Examples of AI Applications in Brazil FEEC in the Past 30 Years (and a Look at the Future)

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EADCA 2022, DCA, FEEC

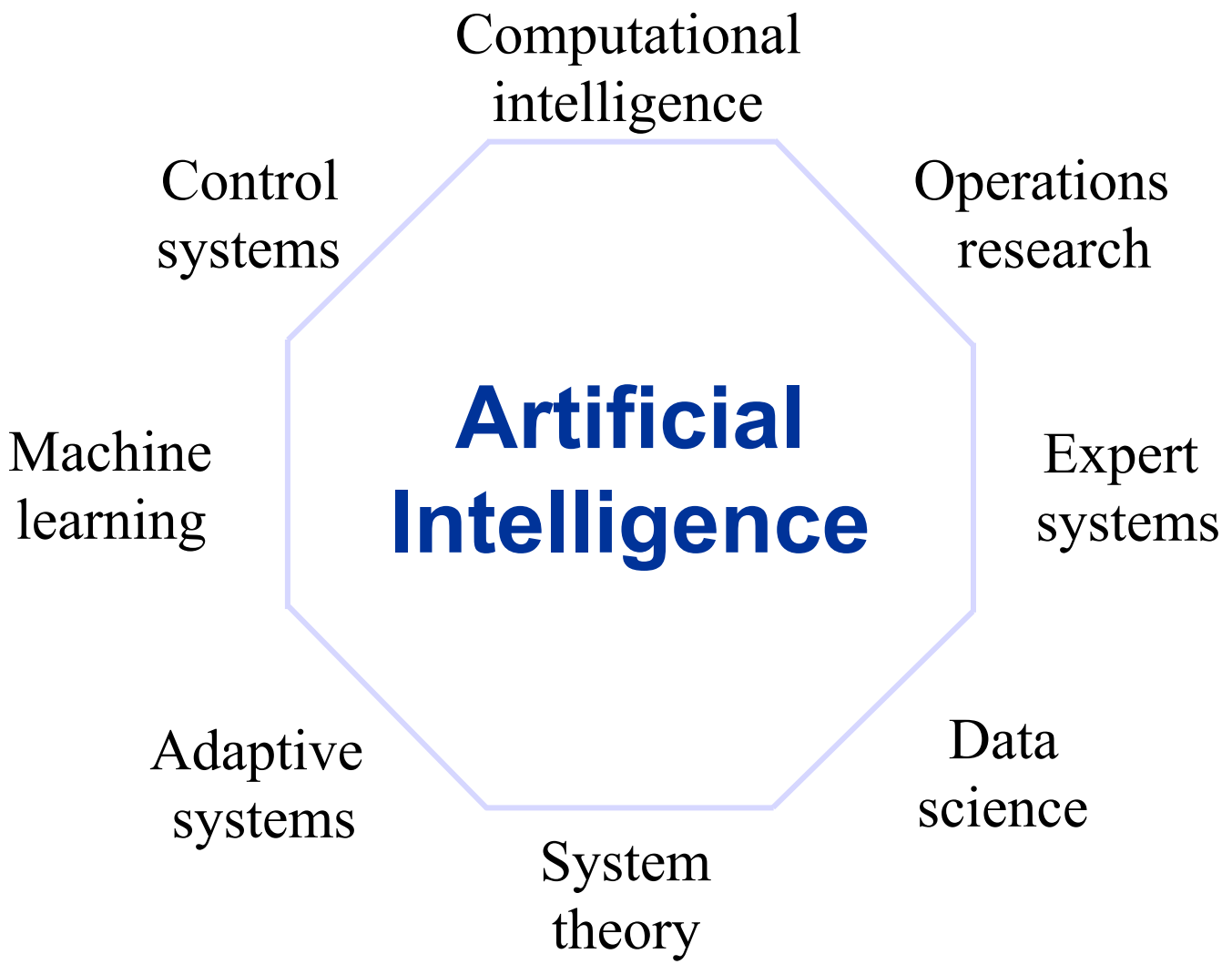
Outline

Our (engineering) view of AI

Early applications

Current/future applications

Our (engineering) view of AI



Early applications

Control systems

Real-time railroad meet-and-pass scheduling

Iron ore stockpiling planning in shipping yards

Oil recovery

Thyroid hormone profiling

Blending and fat formulation

Current/future applications

Real-time rail movement planning

Last mile supply chain planning

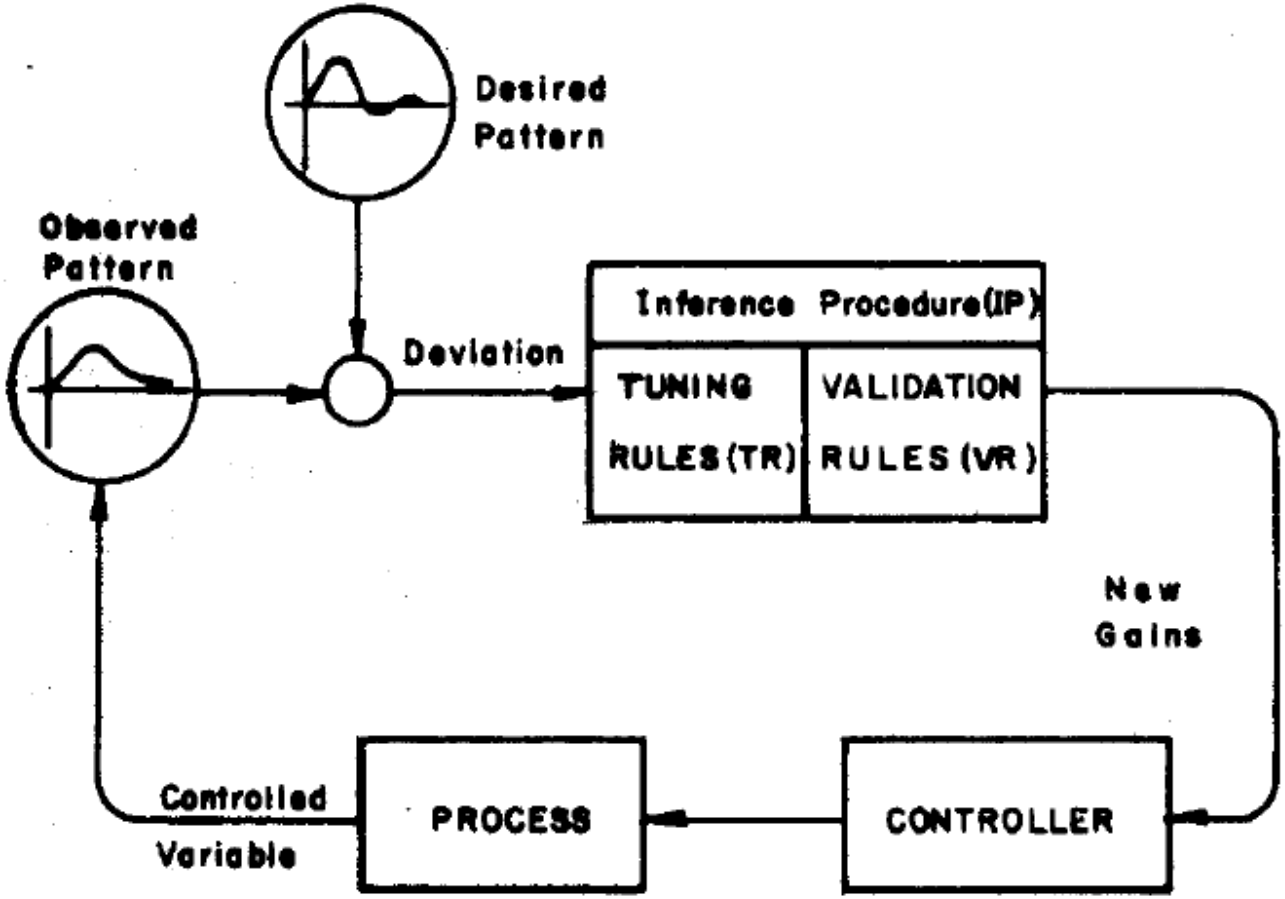
Intelligent railroad yard management

Robot-based compact storage-retrieval

Adaptive real-time flight control

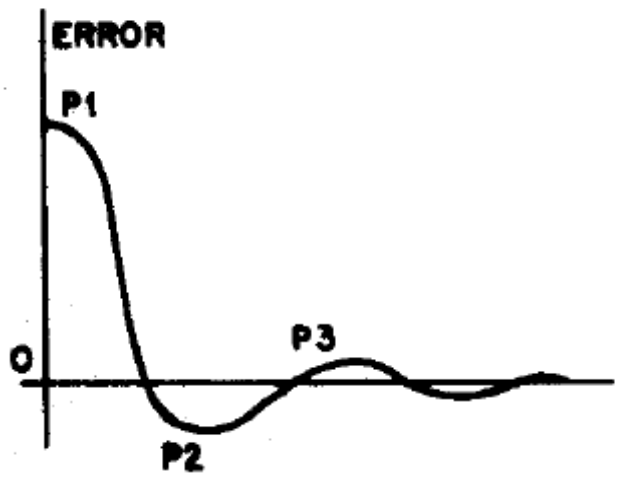
Early applications

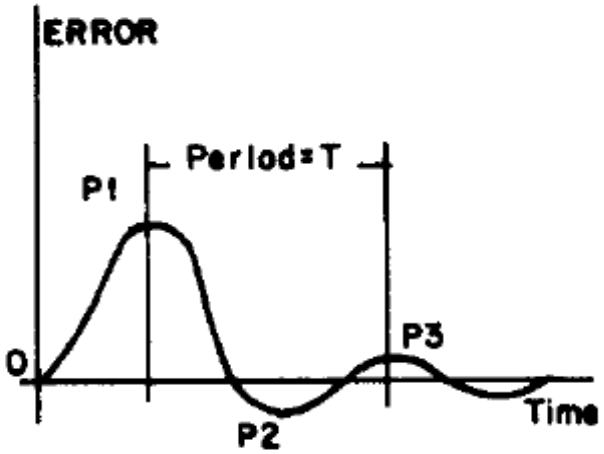
Control systems: process control



The Pattern Recognition Approach

Proc. 27th IEEE Conference on Decision and Control, December 1988

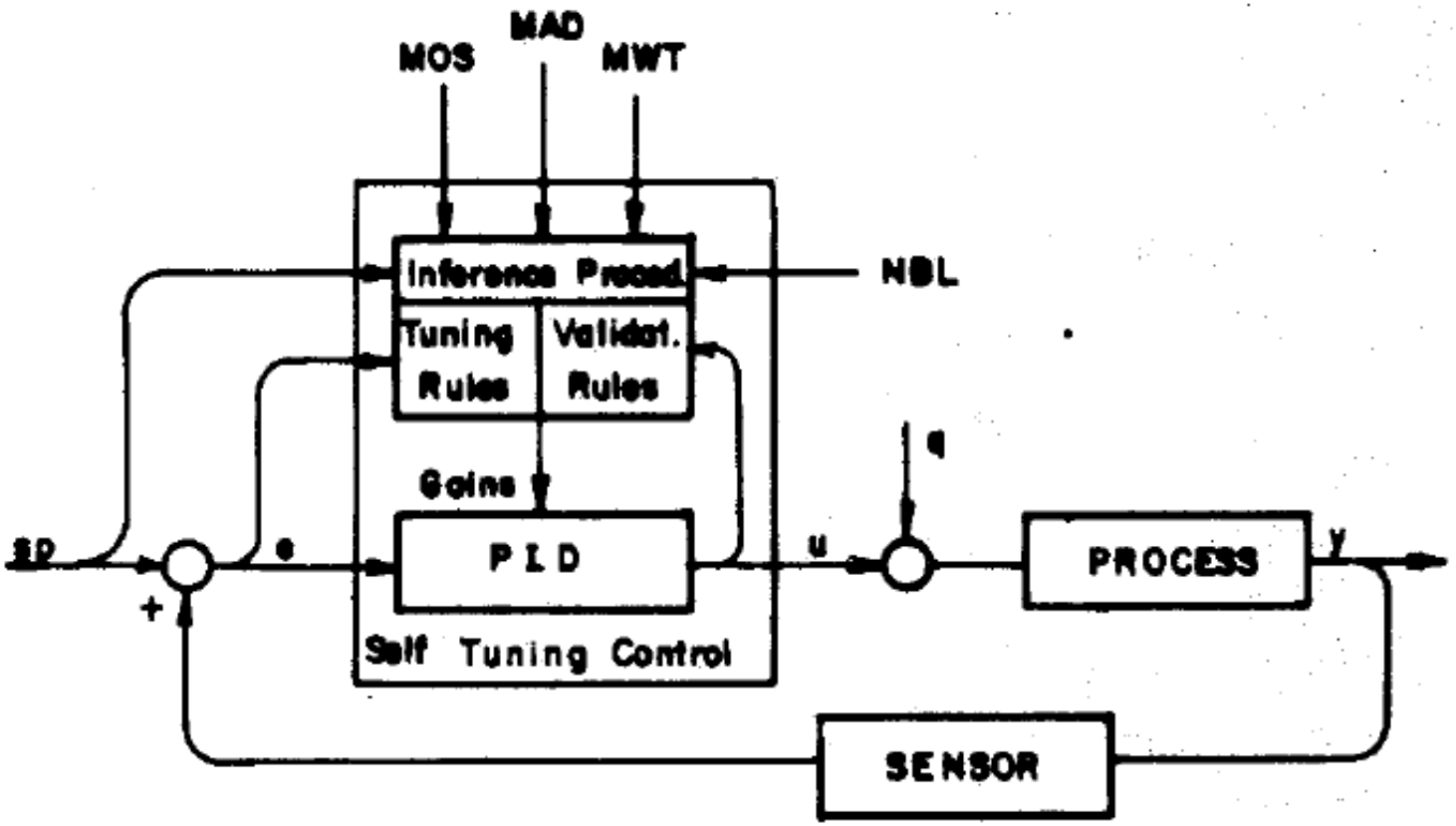




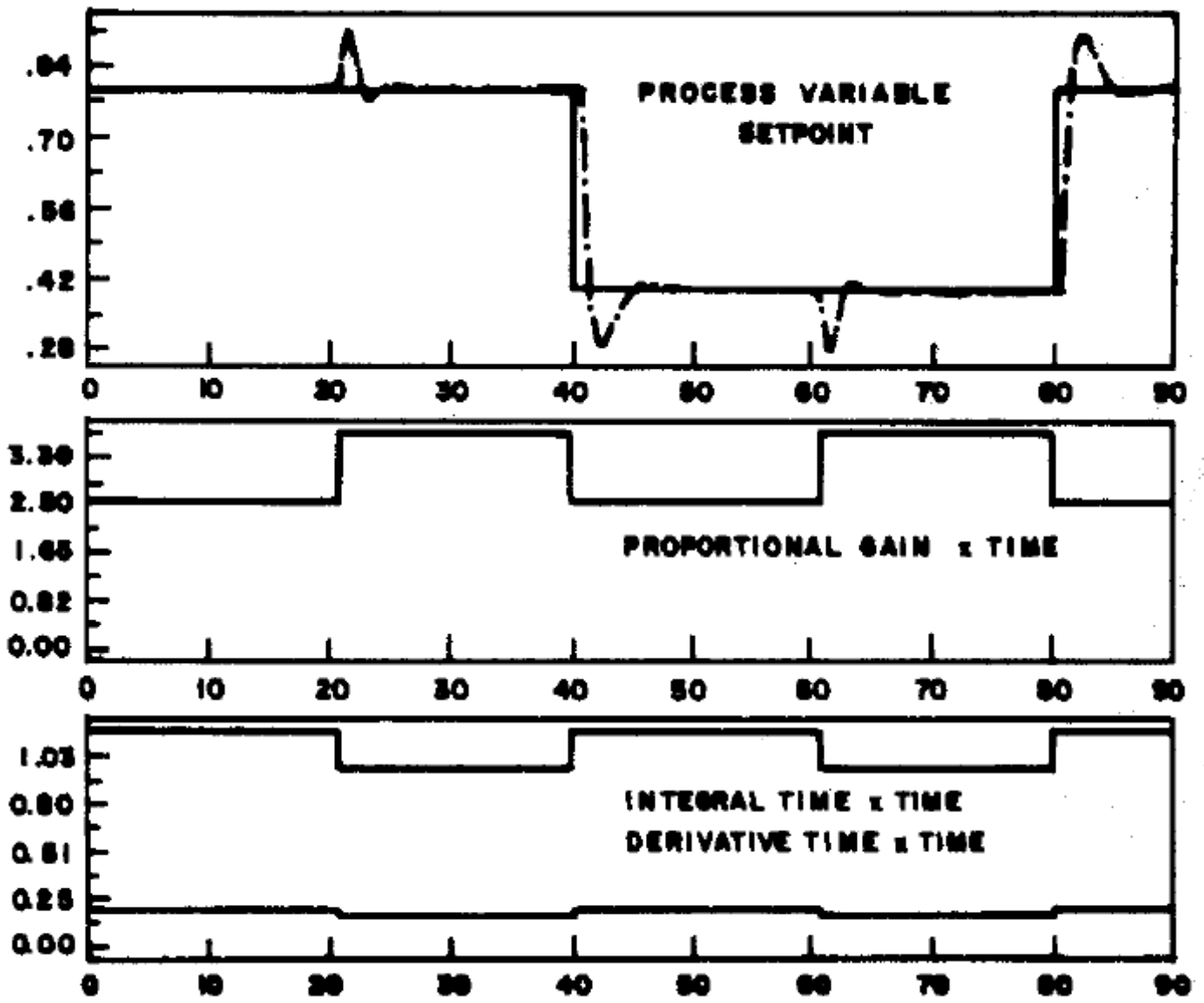
$$\text{Overshoot} = \left| \frac{P2}{P1} \right|$$

$$\text{Damping} = \frac{|P2| + |P3|}{|P1| + |P2|}$$

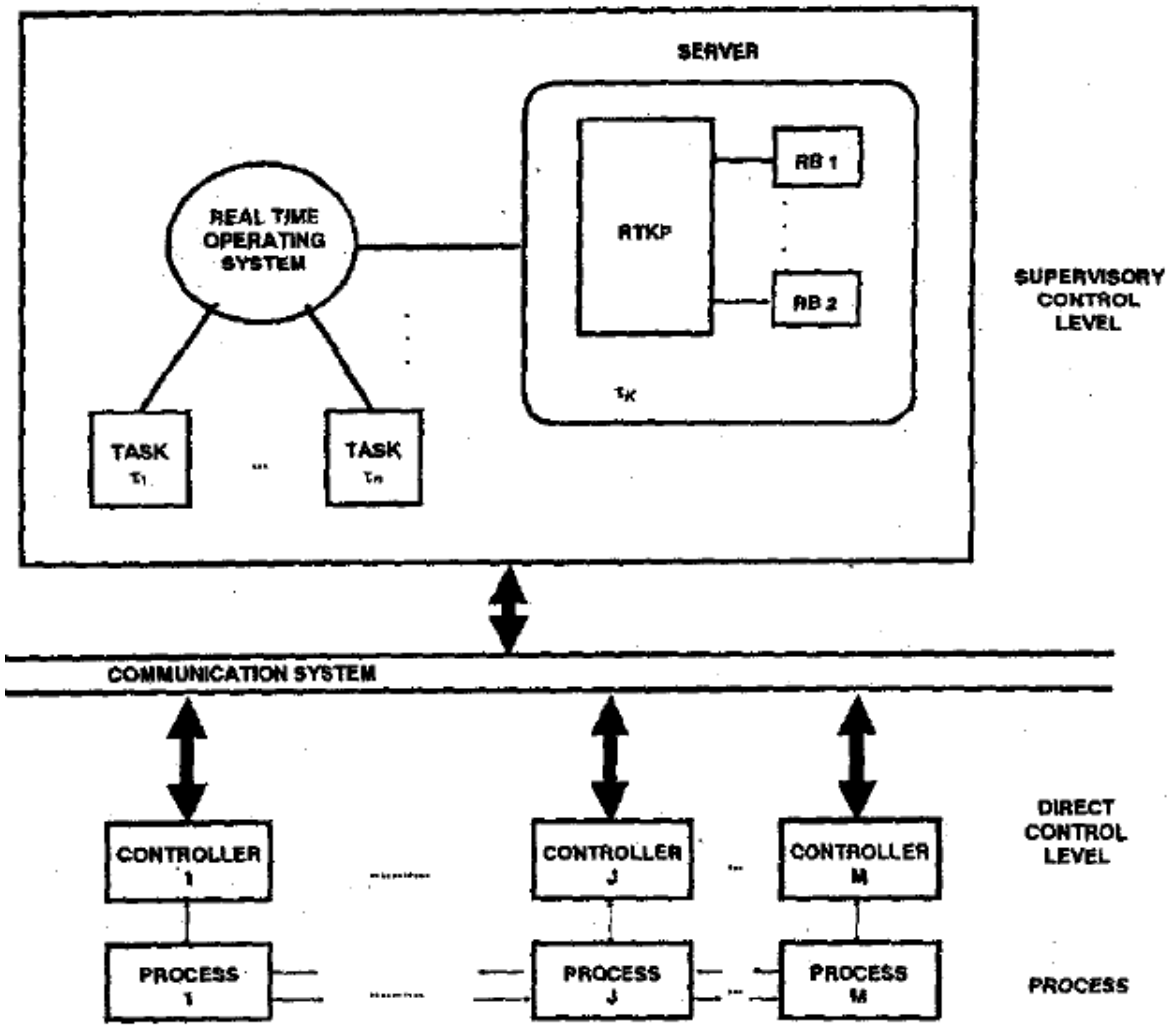
Pattern Characterization



Self-Tuning Controller in the Loop

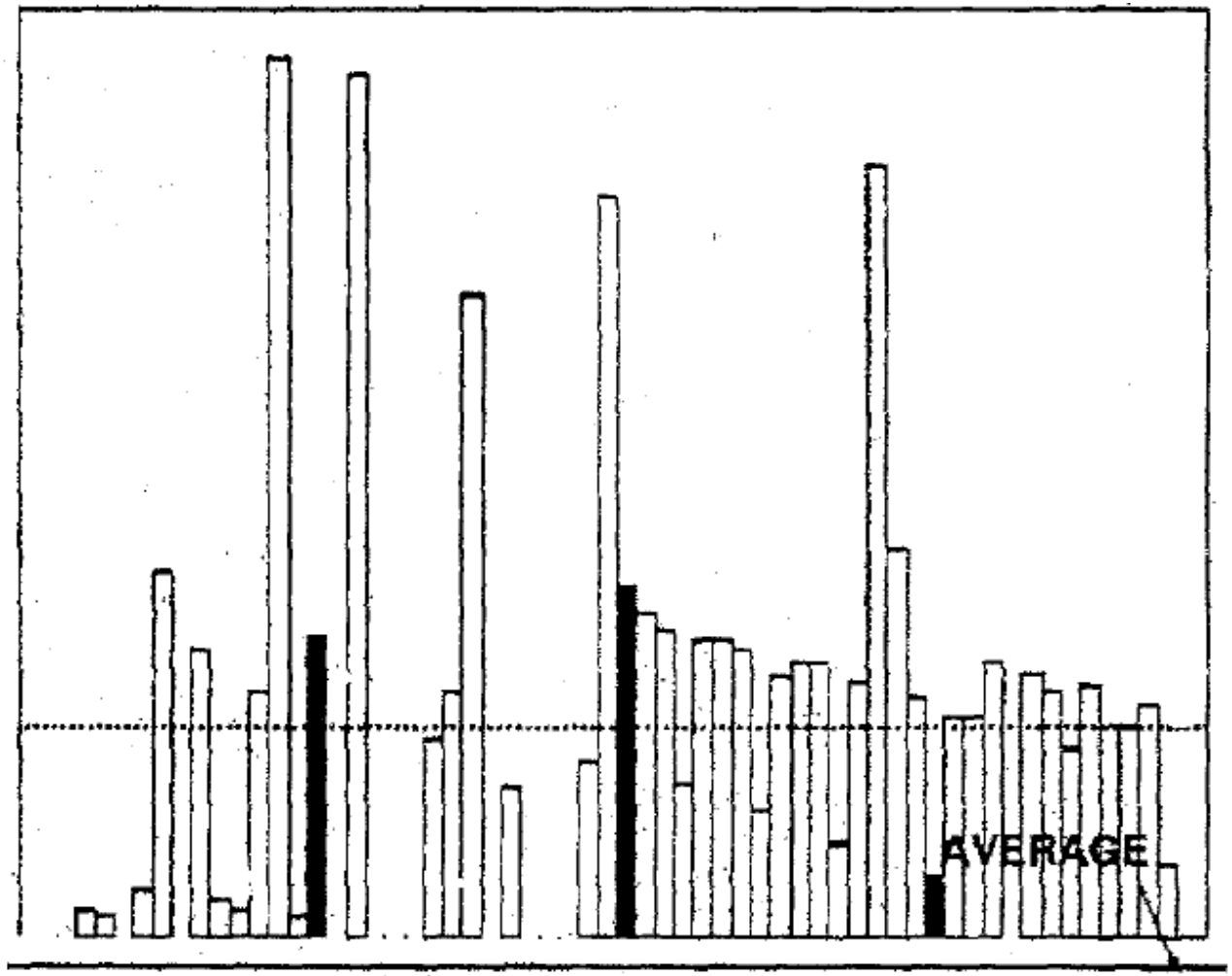

.84
.70
.56
.42
.28
PROCESS VARIABLE
SETPOINT
0
10
20
30
40
50
60
70
80
90
3.30
2.50
1.65
0.82
0.00
PROPORTIONAL GAIN x TIME
1.05
0.80
0.61
0.25
0.00
INTEGRAL TIME x TIME
DERIVATIVE TIME x TIME

Elevator Group Control

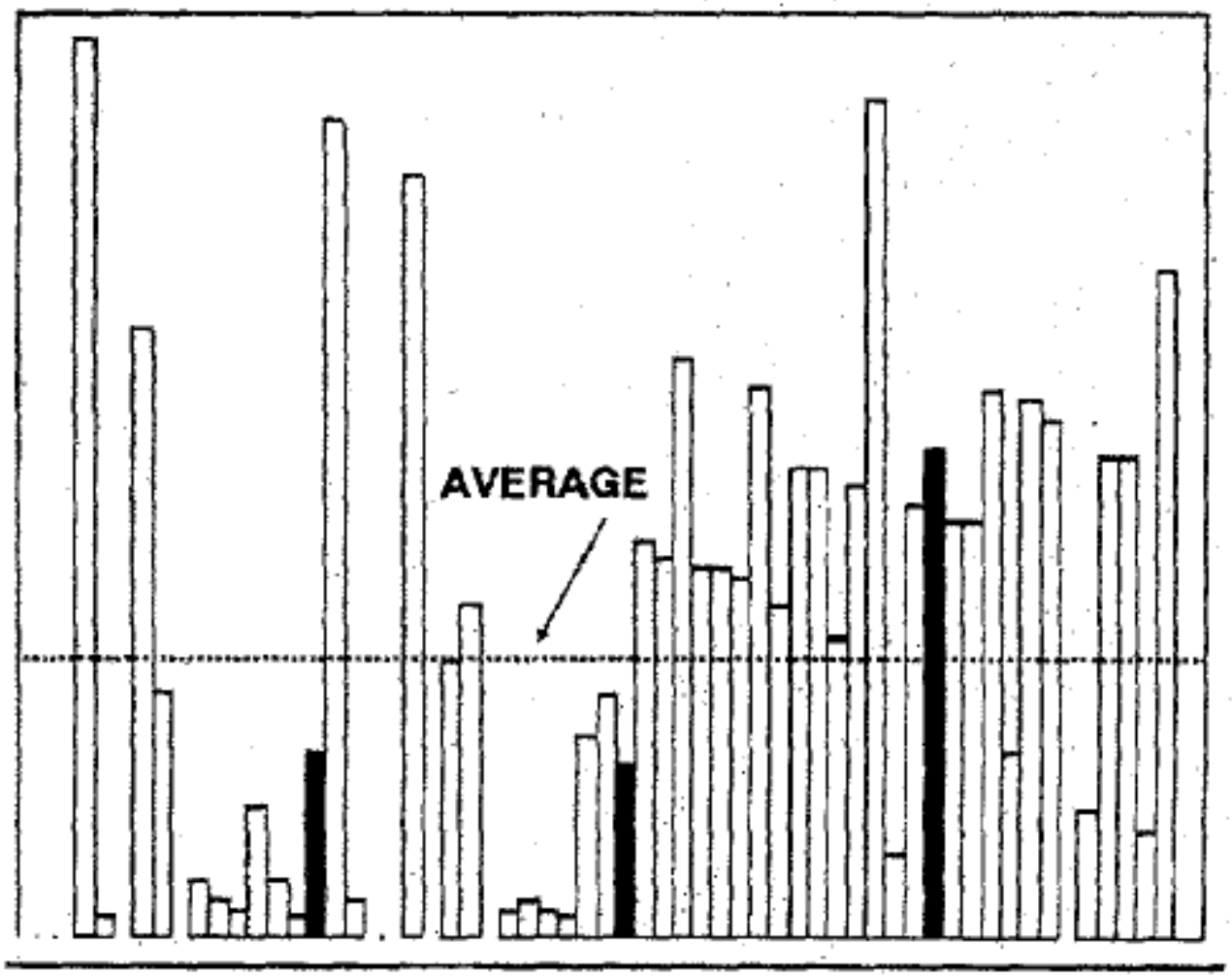


RTKP in supervisory control systems.

IEEE Trans. on Knowledge and Data Engineering, vol. 8, no. 1, 1996



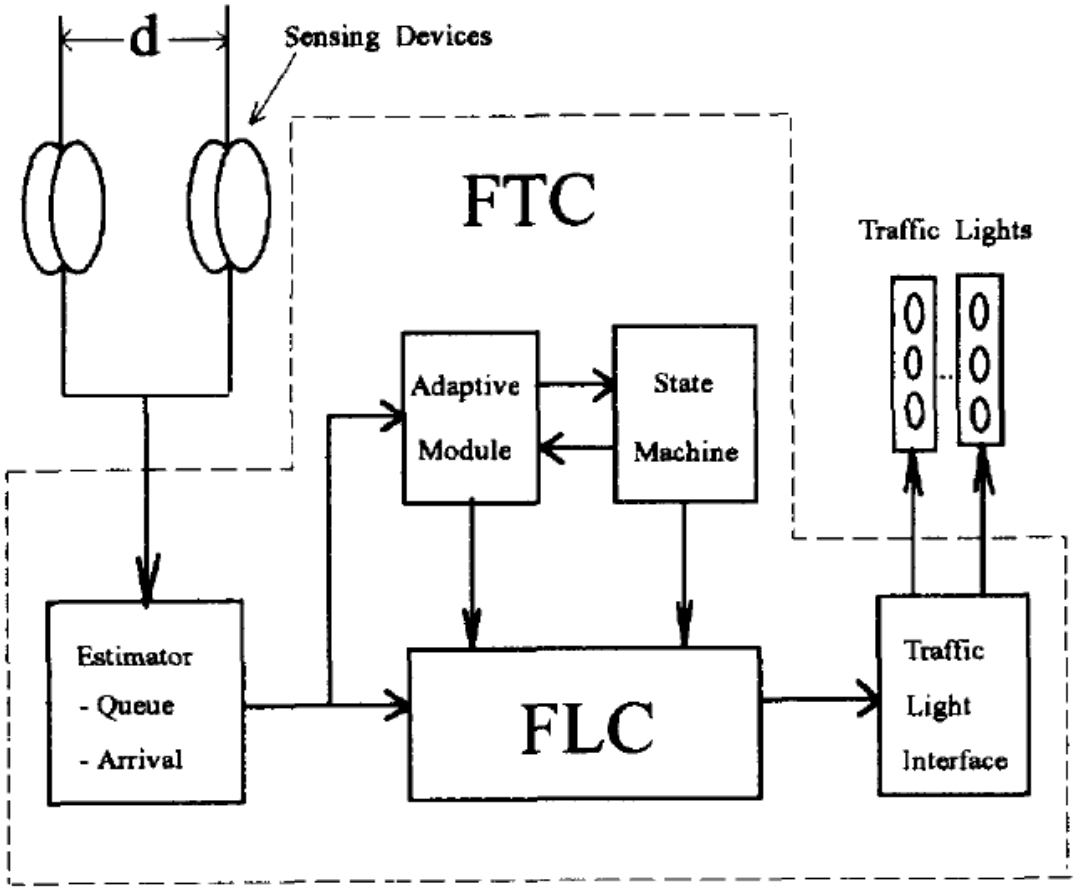
g. 5. Wait time × call—R.B. strategy.



g. 7. Wait time × call—Conventional strategy.

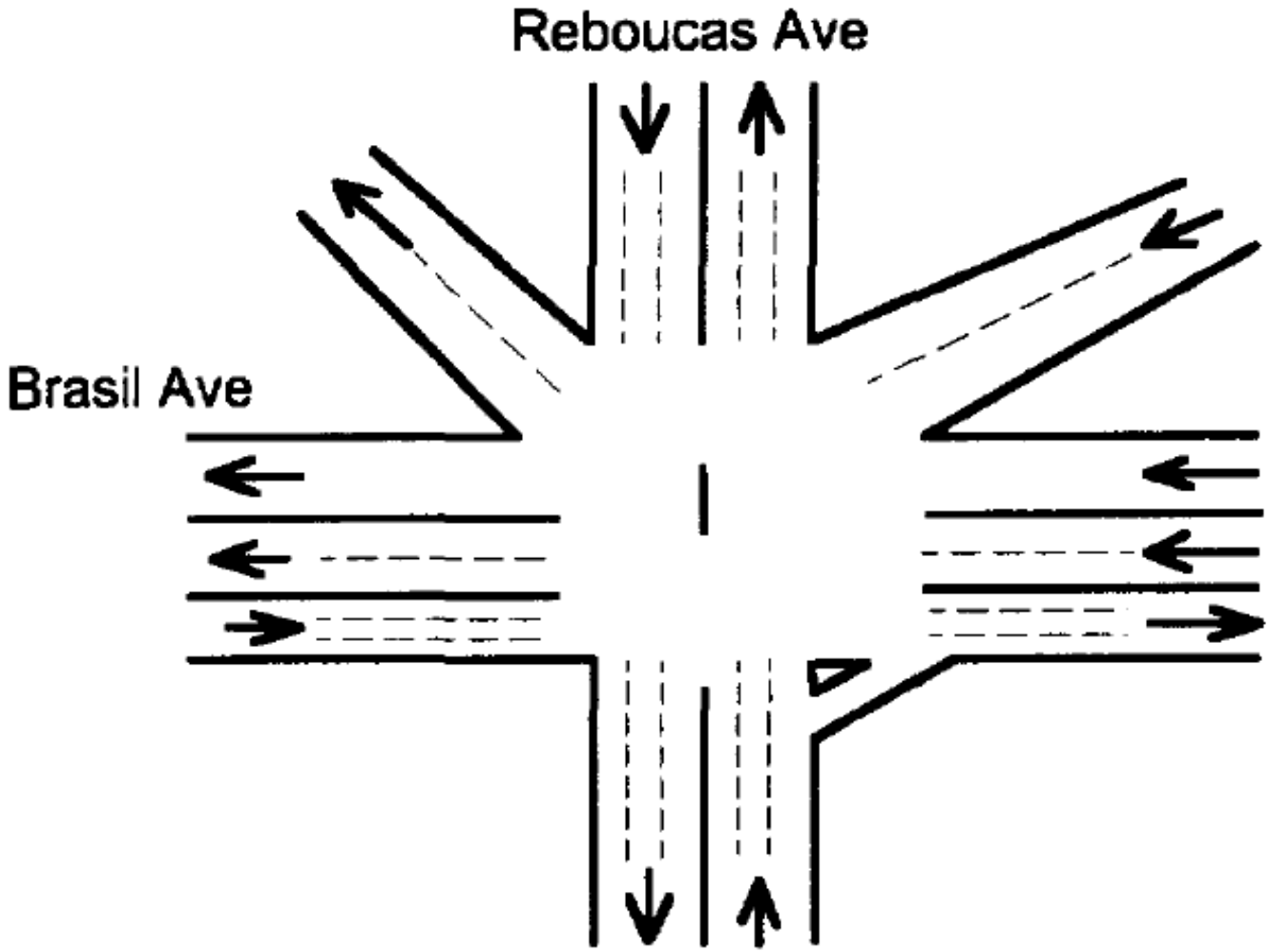
Ricardo R. Gudwin is a PhD candidate at the State University of Campinas (UNICAMP), Campinas, São Paulo, Brazil. He received the BS degree in electrical engineering from the State University of Campinas (UNICAMP), in 1989, and the MS degree in electrical engineering/automation from the same university in 1992. His topics of interest include artificial intelligence, fuzzy systems, neural networks, evolutive systems, and cognitive sciences. He is currently working in his PhD thesis on methods of learning for knowledge processing.

(Fuzzy) Traffic Control

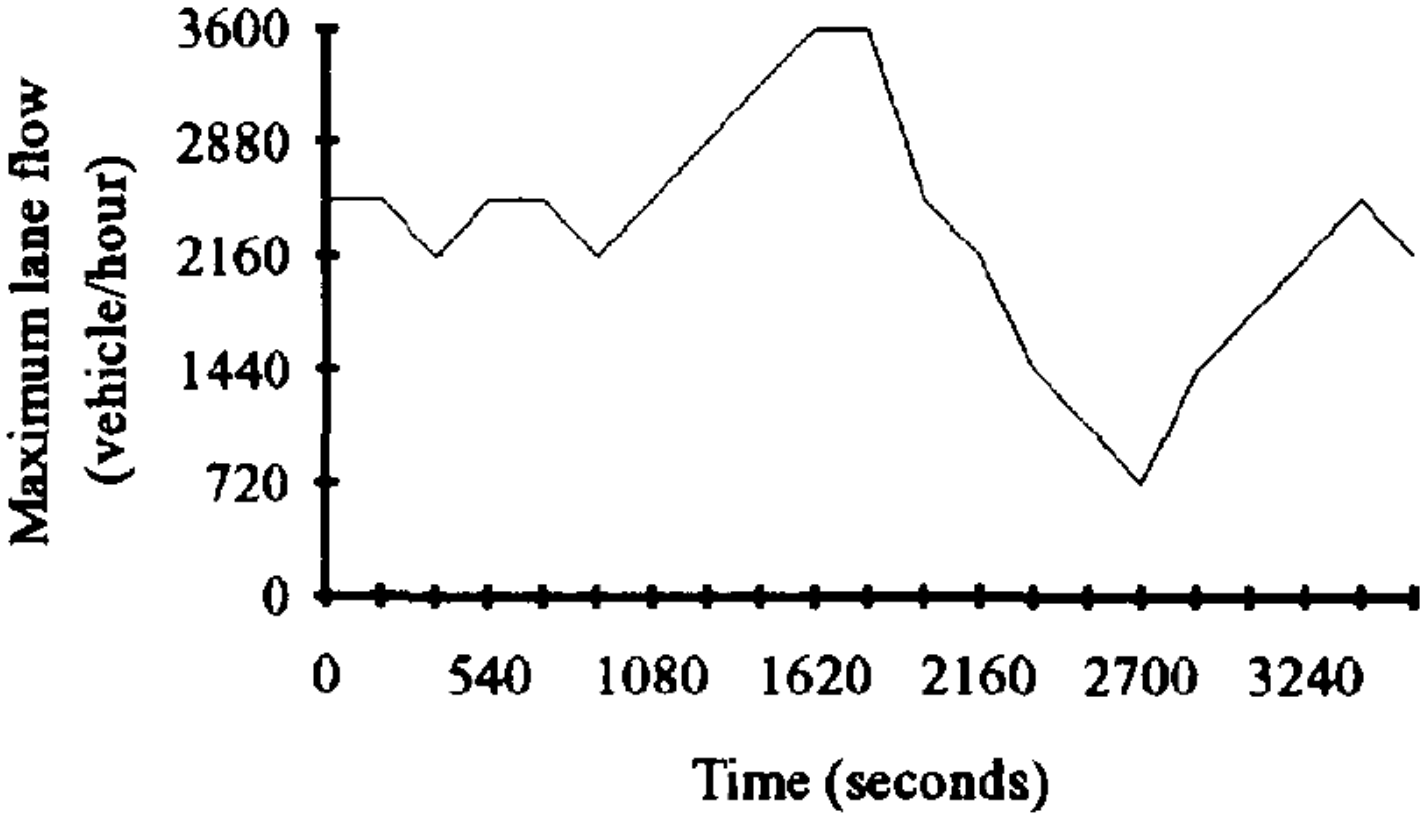


Block diagram of the Fuzzy Traffic Controller

Proc. 2nd IEEE Int. Conference on Fuzzy Systems, San Francisco, March 1993



Intersection of the Brasil avenue with Reboucas avenue



Traffic flow volume along the day

José Roberto Favilla, FEE, Unicamp, BS1982, MS 1988. Currently global leader for Industry 4.0 at IBM in applying advanced analytics, optimization, AI, IoT and Blockchain technologies to drive innovation.

Fuzzy air Conditioning

https://www.mozartleiloeiro.com.br/peca.asp?ID=8602685#

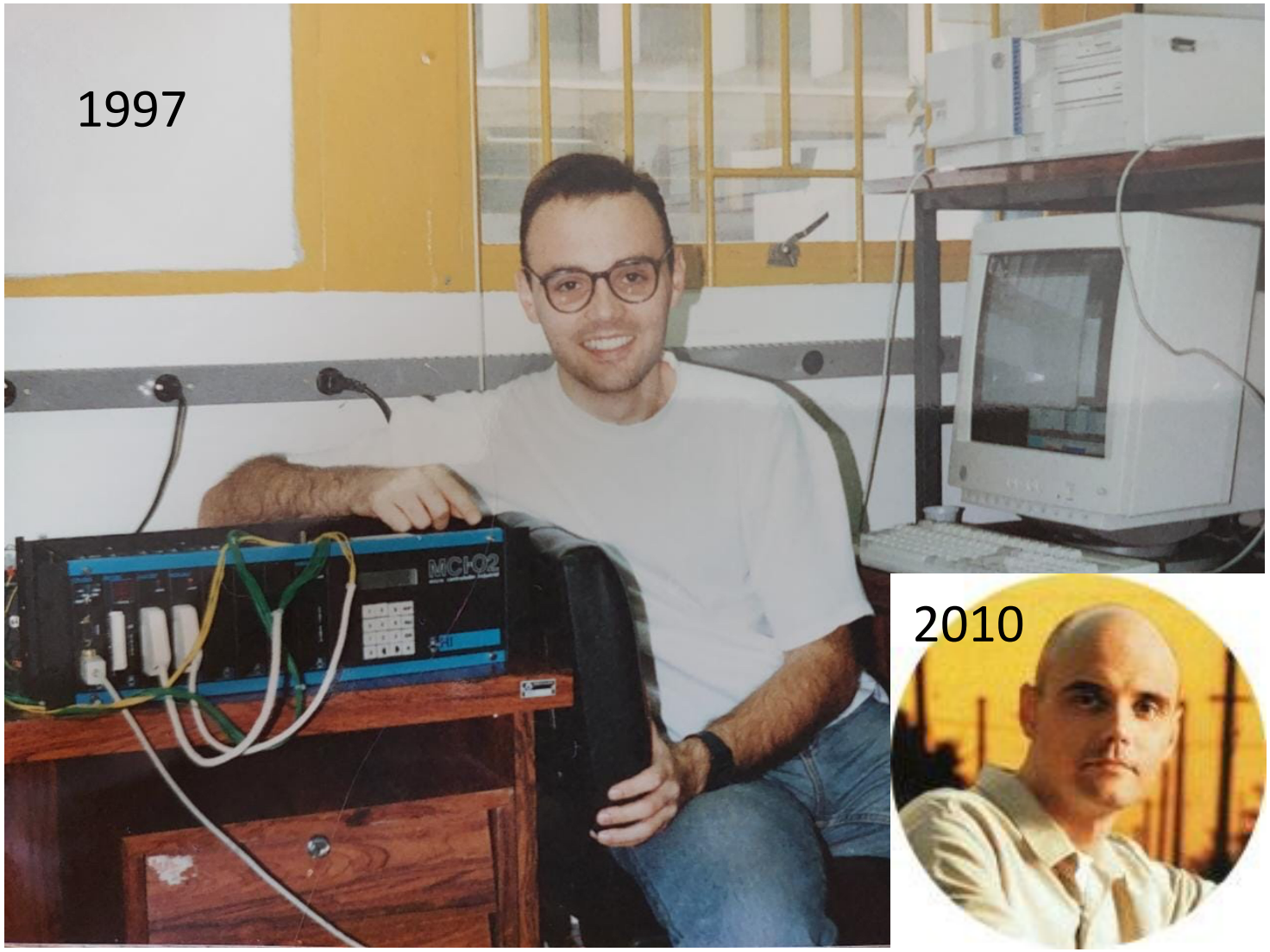

BRASTEMP
LIGA • DESLIGA
FU22Y LOGIC F 10000
EXAUSTÃO
ABERTA
FECHADA

Ricardo Loureiro, FEEC, BS 1989, MS 1996. Currently Director of Citrix, worked for more than 20 years in several multinational technology companies (Whirlpool, Motorola, Microsoft). His career is a combination of technology and business in supply chain and engineering in Brazil and Latin America. He developed several products, processes, and business transformation mechanisms.

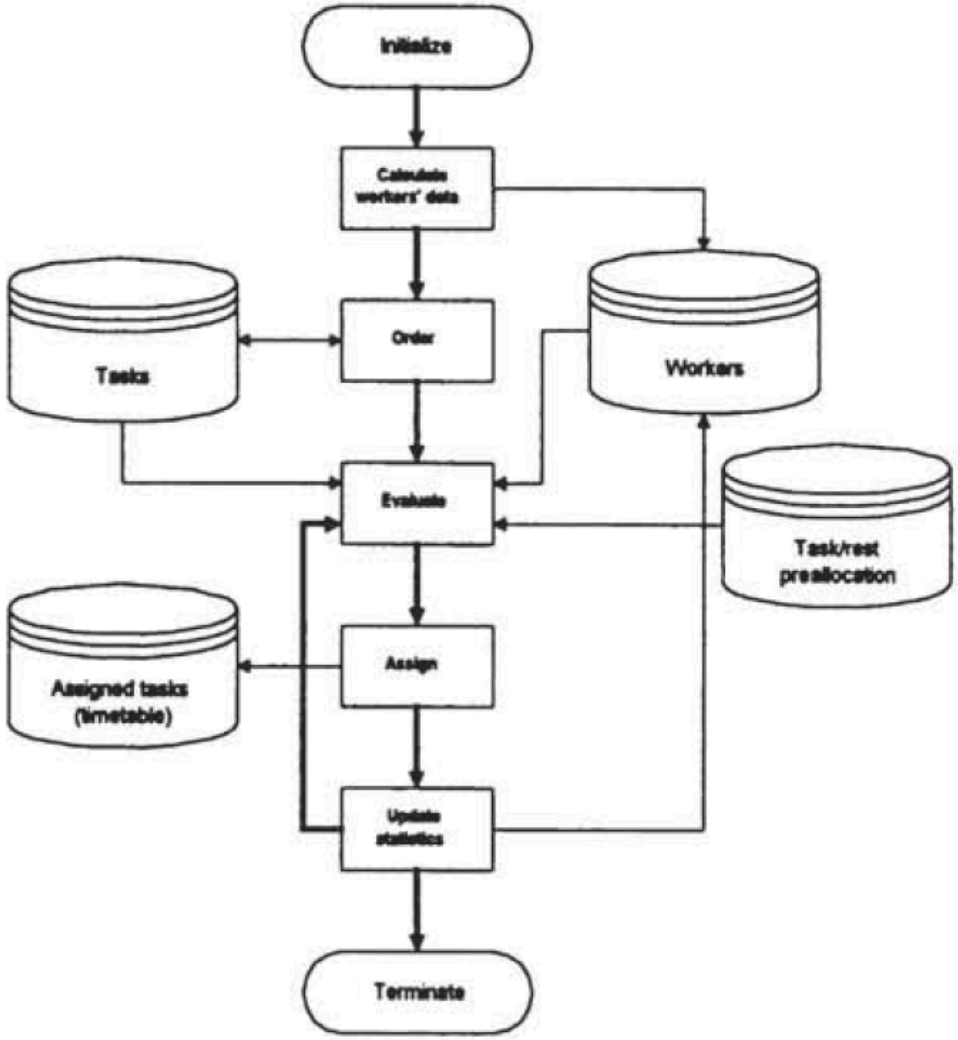
(Fuzzy+Inverter) Air conditioning

Fonte: arquivo Rodrigo Almeida Gonçalves

Rodrigo Almeida Gonçalves, Turma 1990(94) EC-FEEC


1997
MCI 02
2010

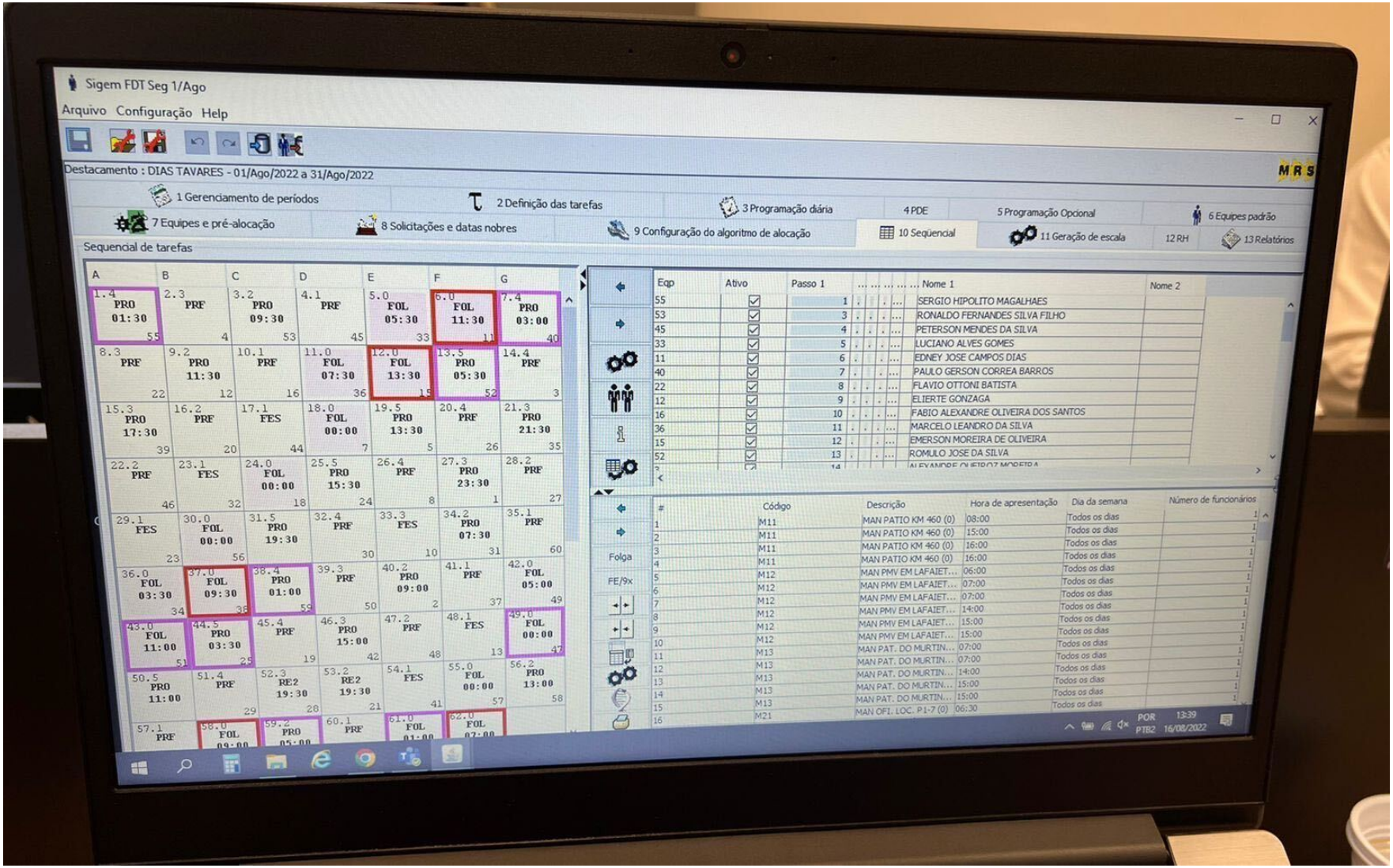
Railroad crew scheduling



Direct allocation algorithm

Proc. IFAC Control in Transportation Systems, Braunschweig, June 2000

MRS operando desde 2000


Sigem FDT Seg 1/Ago
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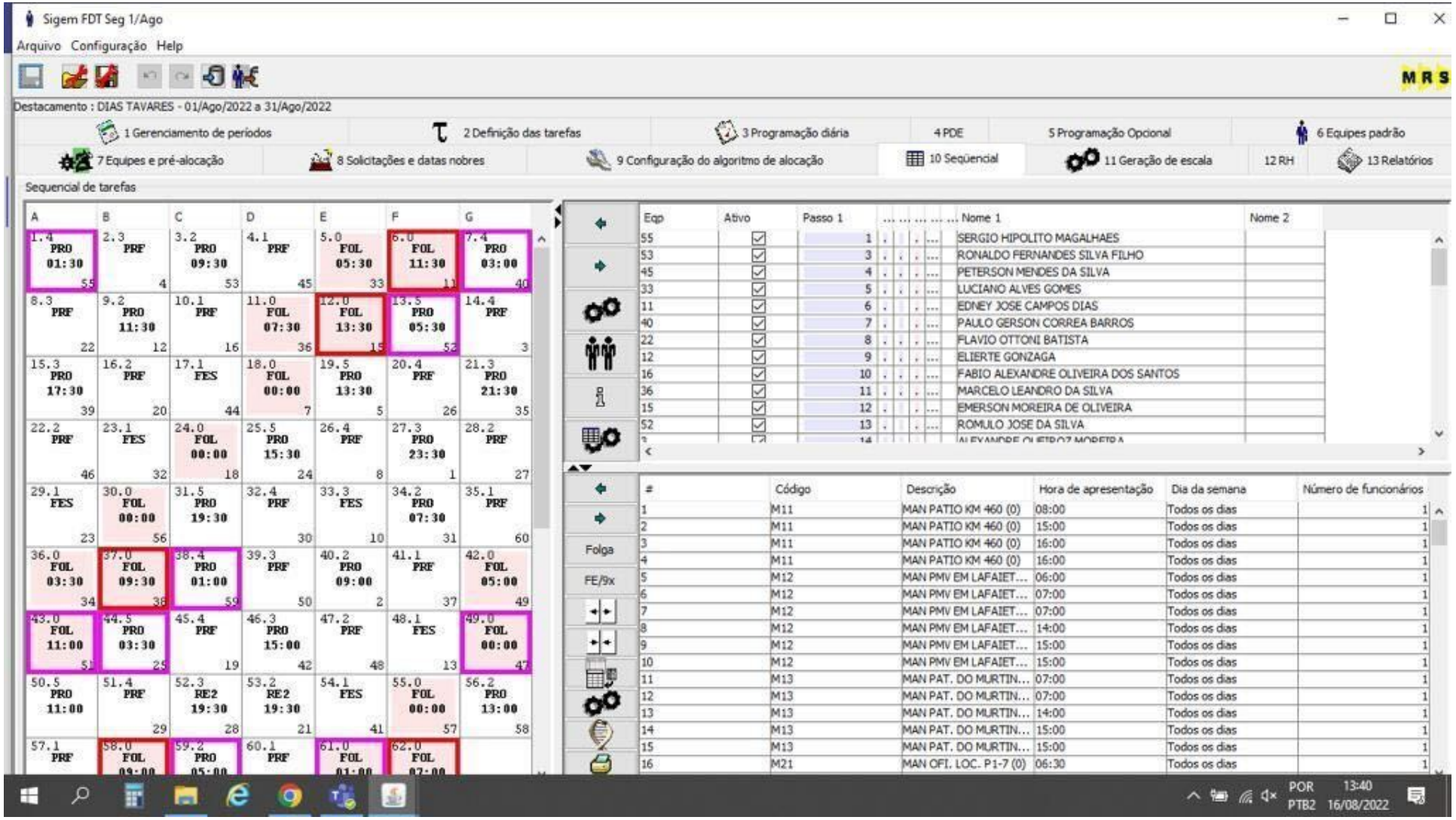
Destacamento : DIAS TAVARES - 01/Ago/2022 a 31/Ago/2022
1 Gerenciamento de períodos
2 Definição das tarefas
3 Programação diária
4 PDE
5 Programação Opcional
6 Equipes padrão
7 Equipes e pré-alocação
8 Solicitações e datas nobres
9 Configuração do algoritmo de alocação
10 Seqüencial
11 Geração de escala
12 RH
13 Relatórios
Sequencial de tarefas
Eqp
Ativo
Passo 1
Nome 1
Nome 2
55 SERGIO HIPOLITO MAGALHAES
53 RONALDO FERNANDES SILVA FILHO
45 PETERSON MENDES DA SILVA
33 LUCIANO ALVES GOMES
11 EDNEY JOSE CAMPOS DIAS
40 PAULO GERSON CORREA BARROS
22 FLAVIO OTTONI BATISTA
12 ELIERTE GONZAGA
16 FABIO ALEXANDRE OLIVEIRA DOS SANTOS
36 MARCELO LEANDRO DA SILVA
15 EMERSON MOREIRA DE OLIVEIRA
52 ROMULO JOSE DA SILVA
Folga
FE/9x
Código
Descrição
Hora de apresentação
Dia da semana
Número de funcionários
M11 MAN PATIO KM 460 (0) 08:00 Todos os dias
M11 MAN PATIO KM 460 (0) 15:00 Todos os dias
M11 MAN PATIO KM 460 (0) 16:00 Todos os dias
M11 MAN PATIO KM 460 (0) 16:00 Todos os dias
M12 MAN PMV EM LAFAIET... 06:00 Todos os dias
M12 MAN PMV EM LAFAIET... 07:00 Todos os dias
M12 MAN PMV EM LAFAIET... 07:00 Todos os dias
M12 MAN PMV EM LAFAIET... 14:00 Todos os dias
M12 MAN PMV EM LAFAIET... 15:00 Todos os dias
M12 MAN PMV EM LAFAIET... 15:00 Todos os dias
M13 MAN PAT. DO MURTIN... 07:00 Todos os dias
M13 MAN PAT. DO MURTIN... 07:00 Todos os dias
M13 MAN PAT. DO MURTIN... 14:00 Todos os dias
M13 MAN PAT. DO MURTIN... 15:00 Todos os dias
M13 MAN PAT. DO MURTIN... 15:00 Todos os dias
M21 MAN OFI. LOC. P1-7 (0) 06:30 Todos os dias
POR PTB2 13:39 16/08/2022


Sigem FDT Seg 1/Ago
Arquivo Configuração Help
MRS
Destacamento : DIAS TAVARES - 01/Ago/2022 a 31/Ago/2022
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Sequencial de tarefas
Folga
FE/9x
Eqp
Ativo
Passo 1
Nome 1
Nome 2
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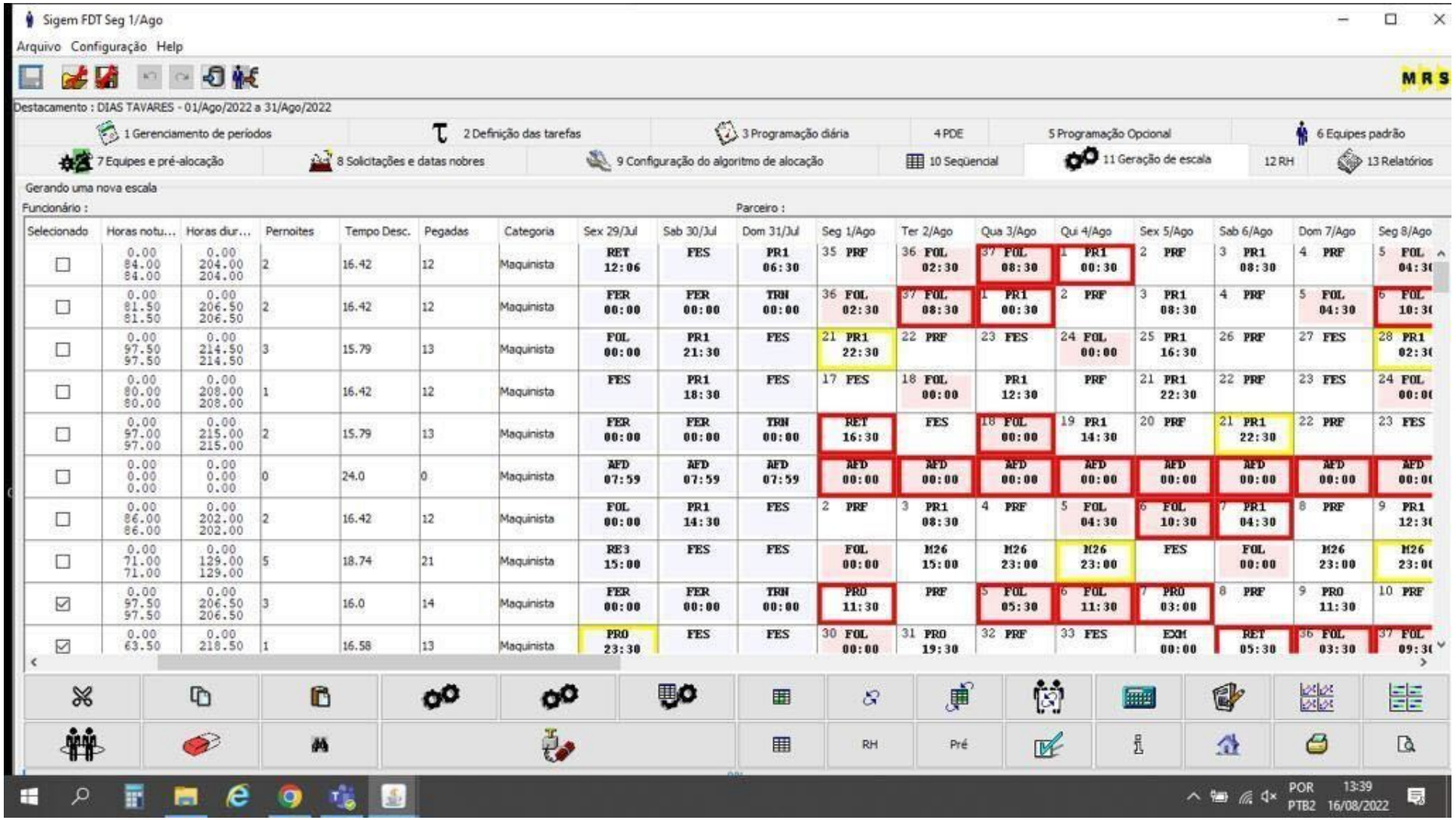
Código Descrição Hora de apresentação Dia da semana Número de funcionários
1 M11 MAN PATIO KM 460 (0) 08:00 Todos os dias 1
2 M11 MAN PATIO KM 460 (0) 15:00 Todos os dias 1
3 M11 MAN PATIO KM 460 (0) 16:00 Todos os dias 1
4 M11 MAN PATIO KM 460 (0) 16:00 Todos os dias 1
5 M12 MAN PMV EM LAFAIET... 06:00 Todos os dias 1
6 M12 MAN PMV EM LAFAIET... 07:00 Todos os dias 1
7 M12 MAN PMV EM LAFAIET... 07:00 Todos os dias 1
8 M12 MAN PMV EM LAFAIET... 14:00 Todos os dias 1
9 M12 MAN PMV EM LAFAIET... 15:00 Todos os dias 1
10 M12 MAN PMV EM LAFAIET... 15:00 Todos os dias 1
11 M13 MAN PAT. DO MURTIN... 07:00 Todos os dias 1
12 M13 MAN PAT. DO MURTIN... 07:00 Todos os dias 1
13 M13 MAN PAT. DO MURTIN... 14:00 Todos os dias 1
14 M13 MAN PAT. DO MURTIN... 15:00 Todos os dias 1
15 M13 MAN PAT. DO MURTIN... 15:00 Todos os dias 1
16 M21 MAN OFI. LOC. P1-7 (0) 06:30 Todos os dias 1
POR PTB2 13:40 16/08/2022


Sigem FDT Seg 1/Ago
Arquivo Configuração Help
MRS
Destacamento : DIAS TAVARES - 01/Ago/2022 a 31/Ago/2022
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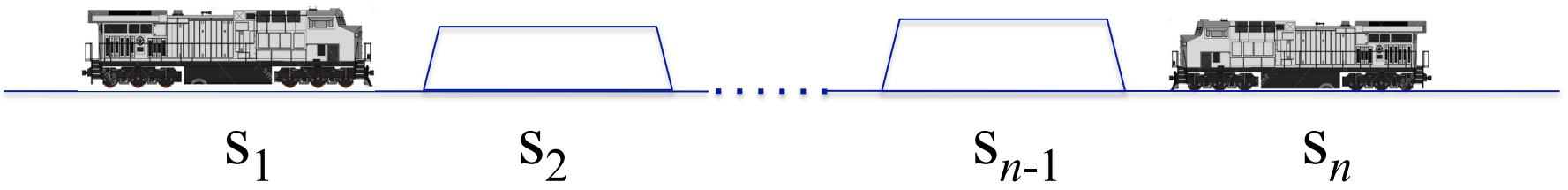
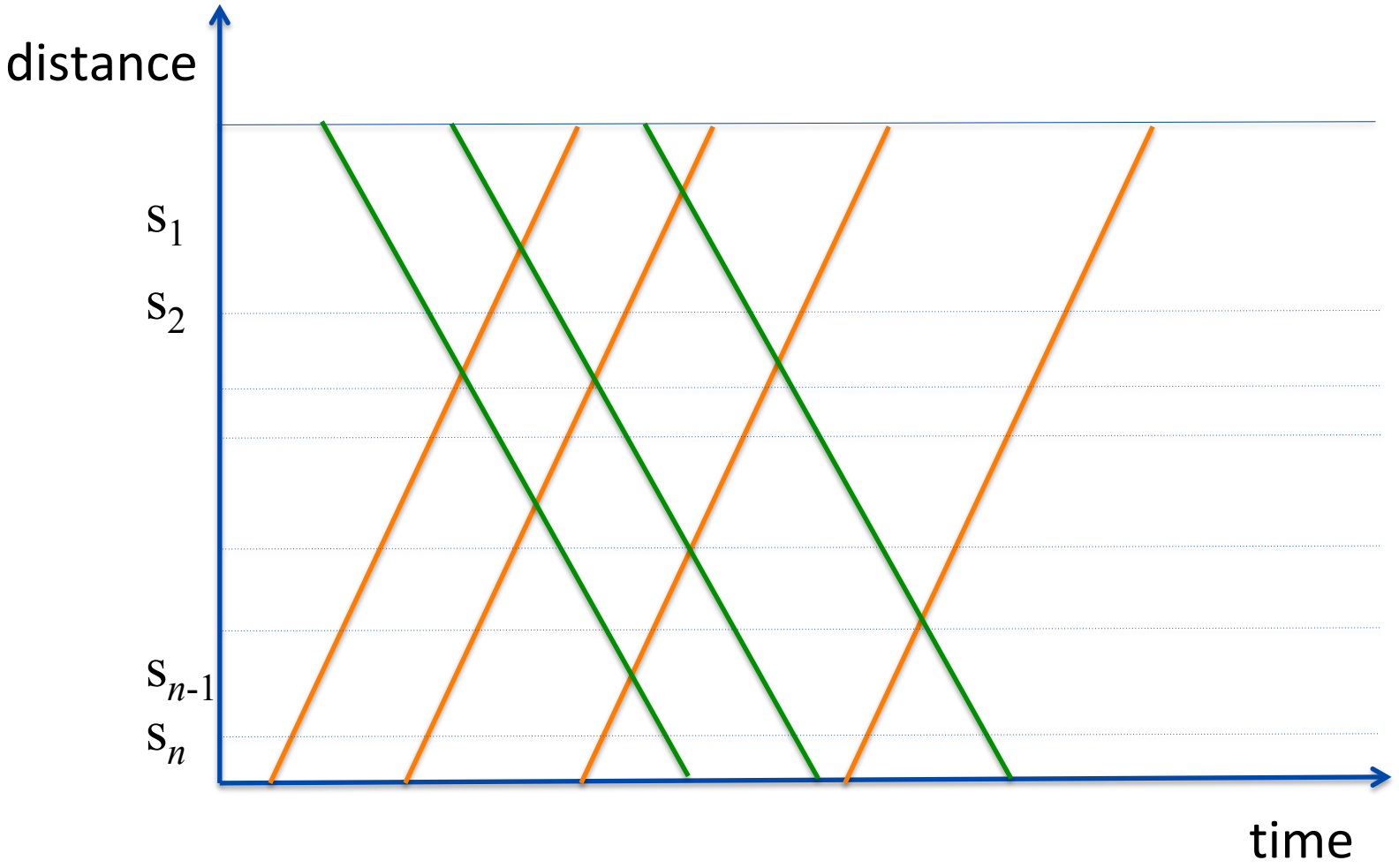
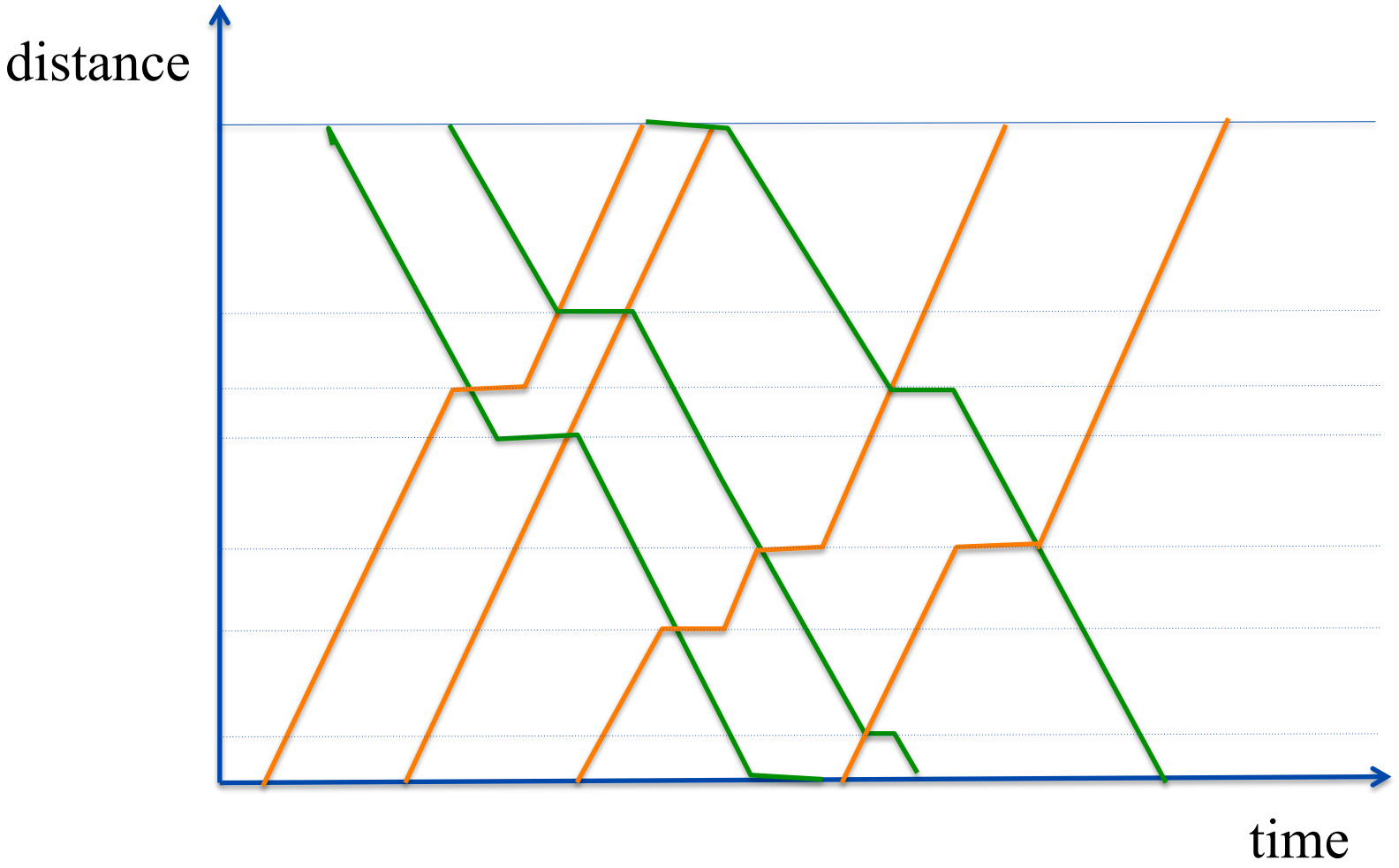
8 Solicitações e datas nobres
9 Configuração do algoritmo de alocação
10 Seqüencial
11 Geração de escala
12 RH
13 Relatórios
Gerando uma nova escala
Funcionário :
Parceiro :
Selecionado | Horas notu... | Horas diur... | Pernoites | Tempo Desc. | Pegadas | Categoria | Sex 29/Jul | Sab 30/Jul | Dom 31/Jul | Seg 1/Ago | Ter 2/Ago | Qua 3/Ago | Qui 4/Ago | Sex 5/Ago | Sab 6/Ago | Dom 7/Ago | Seg 8/Ago
RH
Pré
POR
PTB2
13:39
16/08/2022

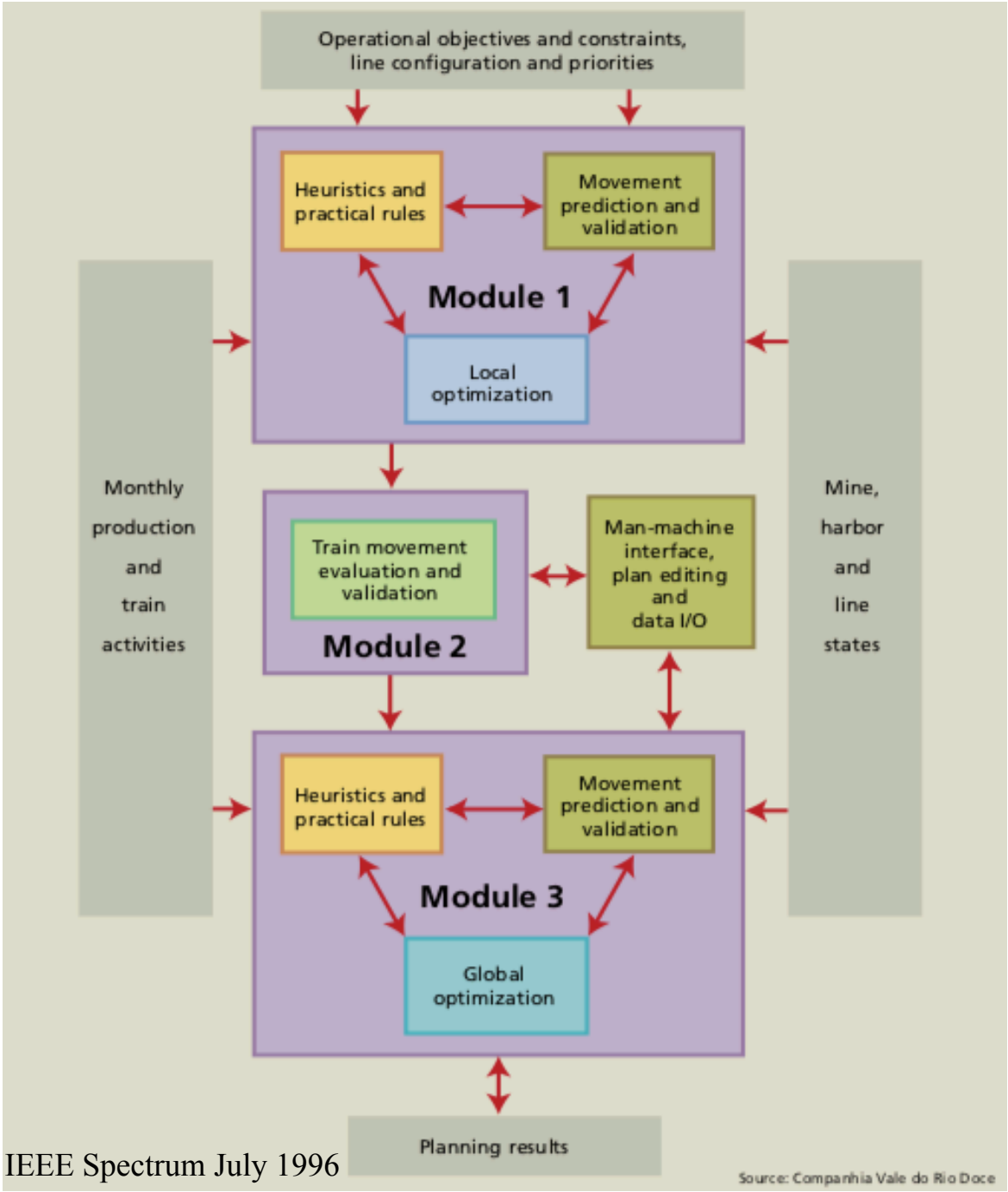
Rodrigo Gonçalves, FEEC, Unicamp, BS 1994, MS 1997, PhD 2000. Currently CTO at Nitryx Progress Rail applying advanced analytics, optimization, AI, DSS and technology driven driven innovation.

Real-time train scheduling

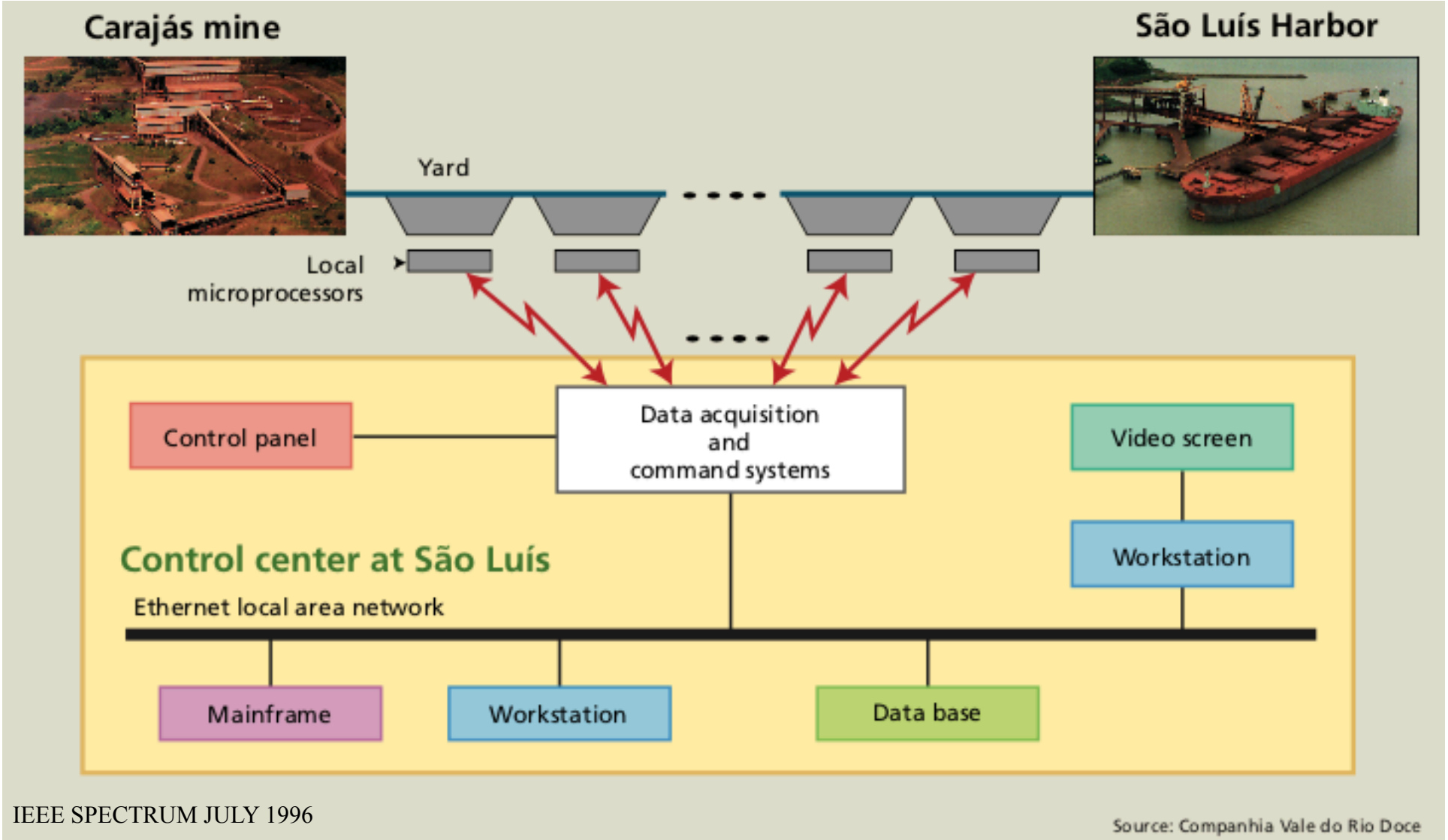

S_1
S_2
S_{n-1}
S_n


distance
s_1
s_2
s_{n-1}
s_n
time


distance
time



IEEE Spectrum July 1996



IEEE SPECTRUM JULY 1996

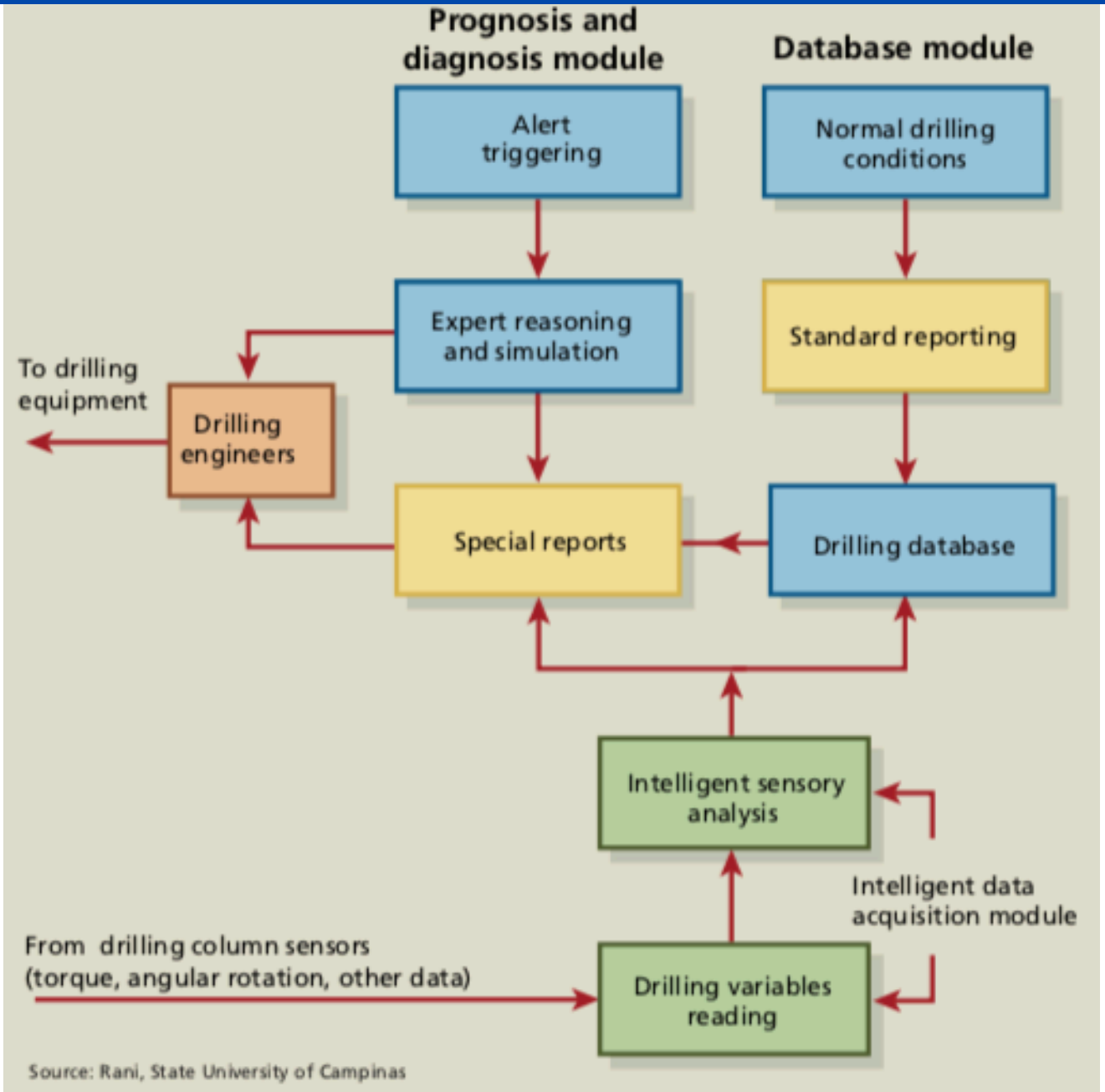
15% increase daily ore volume transportation

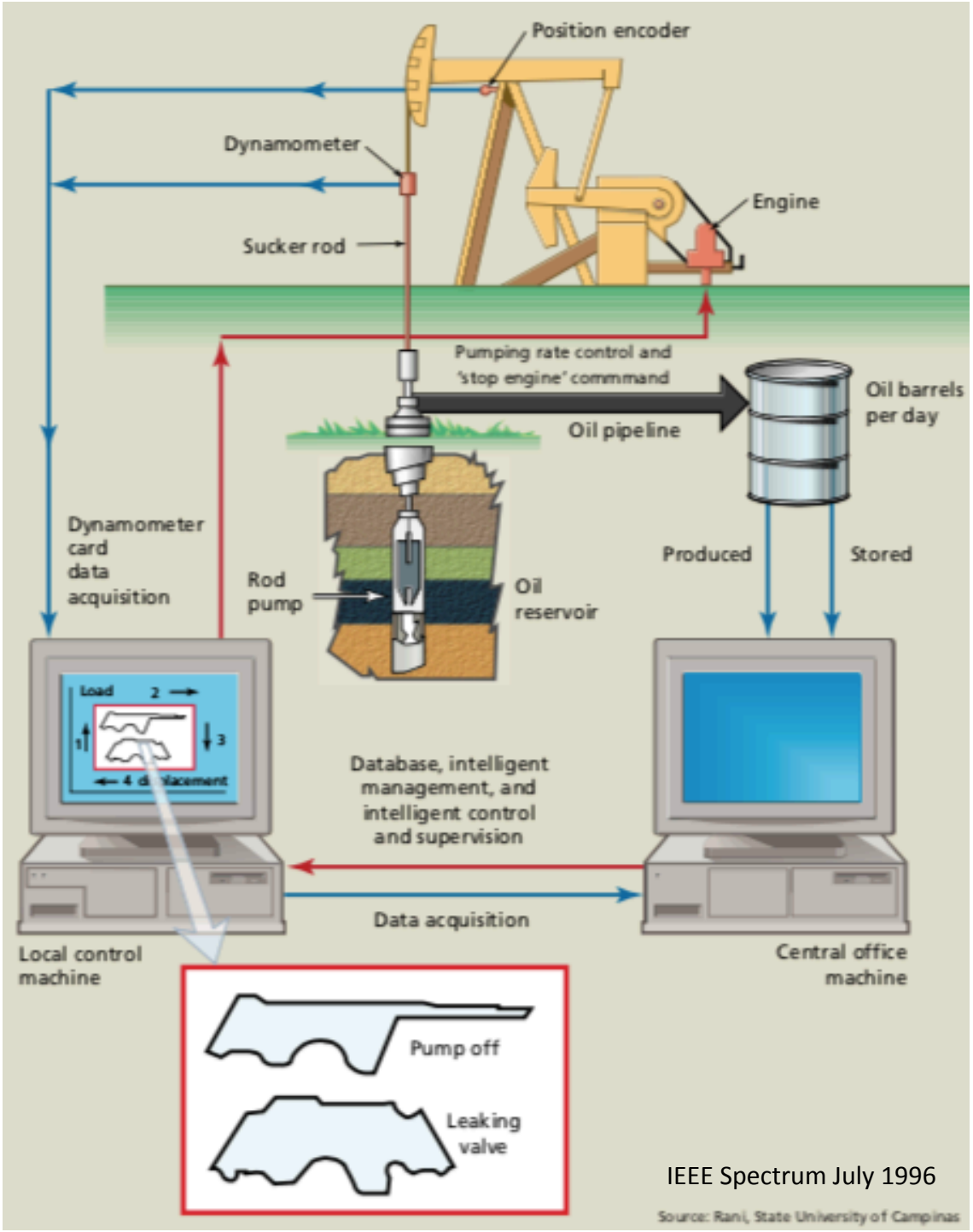
1.6 litters fuel/1000 metric tons ore transported

Helpers maneuvers speed-up on steep ramps

Real-time operation started end of 1995

Smart oil recovery

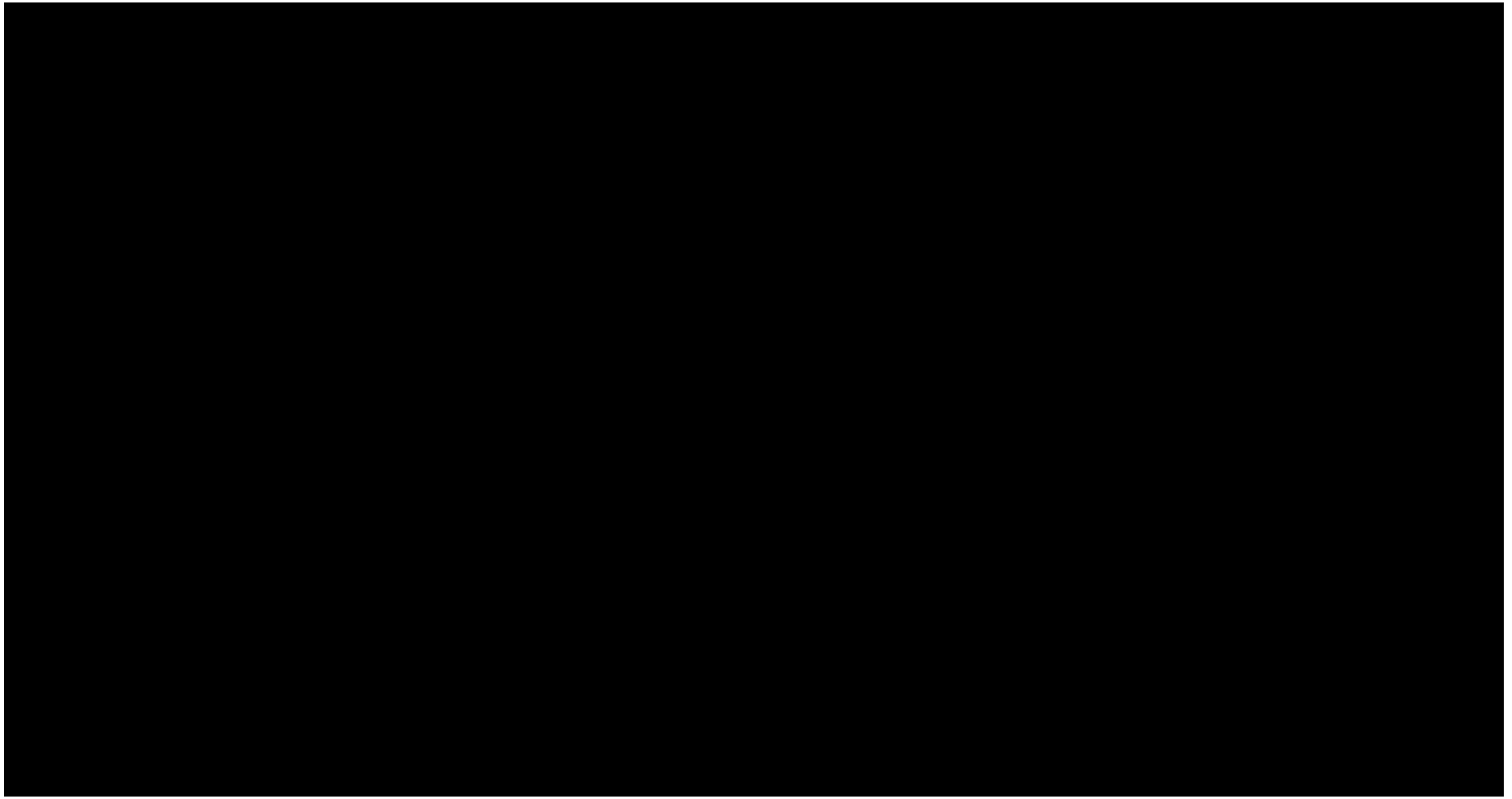


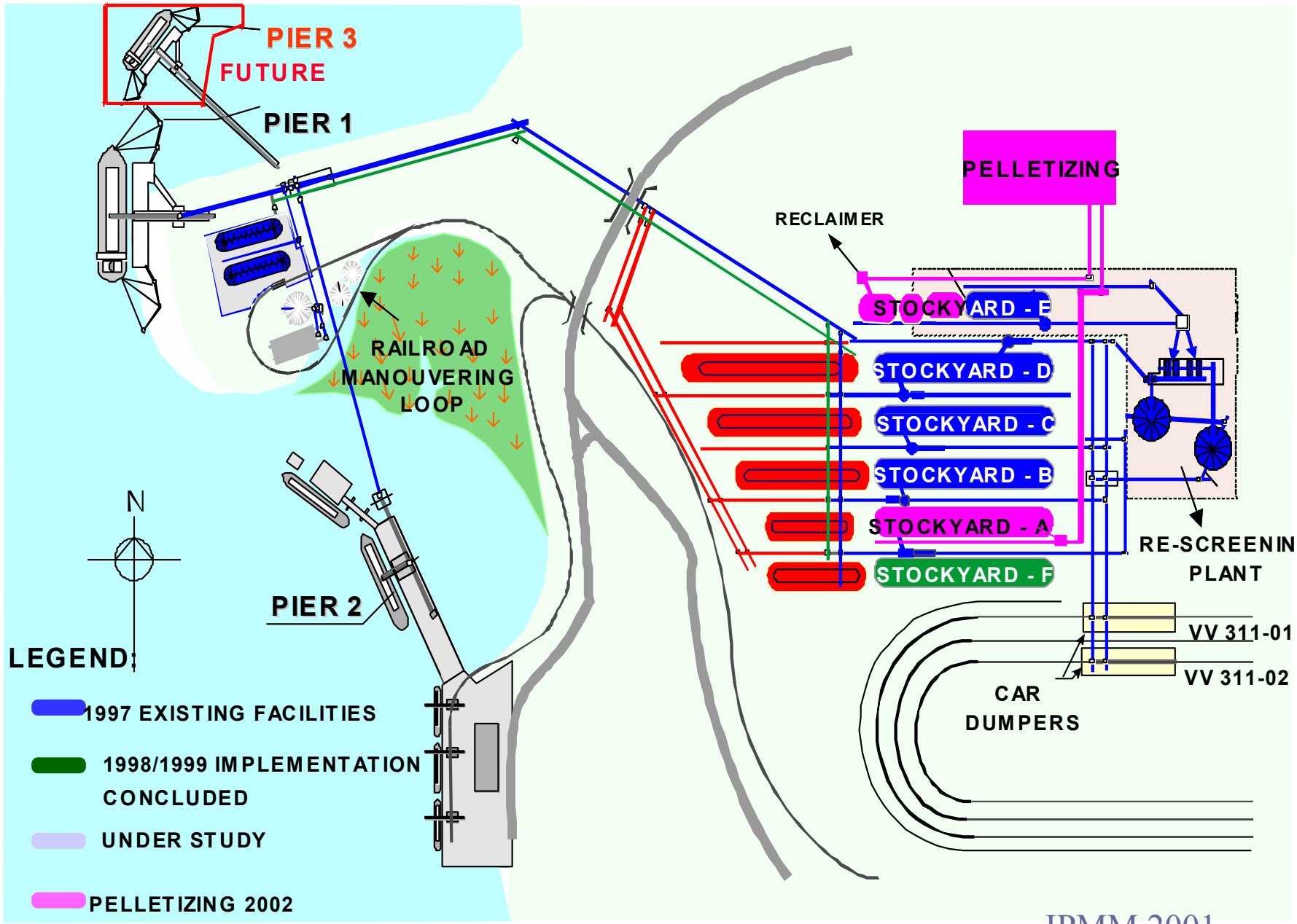


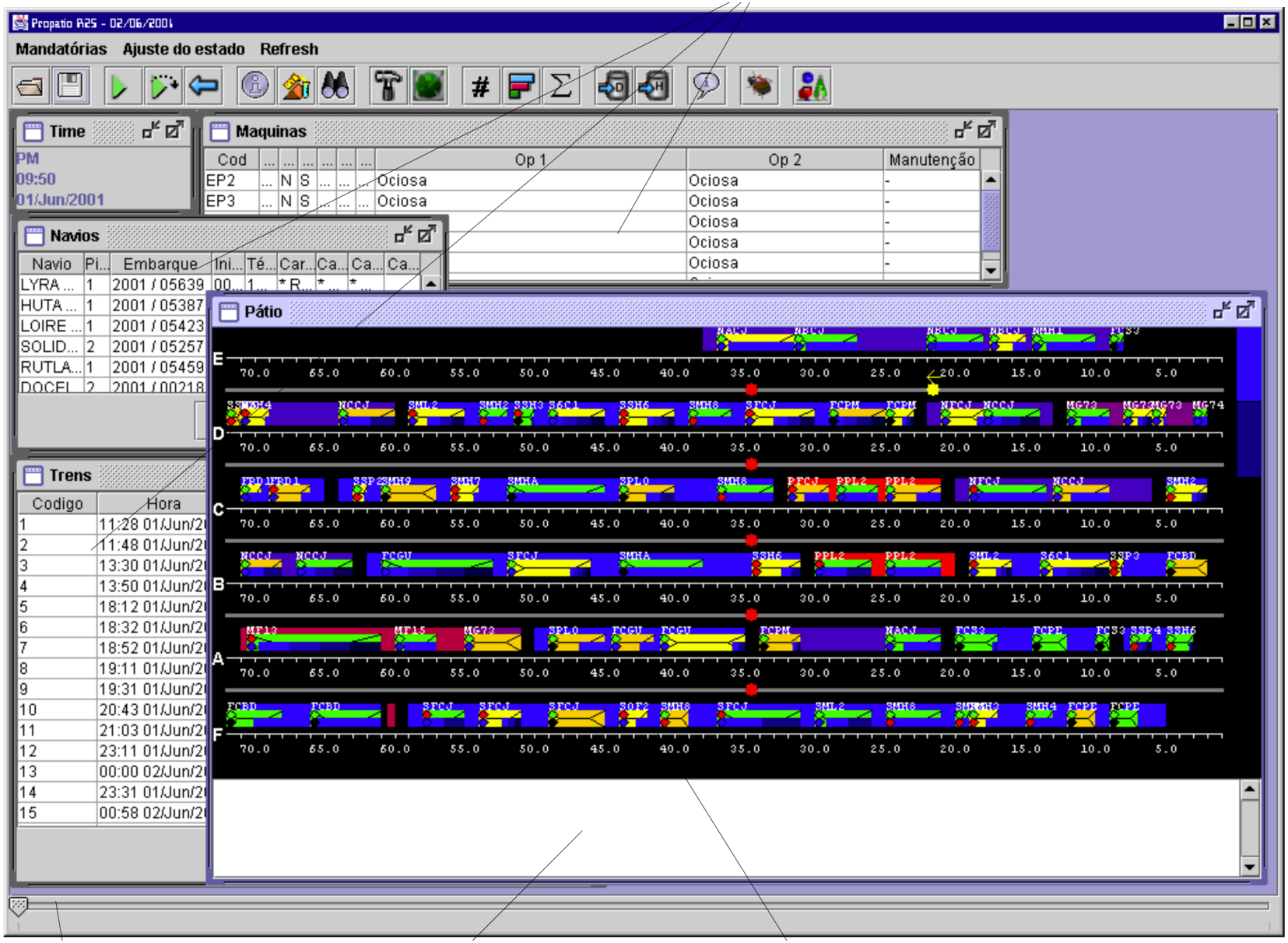
IEEE Spectrum July 1996

Stockpiling in iron ore shipping yard


Empilhamento
Recuperação

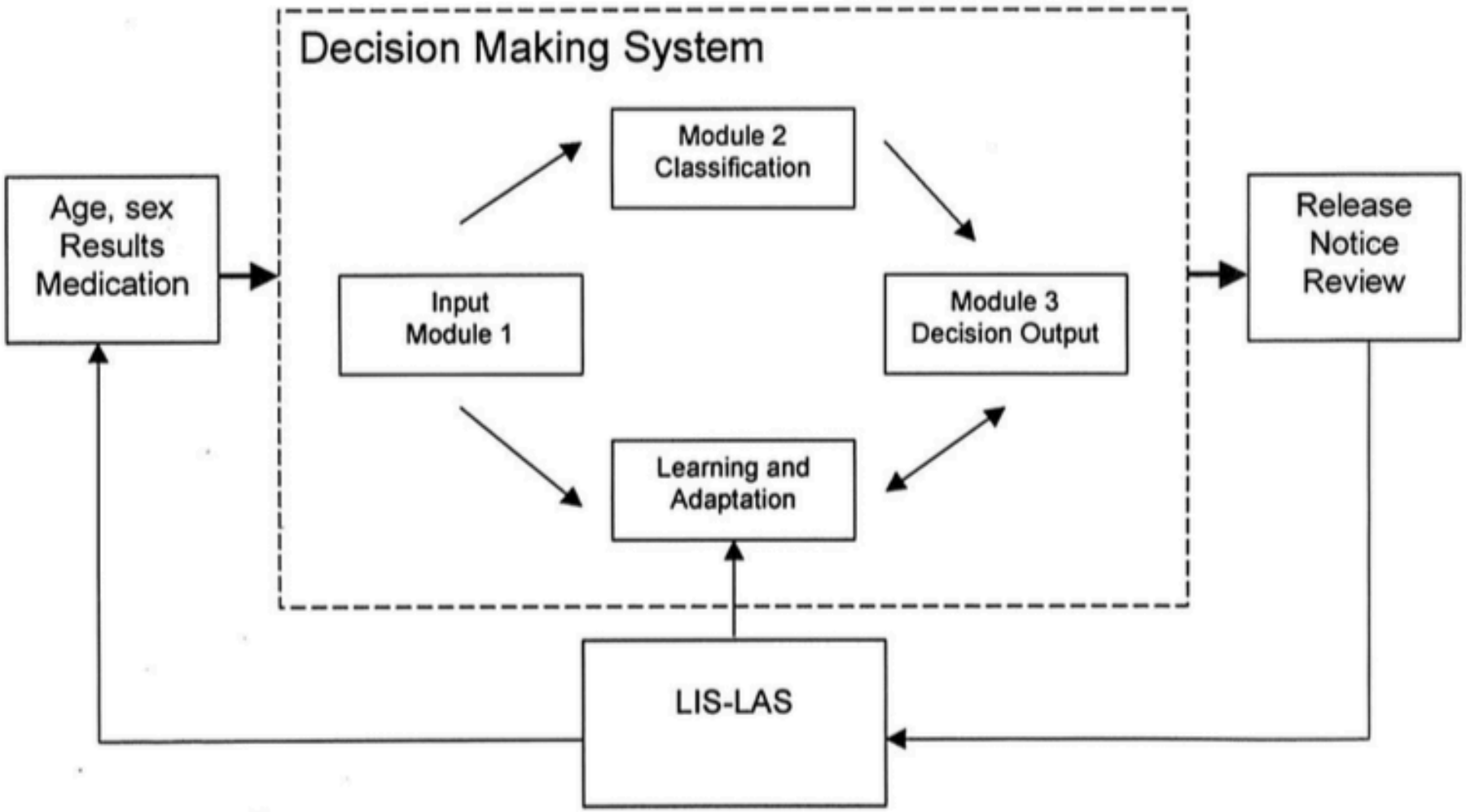



PIER 3
FUTURE
PIER 1
PELLETIZING
RECLAIMER
STOCKYARD - E
STOCKYARD - D
STOCKYARD - C
STOCKYARD - B
STOCKYARD - A
STOCKYARD - F
RAILROAD
MANOUVERING
LOOP
RE-SCREENING
PLANT
VV 311-01
VV 311-02
CAR
DUMPERS
PIER 2
N
LEGEND:
1997 EXISTING FACILITIES
1998/1999 IMPLEMENTATION
CONCLUDED
UNDER STUDY
PELLETIZING 2002

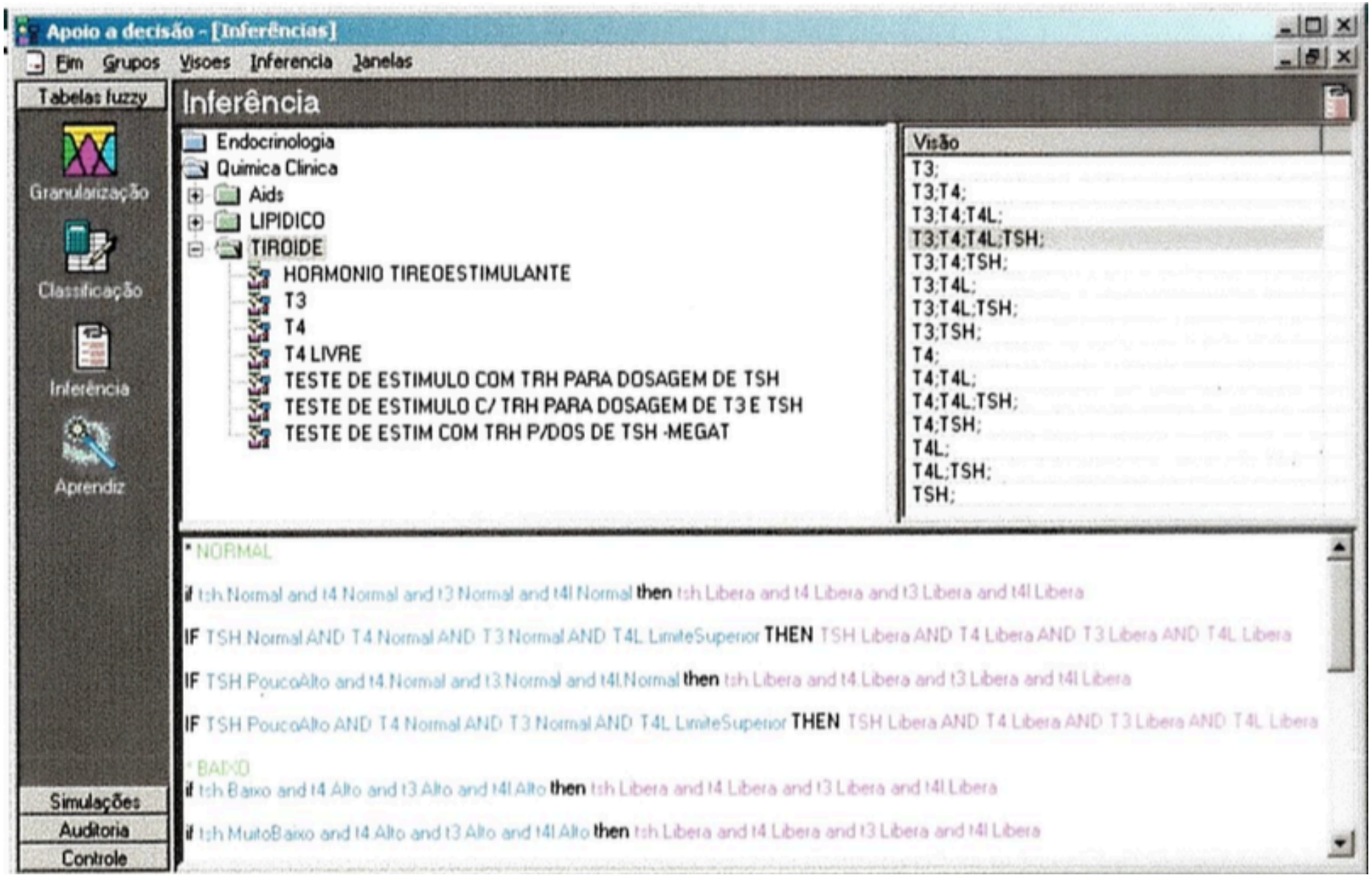

Propatio A25 - 02/06/2001
Mandatórias
Ajuste do estado
Refresh
Time
PM
09:50
01/Jun/2001
Maquinas
Cod
Op 1
Op 2
Manutenção
EP2
EP3
Ociosa
Navios
Navio
Pi...
Embarque
Trens
Codigo
Hora
Pátio
E
D
C
B
A
F

Paulo Molck, Turma 1995 EC-FEEC, MS 2001

Thyroid hormone profiling



Proc. IFSA/NAFIPS 2001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Fim Grupos Visoes Inferencia Janelas
Tabelas fuzzy
Granularização
Classificação
Inferência
Aprendiz
Simulações
Auditoria
Controle
Inferência
Endocrinologia
Quimica Clinica
Aids
LIPIDICO
TIROIDE
HORMONIO TIREOESTIMULANTE
T3
T4
T4 LIVRE
TESTE DE ESTIMULO COM TRH PARA DOSAGEM DE TSH
TESTE DE ESTIMULO C/ TRH PARA DOSAGEM DE T3 E TSH
TESTE DE ESTIM COM TRH P/DOS DE TSH -MEGAT
Visão
T3;
T3;T4;
T3;T4;T4L;
T3;T4;T4L;TSH;
T3;T4;TSH;
T3;T4L;
T3;T4L;TSH;
T3;TSH;
T4;
T4;T4L;
T4;T4L;TSH;
T4;TSH;
T4L;
T4L;TSH;
TSH;
* NORMAL
if tsh Normal and t4 Normal and t3 Normal and t4l Normal then tsh Libera and t4 Libera and t3 Libera and t4l Libera
IF TSH Normal AND T4 Normal AND T3 Normal AND T4L LimiteSuperior THEN TSH Libera AND T4 Libera AND T3 Libera AND T4L Libera
IF TSH PoucoAlto and t4 Normal and t3 Normal and t4l Normal then tsh Libera and t4 Libera and t3 Libera and t4l Libera
IF TSH PoucoAlto AND T4 Normal AND T3 Normal AND T4L LimiteSuperior THEN TSH Libera AND T4 Libera AND T3 Libera AND T4L Libera
* BAIXO
if tsh Baixo and t4 Alto and t3 Alto and t4l Alto then tsh Libera and t4 Libera and t3 Libera and t4l Libera
if tsh MuitoBaixo and t4 Alto and t3 Alto and t4l Alto then tsh Libera and t4 Libera and t3 Libera and t4l Libera

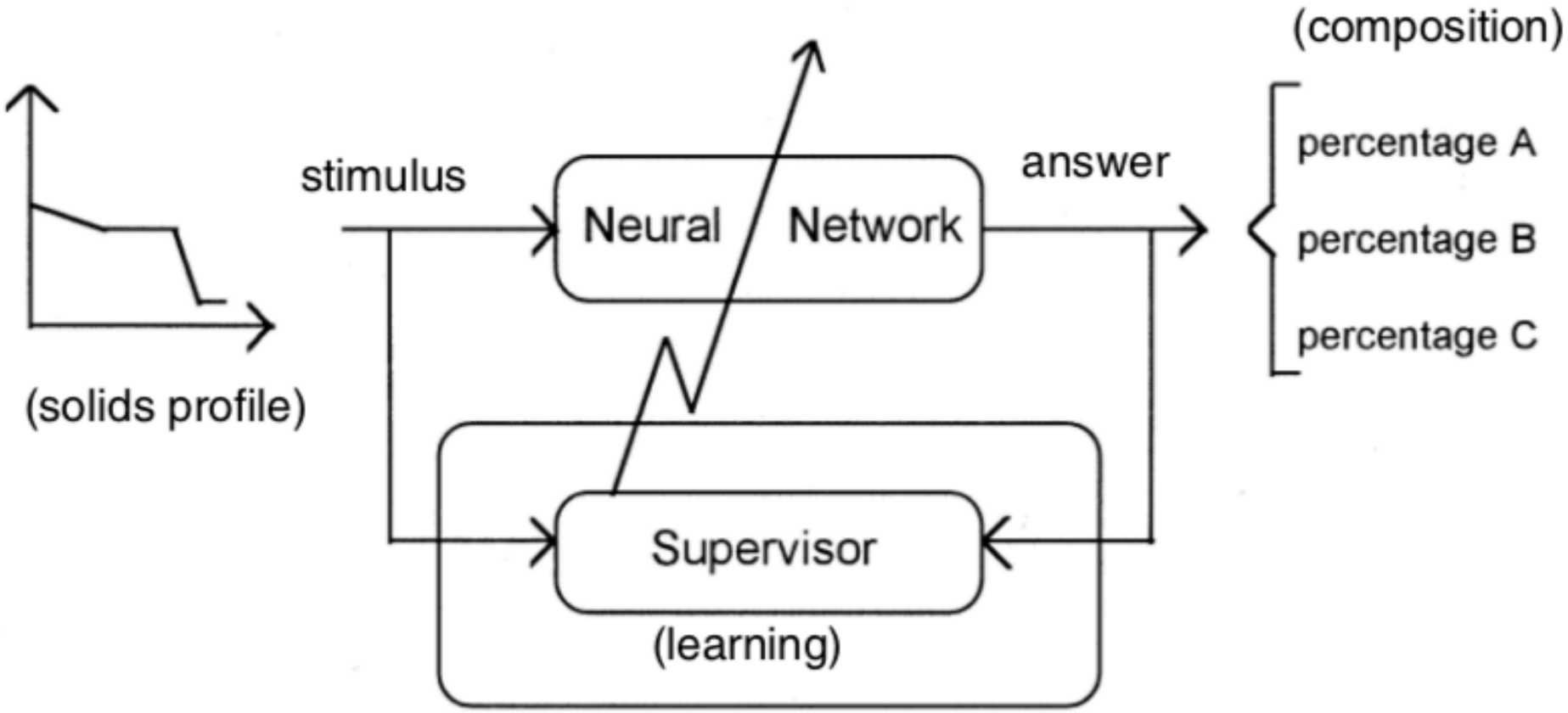
17,500 results reviewed during testing

Disagreements: system judged worth reviewing,
but the expert did not

Real-time operation started on May 2000

341,000 patients results checked

Blending and fat formulation



Journal of the American Oil Chemists' Society, 1997

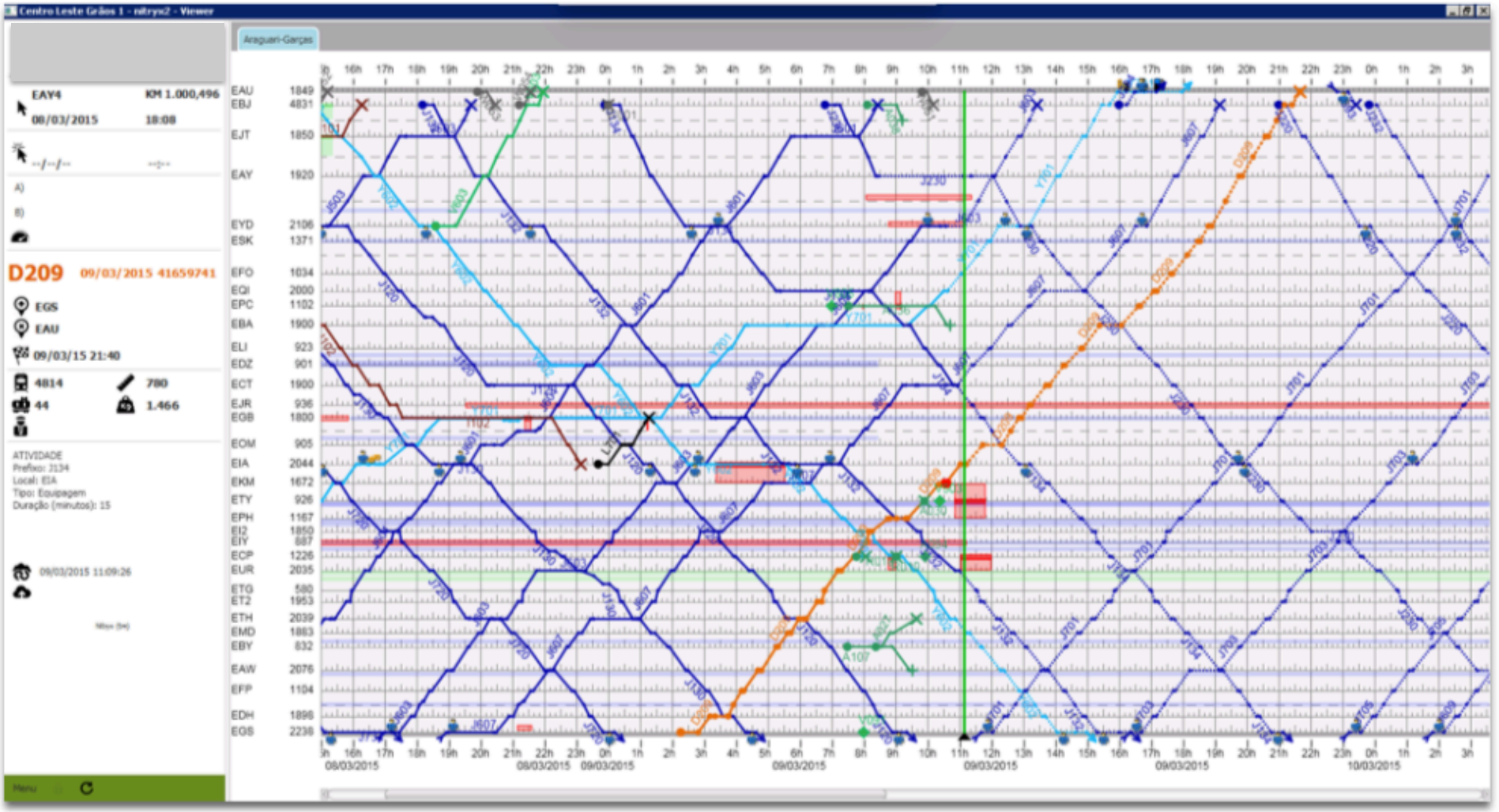
Verification of the Neural Network Formulating Commercial Products

	SFC[a] (%)					
	10°C	20°C	25°C	30°C	35°C	37.5°C
Sample 1						
Required	43.24	24.14	18.52	12.66	5.08	2.83
Network estimate	40.30	24.00	18.50	12.10	4.90	2.90
Experimental	40.66	23.83	18.19	12.35	5.55	2.85
Sample 2						
Required	32.90	19.32	12.60	9.94	4.44	2.52
Network estimate	33.30	19.30	14.60	9.20	3.70	2.10
Experimental	33.64	19.22	14.18	9.19	3.72	2.31
Sample 3						
Required	26.23	17.29	11.82	7.22	3.16	1.23
Network estimate	26.00	15.80	12.20	7.60	3.00	1.70
Experimental	26.04	16.29	12.05	8.09	3.08	1.41
Sample 4						
Required	29.95	14.54	9.87	4.41	0.18	0.00
Network estimate	29.40	14.60	10.20	6.10	2.40	1.40
Experimental	29.94	14.96	10.04	6.18	2.60	1.20
Sample 5						
Required	22.80	14.26	8.98	4.62	1.89	1.38
Network estimate	23.20	12.30	8.80	5.30	2.10	1.20
Experimental	23.71	12.76	8.82	5.20	1.80	0.83
Sample 6						
Required	35.02	22.68	14.51	8.14	3.42	1.85
Network estimate	35.50	19.60	14.60	9.10	3.70	2.10
Experimental	36.22	20.12	14.61	9.30	3.77	2.20
Sample 7						
Required	37.52	22.60	18.23	10.60	4.01	1.98
Network estimate	38.00	22.80	17.60	11.40	4.60	2.70
Experimental	38.56	22.95	17.26	11.25	4.66	2.64
Sample 8						
Required	32.29	20.99	13.32	7.00	3.06	1.65
Network estimate	33.50	17.40	12.60	7.70	3.10	1.80
Experimental	34.27	17.84	12.32	7.74	3.16	1.81

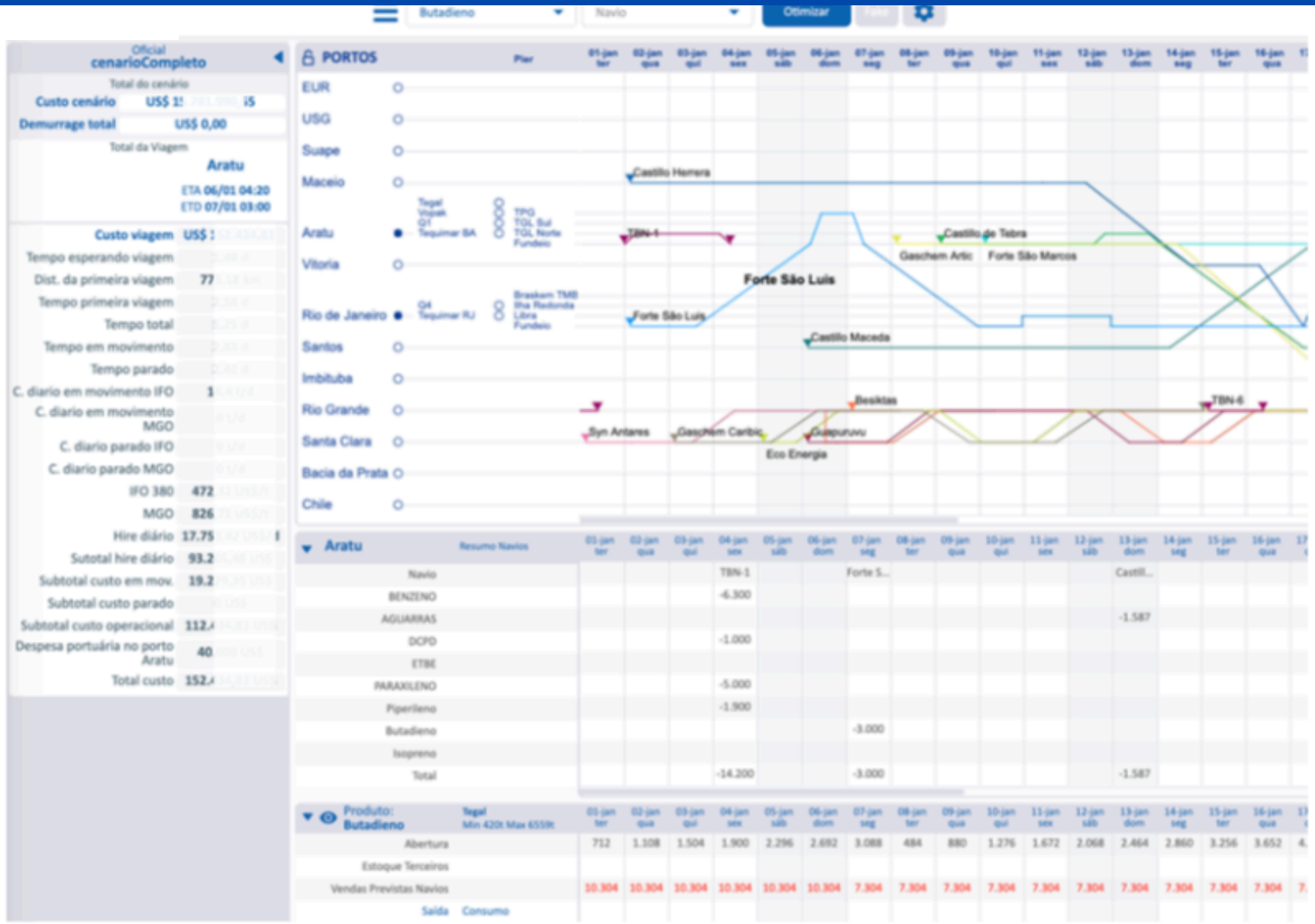
IFSA 1995 São Paulo

Current/future applications

Real-time movement planning



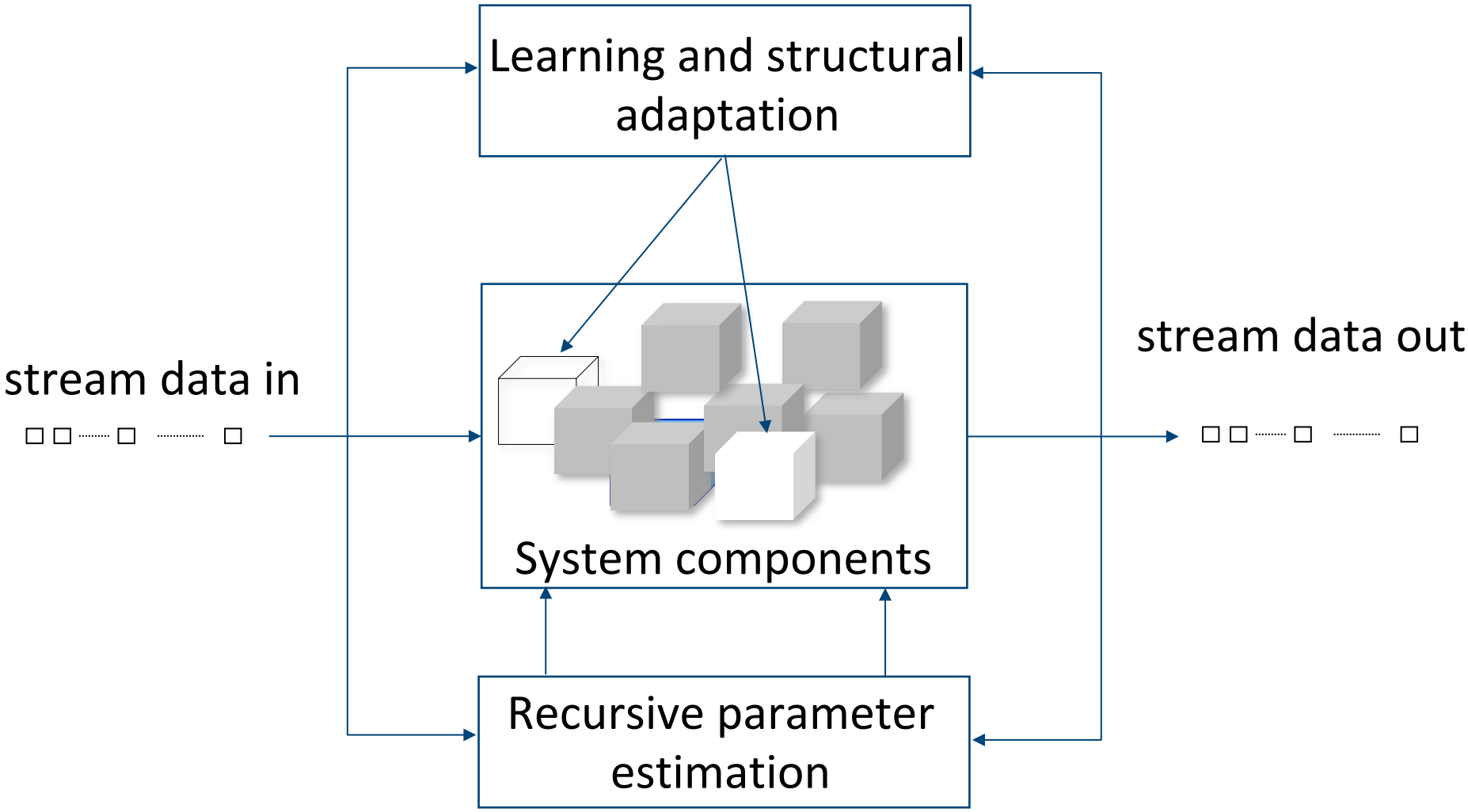
Last mile supply chain



Railroad yard management

Robot-based compact ASRS

Adaptive real-time control



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