Performing Operational Release Planning, Replanning, Risk Analysis using a System Dynamics Simulation Model

SPIP’ 08
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- Related work
- Overall approach
  - Simulation model
- Experiments
- Conclusion
- Discussion
Introduction (1/2)

- **Strategic release planning**
  - Aims at assigning features to subsequent releases

- **Operational release planning**
  - Focuses on the development of a single software release
  - Aims at assigning the resources to tasks under project constraints
Introduction (2/2)

- Due to the uncertainty of development project, additional analysis is required
  - Re-planning
    - It is required due to the change on developers, features, or productivity
  - Risk analysis
    - Help to access the reliability of the plan according to the variation
- In this paper,
  - Provide the system dynamics model to support three issues in operational release planning
## Related work

<table>
<thead>
<tr>
<th></th>
<th>Optimize</th>
<th>REPSIM I</th>
<th>DynaReP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Strategic and operational release planning</td>
<td>Perform risk analysis on existing operational release plans</td>
<td>Support initial generation and re-planning of operational release plans</td>
</tr>
<tr>
<td><strong>Re-planning</strong></td>
<td>Re-planning at the beginning of release, not during a release</td>
<td>X</td>
<td>Automatic re-planning whenever a change on parameters occurs</td>
</tr>
<tr>
<td><strong>Risk analysis</strong></td>
<td>X</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td><strong>Automatic re-planning</strong></td>
<td>X</td>
<td>X</td>
<td>O</td>
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</tbody>
</table>

Combine these two concepts (risk analysis and re-planning) to release plan in the paper.
Overall approach

- Identify the parameters what the model needs
- Identify the inputs to be required for release planning
- Construct the system dynamics model
- Explain the details of the simulation model to generate the release plan
- Execute the experiments with the release plan example
- Execute the simulation model for the example of the release planning problem
First purpose of the simulation model is to produce the release plan against the corresponding inputs.

Input
- Features
  - Task types
  - Information of developers
    - number
    - productivity
    - salary
  - Effort estimates
- Dependency between tasks

Simulation model

Output
- Release plan including total schedule, effort to be required for finishing release
  ...
Identify the parameters (2/3)

- **Input** – 6 tuple \((F,T,D,\text{eff, prod, dep})\)
  - \(F[i]\): \(i\)th feature to be developed (requirements)
  - \(T[j]\): \(j\)th task type such as analysis, design, implementation, or test for each feature
    - Task is defined by 2 tuple \((\text{Feature, Task type})\)
      - Example: Task\((F1, T2)\) – Design for first feature
  - \(D[k]\): \(k\)th developer
  - \(\text{eff}(F,T)\): estimated effort for corresponding task
  - \(\text{prod}(T,D)\): estimated relative productivity factor of developers per task type
    - Less productive \(< 1 (=\text{typical productivity}) < \text{more productive}\)
Identify the parameters (3/3)

- Input – 6 tuple \((F, T, D, \text{eff}, \text{prod}, \text{dep})\) (Cont’d)
  - \text{dep}: dependency between tasks for same feature
  - \text{dep}(T[j-1], T[j]) = x \in (0, 1)
    - T[j] can only start, if at least \(x\) percents of \text{eff}(T[j-1]) is completed
    - Example
      - \text{dep}(T[1], T[2]) = 0.8
        - 80% of \(T[1]\) is completed
          - Design task for feature 1 can start only after 80% of requirement analysis task for feature 1 is completed
Simulation model

- Sub-model for determining the amount of tasks to wait, be ready, or to be completed

Tasks in waiting list

- \( \text{dep}(T[i-1], T[i]) \)
- \( \text{Eff-Variation} \)
- \( \text{Eff-F-T} \)

Determine how many tasks are ready from waiting state per unit time

Determine how many tasks are completed per time unit

\[ F-T \text{-inflow} \]

\[ F-T \text{-outflow} \]

\[ \text{Cum-F-T-outflow} \]
Simulation model

- Sub-model for assigning the resources to the tasks

Assign the resource to the task first, which requires the largest amount of the effort to be completed in unallocated tasks

- Example
  - $\text{eff}[F[1], T[2]] = 20$, $\text{eff}[F[2], T[1]] = 30$, $\text{eff}[F[3], T[3]] = 15$ in ready stack
  - Resource is assigned to Task $[F[2], T[1]]$ first
Experiments

- Experimental frame
  - 6 tuple (F, T, D, eff, prod, dep)
  - Release composes of 24 tasks (8 features, 3 task-type)

<table>
<thead>
<tr>
<th>Task-Type</th>
<th>Effort estimates (person-week)</th>
<th>Productivity estimates (dimensionless)</th>
</tr>
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<tbody>
<tr>
<td>F</td>
<td>D1</td>
<td>D2</td>
</tr>
<tr>
<td>FF1</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>FF2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>FF3</td>
<td>6</td>
<td>2</td>
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</table>

- Type dependency is 1 for all the features
  - For example, implementation can start only after design is complete
Baseline scenario

Example of the release plan from simulation model

Developer 6 is assigned to task [F3,T3] during 17.3 and 22.75
Under constraints

- Under time (25 weeks) and budget (240, -) constraints, one of the developers is excluded in each alternative.

<table>
<thead>
<tr>
<th>Plan alternatives</th>
<th>Description</th>
<th>Development time</th>
<th>Development cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>All developers included</td>
<td>22.71 weeks</td>
<td>265,707 dollars</td>
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<tr>
<td>Alternative 1</td>
<td>D1 is excluded</td>
<td>25.03 weeks</td>
<td>237,785 dollars</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>D2 is excluded</td>
<td>26.40 weeks</td>
<td>250,800 dollars</td>
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<tr>
<td>Alternative 3</td>
<td>D3 is excluded</td>
<td>23.87 weeks</td>
<td>238,700 dollars</td>
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<tr>
<td>Alternative 4</td>
<td>D4 is excluded</td>
<td>23.71 weeks</td>
<td>241,842 dollars</td>
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<tr>
<td>Alternative 5</td>
<td>D5 is excluded</td>
<td>23.18 weeks</td>
<td>227,164 dollars</td>
</tr>
<tr>
<td>Alternative 6</td>
<td>D6 is excluded</td>
<td>24.03 weeks</td>
<td>228,285 dollars</td>
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Alternatives that are satisfied the constraints

- When excluding the developer who is required high salary for high productivity
  - Pro - decrease the cost for a excluded developer
  - Cod - Decrease the productivity, so it increases the duration and cost
Risk analysis

- Reflect the variation on effort estimates and developer productivity using stochastic variables
  - Variation on effort estimates means estimation errors

![Graph showing work backlog and estimated error]

- Overestimation
- Underestimation

- Design
- Implementation
- Test
Re-planning

- Late feature inclusion
  - Case 1 – 3 weeks later from beginning, F9 is included
  - Case 2 – 6 weeks later from beginning, F9 is included

<table>
<thead>
<tr>
<th>Feature</th>
<th>Task</th>
<th>Baseline</th>
<th>Scenario 1a (F9-3Wk)</th>
<th>Scenario 1b (F9-6Wk)</th>
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<tbody>
<tr>
<td></td>
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<td>Developer</td>
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<thead>
<tr>
<th>Case</th>
<th>1</th>
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<tbody>
<tr>
<td>Schedule increase-w</td>
<td>1.04</td>
<td>3.08</td>
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<tr>
<td>Relative increase-%</td>
<td>4.6</td>
<td>13.6</td>
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</table>

Not Linear result
Later feature inclusion has low utilization of developers
Conclusion

Contribution

- Provide the simulation model to support
  - Operational release plan
  - Risk analysis
  - Re-planning

Future work

- Enhancing the heuristic model to allocate the resources for improving the effectiveness
- Including the dependency (precedence) between feature
- Validating in a real industry
Discussion

- What I’m impressed
  - Authors gradually add the functions from basic simulation model
  - With simple simulation model, the authors execute various experiments
    - In the middle of the release, the simulation model can be reflected by the change on the feature and the tool supports it
Base scenario

- Assigned-D-Pool

![Assigned-D-Pool Diagram]

- "Assigned-D-Pool" [Developer]
Risk analysis

- Resource allocation view in overestimates

Overestimation has no work backlog, but the utilization of developers is relatively lower than base scenario.
Re-planning

Timeline view for the task to be completed