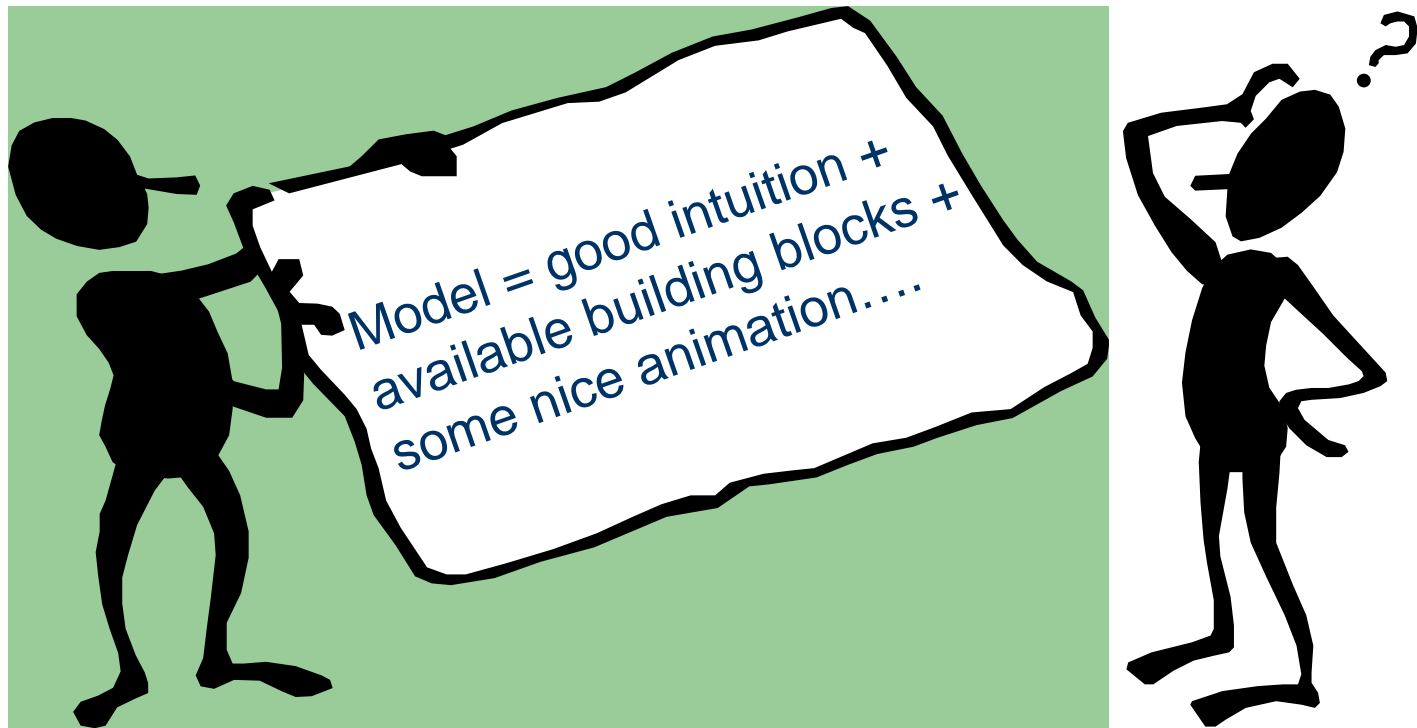


Building Communicative Models – A Job Oriented Approach to Manufacturing Simulation

D.J. van der Zee

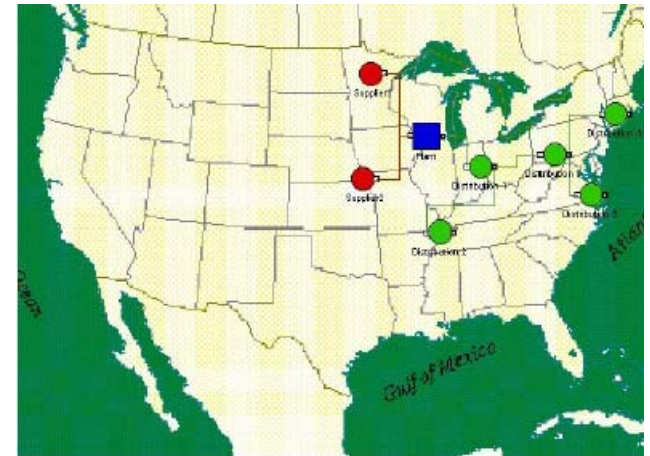
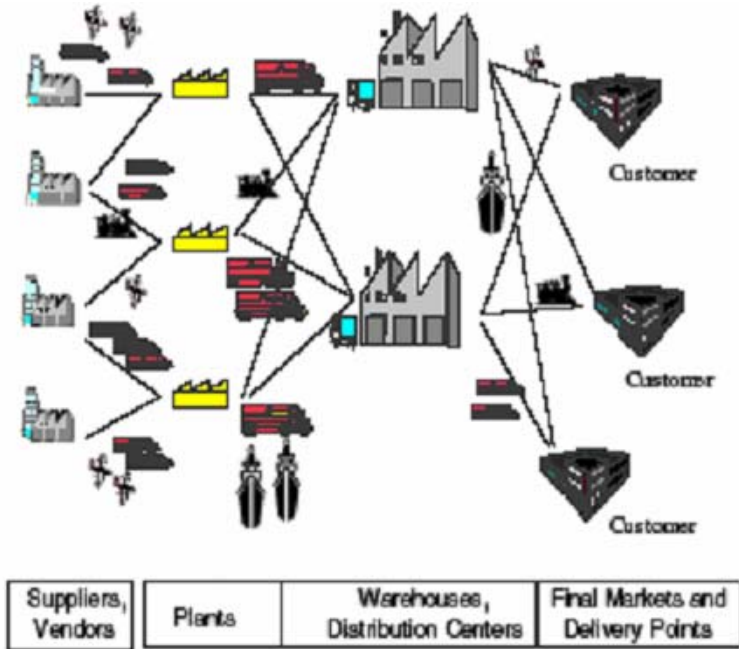
**Production Systems Design Group
University of Groningen
The Netherlands**



OR Society (UK) Simulation Study Group
3rd Simulation Workshop (SW06)

Introduction – Supply chain simulation

Physical infrastructure guides modeling...



Decision logistics - decision makers, rules, dataprocessing etc.???

1. A perspective on simulation modelling

<u>Time</u>	<u>How</u>	<u>Basic idea</u>
<1980s	Code	“trust me”
1980s	Visual interaction	“watch the play”
1990s	Object orientation	“a natural mapping”

Strong focus on simulation technology

Contents: choice of objects & their workings?

-> Model transparency – common understanding of objects

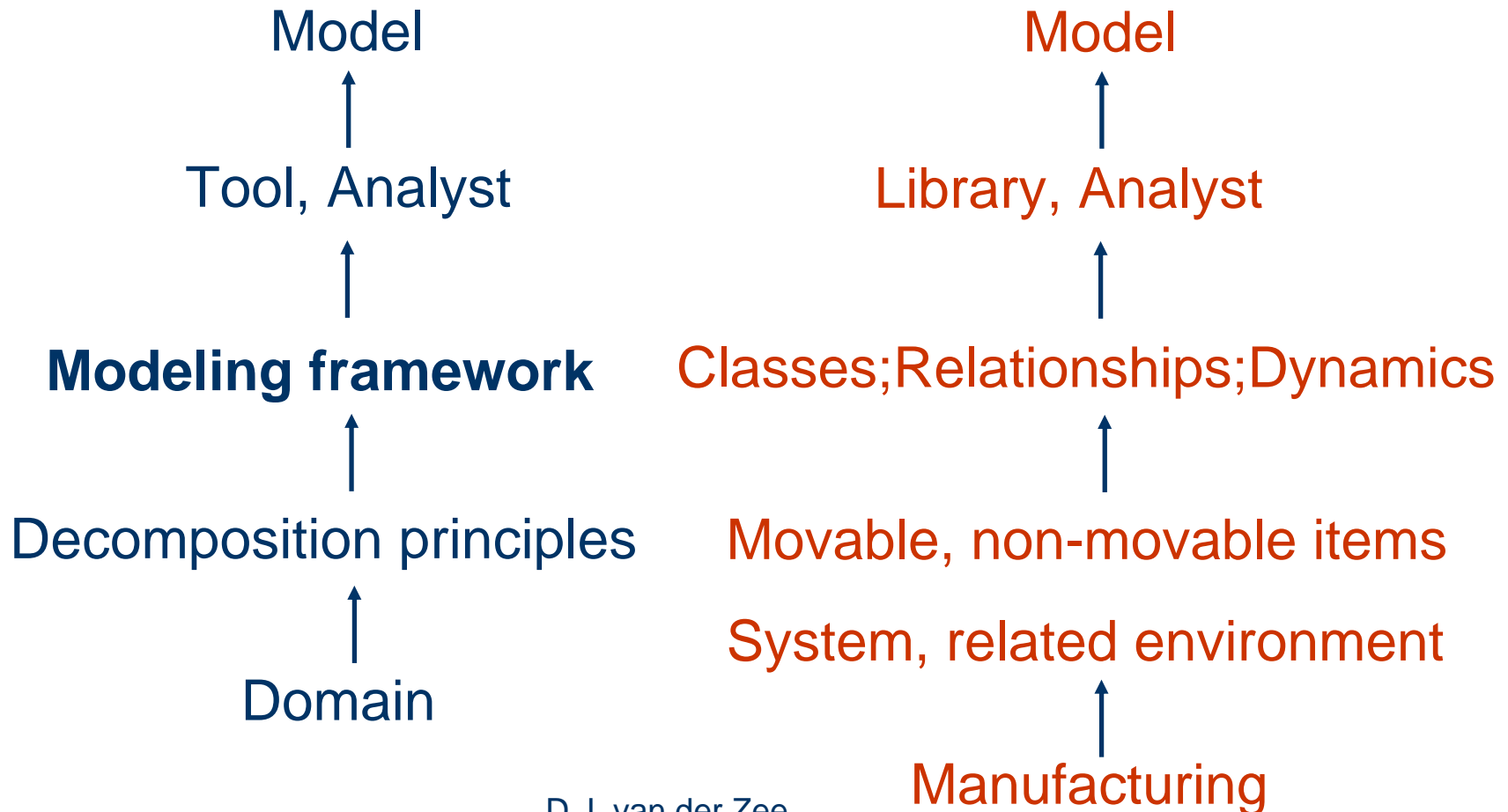
-> Model completeness – explicit notion of key decision variables

Communicative model?

Support dialog between problem owner and analyst?

Note: references can be found in paper

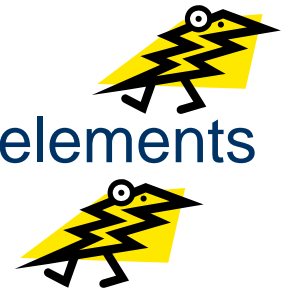
2. Modelling – from domain to model



3. The basics – decomposition principles



- Model and experimental frame
- Model statics and dynamics (rules of interaction)
- External/internal entities
- Movable and non-movable entities
- Queues and servers
- Modalities – physical, information and control elements
- Intelligent and non-intelligent entities - agents
- ...



Decomposition principles – new principle

- Model workings?
- Specification of activities and their execution?

➔ **Implicit modelling (code, visualization)**

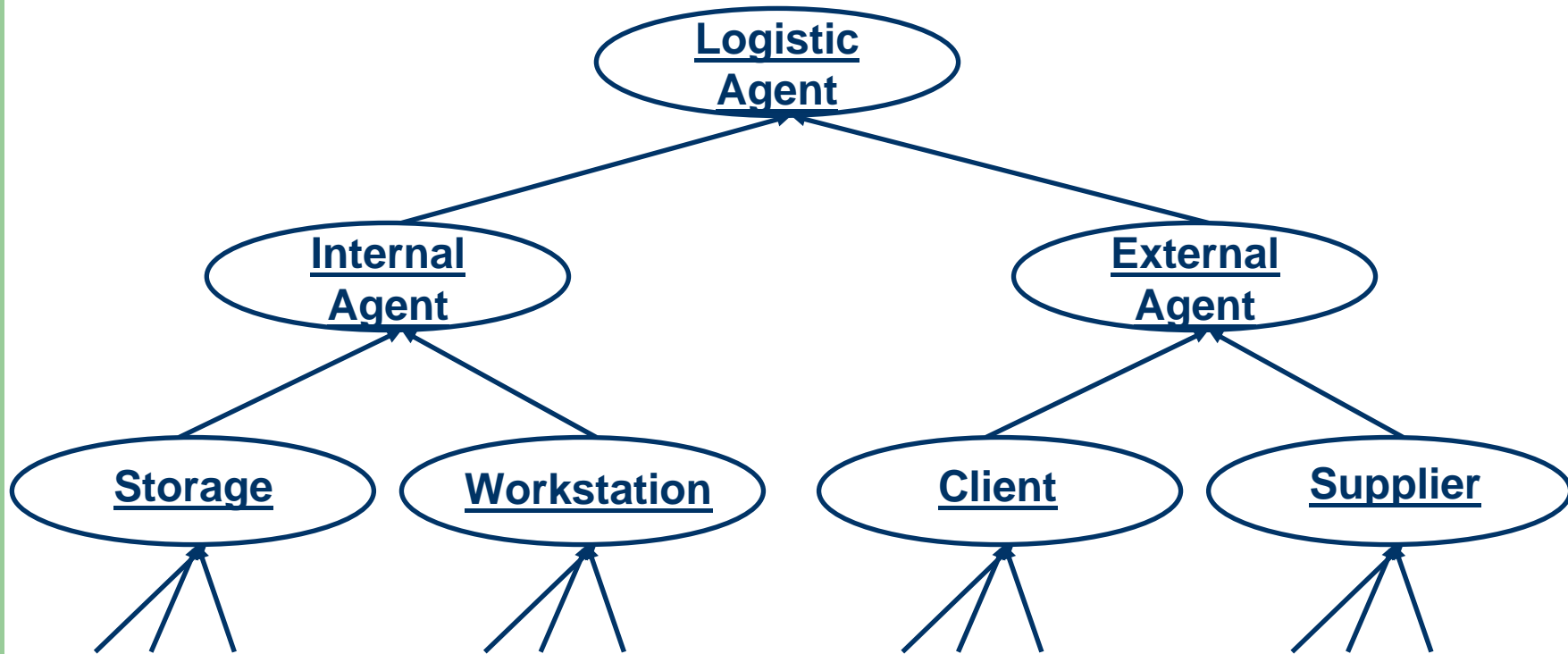
New principle:

“All activities have a common denominator – the job”

➔ **Uniform description**
Model dynamics is related to job execution

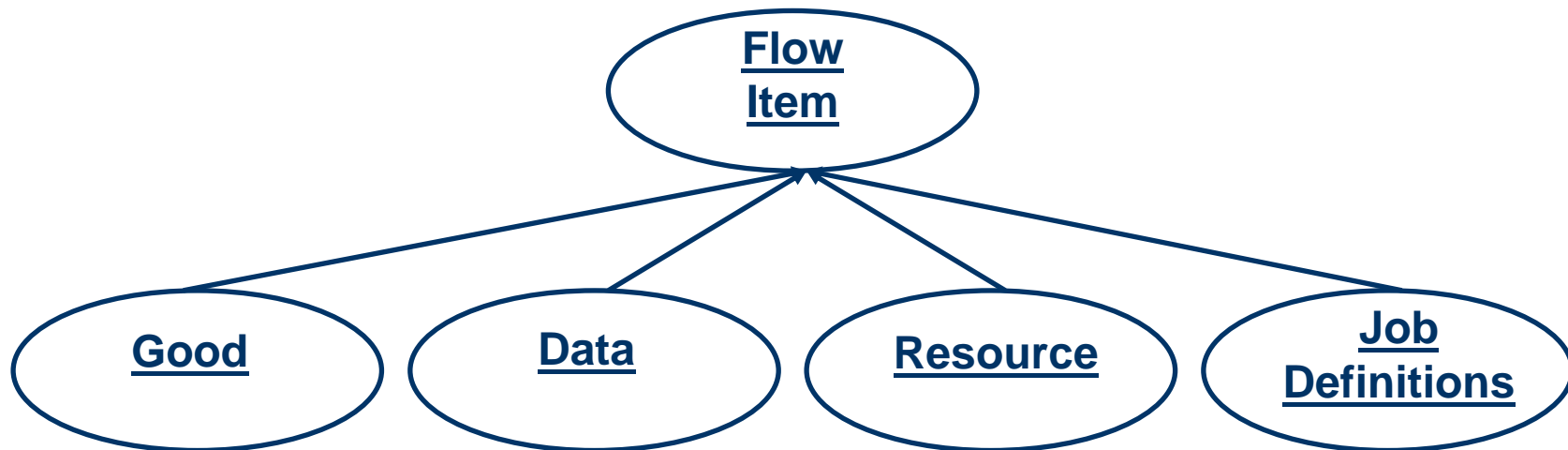
Note: decision logistics made explicit!

4. Definition of the modelling framework

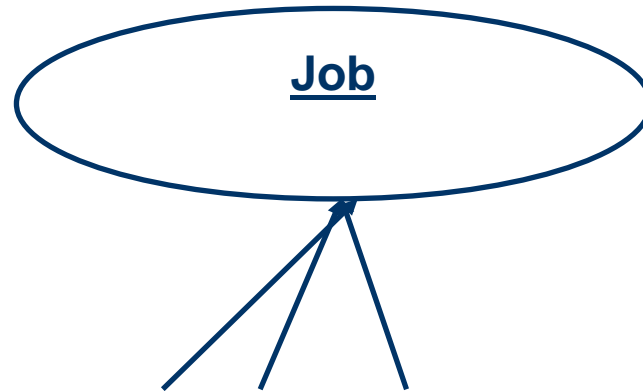


Class hierarchy - agents

Class hierarchy - flows

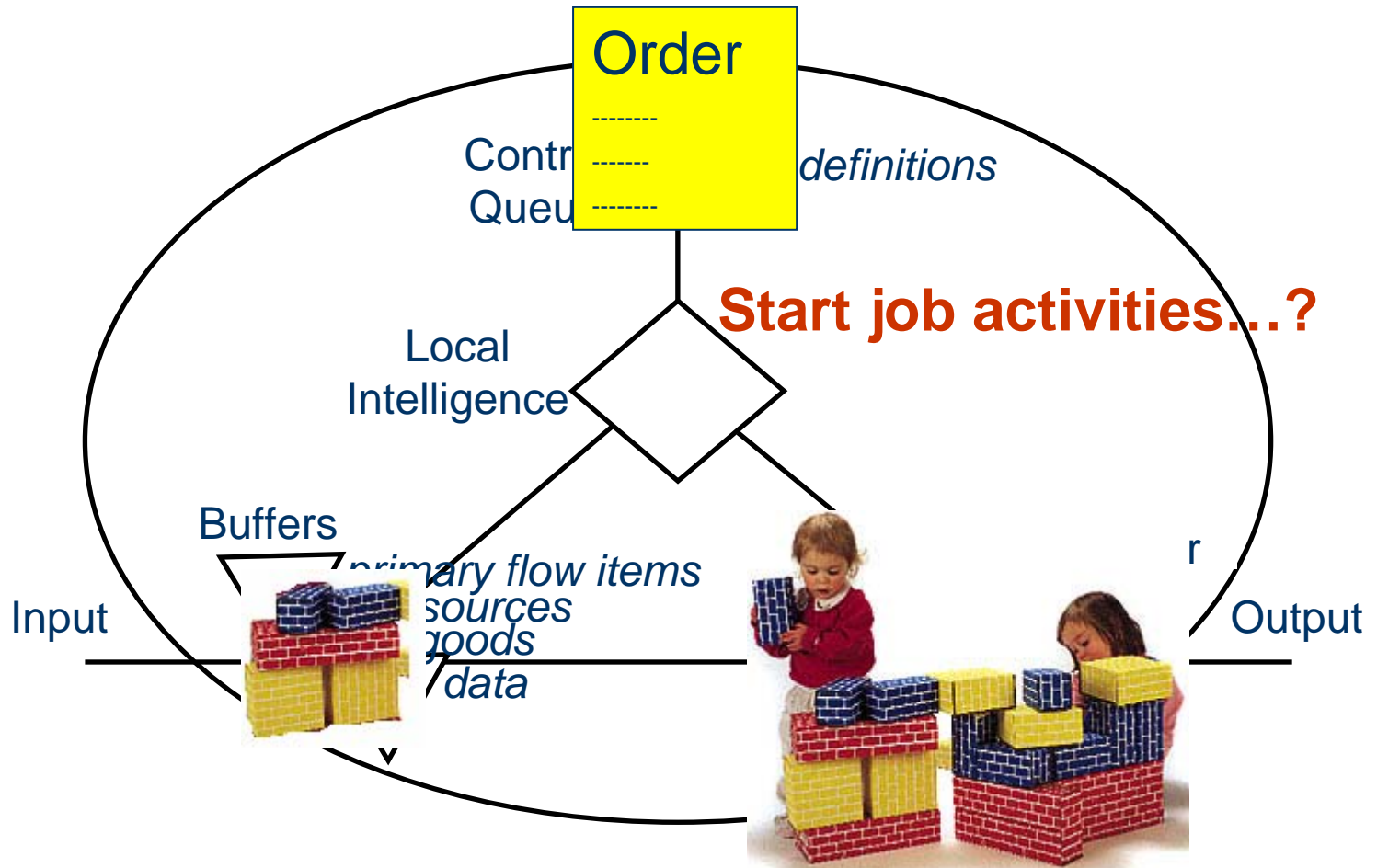
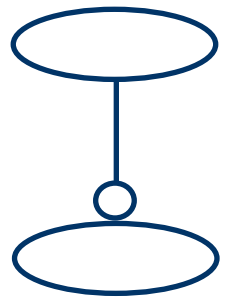


Class hierarchy - activities



All activities are considered jobs, including those associated with decision making, i.e. decision jobs

Internal structure of agents



5. Case example

- Repair shop
 - Repair of engines (stochastic arrival pattern)
 - How to control the shop, i.e., schedule jobs at the work stations, in order to meet customer wishes
 - A schedule is made at start of each new day
- How to model (in EM-Plant)
 - Flows
 - Agents
 - Jobs
 - Dynamics
- Advantages

Example_Shop3.spp - eM-Plant 7.0 - [Models.RepairShop]

File View 3D Debugger Profiler Tools Help

Edit Navigate Objects Icons View Tools Help

Library

- Basis
 - MaterialFlow
 - InformationFlow
 - UserInterface
 - MUs
 - Tools
 - Models
 - FlowItems
 - Engine
 - StatusUpdate
 - JobDefinition
 - Scheduler
 - Jobs
 - CreateEngines
 - SignalRepairs
 - Repair
 - Scheduling
 - SignalJobCompletion
 - UpdateShopData
 - Release
 - Agents
 - InternalAgents
 - InspectionStation
 - RepairStation
 - Planning
 - ExternalAgents
 - CustomersIn
 - CustomersOut

REPAIRSHOP

PERFORMANCE

Results per engine:

- StatisticsCollEngine
- DataCollEngine

Results per run:

- StatisticsCollRun
- DataCollRun
- AverageFlowTime=0.0000

EVENTCONTROL

GLOBAL SETTINGS (set variables before starting an experiment)

- NoRuns=10
- NoEnginesMeas=1000
- NoEnginesWarmup=200

GLOBAL VARIABLES

- Run=1
- NoEngines=0
- IdNo=0

EXPERIMENTAL FACTORS

- PlanningInterval=1:00:00:00.0000
- SchedulingRule=SPT (SPT,FCFS)

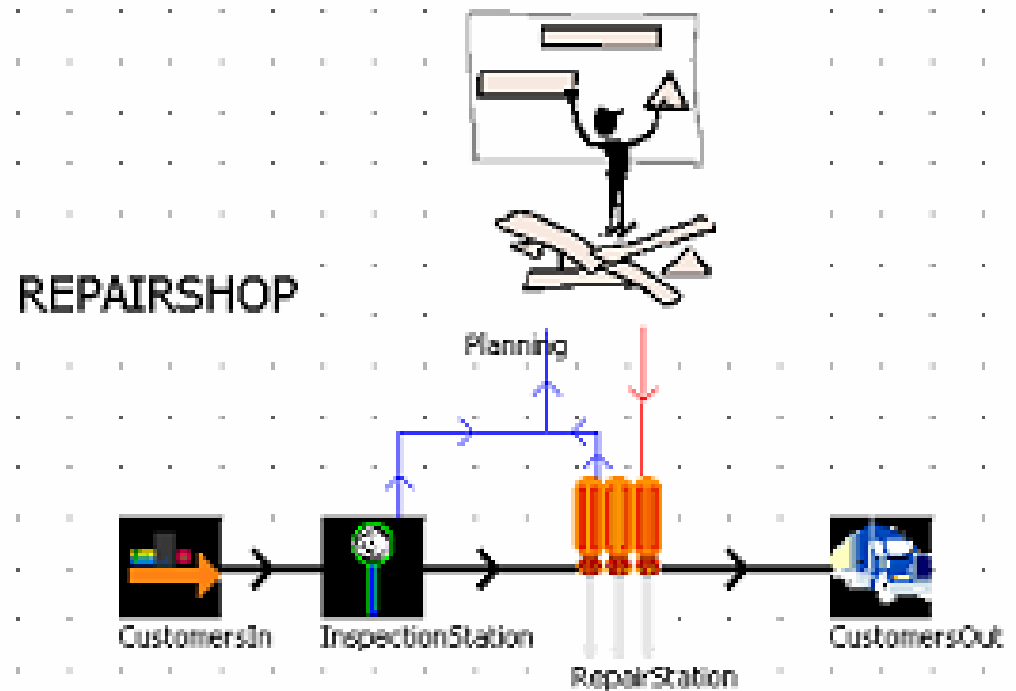
Model

Class Library 3D Model Info

Start Trans... www... Micros... Micros... Acrob... Micros... Exam... Windo... naaml... 16:35

Flows

- Engine
- Status updates - of inspection station and repair station
- Job definition - for scheduling activities at the repair station
- Scheduler - available at the start of the day



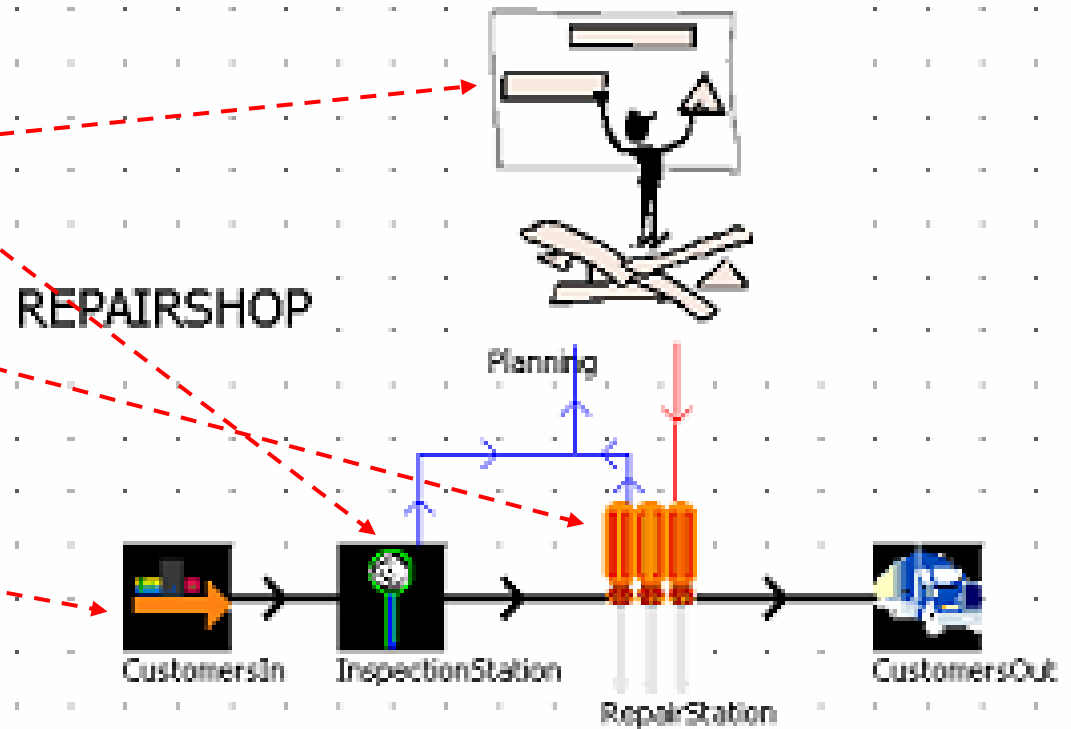
Agents

- Internal agents

- Planning
- Inspection station
- Repair station


- External agents

- Customers

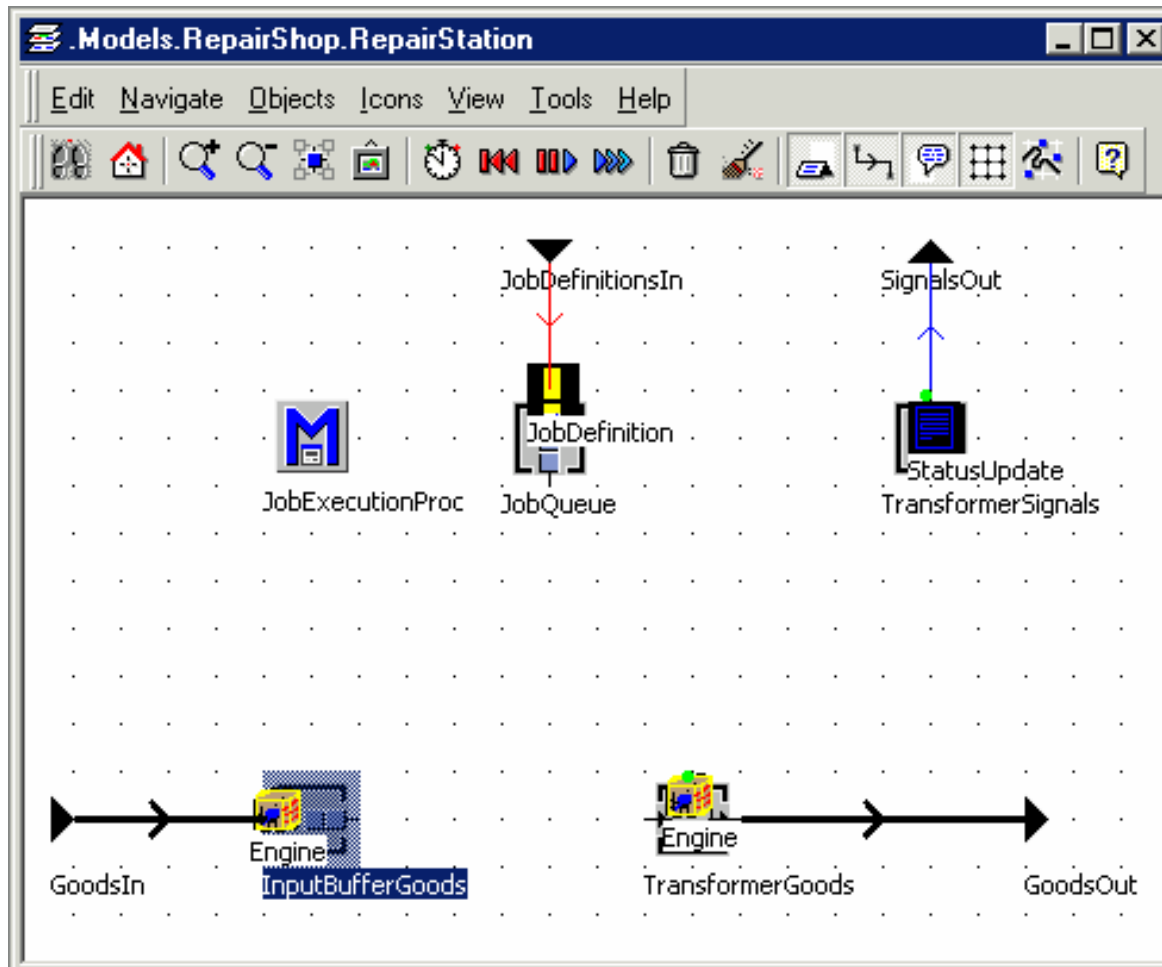


Jobs

	Agents	Which jobs?
Internal agents	<ul style="list-style-type: none">● Planning● Inspection station● Repair station	update order pool, release orders, schedule orders produce repair data repair, report shop status
External agents	<ul style="list-style-type: none">● Customers	deliver engines


Methods

Internal structure - Dynamics



- Local intelligence controls job release
- Job are released if both job definition and engine are present
- Job completion is reported to the planner

6. Conclusions & future research

- Guidance in modelling
 - Aggregate approach – well defined view on the field starting from a combination of elementary decomposition principles
 - Model re-use, adaptation
 - Verification/validation
 - Time savings for analyst
- Model completeness and transparency
 - Joint understanding
 - Opportunities for improved decision making
 - Acceptance/trust
- Future research
 - Specialization/application of the framework for specific industries