From analog to digital computers, and to nanorobots

- KGY CV 1943-1966-2014-????

Looking for Answers to:

WHAT ? WHY ? WHEN ? WHERE ? HOW ?

Results, achievements ??

15th IEEE International Symposium on
Computational Intelligence and Informatics
November 19-21, 2014, CINTI 2014 Budapest, Hungary.

Prof. Dr. Ing. Habil. Prof. Emeritus
George L. KOVÁCS
(George, Gyuri)

~~MTA SZTAKI, Techn. Univ. Budapest,~~ Univ. of Pécs

Fifty Years of USING Computers in Engineering and Manufacturing

Fifty Years USING Computers for AI in Egineering, Manufacturing, Robots – Nanorobots

Now We are Six

When I was one,
I had just begun.
When I was two,
I was nearly new.
When I was three,
I was hardly me.
When I was four,
I was not much more.
When I was five,
I was just alive.
But now I am six,
I'm as clever as clever.
So I think I'll be six
now and forever.

Author: A. A. Milne.

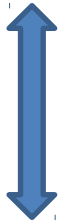
Now I am Seventy

When I was twenty,
I was almost ready.
When I was thirty,
I was coding stead'ly.
When I was forty,
I was at BMW.
When I was fifty,
I headed the party.
When I was sixty,
I Professored plenty.
But now I am seventy,
Am I useless for every' ?
So I think I'll be seventy
now and forever.

Author: G.L.

How ?

- TEAM-work and/or
- Individual work



Depends on position (young, older, old)
and on ambitions

- However the Tasks call for TEAM

Due to

  - The amount of work to do
  - The interdisciplinary character

R:SOME RESULTS without knowing the proper names

(AI graph search, FMS, CNC) **UZSOKY Miklós**

USA
Russia
German
y
Mexico
Italy

Long-term visit
Seminar

Short visit

WHEN ?

1966 - 2014

WHERE ?

CV KGY TOPICS - WHAT ?

- Analog Computers – Digital Computers
- Diploma in EE – Solartron – Quality measurements
- Stepping motors control (patent)
- CAD/CAM/CIM - (digital) electronics, graph search
- Equipment (ADMAP, BARE-TEST, TESTOMAT, TTL-TEST, etc.)
- CAD/CAM/CIM/FMS/FMC/Simulation/Scheduling – Mech. Eng.
- Intelligent design, implementation, control
- Film Saver (DIMORF) Lúdas Matyi (1949) (patent)
- EU Projects, virtual enterprizes, PLCM, re-use, re-cycling
- Paks NPP AI system application at the 400/120 kV Substation
- ***TYPUS metrics, KUT model*** ecology

CV – KGY – Activities – HOW ?

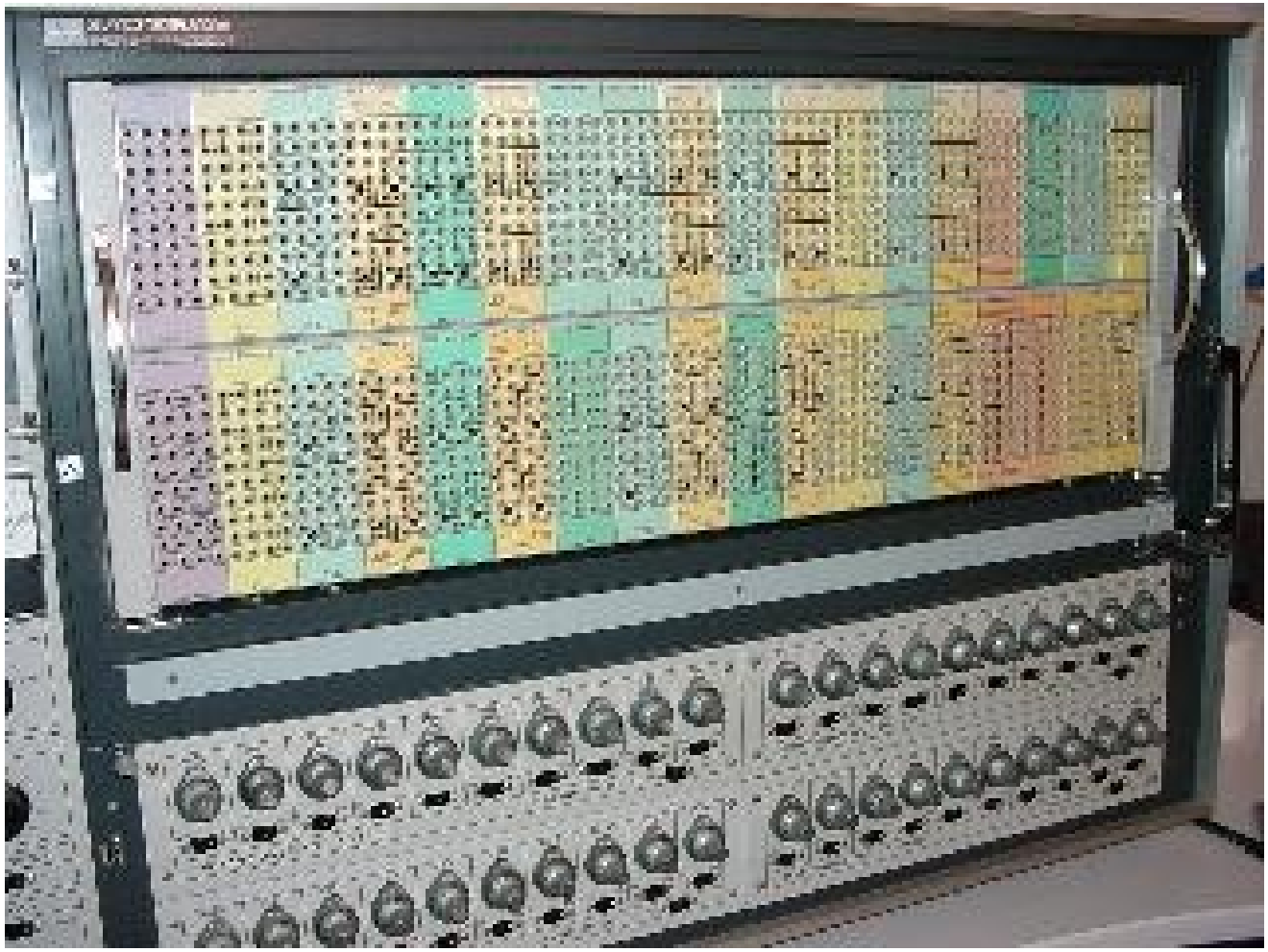
- HARD WORK, still finding fun
- R&D -- Hardware - Software
- Publications
- Conferences
- Teaching, Travelling, Learning Languages
- Promotions , Heading Dept., Lab.
- Bilateral and Multilateral Co-operations
- Project Proposals - Projects
- National and International Committees

- Family, Hobbies

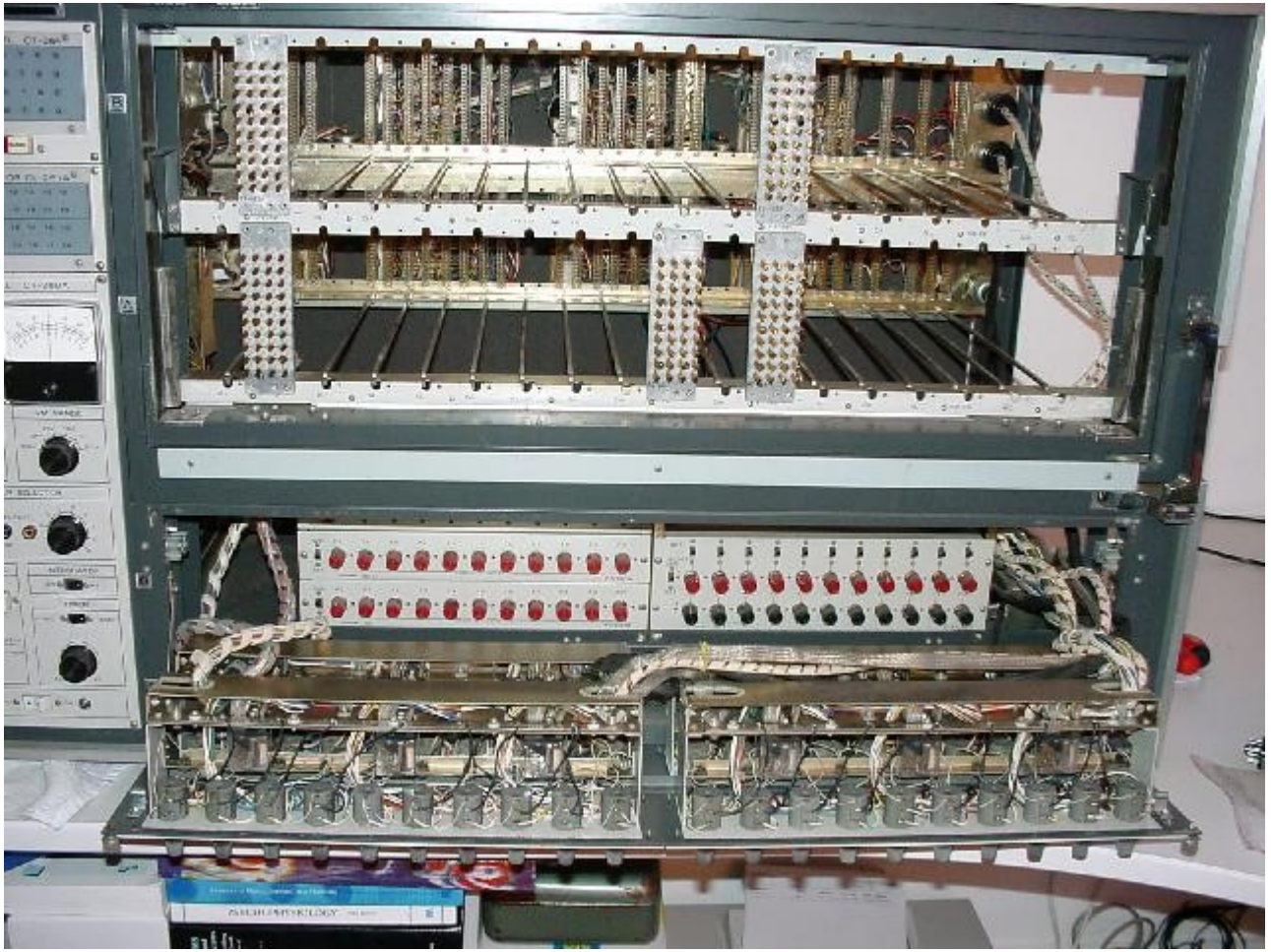
- Retirement

WHY ?

Analog computer programing panel SOLARTRON



SOLARTRON

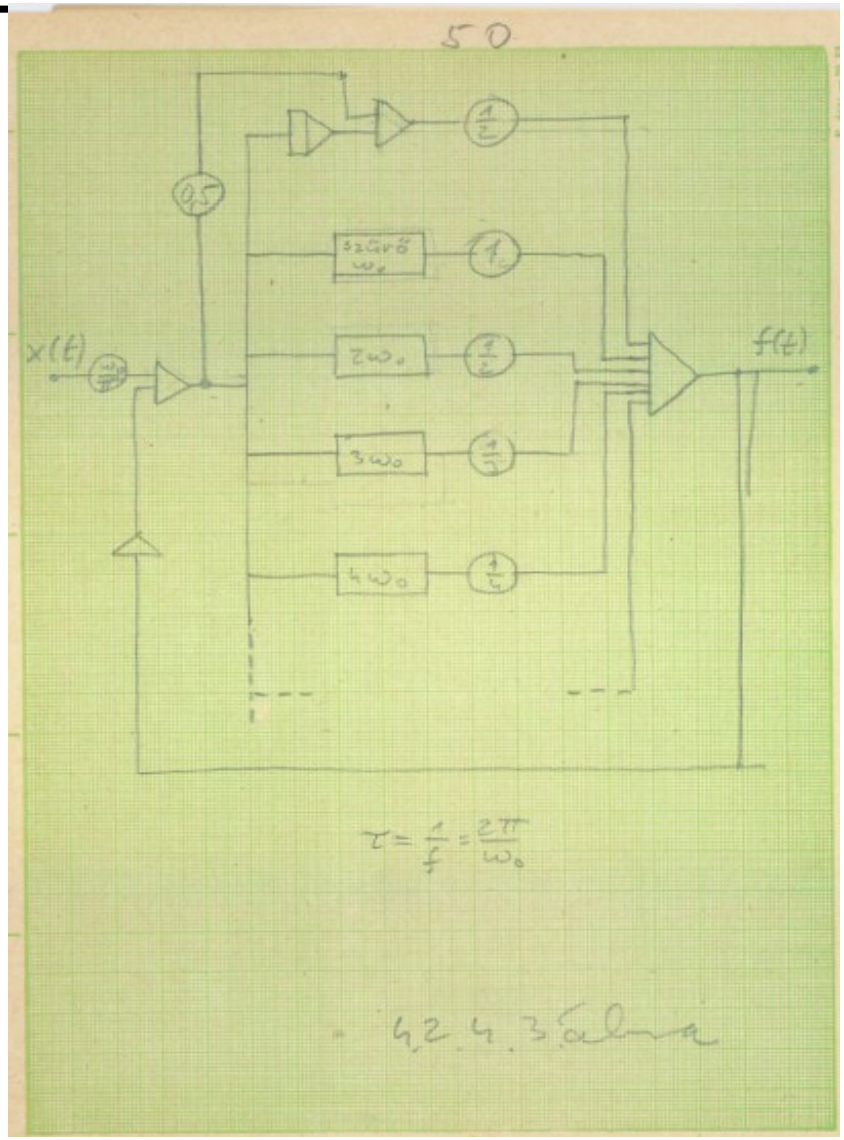


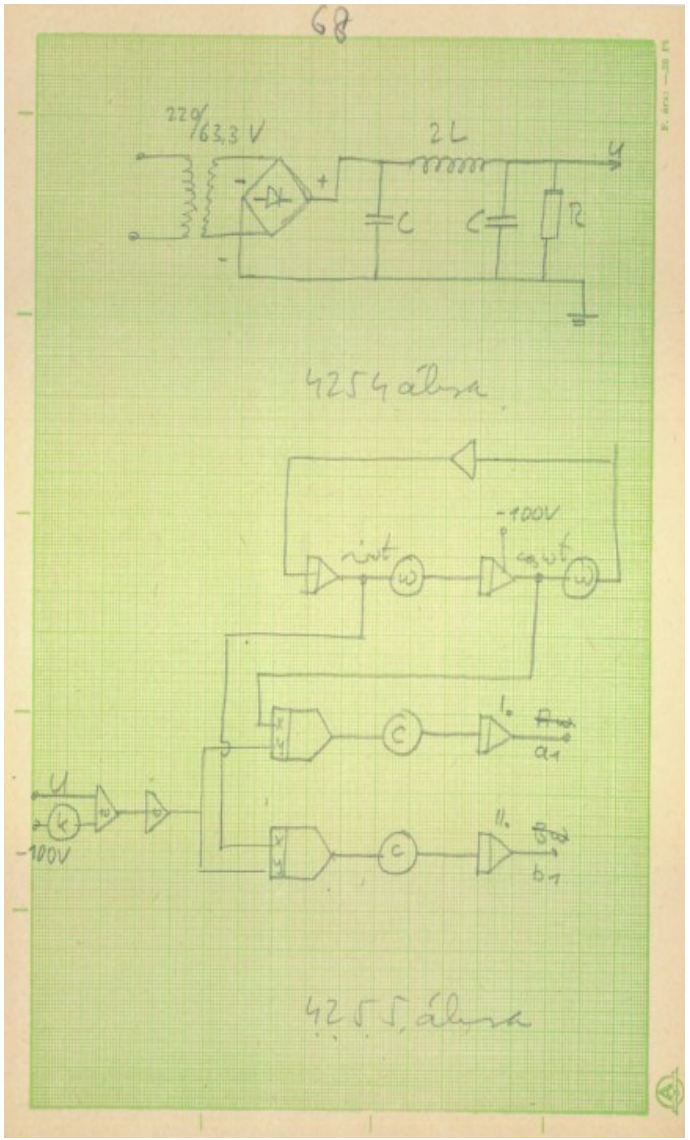
SOLARTRON

Quality control of 400/220 V network voltage

1966-67

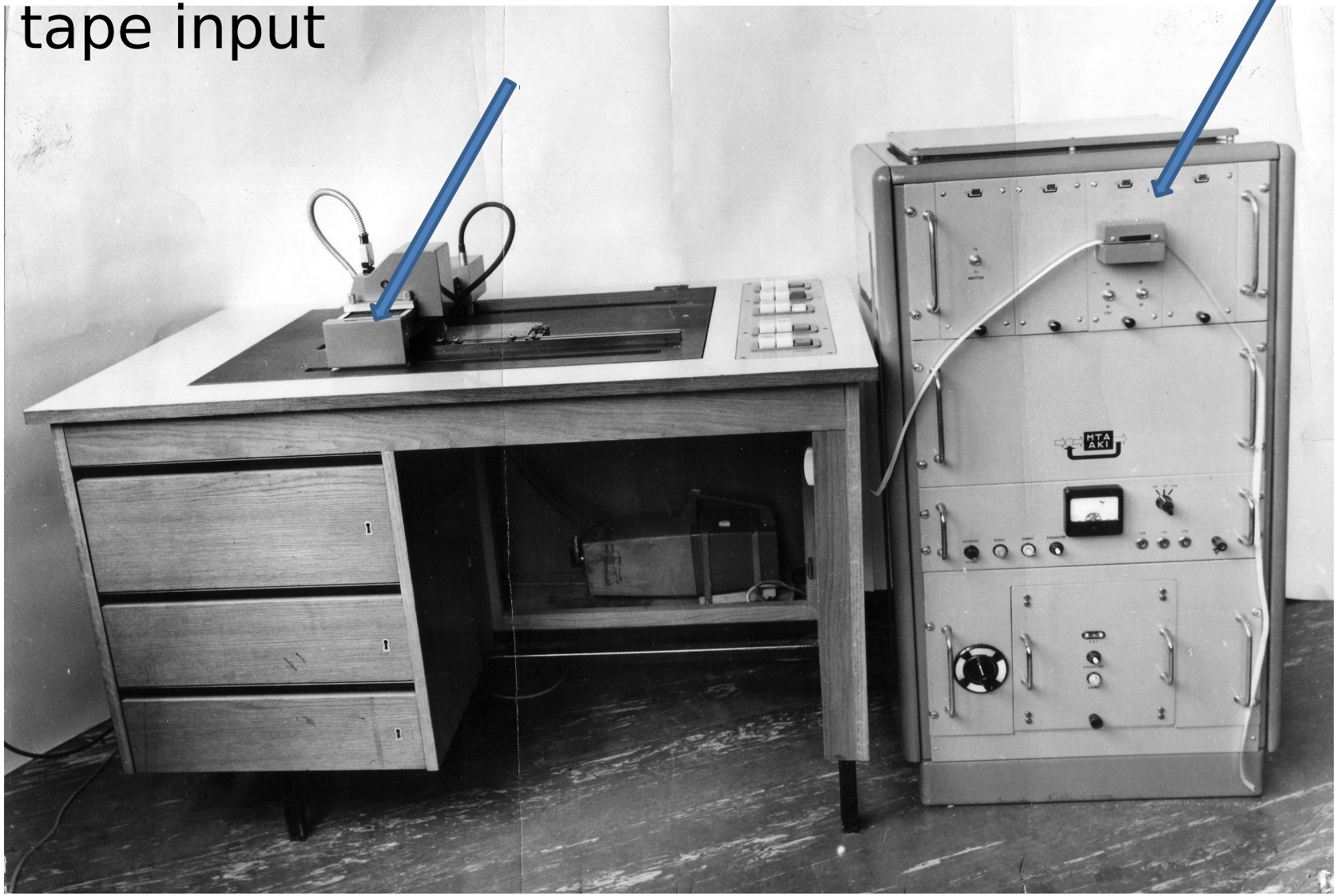
Two models to calculate – from the T





Useful application of analog computer, some new relationships

PCB manufacturing: ADMAP - punched tape input

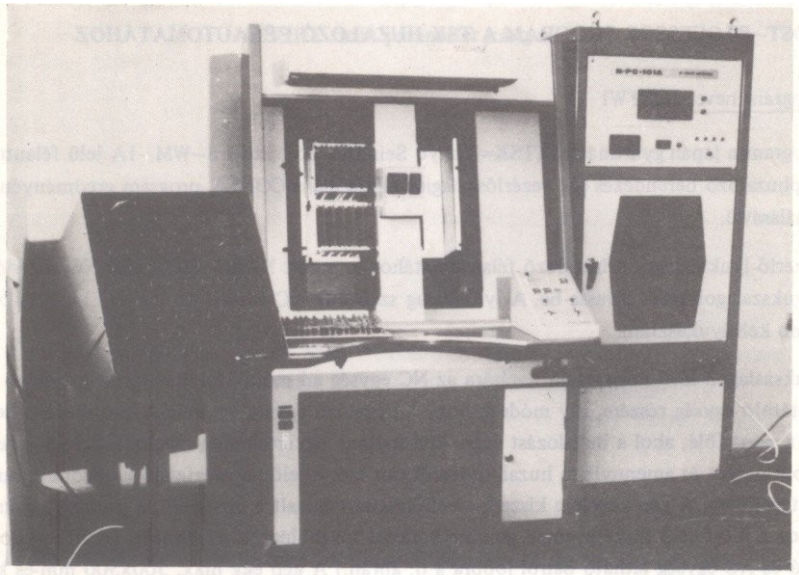


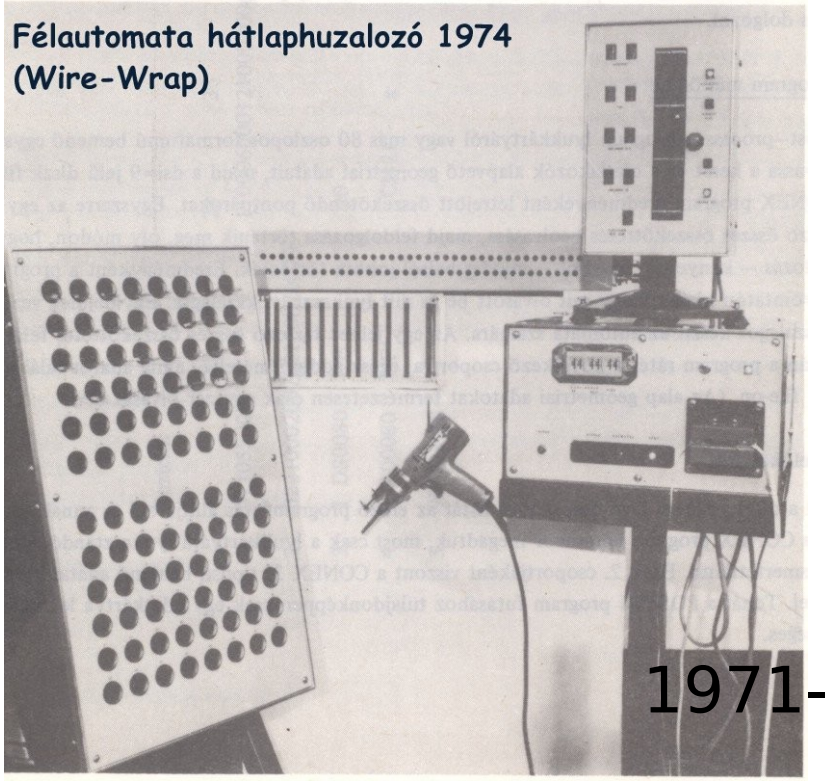
CAD NC - CNC

Stepping motor control invention/patent

WIRE WRAP TECHNOLOGY

TSK : Tokyo Seimtsu Co.





1971-75

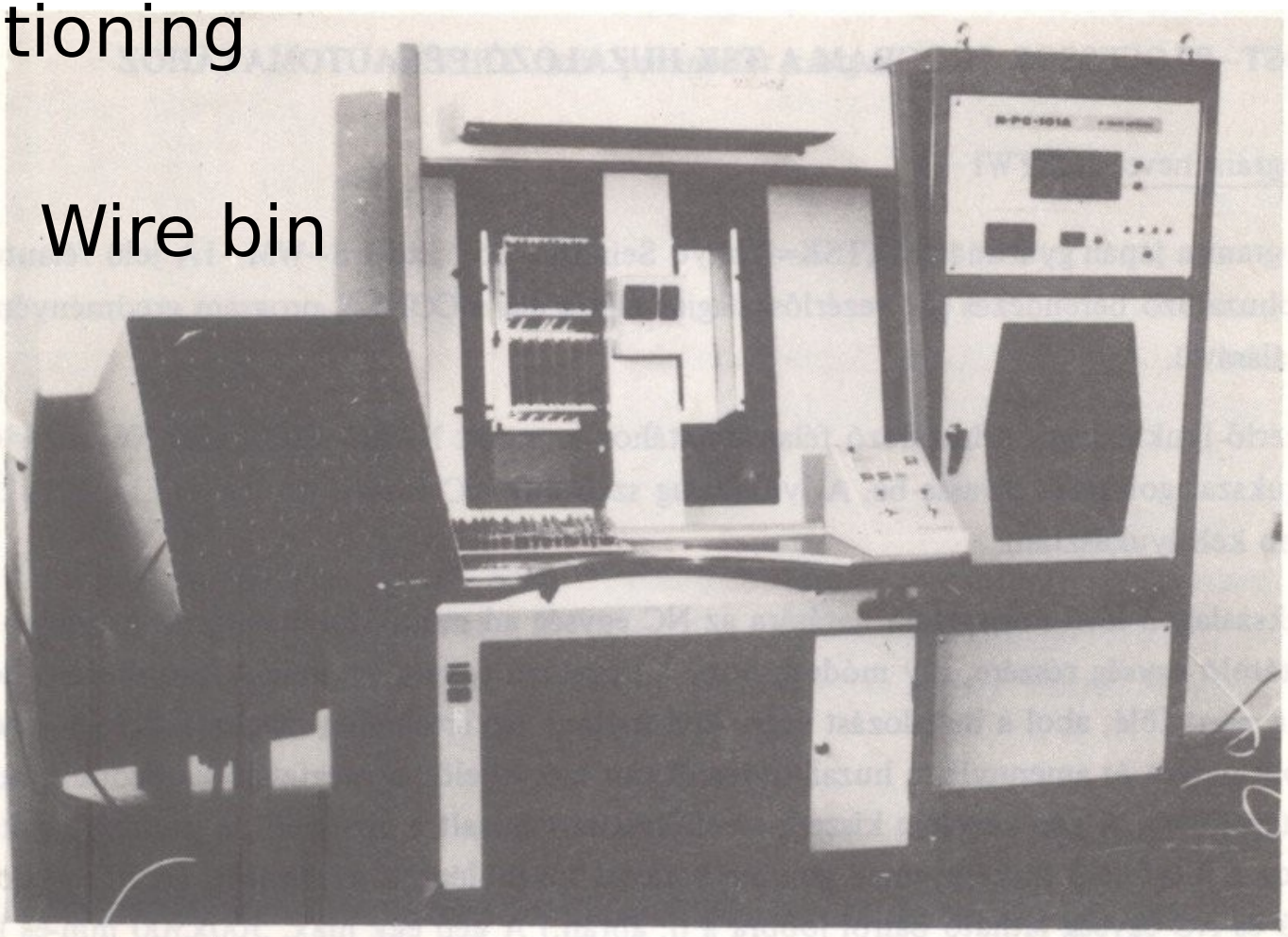
Programing solution:

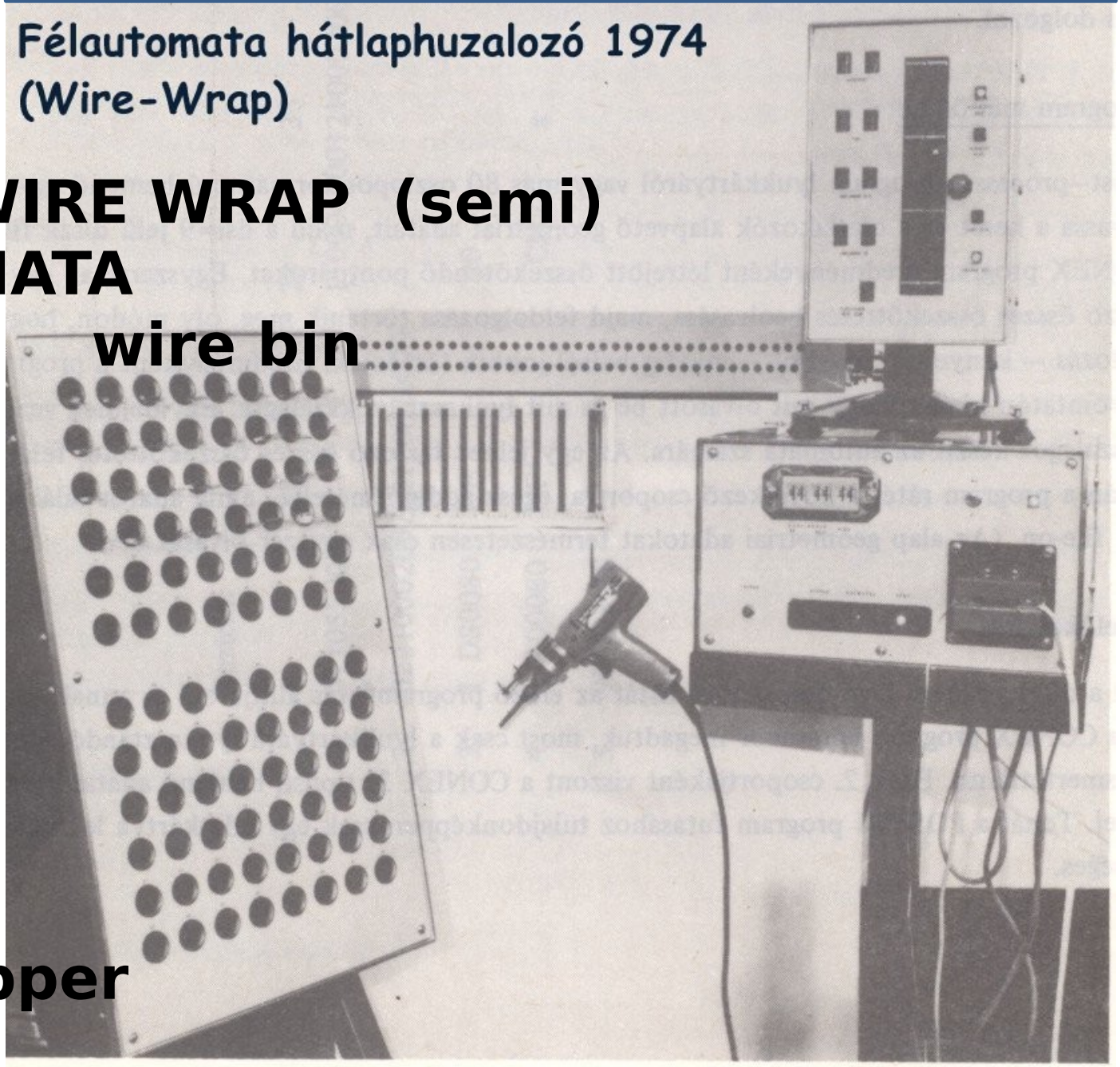
CAD-CAM

- Signal lists
- Optimal placement
- Optimal Wiring and-
- G-Code ⟹ NC-CNC

TSK WIRE WRAP (semi) AUTOMATA - positioning

Wire bin

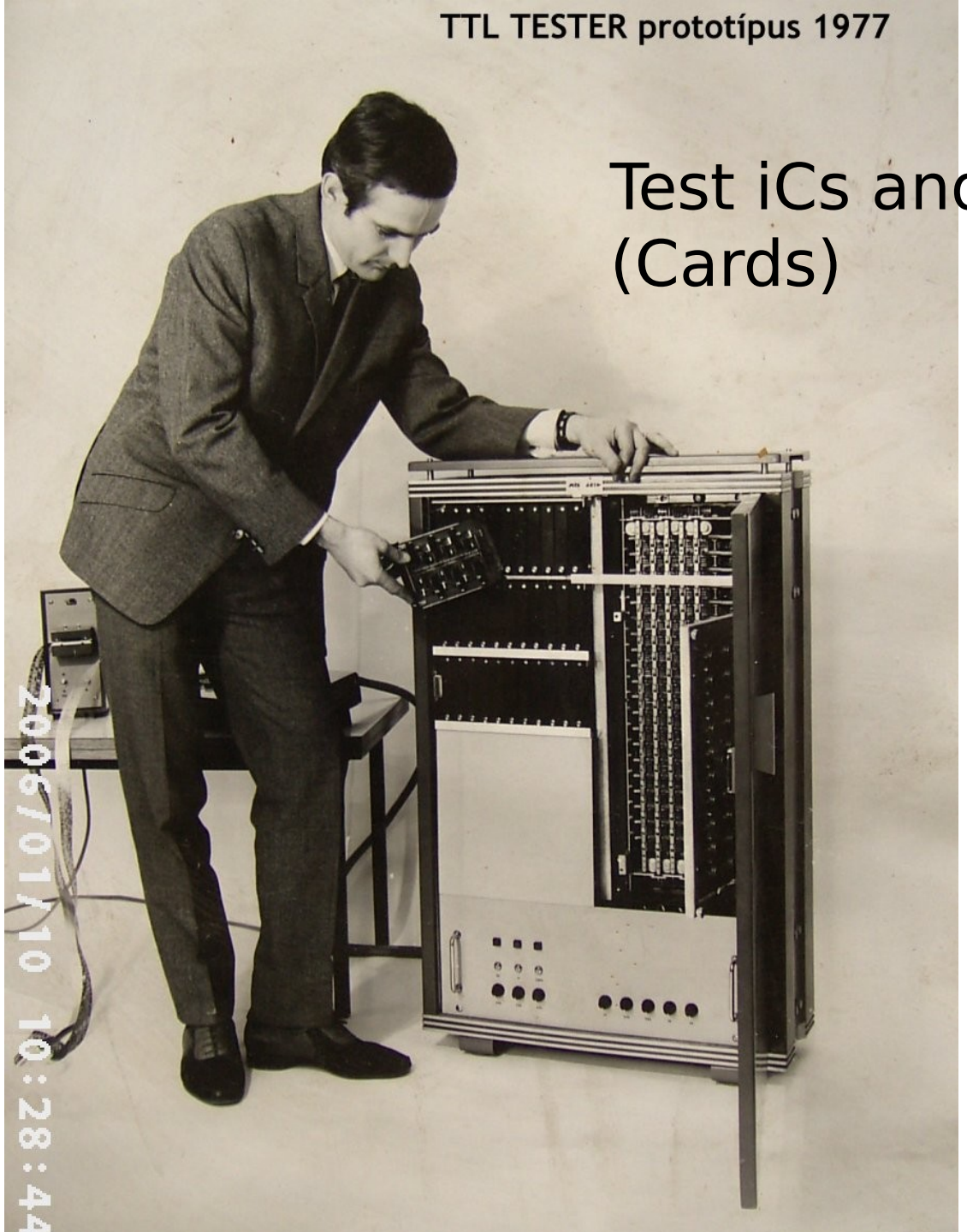




TSK WIRE WRAP (semi) AUTOMATA

wire bin

wrapper tool



Test iCs and Modules (Cards)

TTL IC TESTER

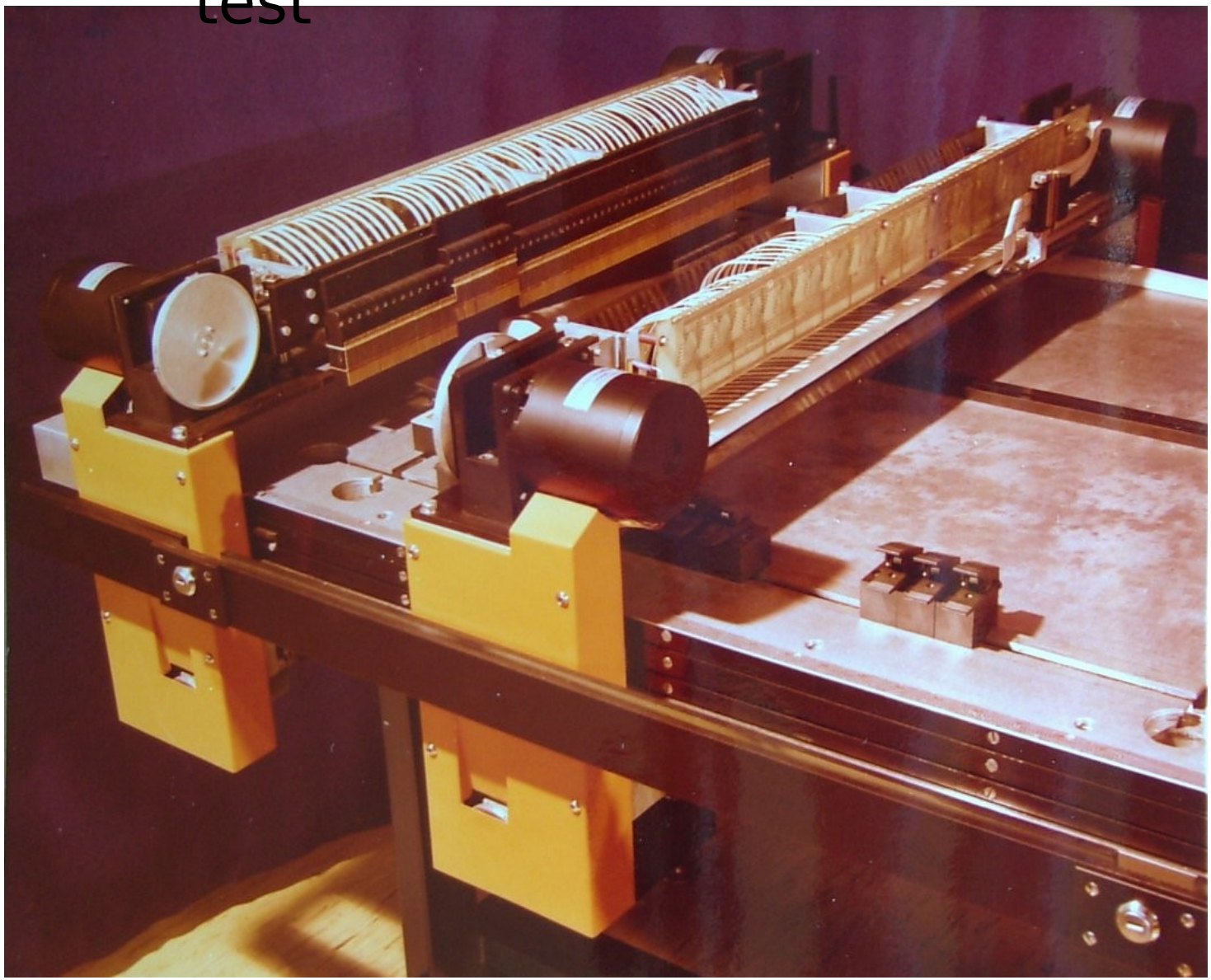
TESTOMAT

No photo

CAD - Control

1975-1978

BARETEST – unmounted PCB test



CAD-CNC

1976-78

MINSZK 22 later on: CDC 3300

I/O – puched tape, simple printer, (line-printer), magnetic tape

8192 words, 37 bits, machine code, autocode (Mitra), TapeOp.

1967-68

WHAT to Do Next – 1969 ?

HARDWARE ?? No, or a little
SOFTWARE ?? Yes, a lot

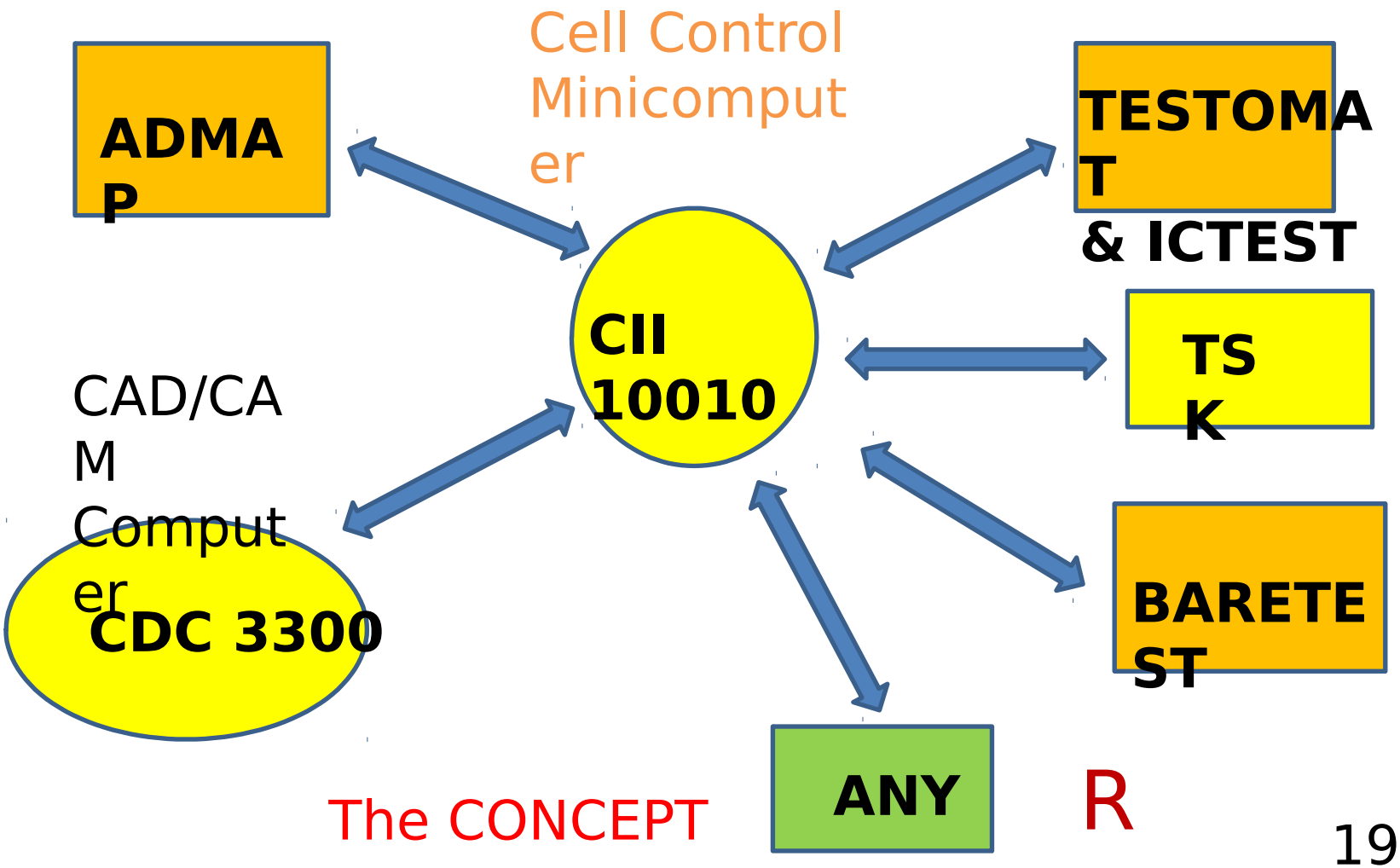
SOFTWARE

- programing to use and control the Hardware
  * all machines of the previous slides
- programing to design and manufacture HW
  * PCB
  * Mother Board

- TEACH new things, if possible (CAD, AI)

WORKSHOP COMPUTER -- CIM/FMS/FMC

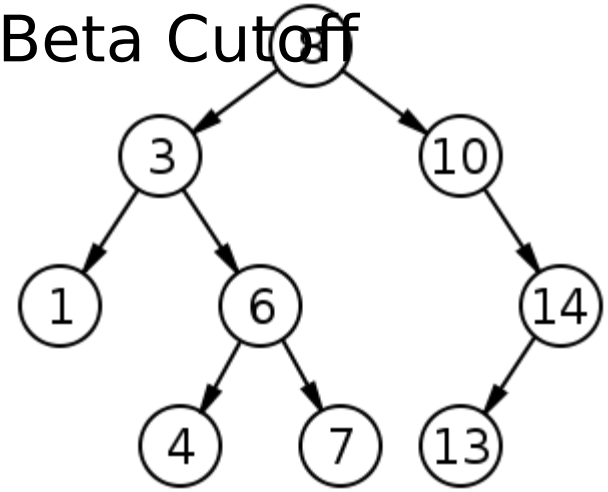
- Information and data exchange



Module placement algorithms, tree-search methods (BF, DF, random)

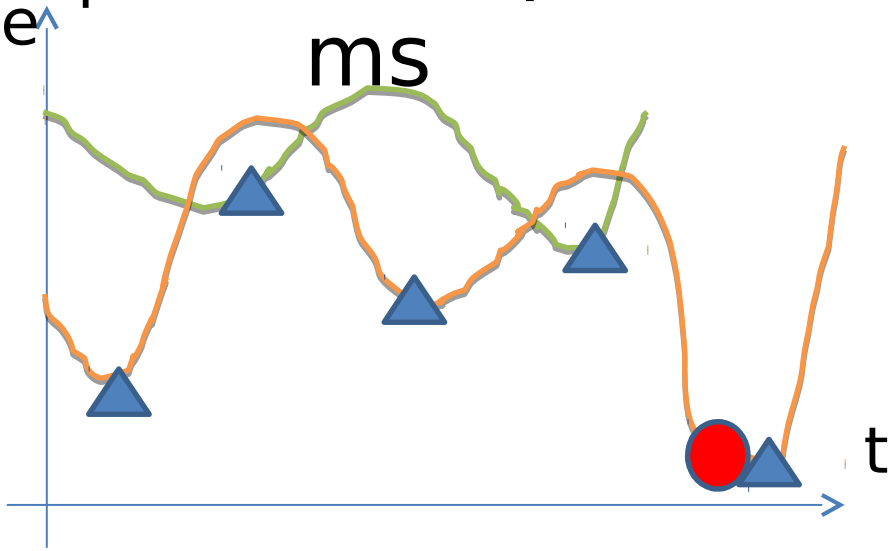
Initial Placement: Random, Built Up
Improvement: Random (Pairs Swap), Algorithmic: Graph Search: Breadth First, Depth First, Min-Max, Alpha-Beta Cutoff

R



Value of..

Optimum
Suboptimums



CNC programing, CAD/CAM programing, Teaching CAD/CAM and AI

$$b^n \qquad b^{\lceil n/2 \rceil} + b^{\lfloor n/2 \rfloor} - 1$$

	number of leaves with depth n and b = 40	
depth	worst case	best case
n	b^n	$b^{\lceil n/2 \rceil} + b^{\lfloor n/2 \rfloor} - 1$
0	1	1
1	40	40
2	1,600	79
3	64,000	1,639
4	2,560,000	3,199
5	102,400,000	65,569
6	4,096,000,000	127,999
7	163,840,000,000	2,623,999
8	6,553,600,000,000	5,119,999

number of leaves with	depth n and b = 40	
worst case	depth	best case
1	0	1
40	1	40
1,600	2	79
64,000	3	1,639
2,560,000	4	3,199
102,400,000	5	65,569
4,096,000,000	6	127,999
163,840,000,000	7	2,623,999
6,553,600,000,000	8	5,119,999

n

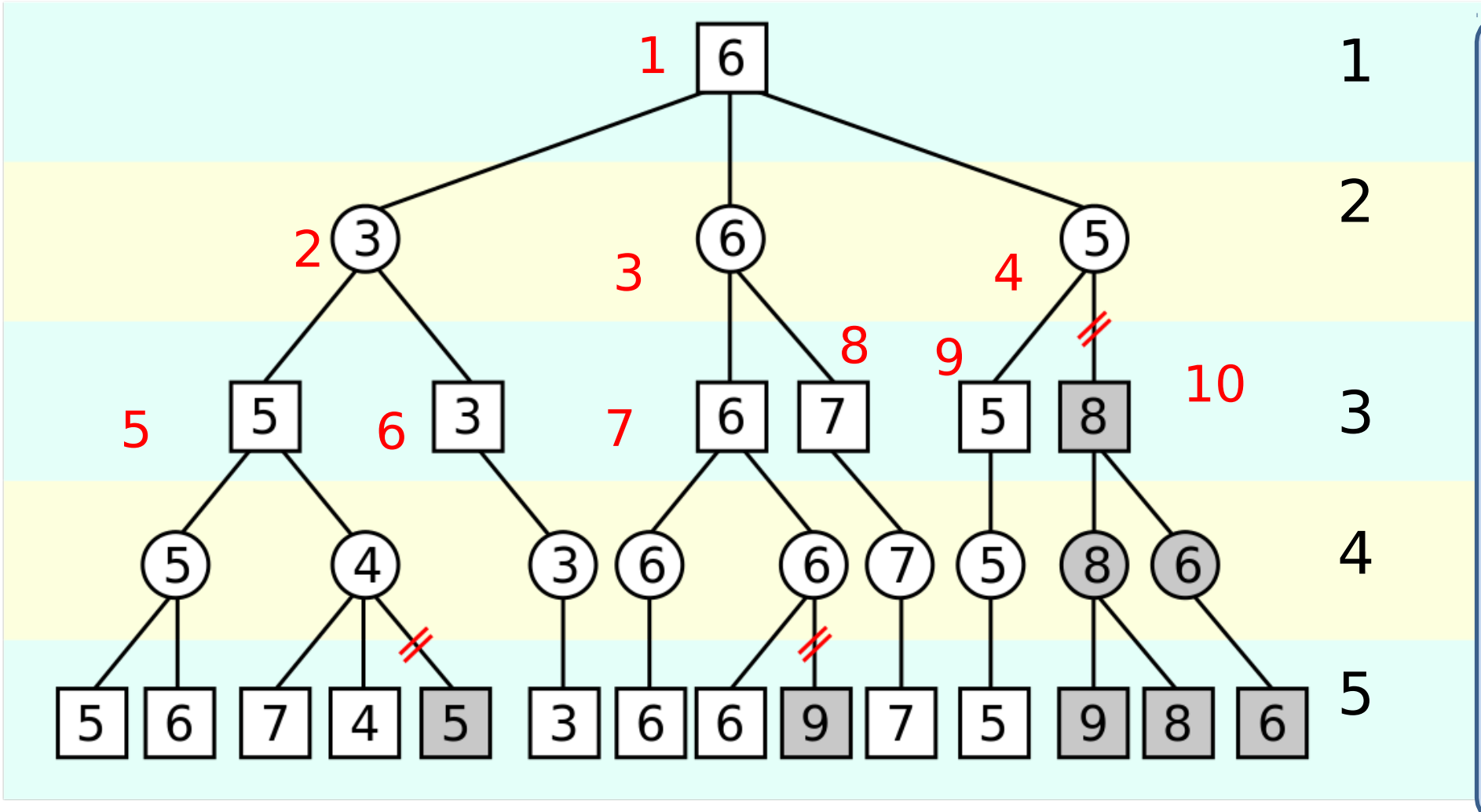
[n/2]

b

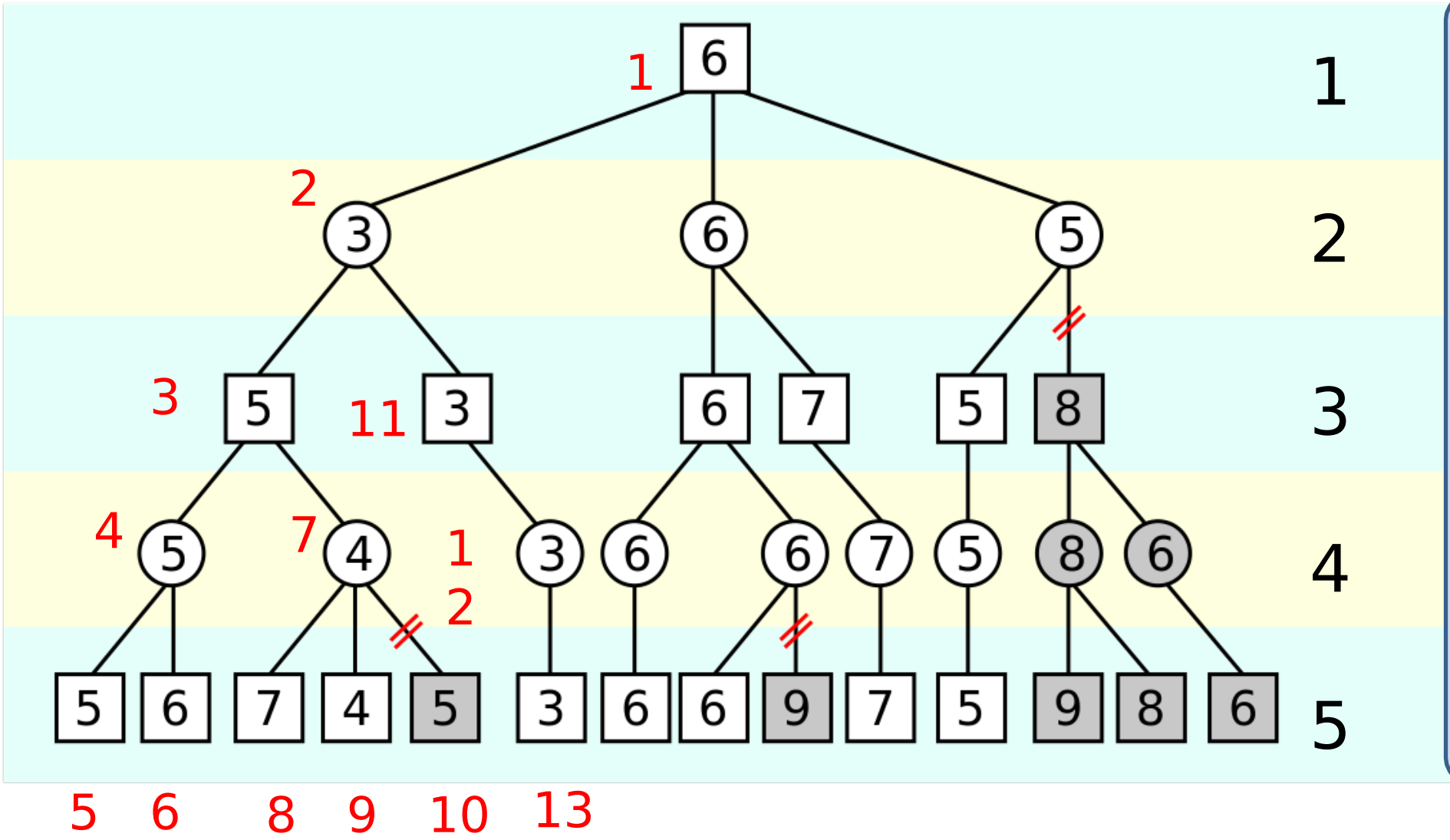
+ b - 1

[n/2]

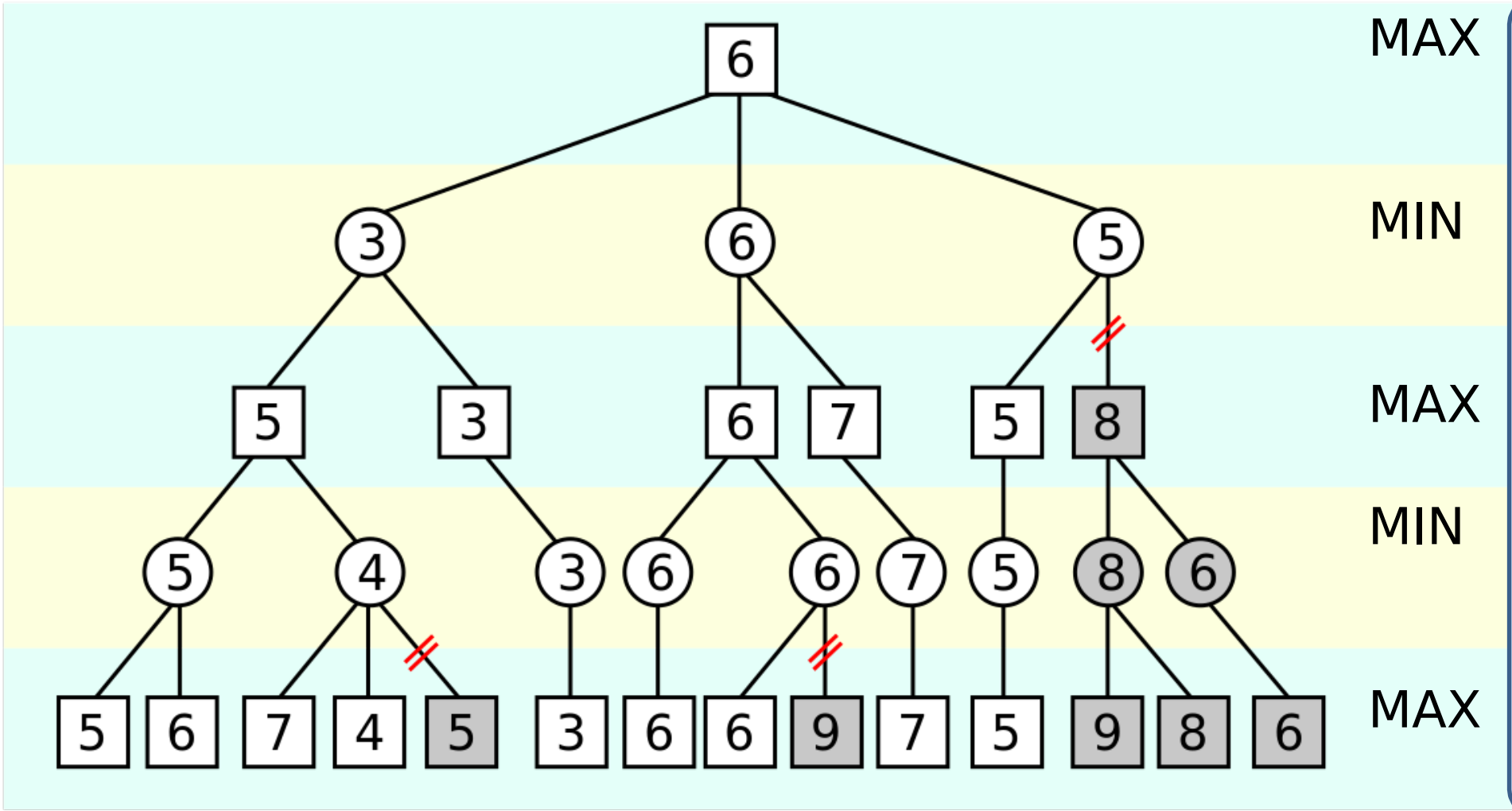
b



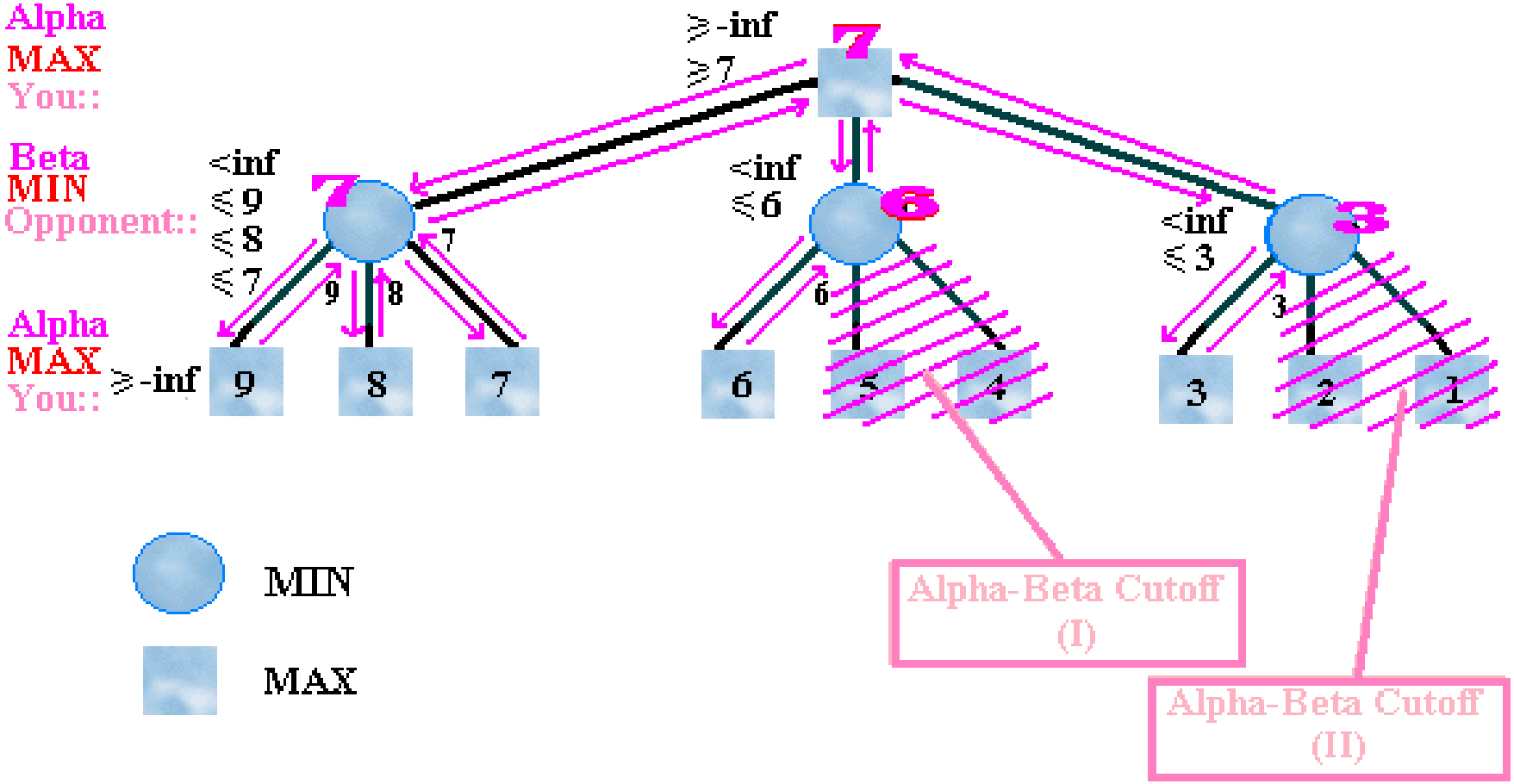
Breadth-First Search



Depth-First Search



Alpha–beta pruning on a two-person game



Alpha-beta search tree with two alpha-cuts at min nodes

LET US SEE

THE REST OF THE WORLD !

UC
BOULDER,
COLORADO,
USA

Module
placement
CAD/CIM

1972-73
(11
months)

RUSSIA, Dubna, JINR, LVE

CAMAC PCB CAD

1977-79 (2.5 years)

Germany, München, BMW, CAD Labor

1982-83

CAR ELECTRONICS CAD - for years

MEXICO, Cuernavaca (IIE) , view of Popocatepetl

Teaching
CIM
Consulting
Coding:
CAD-FEM
Interface
6
months

ITALIA , Trento - Trident Alto Adige, Südtirol

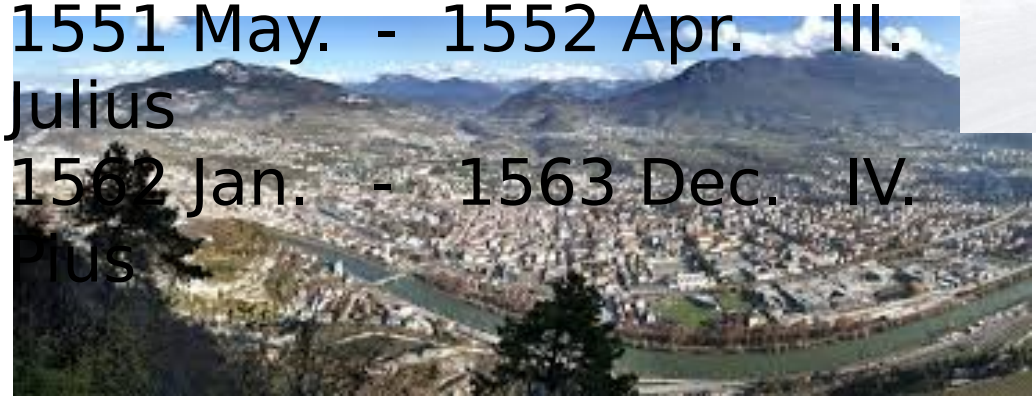
Software re-use projects

1542 May : Call of Concilium Tridentinum III. Paulo

1545 Dec. - 1549 Sept. III. Paulo

1551 May. - 1552 Apr. III. Julius

1562 Jan. - 1563 Dec. IV. Pius

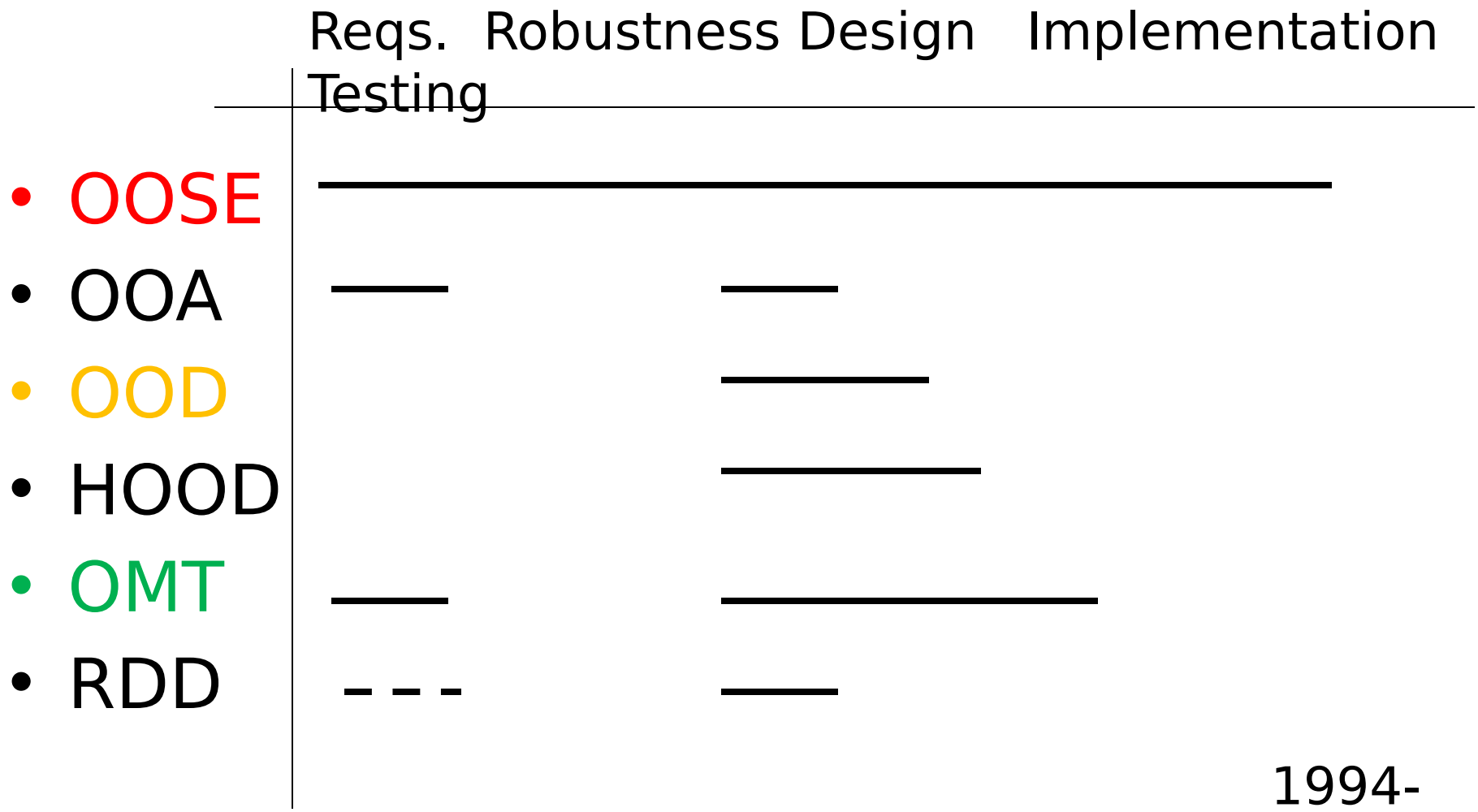


Teaching OO Engineering

6 & 1 months 1994 & 1997

System development – OO

Rumbaugh-Booch-Jacobson 1990-92



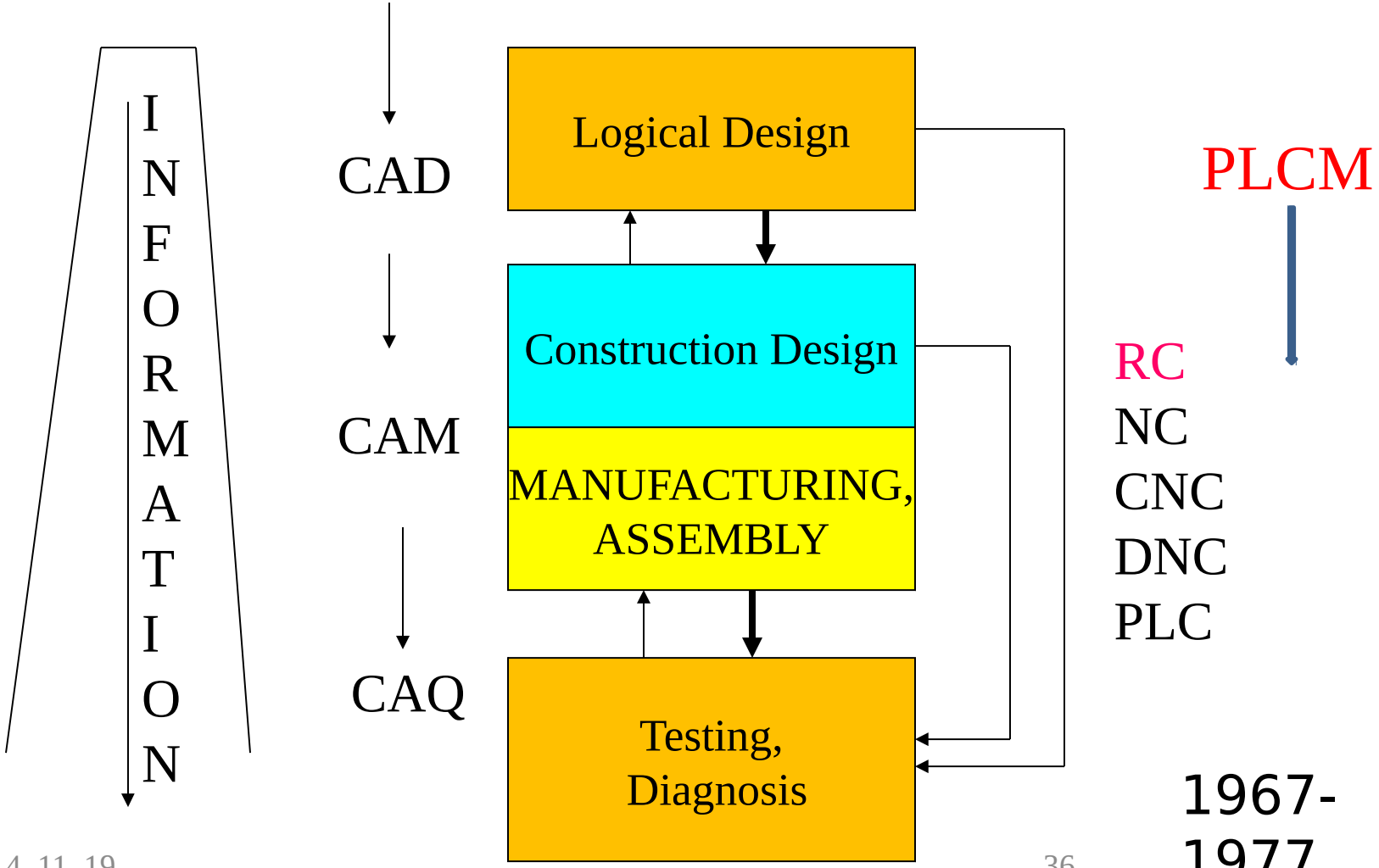
USA
Russia
German
y
Mexico
Italy

Long-term visit
Seminar

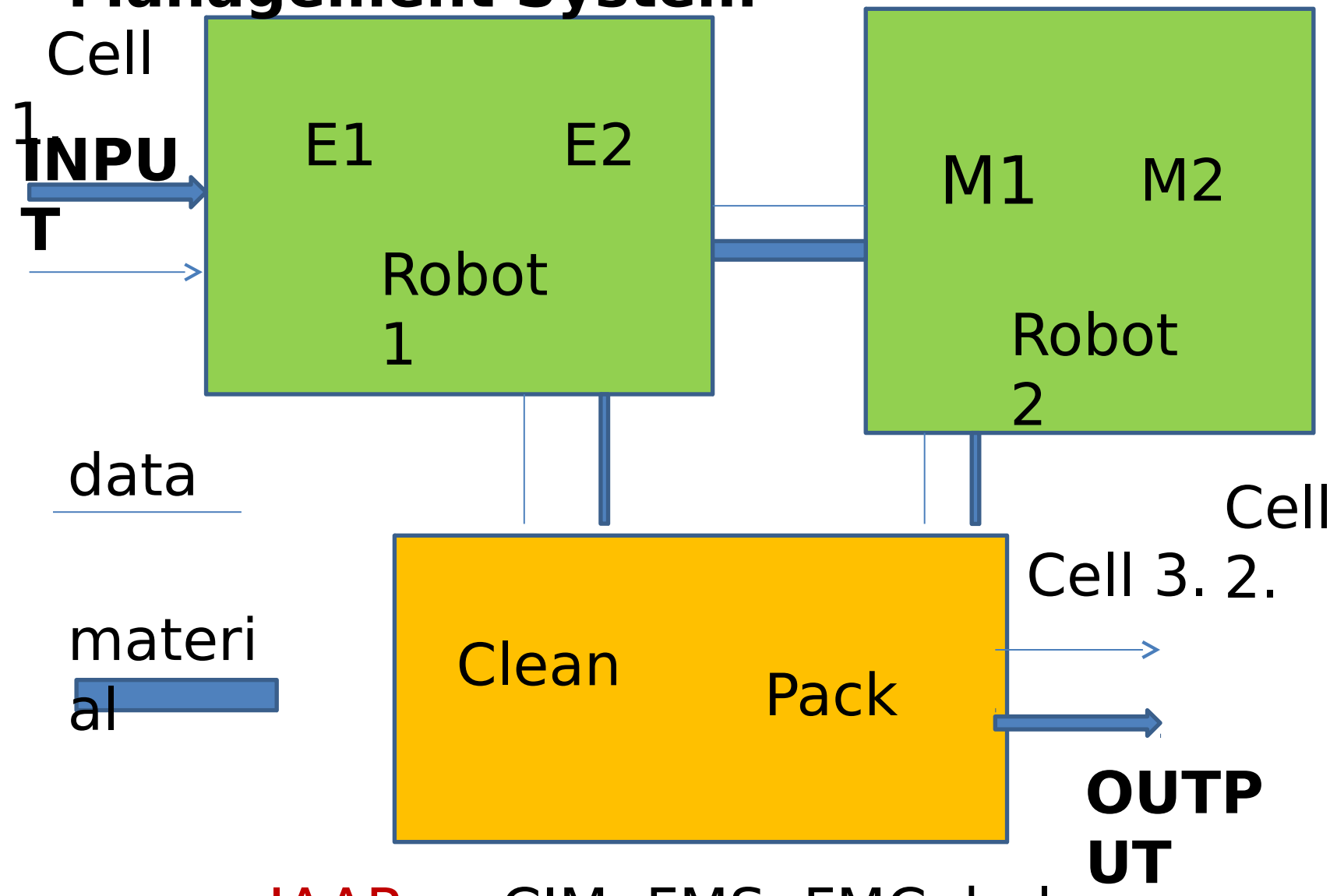
Short visit

1966 - 2013

DESIGN-MANUFACTURING-CONTROL'70
CAD/CAM/CAPP/Caxx/CIM
Computer **I**ntegrated **M**anufacturing



Integrated Data and Material Management System



IAAR - CIM, FMS, FMC, holon,

IAAR - Integrated Data and Material Management System

CIM - Computer Integrated Manufacturing

IMS - Intelligent Manufacturing System

Intelligent Technologies for Information Processing and

Intelligent Technologies for Information Processing and Management (Ufa)

Computational Intelligence and Informatics (Budapest)

Intelligent Technologies for Product Life-Cycle Management:

- **modeling, simulation, design tools**
- **expert systems, KB systems, OO methods**
- **neural networks, genetic algorithms**

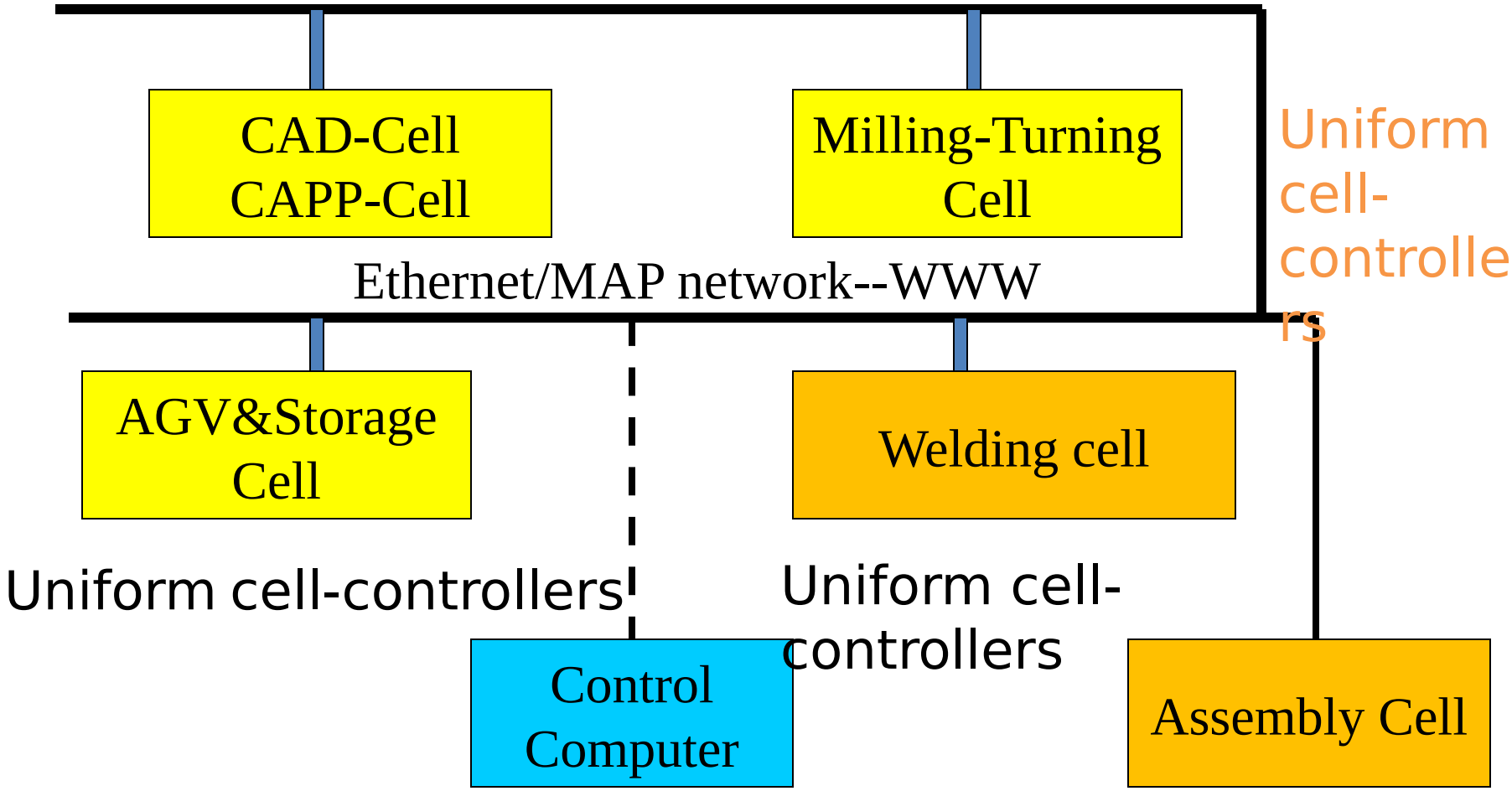
Robotic (Manufacturing) Systems are large: software-hardware-interface complex, dynamical, distributed, virtual heuristic, nonlinear, NP complete, etc.

There is no appropriate mathematical apparatus to solve and to calculate operations

No f1(state, output)= f (input, state, time, etc.)

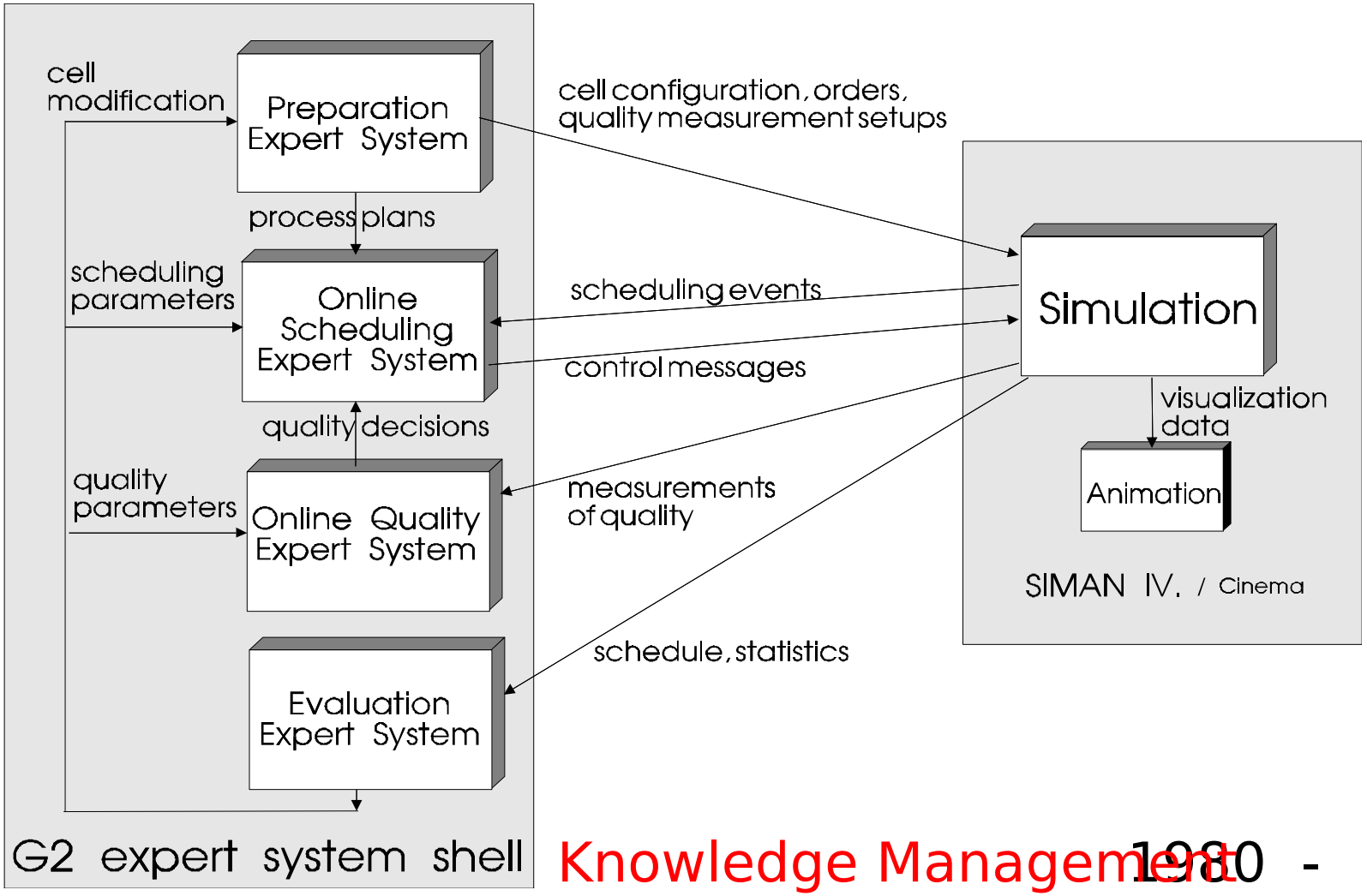
Neither Matrix-, nor Differential equations, no linear or quadratic

CAM-ORIENTED CIM SYSTEM



System Concept and Management

Hibrid simulation, KB scheduling



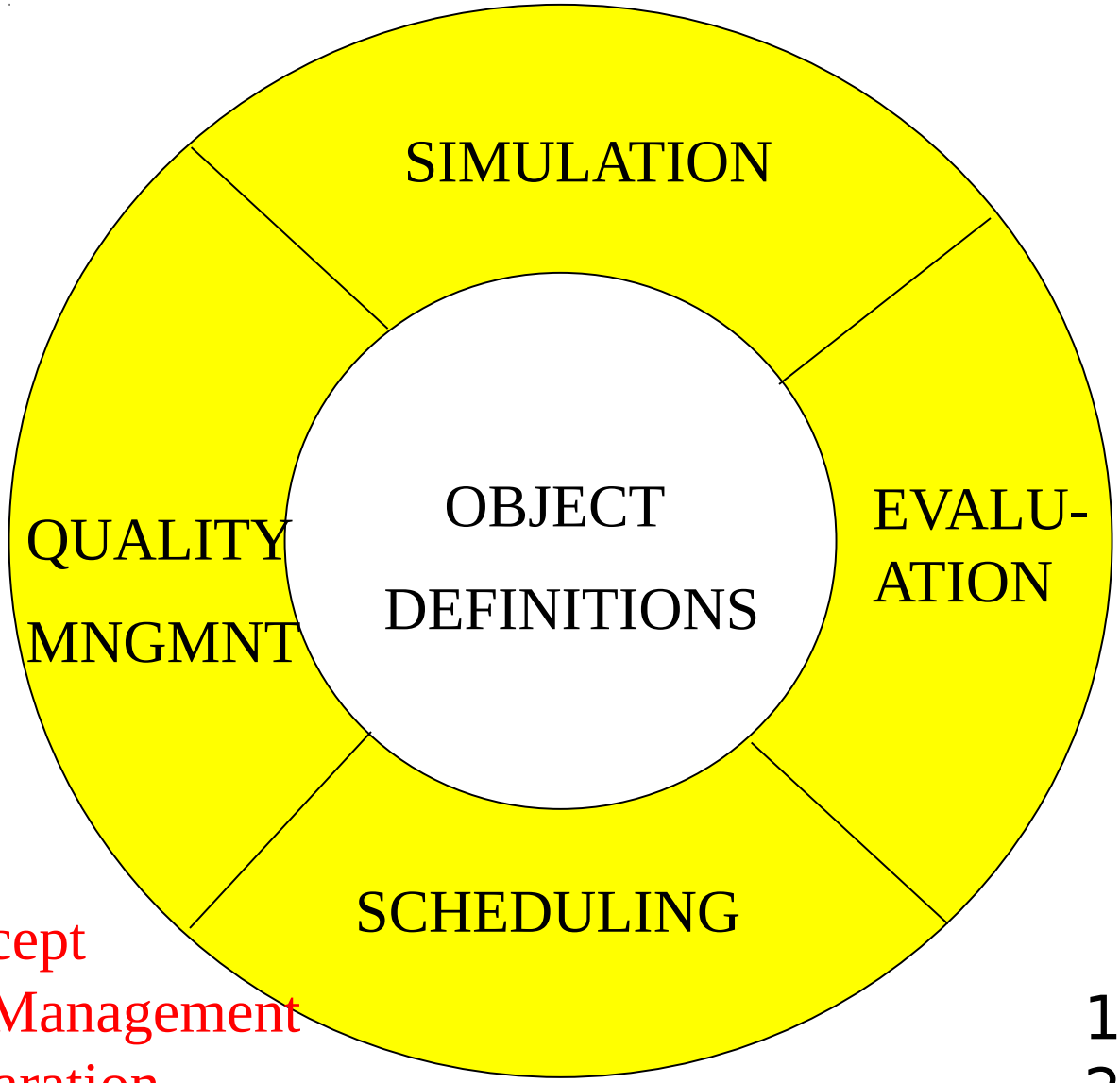
CIM

Knowledge Management

Scheduling Algorithms

1980 - 2000

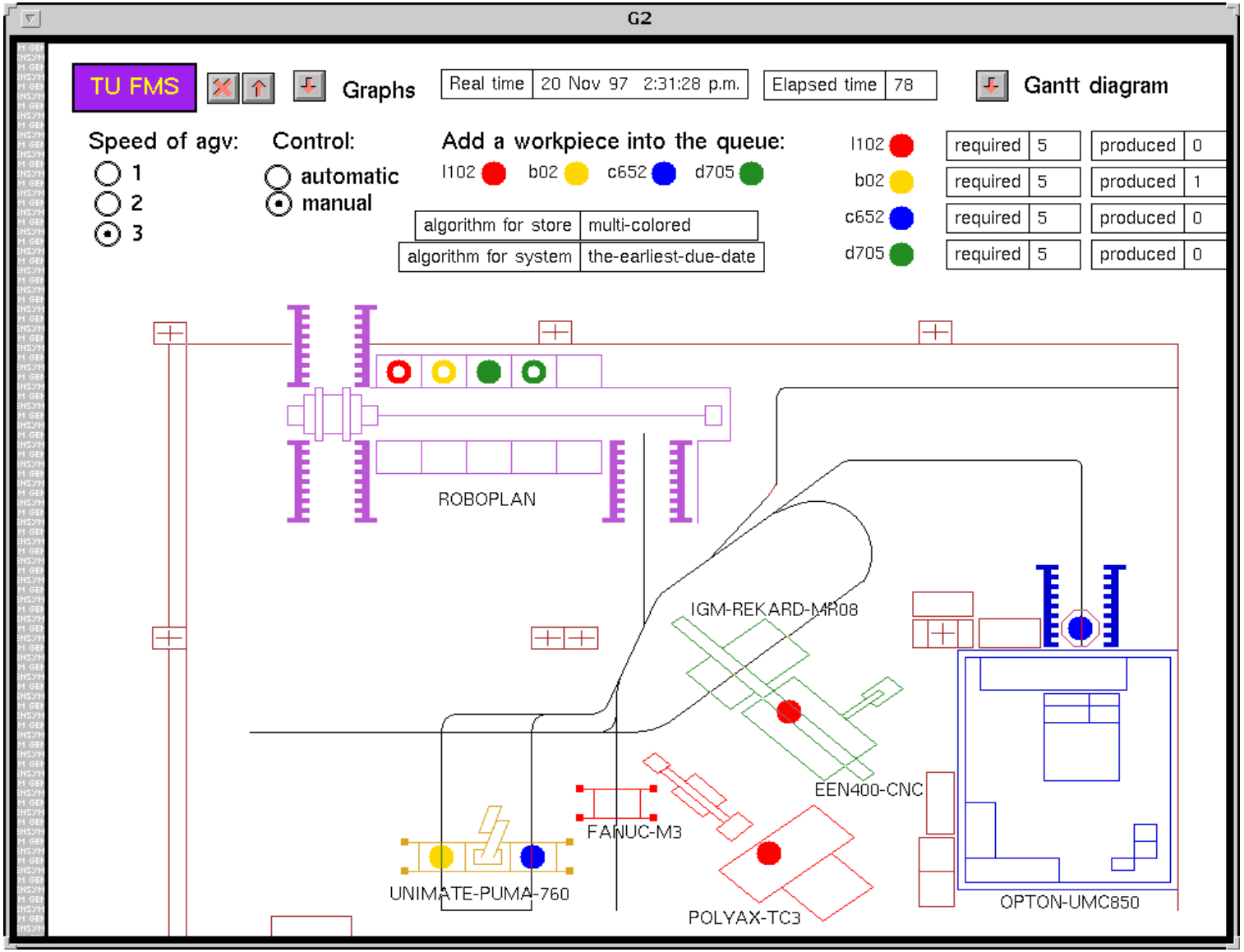
G2 based KB System



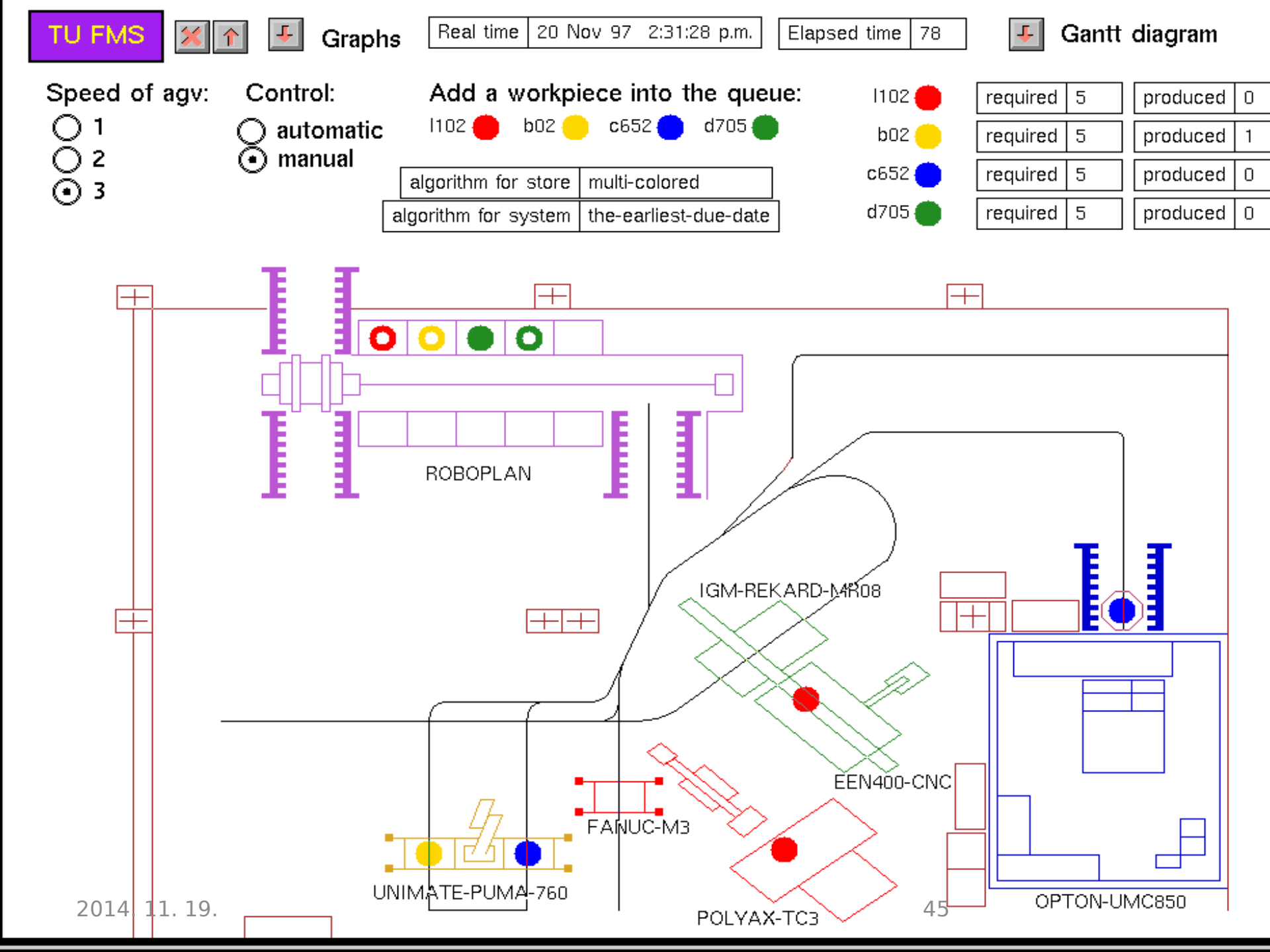
System Concept
Knowledge Management
Separation

1998-2000

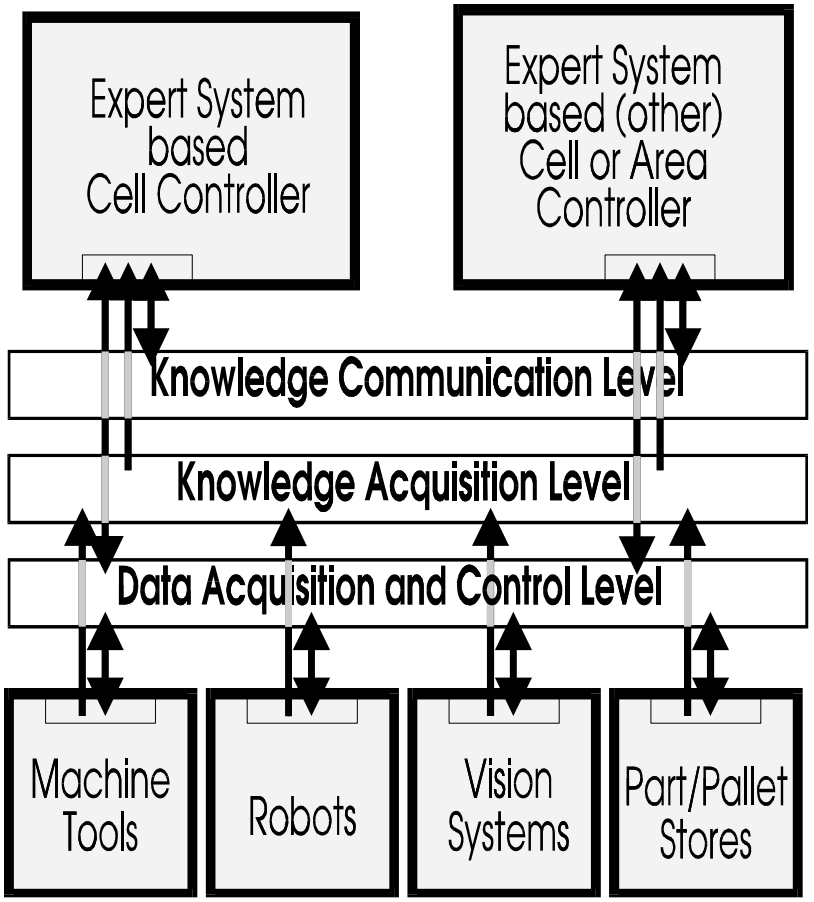
BME CIM Pilot-System Simulation



1985 - 2000


TU FMS
Graphs
Real time
20 Nov 97 2:31:28 p.m.
Elapsed time
78
Gantt diagram
Speed of agv:
1
2
3
Control:
automatic
manual
Add a workpiece into the queue:
l102
b02
c652
d705
algorithm for store
multi-colored
algorithm for system
the-earliest-due-date
l102
required 5
produced 0
b02
required 5
produced 1
c652
required 5
produced 0
d705
required 5
produced 0
ROBOPLAN
IGM-REKARD-MR08
EEN400-CNC
FANUC-M3
UNIMATE-PUMA-760
POLYAX-TC3
OPTON-UMC850

AI in Manufacturing/Robot-control



Type of knowledge processing within the cell-controller (according to the communication levels):

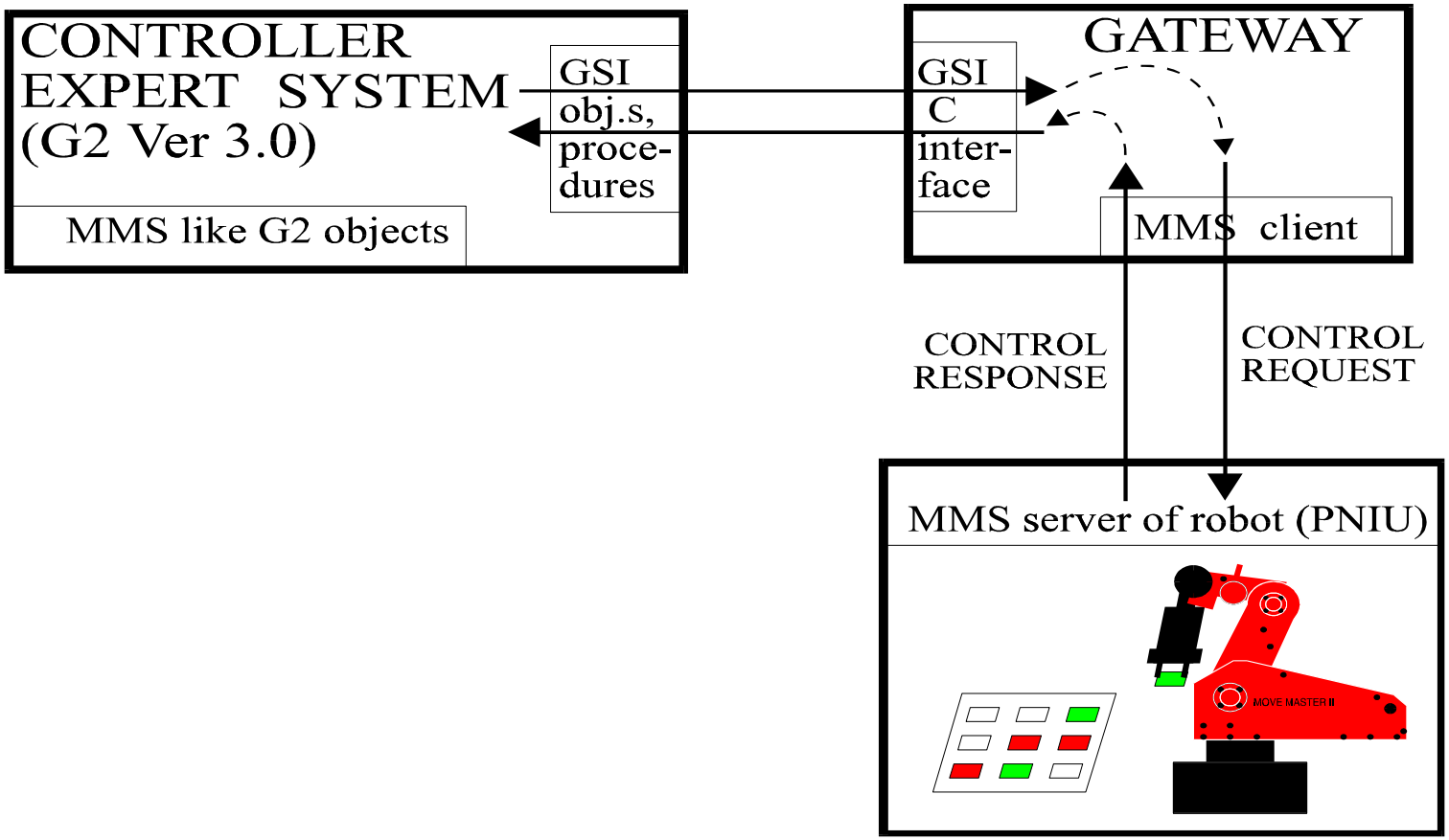
being modified (growing) knowledge base processing or dinamic data base and knowledge exchange

being modified (growing) knowledge base processing on dinamic data base

permanent (no change in rules) knowledge base processing on dinamic data base

1985-2000

G2 based Robot-control (KB, OO, real-time)



1985-2000

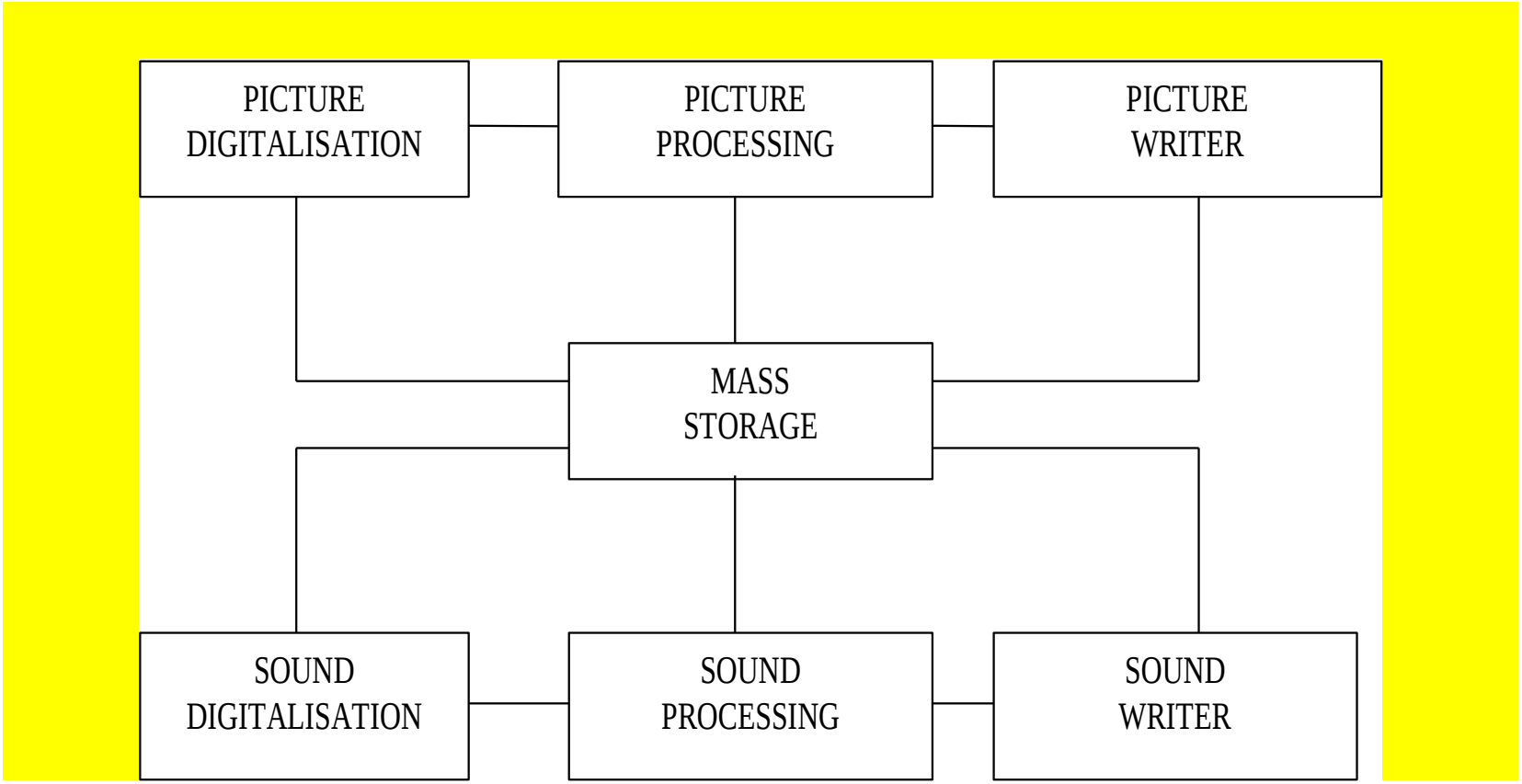
High Volume, long-term **National R&D Projects:**

DIMORF (sound and picture) 35 mm movies
- DIGITAL FILM READER
- FILM SAVER PROGRAMS
  - DIGITAL WRITER TO FILM

Digital Factory
- Interactive Multi-Media
- Intelligent Scheduling
- High-speed Signal Processing

EU conform consortia: Research, Industry, University, SME: 4-7 partners, 3 years

Let Us Save Movie Pictures: pictures and voice
DIMORF – Simplified System Structure



System Concept & Overall Management

2000-2006

Scratch and worn emulsion

ORWO diapositive, 25 years old

2000-2006

Removing Rope Scratches

movie picture, 12 years old

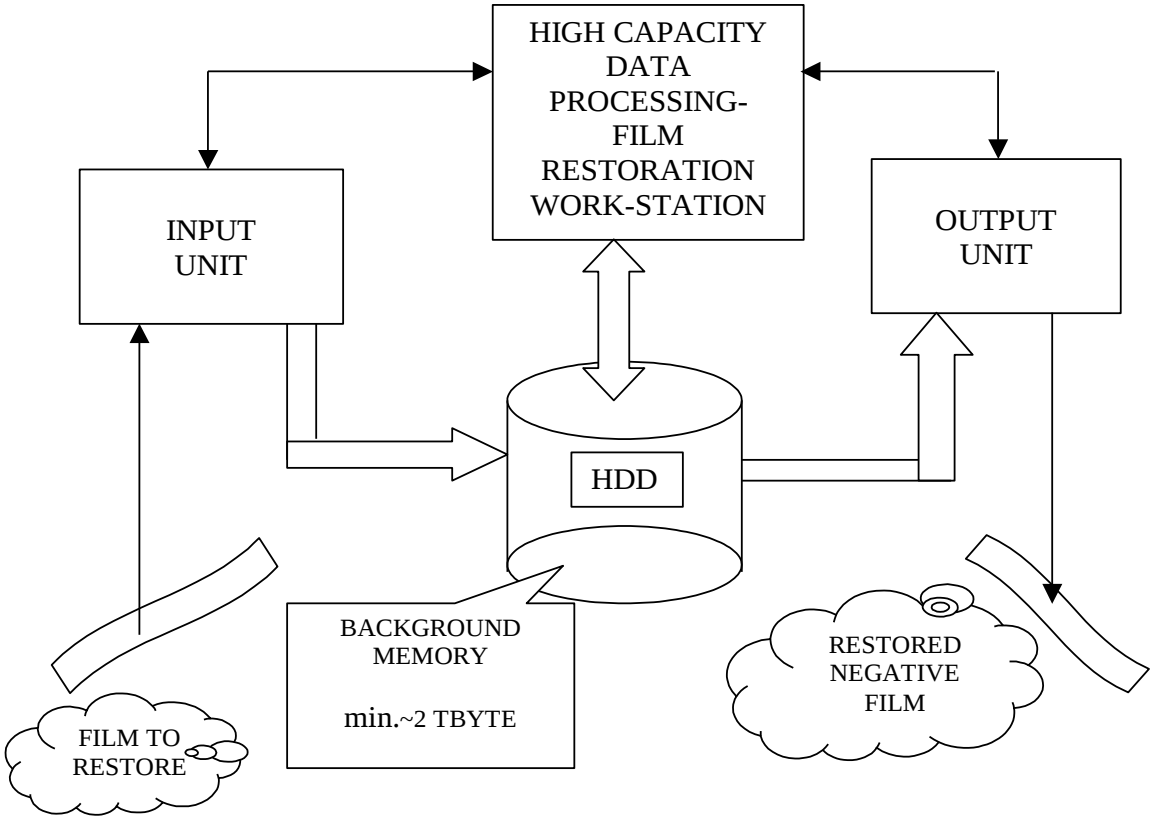
2000-2006

Color - reconstruction

AGFA diapositive, 35 years of age

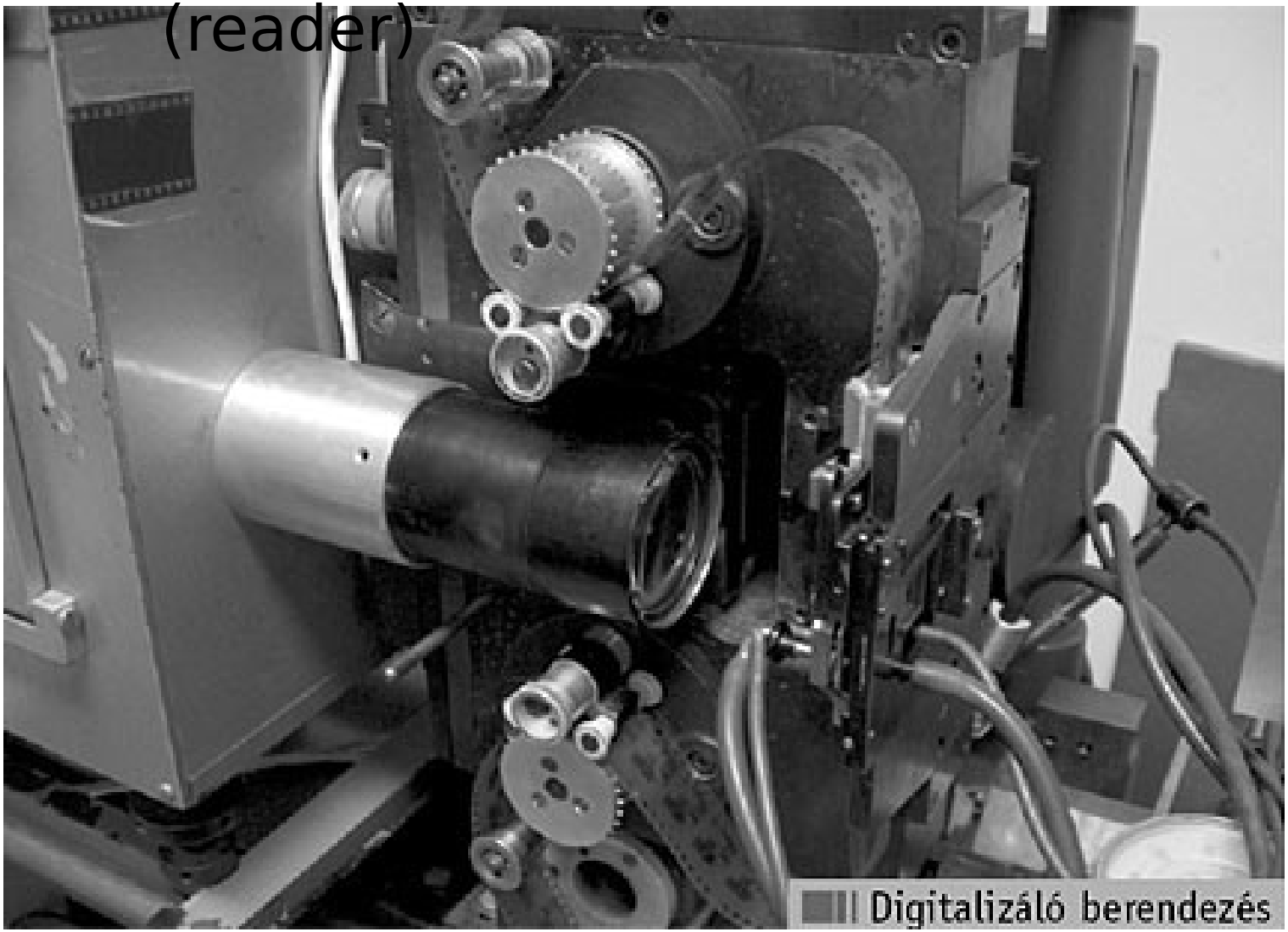
2000-2006

DIMORF -- Simplified



2000-2006

35 mm MOVIE FILM DIGITIZER (reader)



2000-2006

Laser Based Movie Film Write (LaserGraph® MP 6K)

Film manuufacturing (CIM)

2000-2006

PARAMETERS	
Resolution	6 K/line virtually (software) 1,5 & 3 K/line option: 8 K/line
PIXEL Size	4 µm, option: 3 µm
Reading Speed	10 sec/frame option: 20sec/frame
Picture Size	24 x 19 mm 6000 x 4750 pixel
Color System	RGB
Wave Length	R = 635 nm G = 532 nm B = 405 nm
Color Depth	12 bit/color
Data Formats	TIFF, CINEON/log, option: any
Film Length	300 & 600 m
Allowed Vibration	Vertical/horisontal:

Film-Saver Conclusions

- 2004: The Restoration of the first Hungarian Color Movie

  called Lúdas Matyi (1949) is finished.

Perfect solution,

even the lost sound, substituted in 1966 – regained.

- Partners:
  - Film Laboratory (scanning, coloring, recording)
  - DIMORF Project Partners

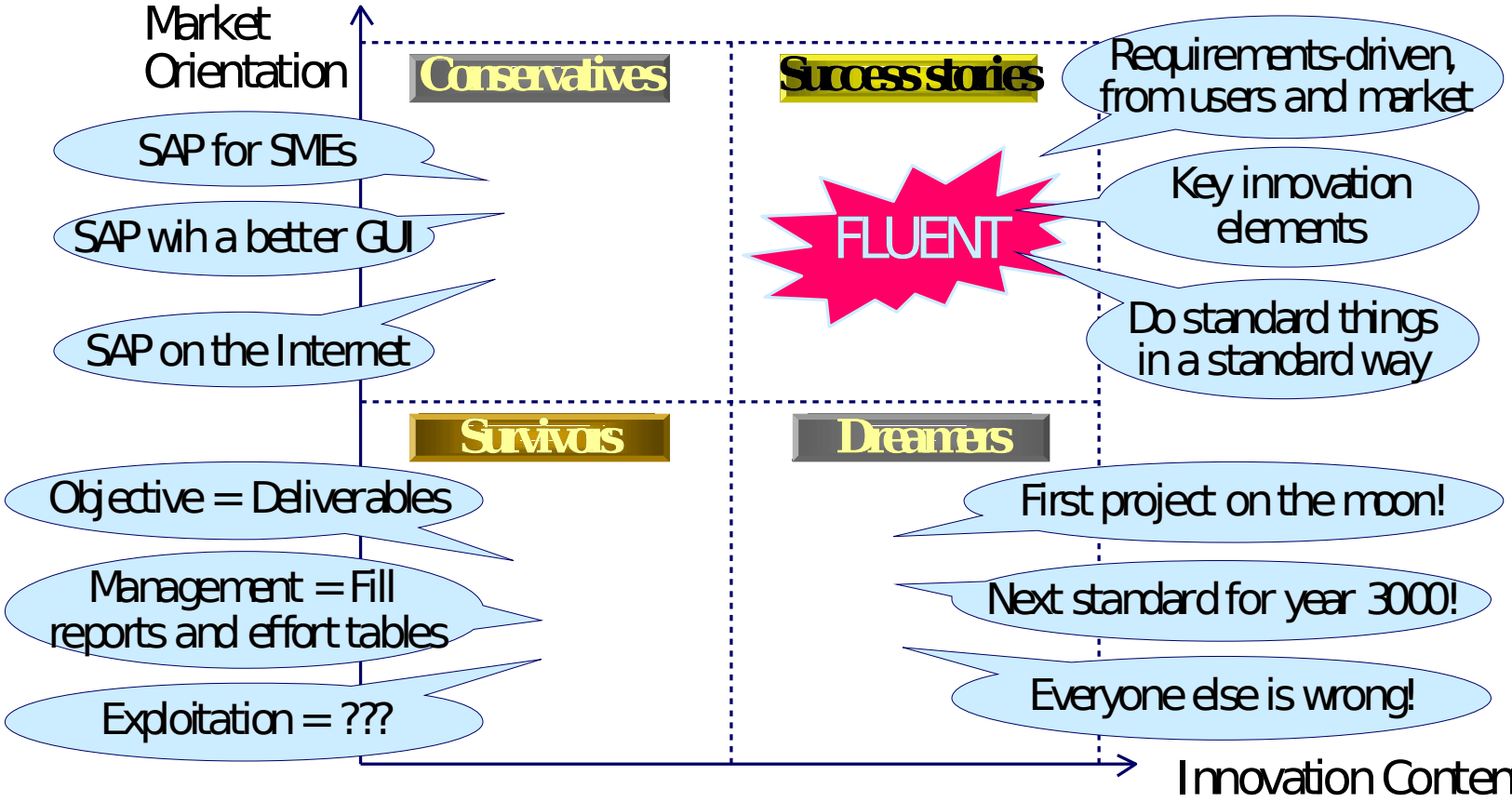
    Computer and Automation Institute and

    University of Veszprém in one team

    (frame stabilization, noise removing, sound restoration)

- Lúdas Matyi was given several times in TV and in movies 2000-2006

Management goals & strategy



EP 29088 Fluent, 1st Review Meeting, Brussels 17th September 1999 *Highlights - P. Paganelli, Gruppo Formula (I)* 7

Harvesting friendships of travels, conferences, publications

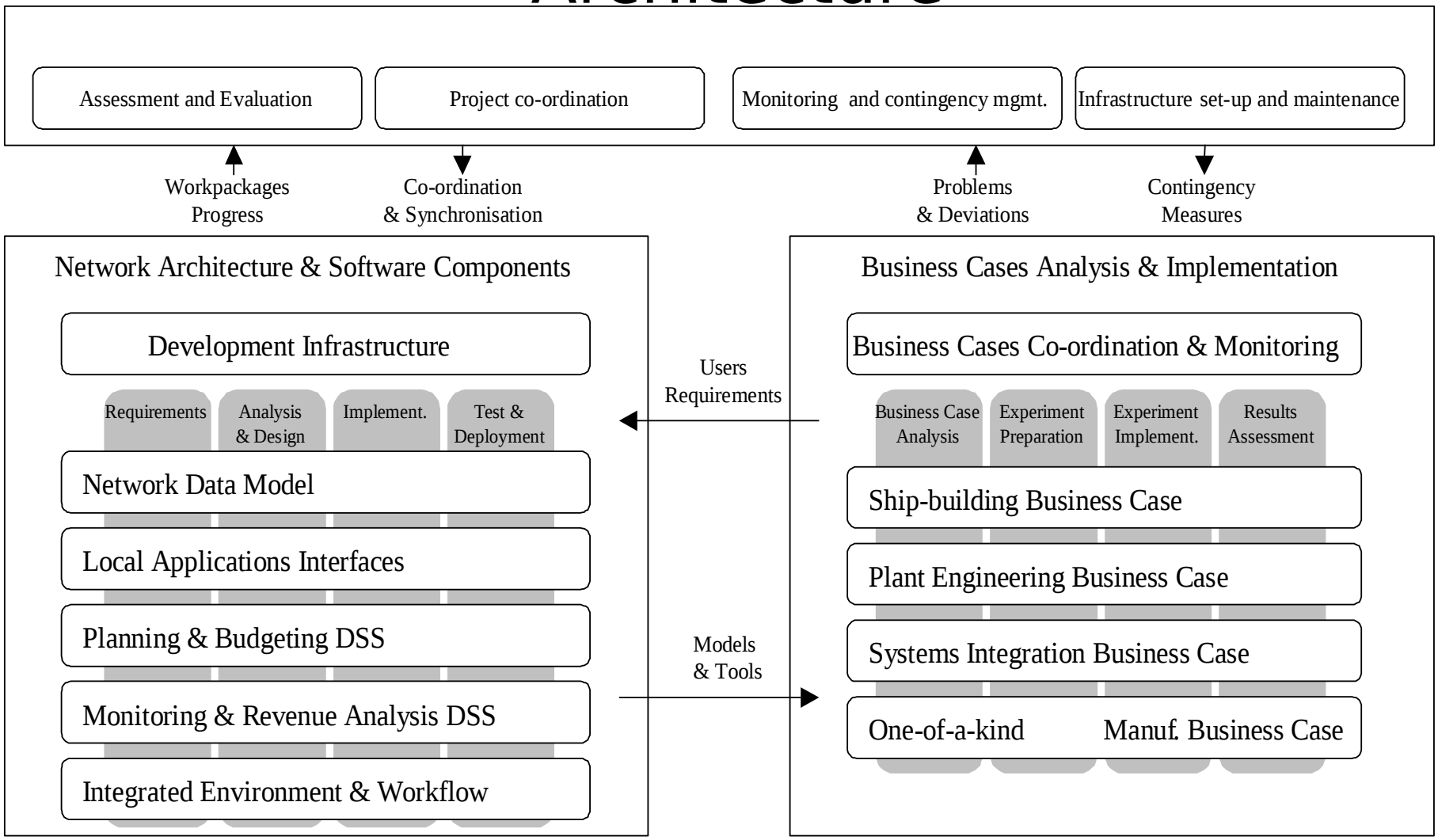
JOINT EU R&D Projects 1995-2010

ANY

PROJE
CT

Harvesting friendships of travels, conferences, publications

(General) Project Development Architecture



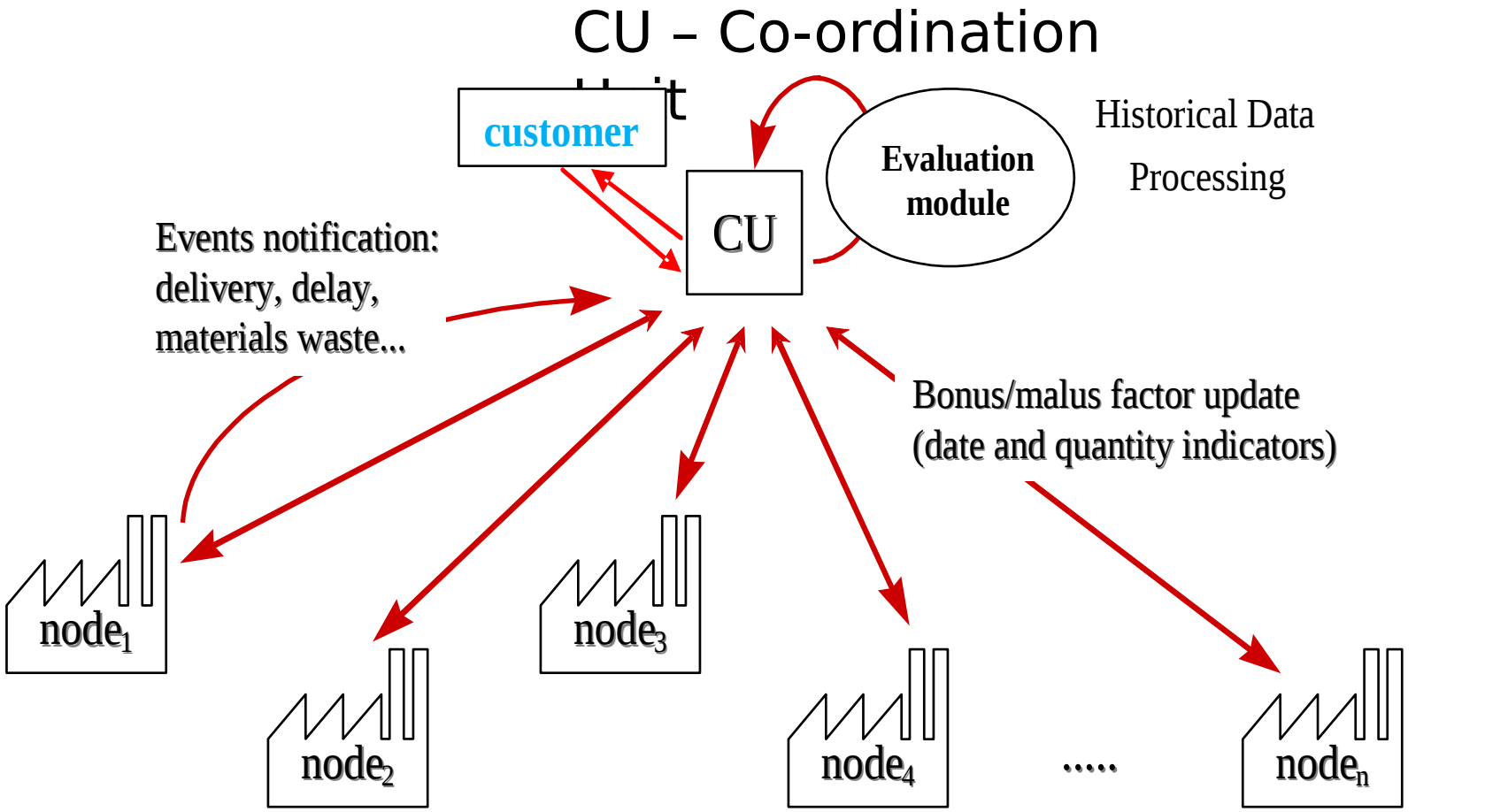
1995-2010

Related, finished EU Projects on virtual/extended enterprises (CIM)

- **EPSYLON** (ESPRIT No. 25359, 1997-2000) :
  Enhanced Process Modelling System for Lean Operations Management
  – manufacturing-assembly-operation-maintenance-
  – disassembly-reuse-recycling
- **PLENT** (ESPRIT No. 20723, 1996-1998):
  Planning Small and Medium Size Enterprises
- **FLUENT** (ESPRIT No. 29088, 1998-2001):
  Flow-oriented Logistics Upgrade for Enterprise Networks
- **WHALES** (EU Fifth FW No. IST-1999-12538, 2000-2002):
  Web-linking Heterogeneous Applications for Large-Scale Engineering and Services

1995-2010

PLENT ARCHITECTURE
virtual enterprize



1995-2010

Some other project names

- NEXPERT, ManuCyte, ManuCloud
- LUDUS, Island, REDEST, Cospa, Ewisme,
- IDAS-OSAKA, CITRO, Beatrice, E-bep, E-mult,
- EURON, EURobotics, Codesnet, Foksai,
- Capinfood, P2P, Smart Frame,

Nonstop urgent communication and work with 5-15 partners for 1-5 months during proposal preparations

Nonstop work for 2-4 years and 3-4 trips/year/project
and 1-2 evaluations/year/project

Nonstop fight with our SMEs

1995-2010

Some project topics

- Software reuse, EOL Vehicle reuse/recycling,
- Expert system applications, FMS control,
- Startup companies, Telecommunication,
- Supply Chain, Best Practice, Simulation,
- Open Source Software, Clever Games,
- Extended and virtual enterprizes
- Food management

1995-2010

Paks Nuclear Power Plant

- 4 nuclear blocks, performance rate: ~85 %
- safest nuclear plant in Middle and East Europe
- 40% of electrical energy of Hungary (~14000 GWh)

1995-2010

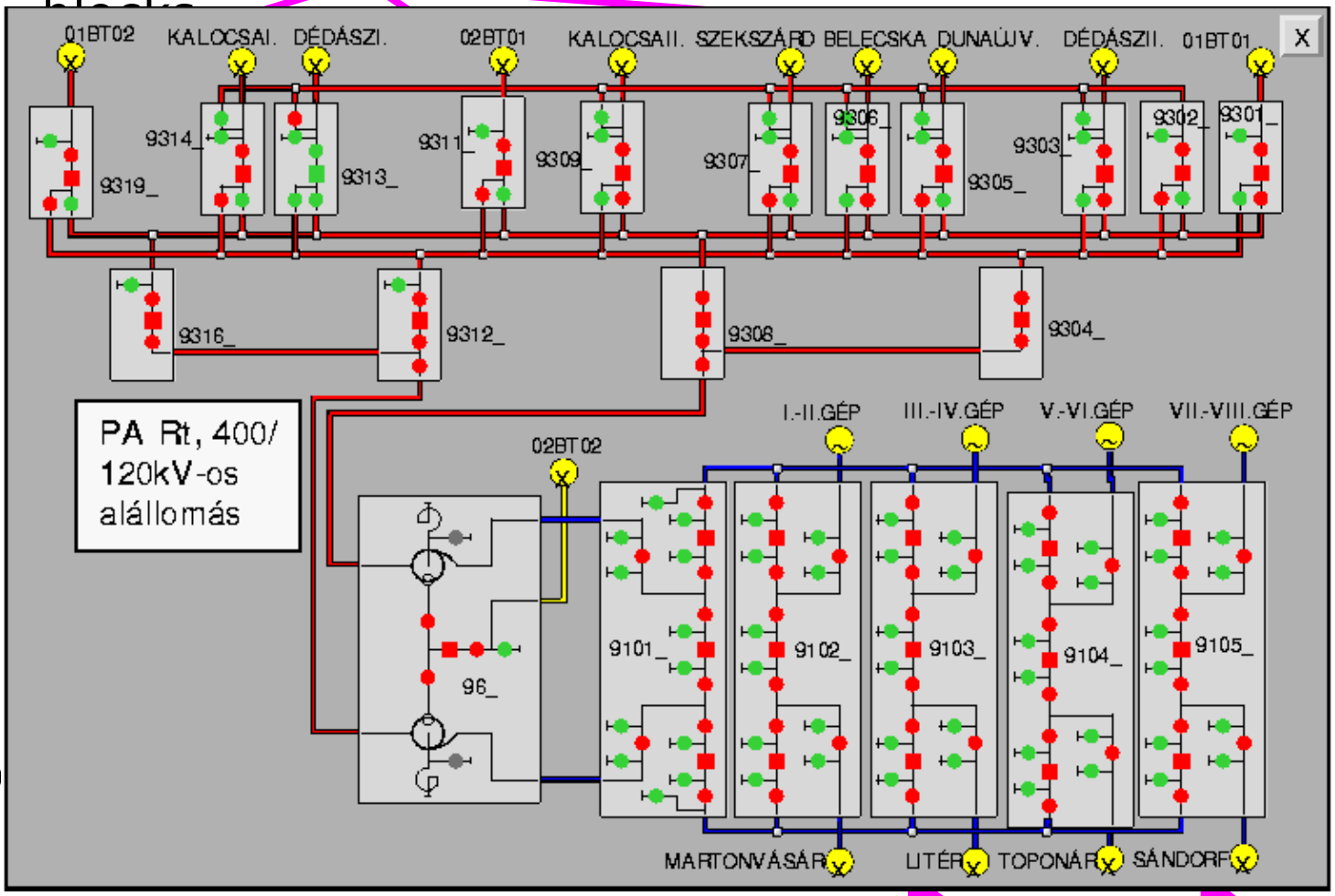
Intelligent Advisory Functions at the 120/400 kV Substation of the Paks Nuclear Power Plant

- Voltage and current map generation, topology analysis
- Finding dangerous topologies and critical trends (ALERT)
- Equipment diagnostics and maintenance scheduling (wear examinations)
- Intelligent interlocking based on measured voltages and currents
- Diagnostics of disturbances, determination of places and types of errors
- Automatic generation of switching sequences

The substation

Feedback to the blocks

Local transmission lines



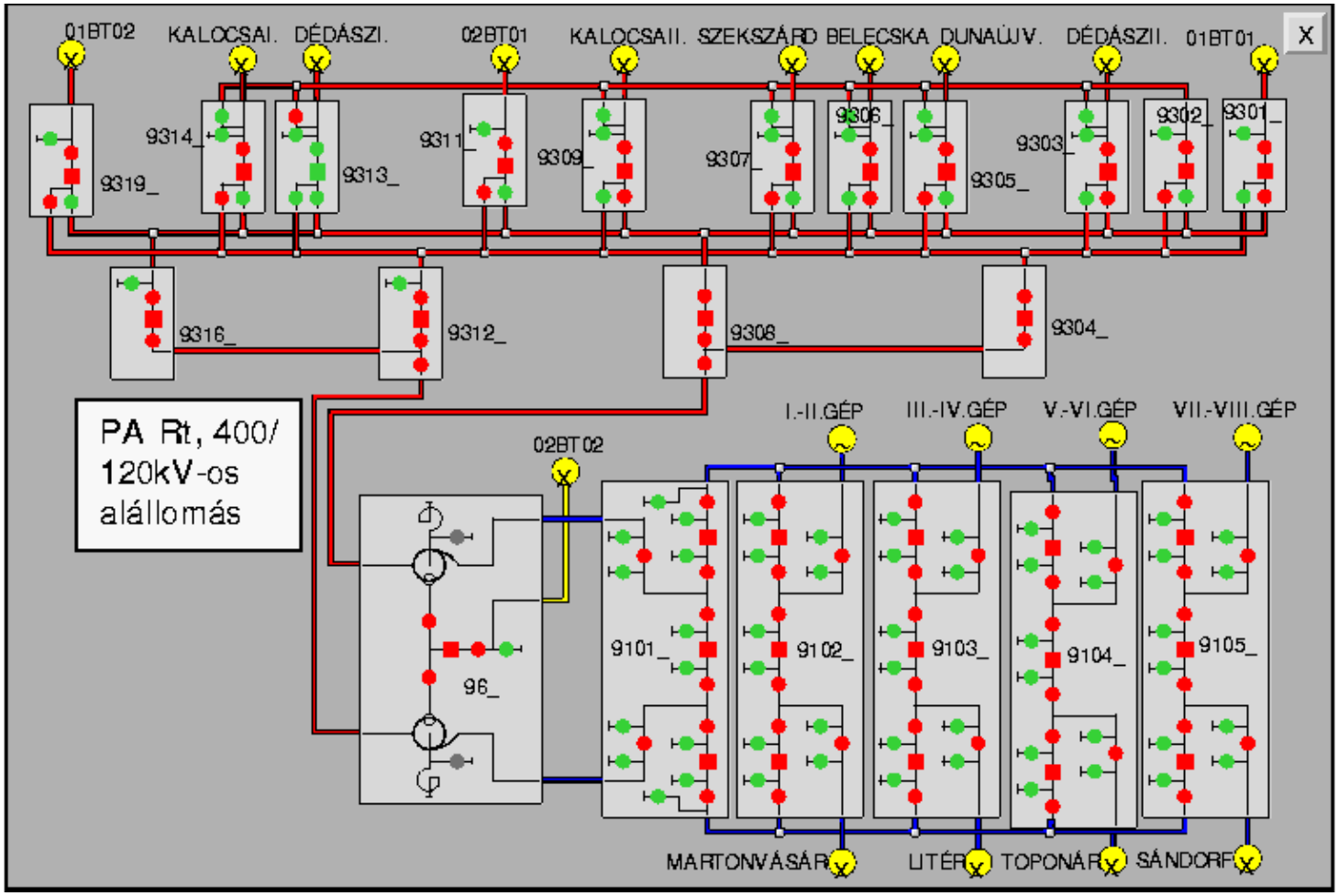
Nuclear blocks

trans
rs
400/
KV

1995-2010

Backbone transmission lines

The substation

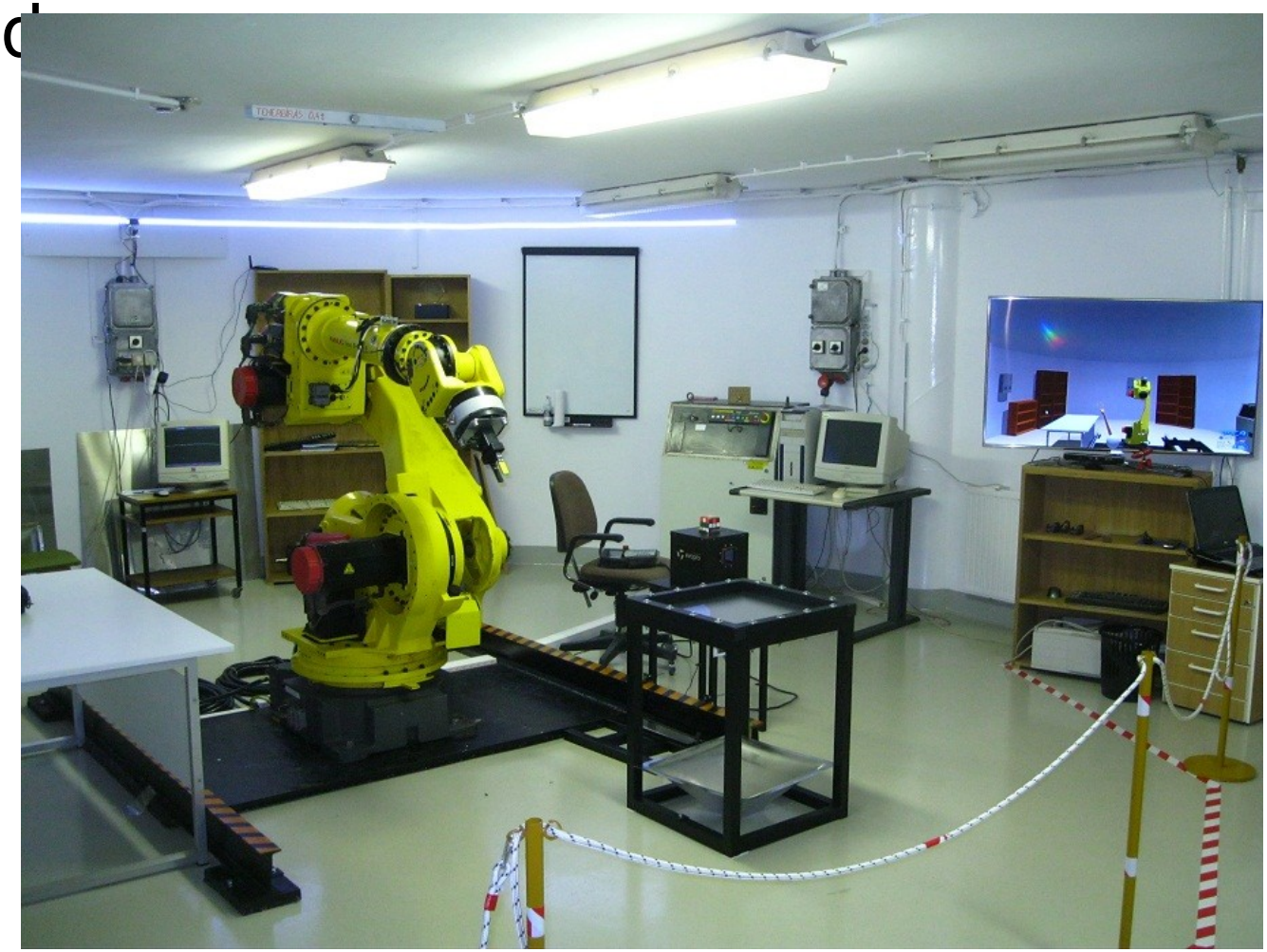


Electrical energy manufacturing/transformation (CIM)

1995-2010

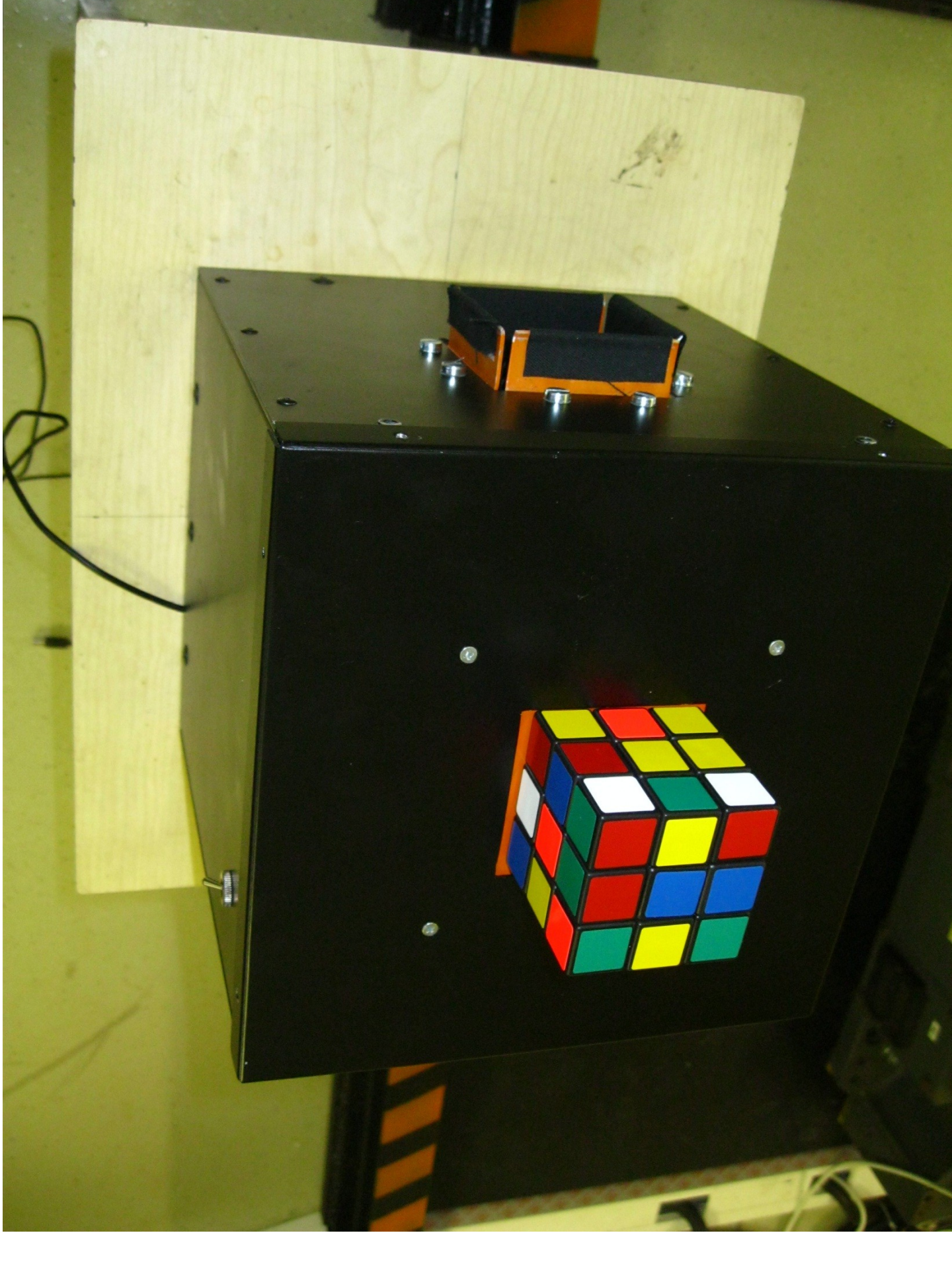
Lab. set-up with a FANUC S-430iF robot

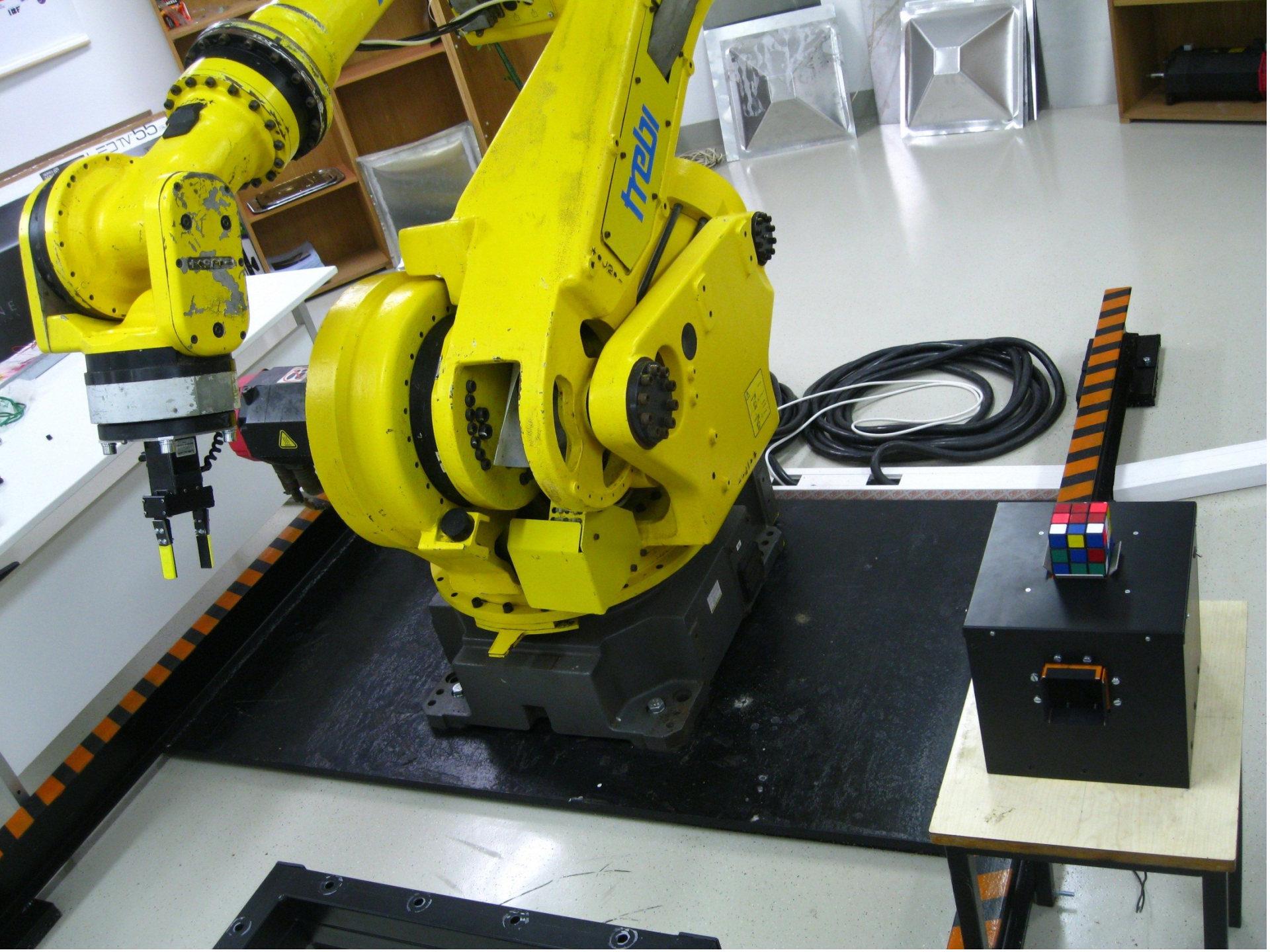
Sheet-metal forming, Jenga and Rubic Cube, etc. d

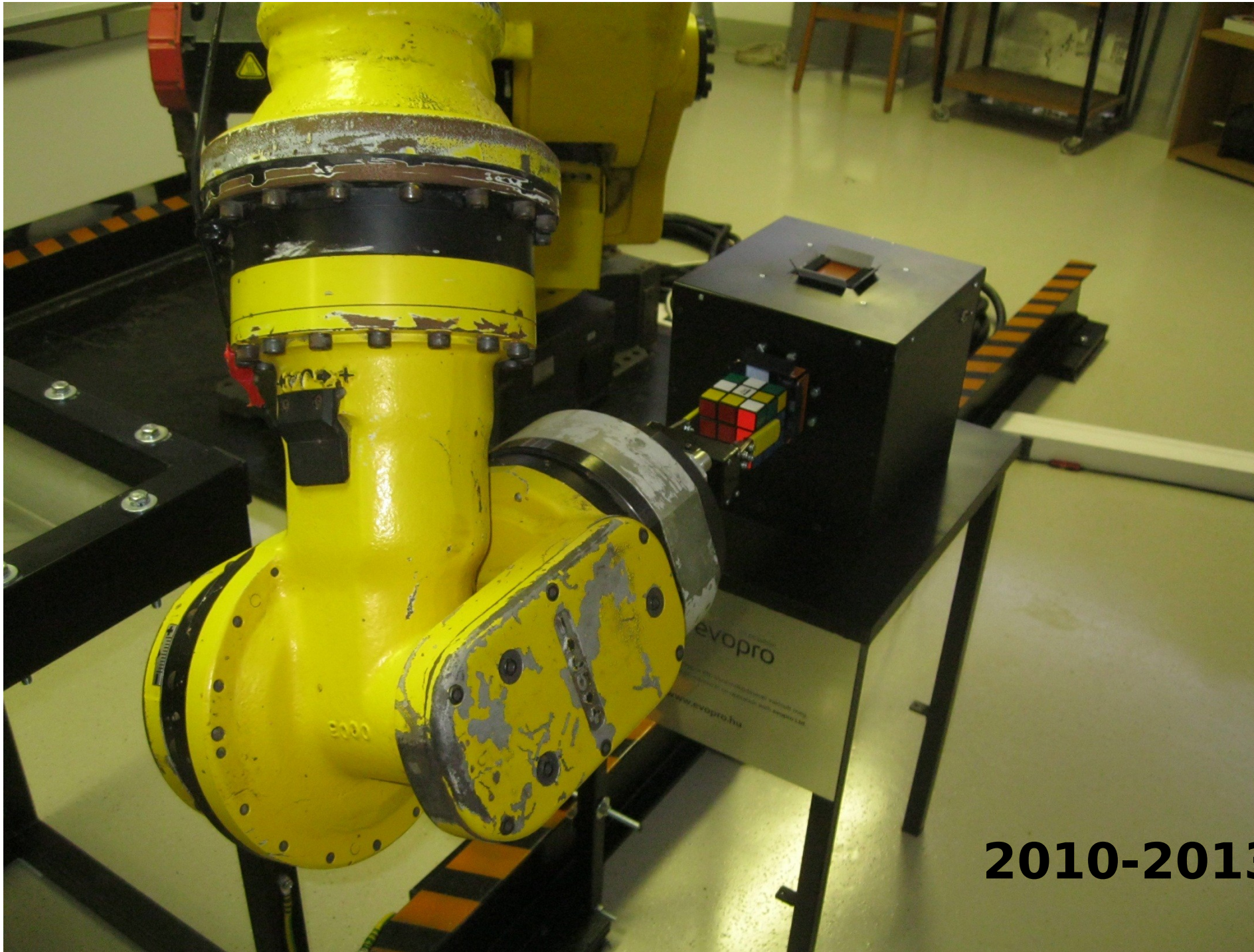


CAM/
CIM

2010-2013

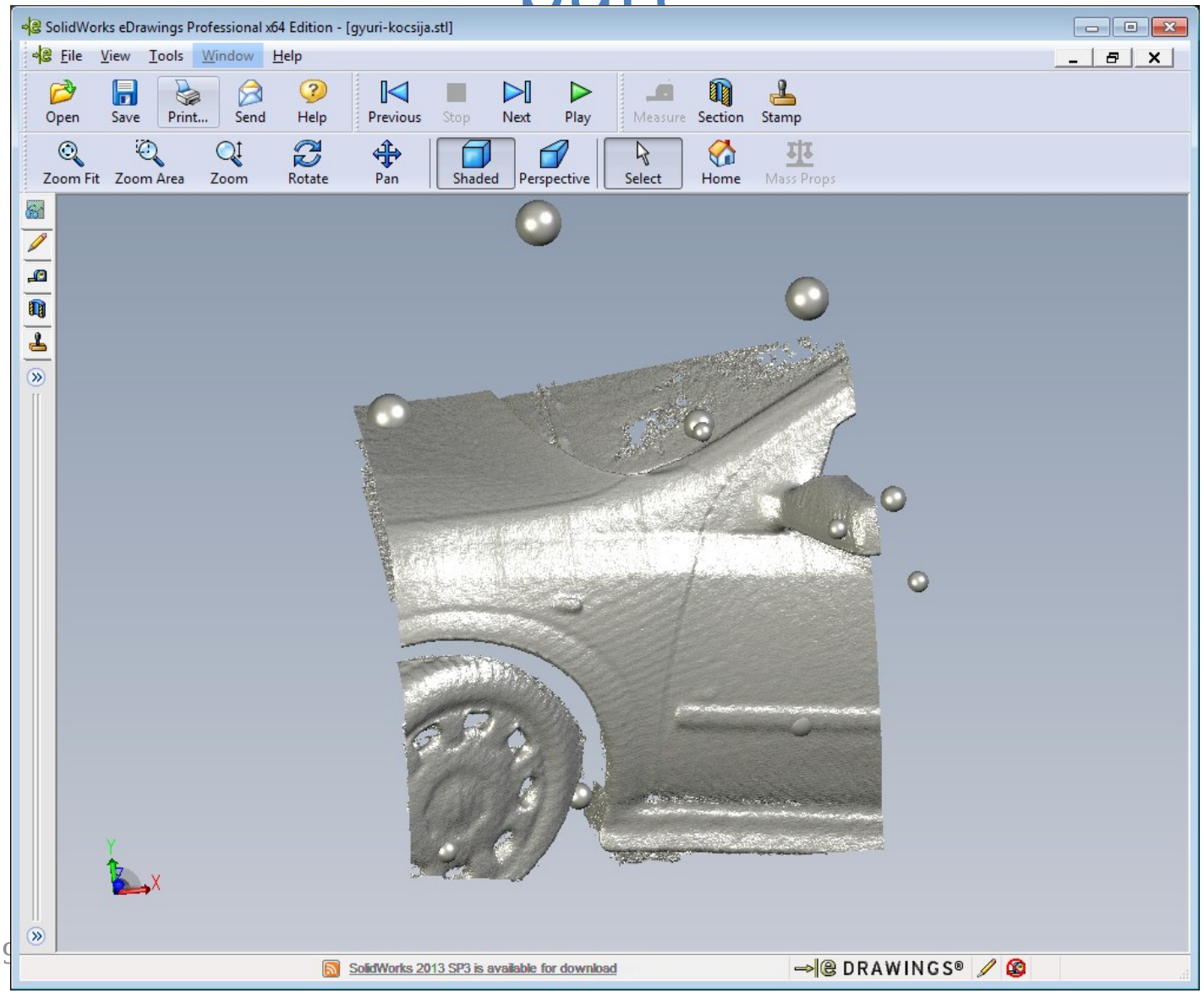





evopro
2010-201


FANUC

A scanned car body sheet-metal part



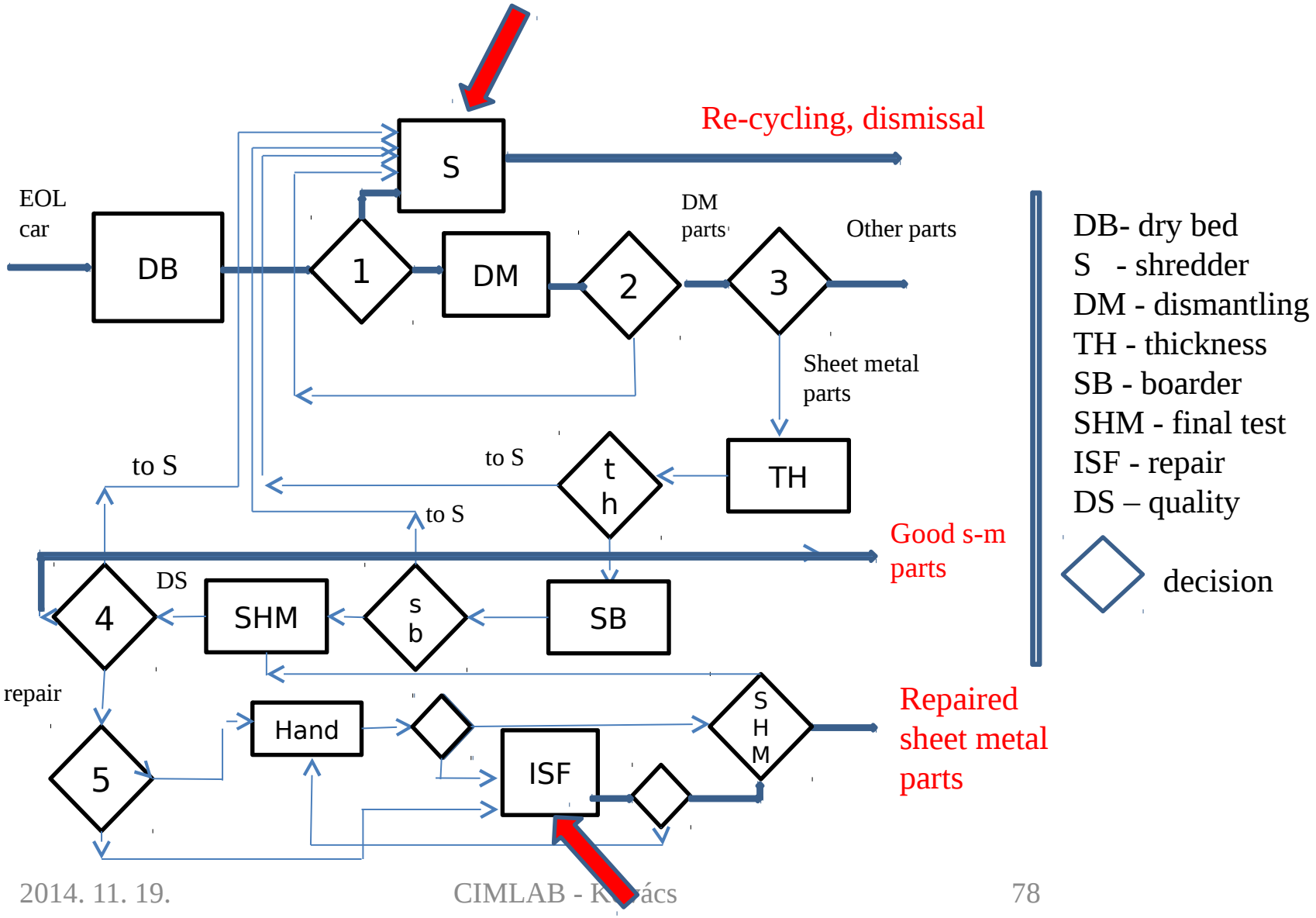
Sheet-metal – car body part

•Figure 4. Car body part

What is necessary to Re-shape a sheet ?

- A proper dismantling technology to remove sheet-metal parts without damaging them
- A measurement technology and software to evaluate and to compare the measured values to requested values, to define the needs of correction
- A technology (ISF) to correct slightly damaged sheets, based on CAD/CAM and CNC/RC data
  - The above digital info may come from design, or from catalog, or by scanning measurements

Management/decisions on EOL cars' sheet-metal parts



Disassembly flowchart - decisions

- 1 **Car arrives,** paperwork
- **2 Dismantling bed** (dry bed)
- 3 **Remove** liquids and dangerous materials (**Unconditional**)
- ***4 Decision 1***: Shredder (S) or dismantling (DM) or delayed (DD)
- 4.1 **if S**: shredder and then burial (dismissal)
- 4.2 **if DM**: disassembly based on a given protocol
- 4.3 i**f DD**: as 4.2, until the next decision can be done
- 5. ***Decision 2***: S or DM - done at any time. Decision: (PS) - (PD)
- 5.1 **if PS&PD**: certain parts are taken apart, the

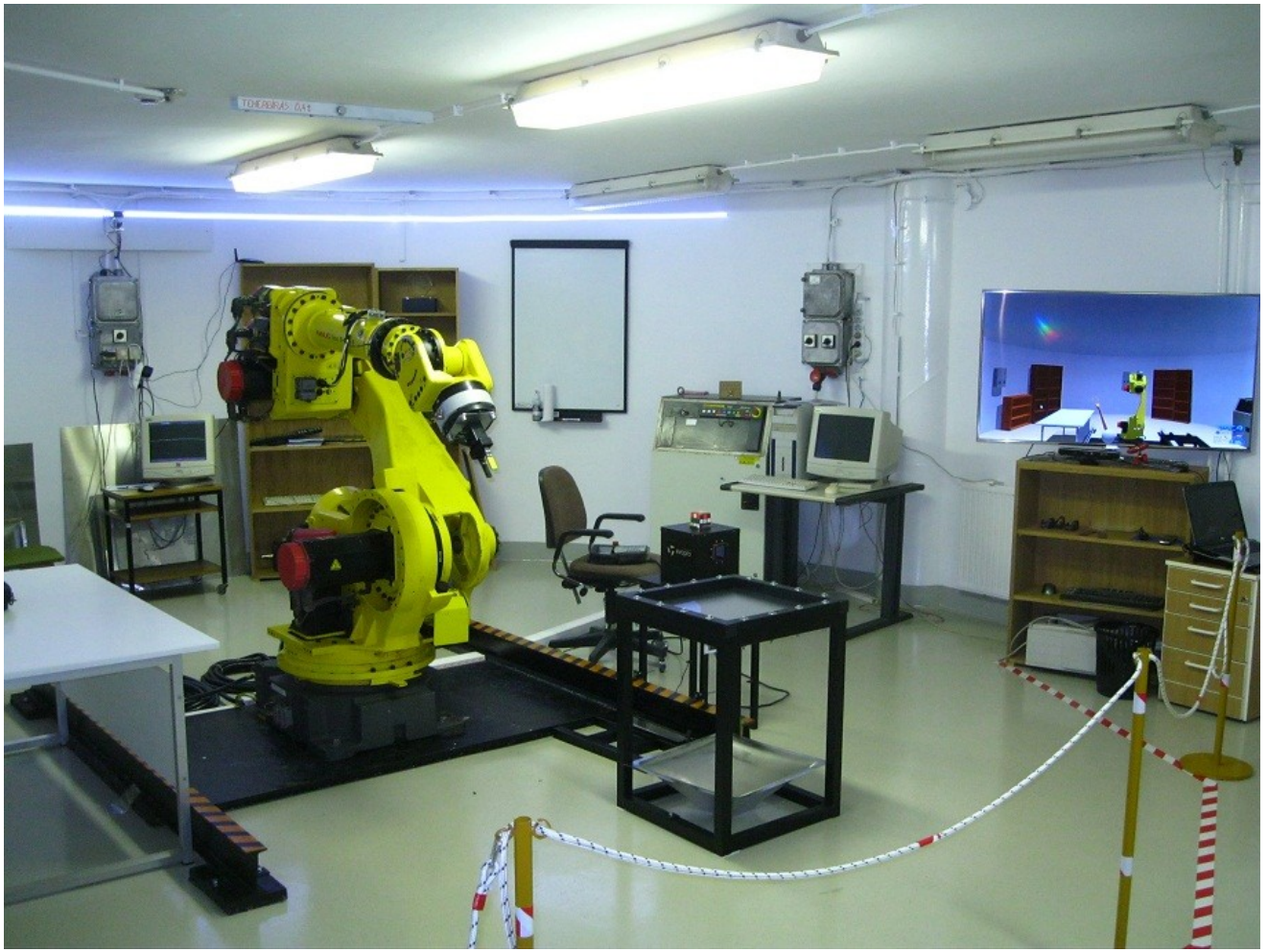
Disassembly flowchart - decisions

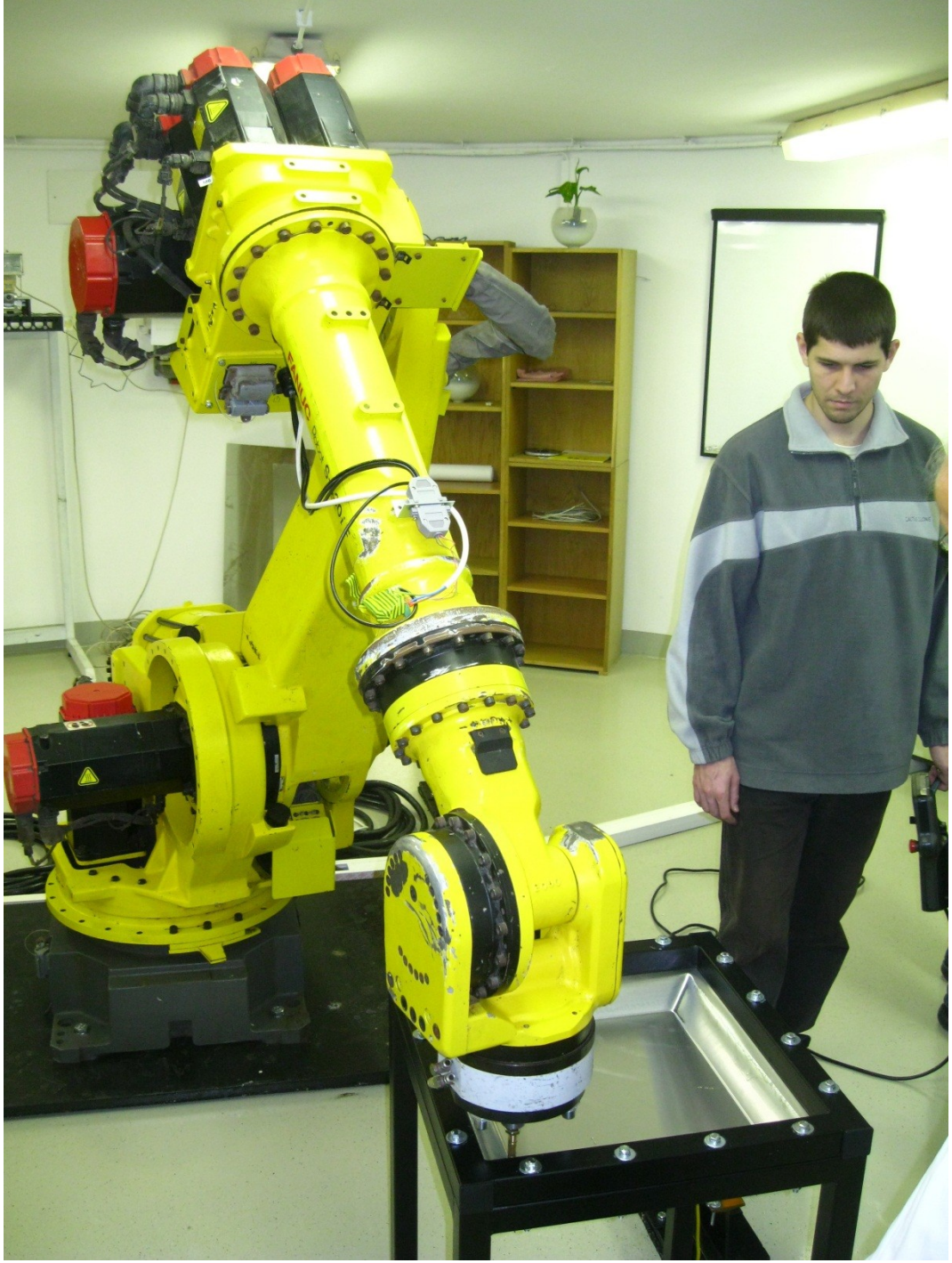
- 6 ***Decision 3***: Select sheet metal parts (SM)
- 6.1 Examine all SM parts, first thickness (TH)
- 6.2 **if TH** is too small, S. The rest boarder checking(SB),
- 6.3 SB by optics and AI and/or by human or both
- 6.4 **if SB** is repairable or good, make shape measurement (SHM)
- 6.5 **Compare** measured sheet (**MS**) to standard shape **(SH**).
- 6.6 **Compare SH with MS**. and calculate differences (DS)
- ***7 Decision 4***: if DS is small enough (defined by the customer, who will need the part, or it is an average value generally accepted), part goes to repair. The rest goes to shredder.

Disassembly flowchart - decisions

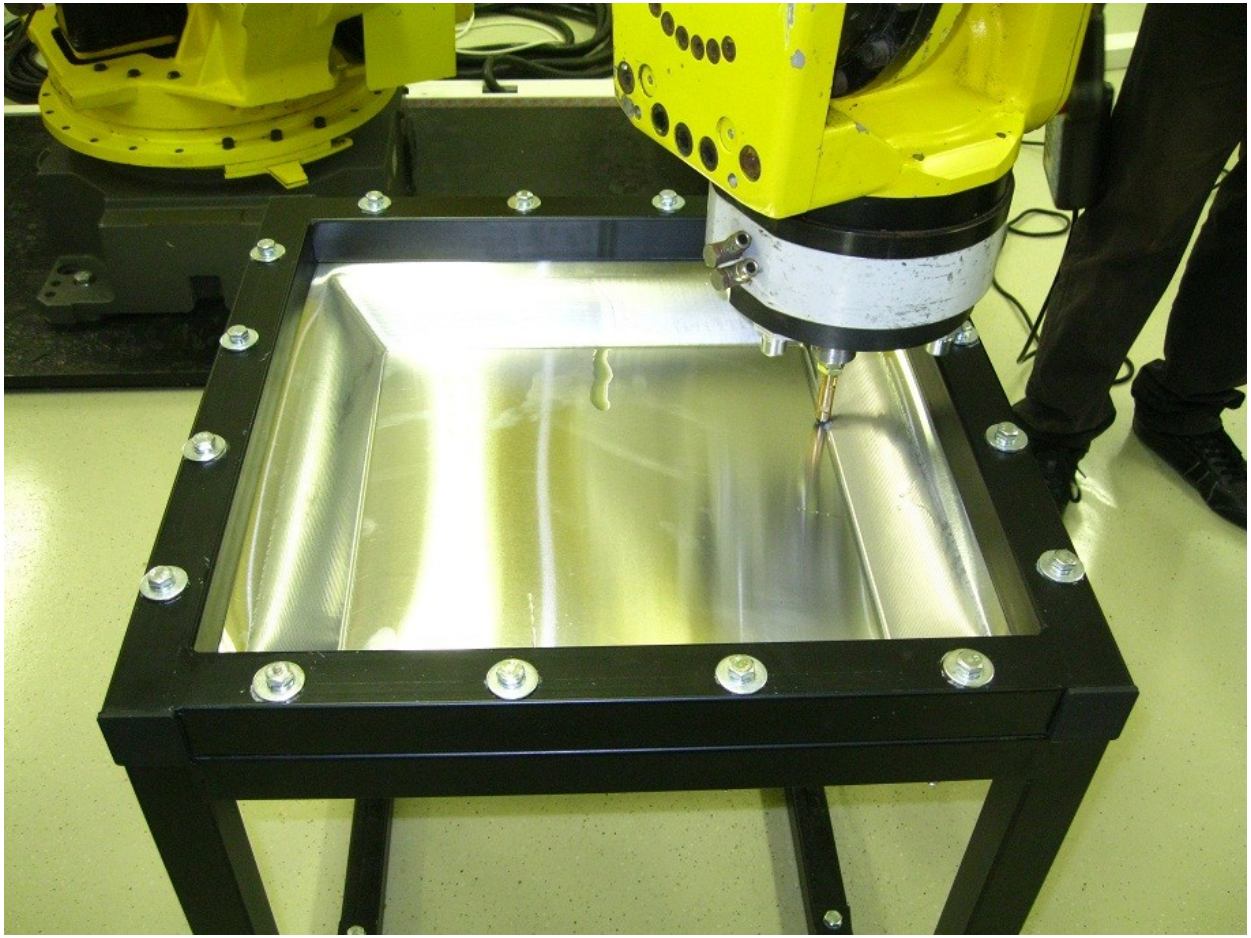
- 8 ***Decision 5***: repair by hand, by ISF or combined, any sequence
- 8.1 **if ISF**: to ISF centre with its CAD/CAM code, and processed
- 8.2 **if Manual or Combined**: part goes to worker, when needed, after or before ISF
- 8.3 **if ISF is done** – a final measurement is needed (SHM).
- 9 ***Decision 6***: if accepted it goes to the shop or to a workshop for painting, and then to a shop to sell.
- 9.1 **if rejected** it goes back to 6.6.
- 10 **The part is accepted,** send to the shop or to business again.

Set-up with the FANUC S-430iF robot

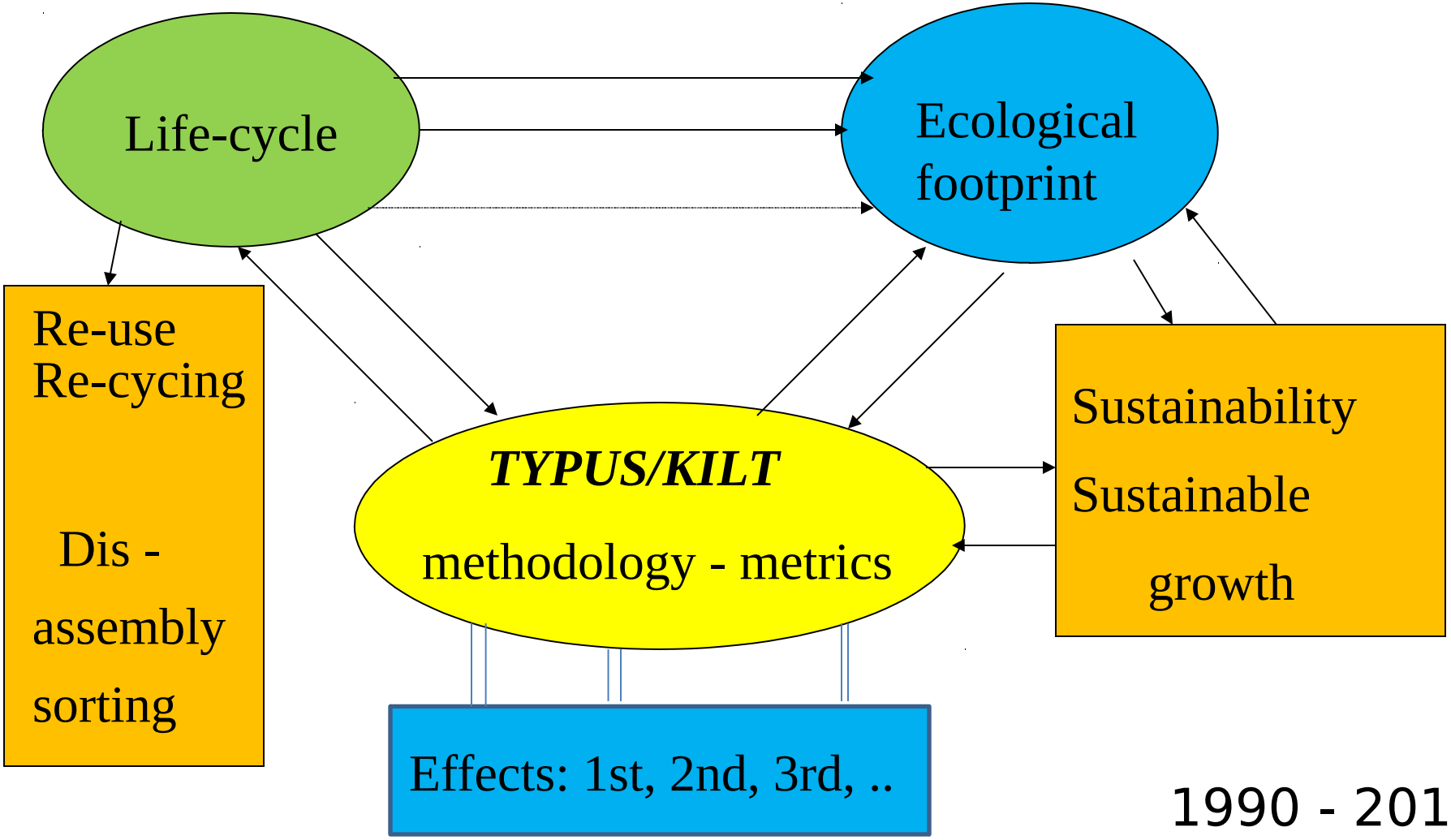




Incremental Sheet Forming with Fanuc robot



LCM-Ecology-Evaluation Relationships



1990 - 2013

TYPUS metrics and *KILT* model

- ***TYPUS*** metrics generally define value measured in money:
- ***TYPUS*** metrics: **T**angibles **Y**ield per **U**nit of **S**ervice

- The ***KILT*** methodology is an application of the ***TYPUS*** metrics, where a balanced compromise is the following:

- **Q**= a0 x **K** x **I** x **L** x **T** - a1x**K** - a2x**I** - a3x**L** - a4x**T**, where

- a0, a1, a2, a3 and a4 are constant values – to be defined/calculated

$Q = f(K, I, L, T)$

Qo=o*KILT*; or incrementally 1990 - 2013

dQ= o*KILT* – (kK + iI + lL + tT)

Q – all enterprize delivery

Q is defined by primary (1) and secondary (2) production factors:

2. *K*: Technical capital – knowledge, technology, know how, etc.- intangibles

1. *I*: Financial capital – investment, capital, etc.

1. *L*: Human capital – labor, human efforts, welfare charges, etc.

2. *T*: Natural capital – tangible resources: material, consumables, ecological fees, utilities, commodities, etc.

- There is a tetra-linear dependence - balanced
- The *KILT* models reliably describe the delivered product quantities, *Q*.
- Lacking any one contribution (any of the above factors has a value of 0), as a result the balance is gone - false or meaningless

$$dQ = Qp2\text{-}Qp1 = o*KILT* – (k*K* + i*I* + l*L* + t*T*),$$

With a simple change taking into account the profit, or losses corresponding to the given activity we get:

dQ = (dk+dI+dL+dT) + dP

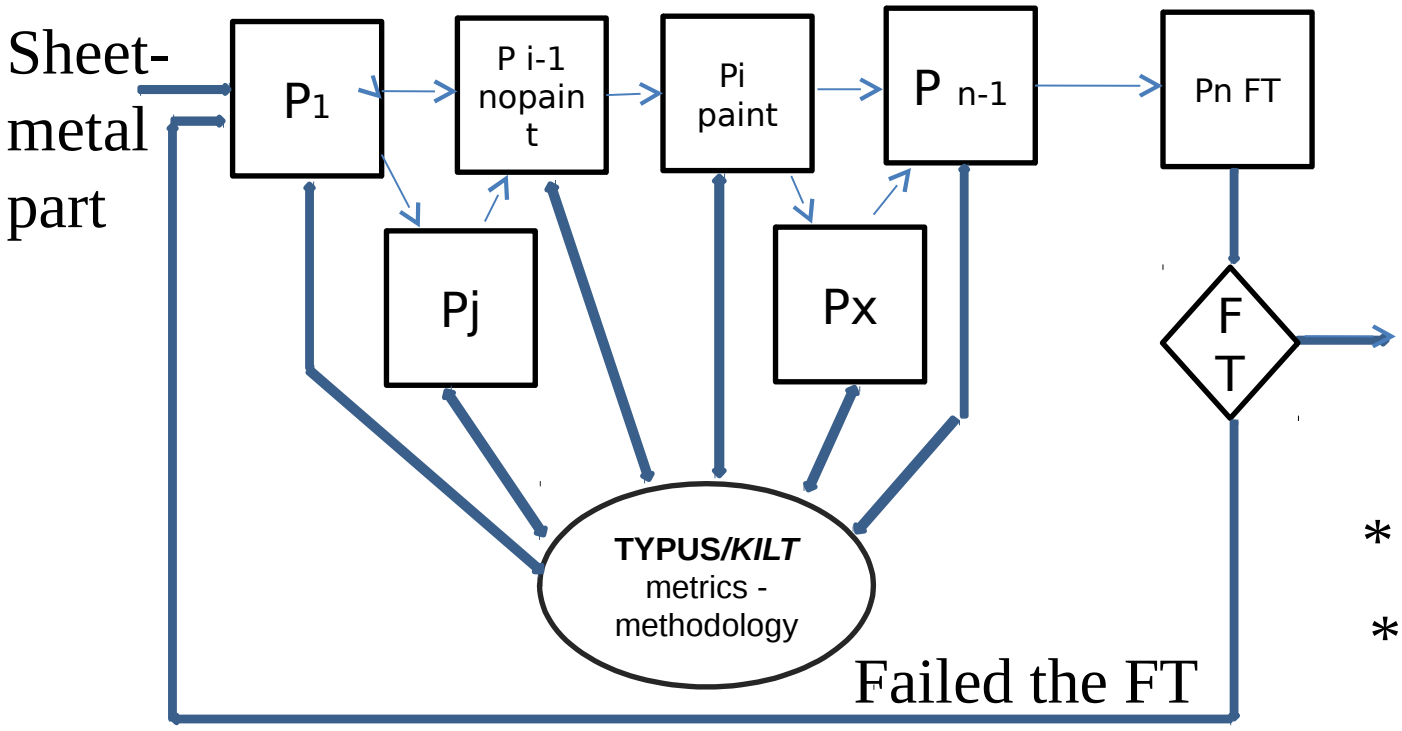
- **IF** the know-how (K), investment (I), human work (L), and used material (T) costs more than the value increase of the part:
- Qp1 > Qp2, or dQ< 0 ⇒ dP<0

➔ the given step did not produce profit, but losses.

- Profit of a factory:
- Starting point (idea, row materials, machines, etc.)

  versus Final point (a brand new car for example)
- Profit of an ISF (or painting) workshop on one operation:
- Value of repaired part – (value of the defcct part + expenses)
- (Value of painted part – (value of the unpainted part + expenses)

dQ/*KILT* calculations between pairs of LCM states

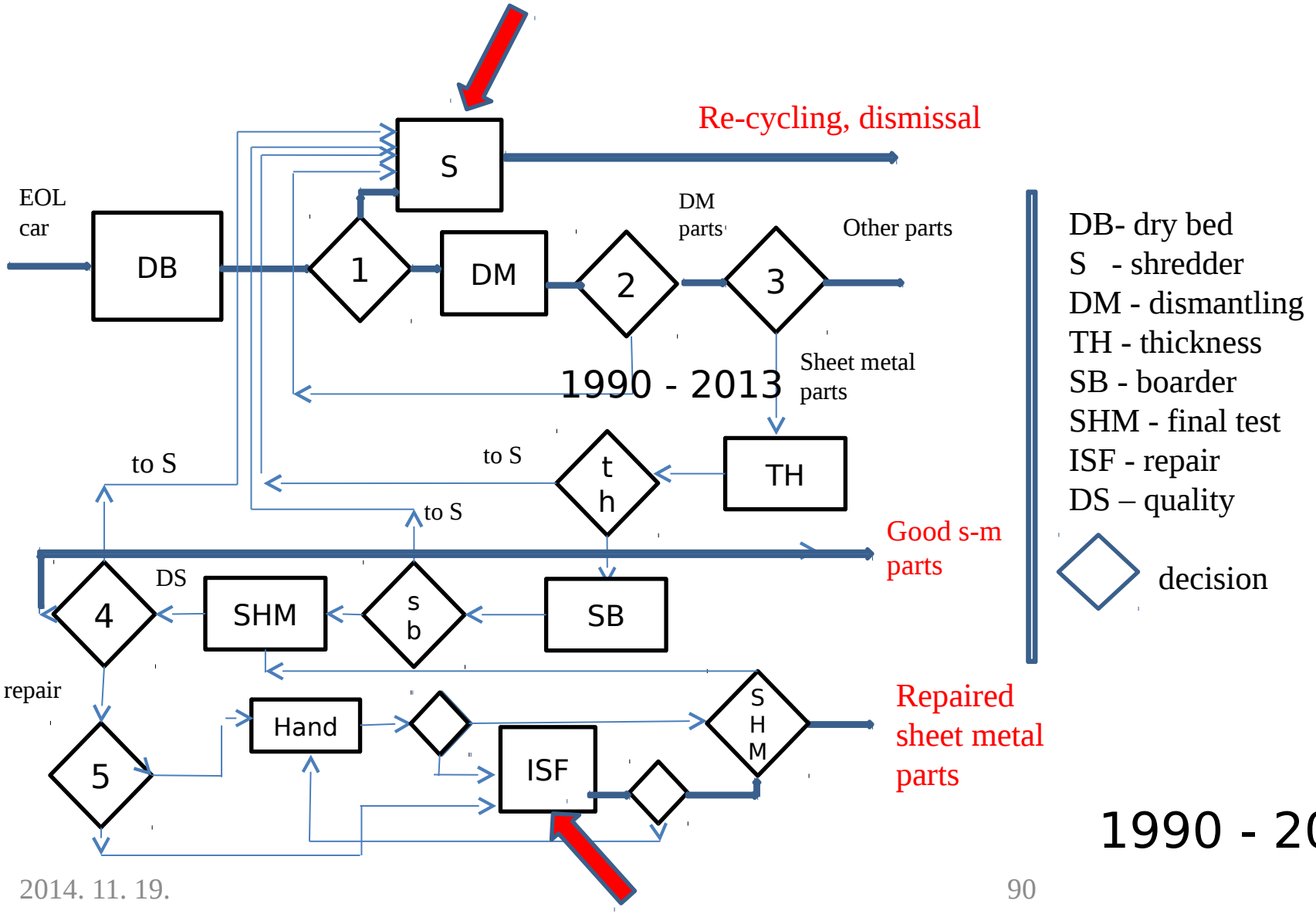


* FT : final test

* Pi: LCM state

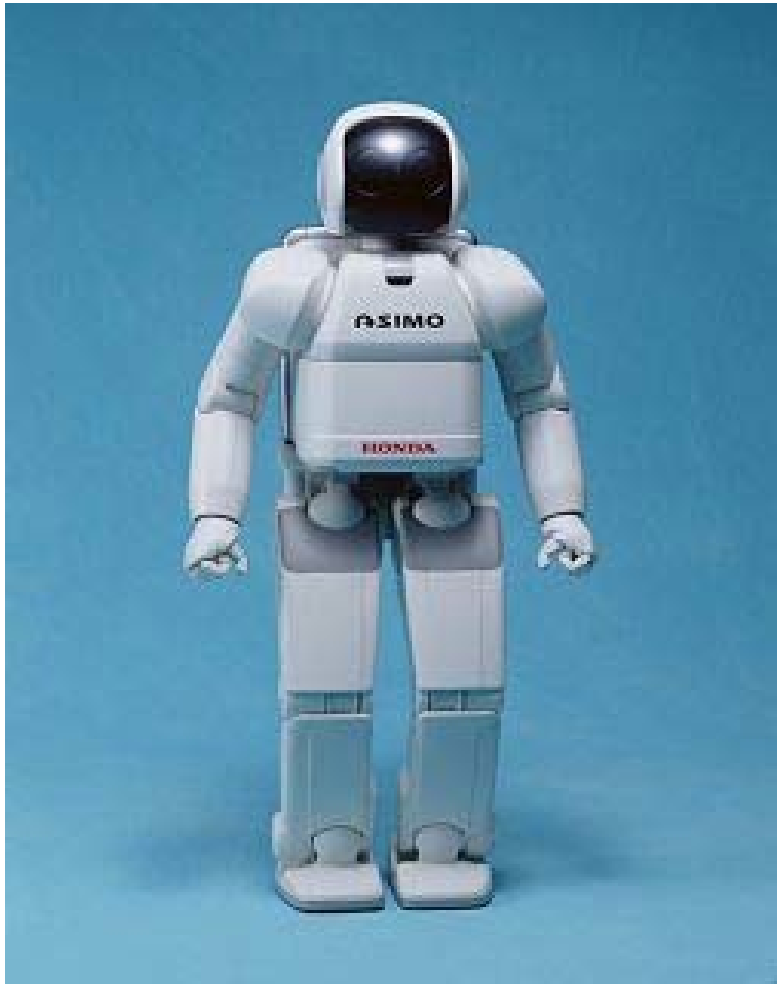
1990 - 2013

Management/decisions of EOL cars' sheet-metal parts

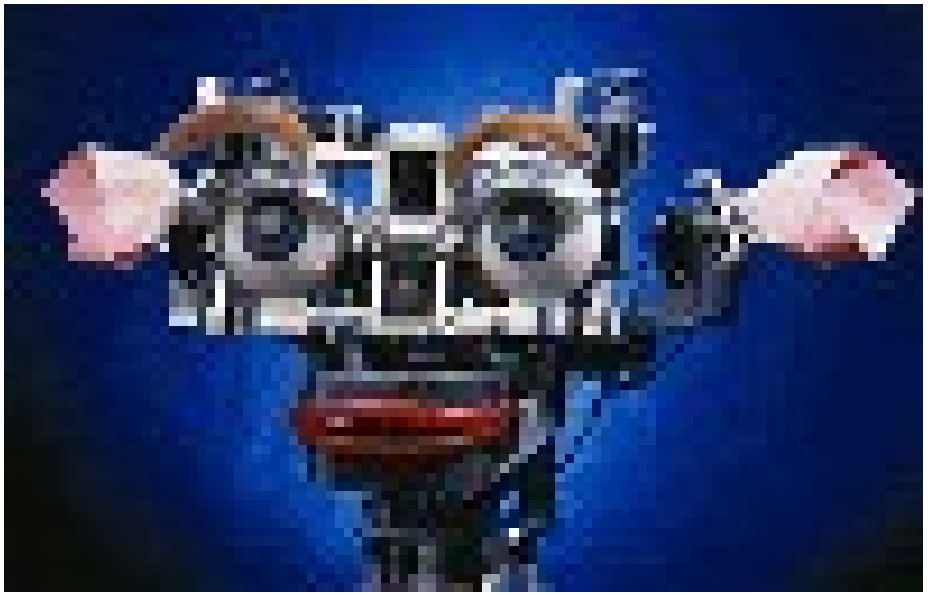


Some Robots

ASIMO



KISMET



AIBO

SOME MORE ROBOTS

NAO H25

R2

C-3PO

Intuitive Surgical, Inc.

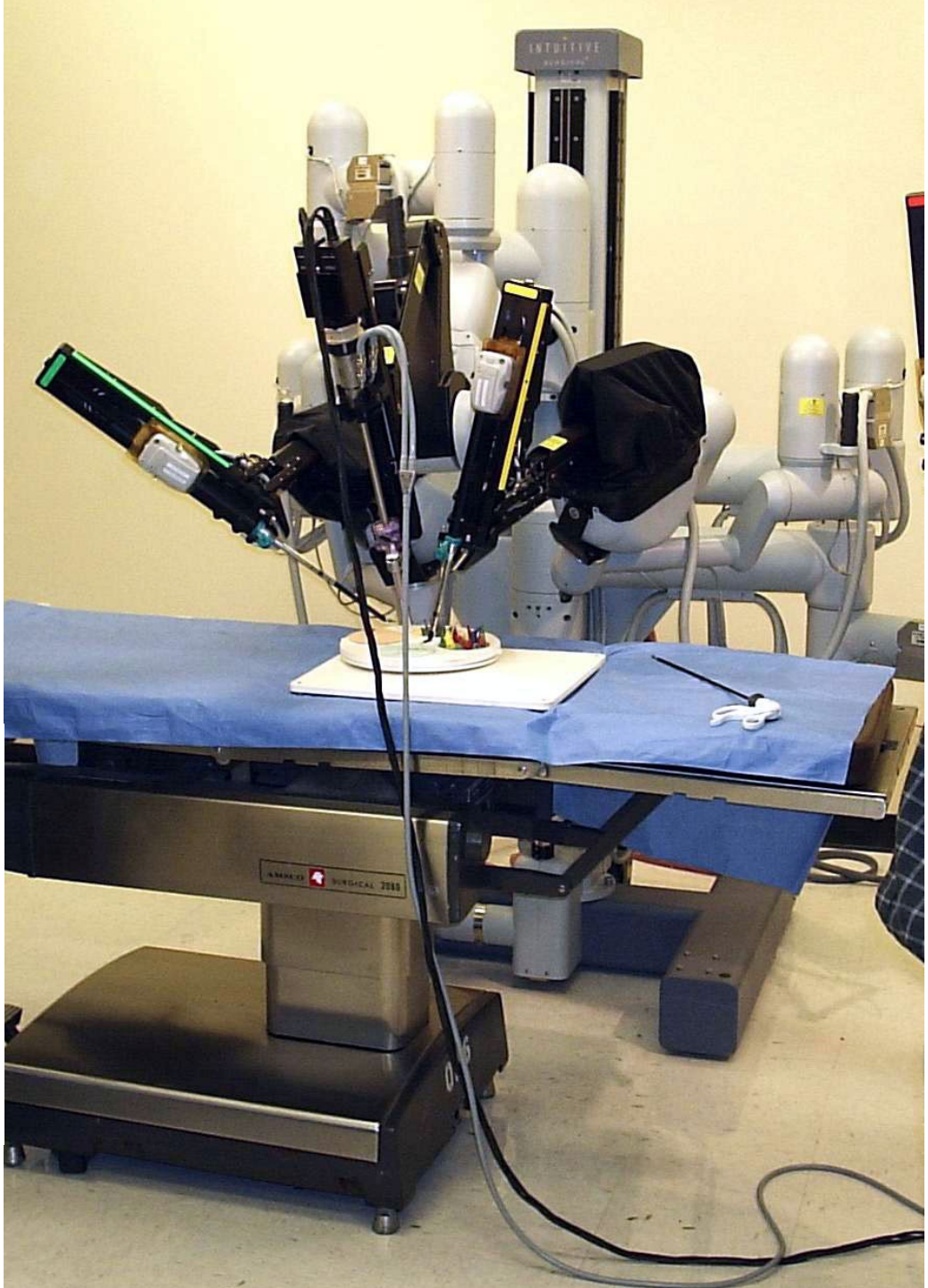
-

***da Vinci* Surgical System**

***da Vinci*®...**

Changing the Experience of Surgery

Human CIM



Manipulator – Robot 1. gen. – Robot 2. gen. – Robot 3. generation - Microrobot

–

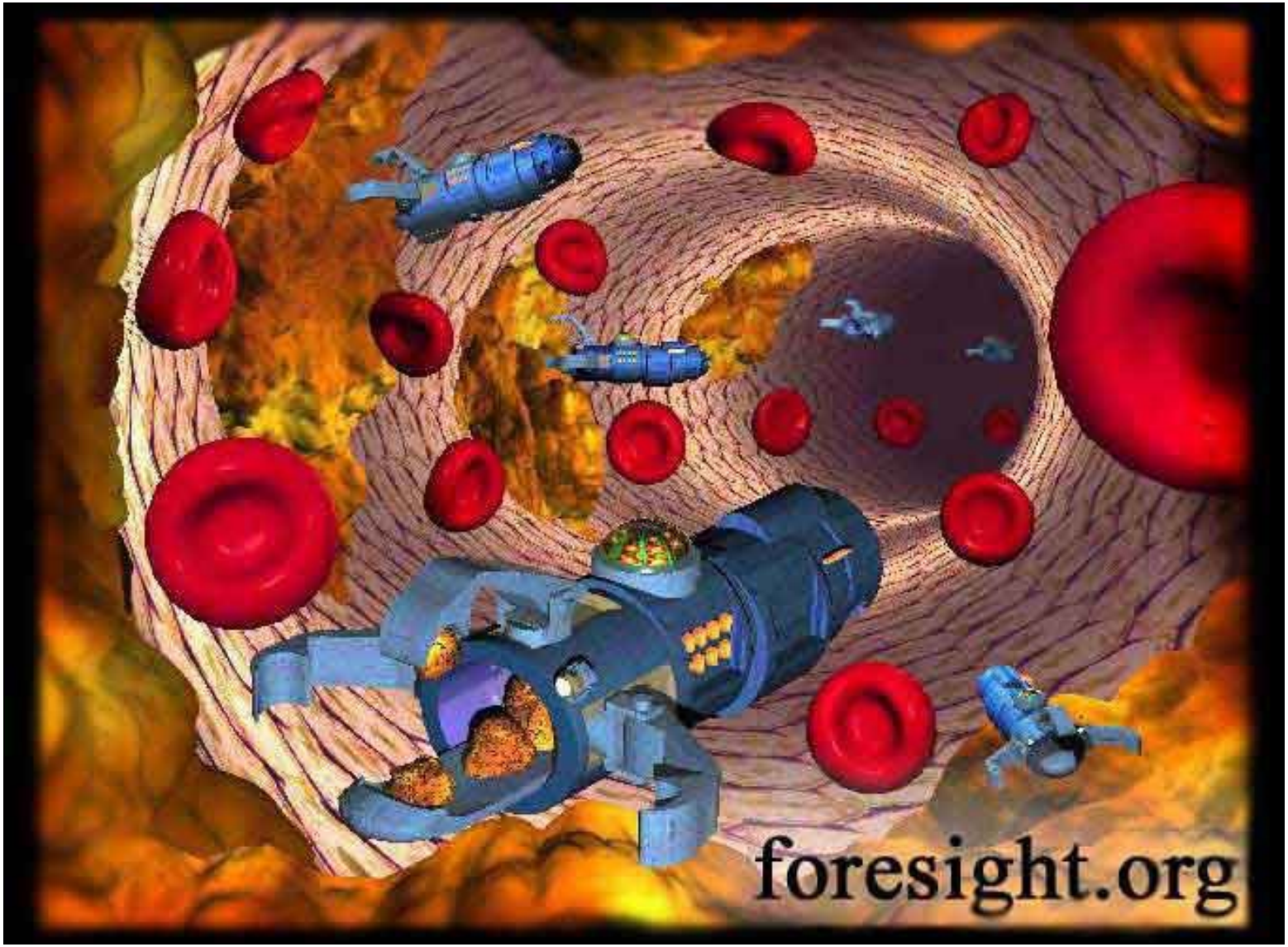
Nanorobot

The knowledge of : Robot -- Computer -- Biology -- Chemistry

Foresight Institute, Palo Alto, Calif. USA : Technology Roadmap for Productive Nanosystems

„A well designed nanorobot may work as the hemoglobin. Letting it into the blood system it produces O2 and absorbs CO2, or vica versa. It can deliver 200 times more O2, i.e. 1 liter (1000 ccm) O2 rich nanorobot in the blood may cause an adult to breathe only once in every 4 hours.”

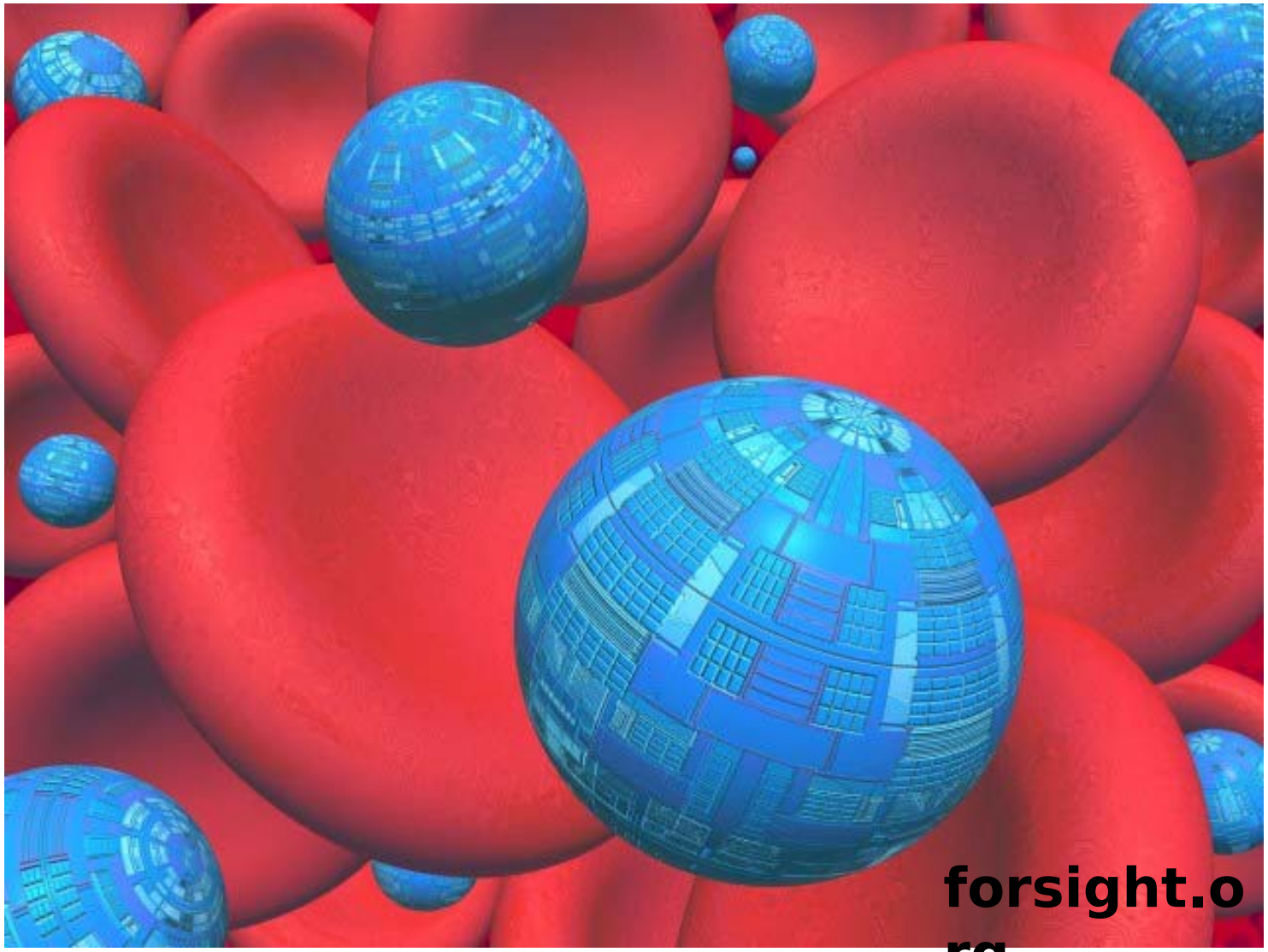
Nanorobot, examples



2012 - 2013

Nanorobot

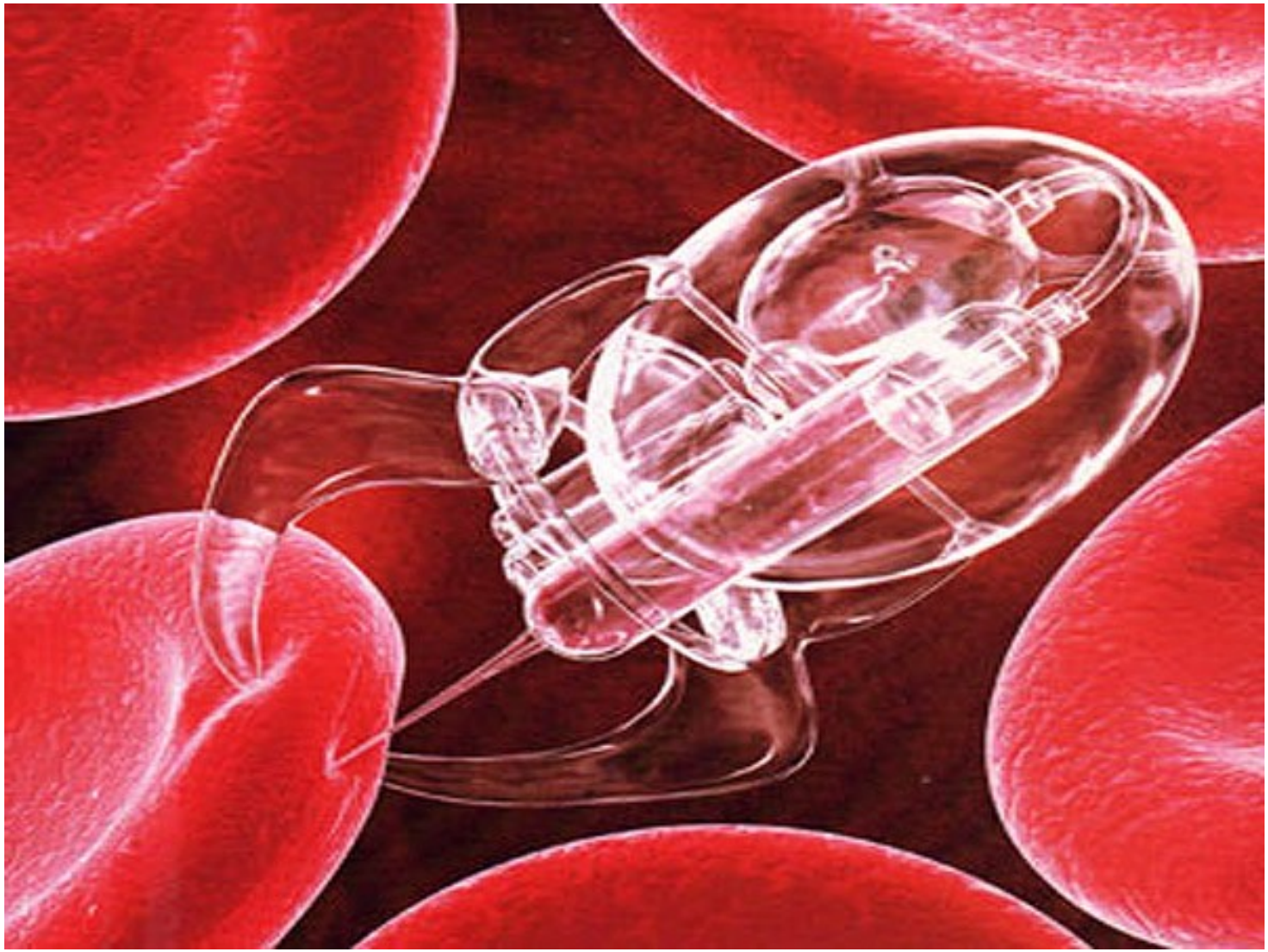
Nanorobot



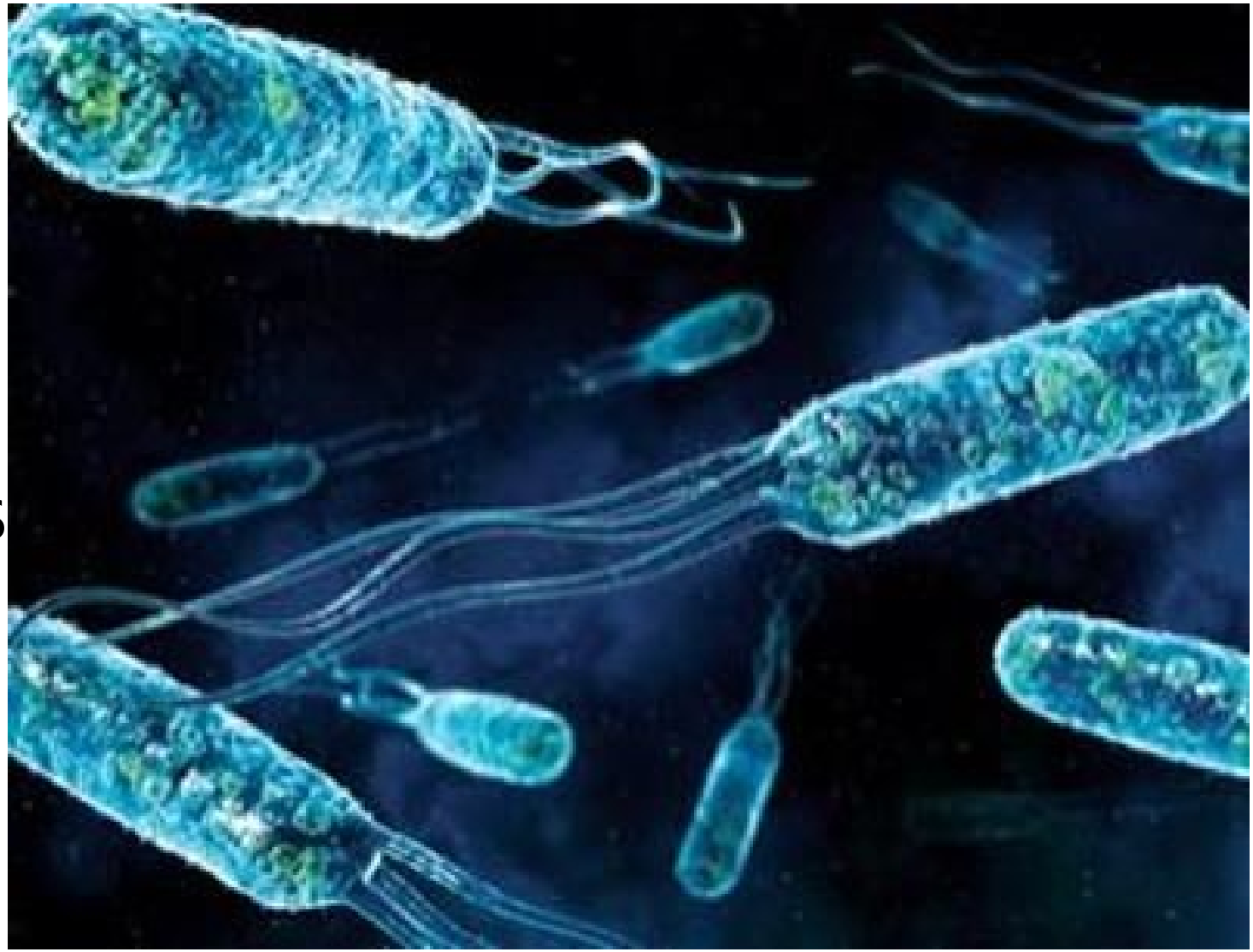
Nanorobotok

2012 - 2013

DN
S



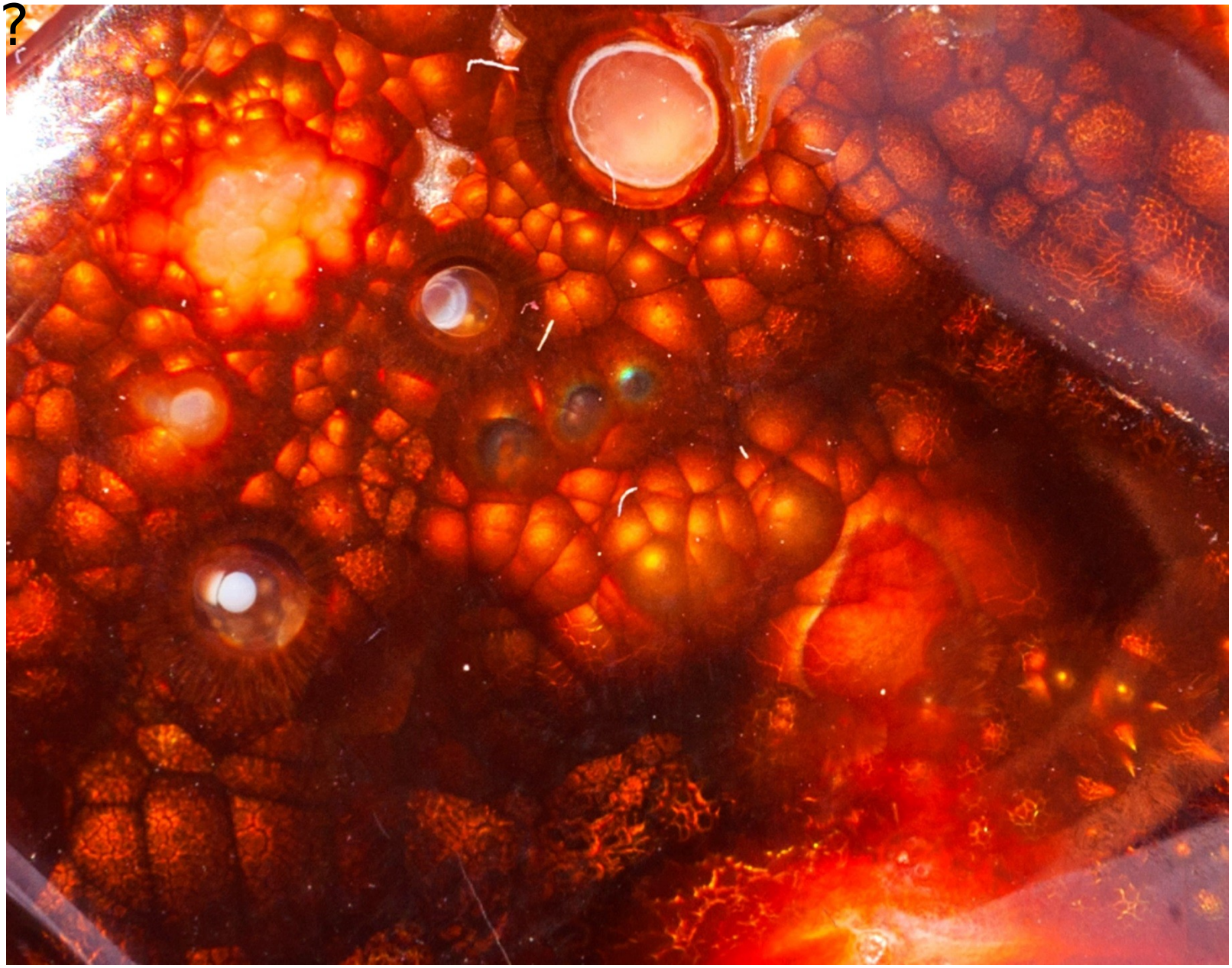
DNS



Nanorobot ?

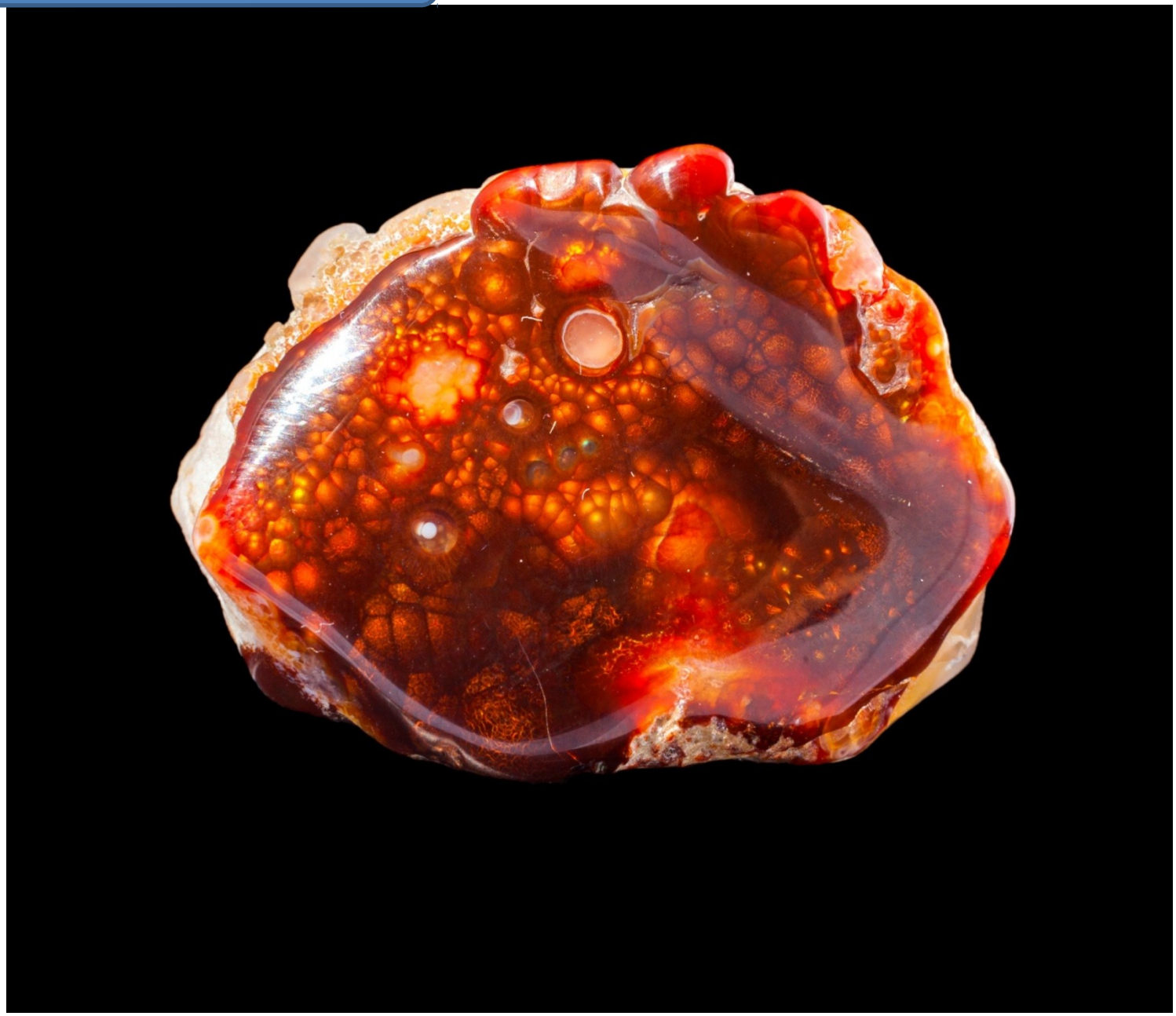
1966 - 2013

?



Nanorobot ??

1966 - 2013



Book to appear in
2015

KOVÁCS GYÖRGY

ÁSVÁNYGYŰJTEMÉNYEM
** KEDVENCEIM **

MY FAVORIT MINERALS
Budapest, 2014

Thanks a lot for your patience !!!