Process Management and Simulation in Hospitals

Riga 22.08.2018

Dr. Olav Goetz, M.Sc.

Agenda – Timeframe

Agenda

1. Process Management

2. Simulation

Timeframe

09.00 – 12.30 o´clock

Coffee Break 10.30 – 11.00 o´clock

Lunch Break 12.30 – 13.30 o´clock

13.30 – 17.00 o´clock

Coffee Break 15.00 – 15.30 o´clock

Dr. Olav Götz, M. Sc.

Academic Education

- 2001 - 2007 — Business Administration (Focus: Health Management; Health Economics)
- 2007 - 2009 — Health Care Management (M. Sc.)
- 09.2013 — PhD (Dr. rer. pol.)

Professional Experience

- 04.2008 – 09.2016 — Research Assistant, University of Greifswald
- 10.2013 – 07.2014 — Process Manager, Strategic Controlling / Medicine Controlling, University Medicine Greifswald
- 04.2016 – 08.2016 — Project Manager, Surgical Process Institute Deutschland GmbH, Leipzig
- 09.2016 – heute — Healthcare Consultant

  Olav Götz | Health Care Simulation & Consulting

  www.goetz-simulation-consulting.de

Fields of Activity

- Cost-Analysis, HR Management, Modelling, Process Management, Simulation

Please introduce yourself!

Lūdzu, iepazīstieties ar sevi!

Thank you very much!

Liels paldies!

Agenda

1 Process Management

- 1.1 Basics
- 1.2 Case Study I
- 1.3 Case Study II

2 Simulation

- 2.1 Basics
- 2.2 Software – MedModel
- 2.3 Case Study III

1 Process Management

1 Process Management

1.1 Basics

1.2 Case Study I

1.3 Case Study II - Using Discrete-Event Simulation to analyze the process of cataract intervention at a university hospital outpatient department

1.1 Basics

Process Management

Process **Process Management**

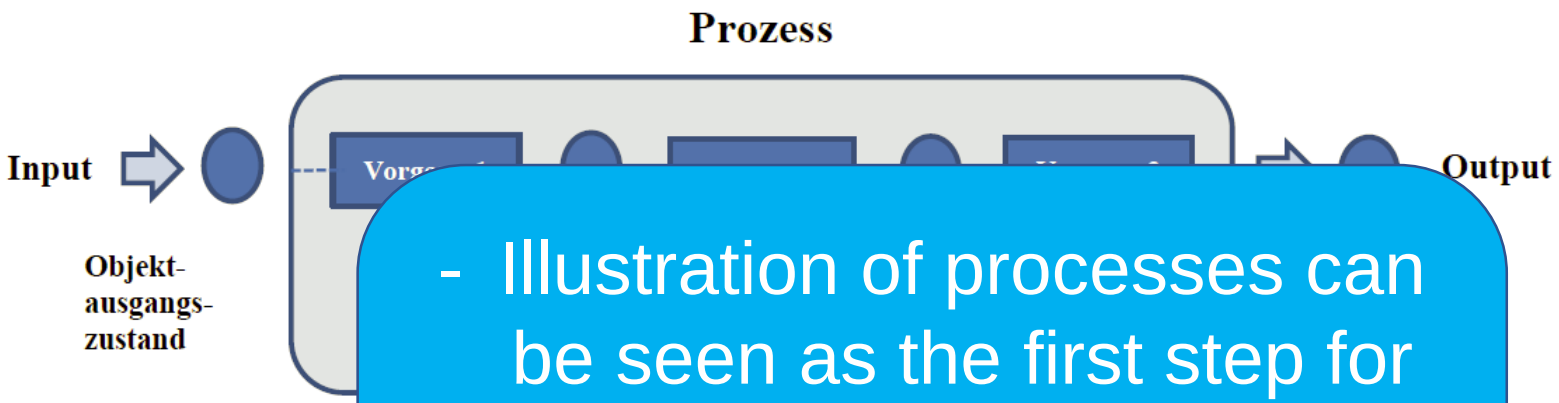
1.1 Basics – Process Definition

Author	Definition
Becker, Kahn (2012), p.6.	Ein Prozess ist die inhaltlich abgeschlossene, zeitliche und sachlogische Folge von Aktivitäten, die zur Bearbeitung eines betriebswirtschaftlich relevanten Objektes notwendig sind.
Eichhorn (1997), p.140.	Prozesse sind Abfolgen von Aktivitäten des Krankenhausleistungsgeschehens, die dadurch in einem logischen inneren Zusammenhang stehen, daß sie im Ergebnis zu einer Leistung führen, die vom Patienten nachgefragt wird.
Ellebracht, Lenz, Osterhold (2009), p. 177.	Unter einem Prozess wird hier ein Vorgang (Aktivität) verstanden, in dessen Verlauf ein Objektausgangszustand (Input) in Richtung eines angestrebten Objektendzustandes (Output) gezielt verändert wird. Da die Veränderung in der Regel nicht in direkter Weise möglich ist, ist die Erzeugung definierter Objektzwischenzustände durch Teilprozesse erforderlich. Die Veränderung der Objektzustände erfolgt dabei auf Grund der Einwirkung von Ressourcen.
Fleßa (2010), p. 272	Unter einem Prozess versteht man allgemein eine Folge von Ereignissen im ursächlichen Zusammenhang bzw. den Ablauf von Teilschritten, die in ihrer Verkettung ein sinnvolles Ganzes bilden.
Zapp (2010), p.20.	Ein Prozess ist die strukturierte Folge von Verrichtungen. Diese Verrichtungen stehen in ziel- und sinnorientierter Beziehung zueinander und sind zur Aufgabenerfüllung angelegt mit definierten Ein- und Ausgangsgrößen und monetären oder nicht monetärem Mehrwehrt unter Beachtung zeitlicher Gegebenheiten.

1.1 Basics – Process Definition

- Sequence of single activities, operations or actions that are interrelated
- Have a recognizable connection
- Deterministic processes → Sequence is defined
- Stochastic processes → durations or order of activities is random
- Treatment process in a hospital is stochastic (order and duration) → definition and optimization of production process is difficult
- Systematic interaction of people, machines, materials and methods → produce a product or provide a service

1.1 Basics – Process Definition



- Illustration of processes can be seen as the first step for Process Optimization
- Illustration of Sub-processes → first step for Process Management

Figure: Definition Process.
Source: Ellebrecht, Lenz, Osterhold (2009), p.178.

1.1 Basics – Process Management – Definition

- Process management includes planning, organizational and controlling measures to control the supply chain of a company in terms of quality, time, cost and customer satisfaction
- Process management as a holisstic approach to control, monitor and manage all business processes
- Strategic and operative Process management

1.1 Basics – Process Management – Definition

→Strategic Process Management:

- strategies of the company according to the corporate objectives are tried to be implemented by using appropriate processes

→Operative Process Management:

- Planning and provision of efficient process solutions.
- Corporate objectives also important, increasing customer benefits, cost reduction
- Can be described by six phases → Life cycle of process management

1.1 Basics – Process Management

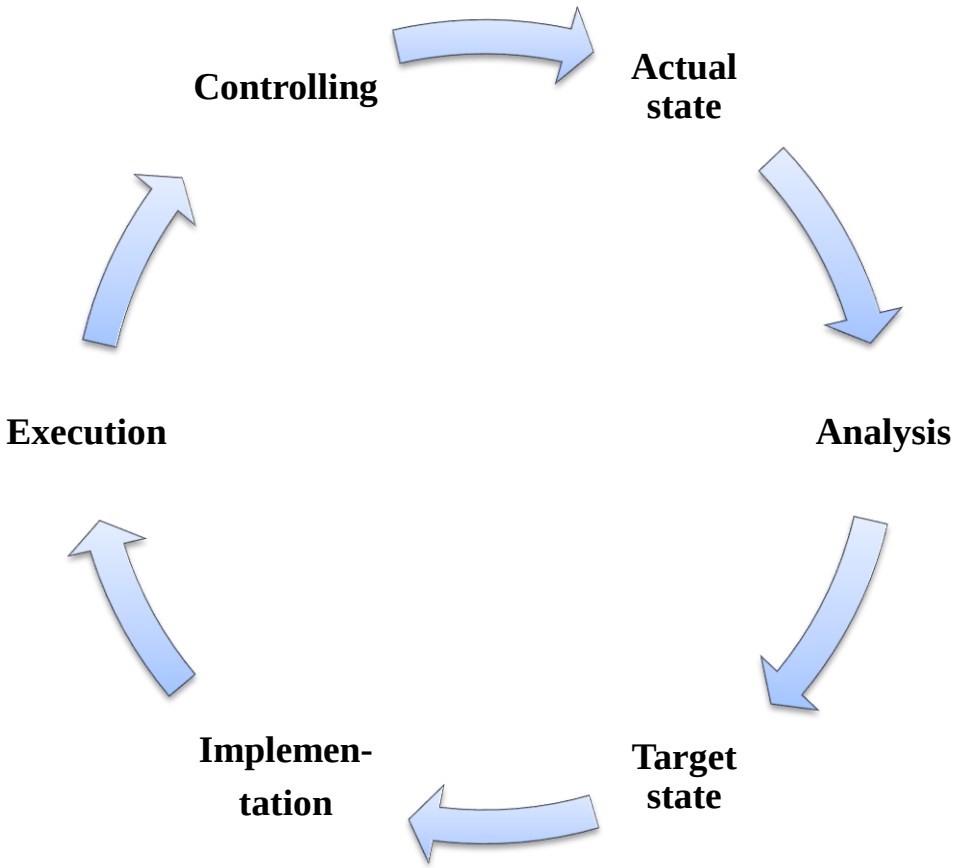


Figure: Life cycle of operative Process Management.
Source: Amberg, Bodendorf, Möslein (2011), p.62.

Life cycle of process management

- Actual state
- Analysis
- Target state
- Implementation
- Execution
- Controlling

Life cycle of process management

- Actual state
- Analysis
- Target state
- Implementation
- Execution
- Controlling

•Acquisition of the actual state
•Capturing of process-related activities, entities, data-input and output, involved resources and process owners
•Basis for Process analysis and redesign
•Supports the recognition of bottle necks and the identification of potential for improvements
•Required for designing the target processes

Life cycle of process man

- Actual state
- Analysis
- Target state
- Implementation
- Execution
- Controlling

- Analysing the processes based on actual state modeling
- Main focus on the recognition of bottle necks in current workflows and potential improvements based on these weak spots
- Process characteristics such as processing times, costs or organisational weaknesses can be shown by using appropriate analyzing methods
- method focus → quantitative or qualitative
- Focused aspects of investigation are base on the objectives defined in the strategic Process Management
  - Process time analysis
  - Process costs analysis
  - Communication analysis
  - Line of Visibility analysis

Life cycle of process man

- Actual state
- Analysis
- Target state
- Implementation
- Execution
- Controlling

- Modeling of the target state based on identified weaknesses and potential improvements and formulated process objectives and principles
- Which improvement is desired and the definition of improvement approaches, e.g. redesign, automatization, outsourcing are important in this phase
- Customer point of view or companies perspective

Life cycle of process management

- Actual state
- Analysis
- Target state
- Implementation
- Execution
- Controlling

- Implementation of target processes inside the company or department
- Training of employees
- Implementation of new IT-Systems or adaptation of the redesigned workflows to existing IT-Systems

Life cycle of process management

- Actual state
- Analysis
- Target state
- Implementation
- Execution
- Controlling

- Executing of the processes as part of the business activity
- Instruments, e.g. process oriented IT-Systems
  → Business-Process-Management-Systems or Workflow-Management-Systems, can support the execution of processes or partly automate them

Life cycle of process man

- Actual state
- Analysis
- Target state
- Implementation
- Execution
- Controlling

- Monitor, analyse, evaluate the process flows
- Special focus on the process performance
- Performance-Measurement-Systems → based on process objectives or predefined indicators such as costs, time, quality the current performance and potentials of an organisation can be investigated → tool for the development of a company
- •Indicators are collected IT-based, e.g. Process Monitorings → automated reports to the process owner
- Tools:
  - Balanced Scorecard (BSC) → Performance Measurment Instrument
  - Process-Benchmarking → Process Performance Analysis

1.1 Basics – Process Management

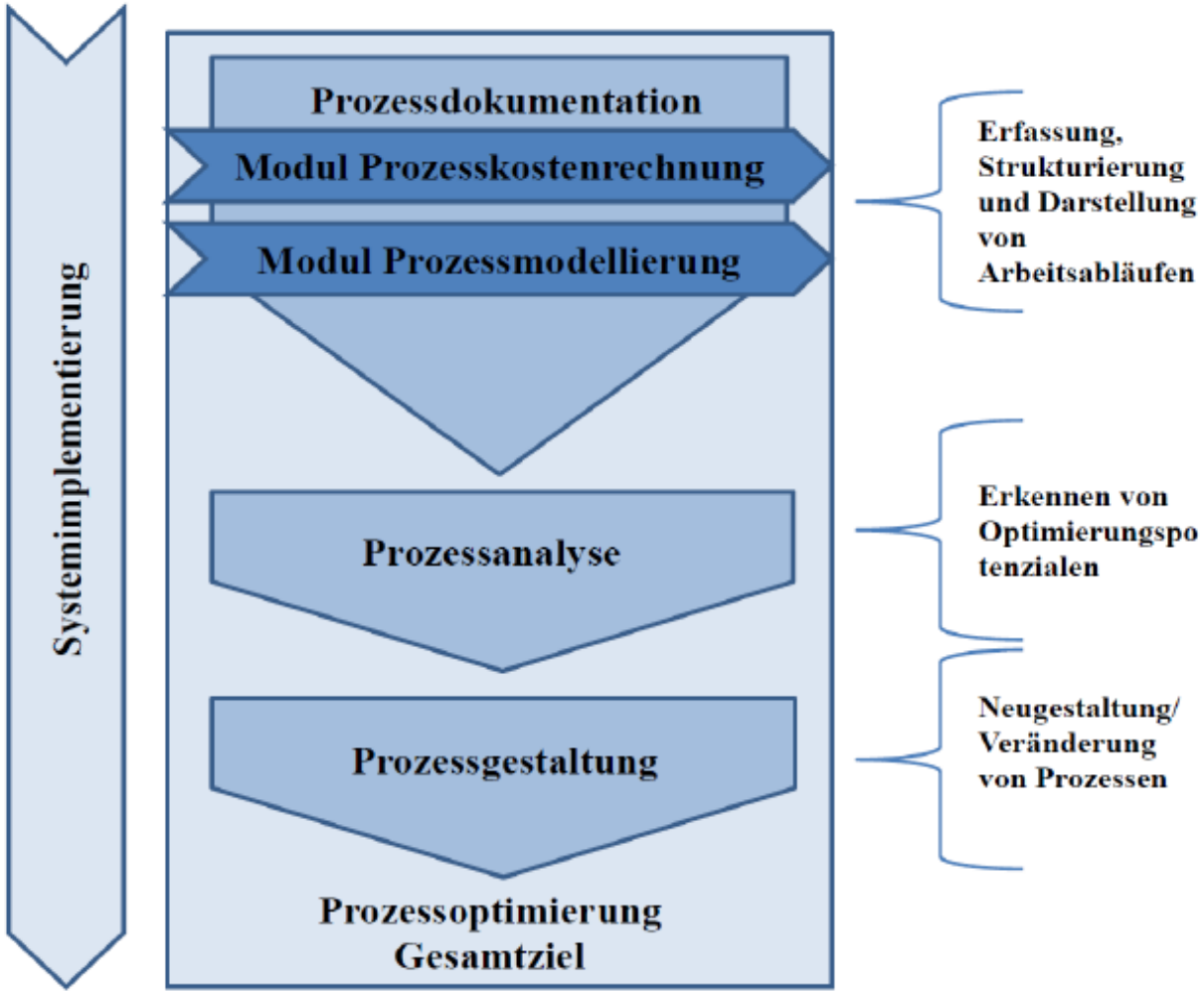


Figure: Clinical Process Management
Source: Greiling (2004), p.21.

1.2 Case Study I

Please edit the case study!

Case Study II - Using Discrete-Event Simulation to analyze the process of cataract intervention at a university hospital outpatient department

1.3 Case Study II – Outline

(1) Introduction

(2) Methods

(3) Results

(4) Conclusions

1.3 Case Study II – (1) Introduction

Initial situation:

- Hospitals and outpatient departments facing several challenges
- Economic analyses of the processes inside the hospital system getting more and more into the focus
- Esp. Patient flow, pathways, workflow, utilization of resources
- Utilization of high price resources (e.g. operation theatre, clinical departments)

Examination question:

Study the whole process of patient treatment inside hospital systems from entering the outpatient department until leaving [illegible] with special focus on the patient flow, utilization of the facilities [illegible] volved, waiting times as a quality aspect and time in sy[illegible]

Simulation

1.3 Case Study II – (1) Introduction

Simulation:

- Method for analyzing systems (to complex for analytical solutions)
- Replication of real systems, objects, proc[illegible]al
- Conducting experimen[illegible]ences on the real system

Discrete-Event Simu[illegible]

- Modeling dyna[illegible] described by state variables
- Variables can ch[illegible]pearance of events

Reasons for Simulation:

-Investigation of the real system is to expensive, time consuming, ethical inacceptable, dangerous
-Real System doesn´t exist yet
-A direct or indirect observation of the real system isn´t possible
-Modification of the model
-Educational reasons
-Reproduction of experiments

Discrete-Event-Simulation (DES)

Example: cataract intervention

1.3 Case Study II – (1) Introduction

Cataract intervention:

- Cataract → clouding that develops in the crystalline lens of the eye or in its envelope (lens capsule)
- Can be treated in an outpatient department by replacing the lens

Examination question:

Study the whole process o outpatient department until leaving the hospital wit , utilization of the facilities and medical personnel involved, wai ect and time in system at all.

Discrete-Event-Simulation Model of the cataract intervention

Process analyses

Data gathering

Analyses of Input Data

Basic Model

1.3 Case Study II – (2) Methods

- Process analyze of cataract intervention
- Gathering data
- Analyzing the data
- Building Stochastic discrete [illegible]el)
- Scenarios [illegible] the model
- Presentati[illegible] hospital

- Guidelines of treatment
- Interviews with involved personnel (medical, nursing)
- observation (staff and patient)

- Time study
  Pre statistical survey: 26/04-29/04/2011
  Statistical survey: 01/05-31/05/2011 from 07.00 o´clock (a.m.) – 5.00 o´clock (p.m.)
  Time study using stopwatches, 13 persons
- [illegible]terviews
- Hospit[illegible]formation system

- Verification and Validation
  Trace-Method, Animation, Debugging
  Testing against real data
  interviews with experts
- Running the model with output analyzing

- Descriptive statistics
- Distribution Fitting, Goodness of fit Tests
- Graphical analysis

1.3 Case Study II – (3) Results

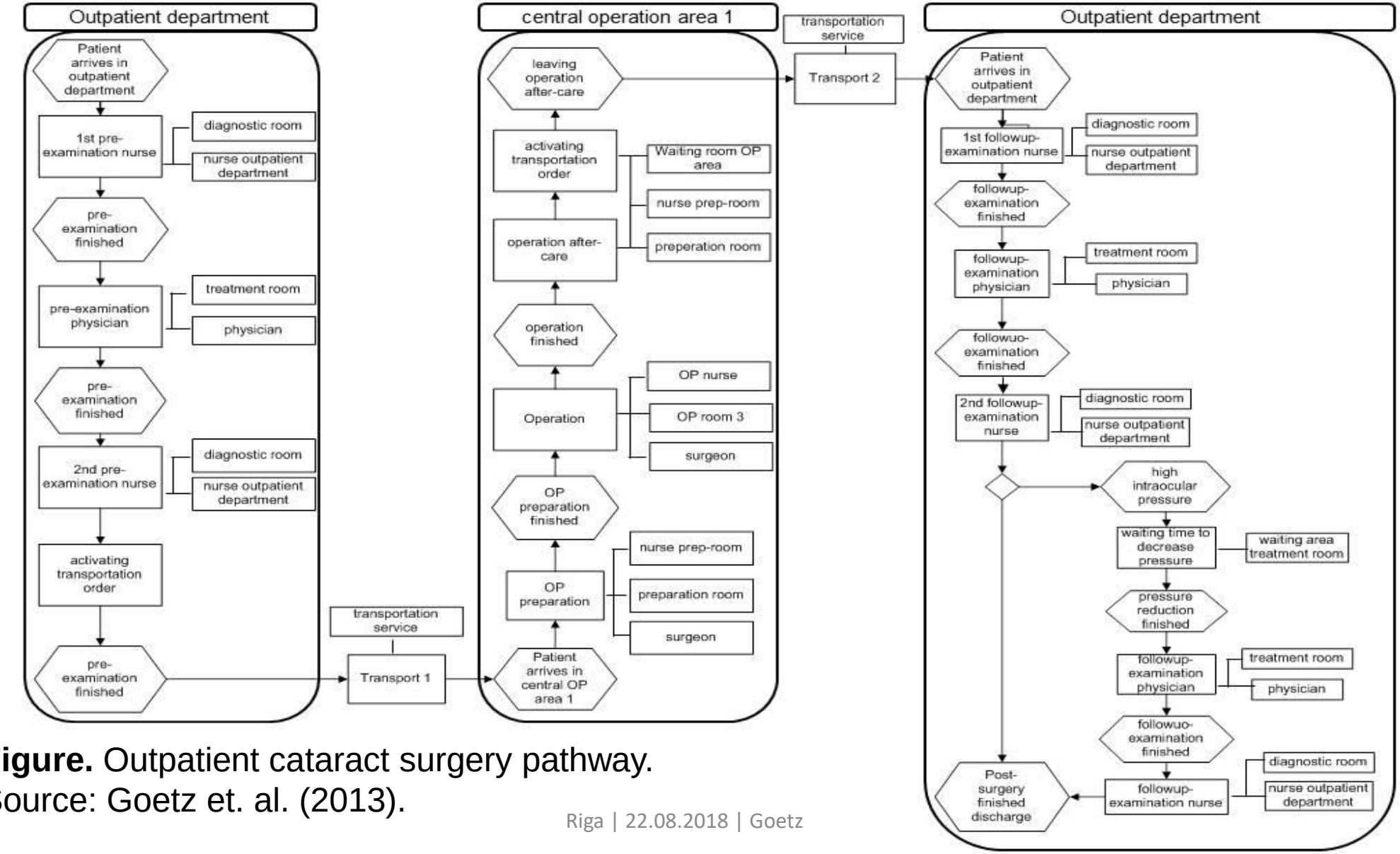


Figure. Outpatient cataract surgery pathway.
Source: Goetz et. al. (2013).

1.3 Case Study II – (3) Results

Time study:

	total time (hh:mm:ss)		total time outpatient department (pre-surgery) (hh:mm:ss)	total time central operation area (surgery) (hh:mm:ss)	total time outpatient department (post-surgery) (hh:mm:ss)	
	normal intraocular pressure	high intraocular pressure			normal intraocular pressure	high intraocular pressure
N	60	6	66	63	65	2
mean	05:10:49	06:05:52	00:45:00	03:26:49	00:47:03	01:45:08
minimum	03:24:41	04:47:17	00:14:10	01:55:49	00:14:42	01:25:51
maximum	07:39:50	07:14:24	01:31:30	06:20:01	02:09:37	02:04:24
standard deviation	00:56:53	00:52:03	00:18:09	00:55:43	00:22:12	00:27:16

Table. Summary of time patients spent in the hospital.
Source: own.

1.3 Case Study II – (3) Results

function (number of data)	distribution function	p-value K-S-Test A-D-Test
deviation of arrival time and appointment time (N=61)	Beta (-3.29e+004, 720, 45.3, 2.21)	0.636 0.483
pre-examination (nurse) (N=66)	LogNormal (25.8, 6.06, 0.383)	0.98 0.989
pre-examination (doctor) (N=66)	LogLogistic (-166, 5.89, 471)	0.943 0.956
time until transportation order is released (N=56)	Inverse Weibull (-27.9, 1.57, 1.34e-002)	0.474 0.613
waiting time for transportation (N=57)	Logistic (626, 261).	0.393 0.163
transportation (N=64)	Pearson6 (120, 278, 7.86, 27.5)	0.994 0.99

Table. Theoretical distribution functions pre-surgery.
Source: own.

1.3 Case Study II – (3) Results

function (number of data)	distribution function	p-value K-S-Test A-D-Test
time until surgeon arrives in prep-room (N=36)	Beta (-150, 3.34e+004, 1.51, 43.2)	0.869 0.756
time until surgeon arrives in OP (N=57)	Inverse Weibull (-1.1e+003, 7.07, 7.07e-004)	0.901 0.964
time until OP-clearance (N=57)	Pearson5 (-1.28, 2.68, 378)	0.961 0.954
time from OP-clearance to OP-start (N=66)	Lognormal (-222, 6.18, 0.158)	0.982 0.973
time OP-start to OP-end (N=66)	Pearson5 (431, 3.08, 1.01e+003)	0.857 0.853
time OP-end to leaving OP (N=66)	LogLogistic (5.67, 4.79, 148)	0.975 0.989
time OP-end to surgeon leaves OP (N=29)	LogLogistic (-3.38, 3.43, 104)	0.711 0.779
prep-room (N=66)	Gamma (-49.4, 3.07, 143)	0.963 0.958
time until transportation order is released (N=56)	Normal (3.43e+003, 1.09e+003)	0.965 0.892
waiting time for transportation (N=56)	LogLogistic (-1.27e+003, 8.97, 1.97e+003)	0.947 0.919
transportation (N=66)	LogLogistic (82.9, 5.01, 150)	0.984 0.966

Table. Theoretical distribution functions surgery.
Source: own.

1.3 Case Study II – (3) Results

function (number of data)	distribution function	p-value K-S-Test A-D-Test
post-examination (nurse) (N=66)	Weibull (72.9, 1.47, 306)	0.878 0.913
post-examination (doctor) (N=66)	Pearson5 (-31.2, 8.73, 2.26e+003).	0.991 0.997
Second post-examination (nurse) (N=65)	Inverse Weibull (-1.56e+003, 11.1, 5.28e-004).	0.97 0.981

Table. Theoretical distribution functions post-surgery.
Source: own.

1.3 Case Study II – (3) Results

Basic Model

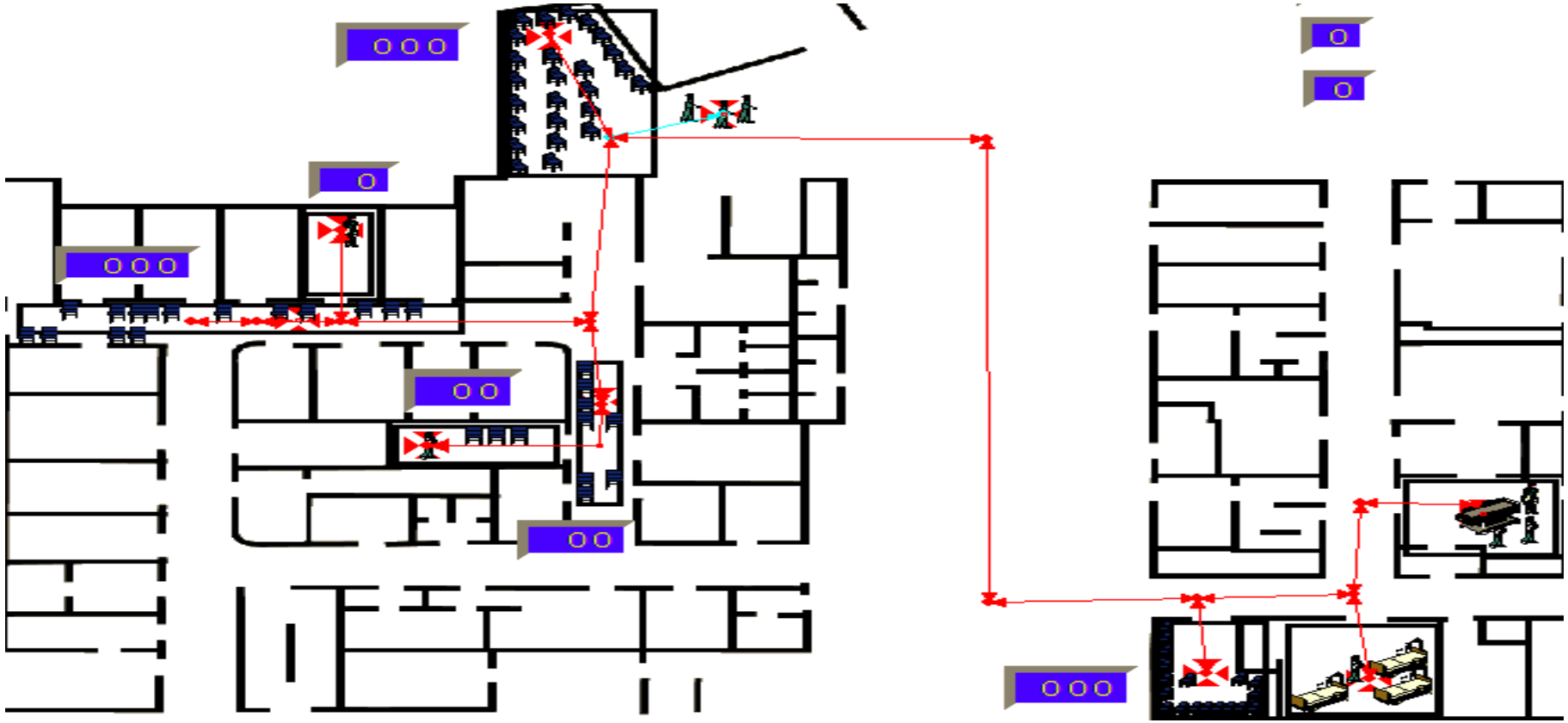
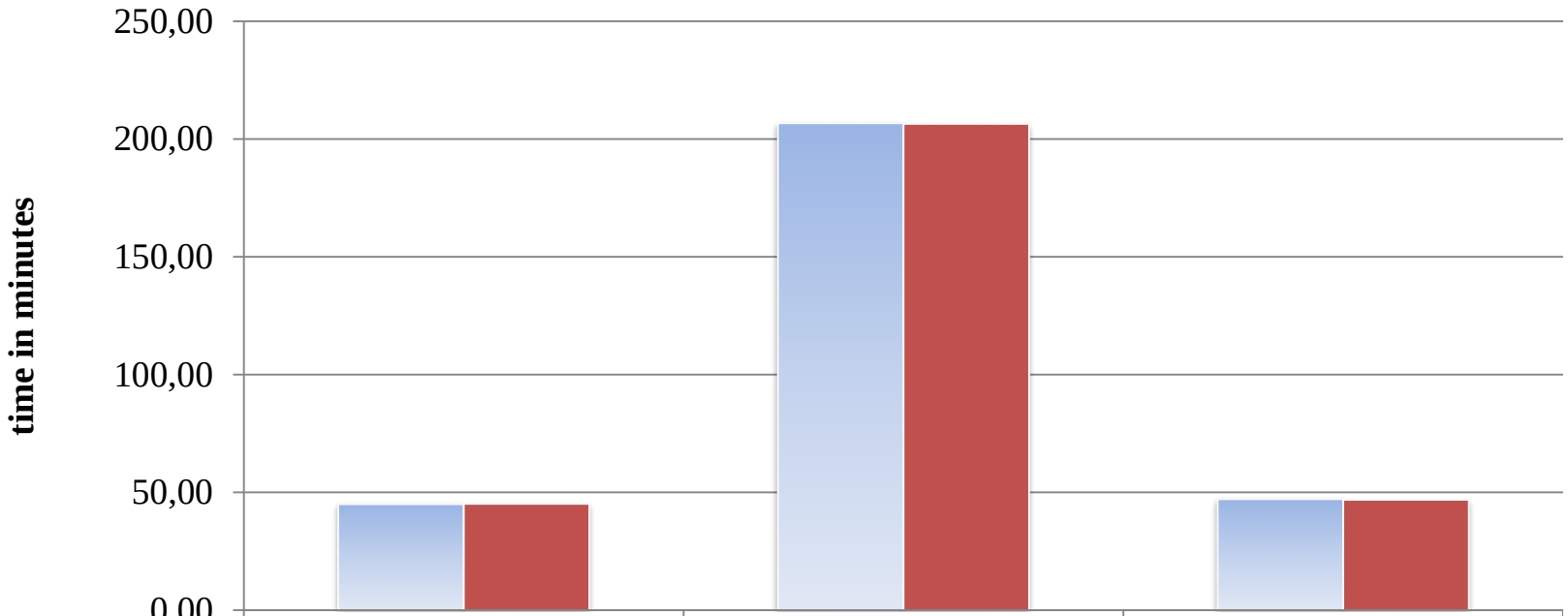


Figure. Basic Model MedModel.
Source: own.

1.3 Case Study II – (3) Results

Basic Model



	pre-surgery	surgery	post-surgery
time study	44,99	206,81	47,05
basic model	45,11	206,55	46,81

Figure. Overall mean time values - time study and basic model.
Source: own.

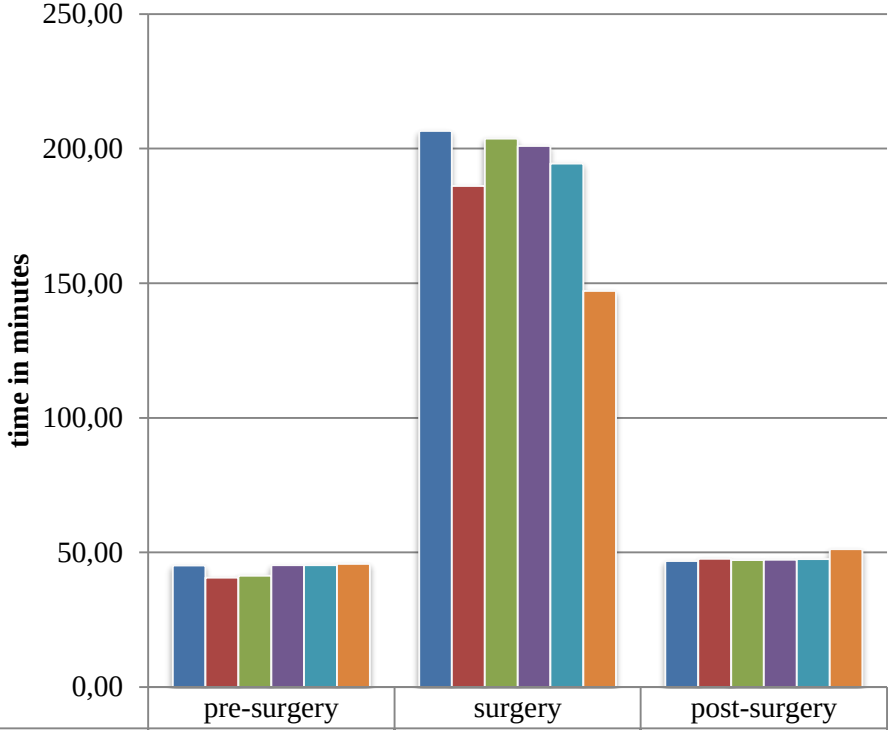
1.3 Case Study II – (3) Results

Scenarios

scenario	Description
1	How does a different appointment policy (appointment of the patient fixed to one hour before operation) affect the model output?
2	How does a fixed waiting for transportation (fixed to 10 minutes) affect the model output?
3	How does a reduction of the time until the surgeon arrives in OP to a maximum of 10 minutes affect the model output?
4	How does an additional nurse (third nurse in prep-room) from 7:15 a.m. to 2:15 p.m. affect the model output?
5	How does an additional doctor in the prep-room affect the model output?

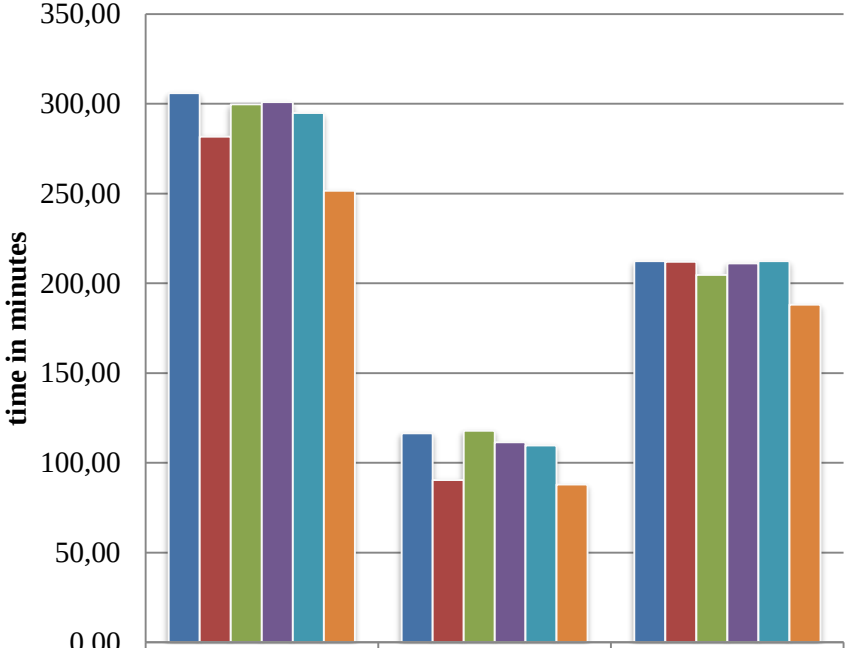
Table. Scenarios of the simulation study.
Source: own.

1.3 Case Study II – (3) Results



	pre-surgery	surgery	post-surgery
basic model	45,11	206,55	46,81
scenario 1	40,64	186,11	47,61
scenario 2	41,31	203,75	47,13
scenario 3	45,25	200,93	47,31
scenario 4	45,30	194,43	47,53
scenario 5	45,76	147,19	51,19

Figure. Overall mean time values - basic model and scenarios.
Source: own.



	total time in system	waiting time	time in operation
basic model	305,88	116,37	212,32
scenario 1	281,68	90,33	211,99
scenario 2	299,63	117,95	204,59
scenario 3	300,99	111,41	211,08
scenario 4	294,82	109,60	212,35
scenario 5	251,57	88,01	188,14

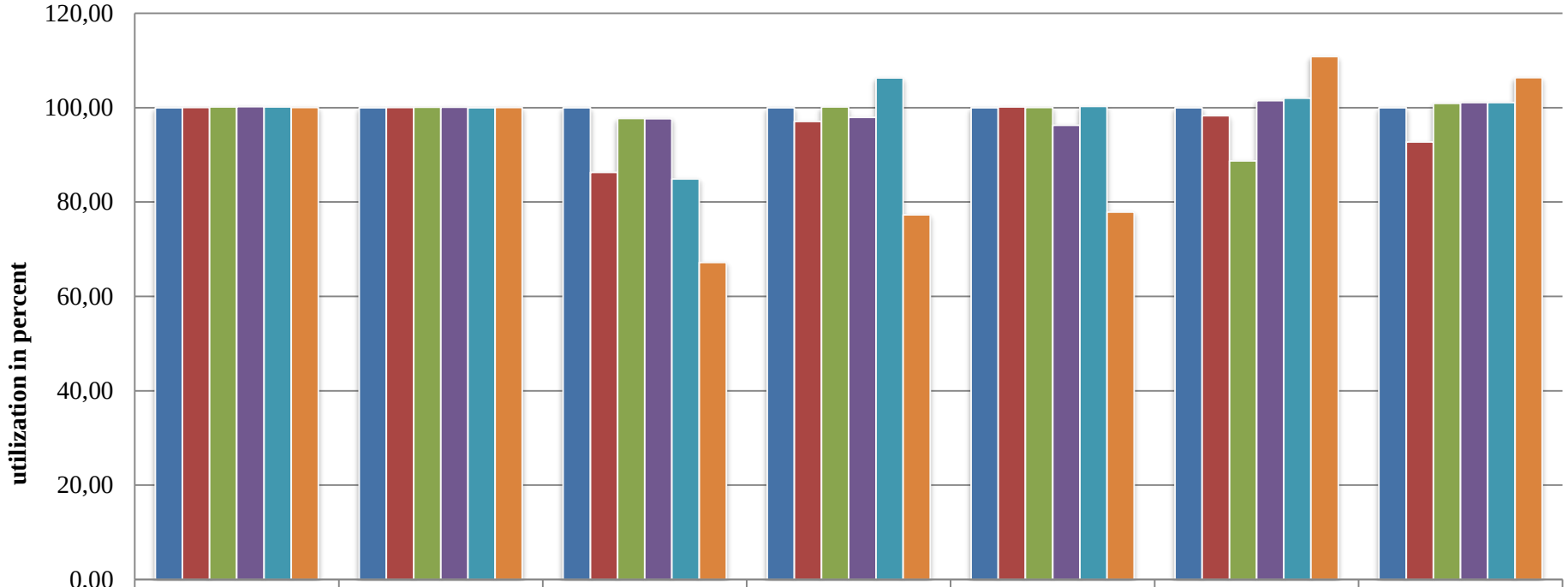
Figure. Mean entity times - basic model and scenarios.
Source: own.

1.3 Case Study II – (3) Results

	time used per day in minutes					
	basic model	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5
doctor	216.01	216.48	216.35	216.69	216.59	220.09
nurse policlinic 1	253.61	249.99	255.54	255.96	257.39	269.07
nurse policlinic 2	21.40	25.08	19.77	19.47	18.00	6.03
nurse prep-room 1	253.06	247.26	254.05	251.89	210.21	155.00
nurse prep-room 2	74.97	81.47	74.26	76.07	50.13	20.83
nurse prep-room 3					67.49	
nurse op	319.23	319.74	319.38	307.38	320.11	248.63
surgeon	312.31	312.10	311.74	312.12	312.51	259.80
doctor prep-room						104.39

Table. Personnel mean utilization.
Source: own.

1.3 Case Study II – (3) Results



	examination room	treatment room	waiting room OP	prep-room	OP	waiting room examination room	waiting room treatment room
basic model	100,00	100,00	100,00	100,00	100,00	100,00	100,00
scenario 1	100,02	100,02	86,28	97,08	100,16	98,28	92,71
scenario 2	100,17	100,08	97,71	100,16	100,05	88,73	100,93
scenario 3	100,22	100,09	97,65	97,94	96,29	101,47	101,07
scenario 4	100,16	99,99	84,91	106,29	100,27	101,98	101,10
scenario 5	100,05	100,06	67,17	77,29	77,88	110,82	106,34

Figure. Location utilization in percent per day.
Source: own.

1.3 Case Study II – (4) Conclusions

Scenario	Differences to Basic Model
1	Functional times on average nearly unchanged in comparison to the basic model, reduction of waiting times in pre-surgery and surgery sector, entire process in scenario 1 shorter than in the basic model: 24 min 30 sec.
2	Little change in comparison to the basic model (moderate reduction of waiting time during first (-238 sec.) and second transport (-228 sec.)
3	Moderate changes at the op-preparation (-90 sec.), at the waiting for the surgeon (-70 sec.), waiting time at the prep-room (-196 sec.), increasing utilization of staff and locations.
4	Reduction of max. duration (21 min 42 sec.) and mean duration of hospital process (12 min 24 sec.)entire process 3.77 % shorter than in basic model. Increasing utilization of personnel inside the prep-room.
5	Reduction of process times at the surgery (59 min 42 sec.) Increasing process times at the post-surgery (04 min 12 sec.) Total time in system on average 17.88% shorter than in basic model. Increasing utilization of the doctor at the prep-room.

Table. Summary of scenario results.
Source: own.

1.3 Case Study II – (4) Conclusions

Basic Model:

- Data (N=66) → theoretical distribution functions
- Patient population comparable to earlier investigations → representative for cataract intervention
- Data availability → assumptions are necessary
- Good averages, but a high variation within in the minimum and maximum values possible

1.3 Case Study II – (4) Conclusions

Scenarios:

- Reduction of waiting times possible
- Partly increasing utilization of resources (staff and locations)
- questionable practicability of scenarios

1.3 Case Study II – (4) Conclusions

- DES representing the patient flow of cataract intervention at an outpatient department
- Investigate several scenarios concerning the underlined examination questions
- Strength of using real empirical data (time study)
- DES as a powerful tool to monitor important aspects inside the health care sector
- Provide substantial support for involved policy-makers
- Good basis for further researches
- Adding costs or other interventions
- Investigating bigger systems (OP Theatre)

2 Simulation

2 Simulation

2.1 Basics

2.2 Software – MedModel

2.3 Case Study III

2.1 Simulation - Basics

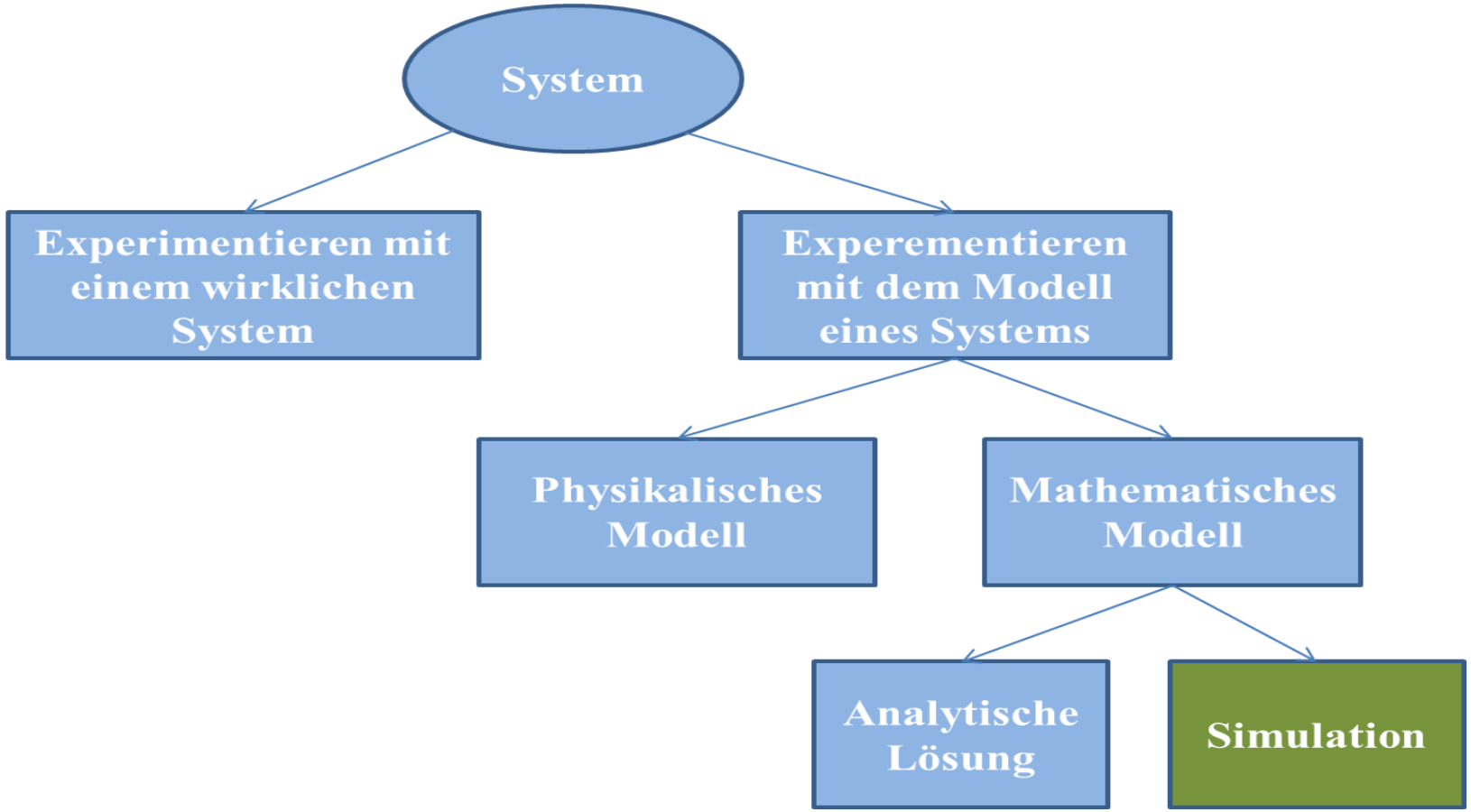


Figure: Analysis of Systems.
Source: Law (2007), S. 4.

2.1 Simulation - Basics

Definition:

- Method for analyzing systems (to complex for analytical solutions)
- Replication of real systems, objects or processes as a model
- Conducting experiments with the help of models to gather inferences on the real system
- All parameters are known → deterministic model
- Some parameters random → stochastic model

2.1 Simulation - Basics

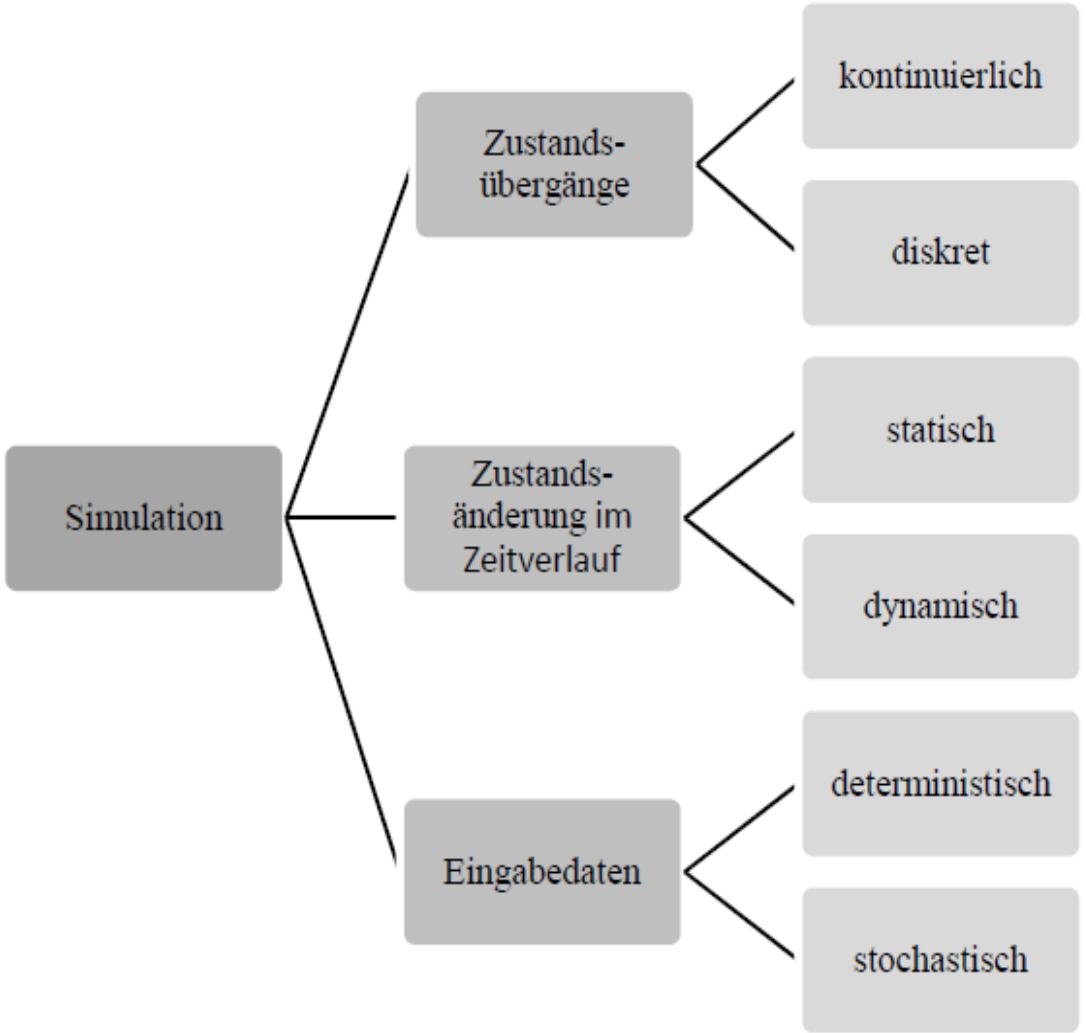


Figure: Types of Simulation.
Source: Laroque (2011), S. 26.

2.1 Simulation - Basics

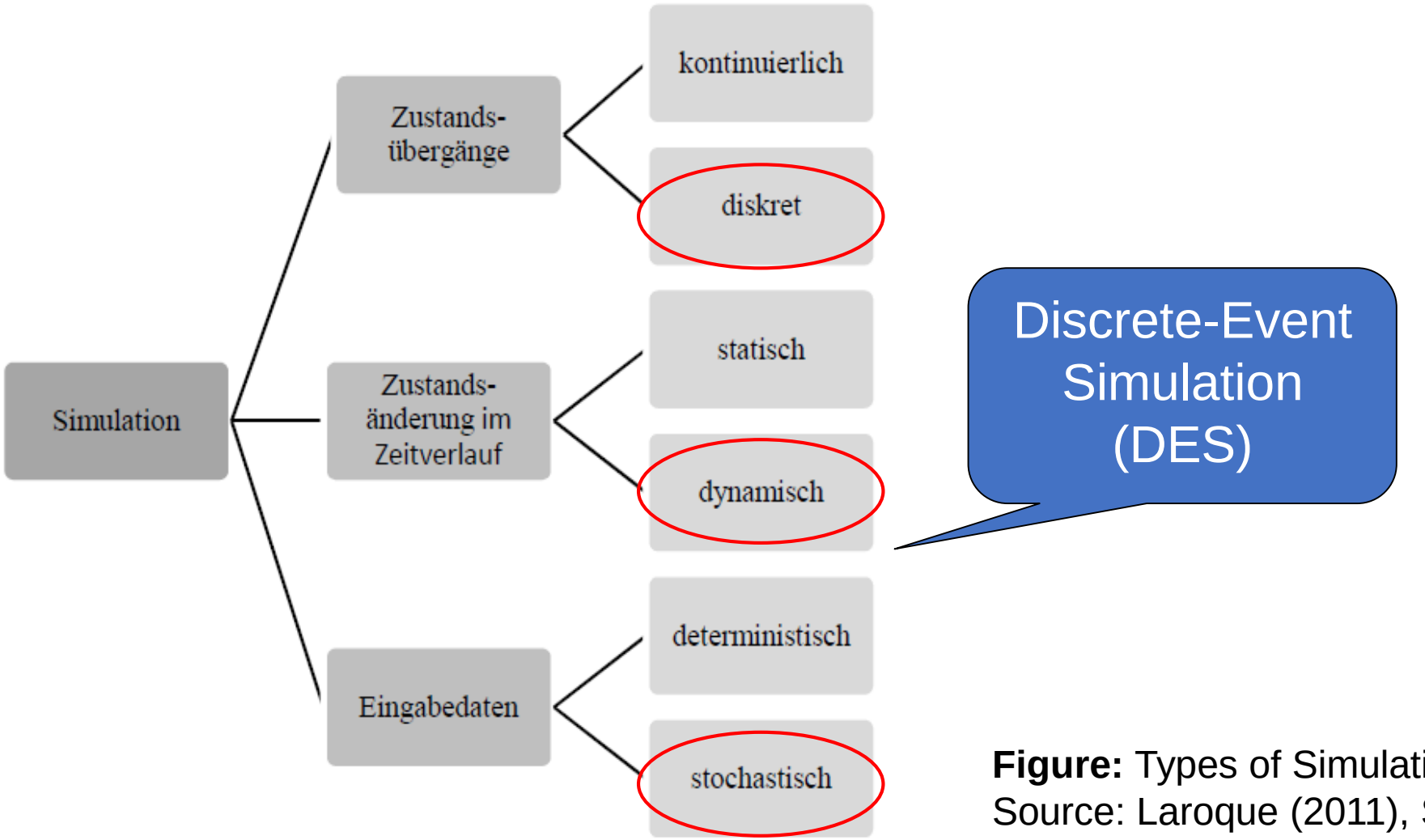


Figure: Types of Simulation.
Source: Laroque (2011), S. 26.

2.1 Simulation - Basics

Reasons for Simulation:

- Investigation of the real system is to expensive, time consuming, ethical inacceptable, dangerous
- Real System doesn´t exist yet
- A direct or indirect observation of the real system isn´t possible
- Modification of the model
- Educational reasons
- Reproduction of experiments

2.1 Simulation - Basics

Reasons for Simulation:

- Costs at approx. 0.5% of the investment volume
- Saving about 2 - 4% of the investment volume

2.1 Simulation - Basics

Steps of a DES study:

- Problem definition / formulation
- Preliminary analysis and project planning
- Data collection
- Build the model
- Model verification
- Model validation
- Experiments / scenarios
- Simulation runs and analysis of results
- Model documentation and implementation of results

2.1 Simulation - Basics

Steps of a DES study:

- Problem definition / formulation
- Preliminary analysis and project plan
- Data collection
- Build the model
- Model verification
- Model validation
- Experiments / scenarios
- Simulation runs and analysis of results
- Model documentation and implementation of results

- Defining goals (capacity analyzes, comparative studies, sensitivity analyzes, performance analyzes)
- Identify restrictions
- Level of detail
- Budget and scheduling

2.1 Simulation - Basics

Steps of a DES study:

- Problem definition / formulation
- Preliminary analysis and project plannir
- Data collection
- Build the model
- Model verification
- Model validation
- Experiments / scenarios
- Simulation runs and analysis of results
- Model documentation and implementati

- Defining the system
- Identification of cause-and-effect relationships
- key factors
- Time and condition dependent activities
- Focus
- Defining necessary data
- Use appropriate data sources
- Make assumptions
- Convert data
- Appraisal of the data

2.1 Simulation - Basics

Steps of a DES study:

- Problem definition / formulation
- Preliminary analysis and project planning
- Data collection
- Build the model
- Model verification
- Model validation
- Experiments / scenarios
- Simulation runs and analysis of results
- Model documentation and implementation of results

- Gradual refinement of the model
- gradual expansion

2.1 Simulation - Basics

Steps of a DES study:

- Problem definition / formulation
- Preliminary analysis and project plann
- Data collection
- Build the model
- Model verification
- Model validation
- Experiments / scenarios
- Simulation runs and analysis of resu
- Model documentation and implementa

- Verification and Validation
- Is the model working correctly?
- How exactly does the model depict the system
- How exactly does the model correspond to reality?
- Trace-Method, Animation, Debugging, Testing against real data, interviews with experts
- Running the model with output analyzing

2.1 Simulation - Basics

Steps of a DES study:

- Problem definition / formulation
- Preliminary analysis and project planning
- Data collection
- Build the model
- Model verification
- Model validation
- Experiments / scenarios
- Simulation runs and analysis of results
- Model documentation and implementation of results

- Compare alternative systems
- scenarios
"What-If"?
"How to achieve"?

2.1 Simulation - Basics

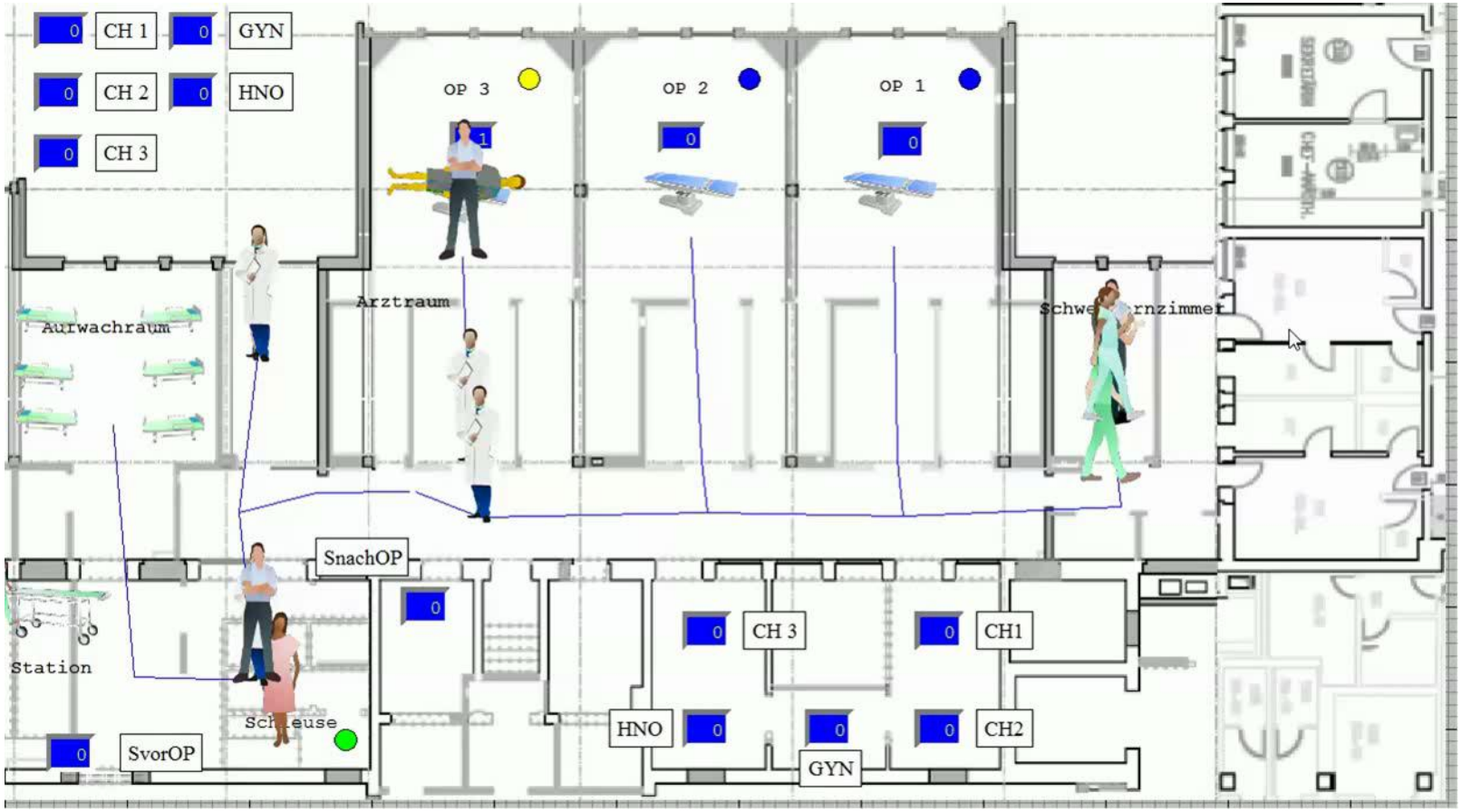
Steps of a DES study:

- Problem definition / formulation
- Preliminary analysis and project planning
- Data collection
- Build the model
- Model verification
- Model validation
- Experiments / scenarios
- Simulation runs and analysis of results
- Model documentation and implementation of results

- Great care is needed when interpreting the results
- Significance measurement necessary
- Analysis of bottlenecks
- Make recommendations - final simulation report
- Understandable, alternative solutions

2.1 Simulation - Basics

How could such a simulation look like?



2.2 Simulation – Software – MedModel

Please follow the link and download a Student Version of MedModel.

LINK

Special thanks to the ProModel® Corporation and to the GBU mbH for supporting this workshop by providing the Student Version MedModel licenses free of charge.

2.2 Simulation – Software – MedModel

- Flexible simulation tool → especially for the needs of the health care system

2.2 Simulation – Software – MedModel

Applications:

- Capacity analysis for patient admission
- patient pathways
- Logistics analyses and concepts
- "What if" – analyses
- Optimization of personnel deployment planning
- Design of departments / facilities

2.2 Simulation – Software – MedModel

Applications:

- Design of processes
- process optimization
- emergency planning
- utilization analysis
- OP-utilization planning
- Investment planning, controlling
  quality management

2.2 Simulation – Software – MedModel

User field:

- Board of Directors, Head of Administration, Managing Director
- Organization Manager, Process Optimizer
- Medical Director, Nursing Manager
- Investment and project planner, architects
- Logistics specialists
- Quality manager, - commissioned
- Established doctors, practices
- health insurance

2.2 Simulation – Software – MedModel

Use:

- Improve processes / processes
- Find and prevent bottlenecks
- Optimized use of resources and resources
- Optimized personnel planning and workloads

2.2 Simulation – Software – MedModel

Use:

- Risk-free Evaluation of the impact of new concepts
- Continuously improving the qualities
- Gaining data for statistics and controlling
- Increased acceptance in the workforce by visualizing planned projects
- Improved convincability by presenting concrete animations

2.2 Simulation – Software – MedModel

Next steps:

- create a new model
- Set layout
- Define elements

→ Locations
→ Entities
→ Arrivals
→ Ressources

→ Path Networks
→ Processings
→ others

2.2 Simulation – Software – MedModel

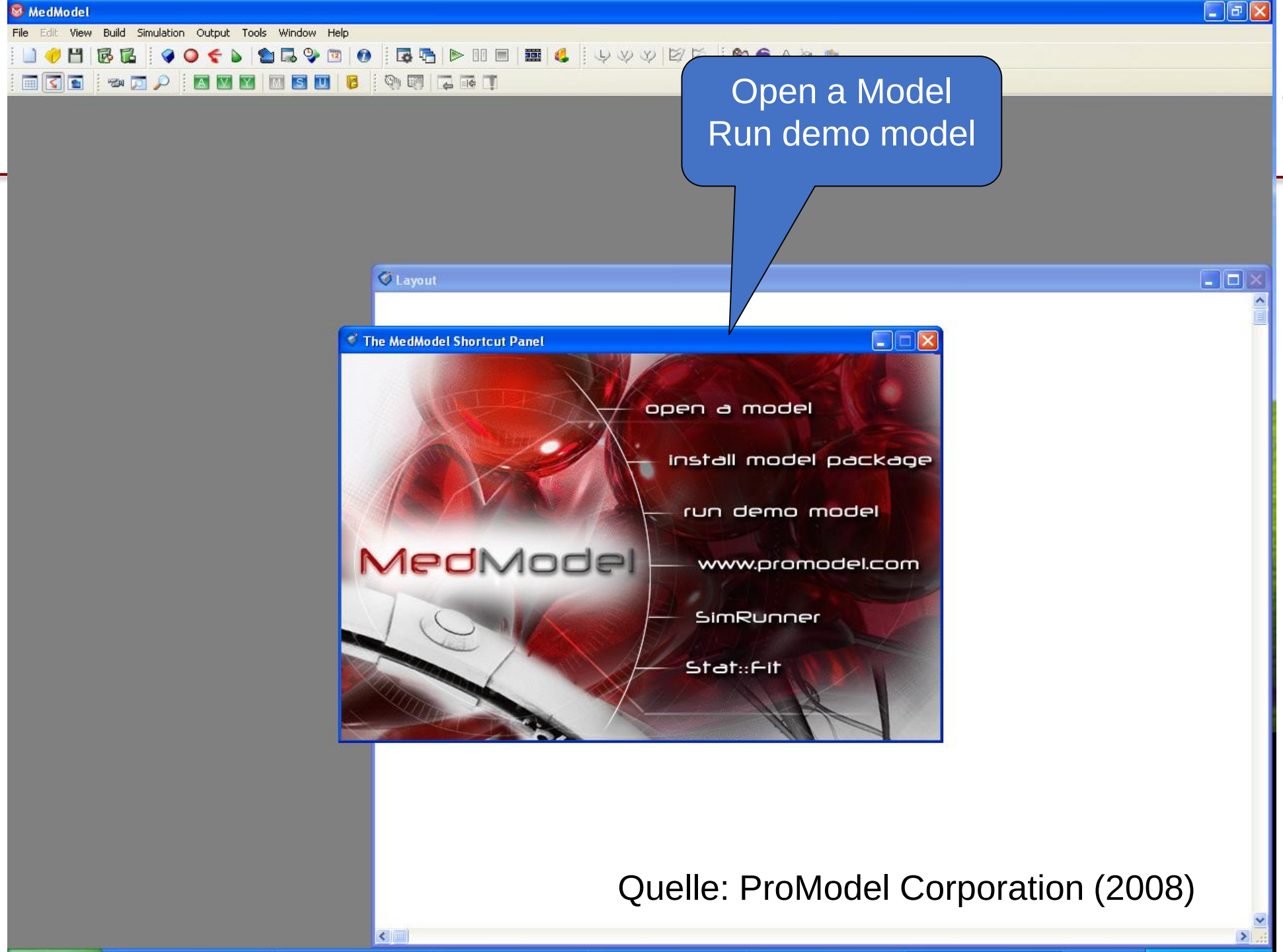
Next steps:

- create a new model
- Set layout
- Define elements

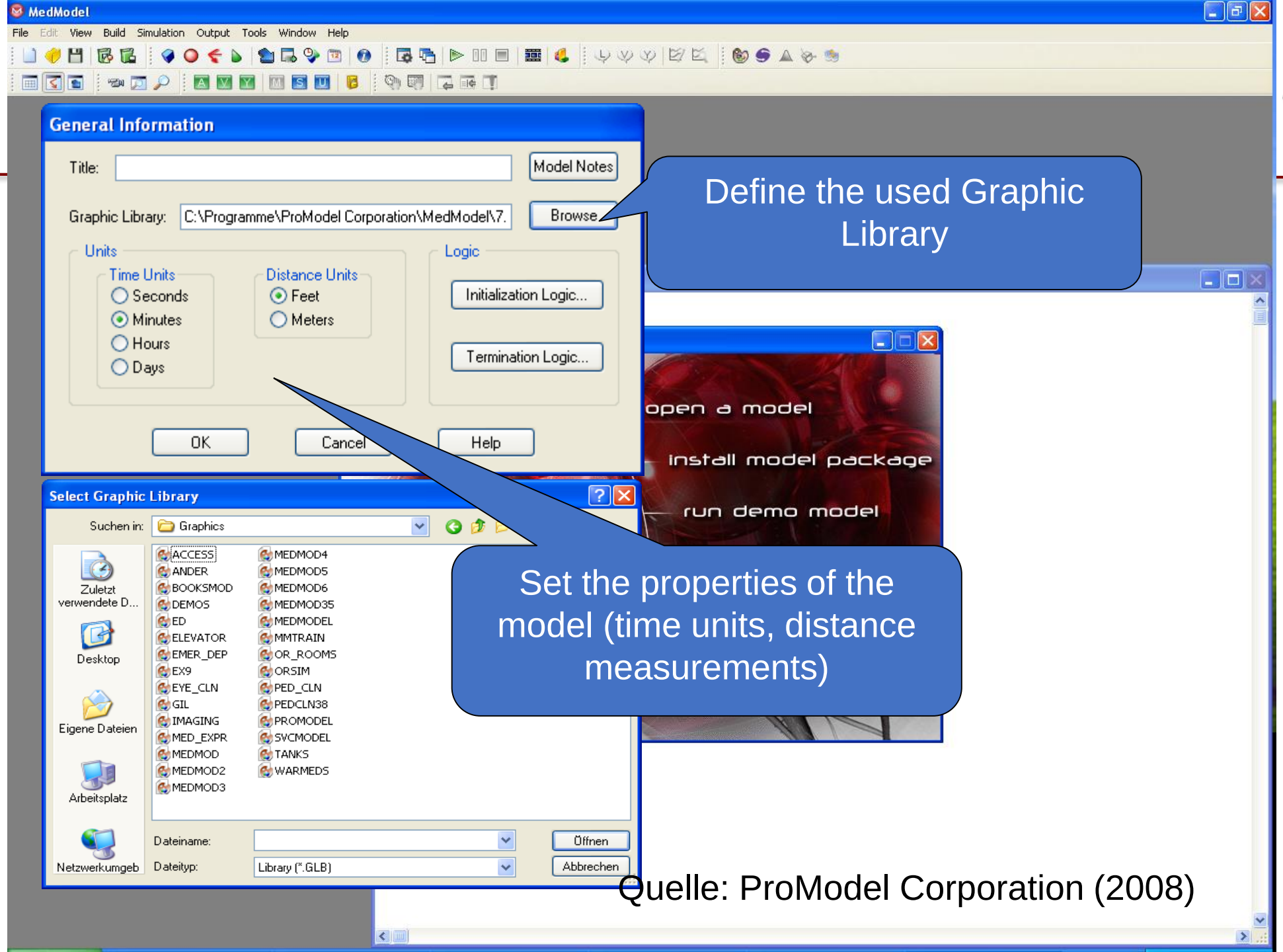
→ Locations
→ Entities
→ Arrivals
→ Ressources

→ Path Networks
→ Processings
→ others

- Attributes
- Variables
- User Distribution
- Subroutines
- Macros
- Shifts



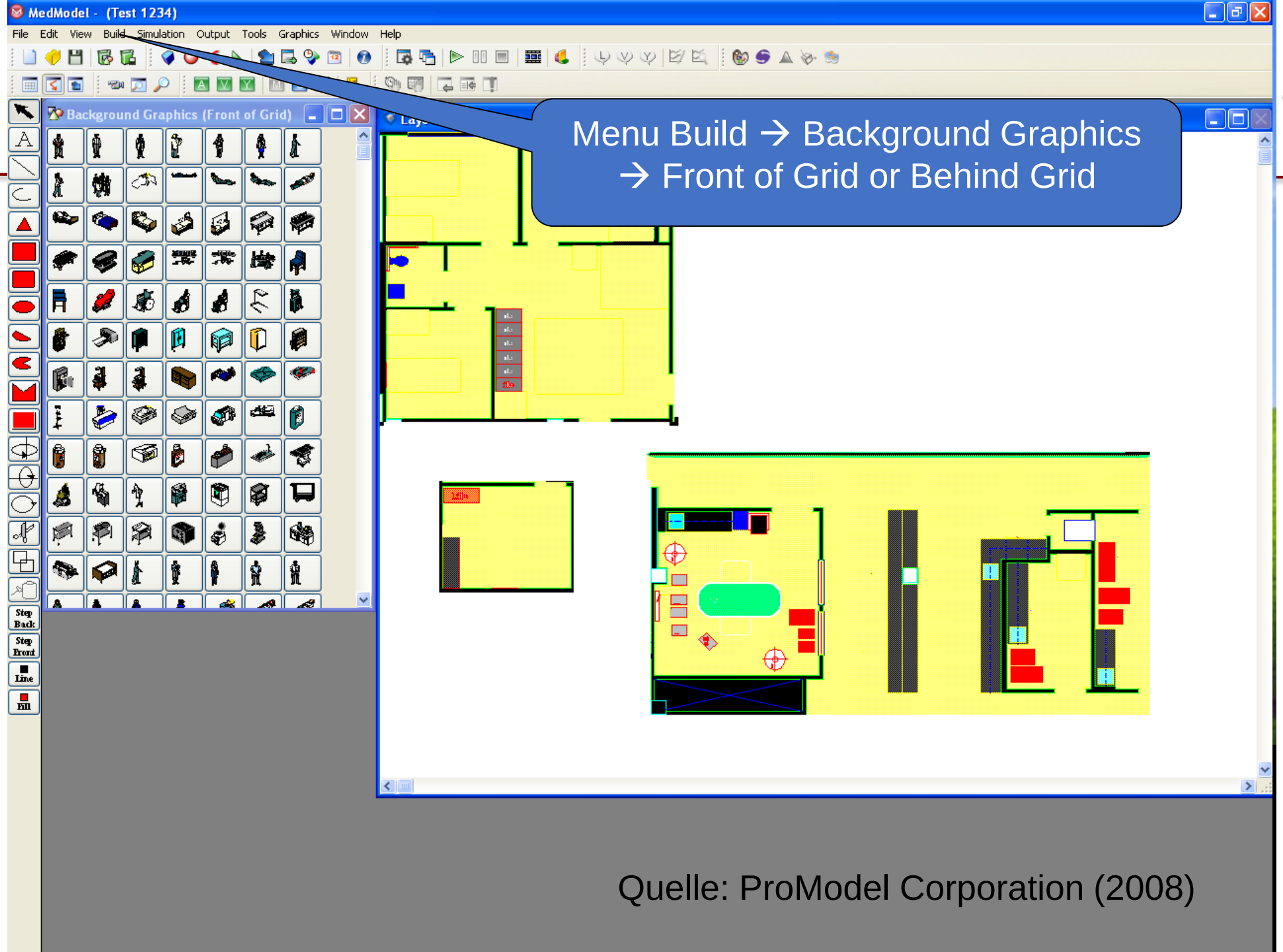
Quelle: ProModel Corporation (2008)



Define the used Graphic Library

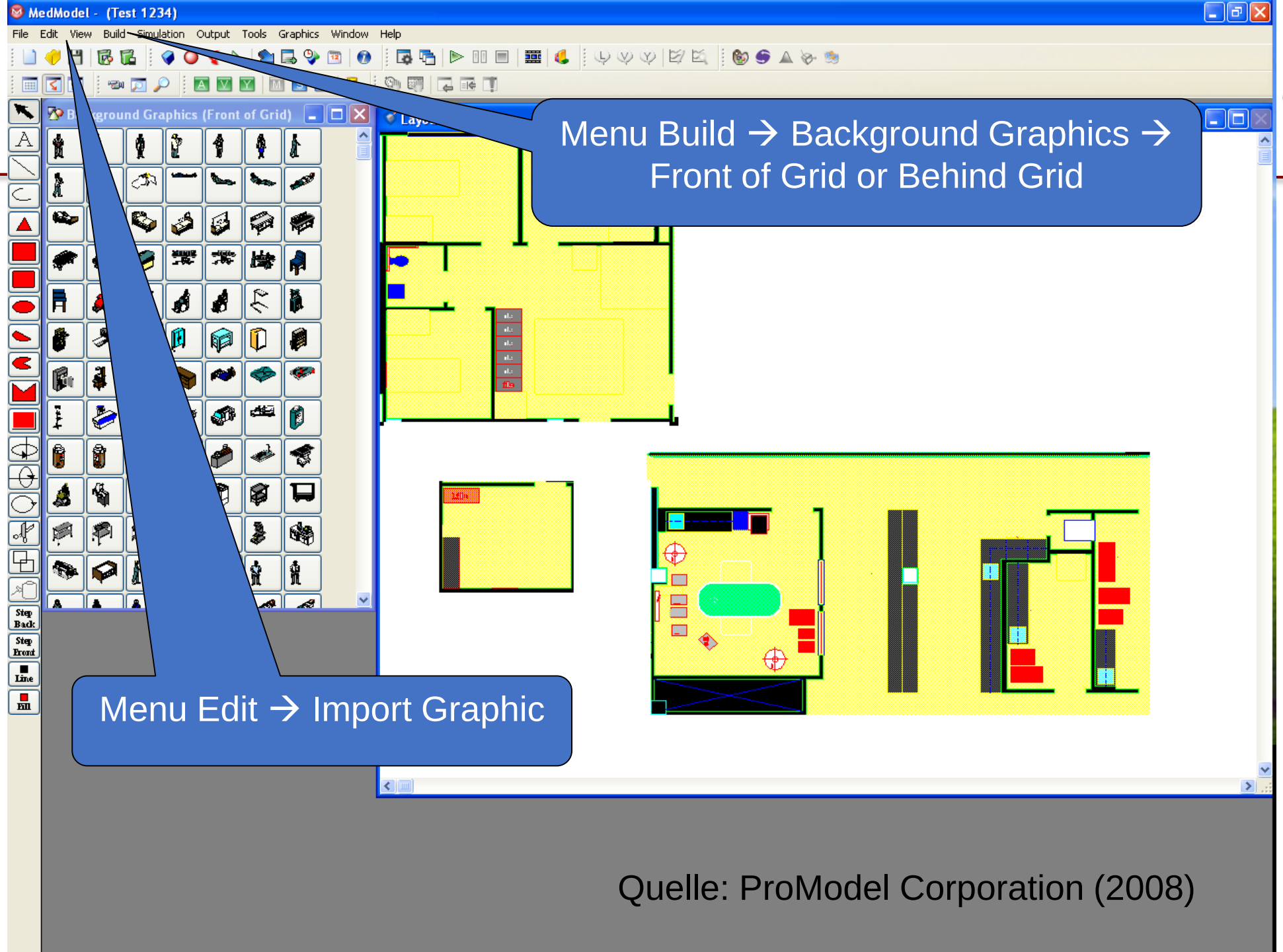
Set the properties of the model (time units, distance measurements)

Quelle: ProModel Corporation (2008)



Menu Build → Background Graphics → Front of Grid or Behind Grid

Quelle: ProModel Corporation (2008)

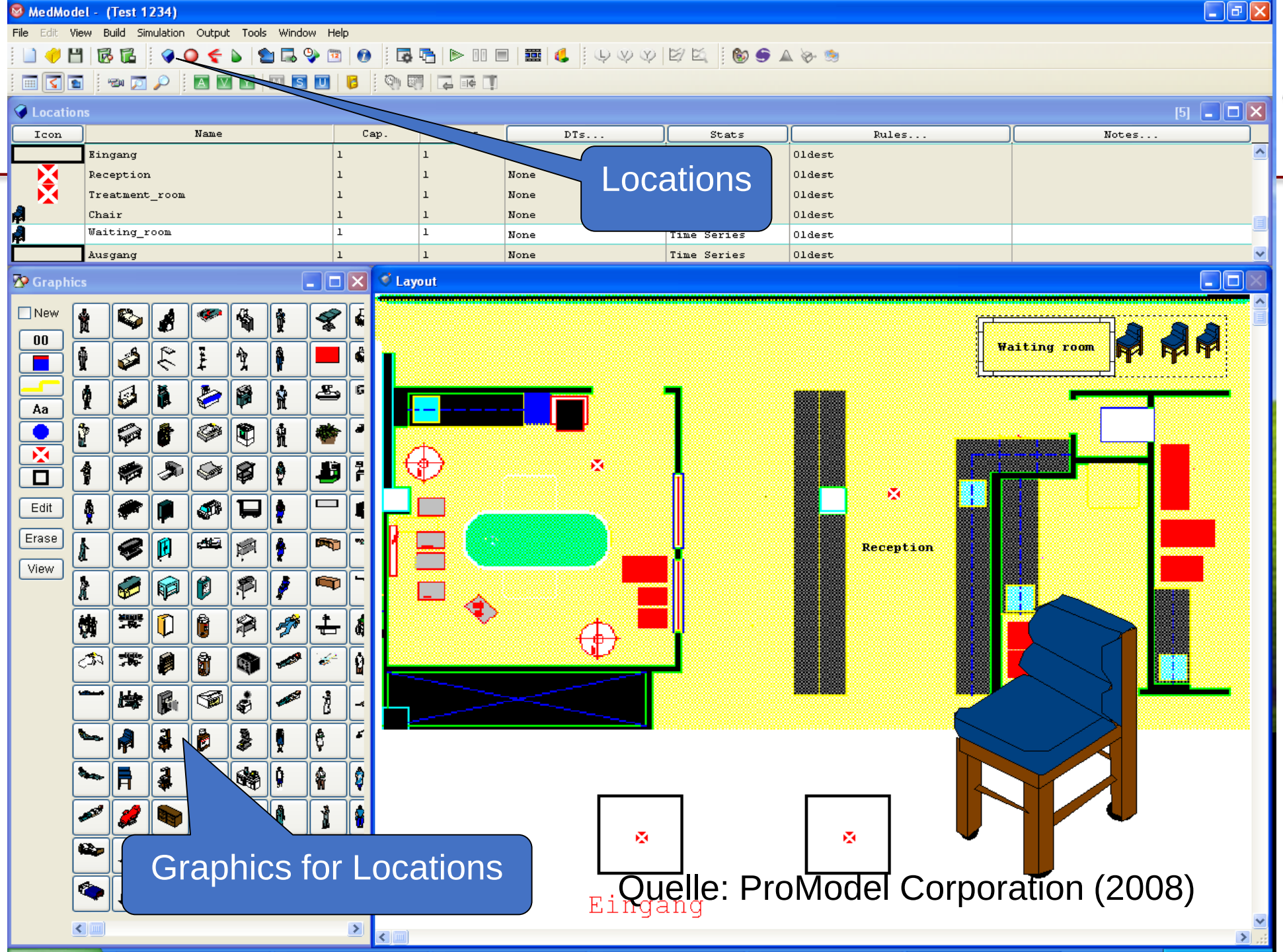


Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Locations:

- Places where the entities are treated by resources or wait for the next processes
- Operating tables, waiting room, ECG, equipment, warehouses, etc.
- Capacity, availability as a parameter possible

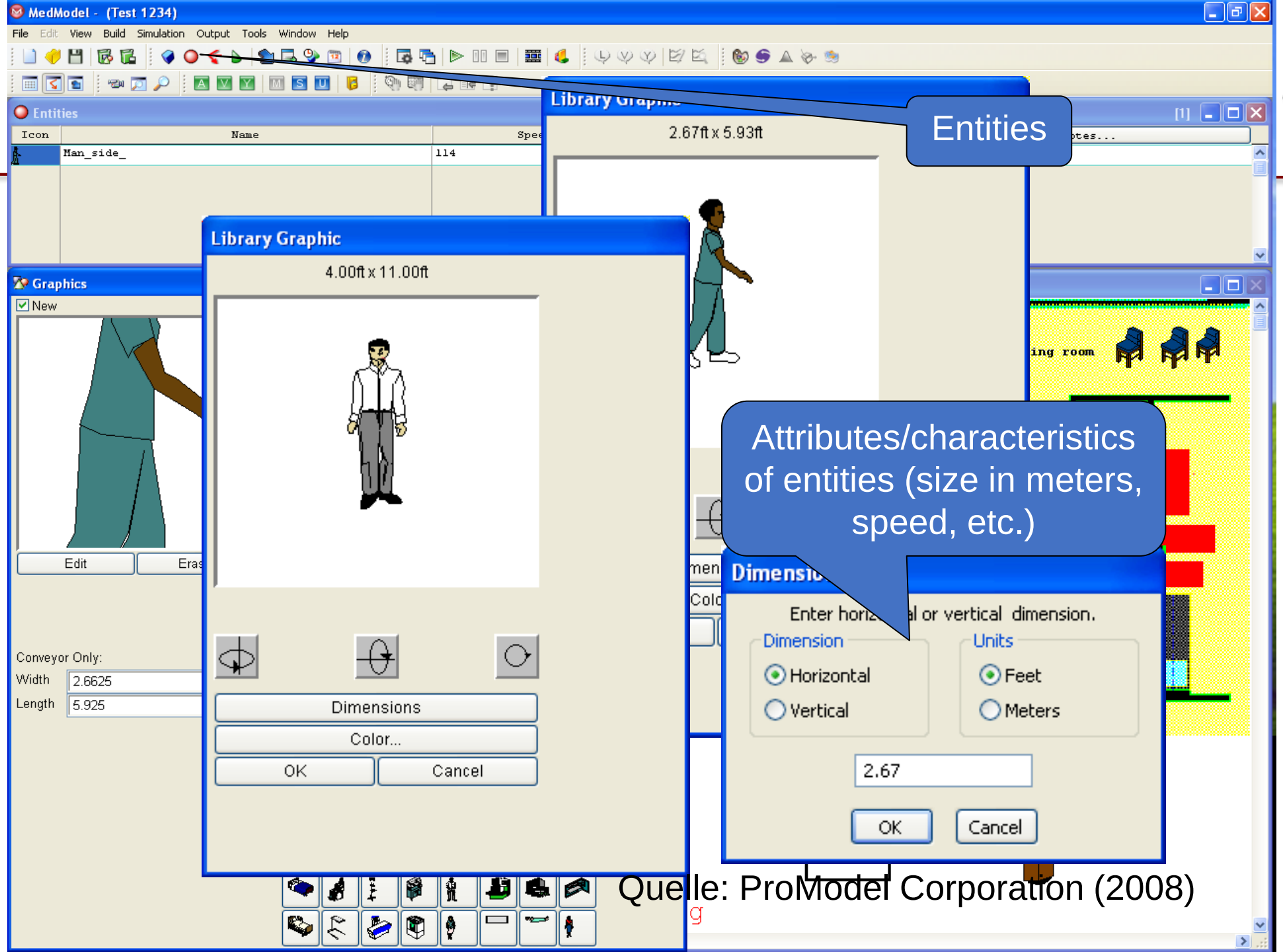


Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Entities:

- Objects that go through predefined processes during a simulation
- Patients, blood samples, x-rays, raw materials, finished medicinal products, etc.
- Assignment of properties possible, which determine the behaviour of entities in the simulation, e.g. running speed, quantity, priorities, etc.

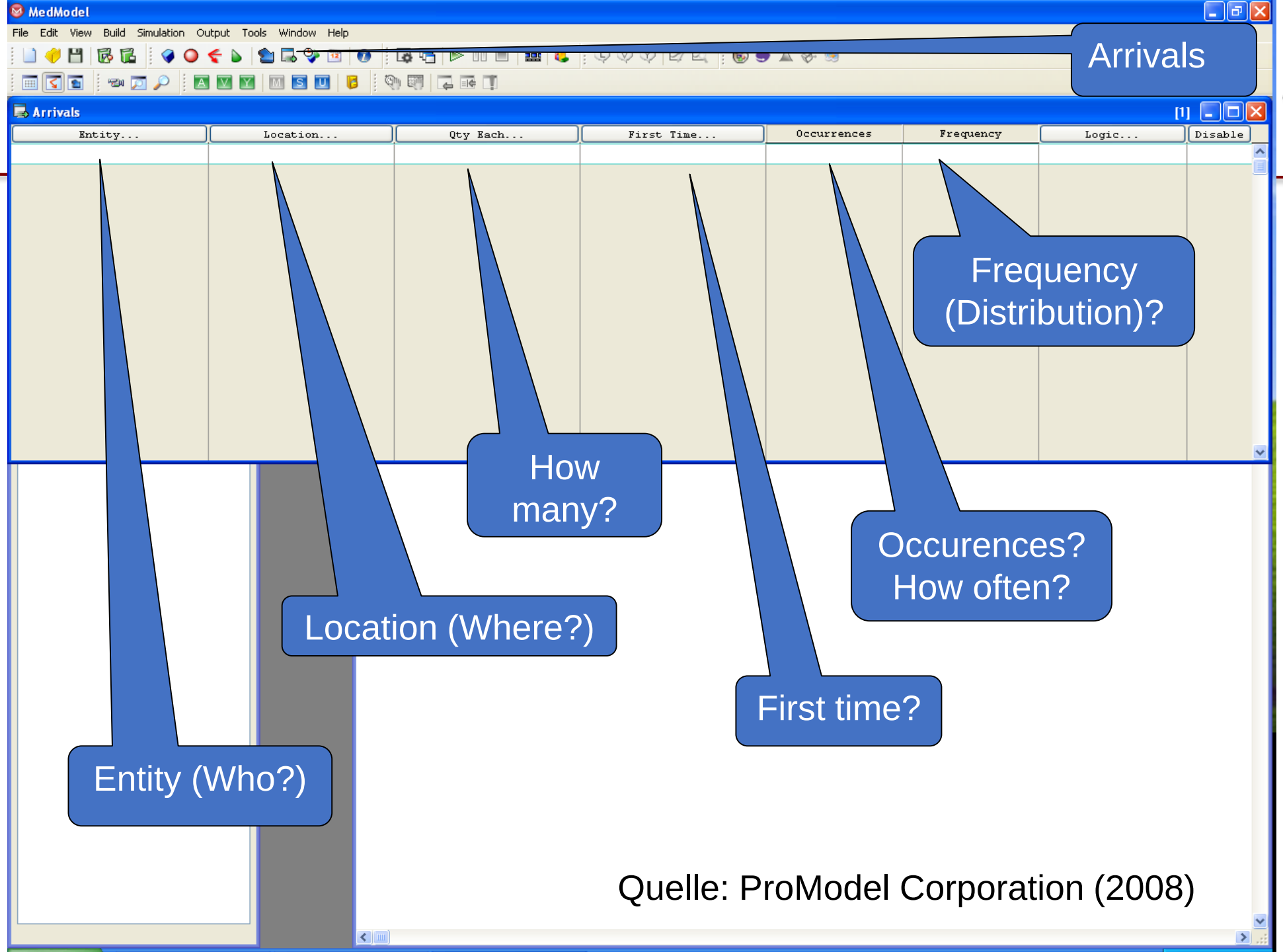


Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Arrivals:

- Where and when do defined objects arrive in the system, quantity, time and frequency

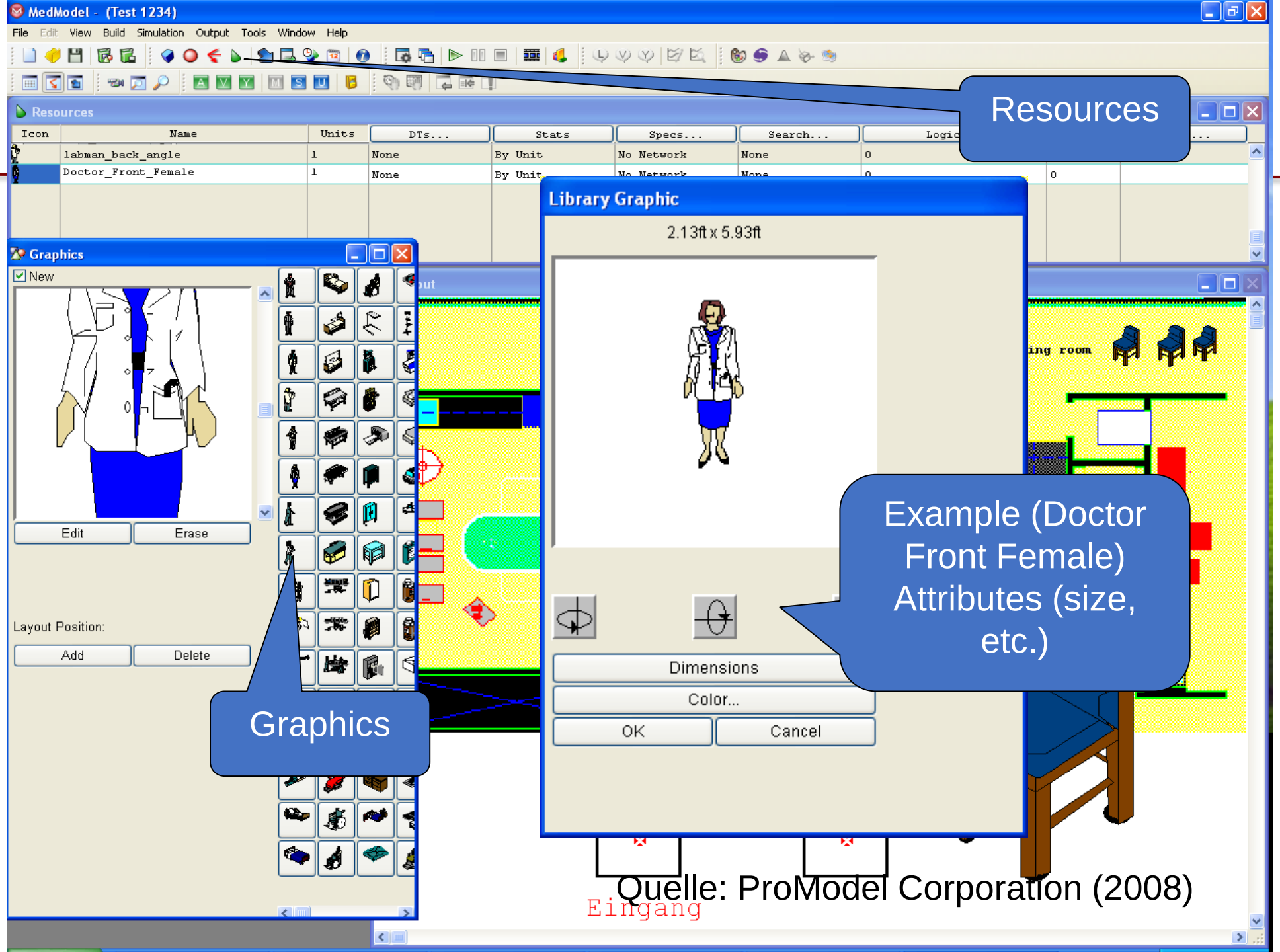


Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Resources:

- Necessary so that entities can go through or perform processes
- Tasks e.g. transporting entities, performing measures on / with entities
- E.g. persons, tools, means of transport
- Assignment of parameters possible, e.g. shift model, downtime

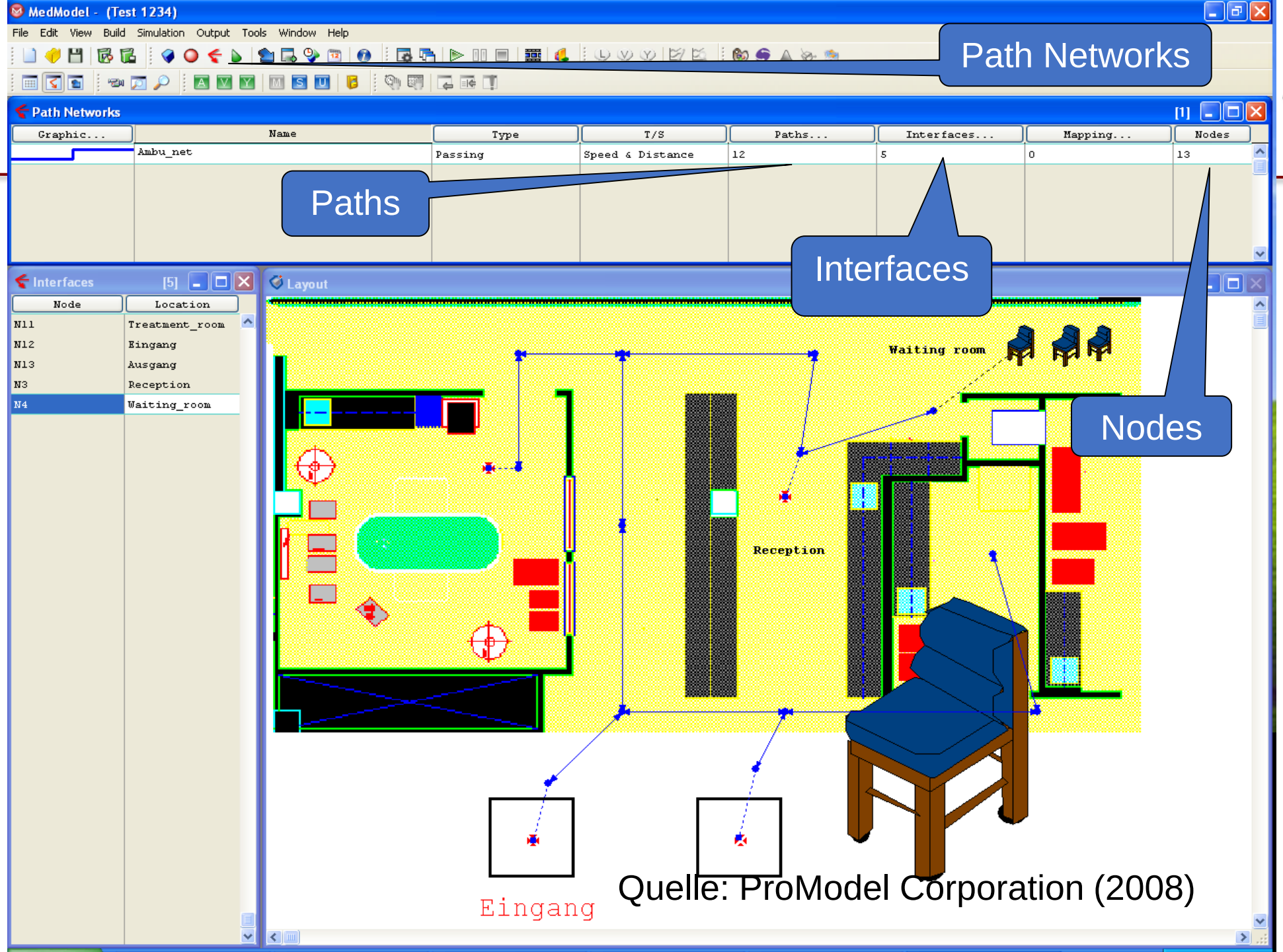


Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Path Networks (Pfade und Netzwerke):

- Representation of routes, times or distances, as well as speed factors for sections
- Along the Path Networks, the resources or mobile entities move between locations



Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Processing (Verarbeitung) :

- Processing defines the flow and the processing of the objects
- processing logic
- Type, order, duration of processes can be defined

MedModel - Urology.MOD (Small Urology Clinic Model)

File Edit View Build Simulation Output Tools Window Help

Processings

Process [5]

Entity...	Location...	Operation...
Patient	Enter	
Patient	Recept_Q	
Patient	Recept	USE NURSE for N(5,1,1) # Causes :
Patient	Waiting_Rm	GRAPHIC 2
Patient	Treat_rm	aTYPE=dType_Distribution()
Patient	Office	GRAPHIC 2
Patient	Leav	

Routing for Patient @ Treat_rm [1]

Blk	Output...	Destination...	Rule...	Move Logic...
1	Patient	Office	FIRST 1	GRAPHIC 1 MOVE WITH

Process (Entity – Location – Operation)

Routing (Output – Destination – Rule – Move Logic)

Operation

```
aTYPE=dType_Distribution()          # Sets the patient attribute type according
                            # to the established user distribution.
GRAPHIC 3
WAIT N(5,1,1)
free Nurse
GET DOCTOR
if aTYPE=1 then WAIT N(25,5,1)    # Sets a variable use time of the doctor
else WAIT N(15,5,1)                       # depending on the patient type.  Waits
                                                  # normally distributed with means
                                # standard deviations as indicated.
```

Line: 1

Move Logic

```
GRAPHIC 1
MOVE WITH Doctor # The doctor is assigned
                 # to the same network
                 # as the patient.
```

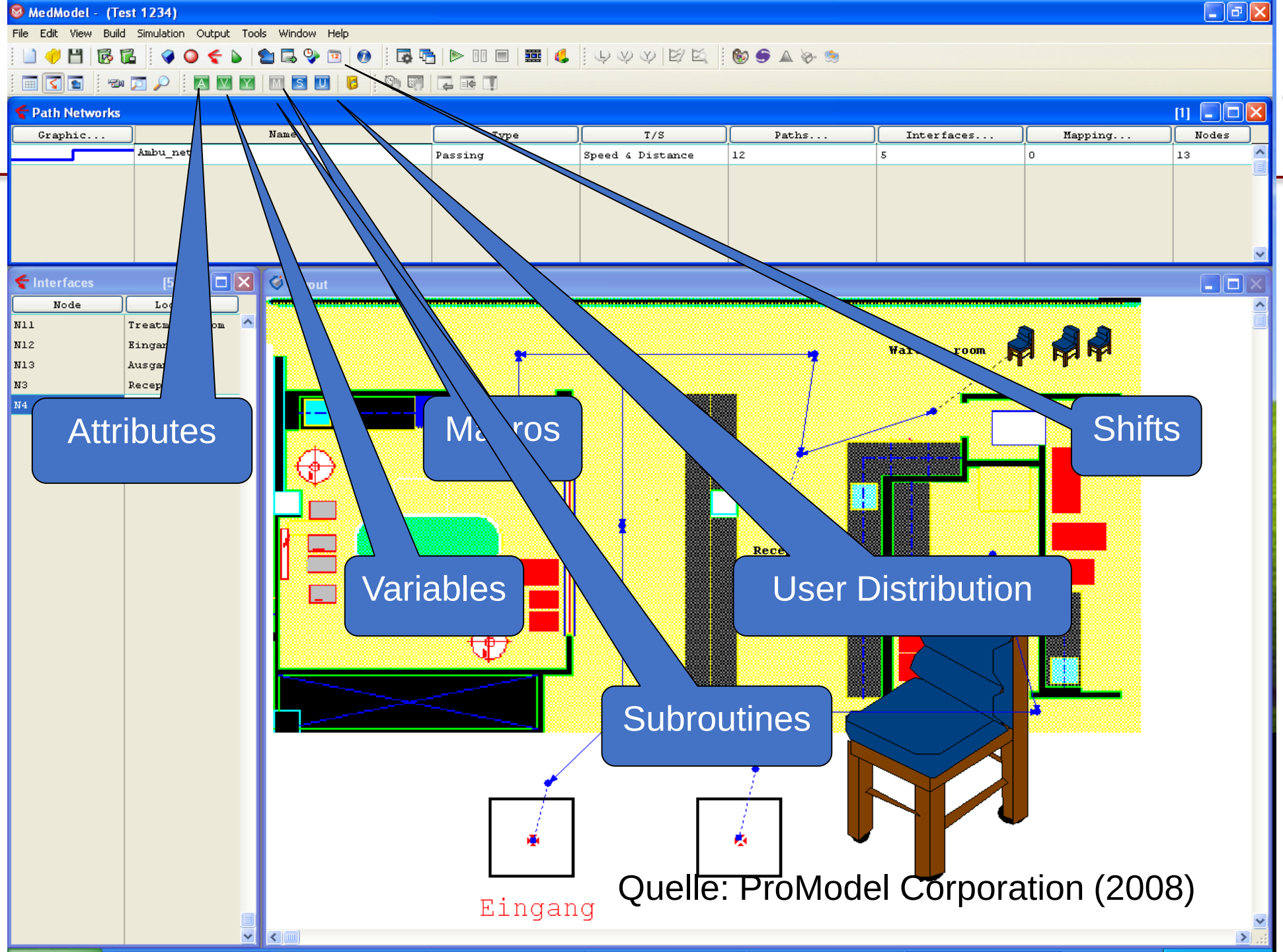
Line: 1

Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Other important Elements (Selection) :

- Attributes
- Variables
- User Distribution
- Subroutines
- Macros
- Shifts



Quelle: ProModel Corporation (2008)

2.2 Simulation – Software – MedModel

Subroutines [12]

ID	Type	Parameters...	Logic...
sPatient_Ortho_OP_1	None	None	Inc vWOWI_Saal_1 sPatient_Desinfektio
sPatient_Ortho_OP_2	None	None	Inc vWOWI_Saal_2 sPatient_Desinfektio

Logic

```
1  Inc vWOWI_Saal_1
2
3  sPatient_Desinfektion_Abdeckung_Ortho()
4
5  Inc vNSZ_Saal_1
6
7  Order 1 Schnitt_Saal_1 To Schnitt_Location_Saal_1
8
9  If vOP_Woche < (yAnzahl_OP_Wochen_Sportho[1,1]+1)  Then
10 {
11     Get yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_1  Or yRessourcenbedarf[1, mRessourcenbedarf_
12 }
13
14 If vOP_Woche > yAnzahl_OP_Wochen_Sportho[1,1]  Then
15 {
16     Get yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_1  Or yRessourcenbedarf[1, mRessourcenbedarf_
17 }
18
19 Wait yProzesszeiten[aPatiententyp, mProzesszeiten_SNZ] min
20
21 Dec vNSZ_Saal_1
22
23 Order 1 Naht_Saal_1 To Naht_Location_Saal_1
24
25 sNSZ_Bestellung_Saal_1()
26
27
28 Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_1
29 Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_2
30 Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_3
31
32 sPatient_Abschluss_chirigischer_Maßnahmen_Ortho()
33
```

2.2 Simulation – Software – MedModel

Subroutines [12]

ID	Type	Parameters...	Logic...
sPatient_Ortho_OP_1	None	None	Inc vWOWI_Saal_1 sPatient_Desinfektio
sPatient_Ortho_OP_2	None	None	Inc vWOWI_Saal_2 sPatient_Desinfektio

Logic

```
1  Inc vWOWI_Saal_1
2
3  sPatient_Desinfektion_Abdeckung_Ortho()
4
5  Inc vNSZ_Saal_1
6
7  Order 1 Schnitt_Saal_1 To Schnitt_Location_Saal_1
8
9  If vOP_Woche < (yAnzahl_OP_Wochen_Sportho[1,1]+1)  Then
10 {
11     Get yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_1  Or yRessourcenbedarf[1, mRessourcenbedarf_
12 }
13
14 If vOP_Woche > yAnzahl_OP_Wochen_Sportho[1,1]  Then
15 {
16     Get yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_1  Or yRessourcenbedarf[1, mRessourcenbedarf_
17 }
18
19 Wait yProzesszeiten[aPatiententyp, mProzesszeiten_SNZ] min
20
21 Dec vNSZ_Saal_1
22
23 Order 1 Naht_Saal_1 To Naht_Location_Saal_1
24
25 sNSZ_Bestellung_Saal_1()
26
27
28 Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_1
29 Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_2
30 Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Operateur] ÄD_Operateur_3
31
32 sPatient_Abschluss_chirigischer_Maßnahmen_Ortho()
33
```

2.2 Simulation – Software – MedModel

Subroutines

ID	
sPatient_Ortho_OP_1	None
sPatient_Ortho_OP_2	None

Logic

```
1  Inc vWOWI_Saal_1
2
3  sPatient_Desinfektion_Abdeckung_Ortho()
4
5  Inc vNSZ_Saal_1
6
7  Order 1 Schnitt_Saal_1 To Schnitt_Location
8
9  If vOP_Woche < (yAnzahl_OP_Wochen_Sportho[1,1]+1) Then
10 {
11     Get yRessourcenbedarf[1, mRessourcenbe
12 }
13
14 If vOP_Woche > yAnzahl_OP_Wochen_Sportho[1
15 {
16     Get yRessourcenbedarf[1, mRessourcenbe
17 }
18
19 Wait yProzesszeiten[aPatiententyp, mProzes
20
21 Dec vNSZ_Saal_1
22
23 Order 1 Naht_Saal_1 To Naht_Location_Saal_
24
25 sNSZ_Bestellung_Saal_1()
26
27
28 Free yRessourcenbedarf[1, mRessourcenbedar
29 Free yRessourcenbedarf[1, mRessourcenbedar
30 Free yRessourcenbedarf[1, mRessourcenbedar
31
32 sPatient_Abschluss_chirigischer_Maßnahmen_Ortho()
33
```

Subroutines

ID	
sWOWI_Bestellung_Saal_2	None
sRoutenabfrage_für_Sportho_und_Ortho_OP_Woche	None
sPatient_Lagern_Sportho	None
sPatient_Lagern_Ortho	None
sPatient_Desinfektion_Abdeckung_Sportho	None
sPatient_Desinfektion_Abdeckung_Ortho	None

Logic

```
1  Wait yProzesszeiten[aPatiententyp, mProzesszeiten_Desinfektion_Abdeckung] min
```

Subroutines

ID
sNSZ_Bestellung_Saal_1

Logic

```
1  aMax_Bestellzeit = yMax_Bestellzeit[vOP_Tag, 2]
2
3  aMax_Bestellzeit_NSZ = (aMax_Bestellzeit - mReduzierte_max_Zeit_für_NSZ)
4
5  If Clock() < aMax_Bestellzeit_NSZ Then
6
7  {
8
9      Order 1 NSZ_Saal_1 To OP_1_Hilfslocation
10
11 }
12
```

2.2 Simulation – Software – MedModel

Subroutines

ID	
sPatient_Ortho_OP_1	None
sPatient_Ortho_OP_2	None

Logic

```
1  Inc vWOWI_Saal_1
2
3  sPatient_Desinfektion_Abdeckung_Ortho()
4
5  Inc vNSZ_Saal_1
6
7  Order 1 Schnitt_Saal_1 To Schnitt_Location
8
9  If vOP_Woche < (yAnzahl_OP_Wochen_Sportho[1,1]+1) Then
10 {
11     Get yRessourcenbedarf[1, mRessourcenbe
12 }
13
14 If vOP_Woche > yAnzahl_OP_Wochen_Sportho[1
15 {
16     Get yRessourcenbedarf[1, mRessourcenbe
17 }
18
19 Wait yProzesszeiten[aPatiententyp, mProzes
20
21 Dec vNSZ_Saal_1
22
23 Order 1 Naht_Saal_1 To Naht_Location_Saal_
24
25 sNSZ_Bestellung_Saal_1()
26
27
28 Free yRessourcenbedarf[1, mRessourcenbedar
29 Free yRessourcenbedarf[1, mRessourcenbedar
30 Free yRessourcenbedarf[1, mRessourcenbedar
31
32 sPatient_Abschluss_chirigischer_Maßnahmen_Ortho()
33
```

Subroutines

ID	
sWOWI_Bestellung_Saal_2	None
sRoutenabfrage_für_Sportho_und_Ortho_OP_Woche	None
sPatient_Lagern_Sportho	None
sPatient_Lagern_Ortho	None
sPatient_Desinfektion_Abdeckung_Sportho	None
sPatient_Desinfektion_Abdeckung_Ortho	None

Logic

```
1  Wait yProzesszeiten[aPatiententyp, mProzesszeiten_Desinfektion_Abdeckung] min
```

Subroutines

ID
sNSZ_Bestellung_Saal_1

Logic

```
1  aMax_Bestellzeit = yMax_Bestellzeit[vOP_Tag, 2]
2
3  aMax_Bestellze  NSZ = (aMax_Bestellzeit -  eduzierte_max_Zeit_für_NSZ)
4
5  If Clock() < aMax_Bestellzeit_NSZ Then
6
7  {
8
9      Orde  ocati
10
11 }
12
```

Attribute, calculates the maximum order time of a patient on the surgery day

Array, Data comes from an external file (here: Excel)

2.2 Simulation – Software – MedModel

```
00:58:00.000 1 Patient_GYN scheduled to arrive at Schlange_vor_Schleuse_vor_OP.
00:58:00.000 Patient_GYN (ID: 2) arrives at Schlange_vor_Schleuse_vor_OP.
00:58:00.000    Ent Attr: Datum_Patient = 1 (old value = 0)
00:58:00.000    Int: OP2_Gesamt = 0 (old value = 0)
00:58:00.000 For Patient_GYN (ID: 2) at Schlange_vor_Schleuse_vor_OP:
00:58:00.000    Patient_GYN enters Schlange_vor_Schleuse_vor_OP.
00:58:00.000    Int: Anzahl_Schlange_vor_OP = 1 (old value = 0)
00:58:00.000    Start moving for  1.842 Sec.
00:58:01.842    Select route from route block #1; output quantity is 1.
00:58:01.842 For Patient_GYN (ID: 2) at Schlange_vor_Schleuse_vor_OP:
00:58:01.842    No location is available for routing.
00:59:14.006 For Patient_CH3 (ID: 1) at Schleuse:
00:59:14.006    Select route from route block #1; output quantity is 1.
00:59:14.006 For Patient_CH3 (ID: 1) at Schleuse:
00:59:14.006    OP_3_Eingang is selected for routing.
00:59:14.006    The main entity is routed out as Patient_CH3.
00:59:14.006    Output is named as Patient_CH3.
00:59:14.006    Ent Attr: Transportzeit_zum_OP_CH3 = 3554 (old value = 0)
00:59:14.006    Ent Attr: t2_ch3 = 21 (old value = 0)
00:59:14.006    Start move to OP_3_Eingang.
00:59:14.006 For Patient_CH3 (ID: 1) at Schleuse:
00:59:14.006    Process completed.
00:59:14.006    Release the captured capacity.
00:59:14.006 For Patient_GYN (ID: 2) at Schlange_vor_Schleuse_vor_OP:
00:59:14.006    The main entity is routed out as Patient_GYN.
00:59:14.006    Output is named as Patient_GYN.
00:59:14.006    Int: Anzahl_Schlange_vor_OP = 0 (old value = 1)
00:59:14.006    Start move to Schleuse.
00:59:14.006 Patient_GYN (ID: 2) arrives at Schleuse.
00:59:14.006 For Patient_GYN (ID: 2) at Schleuse:
00:59:14.006    Patient_GYN enters Schleuse.
00:59:14.006    Ent Attr: Zeit_in_Schleuse_vor_OP_GYN = 3554 (old value = 0)
00:59:14.006    Ent Attr: Gesamtzeit_in_OP_Bereich_GYN = 3554 (old value = 0)
00:59:14.006 Anästhesiearzt2.1 starts moving to Schleuse.
00:59:14.006 For Patient_GYN (ID: 2) at Schlange_vor_Schleuse_vor_OP:
00:59:14.006    Process completed.
```

2.3 Case Study III

Please edit the case study!

Liels paldies par jūsu uzmanību.

OLAV
GÖTZ

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Are there any questions?

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