

This presentation does not
contain much math

Application of OR to settle a major HRM conflict at Dutch Railways

Presentation for LNMB
Lunteren, 18 January 2007
Michiel Odijk, ORTEC

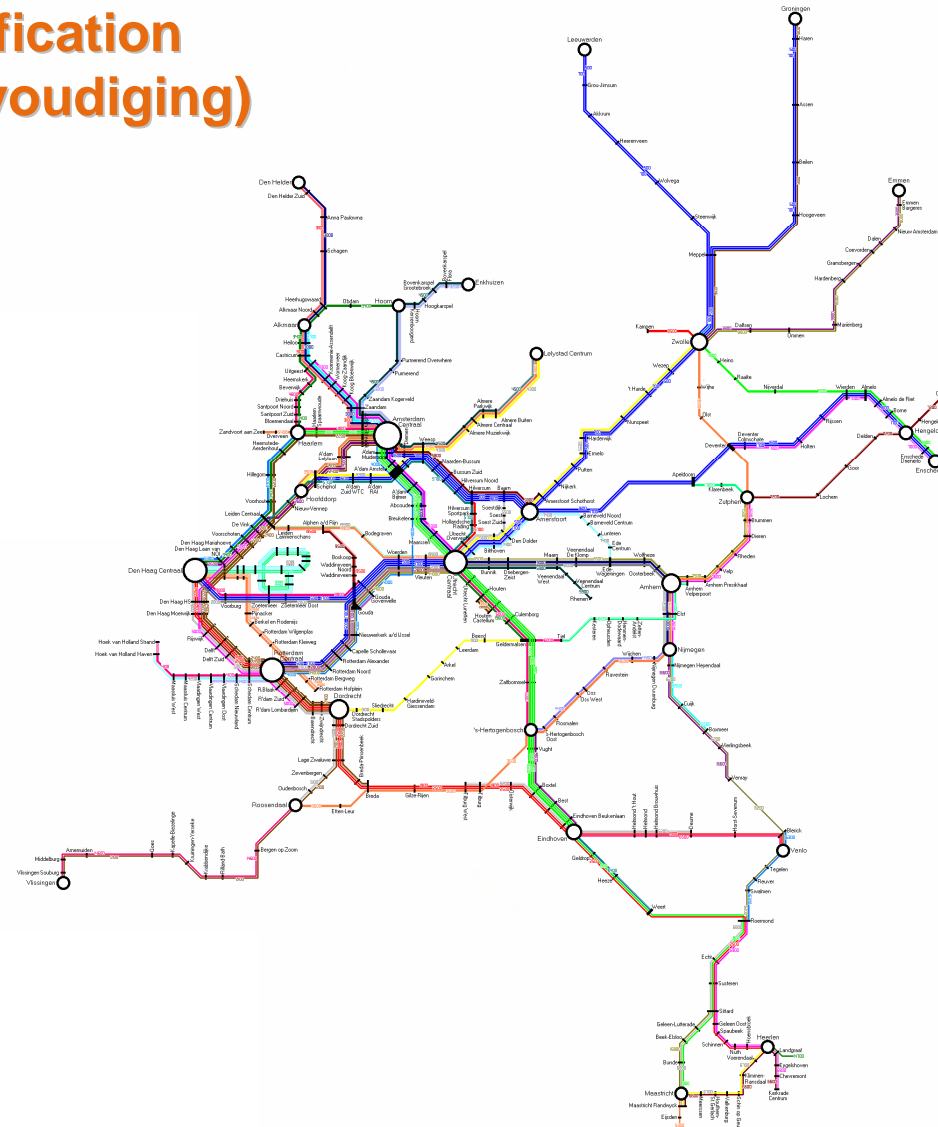
In the beginning ...

- 20 September 1839: First train in the Netherlands (Amsterdam-Haarlem)
- Operated by Hollandse IJzeren Spoorweg Maatschappij
- 1863: Maatschappij tot Exploitatie van Staatsspoorwegen
- 1917: Co-operation lead to Dutch Railways (NS)
- ...

About 80 years later ...

- ...
- NS announces new crew assignment model
- Guards and drivers exclusively assigned to train series starting in their home base

Process Simplification (Procesvereenvoudiging)



This is what happened ...

- Unions and works council opposed
 - Less variation in work (“Rondje om de kerk”)
 - “Making small lines ready to go for sale”
- Local and nation-wide strikes in Spring 2001
- NS paralised (managerial and operational)
- Cease fire in April 2001: New model to become operational unless Works Council of NS presents an alternative

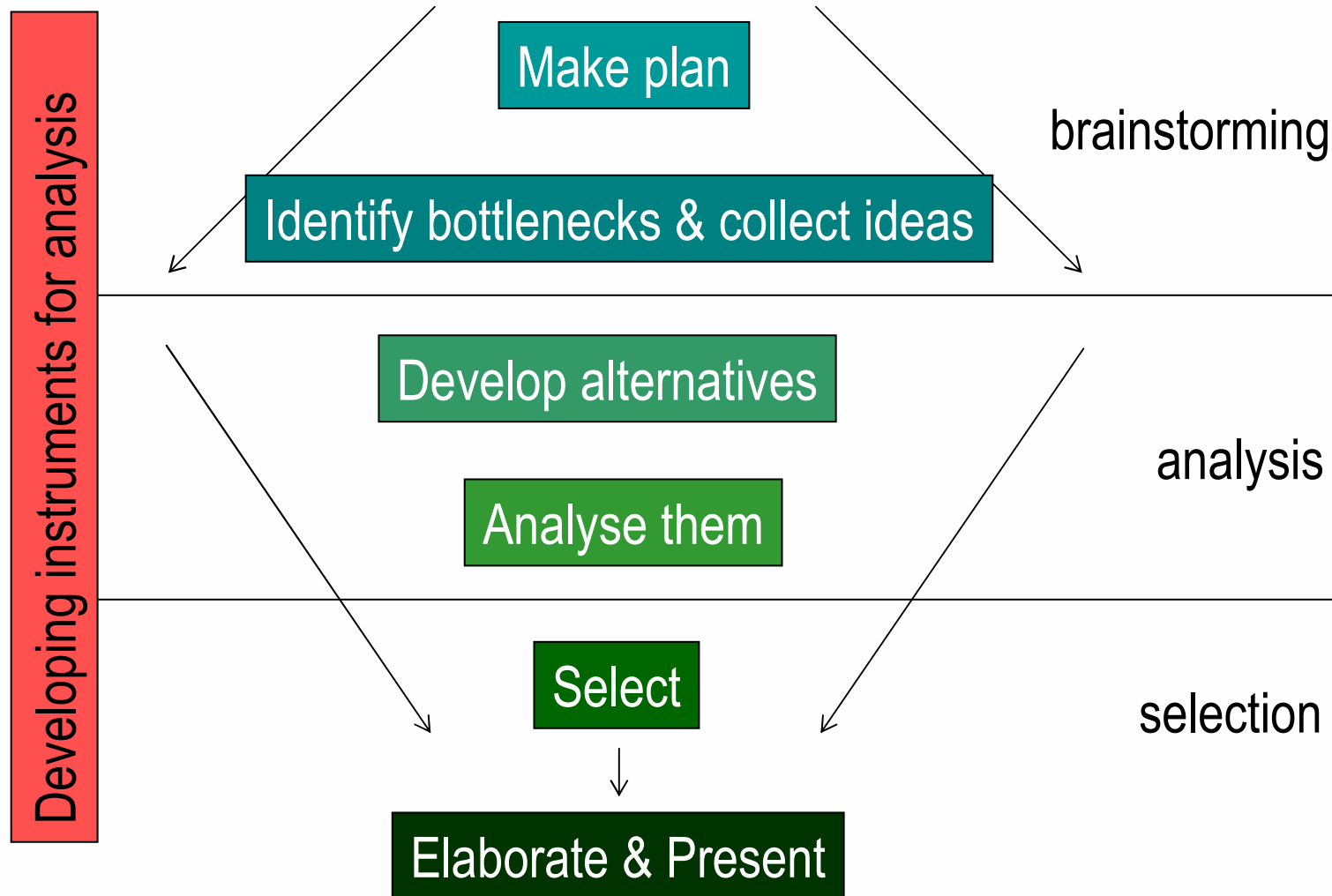
Mission statement of NS Works Council

- Fatal deadline (May 2002) for presenting alternative model
- Scope is limited to presenting the model, NS Works Council is not responsible for possible implementation
- Conditions upon alternative model:
 - Within legal boundaries and labour agreements (ATW/CAO)
 - Within context of NS timetable and rolling stock allocation
 - Not more expensive than current model
 - Positive contributing to punctuality
 - Facilitating future growth
 - Contributing to improving quality of labour
 - Alternative model supported by crew

In the beginning ...

- April 2001: Policy Research Corporation started to investigate the current processes
- October 2001: PRC had to give up its assignment, ORTEC and Basis&Beleid took over
- “Je bent erbij” (“you are part of it”)

Approach



Identify bottlenecks and collect ideas

- Site visits to all 29 depots
 - Collect complaints and ideas
- 4 work shops to blue print alternatives
 - 2-day events
 - Each with about 100 participants (drivers and guards)
- About 15% of crew consulted in these events

“Je bent erbij”

ORTEC

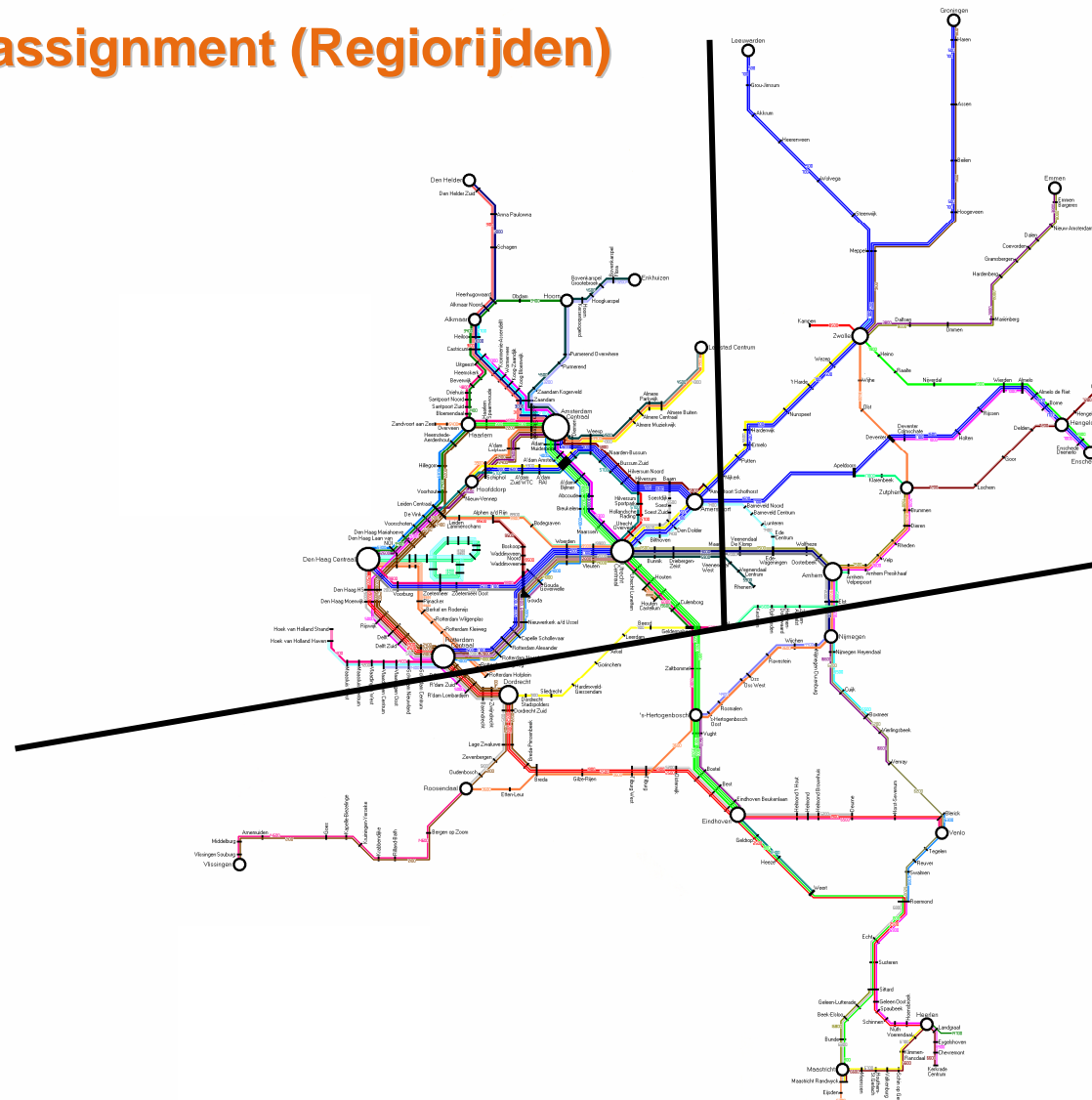
Identify bottlenecks and collect ideas



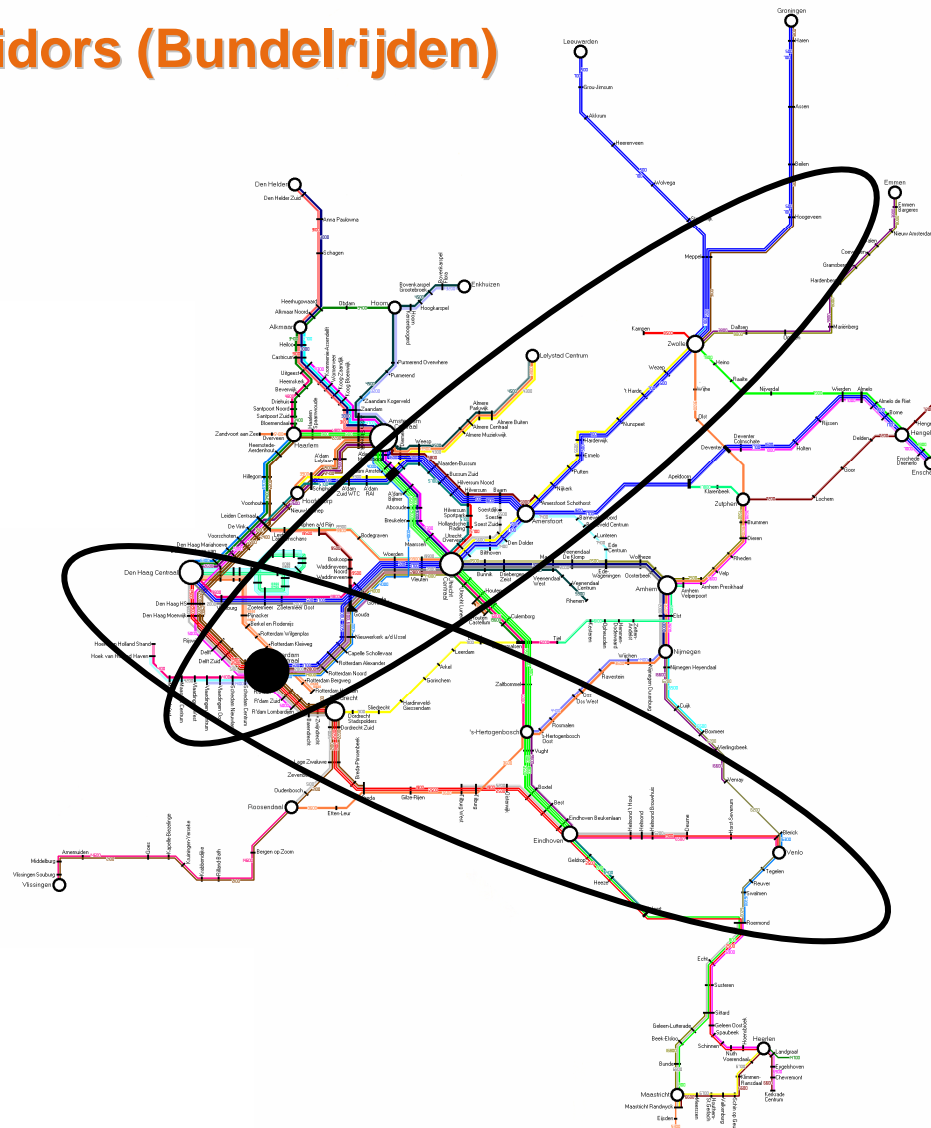
“Je bent erbij”

ORTEC

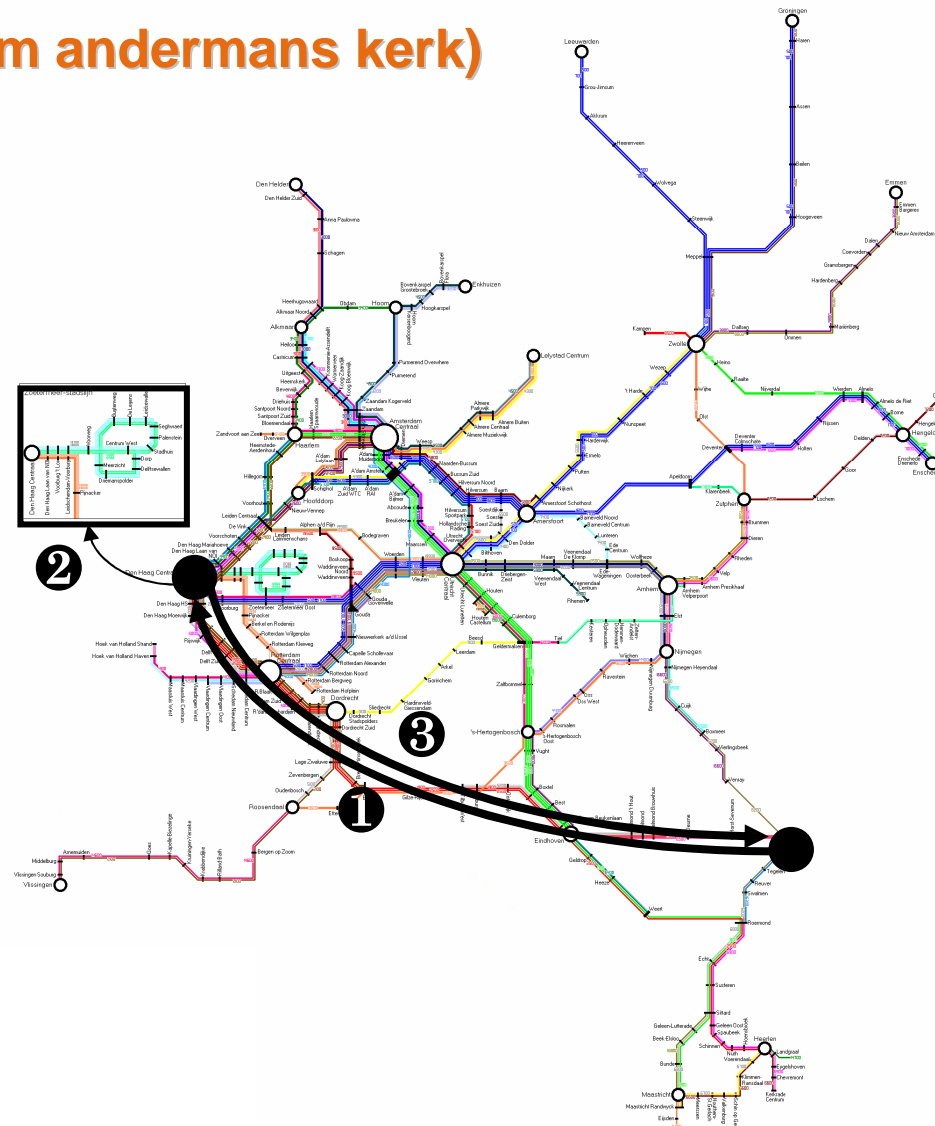
1. Regional assignment (Regiorijden)



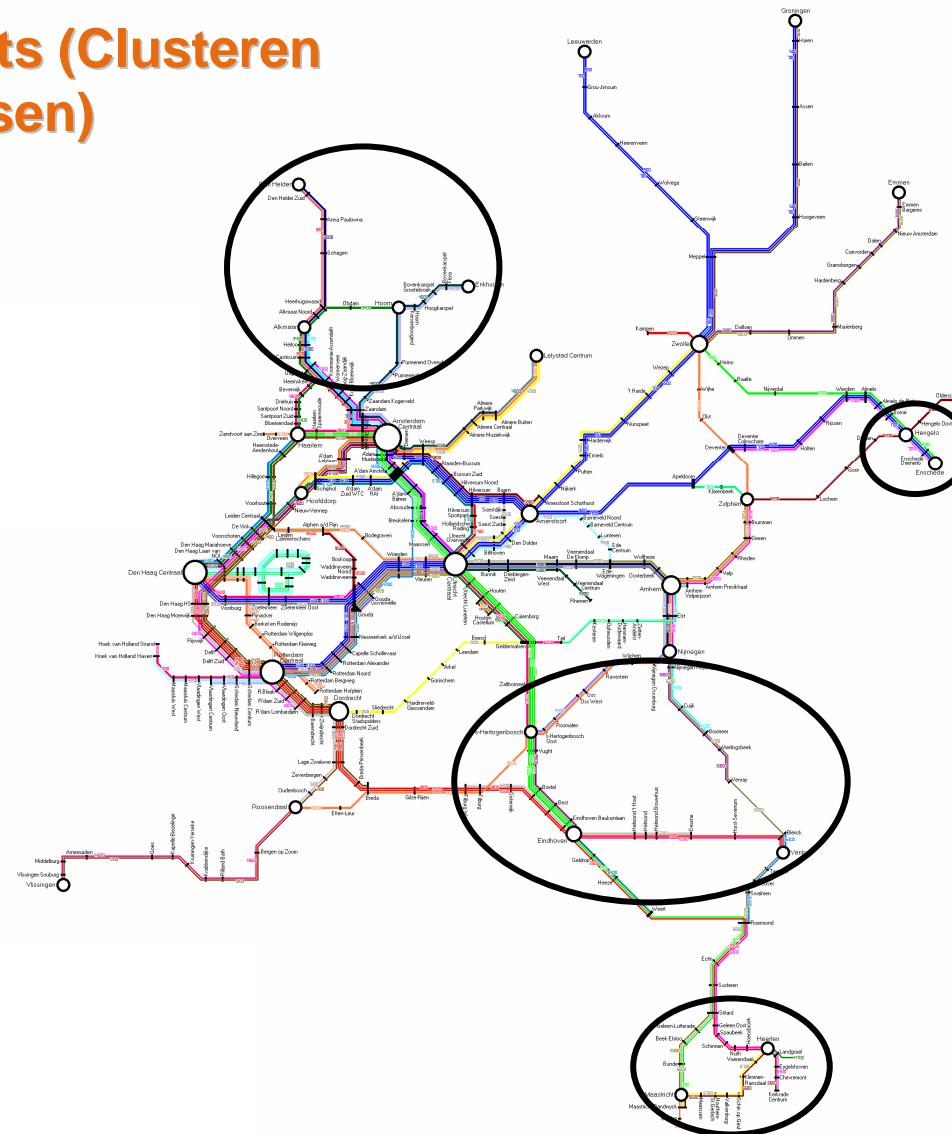
2. Assignment to corridors (Bundelrijden)



3. ?? (Rondje om andermans kerk)

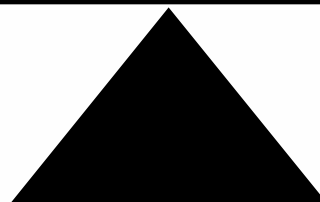


4. Cluster depots (Clusteren van standplaatsen)

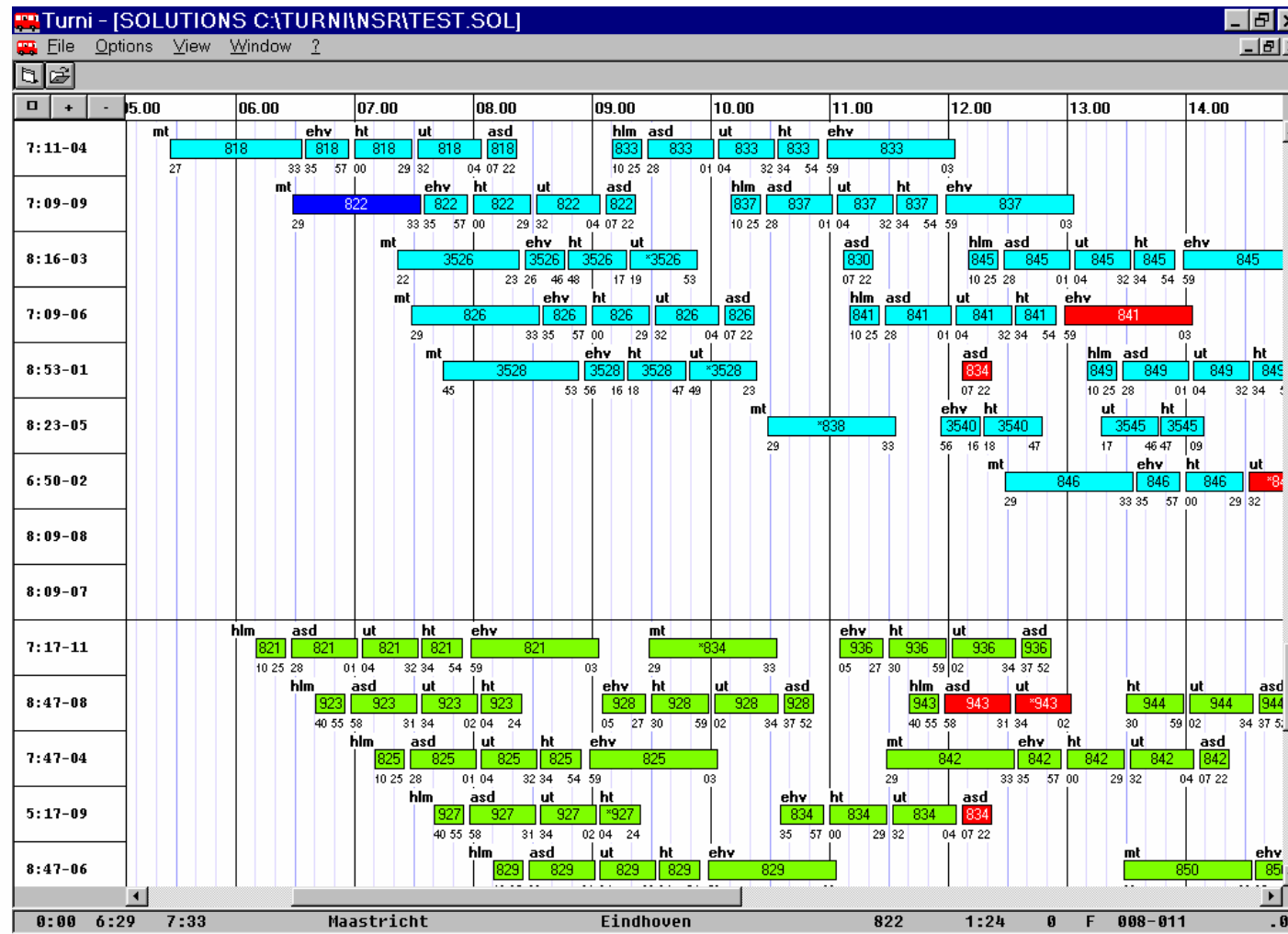


5. Sharing pleasures and burdens (Lusten en lasten delen)

Violent	Safety on the train	Non-violent
Mat'64	Rolling stock type	ICM
Stoptrain	Train type	IC
1	Nof different legs assigned to depot	Many
1	Nof different legs within duties	Many



Generating crew duties



Set covering model

	duty1	duty2	duty3	duty4	duty5	duty6	duty7		
min	c1	c2	c3	c4	c5	c6	c7		
s.t.									
task1	1	1	0	1	1	1	0	\geq	1
task2	0	1	0	0	0	1	0	\geq	1
task3	0	0	1	1	0	1	0	\geq	1
task4	1	0	1	0	0	0	0	\geq	1
task5	1	1	0	1	0	0	1	\geq	1
task6	0	0	0	0	1	1	1	\geq	1

Set covering model

	duty1	duty2	duty3	duty4	duty5	duty6	duty7		
min	c1	c2	c3	c4	c5	c6	c7		
s.t.									
task1	1	1	0	1	1	1	0	\geq	1
task2	0	1	0	0	0	1	0	\geq	1
task3	0	0	1	1	0	1	0	\geq	1
task4	1	0	1	0	0	0	0	\geq	1
task5	1	1	0	1	0	0	1	\geq	1
task6	0	0	0	0	1	1	1	\geq	1

Set covering model

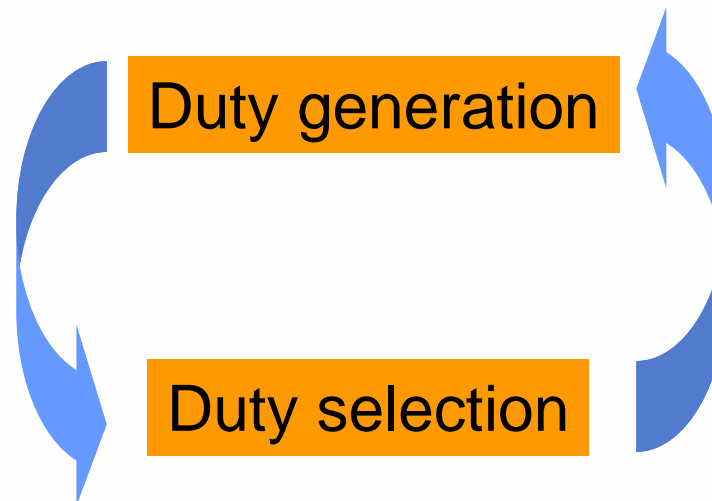
	duty1	duty2	duty3	duty4	duty5	duty6	duty7		
min	c1	c2	c3	c4	c5	c6	c7		
s.t.									
task1	1	1	0	1	1	1	0	\geq	1
task2	0	1	0	0	0	1	0	\geq	1
task3	0	0	1	1	0	1	0	\geq	1
task4	1	0	1	0	0	0	0	\geq	1
task5	1	1	0	1	0	0	1	\geq	1
task6	0	0	0	0	1	1	1	\geq	1

Set covering model

	duty1	duty2	duty3	duty4	duty5	duty6	duty7		
min	c1	c2	c3	c4	c5	c6	c7		
s.t.									
task1	1	1	0	1	1	1	0	\geq	1
task2	0	1	0	0	0	1	0	\geq	1
task3	0	0	1	1	0	1	0	\geq	1
task4	1	0	1	0	0	0	0	\geq	1
task5	1	1	0	1	0	0	1	\geq	1
task6	0	0	0	0	1	1	1	\geq	1

Set covering model



- TURNI
 - Double Click, Italy (Matteo Fischetti)
- Dynamic duty generation + duty selection
 - Implicit column generation
 - Langrangian relaxation



Set covering model

	duty1	duty2	duty3	duty4	duty5		
min	c1=1	c2=1	c3=1	c4=1	c5=1		
s.t.							
task1	1	1	0	1	1	\geq	1
task2	0	1	0	0	0	\geq	1
task3	0	0	1	1	0	\geq	1
task4	1	0	1	0	0	\geq	1
task5	1	1	0	1	0	\geq	1
task6	0	0	0	0	1	\geq	1

Set covering model

								
	duty1	duty2	duty3	duty4	duty5	duty6		
min	c1=1	c2=1	c3=1	c4=1	c5=1	c6=1		
s.t.								
task1	1	1	0	1	1	1	≥	1
task2	0	1	0	0	0	1	≥	1
task3	0	0	1	1	0	1	≥	1
task4	1	0	1	0	0	0	≥	1
task5	1	1	0	1	0	0	≥	1
task6	0	0	0	0	1	1	≥	1

Set covering model

	duty1	duty2	duty3	duty5	duty6		
min	c1=1	c2=1	c3=1	c5=1	c6=1		
s.t.							
task1	1	1	0	1	1	\geq	1
task2	0	1	0	0	1	\geq	1
task3	0	0	1	0	1	\geq	1
task4	1	0	1	0	0	\geq	1
task5	1	1	0	0	0	\geq	1
task6	0	0	0	1	1	\geq	1

Set covering model

```

Test.SOL - WordPad
File Modifica Visualizza Inserisci Formato ?
[Icons]
Courier New (Occidentale) 10 [Icons]
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
===== > DUTIES FOR GROUP N.      1  "Ehv"      "

--> DUTY N.      1 COST:      31296.00 --> NAME Duty      1-001 GROUP N.      1  "Ehv"      "

WAIT  DEPAR  ARRIV TYPE  PAS |-- STARTING LOCATION --| |-- ARRIVAL  LOCATION --| |DUT-| WORK  BAD  BUS TRIP CODE
0:00  7:05   7:27      Eindhoven      Den Bosch      920    0:42  0  F  009-007
0:03  7:30   7:59      Den Bosch      Utrecht      920    1:14  0      009-008
0:03  8:02   8:34      Utrecht      Amsterdam     920    1:49  0      009-009
0:03  8:37   8:52      Amsterdam     Haarlem      920    2:07  0  L  009-010
-----
* 0:48  9:40   9:55      Haarlem      Amsterdam     935    3:10  0  F  009-035
0:02  9:57  10:30      Amsterdam     Utrecht      935    3:45  0      009-036
0:04 10:34  11:02      Utrecht      Den Bosch     935    4:17  0      009-037
0:02 11:04  11:24      Den Bosch     Eindhoven     935    4:39  0  L  009-038
-----
* 0:47 12:11  12:40      Eindhoven     Den Bosch     9642   5:55  0  B  096-025
-----
* 0:40 13:20  13:48      Den Bosch     Eindhoven     9643   7:03  0  B  096-026
0:23 14:11  14:40      Eindhoven     Den Bosch     9650   7:55  0  B  096-029
-----
* 0:40 15:20  15:48      Den Bosch     Eindhoven     9651   9:03  0  B  096-030
-----
--> SPREAD= 9:18 WORK= 9:18 EFFIC= 55% KM=      .0 CLEAN=S MEALB= 0 D-HEA= 0 CONT= 2:07 BUS-C= 0 OPU-C= 0 BONUS= 0% AD

--> DUTY N.      2 COST:      30686.00 --> NAME Duty      2-001 GROUP N.      1  "Ehv"      "
    
```

Selecting an alternative

- 5 alternatives
- 4 work shops
 - 2-day events
 - Each with about 100 participants from local work councils (POC/NOC)
- In a first round of work shops alternative “Cluster depots” and “?? (rondje om andermans kerk)” were eliminated by the crew
- In a second round “Sharing pleasures and burdens” was selected

“Je bent erbij”

ORTEC

Ending the mission



May 2002

June 2002



December 2002



Value of OR

- OR played a vital role in securing operational and economical conditions
- OR hardly played a role in processes with participation of crew
 - Crew selects strategically
- Smart and flexible implementation and creative application of an algorithm are at least as important as theoretical foundations