3D Support for Business Process Simulation

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Overview

• Introduction and Motivation

• 3D Representation of Data and Process Objects

• Forming Data and Process Objects in 3D Simulation Environment

• Analysis of Simulation Results

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Introduction

• **About simulation:**
  • key technique for design and redesign of business processes,
  • way to test decisions prior to their implementation in real business environment.

• **What simulation allows:**
  • integration of variability and uncertainty,
  • introduction of dynamic process parameters,
  • measurement of process performance \([ABGK06][FNSE99]\).
Motivation

• **What tools provide:**
  • a variety of analysis possibilities for simulation runs based on standard process performance metrics [JaNe06].

• **What is the problem yet:**
  • increasing complexity of business processes hampers quick visual allocation of weak points.

• **What is our aim:**
  • compact visualization of business process simulation and result by adding a third dimension.
Motivation

• **Why third dimension:**
  • supports users to quickly identify weak points of modeled business processes,
  • supports the human visual intuition \[\text{BaES00}\].

• **How to get there:**
  • enhance concept for spatial visualization of Petri net diagrams with a third modeling dimension,
  • enables interactive 3D animations of business process models,
  • statistical analyses of simulation results based on volume changes of 3D process and data objects.
3D Representation of Data and Process Objects

- objects in business processes are classified into data objects and process objects [AaBe01].

- *data objects* refer to flowing objects conveying data that are manipulated and delivered across a process net.

- *process objects* are non-flowing objects used to construct the control flow or serving as parameterized indicators.

- discuss following process objects:
  - transition cost, transition time, resources, and place capacity.
3D Representation of Data and Process Objects

- **Transition Cost:**
  \[ C_{\text{trans}}(t,i) = C_{\text{fix}}(t) + C_{\text{var}}(t,i) \text{ with } t \in T, i \in J \]

- height of the cylinder varies according to current values of its corresponding cost indicators.
- cost cylinder is included in a transparent cylinder that controls the increase/decrease of cost factors.

![3D representation of costs](image-url)
3D Representation of Data and Process Objects

- **Transition Time:**
  
  \[ T_{\text{trans}}(t,i) = T_{\text{pre}}(t,i) + T_{\text{dur}}(t,i) + T_{\text{post}}(t,i) \text{ with } t \in T, i \in J \]

- area diagrams can be rotated for different view perspectives.
3D Representation of Data and Process Objects

• **Resources:**

  - are displayed over each transition icon, representing resources with their time attributes,
  - size of the icon is proportional to the value of available time for a transition and remains constant in a simulation.
  - each icon is filled with colors for warning purpose,
  - filling level varies according to load of the resource.
3D Representation of Data and Process Objects

- **Place Capacity:**
  - Place capacity restricts the number of tokens that are allowed to be contained in a place.
  - Infinite capacity places are displayed as non-transparent spheres.
  - Transparent places are filled with tokens that are displayed as small balls.
  - For alerting capacity bottlenecks, tokens are colored green, yellow, or red.

3D Representation of Capacity
Forming Data and Process Objects in 3D Simulation Environment

• Size and Volume
• Monitoring
• Metrics
Forming Data and Process Objects in 3D Simulation Environment

- **Size and Volume**
  - visualize weak points of the process design by changing volume $v$ or size $s$ of the representation of the objects.

- Monitoring
- Metrics
Forming Data and Process Objects in 3D Simulation Environment

- **Size and Volume**

- **Monitoring**
  - each formula defines changes $s$ or $v$ of the figures in simulation.
  - each figure has a default size and volume computed from its corresponding default parameters (e.g., height, length). The modification for each $p$ is defined by:

\[
\text{modification } p = \frac{c \times \Delta \text{objectUnit}}{\text{objectUnit}}
\]

- current status of an objectUnit is monitored with three colors for the size or volume:
  - **Green**: the value is performing well,
  - **Yellow**: warning that a value indicates a critical degree,
  - **Red**: alarming that a value indicates an impact problem.

- **Metrics**
Forming Data and Process Objects in 3D Simulation Environment

- Size and Volume
- Monitoring

**Metrics**

1. Prioritization Number
   - User can prioritize objects,
   - Objects will be more highlighted referring to their priority.

2. Control Flow Complexity
   - Computes the complexity degree required to simulate a process,
   - The degree depends on the amount of data and process objects,
   - Which affects the control flow.

3. Data Flow Complexity
   - Data flow complexity is calculated by using the information flow complexity
     of Henry and Kafura [HeKa81]:
     \[
     \text{Information flow complexity}(M) = \text{length}(M) \times (\text{fan-in}(M) \times \text{fan-out}(M))
     \]

4. Cognitive Complexity
   - Cognitive complexity is situation-specific and affects the user's individual perception,
   - Cognitive weights measures the effort required to comprehend a simulation result [ShWa03].

5. Role/Resource
   - Role metric is computed between assigned roles and all roles belonging to an organizational unit:
   - Resource metric computes the degree between assigned resource and all available resources:
Analysis of Simulation Results

- **Analysis and Monitoring**
  - the aim of a 3D representation of analysis results is a quicker understanding of the simulation data set.

- **Customization of Analysis Results**
  - possibility to display the right diagram in the middle for a better recognition of the details.
Conclusion

✓ added a third dimension into the graphical representation of process objects.

✓ benefit is a statistical analysis of simulation results based on volume and size changes.

✓ by 3D environment, different views can examine and gather easily process-specific information.

=> visualizing of weak points is more easy.
Future Work

- integration of the implemented prototype into HORUS,
- execution of simulation runs of different process models,
- analysis of the results,
- discussion of our approach with selected test users,
- 3D visualization and animation of other process objects,
- 3D representation concerning the data flow of processes (e.g. XML documents in high level Petri nets).
References


Thanks for Your Attention

Questions?