Software Process Simulation and Modeling: A Review

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Overview

- ProSim, ISPW, FEAST/IWSE
- ProSim tools, techniques, concepts
- Results, findings, accomplishments
- Emerging R&D opportunities
- Conclusions
ProSim, ISPW, FEAST/IWSE

- ProSim roots: Intern. Software Process Workshops 1980-1990s (ten)
- ProSim Workshop legacy: 1998-2003 (four)
  - 40 journal papers (JSS, SPIP)
- ProSim cousins:
  - Feedback, Evolution and Software Technology (FEAST)
  - Intern. Workshop on Software Evolution

ProSim Focus Areas

- Software Process Simulation and Modeling
  - Project modeling and simulation
  - Process simulations and simulators
  - COTS vs. custom simulation packages
  - Group, team, engineering and evolution processes
  - Centralized and distributed processes
  - Relation to other process engineering activities
    - Analysis, redesign, visualization, scheduling, etc.
ProSim Tools

- Commercial simulation & modeling packages
  - Discrete-event
  - Systems dynamics (continuous systems)
- Research prototypes
  - Knowledge-based systems
  - Multi-agent systems
  - Distributed systems
  - Model-driven process support environments
  - Meta-modeling/process ontology interpreters
Figure 3 - The Dynamic Model to Investigate the Role of Anti-Regressive Policies
ProSim Techniques

- **Descriptive M&S**: Collect empirical data on existing software processes to reproduce observed patterns, or to improve them.
- **Pro/Prescriptive M&S**: Construct M&S that demonstrate advantages of new processes compared to some real/imaginary baseline.
- **Experimental M&S**: Construct M&S that test theoretical propositions or enable exploration of emerging concepts.
<table>
<thead>
<tr>
<th>Level</th>
<th>Type</th>
<th>Task</th>
<th>Predecessor</th>
<th>People</th>
<th>Input</th>
<th>Output</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TC</td>
<td>manage_order</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>2</td>
<td>TC</td>
<td>credit_response</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>3</td>
<td>TC</td>
<td>credit_request</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>4</td>
<td>TC</td>
<td>verify_credit</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**Process Definition for Order Fulfillment**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC manage_order</td>
<td>Manage order process</td>
</tr>
<tr>
<td>TC credit_response</td>
<td>Credit verification and approval process</td>
</tr>
<tr>
<td>TC credit_request</td>
<td>Credit request process</td>
</tr>
<tr>
<td>TC verify_credit</td>
<td>Credit verification process</td>
</tr>
</tbody>
</table>

**Graphs**

- **QS/350**
  - Linear Growth
  - Inverse Square Growth

- **CLYME Kernel**
  - Inverse Square (Two Segments)

- **Logica FW**
  - Inverse Square Growth

- **Lucent Sys 1**
  - Inverse Square Growth
# ProSim Engineering Techniques

<table>
<thead>
<tr>
<th>Meta-modeling</th>
<th>Visualization</th>
<th>Instantiation and enactment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling</td>
<td>Prototyping and walkthrough</td>
<td>Monitoring and measurement</td>
</tr>
<tr>
<td>Analysis</td>
<td>Change management</td>
<td>History capture and replay</td>
</tr>
<tr>
<td>Simulation</td>
<td>Integration</td>
<td>Repair and Improvement</td>
</tr>
<tr>
<td>Redesign</td>
<td>Environment generation</td>
<td>Evolution and asset mgmt.</td>
</tr>
</tbody>
</table>

![Diagram showing ProSim's engineering techniques](image_url)
ProSim Concepts

- Meta-modeling vs. modeling
- Model-driven process support environments
  - Simulators, PSE/IDEs, Web-based process hypertext/media
- Process improvement via simulation, analysis, and redesign
- Process depth vs. breadth
Results, Findings, Accomplishments

- Identifying high-yield and pathological processes and process domains
- Software evolution
- Software process improvement/redesign
- Software process vs. business process
- Hybrid simulations/models
- Process modeling languages
  - JIL, PML, xPADL, BPEL4WS (?)
A complex SDLC process model: a decomposition-precedence relationship view (19 levels of decomposition, 400+ tasks)

Research grant justification and approval process at Office of Naval Research
**Missing Results, Findings, Accomplishments**

- M&S of CMM assessed processes
- M&S of alternative SDLC process/tool frameworks (Waterfall vs. Spiral vs. Agile)
- M&S software deployment/release, diffusion, and adoption processes
- M&S of software evolution process across
  - Product lines
  - Product/technology generations

**Emerging ProSim R&D Opportunities**

- M&S open source software development/evolution processes
- Open source ProSim tools and M&S examples
- Global ProSim interoperability testbeds
- Computer Game-based ProSim tools and techniques
Emerging ProSim R&D Opportunities

- M&S open source software development/evolution processes

Release Process for NetBeans.org
Emerging ProSim R&D Opportunities

- Open source ProSim tools and M&S examples
Emerging ProSim R&D Opportunities

• Global ProSim interoperability testbeds
Emerging ProSim R&D Opportunities

- Computer Game-based ProSim tools and techniques
Another game M&S
Another game M&S
environment
QuakeCon LAN Party with
>1700 game players
Conclusions

- R&D in Process Simulation and Modeling is active, sustained, growing
- Systems Dynamics remains the major mode of ProSim research, though this may require rethinking
- ProSim has produced substantial results and accomplishments
- New opportunities for ProSim R&D are apparent and high value

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