TU/e technische universiteit eindhoven

Business Process Management in Healthcare

Closing the loop by mining careflows

Prof.dr.ir. Wil van der Aalst

Eindhoven University of Technology
Department of Information and Technology
P.O. Box 513, 5600 MB Eindhoven
The Netherlands
w.m.p.v.d.aalst@tm.tue.nl

Outline

- Business Process Management (BPM) in healthcare
- Closing the BPM cycle
- What is workflow management?
- 25 years of workflow management (systems)
- Challenges for the next 25 years
- Process mining
  - Overview
  - Toolset
  - Examples
- Conclusion

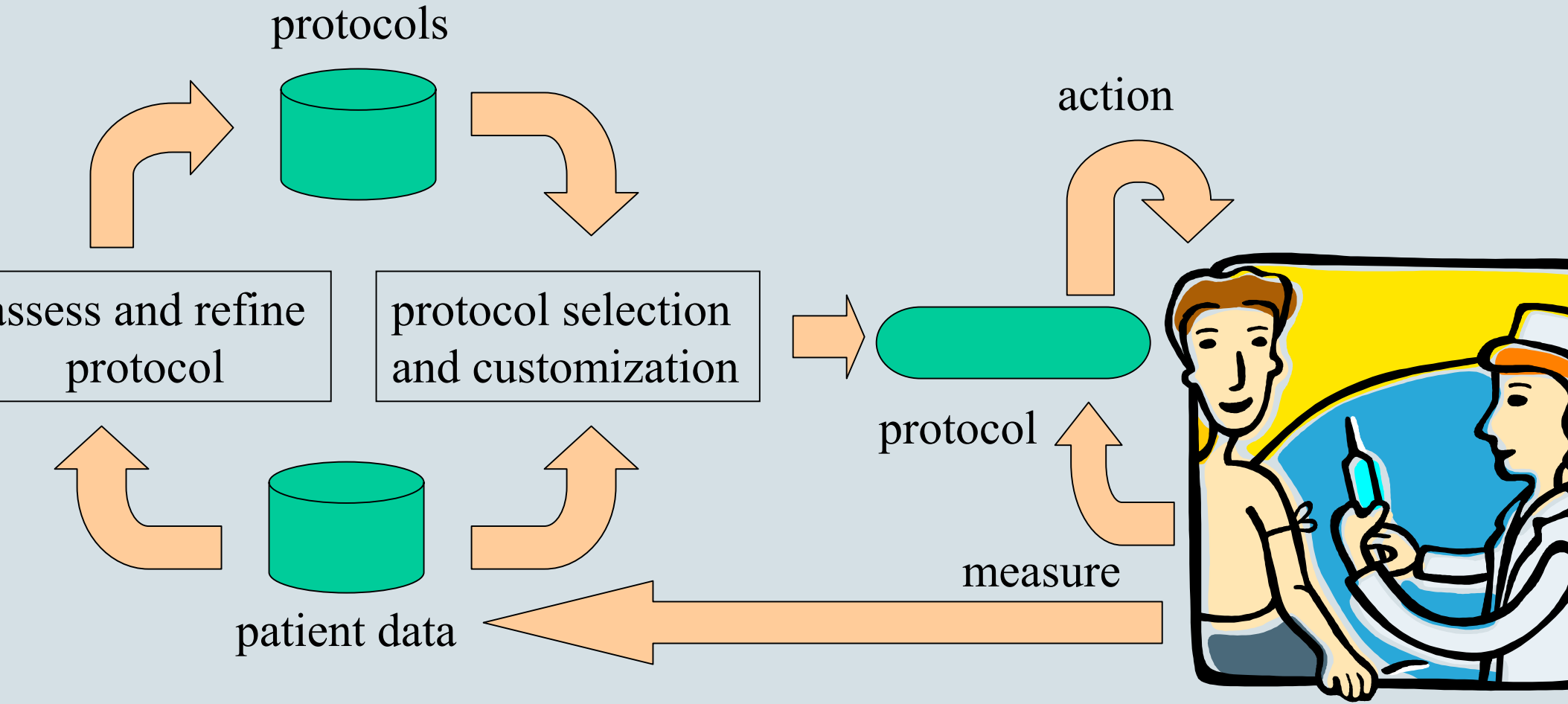
BPM in healthcare

From workflow to careflow

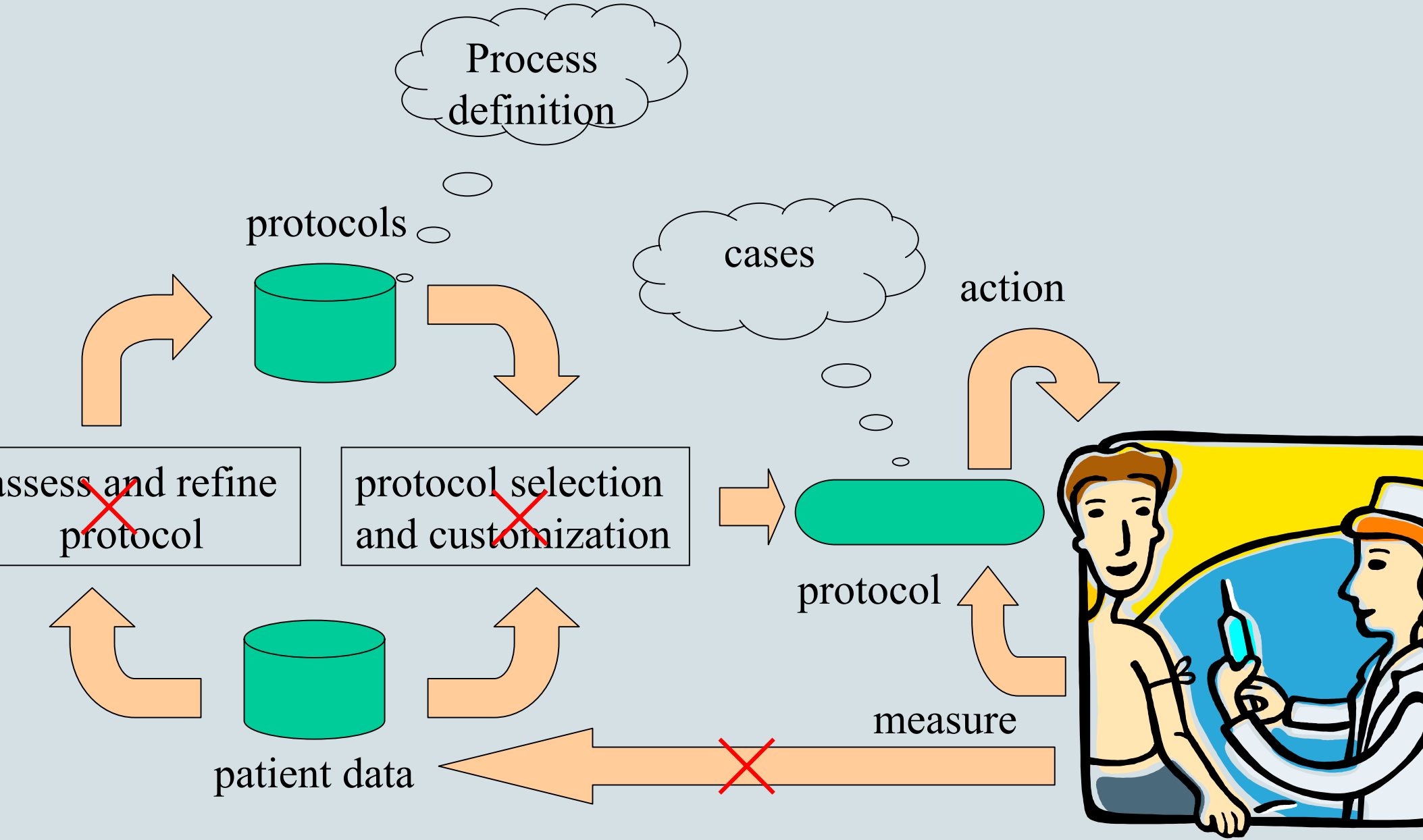
- *Workflow Management* (WFM) and *Business Process Management* (BPM) are widely applied in administrative processes but not in healthcare.
- Increasingly, clinical decisions need to be based on *scientific evidence*, *social-ethical values* and *economic factors*.
- Evidence-based care requires transparency, justification, and accountability.
- *Careflow processes* need to be supported, controlled, and monitored.

Medical protocols

- Also named *medical guidelines* (to emphasize support) or *pathways* (to emphasize prediction).



Comparing classical workflow with careflow



Medical protocols

- Existing languages for describing medical protocols, guidelines and/or pathways: Asbru, EON, GLIF, GUIDE, PRODIGY and PROforma.
- Use of the protocols:
  - Passive: used to check afterwards
  - Active: used to “control” the careflow
- BPM software/research supports both uses:
  - Passive: process mining tools
  - Active: workflow management systems

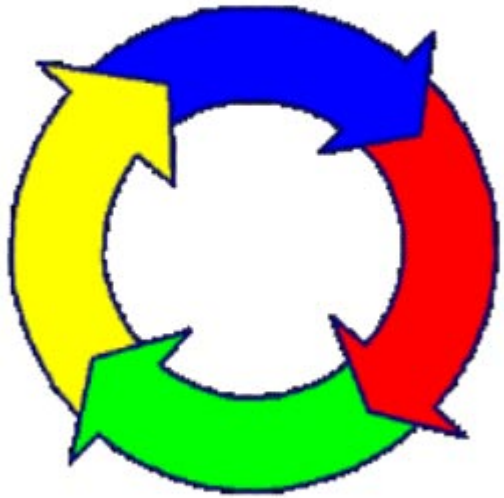
Closing the BPM cycle …

Press arrow to start

The BPM life-cycle

Diagnosis

Process enactment



Process design

Implementation /configuraton

2008 -

2003 -

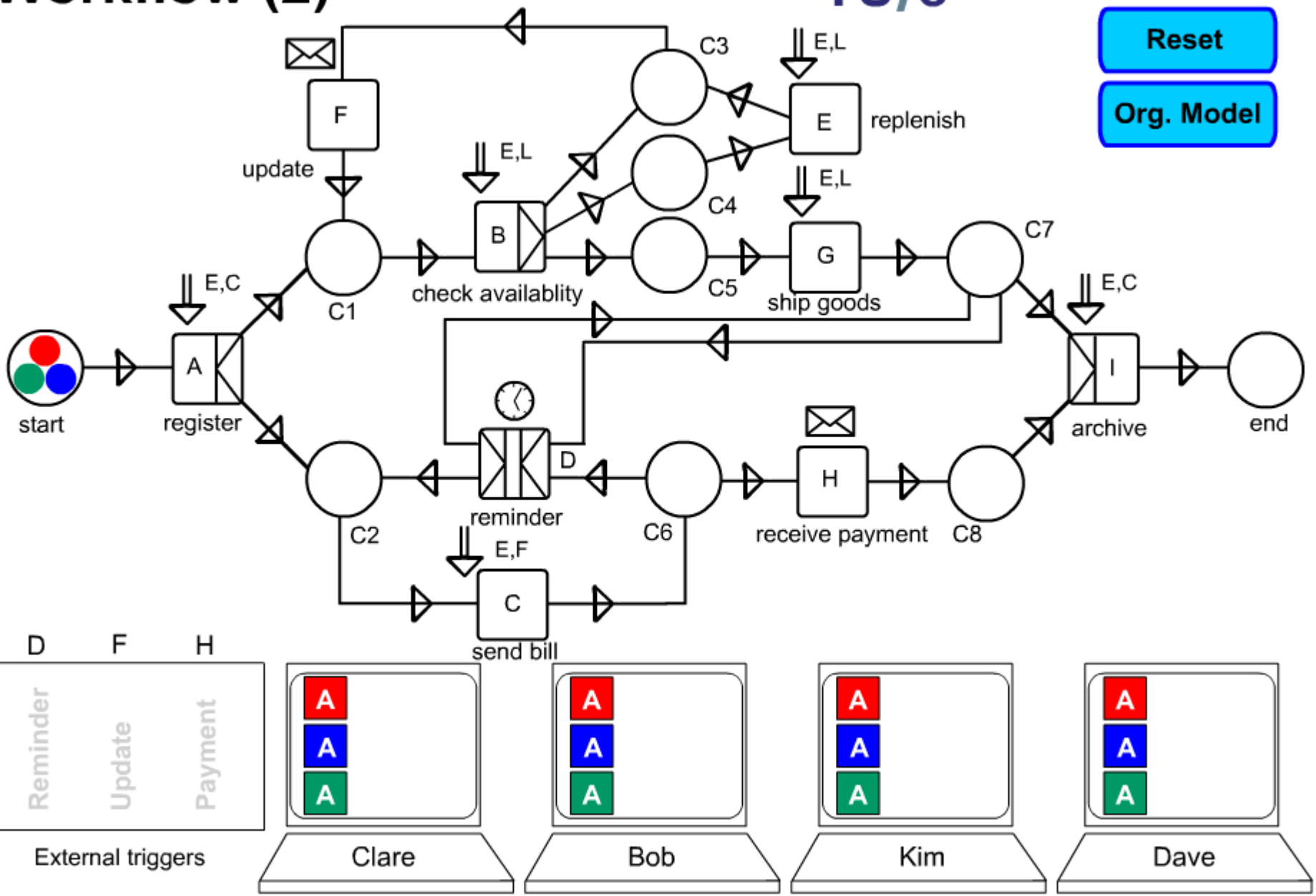
1998 -

1993 -

What is workflow management ?

Workflow (2)

TU/e technische universiteit eindhoven

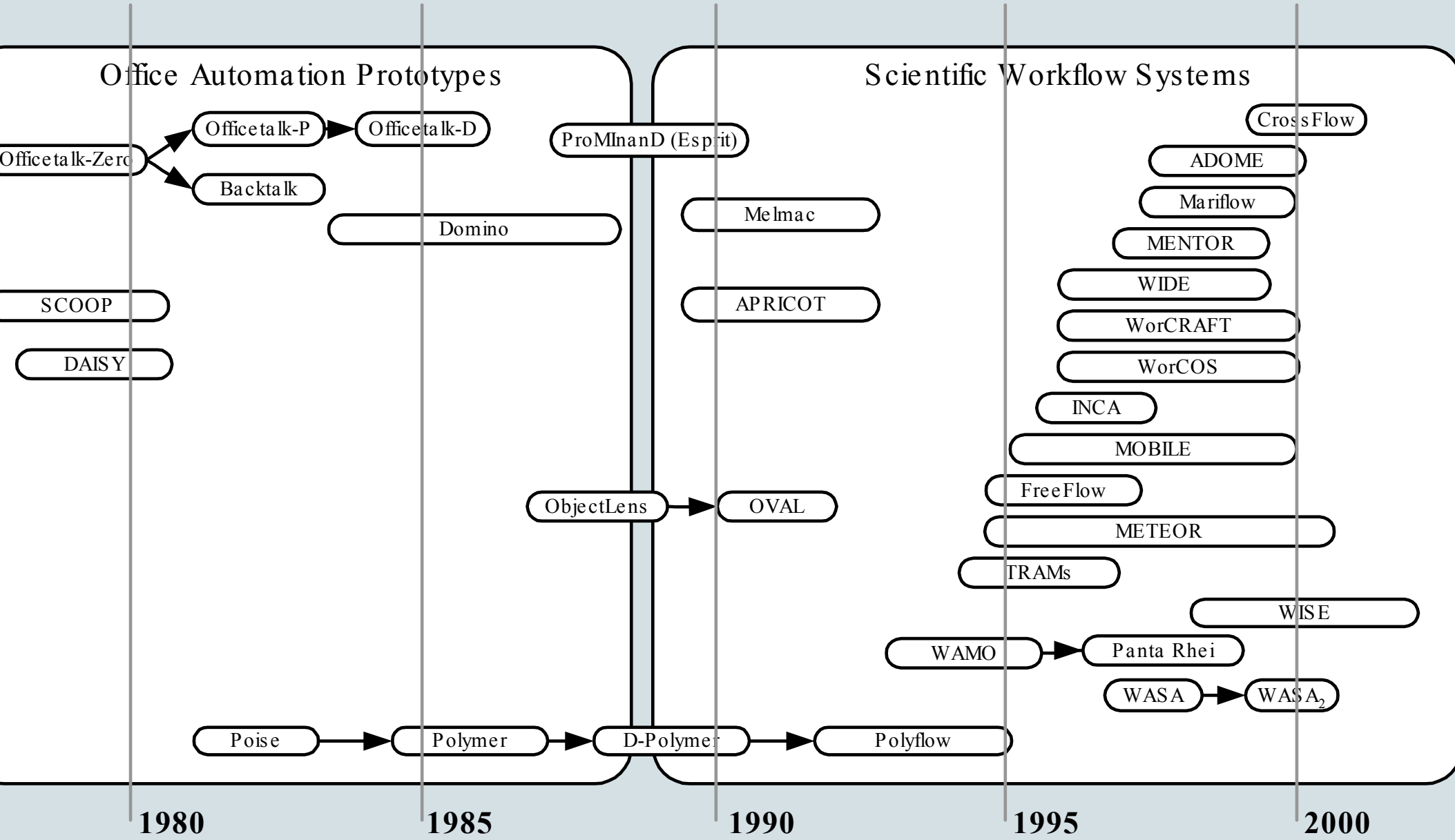


Click on a work-item to select a piece of work for a specific case.

25 years of workflow management

office automation = workflow management = business process management = WSCL

Historical overview of systems

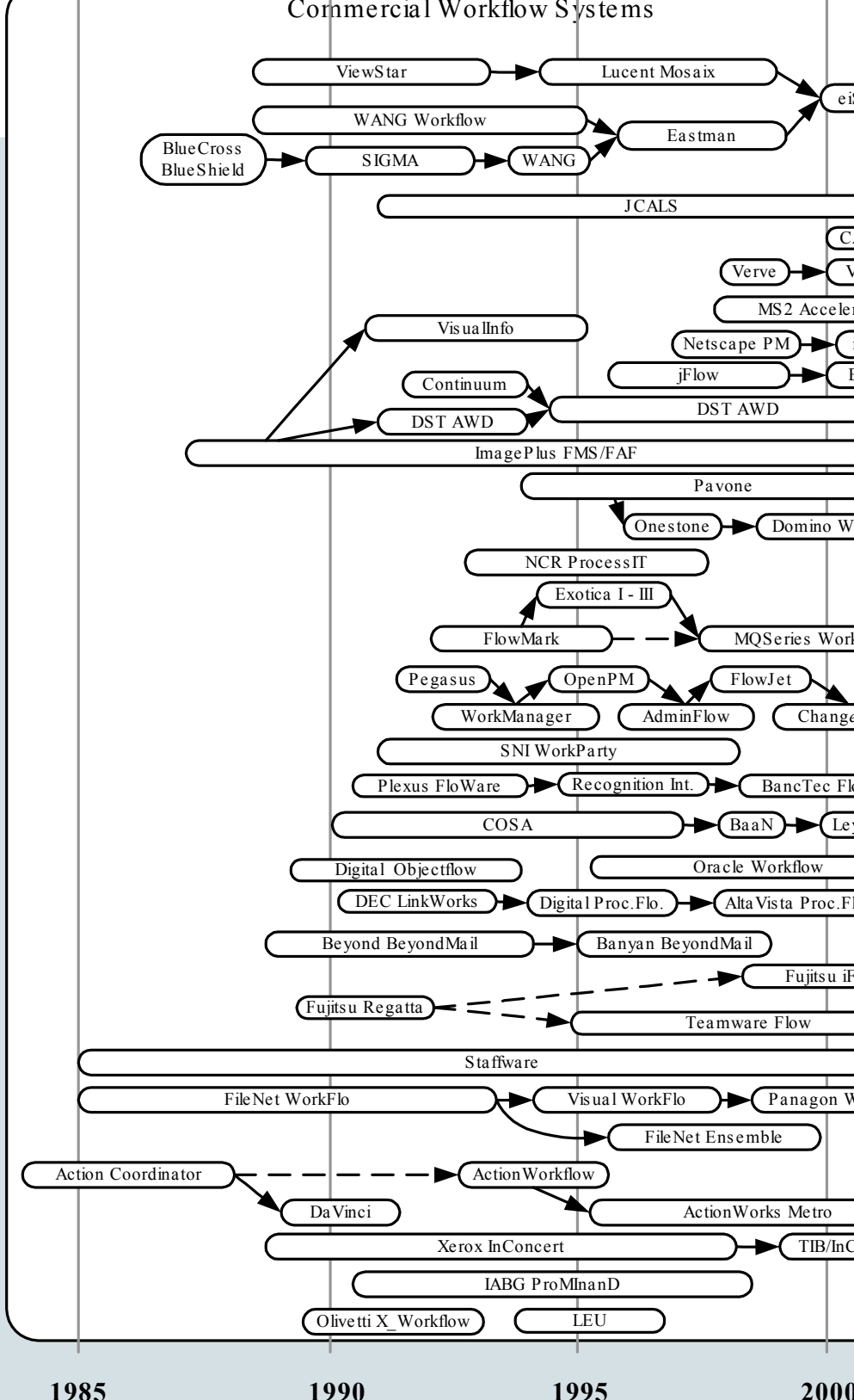


(Muehlen, 2003)

(Zur Muehlen, 2003)

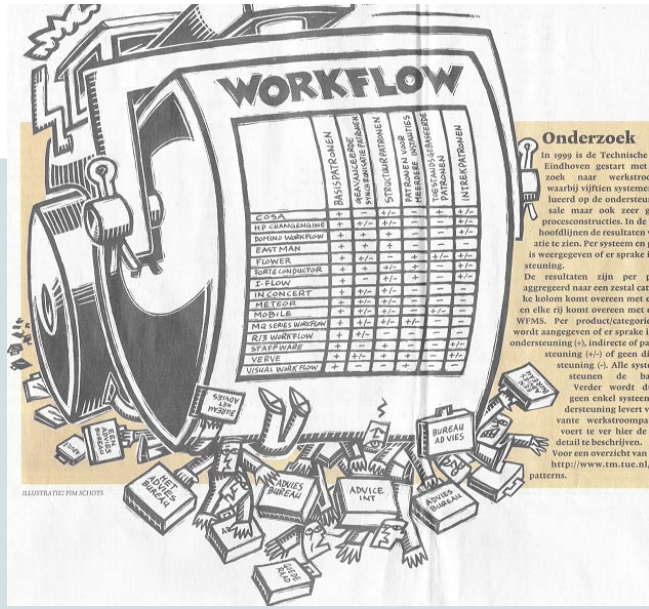
Workflow management is already 25 years old (cf. OfficeTalk, Skip Ellis/Xerox)!

The WFM hype is over …, but there are more and more applications, and WFM is adopted by many other technologies (ERP, Web Services, etc.).



TU/e technische universiteit eindhoven

Workflow patterns



Basic Control Flow Patterns

- Pattern 1 (Sequence)
- Pattern 2 (Parallel Split)
- Pattern 3 (Synchronization)
- Pattern 4 (Exclusive Choice)
- Pattern 5 (Simple Merge)

Advanced Branching and Synchronization Patterns

- Pattern 6 (Multi-choice)
- Pattern 7 (Synchronizing Merge)
- Pattern 8 (Multi-merge)
- Pattern 9 (Discriminator)

Structural Patterns

- Pattern 10 (Arbitrary Cycles)
- Pattern 11 (Implicit Termination

Patterns involving Multiple Instances

- Pattern 12 (Multiple Instances Without Synchronization)
- Pattern 13 (Multiple Instances With a Priori Design Time Knowledge)
- Pattern 14 (Multiple Instances With a Priori Runtime Knowledge)
- Pattern 15 (Multiple Instances Without a Priori Runtime Knowledge)

State-based Patterns

- Pattern 16 (Deferred Choice)
- Pattern 17 (Interleaved Parallel Routing)
- Pattern 18 (Milestone)

Cancellation Patterns

- Pattern 19 (Cancel Activity)
- Pattern 20 (Cancel Case)

www.workflowpatterns.com

	Staffw.	COSA	InConc.	Eastm.	Verve	MQSeries	SAP/R3	BPML	BPEL4WS
1 (seq)	+	+	+	+	+	+	+	+	+
2 (par-spl)	+	+	+	+	+	+	+	+	+
3 (synch)	+	+	+	+	+	+	+	+	+
4 (ex-ch)	+	+	+/-	+	+	+	+	+	+
5 (simple-m)	+	+	+/-	+	+	+	+	+	+
6 (m-choice)	-	+	+/-	+/-	+	+	+	-	+
7 (sync-m)	-	+/-	+	+	-	+	-	-	+
8 (multi-m)	-	-	-	+	+	-	-	+/-	-
9 (disc)	-	-	-	+	+	-	+	-	-
10 (arb-c)	+	+	-	+	+	-	-	-	-
11 (impl-t)	+	-	+	+	-	+	-	+	+
12 (mi-no-s)	-	+/-	-	+	+	-	-	+	+
13 (mi-dt)	+	+	+	+	+	+	+	+	+
14 (mi-rt)	-	-	-	-	-	-	+/-	-	-
15 (mi-no)	-	-	-	-	-	-	-	-	-
16 (def-c)	-	+	-	-	-	-	-	+	+
17 (int-par)	-	+	-	-	-	-	-	-	+/-
18 (milest)	-	+	-	-	-	-	-	-	-
19 (can-a)	+	+	-	-	-	-	+	+	+
20 (can-c)	-	-	-	-	+	-	+	+	+

TU/e technische universiteit eindhoven

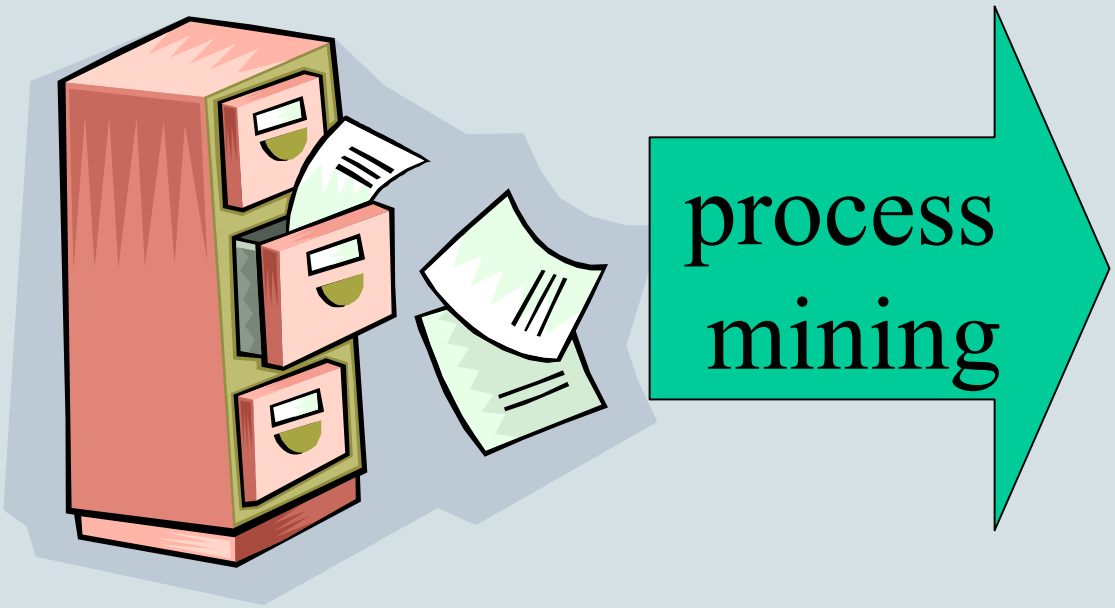
Challenges for the next 25 years

Challenges

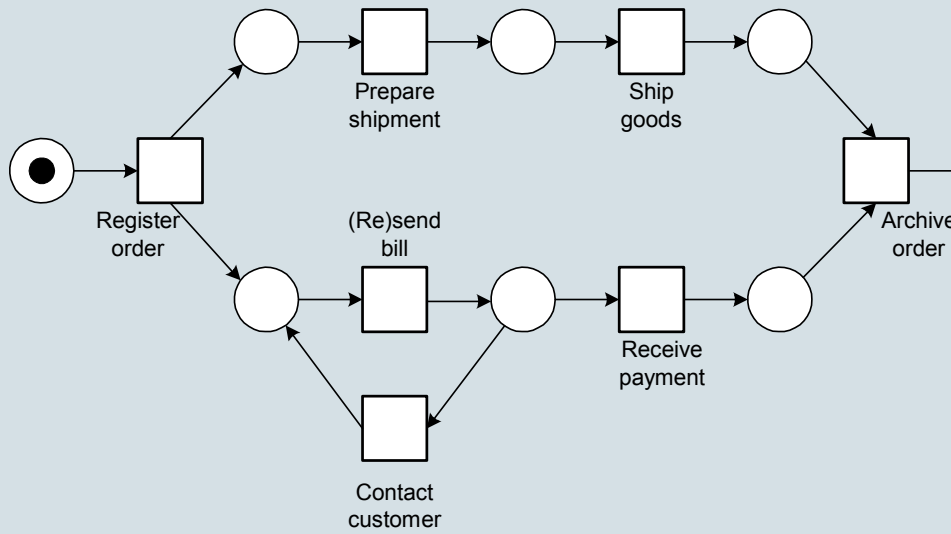
- Realize what has been promised in the last 25 years …..
  - Design support
  - Verification, validation and performance analysis
  - Cross-organizational workflow support
  - More flexibility (case handling)
  - ***Better management information (process mining)***
  - …
- **These challenges also apply to careflow!**

Process mining

Process mining: Reversing the process



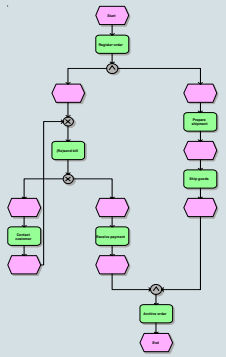
process mining



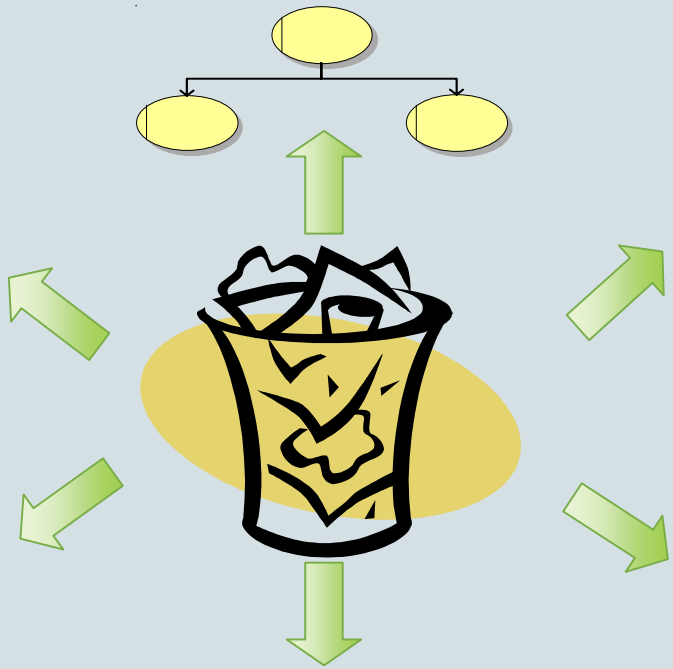
- Process mining can be used for:
  - Process discovery (What is the process?)
  - Delta analysis (Are we doing what was specified?)
  - Performance analysis (How can we improve?)

Process mining (overview)

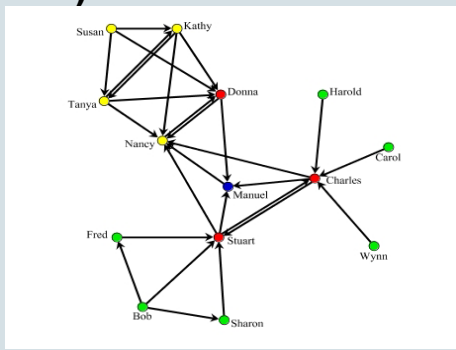
2) process model



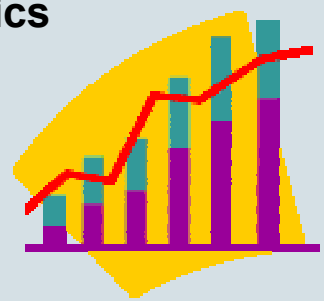
3) organizational model



4) social network



1) basic performance metrics

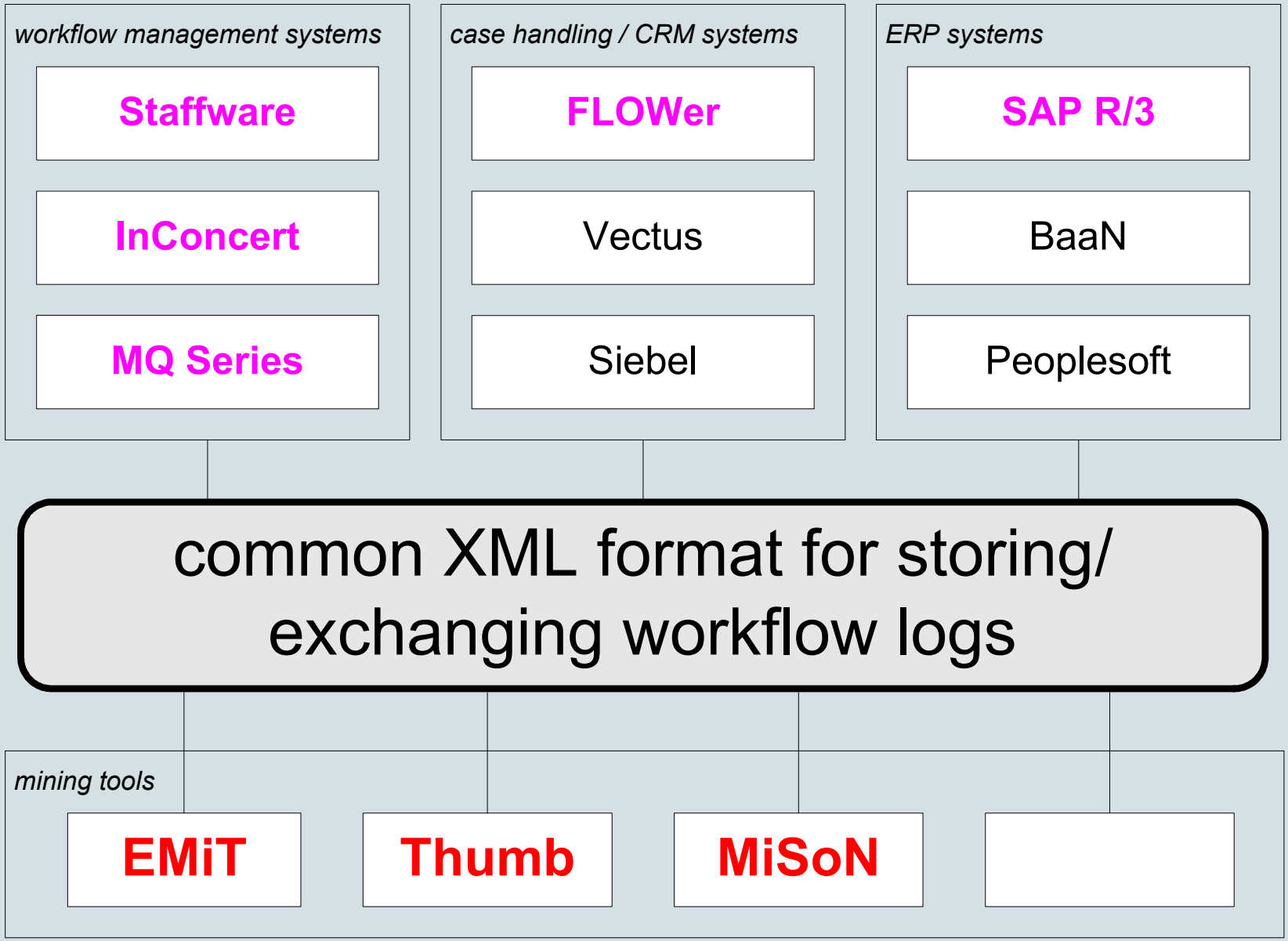


5) performance characteristics

If …then …

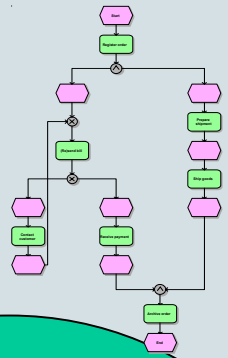
6) auditing/security

Process Mining: Tooling

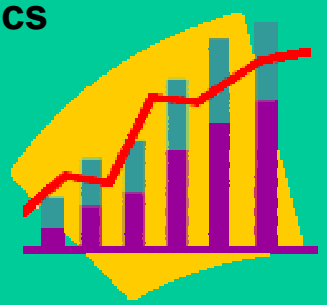


Focus of BPM vendors so far …

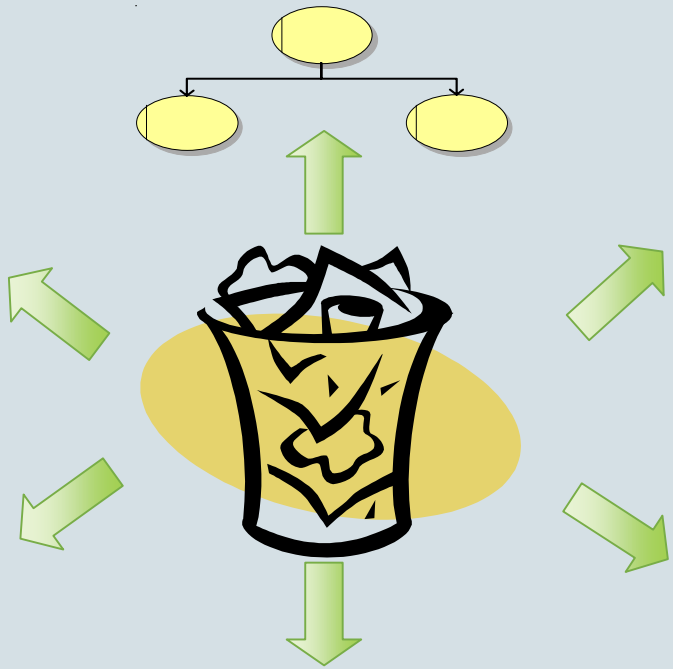
2) process model



1) basic performance metrics

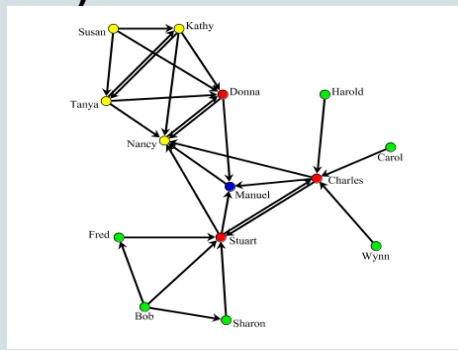


3) organizational model



6) auditing/security

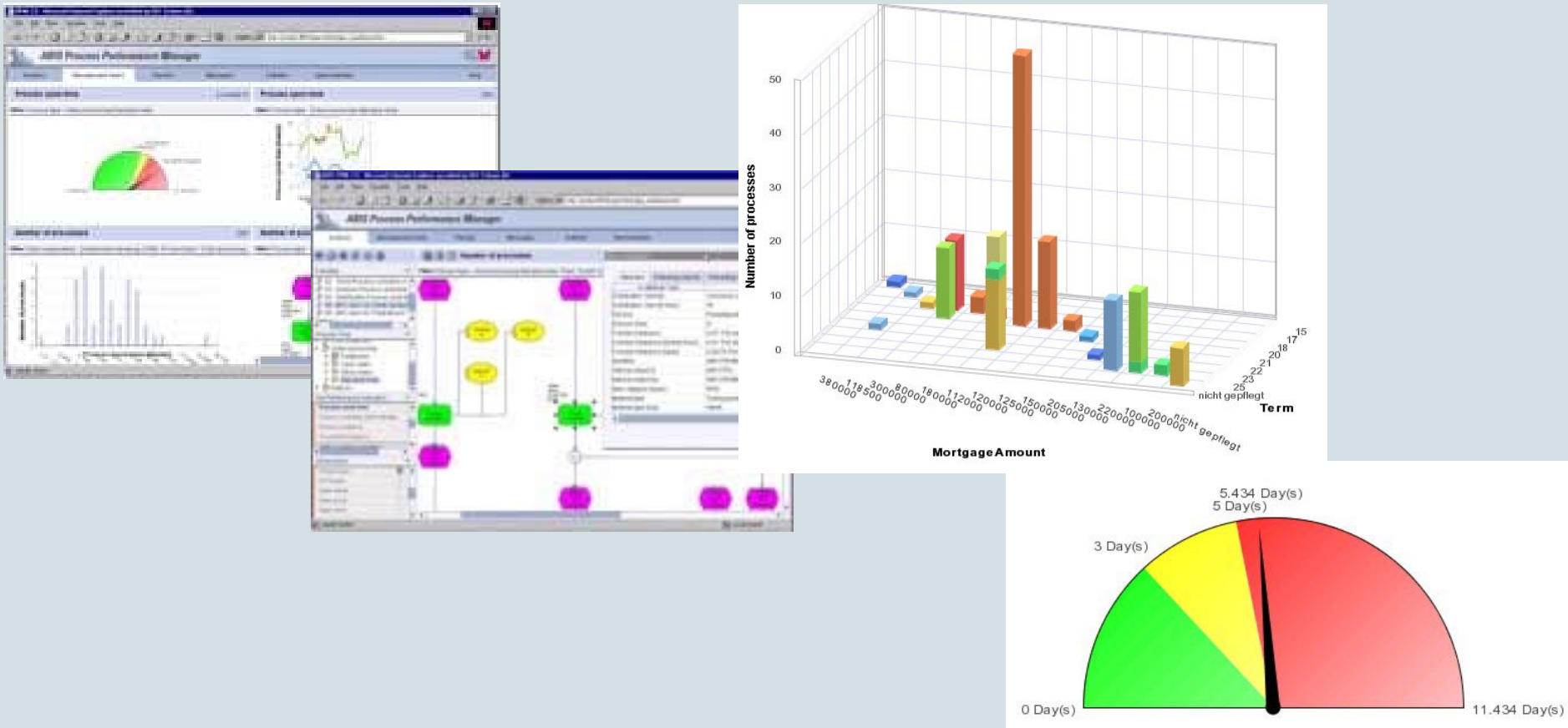
4) social network



5) performance characteristics

If …then …

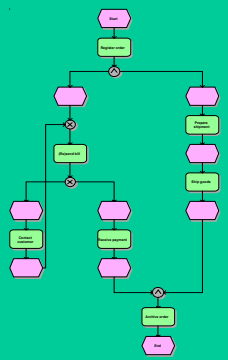
Example (ARIS PPM)



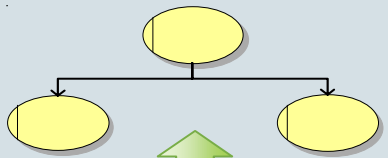
IDS Scheer's ARIS Process Performance Manager

Example: mining process models (control-flow)

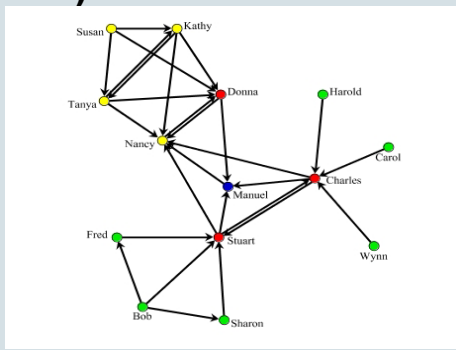
2) process model



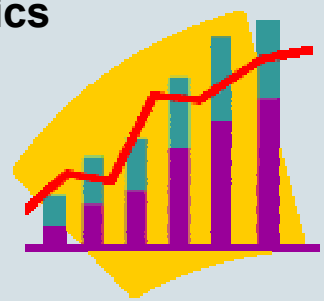
3) organizational model

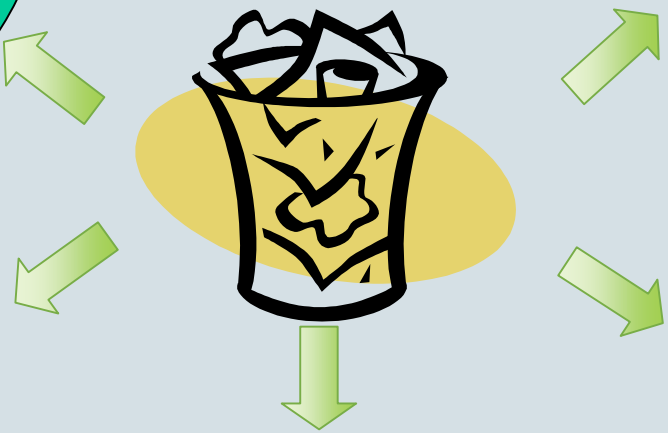


4) social network



1) basic performance metrics



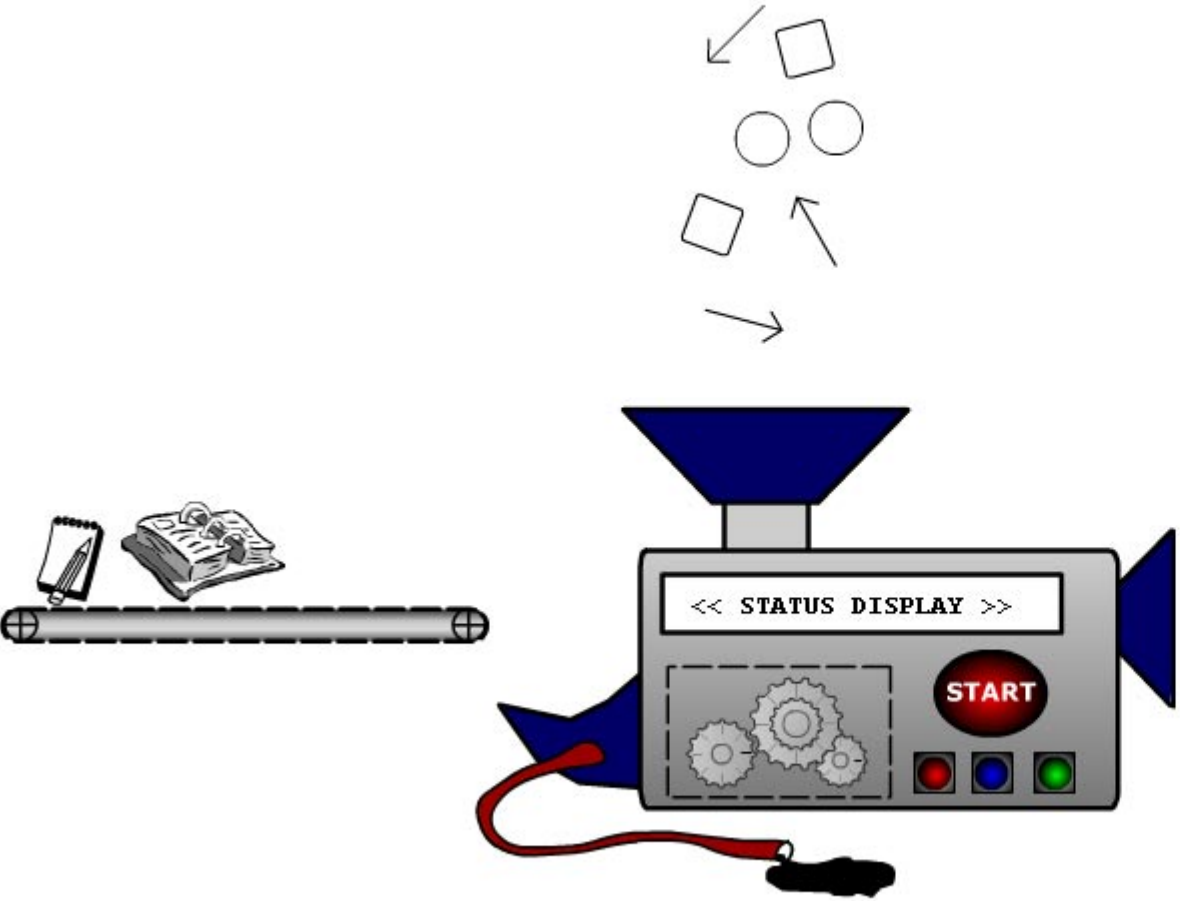


5) performance characteristics

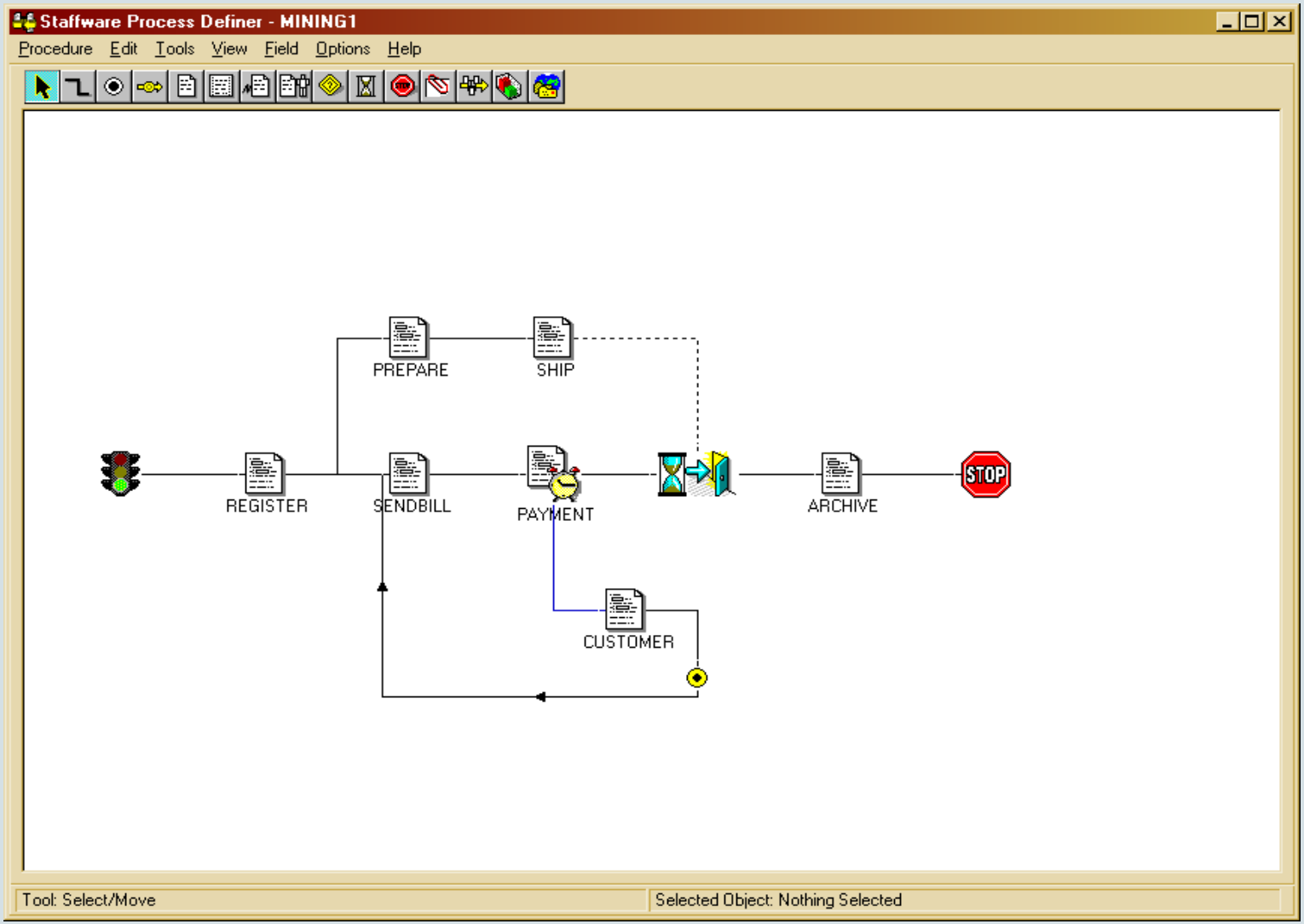
If …then …

6) auditing/security

Process Mining



Example: processing customer orders



Example in Staffware: 7 tasks and all basic routing constructs

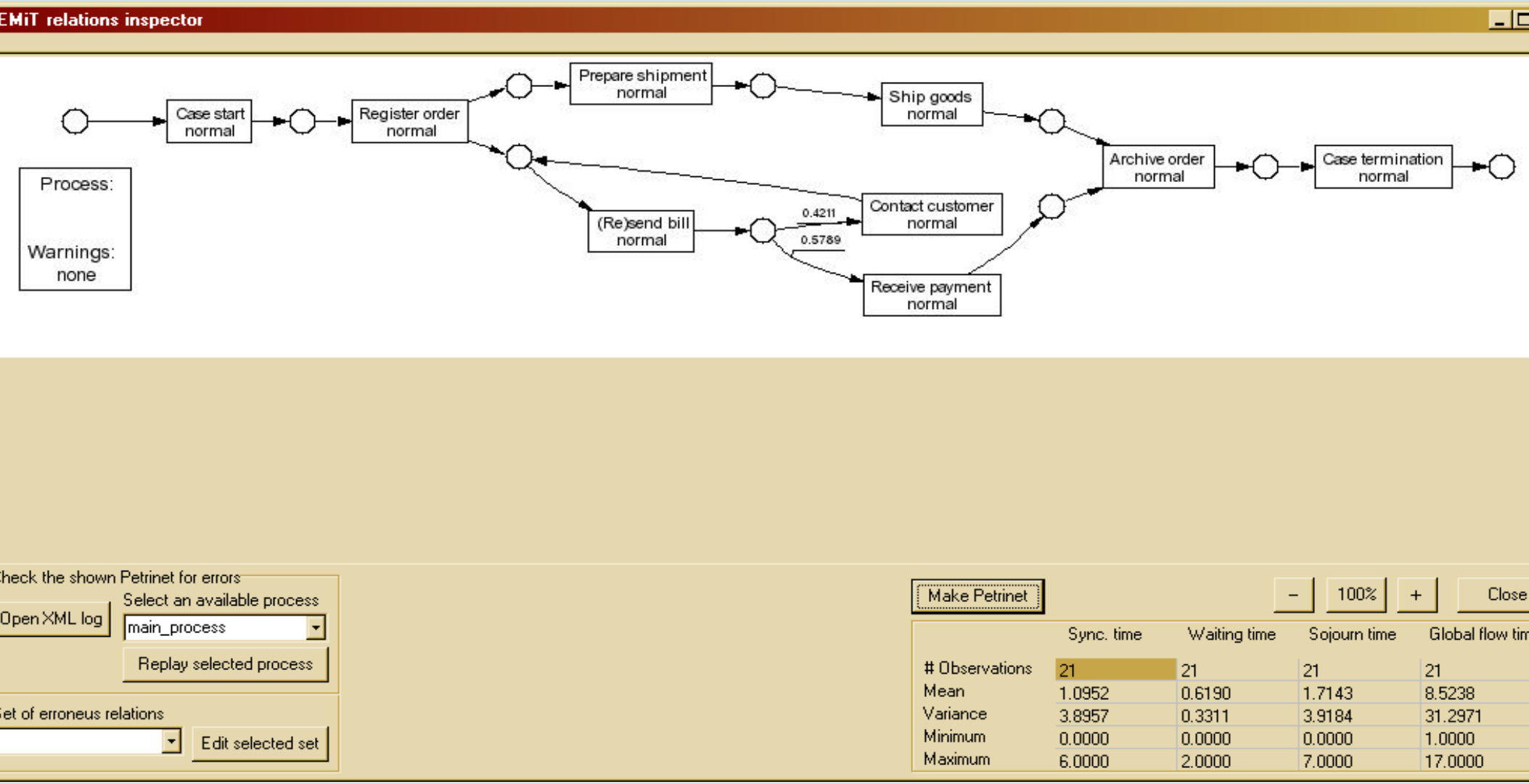
ragment of Staffware log

```
Case 21
Diractive Description    Event             User                yyyy/mm/dd hh:mm
-------------------------------------------------------------------------------
                         Start             swdemo@staffw_edl   2003/02/05 15:00
Register order           Processed To      swdemo@staffw_edl   2003/02/05 15:00
Register order           Released By       swdemo@staffw_edl   2003/02/05 15:00
Prepare shipment         Processed To      swdemo@staffw_edl   2003/02/05 15:00
(Re)send bill            Processed To      swdemo@staffw_edl   2003/02/05 15:00
(Re)send bill            Released By       swdemo@staffw_edl   2003/02/05 15:01
Receive payment          Processed To      swdemo@staffw_edl   2003/02/05 15:01
Prepare shipment         Released By       swdemo@staffw_edl   2003/02/05 15:01
Ship goods               Processed To      swdemo@staffw_edl   2003/02/05 15:01
Ship goods               Released By       swdemo@staffw_edl   2003/02/05 15:02
Receive payment          Released By       swdemo@staffw_edl   2003/02/05 15:02
Archive order            Processed To      swdemo@staffw_edl   2003/02/05 15:02
Archive order            Released By       swdemo@staffw_edl   2003/02/05 15:02
                         Terminated                            2003/02/05 15:02

Case 22
Diractive Description    Event             User                yyyy/mm/dd hh:mm
-------------------------------------------------------------------------------
                         Start             swdemo@staffw_edl   2003/02/05 15:02
Register order           Processed To      swdemo@staffw_edl   2003/02/05 15:02
Register order           Released By       swdemo@staffw_edl   2003/02/05 15:02
Prepare shipment         Processed To      swdemo@staffw_edl   2003/02/05 15:02
```

Fragment of XML file

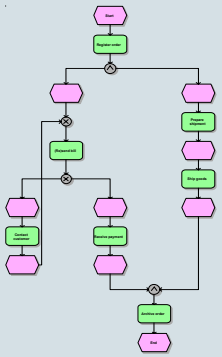
```
<?xml version="1.0"?>
<!DOCTYPE WorkFlow_log SYSTEM
   "http://www.tm.tue.nl/it/research/workflow/mining/WorkFlow_log.dtd">
<WorkFlow_log>
   <source program="staffware"/>
   <process id="main_process">
        <case id="case_0">
             <log_line>
                  <task_name>Case start</task_name>
                  <event kind="normal"/>
                  <date>05-02-2003</date>
                  <time>15:04</time>
             </log_line>
             <log_line>
                  <task_name>Register order</task_name>
                  <event kind="schedule"/>
                  <date>05-02-2003</date>
                  <time>15:04</time>
```



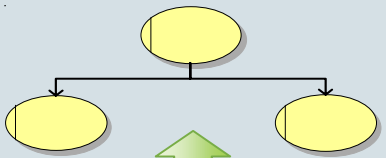
Focus on time.

Example: mining social networks

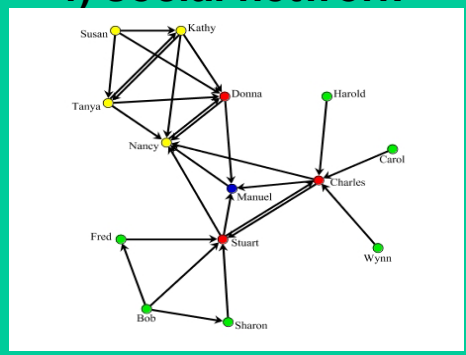
2) process model



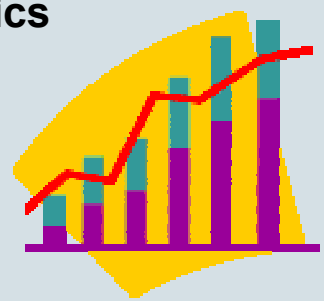
3) organizational model

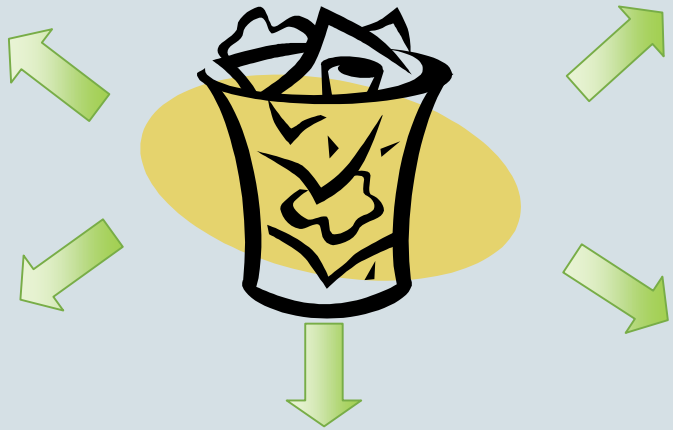


4) social network



1) basic performance metrics



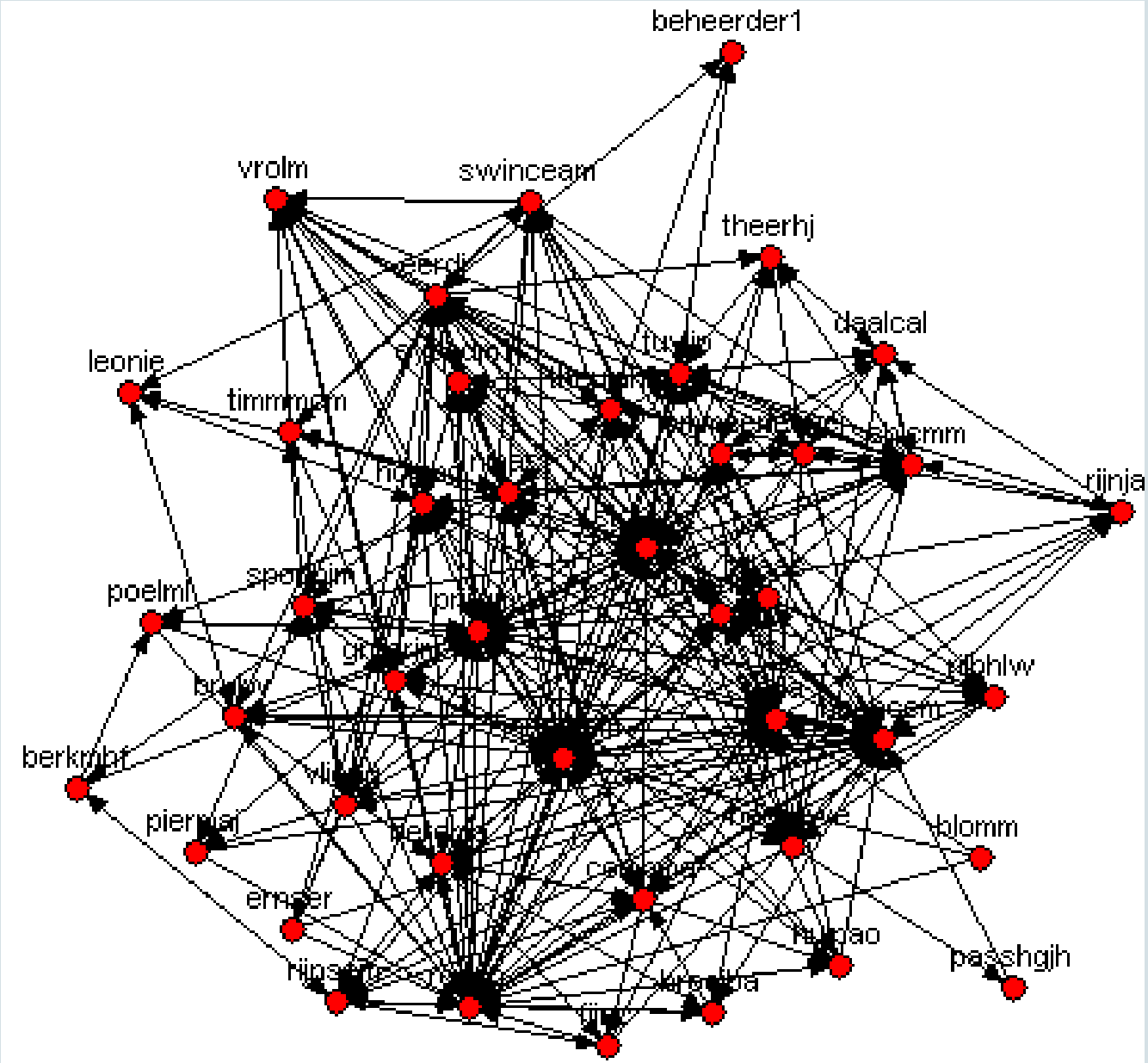


5) performance characteristics

If …then …

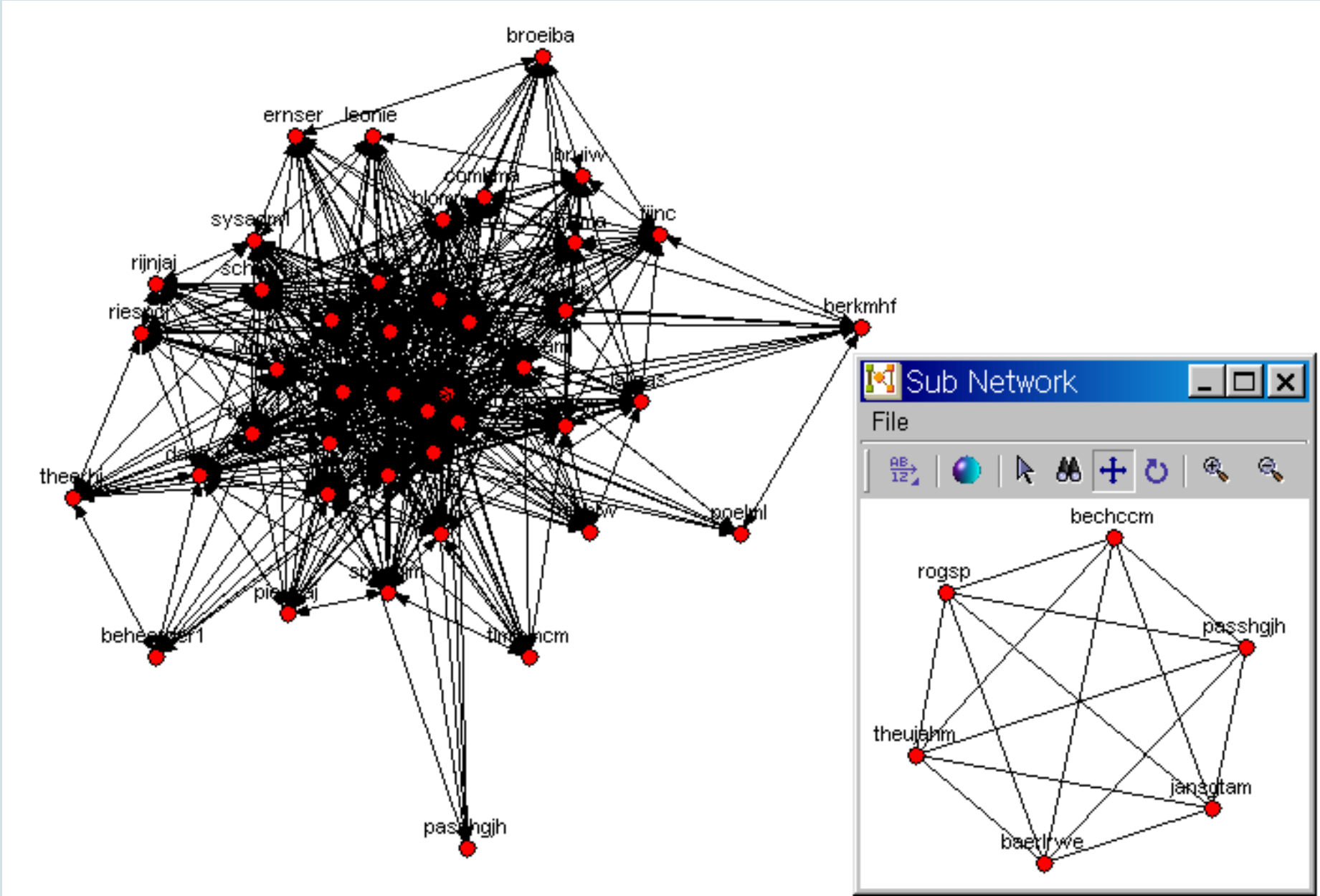
6) auditing/security

SN based on hand-over of work metric

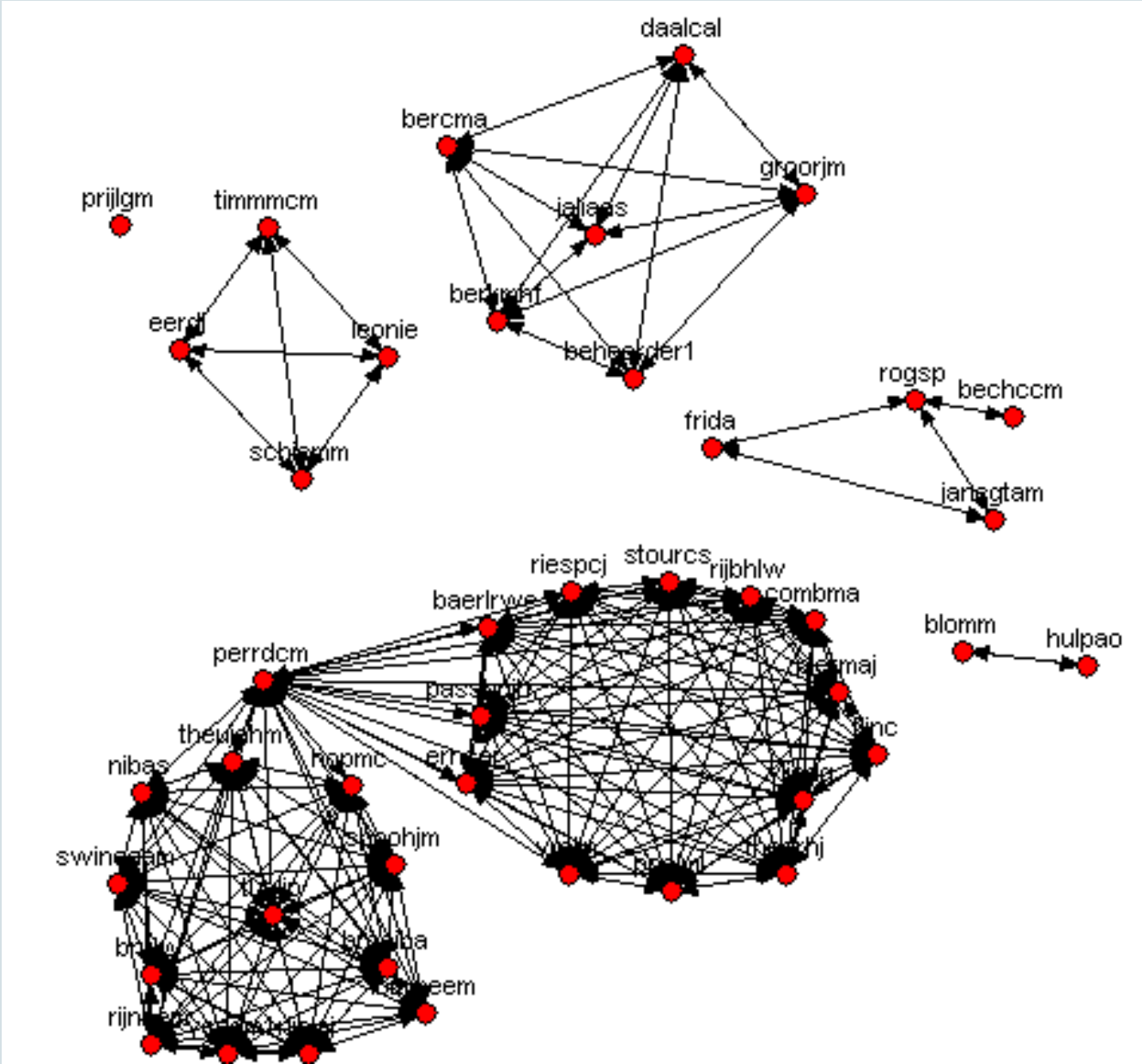


density of network is 0.225

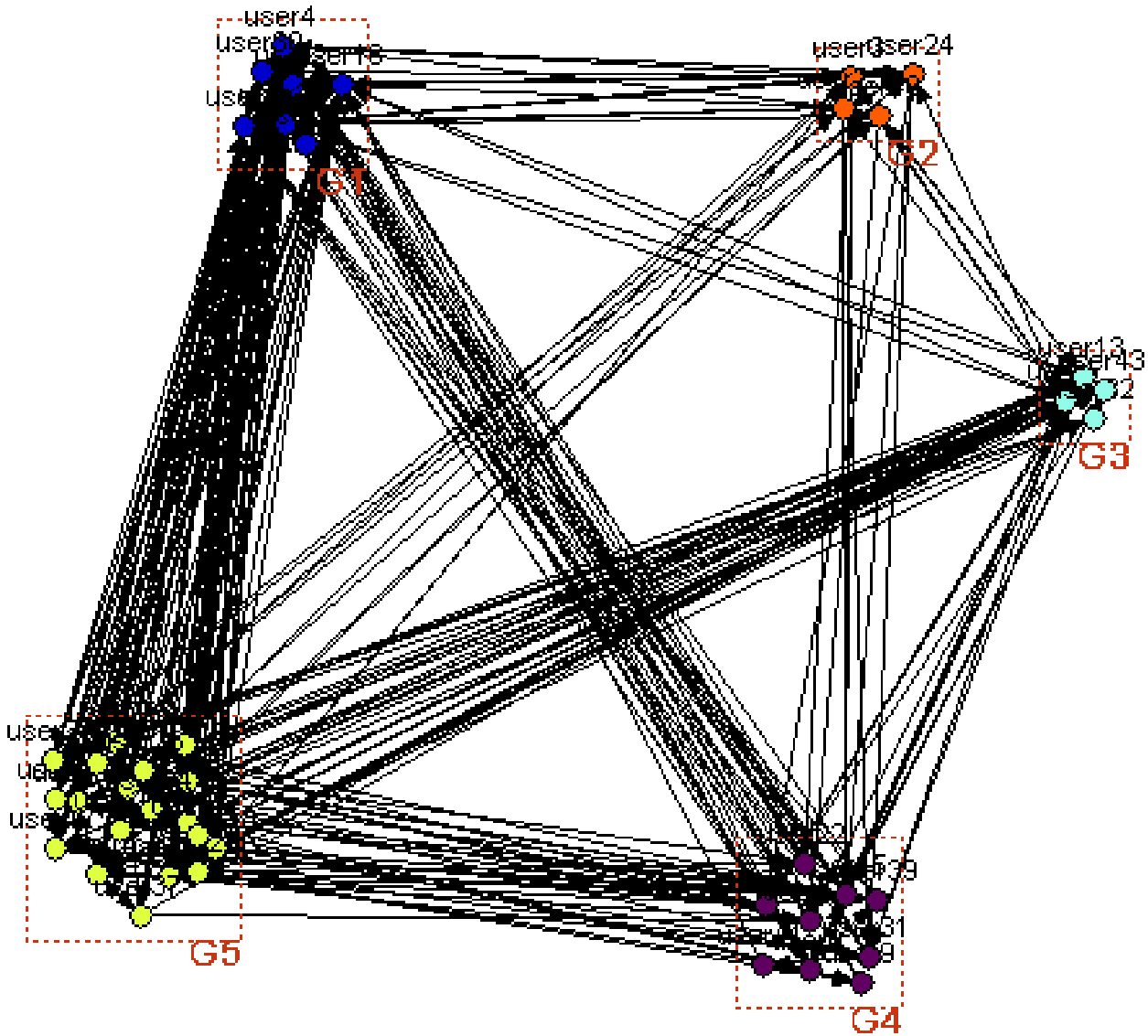
SN based on working together (and ego network)

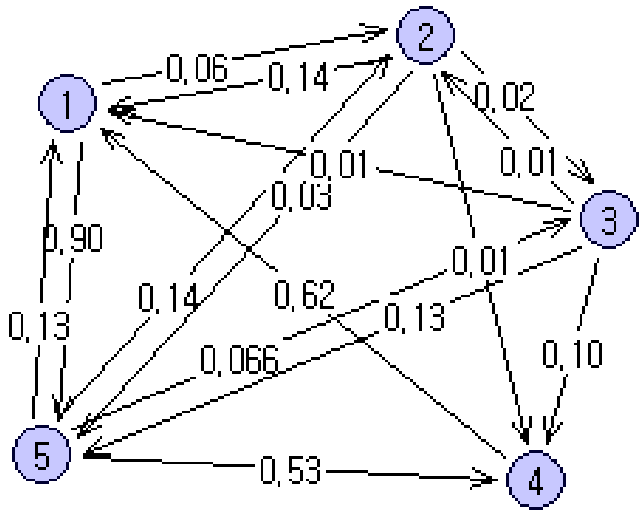


SN based on joint activities

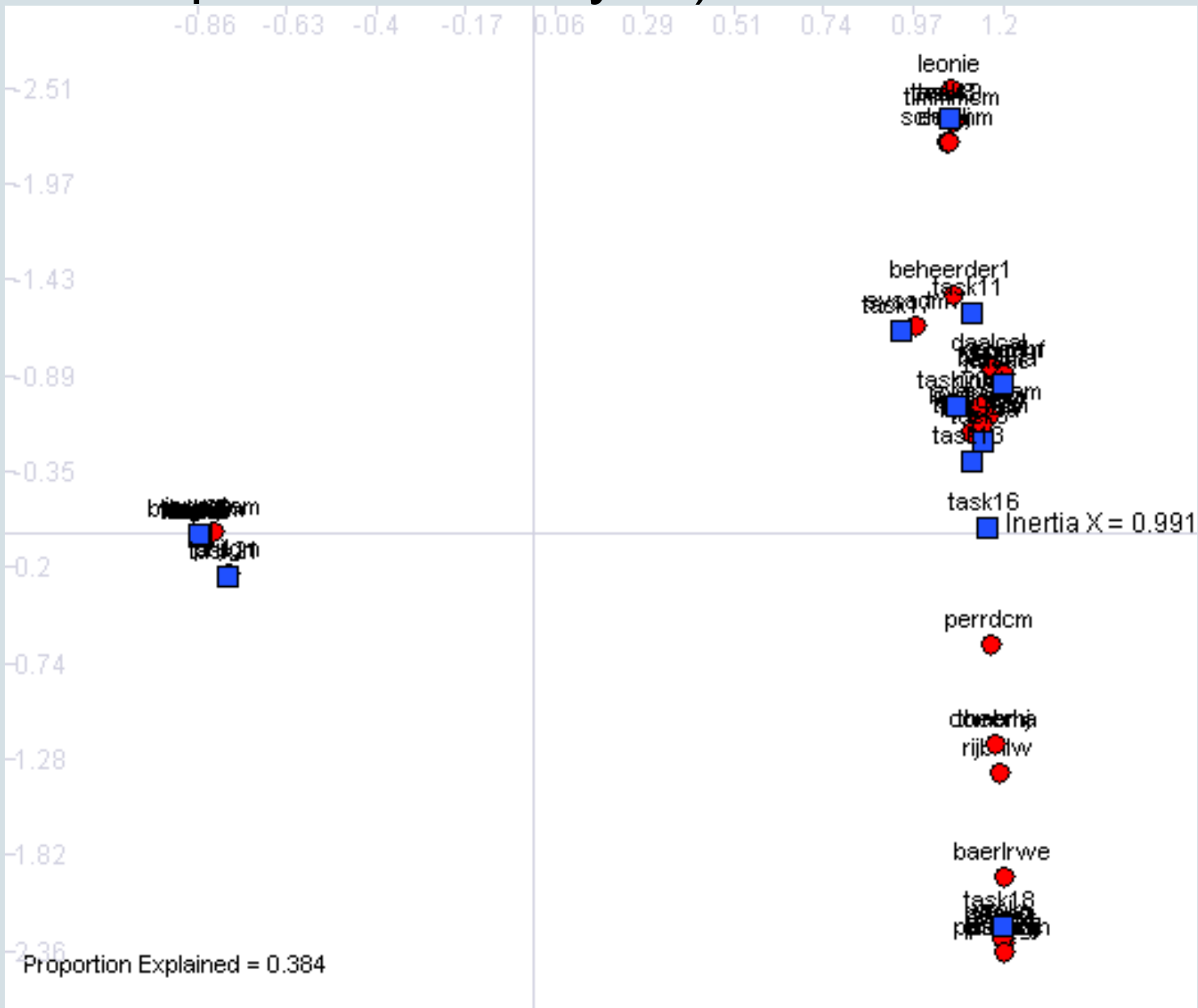


SN based on hand-over of work between groups



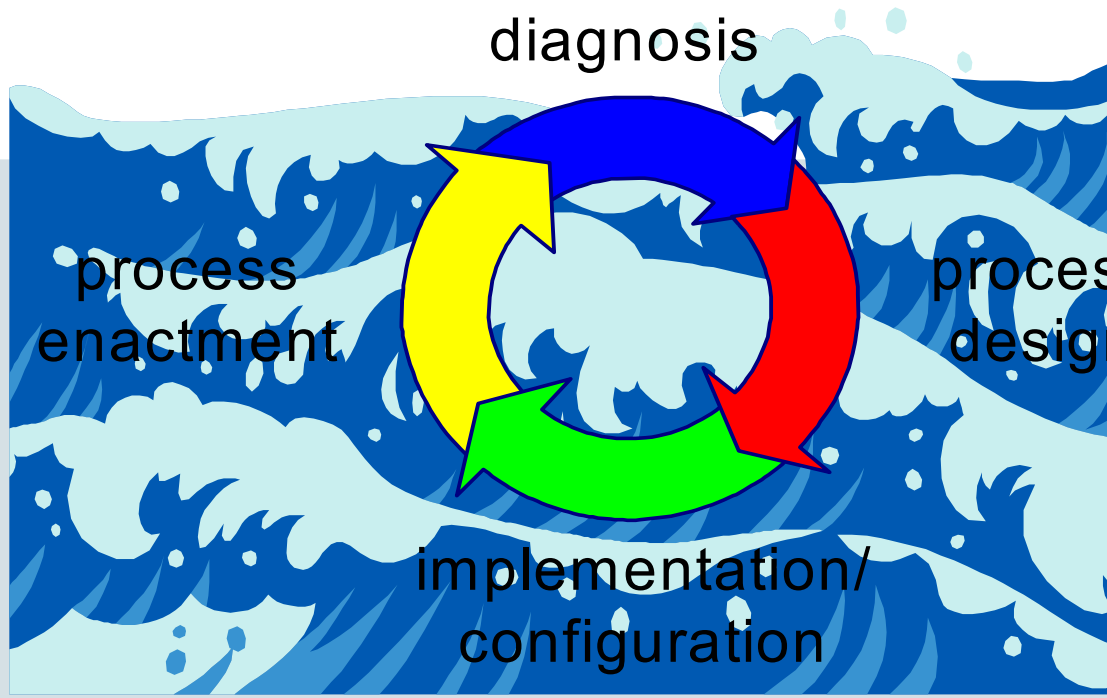


Relating tasks and performers
(using correspondence analysis)



Conclusion

Conclusion



Careflow is an interesting but also challenging application domain for BPM/WFM technology.

It is important to close the BPM loop. Process mining is one way to do this.

Process mining provides many interesting challenges for scientists, customers, users, managers, consultants, and tool developers.

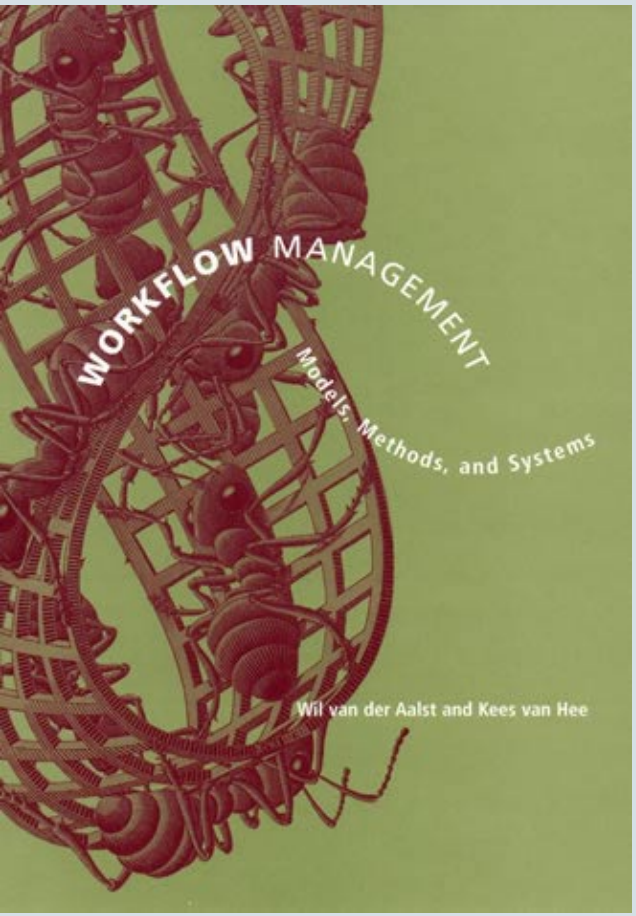
Process mining is particularly interesting in the healthcare domain (cf. evidence-based medicine, increased accountability, and need to cut costs).

More information

http://www.workflowcourse.com

http://www.workflowpatterns.com

http://www.processmining.org



W.M.P. van der Aalst and K.M. van Hee.
Workflow Management: Models, Methods, and Systems.
MIT press, Cambridge, MA, 2002/2004.