

Introduction: Processes, information systems, and transition systems

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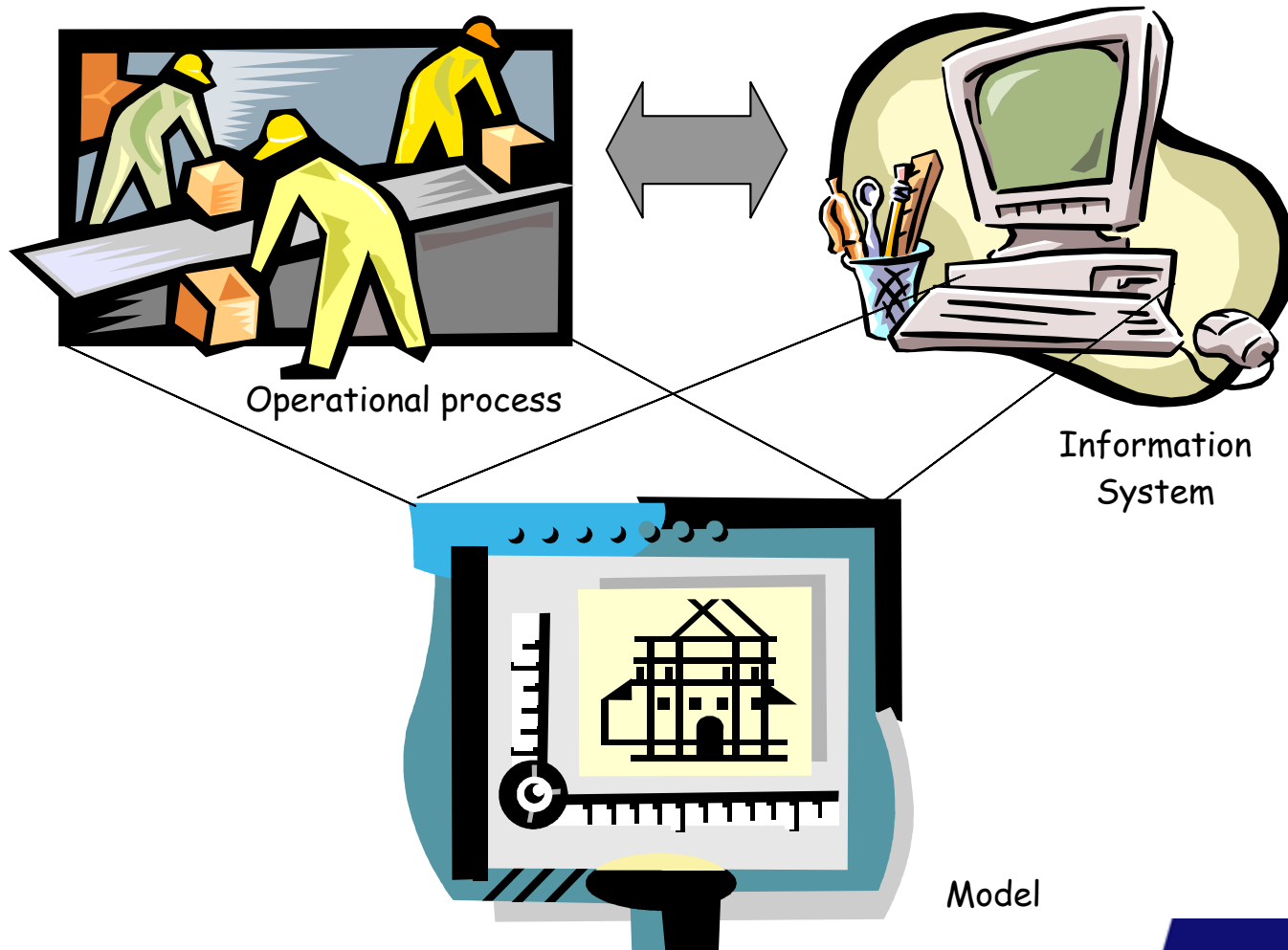
Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

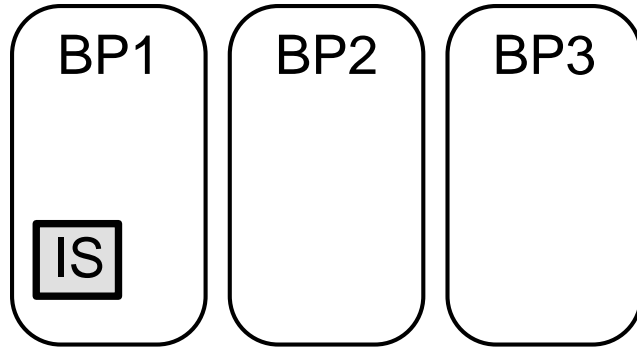
Outline

- **On the relation between processes, systems, and models**
- **Basic model: Transition systems**
- **Process models versus object/data models**
- **Petri nets and other process modeling languages**
- **Applications/tools**
- **Process-aware information systems: Trends**

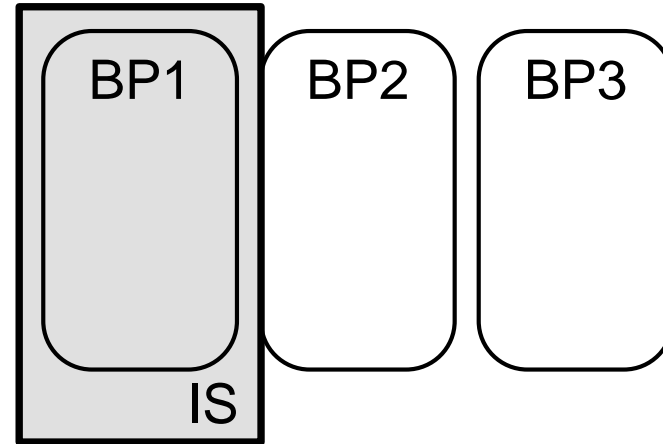
On the relation between processes, systems, and models



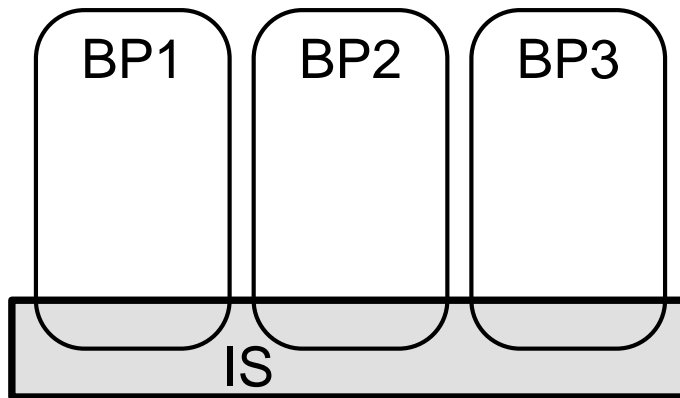
On the relation between information systems and processes



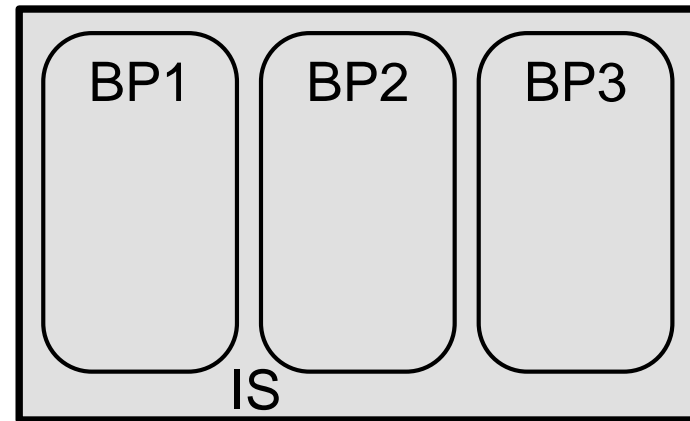
(a)



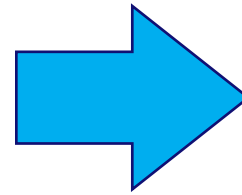
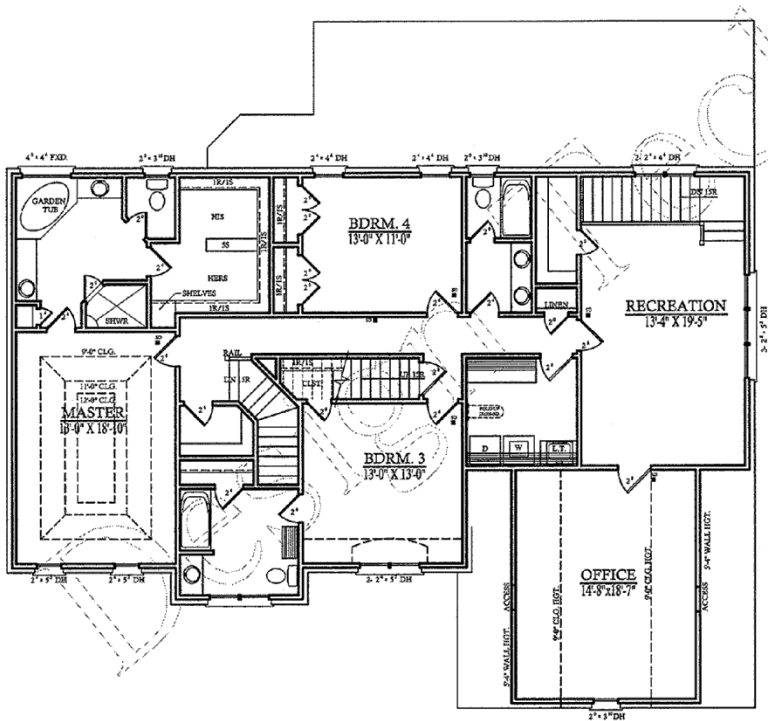
(b)



(c)



(d)



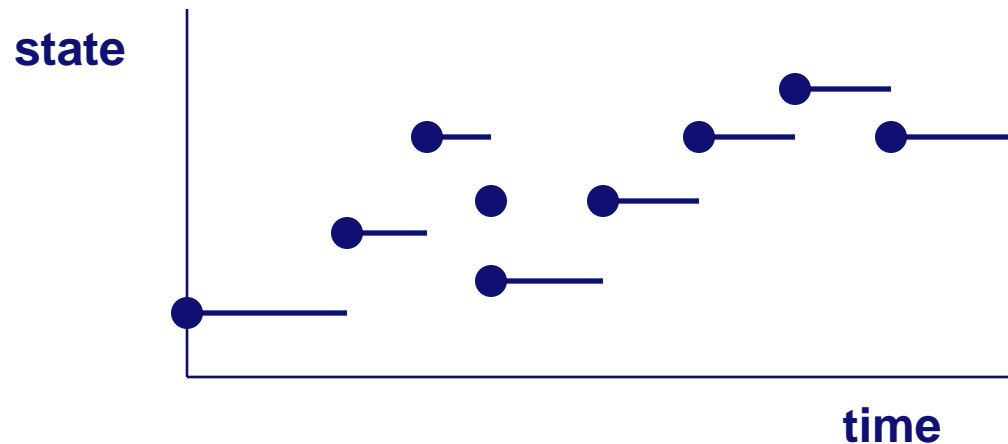
Three good reasons for making a process model:

- **gain insight**
for a better understanding of the system
- **analysis**
validation and verification
- **specification**
a blue print for construction

Basic model: Transition systems

- ***Any discrete dynamic system can be described as a transition system.***
- **Low level model: Mother of all (process) models.**
- **Elements:**
 - **State**
 - **Transition**
 - **State space**
 - **Transition relation**

Discrete dynamic systems



- Y-axis is state space.
- Bullets are transitions (no continuous changes, only discrete ones).
- One possible execution: Transition relation is not described.

Definitions

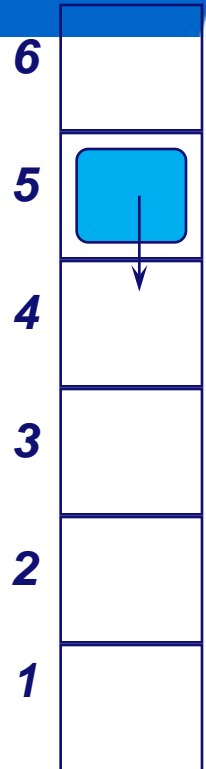
- A transition system is specified by a pair (S, TR)
 - S is the state space
 - $TR \subseteq S \times S$ is the transition relation
- The elements of S (state space) are states.
- The elements of TR (transition relation) are transitions.

1) Model a light bulb with three states (on, off, broken).

2) Model a queue in a supermarket.

Example: Elevator

- **State space:** $S =$
 $\{ (floor, direction) \in \mathbb{N} \times \{-1, 0, 1\} \mid$
 $(1 \leq floor \leq 6) \wedge$
 $(floor = 1) \Rightarrow (direction \geq 0) \wedge$
 $(floor = 6) \Rightarrow (direction \leq 0) \}$
- **Transition relation:** $TR =$
 $\{((1,0),(1,1)), ((1,1),(2,1)), ((1,1),(2,0)), \dots$

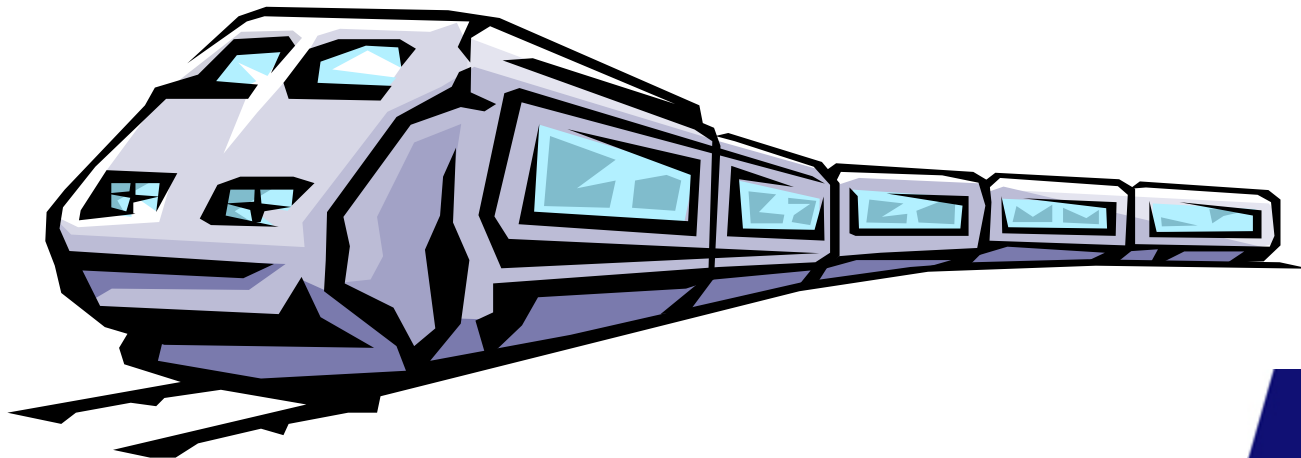


Describe transition relation formally.

Give graphical representation.

Exercise: Make transition system

- Consider a circular railroad system with 4 tracks (0,1,2,3) and 2 trains (A,B). No two trains should be at the same track at the same time. Trains can only move clockwise.
- Imagine how this would be if there are 50 tracks or more complex rules like claiming the next track or keeping tracks free in-between trains.



Exercise

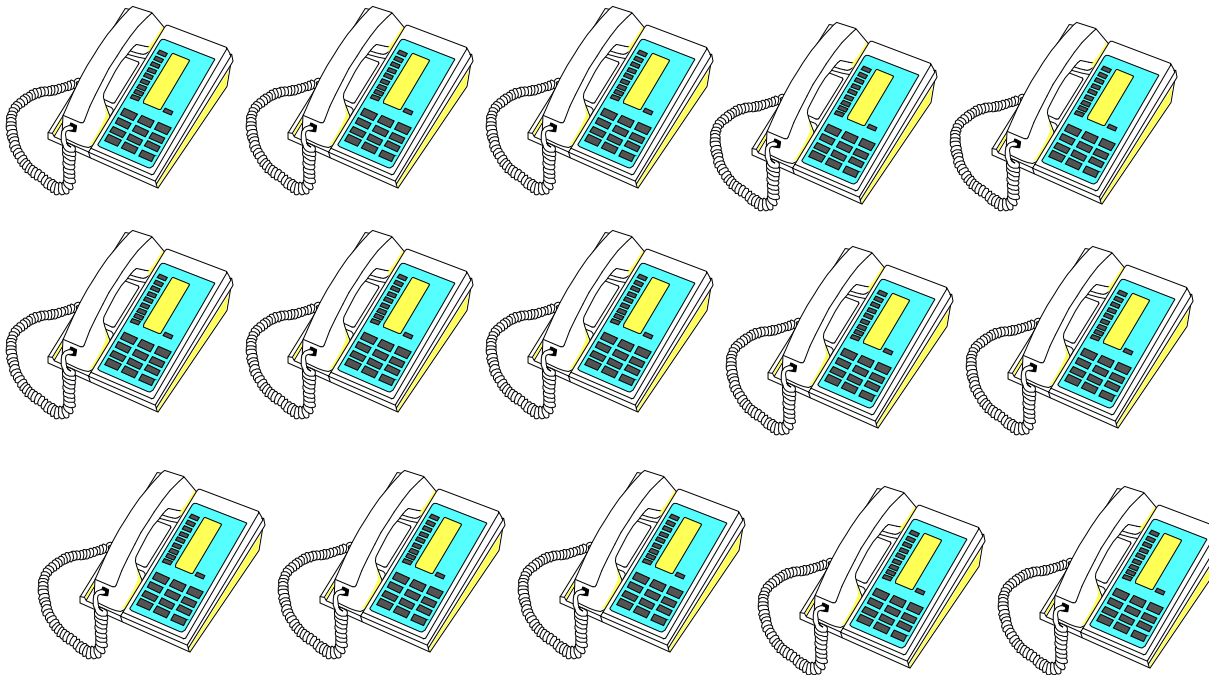


- Consider two parallel queues in a supermarket
- Describe transition relation formally.
- Give graphical representation.

State explosion problem



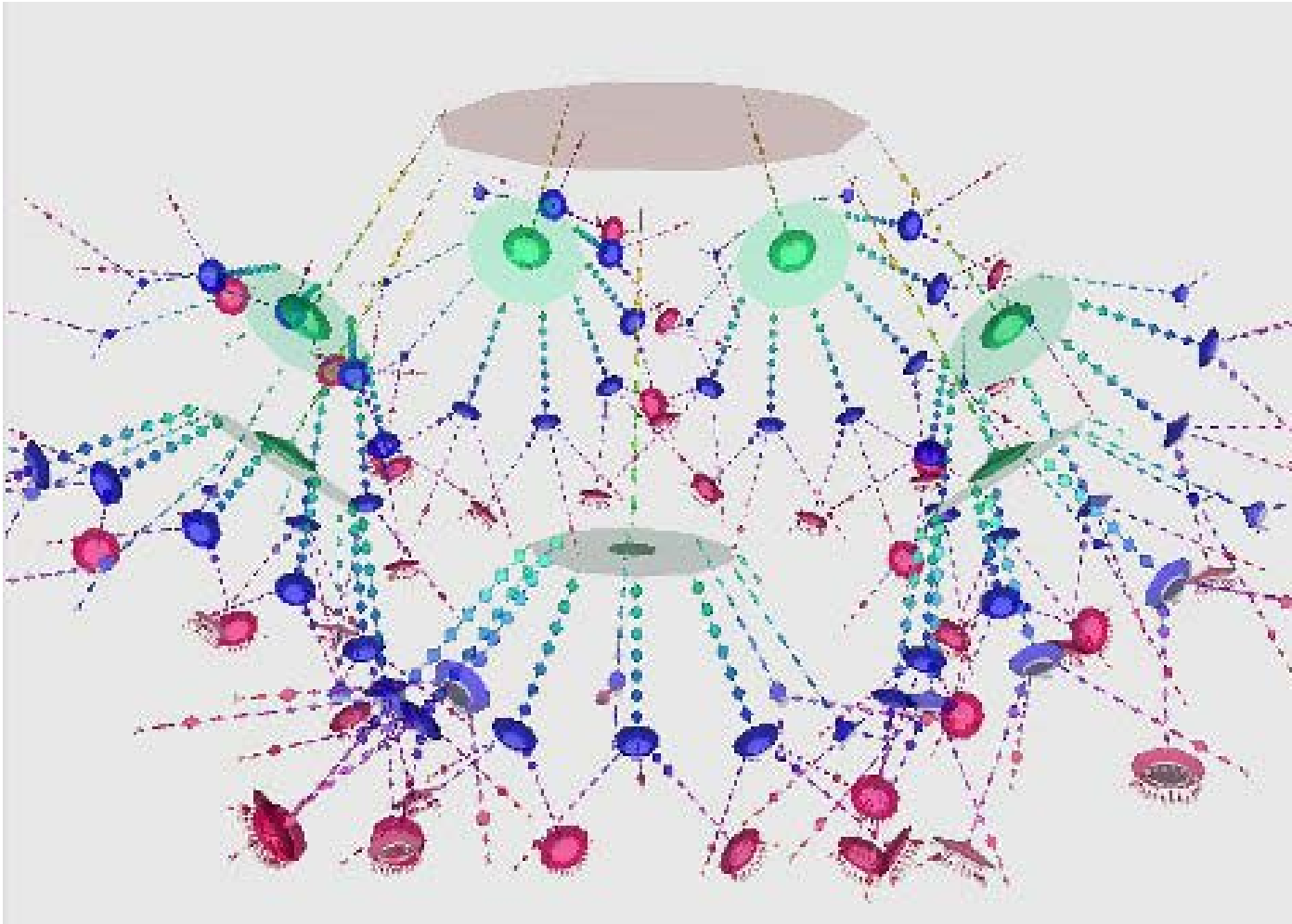
50 states



$50^{15} = +/- 305175781250000000000000000000$ states

Large state spaces ...

Figure taken from Frank van Ham



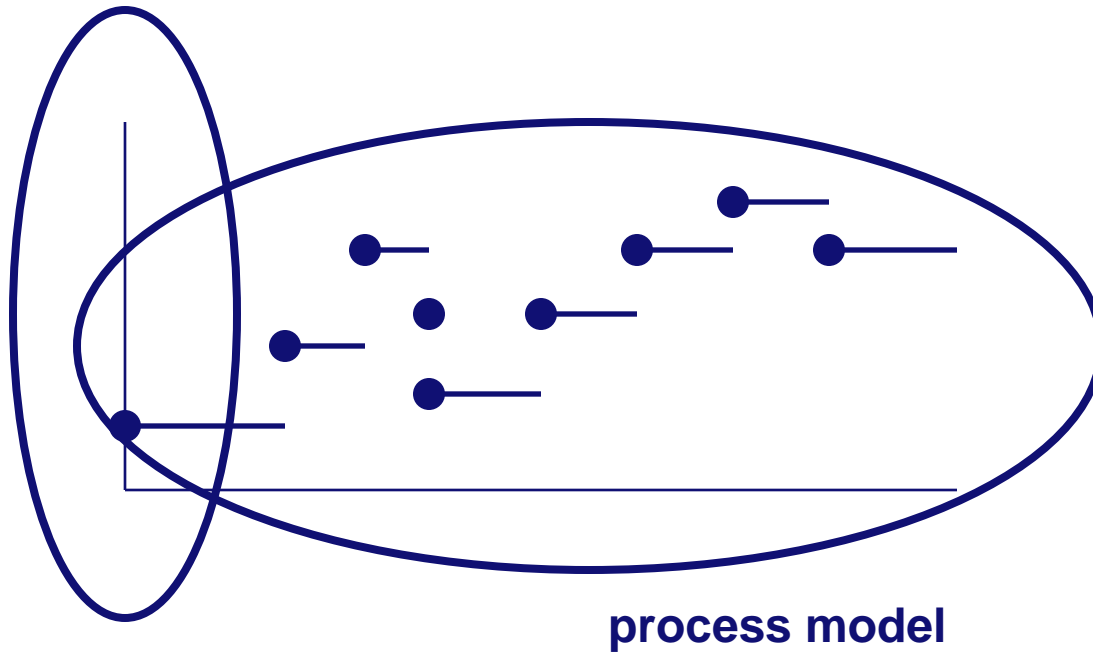
communication protocol (10^6 states)



**link layer of the
IEEE1394 standard
(FireWire) simulated
using two
communication
nodes and a bus
(25,000 states)**

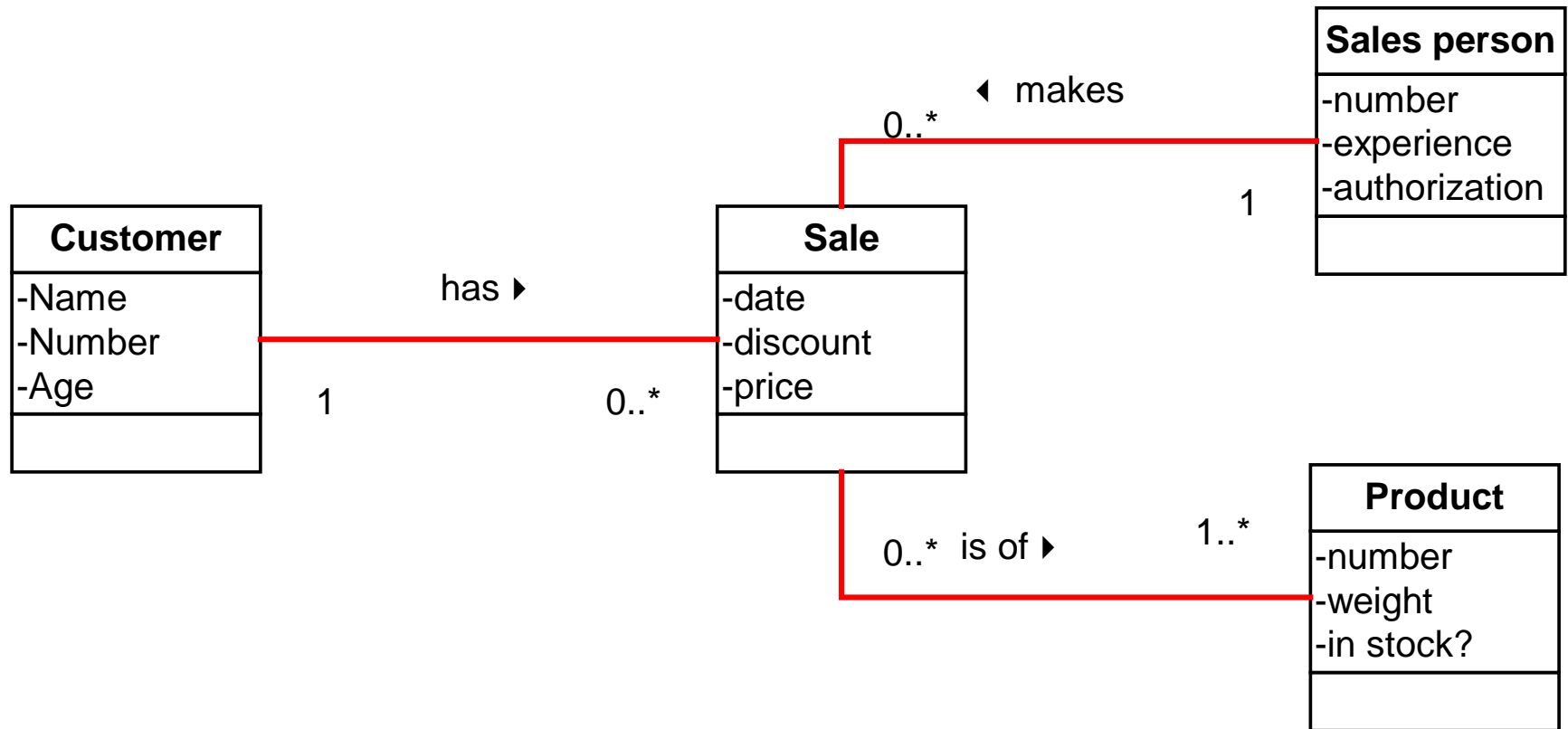
Process models versus object/data models

object/data model



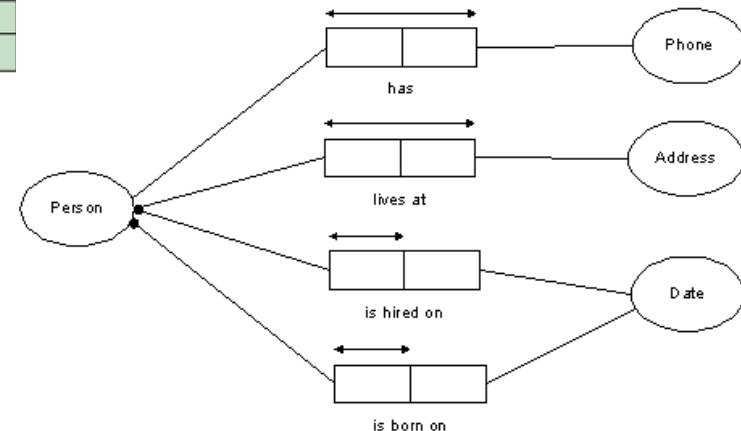
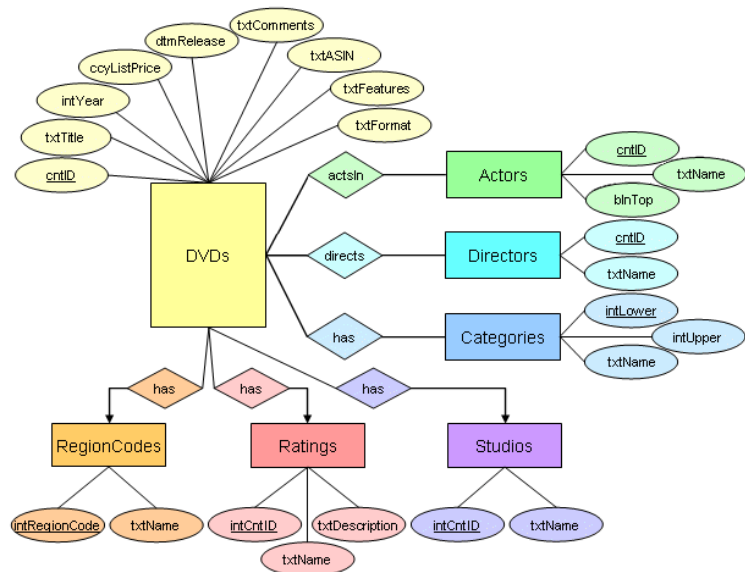
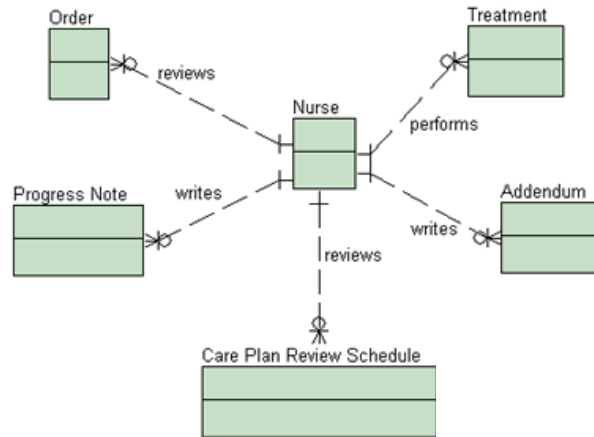
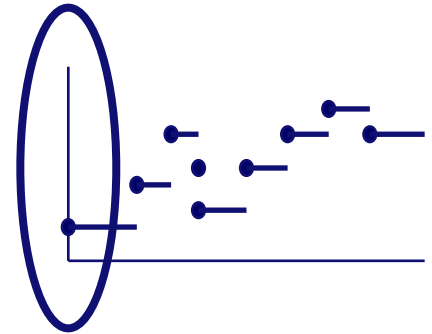
system model = process model + data/object model

Example of a data/object model: A UML class diagram

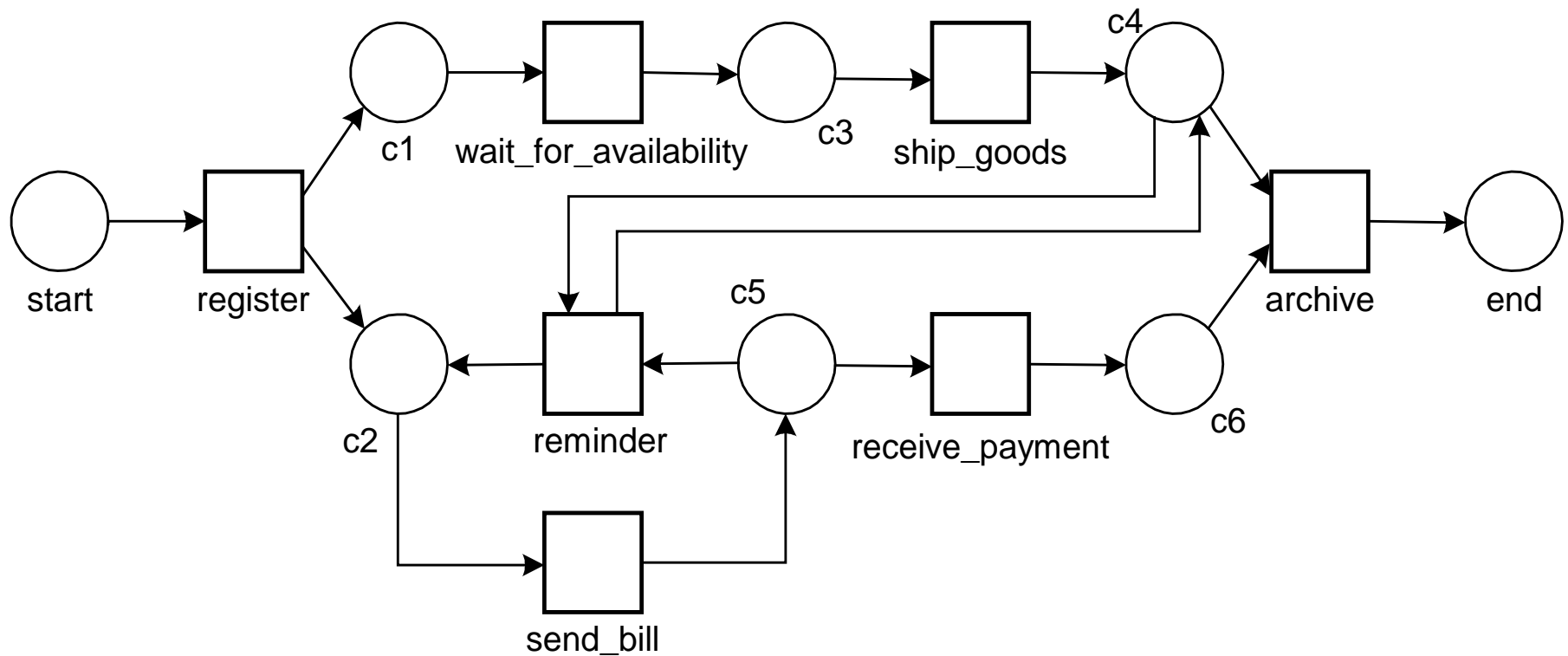


Other data/object modeling techniques

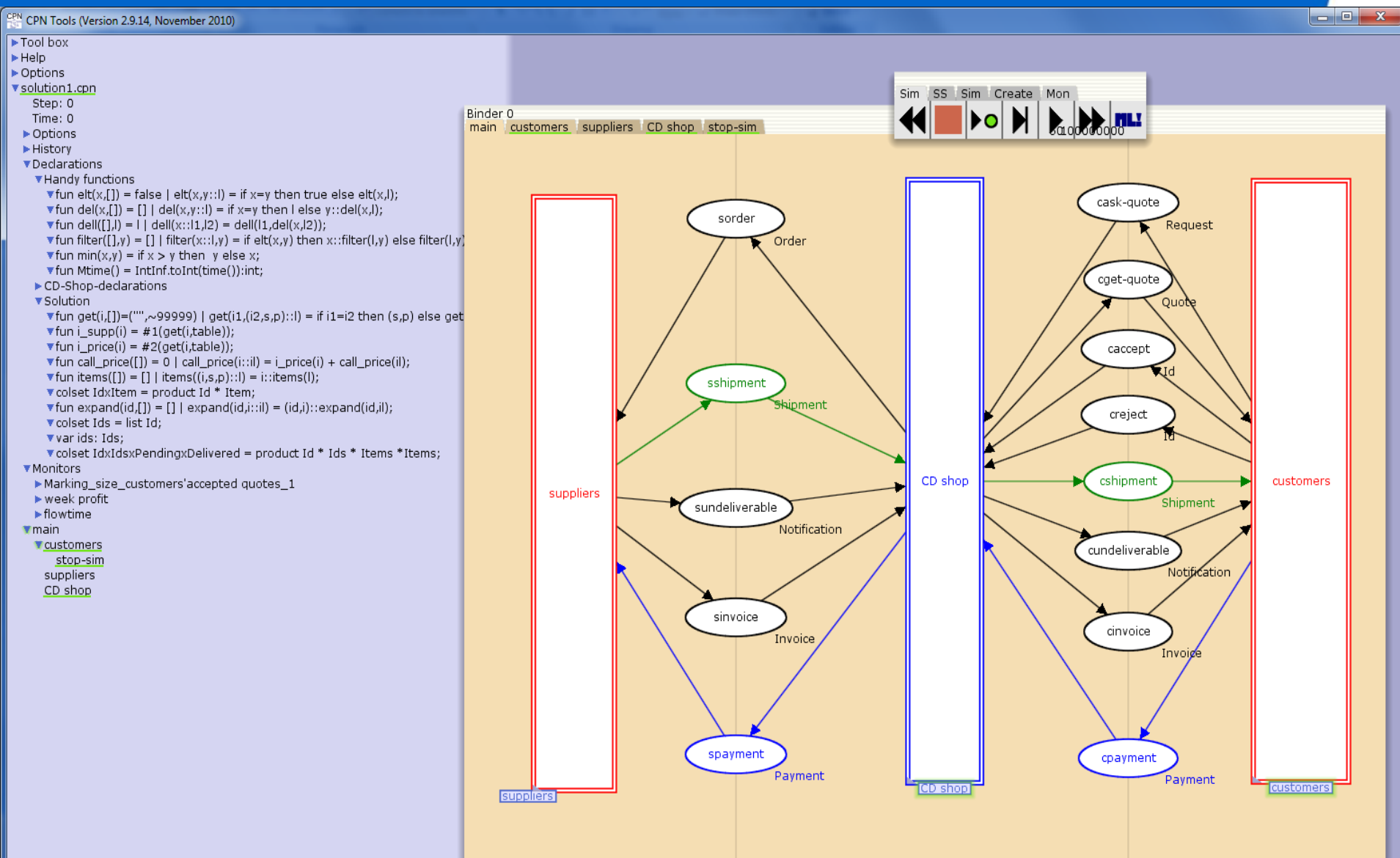
- Entity-Relationship (ER) diagrams
- Crow's Foot diagrams
- NIAM/ORM diagrams



Example of a process model: A Petri net modeling order processing

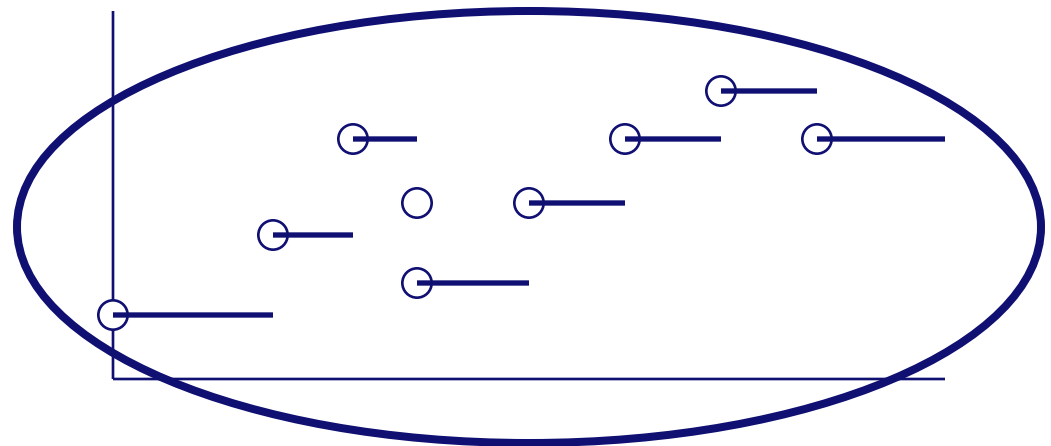


CPN Tools 3 (download from cpntools.org)



Other process modeling techniques

- UML activity/statechart diagrams
- Event-driven Process Chains (EPCs)
- IDEF/DFD diagrams
- BPMN/BPEL
- Etc.



Applications of process modeling in concrete products

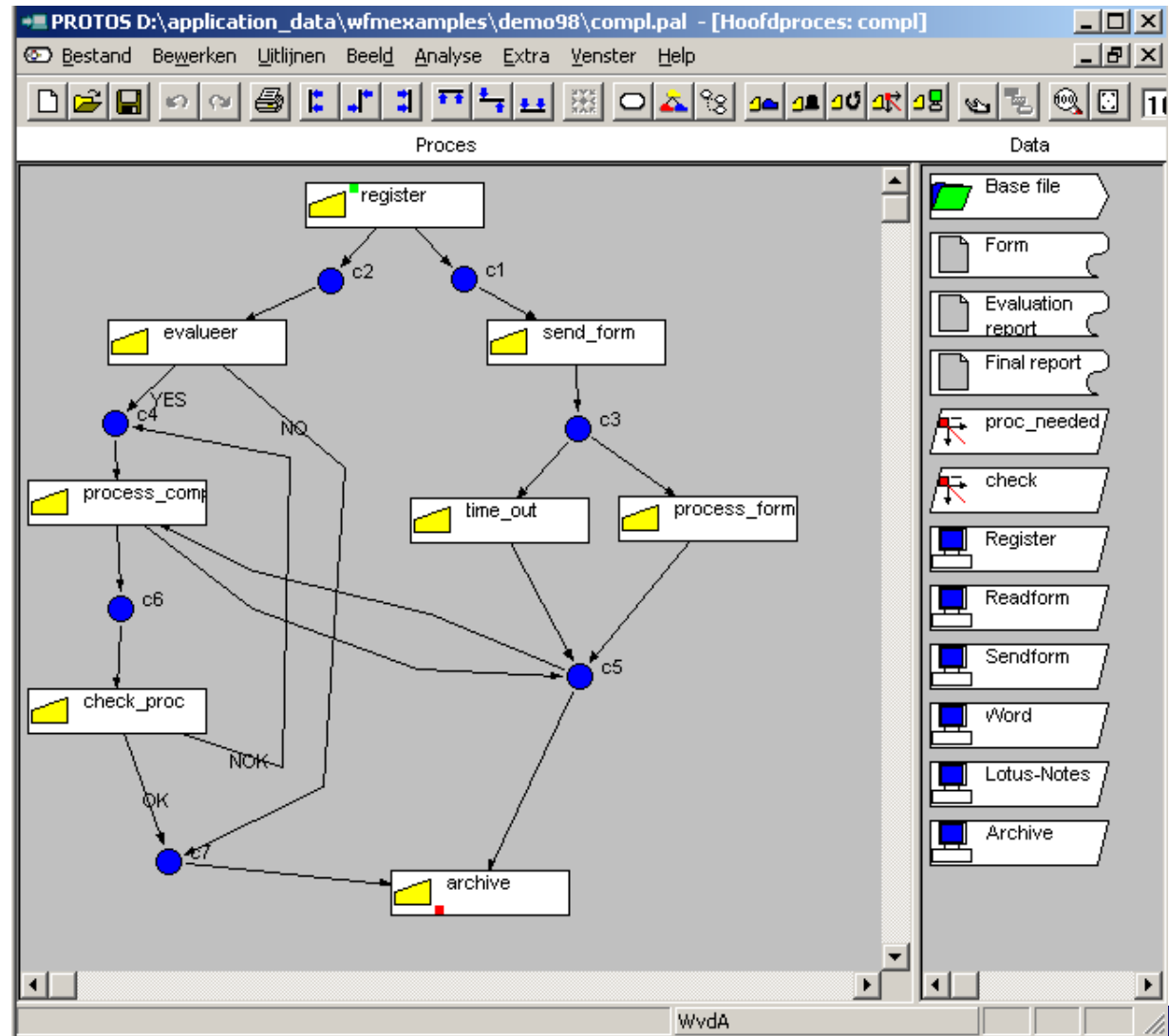
- **Business modeling tools: Protos, ARIS, ...**
- **Simulation tools: ExSpect, Arena, Simula, ...**
- **Verification tools: Woflan, ...**
- **Petri net tools: Design CPN, CPN Tools, ...**
- **Workflow management systems: Staffware, COSA, MQSeries Workflow, BPM|one, ...**
- **Enterprise resource planning systems: SAP, Baan, JD Edwards, Oracle, PeopleSoft, ...**
- **Project planning tools: Microsoft project, ...**
- **Web services languages: BPML, BPEL4WS, ...**
- **...**

Business process modeling tools

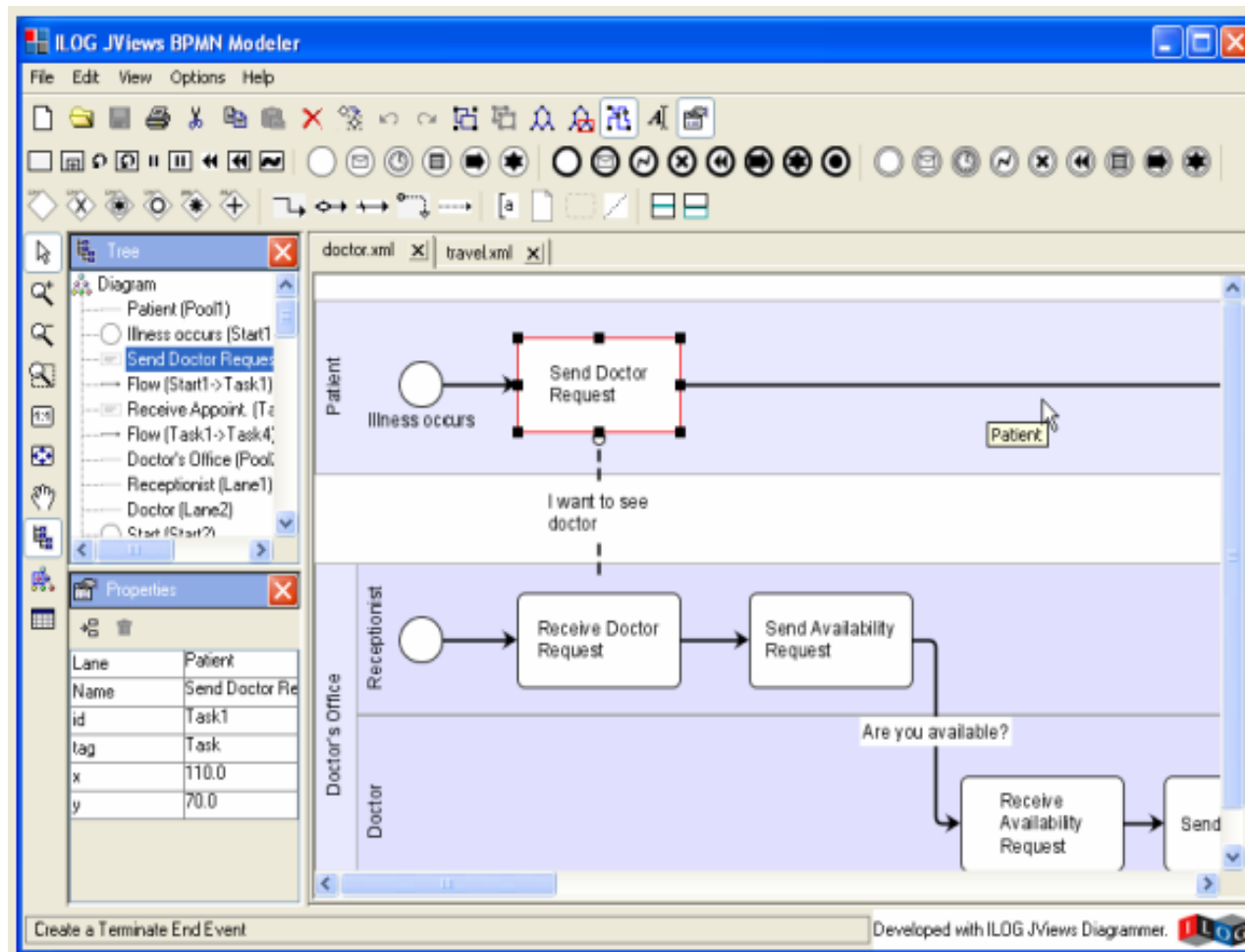
Protos

*Design,
communication,
(export to)
analysis and/or
implementation*

Based on
Petri nets



Business process modeling tools (2)

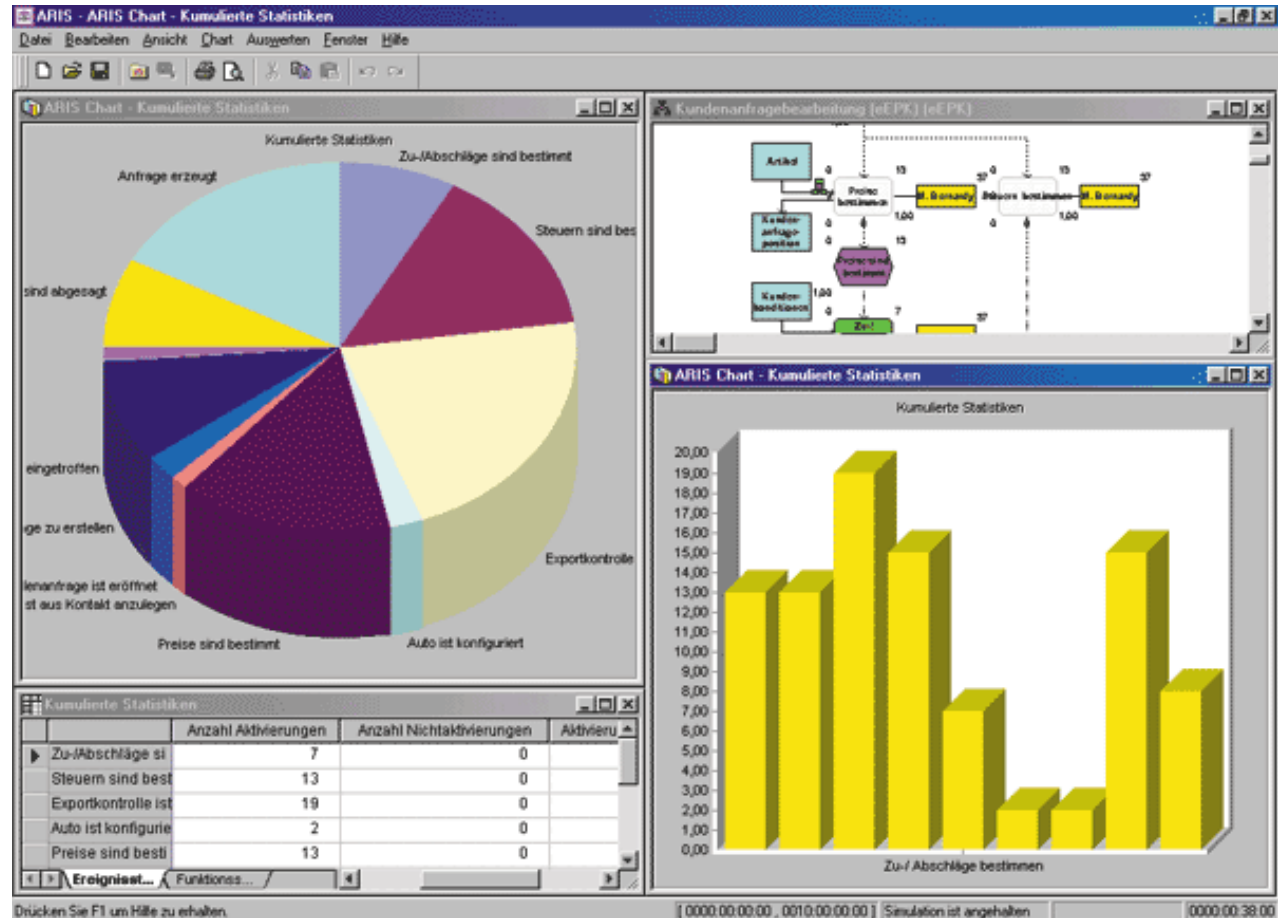


Business process modeling tools (3)

ARIS

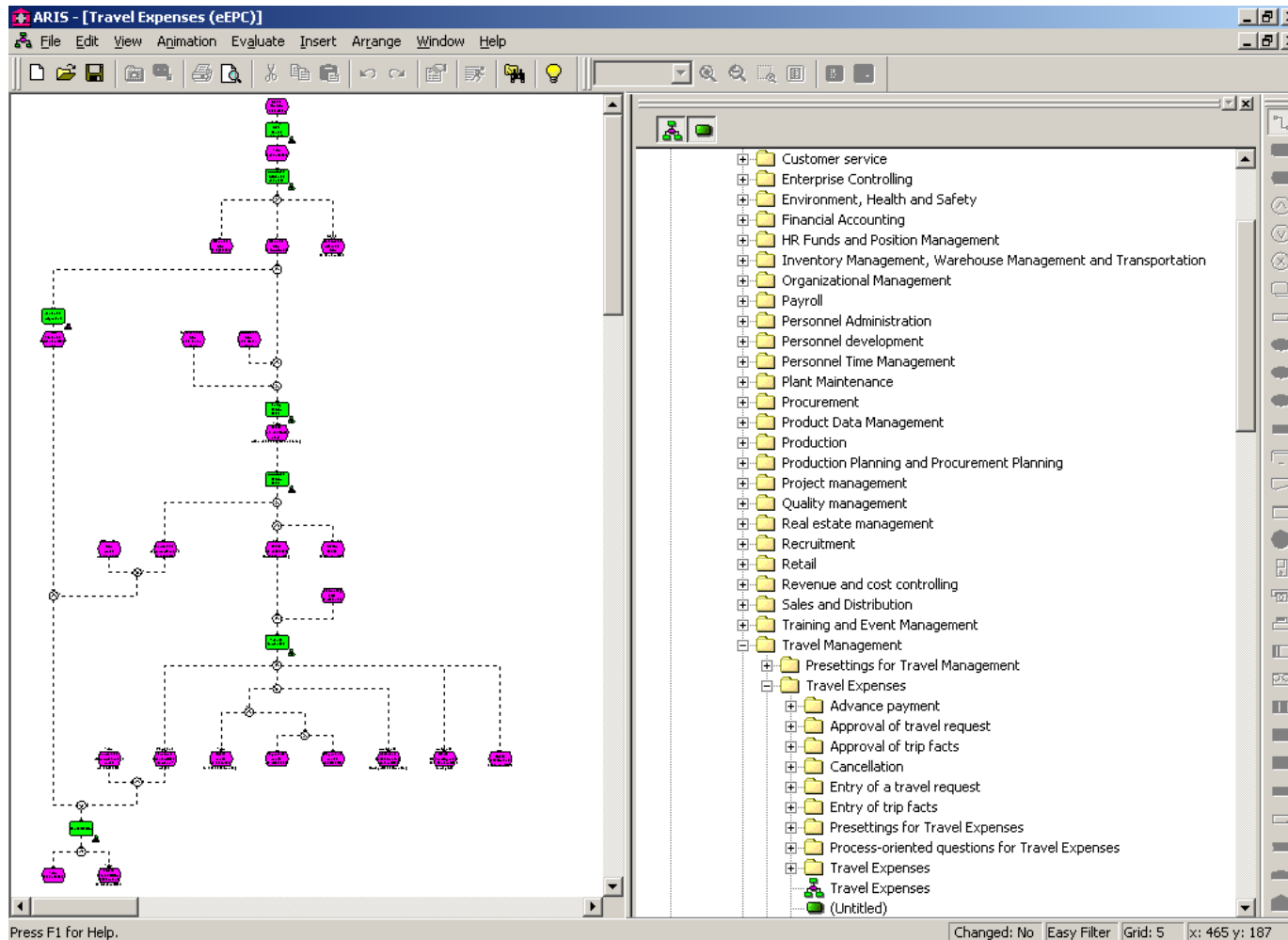
*Design,
communication,
(export to)
analysis and/or
implementation,
import of real
data.*

**Based on
EPCs**



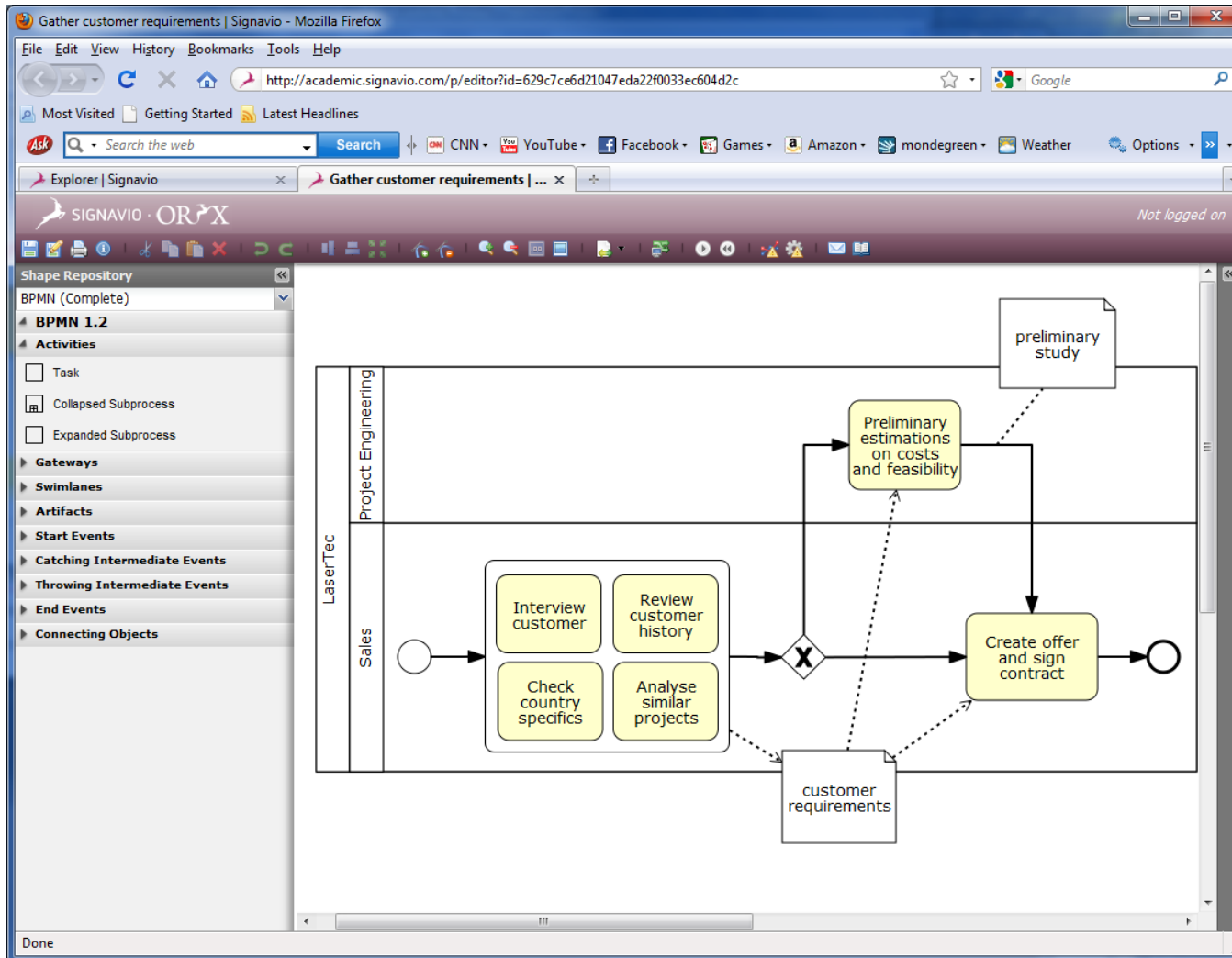
Business process modeling tools (4)

ARIS
Platform



**SAP reference
model (>600
EPCs)**

Business process modeling tools (5)

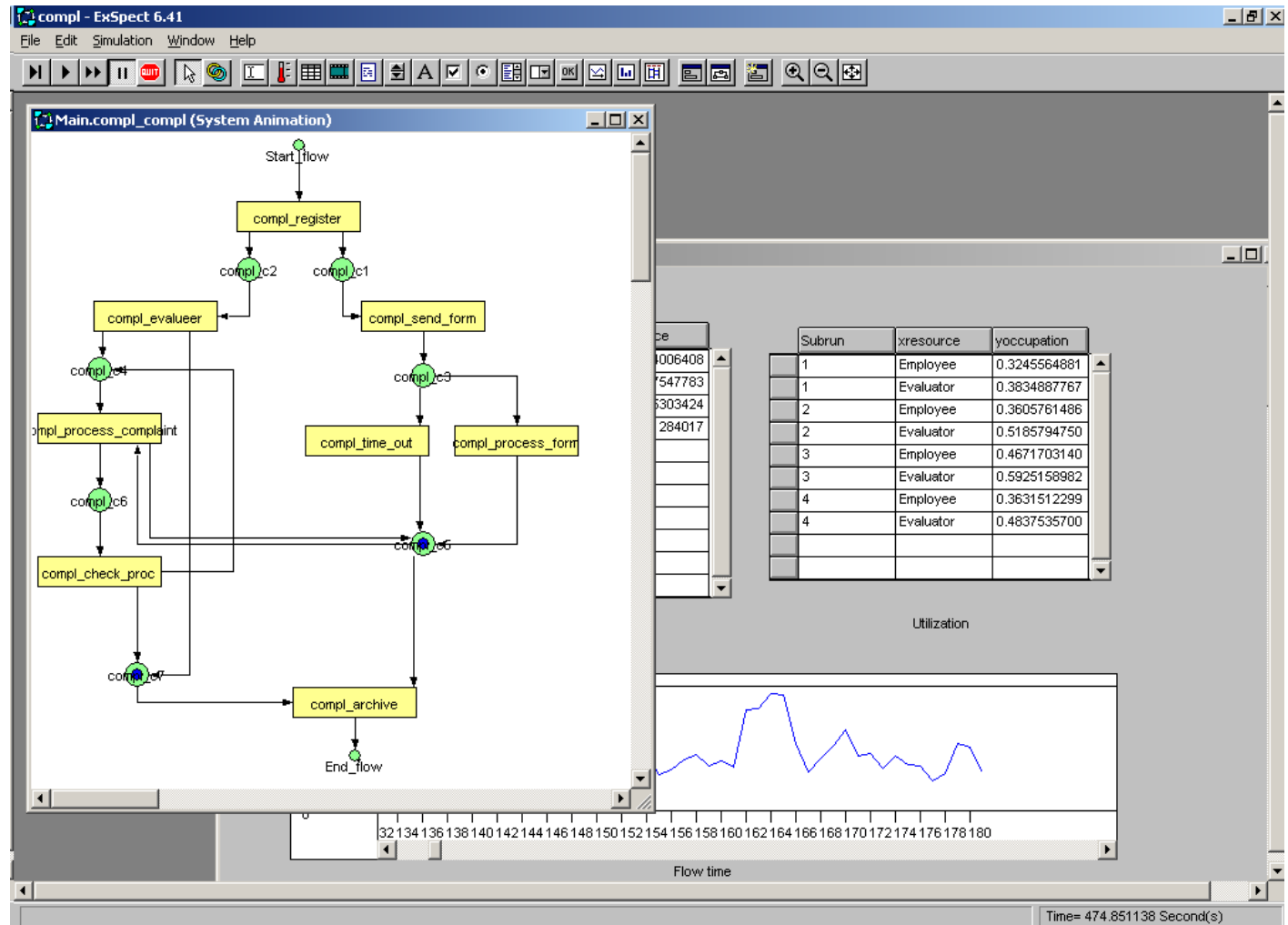


Simulation tools

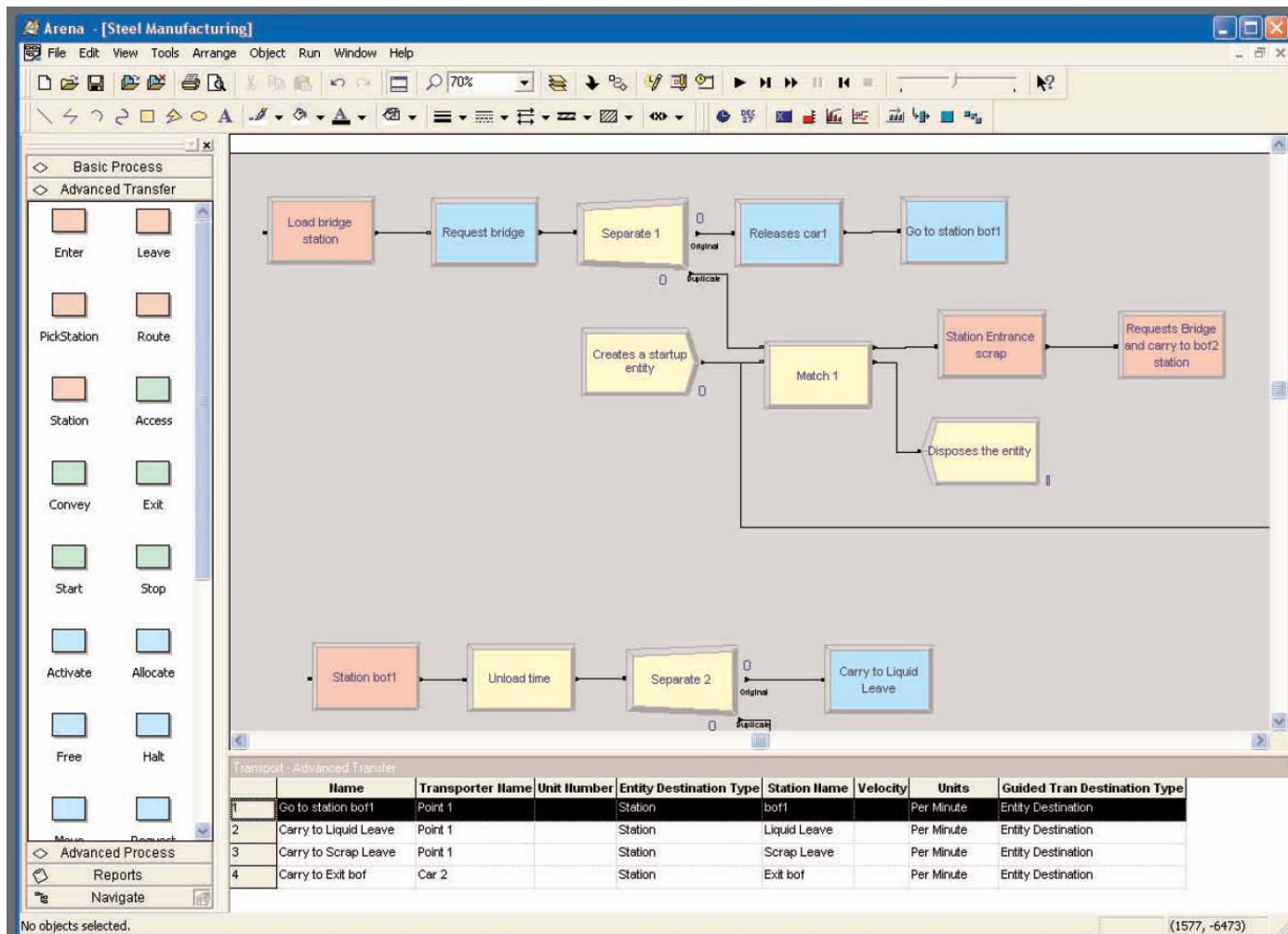
ExSpect

*Rapid
prototyping,
performance
analysis,
validation,
gaming.*

Based on
Petri nets.



Simulation tools (2)



Arena

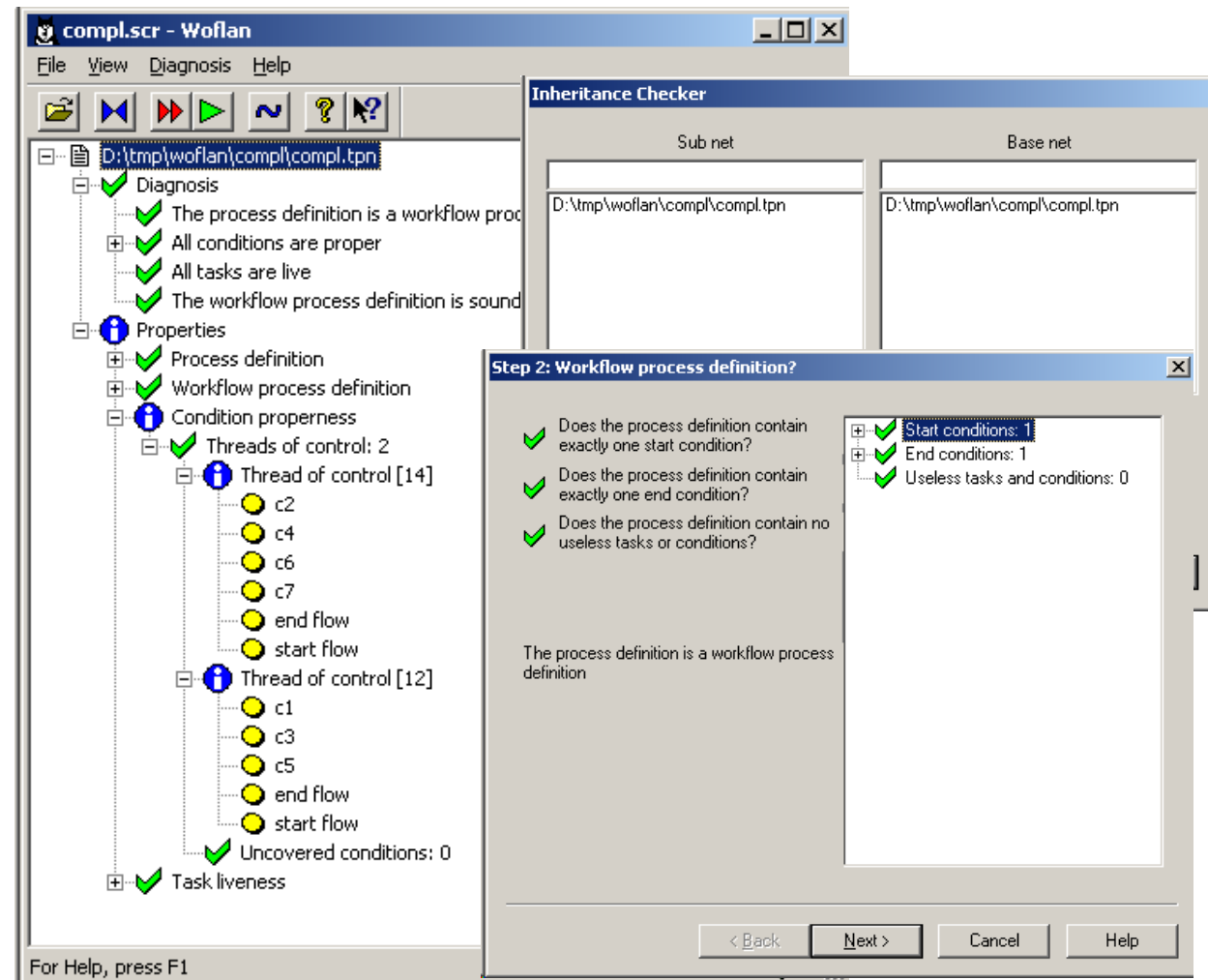
**Rockwell
Automation**

Verification tools

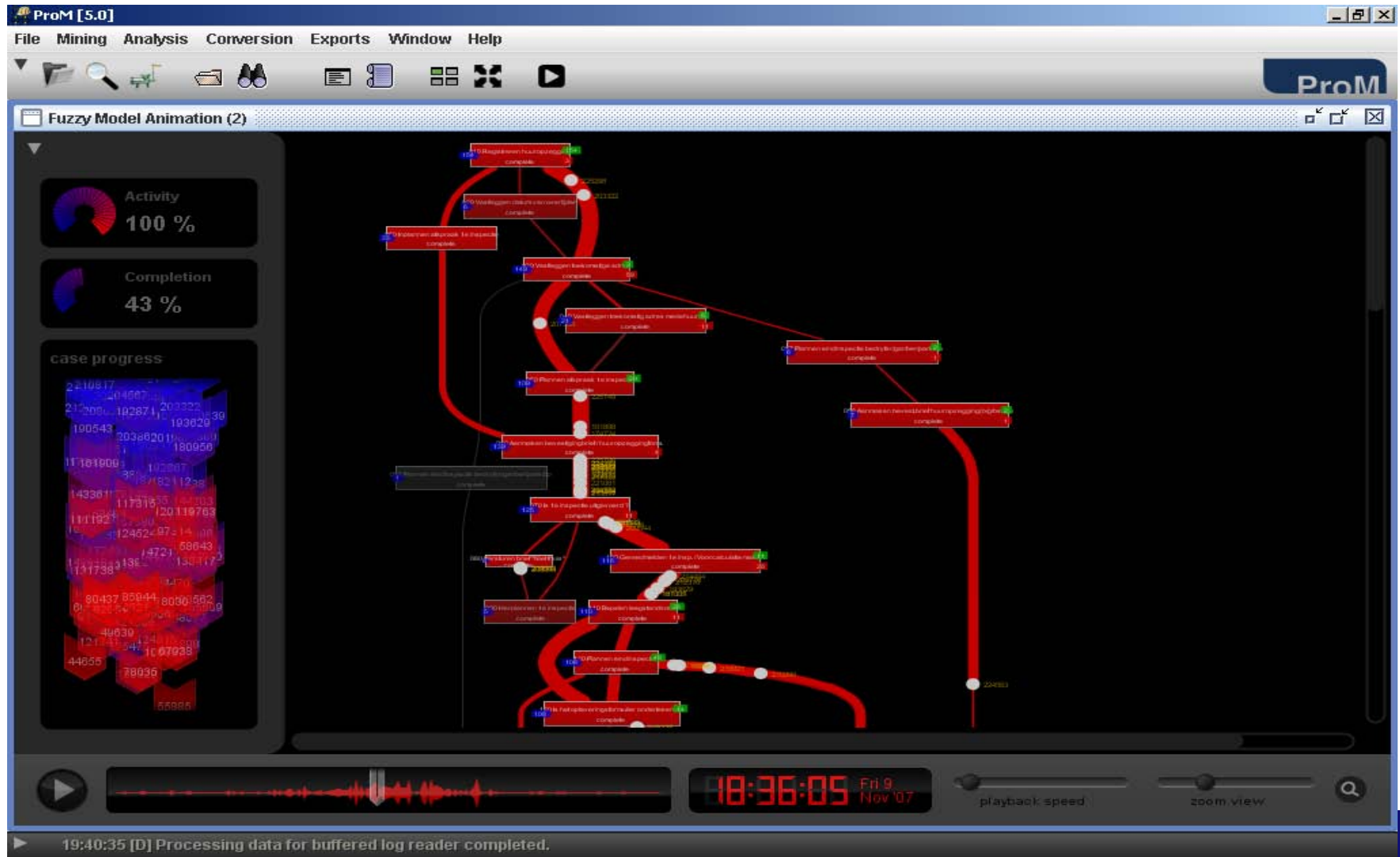
Woflan

Detecting errors.

Based on Petri nets.



Process Mining tools (1)



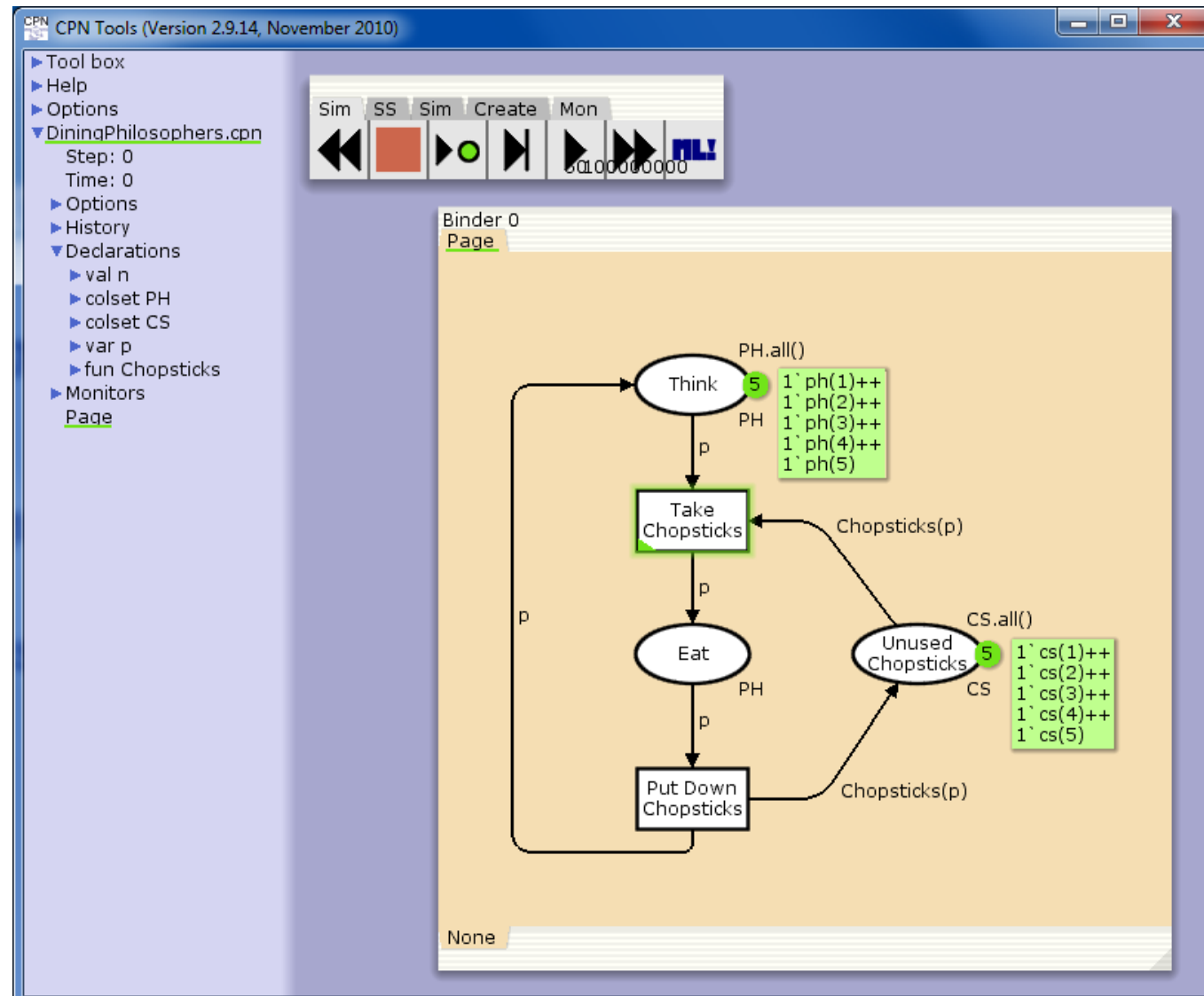


Petri net tools

CPN Tools

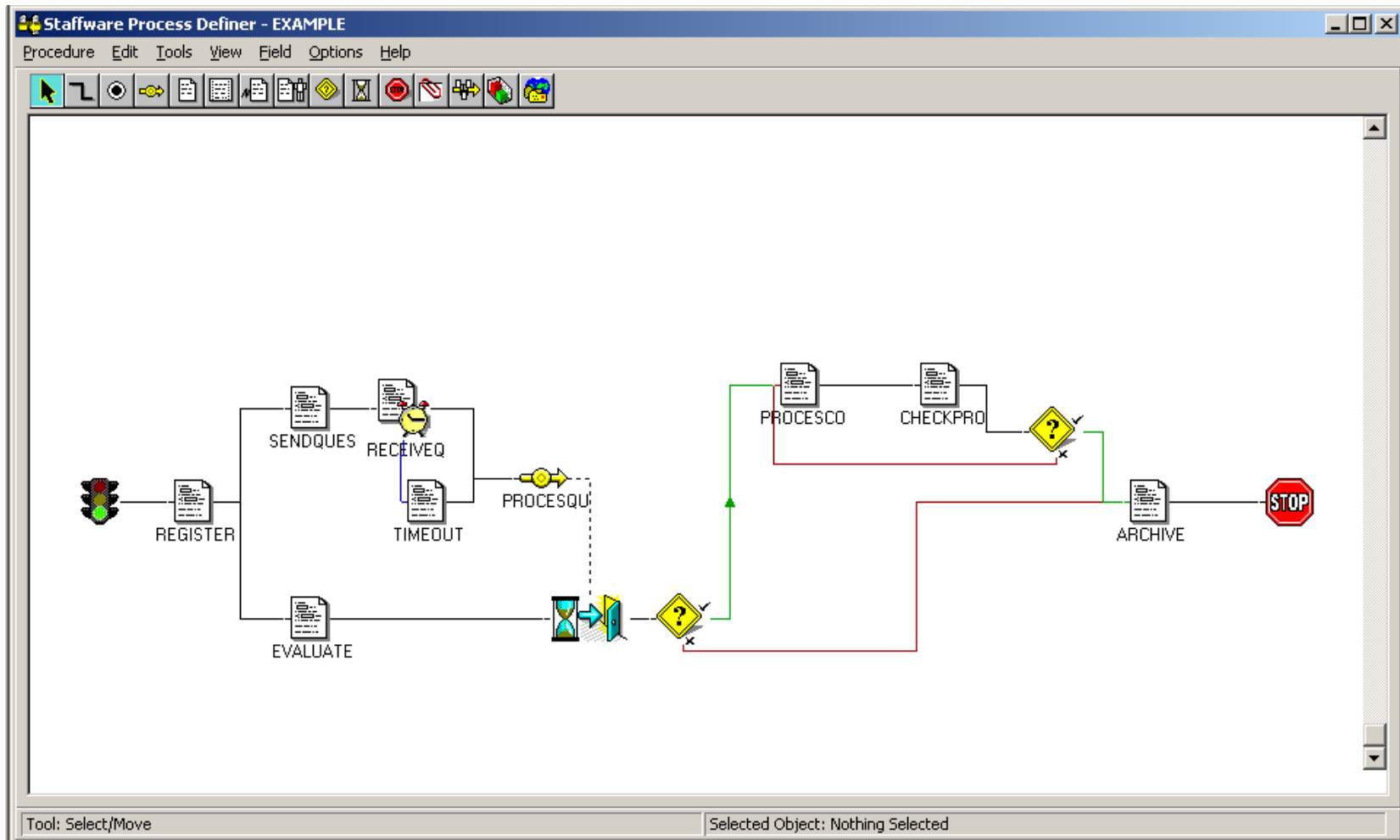
Design and analysis

Based on
Petri nets.



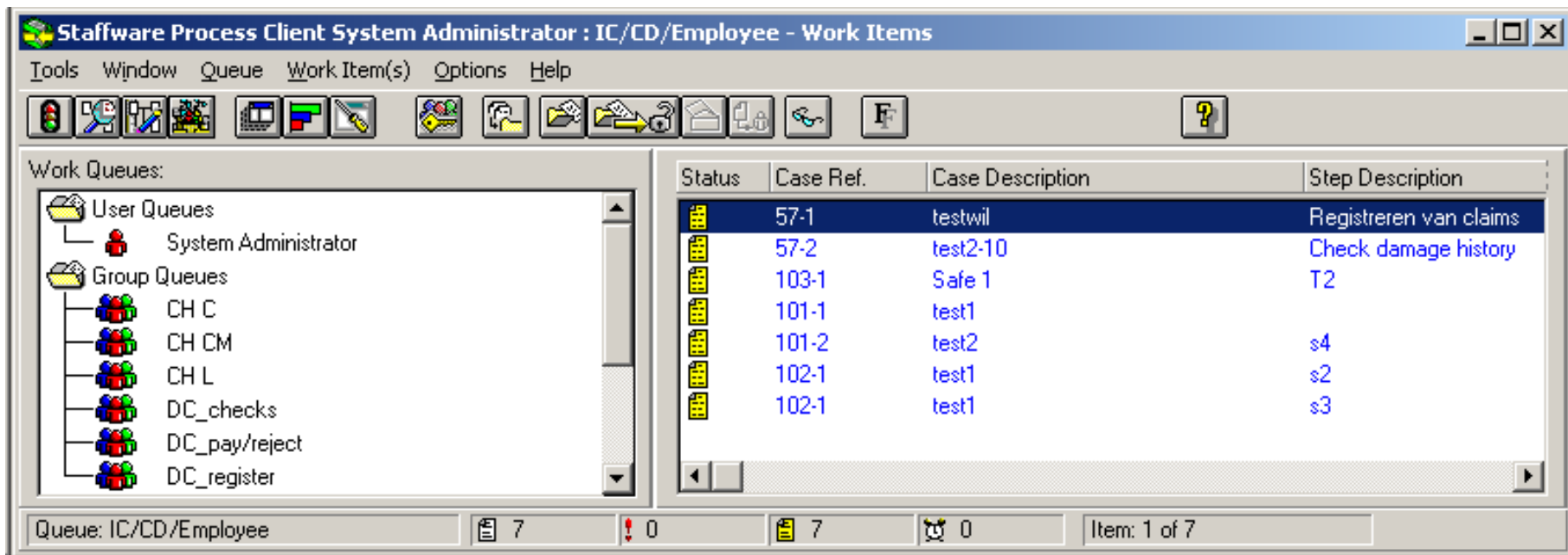
Workflow management systems

Staffware workflow designer



Workflow management systems (2)

Staffware worklist handler



The screenshot displays the 'Staffware Process Client System Administrator : IC/CD/Employee - Work Items' window. The interface includes a menu bar (Tools, Window, Queue, Work Item(s), Options, Help) and a toolbar with various icons. On the left, a 'Work Queues' tree shows 'User Queues' (System Administrator) and 'Group Queues' (CH C, CH CM, CH L, DC_checks, DC_pay/reject, DC_register). The main area is a table of work items.

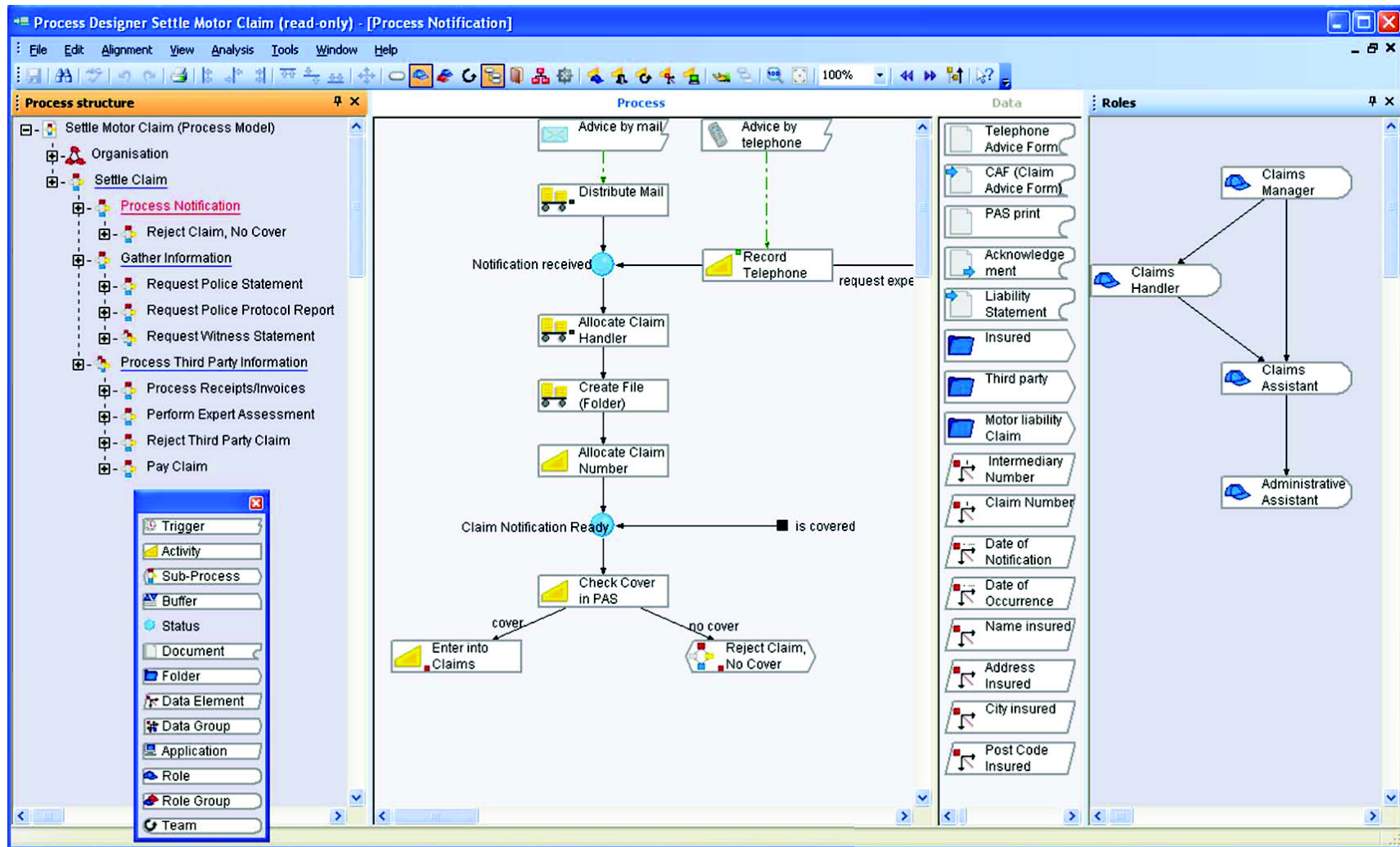
Status	Case Ref.	Case Description	Step Description
	57-1	testwil	Registreren van claims
	57-2	test2-10	Check damage history
	103-1	Safe 1	T2
	101-1	test1	
	101-2	test2	s4
	102-1	test1	s2
	102-1	test1	s3

The status bar at the bottom shows: Queue: IC/CD/Employee, 7 items, 0 errors, 7 warnings, 0 alerts, and Item: 1 of 7.

Based on a vendor specific language.

Enactment

Workflow management systems (4)



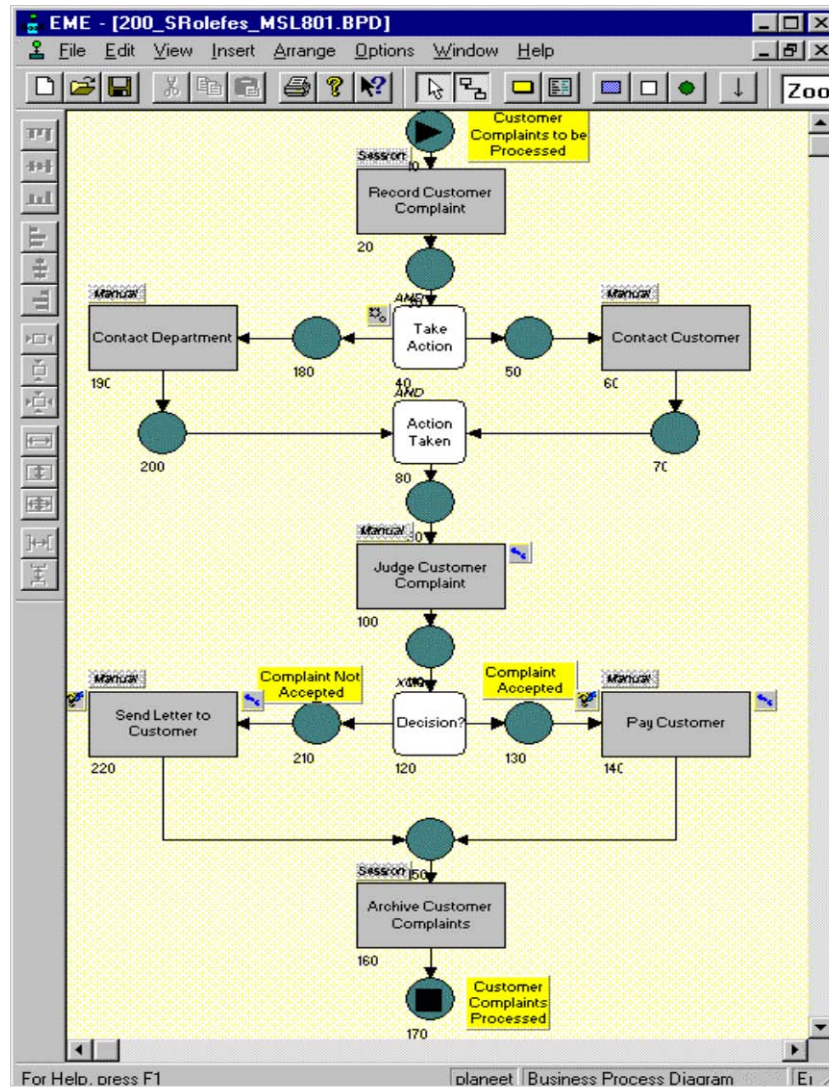
Enterprise resource planning (ERP) systems

Baan

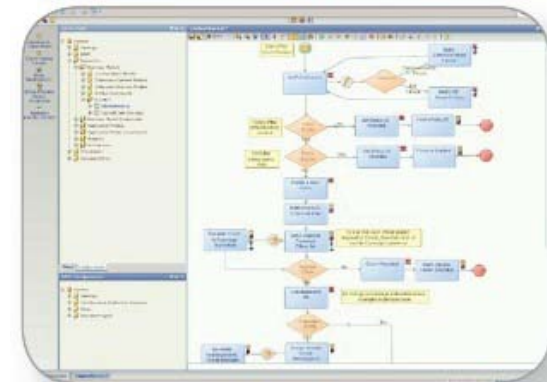
Baan (DEM)

*Design,
training,
configuration,
and
enactment*

Based on
Petri nets.



CORDYS

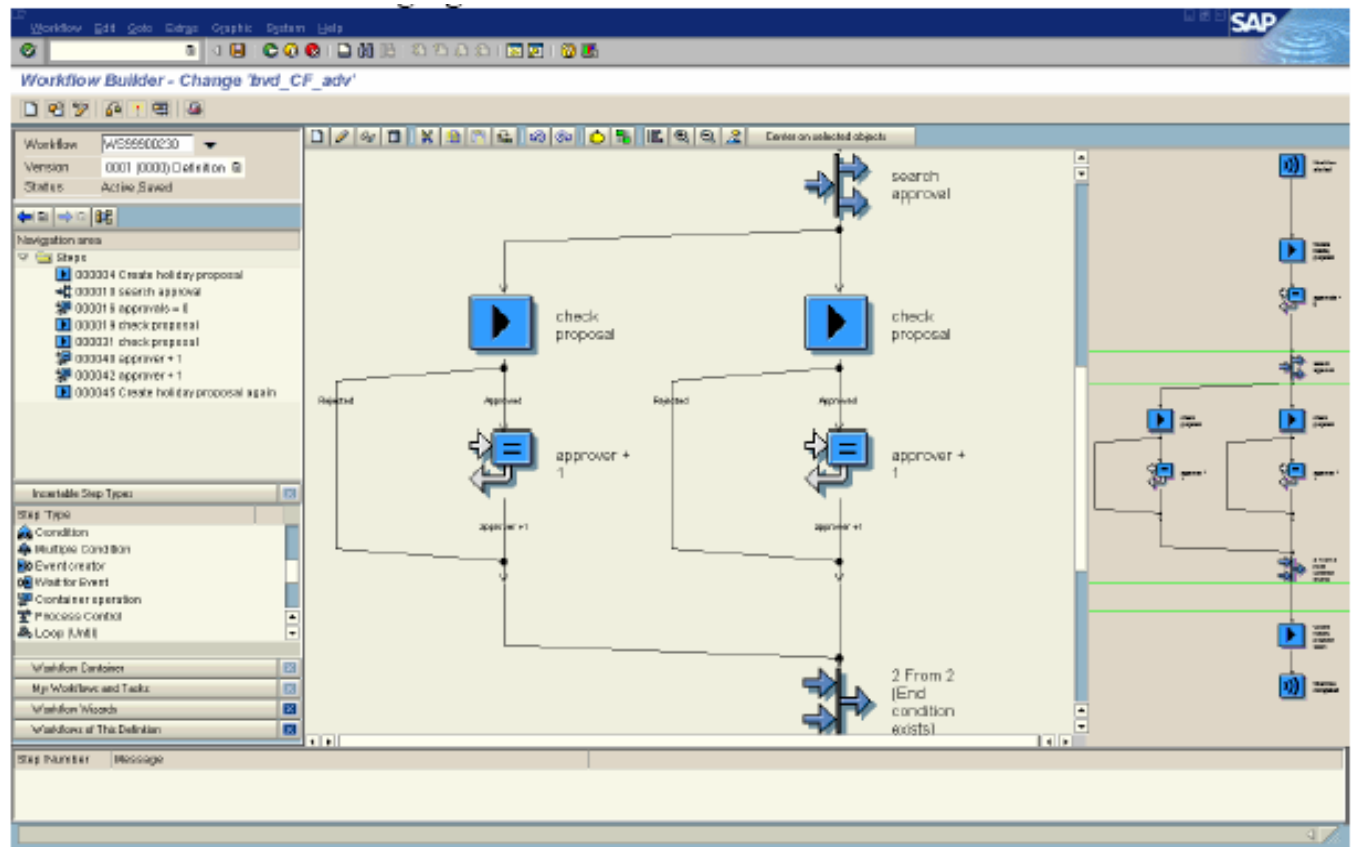


Enterprise resource planning (ERP) systems (2)

SAP (workflow)

*Design,
training,
configuration,
and enactment*

Also EPC view

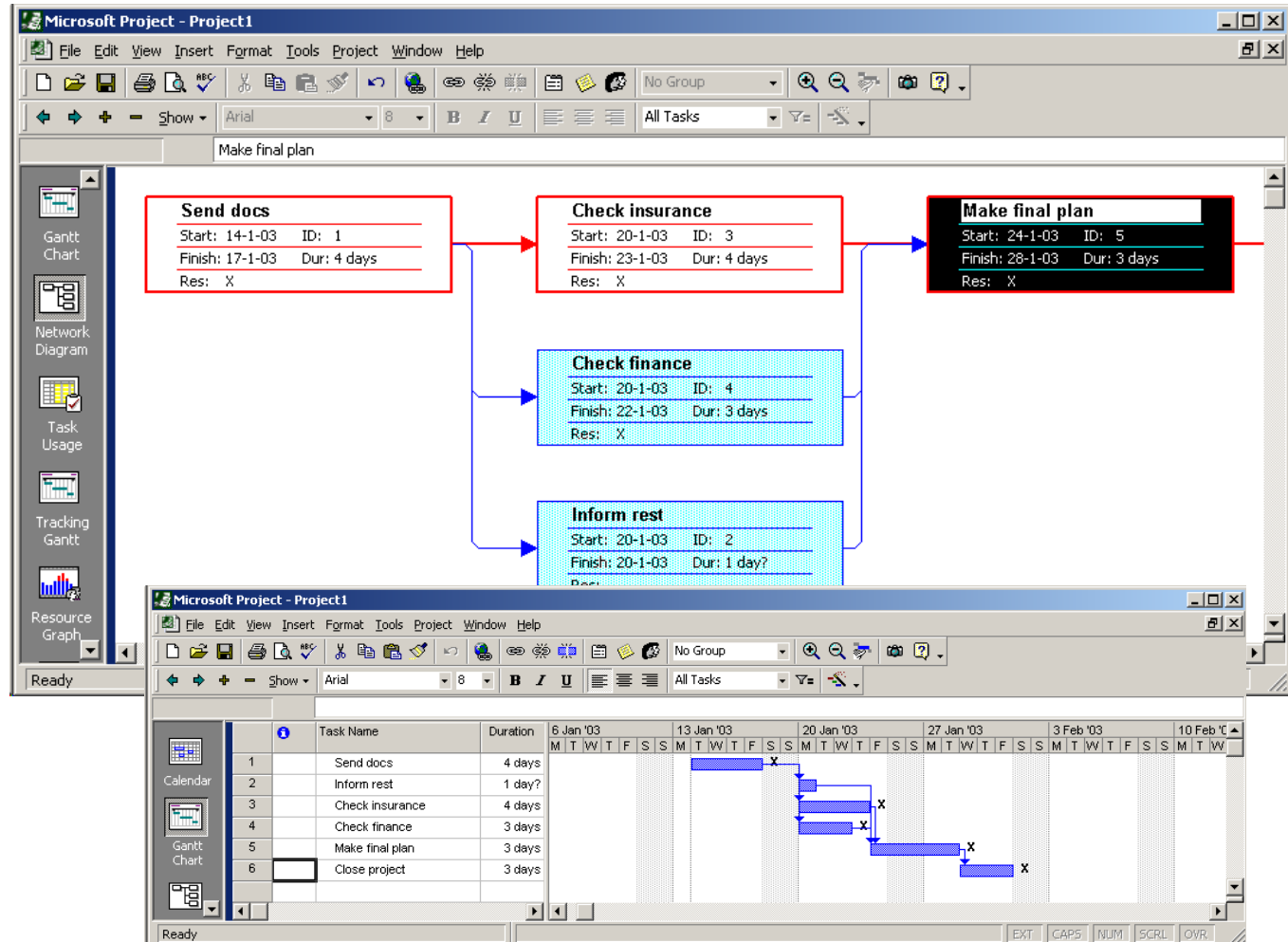


Project planning

MS project

Planning

cf. PERT/CPM

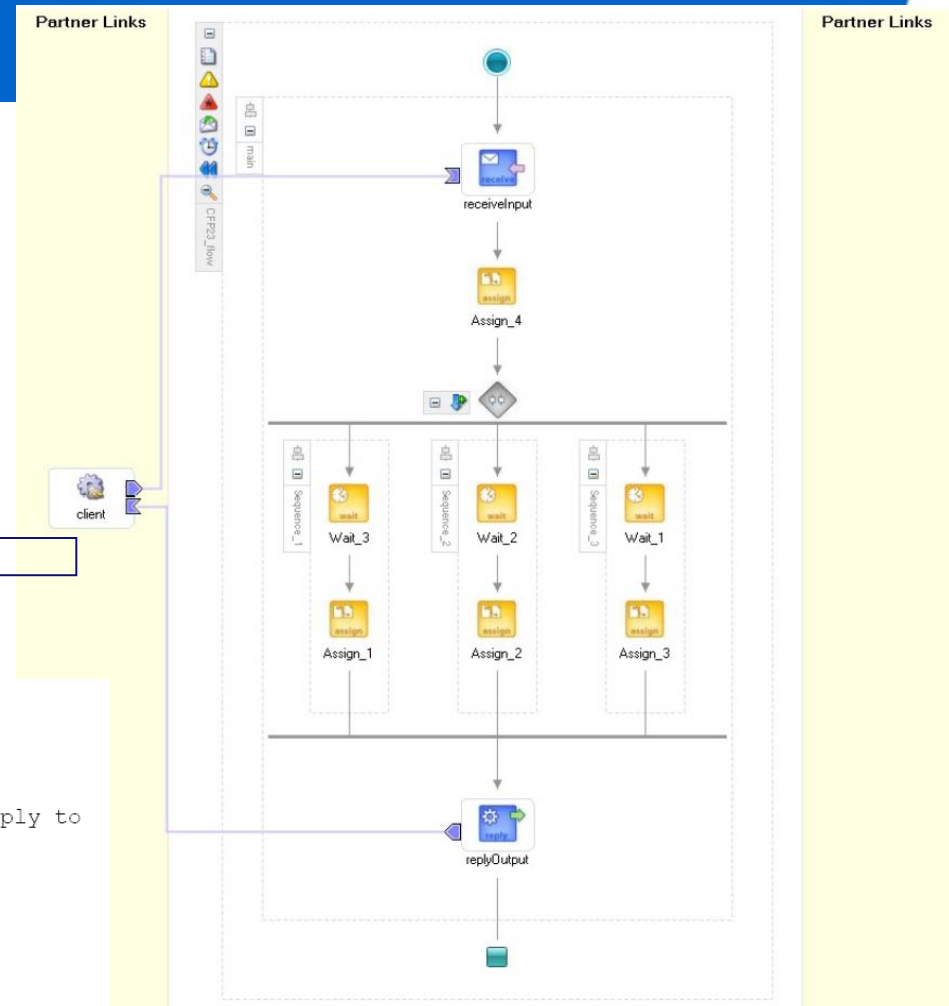


Web services

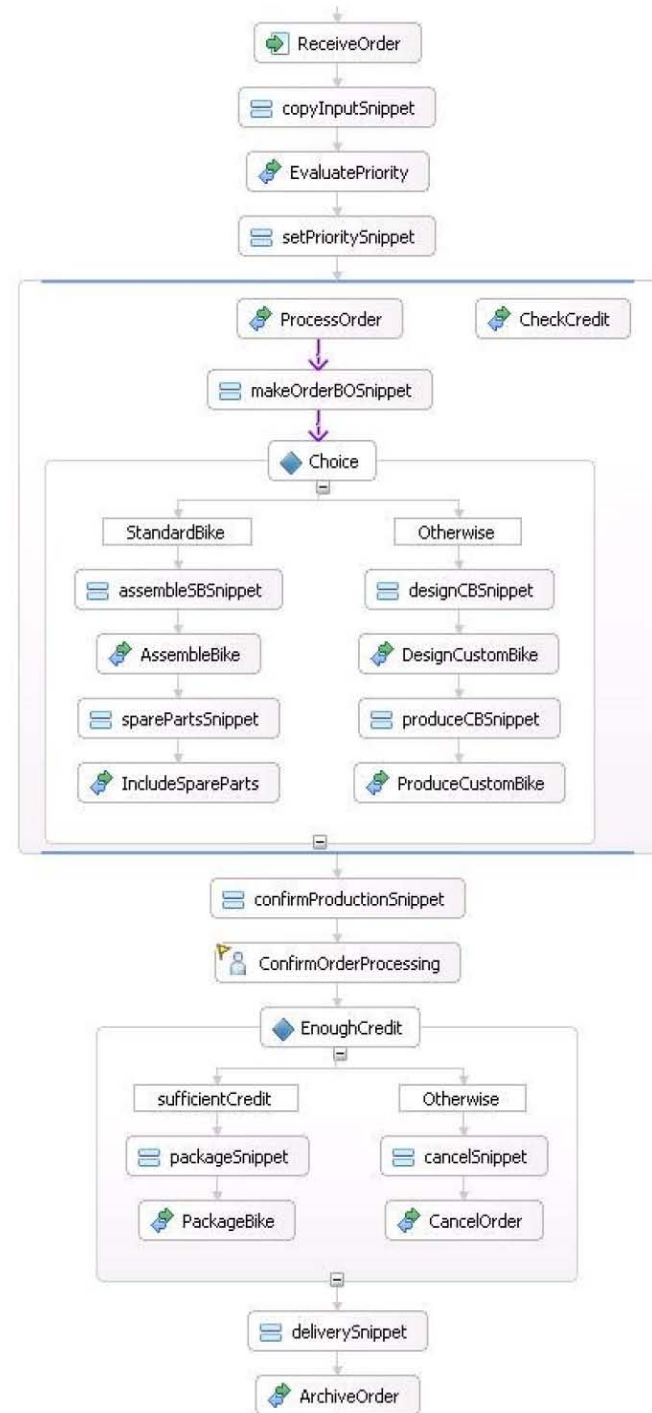
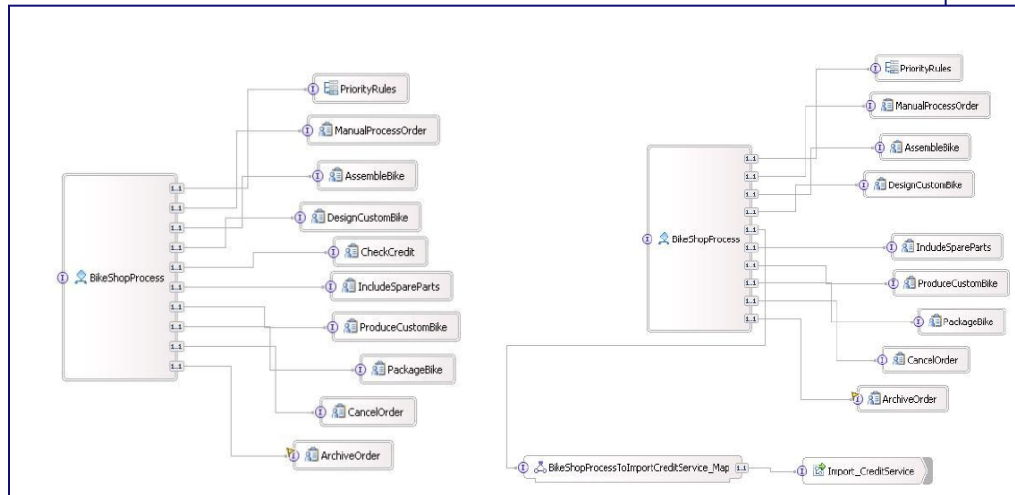
Oracle BPEL

Enactment based on BPEL standard

```
<sequence name="main"><!-- Receive input from requestor.  
Note: This maps to operation defined in CFP23_flow.wsdl  
-->  
<receive name="receiveInput" partnerLink="client"  
portType="client:CFP23_flow" operation="process"  
variable="inputVariable" createInstance="yes"/><!-- Generate reply to  
synchronous request -->  
<assign name="Assign_4">  
  <copy>  
    <from variable="inputVariable" part="payload"  
query="/client:CFP23_flowProcessRequest/client:input"/>  
    <to variable="outputVariable" part="payload"  
query="/client:CFP23_flowProcessResponse/client:result"/>  
  </copy>  
</assign>  
<flow name="Flow_1">  
  <sequence name="Sequence_3">  
    <wait name="Wait_1" for="PT1M"/>  
    <assign name="Assign_3">  
      <copy>
```



IBM WebSphere (also uses BPEL)



[illegible]

Worklist in WebSphere

Business Process Choreographer Explorer - My To-dos - Windows Internet Explorer

https://localhost:9445/bpc/aces/pages/layouts/views/TaskInstanceView.jsp

File Edit View Favorites Tools Help

Business Process Choreographer Explorer - My To-dos

Business Process Choreographer Explorer

Welcome admin | Logout | My Substitutes | Define Substitutes | Define Views | Customize | Help | About

My To-dos

Use this page to work on tasks that are assigned to you. ⓘ

Start Work on Release Transfer Refresh Change Priority Change Business Category

<input type="checkbox"/>	Priority	Task Name	State	Kind	Owner	Originator	Escalated	Suspended	Activated	Last Modified	Expires	Description
<input type="checkbox"/>	5	Review Order	Ready	To-do Task		admin	no	no	12/15/09 2:06:46 PM	12/15/09 2:06:46 PM		
<input type="checkbox"/>	5	Review Order	Claimed	To-do Task	admin	admin	no	no	12/15/09 2:08:26 PM	12/15/09 2:15:54 PM		
<input type="checkbox"/>	5	Ship Order to Customer	Ready	To-do Task		admin	no	no	12/15/09 2:09:36 PM	12/15/09 2:09:36 PM		
<input type="checkbox"/>	5	Ship Order to Customer	Ready	To-do Task		admin	no	no	12/15/09 2:12:27 PM	12/15/09 2:12:27 PM		

Items found: 4 Items selected: 0 Page 1 of 1 Items per page: 20

IBM WebSphere software

Management information in WebSphere

BusinessSpace

Welcome admin | Help | Logout

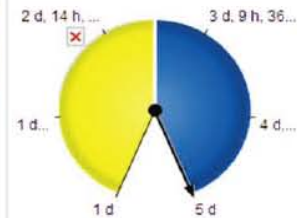
Manage Business Spaces

Monitor Dashboards

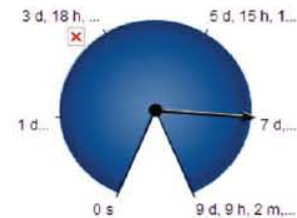
KPIs Instances New Page

KPIs

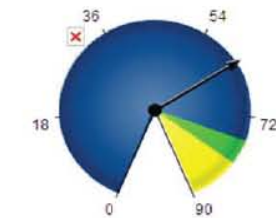
Average Process Duration



Order Handling (Future 1) Average Working Duration



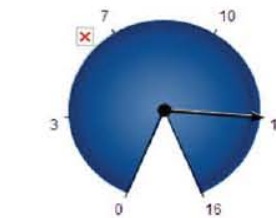
Percentage of Orders Shipped



Shipped Orders



Total Orders

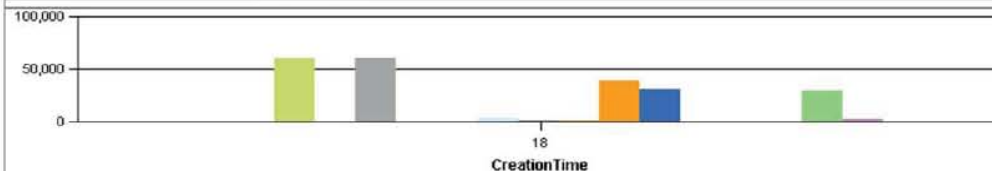


Reports

Basic analysis

File Edit View Bookmarks Data Chart Tools Help

Drill Down



- InstancesCount
- Order Handling Future 1 Average Working DurationMP
- Order Handling Future 1 Average Elapsed DurationMP
- Average Approve Without Review Yes Percentage8
- Order Price Average
- Review Order Average Elapsed Duration
- Average Account in Good Standing No Percentage8
- Average Account in Good Standing Yes Percentage8
- Order Price Total
- Average Acceptable Credit Risk No Percentage8
- Check Customer Account Status Average Elapsed Duration
- Average Approve Without Review No Percentage8
- Check Order Handling Policy for Automatic Approval Average Elapsed Duration
- Update Order Database Average Elapsed Duration
- Cancel Order and Send Notification Average Elapsed Duration
- Average Acceptable Credit Risk Yes Percentage8
- Ship Order to Customer Average Elapsed Duration

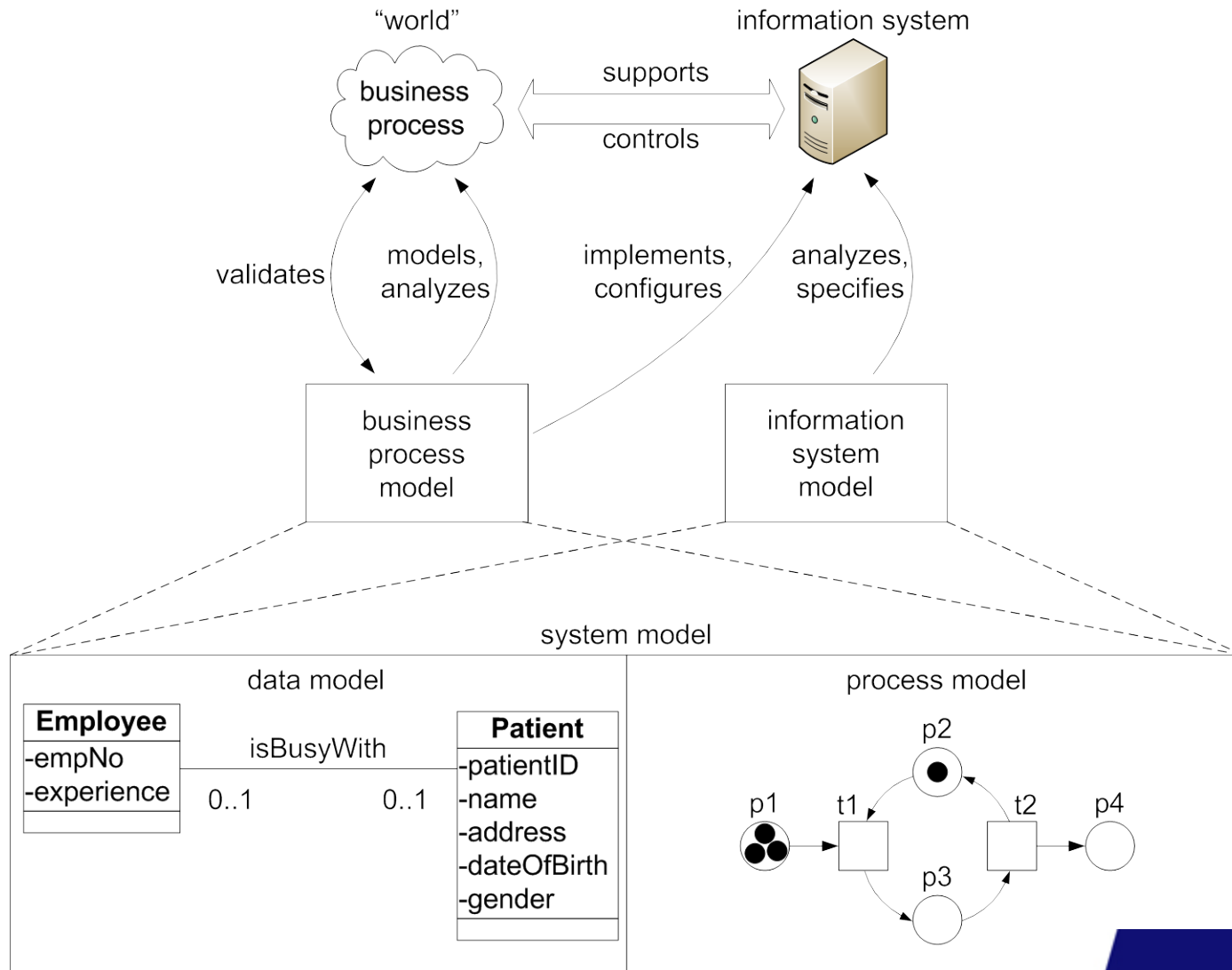
CreationTime ↑↓	InstancesCount ↑↓	Average Acceptable Credit Risk No Percentage8 ↑↓
2009 ↑↓	17	45.455
11 ↑↓	2	0
18 ↑↓	2	0

Add a widget

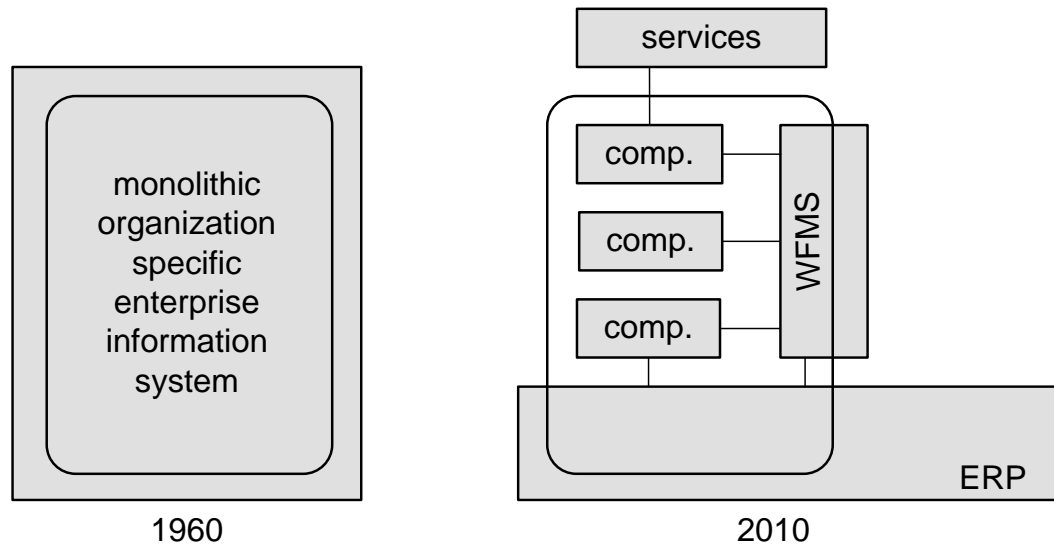
As shown ...

**processes &
process models are
everywhere!!**

Business process models versus information system models



Some trends



Trend 1: from data orientation to process orientation

Trend 2: from programming to assembling

Trend 3: from programming to configuration

Trend 4: toward redesign and organic growth

Preview

- **Classical Petri net**
- **Extensions with**
 - Color (data)
 - Time
 - Hierarchy
- **Colored Petri Nets (CPN) language**
- **Analysis of processes**
 - state-space analysis
 - structural methods
 - process mining
 - simulation
- **Design patterns**
- **Other modeling techniques (UML, EPC, BPMN, ...)**