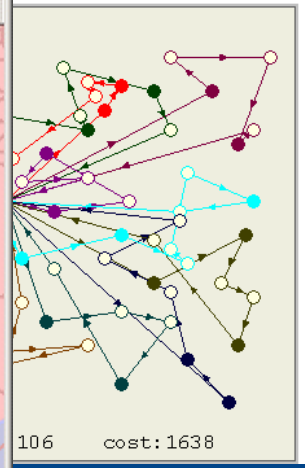

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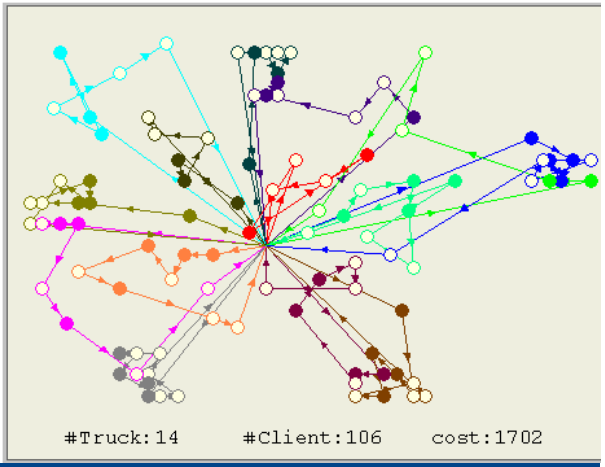

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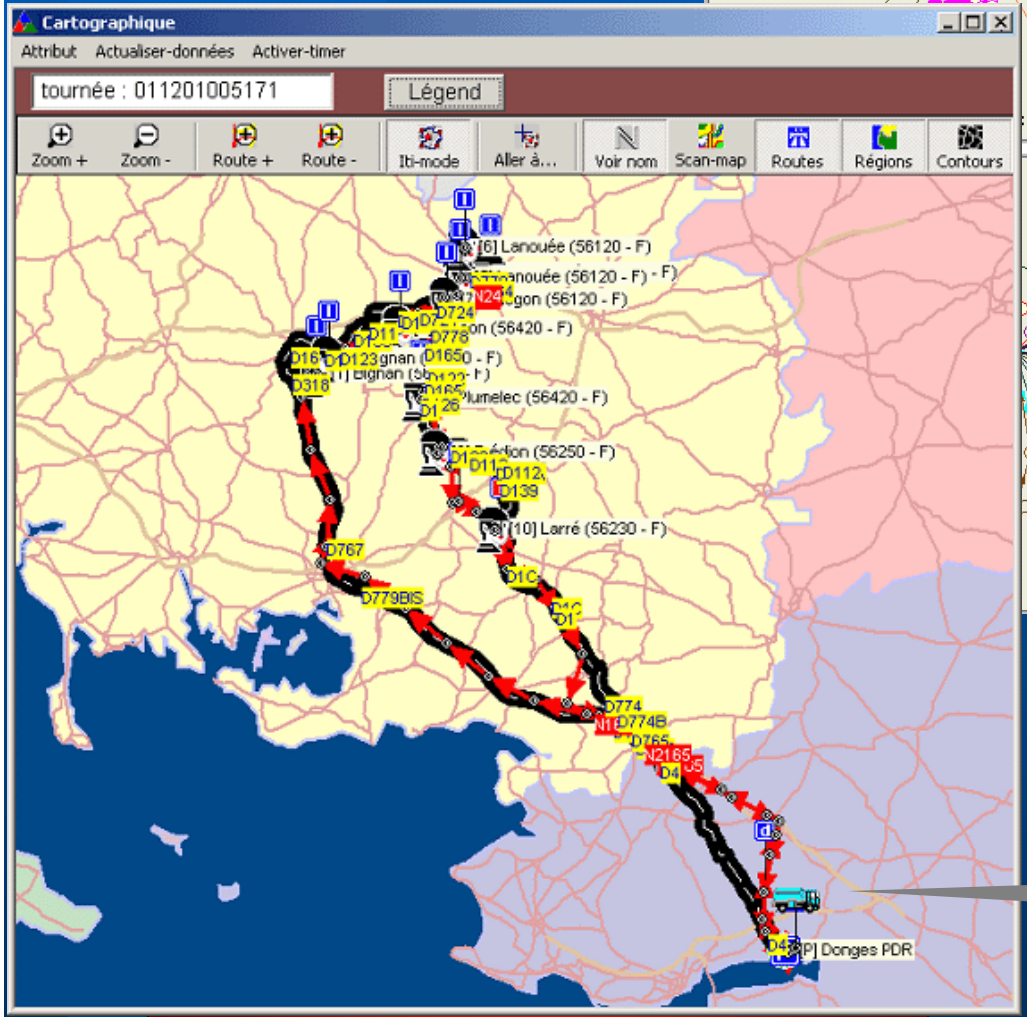

In Reality

POEM APS: Production Scheduling

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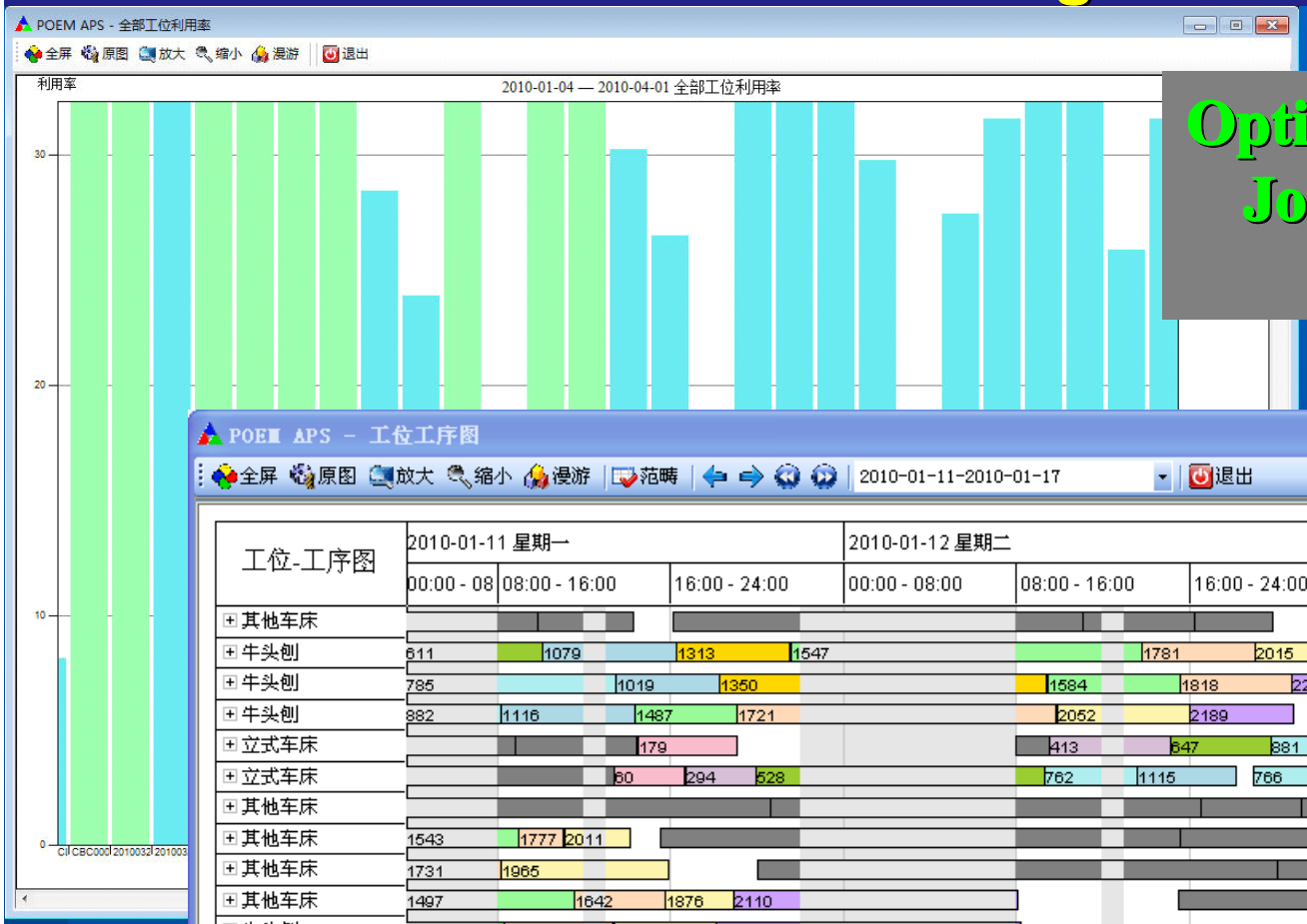
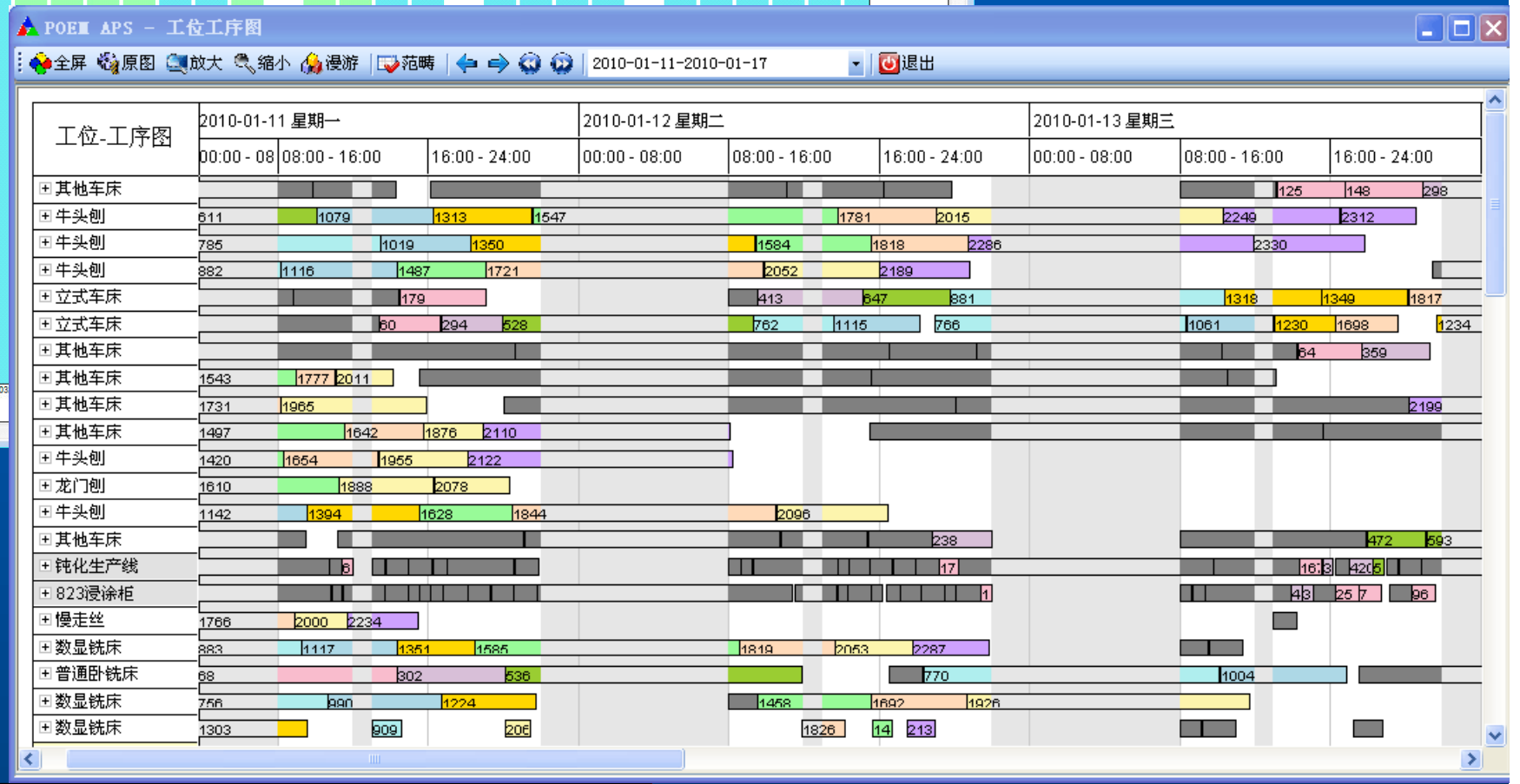


Optimization Module for Job/Task Scheduling over Resources.



Production Scheduling: Electronics

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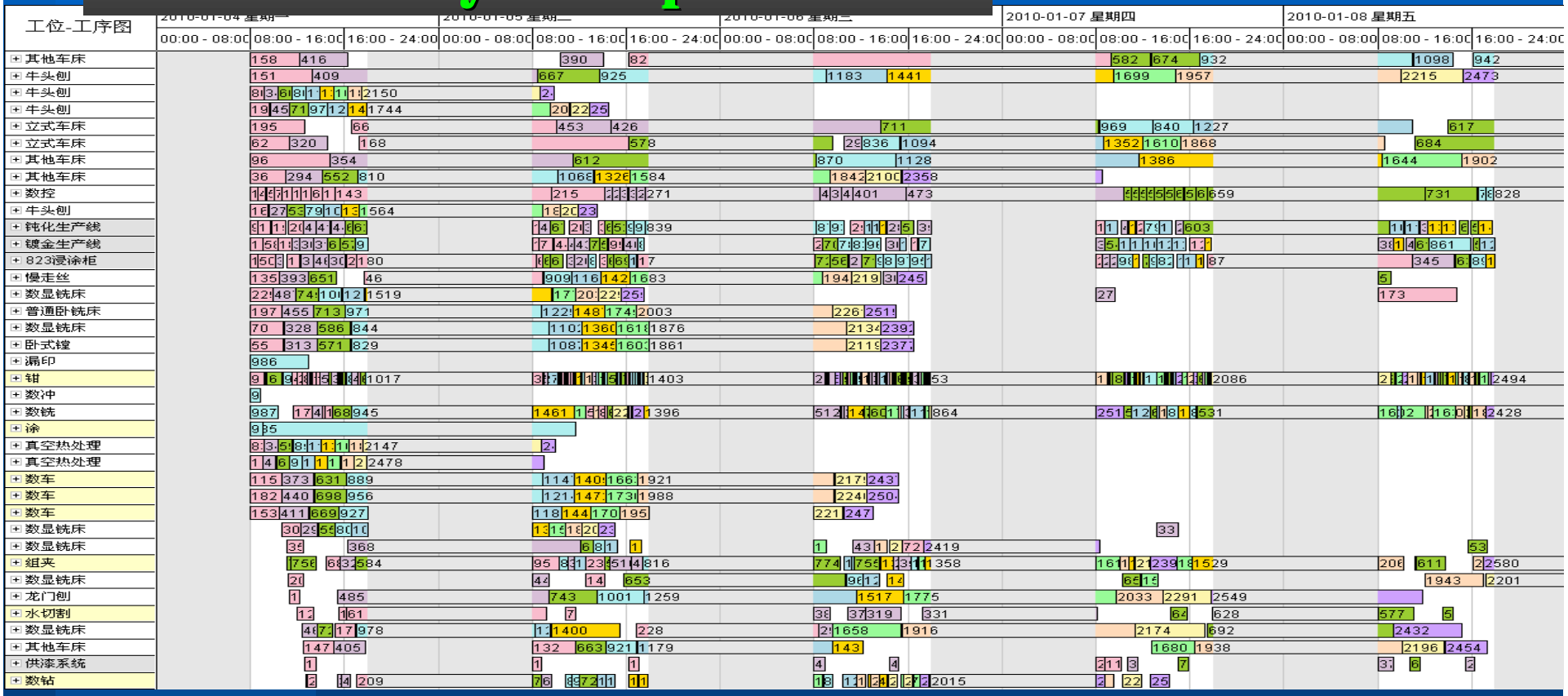
Scheduling jobs on resources so as to efficiently make products.

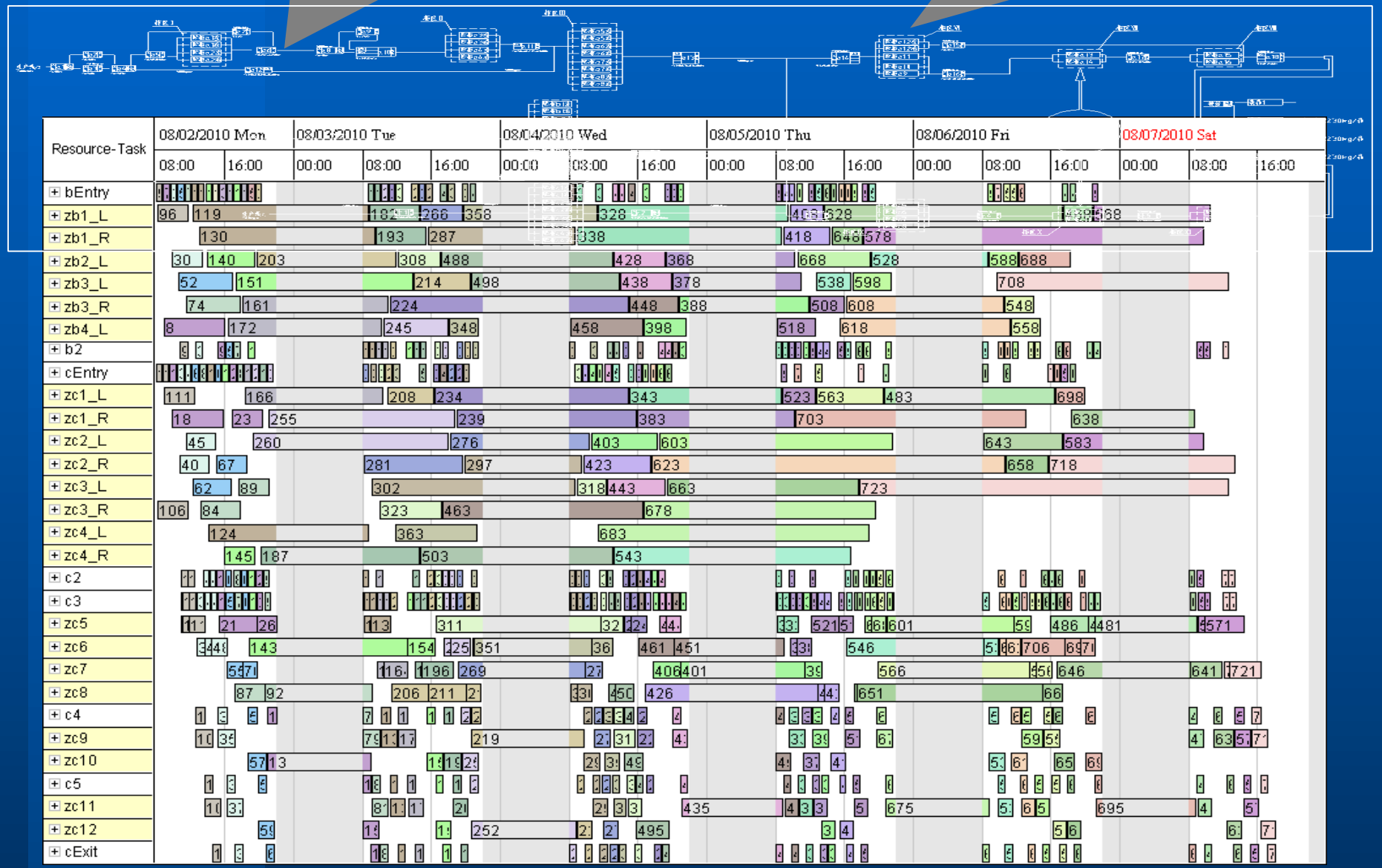


Production Scheduling: Tobacco

Simpler • Smarter • Swifter

Process Scheduling

Discrete Scheduling



Aircraft Scheduling: Flights & Maintenances

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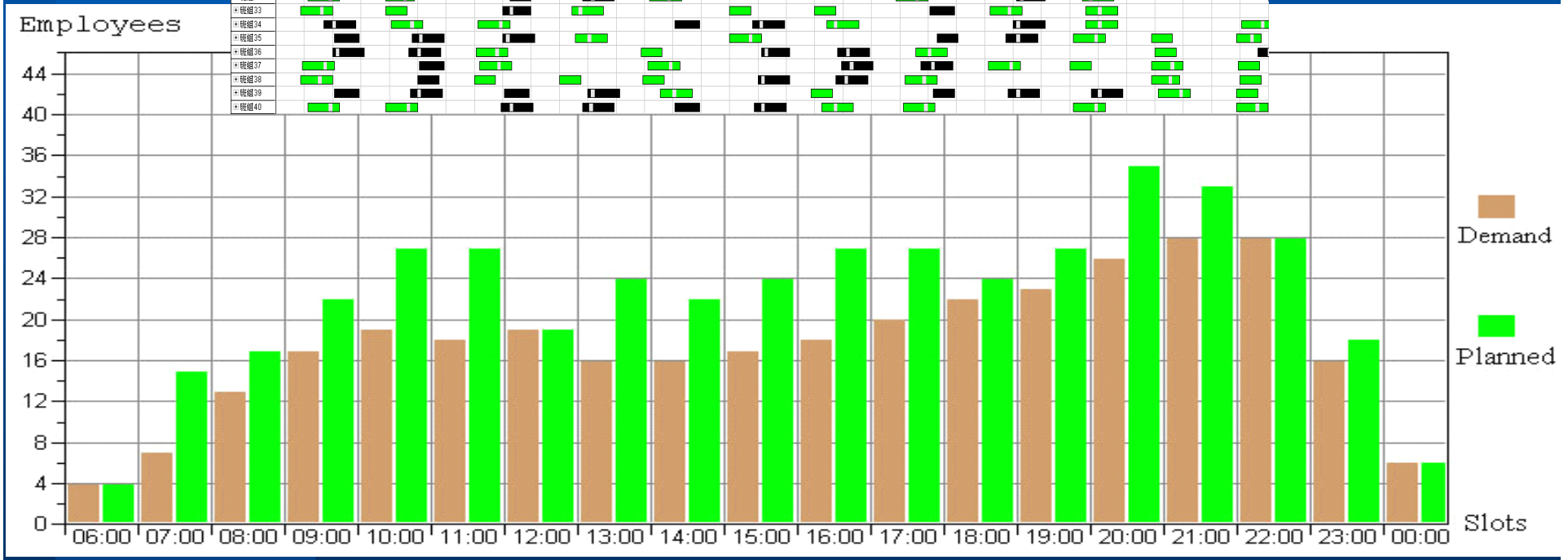
Planning flights and maintenances for aircrafts over 90-180 days.

AIR CHINA 中国国际航空公司

Personnel Planning: Call Center

Simpler • Smarter • Swifter

Planning a working schedule for the employees of a call center to satisfy personnel requirement.



Personnel Planning: Critical Missions

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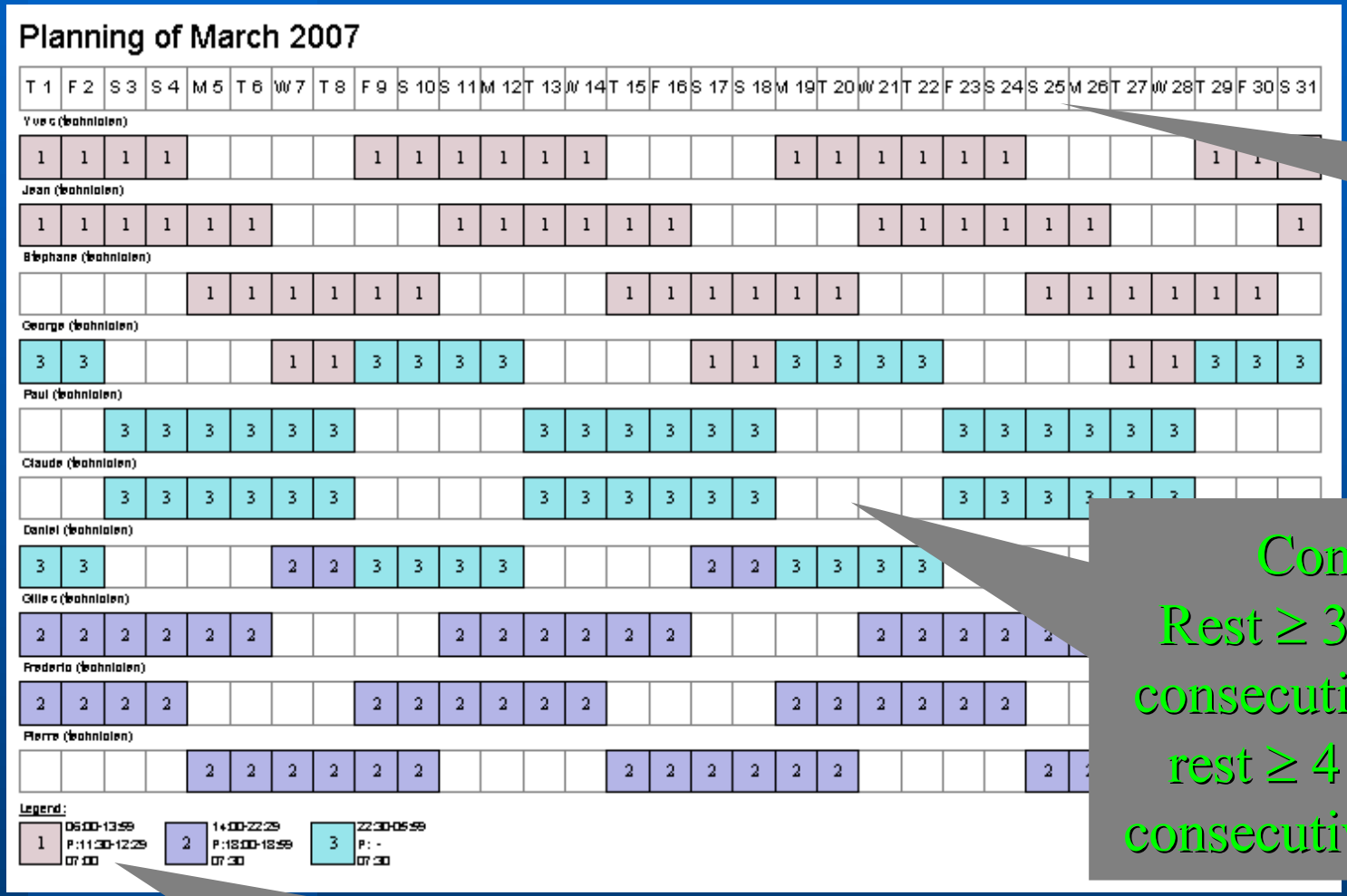
Personnel planning, 24H/24, over 365 days: 2 technicians be available anytime.



Periodic planning

Constraints:
Rest ≥ 3 days after 6 consecutive day shifts;
rest ≥ 4 days after 6 consecutive night shifts

morning: 06:00-13:59, afternoon: 14:00-22:29, night: 22:30-05:59

Thank you

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