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

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Please introduce yourself!
Lūdu, 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

1.1 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

<table>
<thead>
<tr>
<th>Author</th>
<th>Definition</th>
</tr>
</thead>
</table>
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 Prozess.
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 holistic 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

1.1 Basics – Process Management

Life cycle of process management

• Actual state
• Analysis
• Target state
• Implementation
• Execution
• Controlling
1.1 Basics – Process Management

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
1.1 Basics – Process Management

Life cycle of process management:

• 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 management:

- 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
1.1 Basics – Process Management

**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

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1.1 Basics – Process Management

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
1.1 Basics – Process Management

Life cycle of process management:

- 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 Measurement Instrument
  - Process-Benchmarking → Process Performance Analysis
1.1 Basics – Process Management

Figure: Clinical Process Management
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
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 the hospital with special focus on the patient flow, utilization of the facilities involved, waiting times as a quality aspect and time in system.
1.3 Case Study II – (1) Introduction

Simulation:
- Method for analyzing systems (too complex for analytical solutions)
- Replication of real systems, objects, processes, or scenarios
- Conducting experiments with the help of models to gather inferences on the real system

Discrete-Event Simulation:
- Modeling dynamic systems, where the state of the model can be described by state variables
- Variables can change at several points of time caused by the appearance of events

Reasons for Simulation:
- Investigation of the real system is too expensive, time consuming, ethical unacceptable, 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

Example: cataract intervention

Discrete-Event Simulation (DES)
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 of cataract intervention from entering the outpatient department until leaving the hospital with special focus on the patient flow, utilization of the facilities and medical personnel involved, waiting times as a quality aspect 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-event simulation model
- Scenarios of the model
- Presentation to the 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
  • Interviews
  • Hospital information 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).
### Time study:

<table>
<thead>
<tr>
<th></th>
<th>total time (hh:mm:ss)</th>
<th>total time outpatient department (pre-surgery) (hh:mm:ss)</th>
<th>total time central operation area (surgery) (hh:mm:ss)</th>
<th>total time outpatient department (post-surgery) (hh:mm:ss)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>normal intraocular pressure</td>
<td>high intraocular pressure</td>
<td>normal intraocular pressure</td>
<td>high intraocular pressure</td>
</tr>
<tr>
<td>N</td>
<td>60</td>
<td>6</td>
<td>66</td>
<td>63</td>
</tr>
<tr>
<td>mean</td>
<td>05:10:49</td>
<td>06:05:52</td>
<td>00:45:00</td>
<td>03:26:49</td>
</tr>
<tr>
<td>minimum</td>
<td>03:24:41</td>
<td>04:47:17</td>
<td>00:14:10</td>
<td>01:55:49</td>
</tr>
<tr>
<td>maximum</td>
<td>07:39:50</td>
<td>07:14:24</td>
<td>01:31:30</td>
<td>06:20:01</td>
</tr>
<tr>
<td>standard deviation</td>
<td>00:56:53</td>
<td>00:52:03</td>
<td>00:18:09</td>
<td>00:55:43</td>
</tr>
</tbody>
</table>

**Table.** Summary of time patients spent in the hospital.  
Source: own.
## 1.3 Case Study II – (3) Results

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

**Table.** Theoretical distribution functions pre-surgery.  
Source: own.
### 1.3 Case Study II – (3) Results

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

**Table.** Theoretical distribution functions surgery.

Source: own.
1.3 Case Study II – (3) Results

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

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

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

<table>
<thead>
<tr>
<th></th>
<th>pre-surgery</th>
<th>surgery</th>
<th>post-surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>time study</strong></td>
<td>44.99</td>
<td>206.81</td>
<td>47.05</td>
</tr>
<tr>
<td><strong>basic model</strong></td>
<td>45.11</td>
<td>206.55</td>
<td>46.81</td>
</tr>
</tbody>
</table>

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## Scenarios

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

**Table.** Scenarios of the simulation study.

Source: own.
1.3 Case Study II – (3) Results

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

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Pre-surgery</th>
<th>Surgery</th>
<th>Post-surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic model</td>
<td>45.11</td>
<td>206.55</td>
<td>46.81</td>
</tr>
<tr>
<td>Scenario 1</td>
<td>40.64</td>
<td>186.11</td>
<td>47.61</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>41.31</td>
<td>203.75</td>
<td>47.13</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>45.25</td>
<td>200.93</td>
<td>47.31</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>45.30</td>
<td>194.43</td>
<td>47.53</td>
</tr>
<tr>
<td>Scenario 5</td>
<td>45.76</td>
<td>147.19</td>
<td>51.19</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total Time in System</th>
<th>Waiting Time</th>
<th>Time in Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic model</td>
<td>305.88</td>
<td>116.37</td>
<td>212.32</td>
</tr>
<tr>
<td>Scenario 1</td>
<td>281.68</td>
<td>90.33</td>
<td>211.99</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>299.63</td>
<td>117.95</td>
<td>204.59</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>300.99</td>
<td>111.41</td>
<td>211.08</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>294.82</td>
<td>109.60</td>
<td>212.35</td>
</tr>
<tr>
<td>Scenario 5</td>
<td>251.57</td>
<td>88.01</td>
<td>188.14</td>
</tr>
</tbody>
</table>
### 1.3 Case Study II – (3) Results

<table>
<thead>
<tr>
<th></th>
<th>time used per day in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>basic model</td>
</tr>
<tr>
<td>doctor</td>
<td>216.01</td>
</tr>
<tr>
<td>nurse policlinic 1</td>
<td>253.61</td>
</tr>
<tr>
<td>nurse policlinic 2</td>
<td>21.40</td>
</tr>
<tr>
<td>nurse prep-room 1</td>
<td>253.06</td>
</tr>
<tr>
<td>nurse prep-room 2</td>
<td>74.97</td>
</tr>
<tr>
<td>nurse prep-room 3</td>
<td></td>
</tr>
<tr>
<td>nurse op</td>
<td>319.23</td>
</tr>
<tr>
<td>surgeon</td>
<td>312.31</td>
</tr>
<tr>
<td>doctor prep-room</td>
<td></td>
</tr>
</tbody>
</table>

**Table.** Personnel mean utilization.
Source: own.
1.3 Case Study II – (3) Results

Figure. Location utilization in percent per day.
Source: own.
### Scenario Differences to Basic Model

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Differences to Basic Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>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.</td>
</tr>
<tr>
<td>2</td>
<td>Little change in comparison to the basic model (moderate reduction of waiting time during first (-238 sec.) and second transport (-228 sec.)</td>
</tr>
<tr>
<td>3</td>
<td>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.</td>
</tr>
<tr>
<td>4</td>
<td>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.</td>
</tr>
<tr>
<td>5</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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
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

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

Figure: Analysis of Systems. Source: Law (2007), S. 4.
Definition:
- Method for analyzing systems (too 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 too expensive, time consuming, ethical unacceptable, 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
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- Model verification
- Model validation
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- 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 planning
- Data collection
- Build the model
- Model verification
- Model validation
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- Simulation runs and analysis of results
- Model documentation and implementation

2.1.1 Simulation

- 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:

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Steps of a DES study:

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2.1 Simulation - Basics

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"?
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

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 $\rightarrow$ especially for the needs of the health care system
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
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 → Path Networks
→ Entities → Processings
→ Arrivals → others
→ Ressources
Next steps:

- create a new model
- Set layout
- Define elements

→ Locations → Path Networks
→ Entities → Processings
→ Arrivals → others
→ Ressources

- Attributes
- Variables
- User Distribution
- Subroutines
- Macros
- Shifts
Open a Model
Run demo model

Quelle: ProModel Corporation (2008)
Define the used Graphic Library

Set the properties of the model (time units, distance measurements)
Menu Build → Background Graphics → Front of Grid or Behind Grid

Quelle: ProModel Corporation (2008)
Menu Build → Background Graphics → Front of Grid or Behind Grid

Menu Edit → Import Graphic

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
<table>
<thead>
<tr>
<th>Icon</th>
<th>Name</th>
<th>Type</th>
<th>Cap</th>
<th>DTE</th>
<th>State</th>
<th>Status</th>
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<tr>
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<td>Eingang</td>
<td>I</td>
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<td></td>
<td>None</td>
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<td></td>
<td>Chair</td>
<td>I</td>
<td>I</td>
<td></td>
<td>None</td>
<td>Oldest</td>
</tr>
<tr>
<td></td>
<td>Waiting_room</td>
<td>I</td>
<td>I</td>
<td>None</td>
<td>Time Series</td>
<td>Oldest</td>
</tr>
</tbody>
</table>

Quelle: ProModel Corporation (2008)
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.
Entities

Attributes/characteristics of entities (size in meters, speed, etc.)
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
Resources

Example (Doctor Front Female)
Attributes (size, etc.)

Graphics

Quelle: ProModel Corporation (2008)
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
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
Process (Entity – Location – Operation)

Routing (Output – Destination – Rule – Move Logic)

Quelle: ProModel Corporation (2008)
Other important Elements (Selection): 

- Attributes
- Variables
- User Distribution
- Subroutines
- Macros
- Shifts
Quelle: ProModel Corporation (2008)
2.2 Simulation – Software – MedModel
2.2 Simulation – Software – MedModel

- Subroutines
- Logic

```plaintext
1. Inc vWf1_Saal_1
2. sPatient_Desinfektion_Abdeckung_Ortho()
3. Inc vWf1_Saal_1
4. Order 1 Schnitt_Saal_1 To Schnitt_Location_Saal_1
5. If vOP_Moche < (yAnzahl_OP_Moche_Sportho[1,1]+1) Then
6. Get yRessourcenbedarf[1, mRessourcenbedarf_OP_Ope1] AD_Operateur_1 Or yRessourcenbedarf[1, mRessourcenbedarf_]
7. If vOP_Moche > yAnzahl_OP_Moche_Sportho[1,1] Then
8. Get yRessourcenbedarf[1, mRessourcenbedarf_OP_Ope1] AD_Operateur_1 Or yRessourcenbedarf[1, mRessourcenbedarf_]
9. Wait yProzesszeiten[aPatiententyp, mProzesszeiten_Saal] min
10. Dec vWf1_Saal_1
11. Order 1 Naht_Saal_1 To Naht_Location_Saal_1
12. sWf1_Bestellung_Saal_1()
13. Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Ope1] AD_Operateur_1
14. Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Ope1] AD_Operateur_2
15. Free yRessourcenbedarf[1, mRessourcenbedarf_OP_Ope1] AD_Operateur_3
16. sPatient_Abschluss_chirurgischer_Maßnahmen_Ortho()
```
2.2 Simulation – Software – MedModel
Array, Data comes from an external file (here: Excel)

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

2.2 Simulation – Software – MedModel
2.2 Simulation – Software – MedModel

00:58:00.000 1 Patient_GYN scheduled to arrive at Schlane_vor_Schleuse_vor_OP.
00:58:00.000 Patient_GYN (ID: 2) arrives at Schlane_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 Schlane_vor_Schleuse_vor_OP:
00:58:00.000 Patient_GYN enters Schlane_vor_Schleuse_vor_OP.
00:58:00.000 Int: Anzahl_Schlane_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 Schlane_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 Schlane_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_Schlane_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 Anæsthesiefarzt2.1 starts moving to Schleuse.
00:59:14.006 For Patient_GYN (ID: 2) at Schlane_vor_Schleuse_vor_OP:
00:59:14.006 Process completed.
Please edit the case study!
Liels paldies par jūsu uzmanību.

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Are there any questions?


Literature

Literature


Riga | 22.08.2018 | Goetz


Winter Simulation Conference –(http://www.wintersim.org/)