
Automatic Failure Mode and Effect Analysis (FMEA) for Little-JIL Processes

Danhua Wang, Bin Chen,
George S. Avrunin, and Lori A. Clarke
University of Massachusetts, Amherst

Presented by Bin Chen

Outline

- Introduction of FMEA
 - Motivation
 - Automatic FMEA for Little-JIL processes
 - Future Work
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Introduction to FMEA

- Systematic
 - Safety analysis technique
 - Identify
 - Where and how a component might fail – failure mode
 - How each failure mode might cause failures in other components
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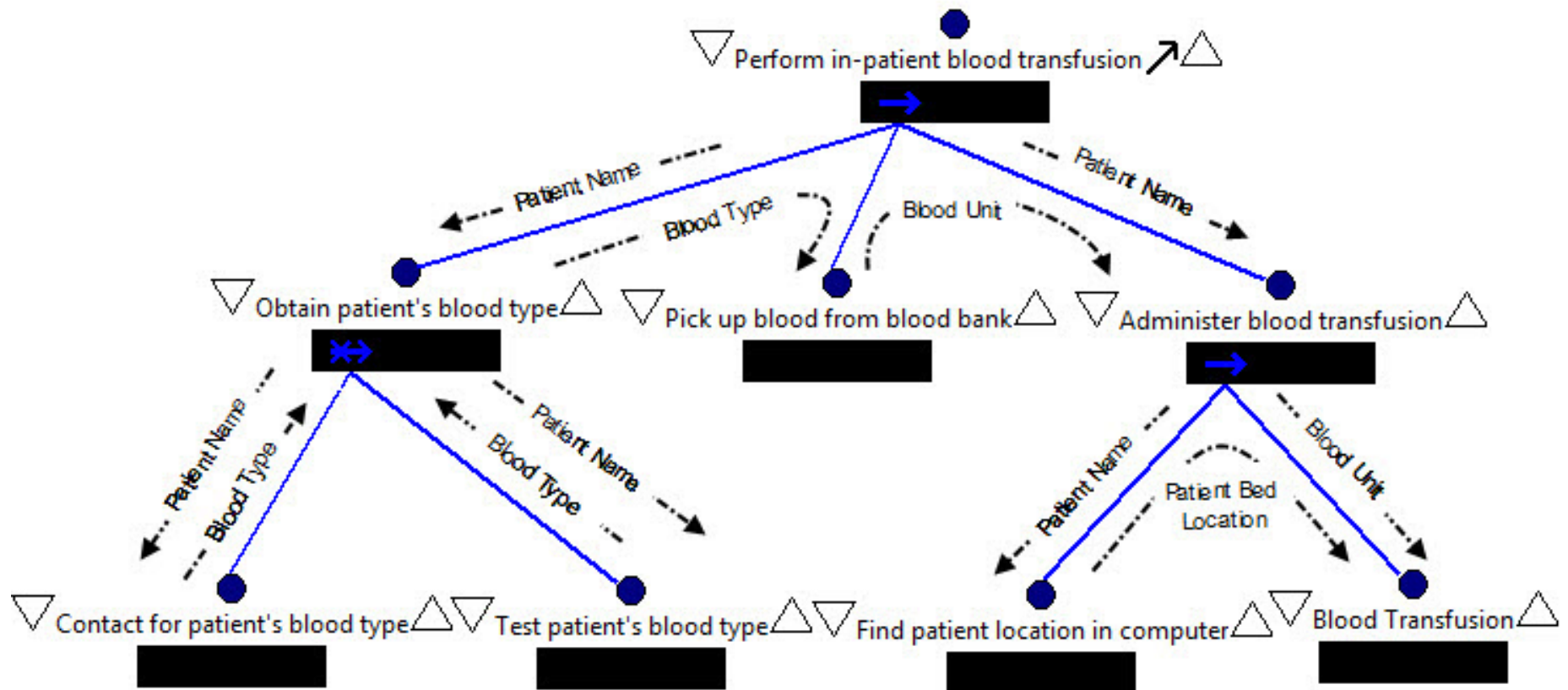
Motivation

- Intend to apply FMEA to analyze processes
 - Traditionally, FMEA is performed manually
 - Time-Consuming
 - Error-Prone
 - Hypothesis: FMEA can be automated if the process is precisely defined
 - We use the Little-JIL process definition language
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Automatic FMEA for Little-JIL Process

- Identify the failure mode (s)
 - Identify the effect (s) for each failure mode
 - Identify the cause (s) for each critical failure mode
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Running Example



Automatic FMEA for Little-JIL Process

- **Identify the failure mode (s)**
 - Identify the effect (s) for each failure mode
 - Identify the cause (s) for each critical failure mode
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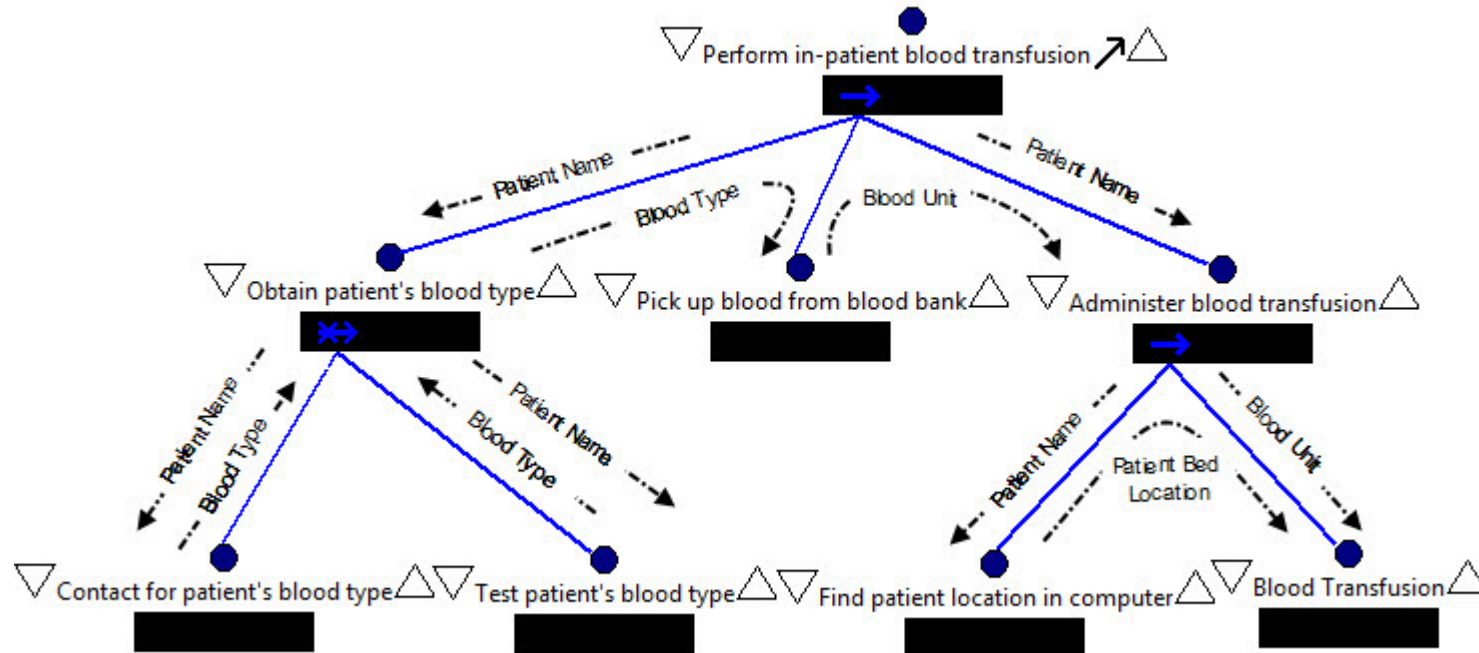
Identify the Failure Mode (s)

- Failure mode: artifact-related
 - A large number of interesting failure modes are artifact-related or can be easily turned into artifact-related failure modes
 - In many processes, hazards are caused by the delay of certain steps. To capture such failure modes, we can associate an artifact representing the execution time to each step. Then the delays can be handled just like the other artifact-related failure modes.
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Identify the Failure Mode (s)

- Predefine two types of failure mode for Step s:
 - Type1: Artifact p from Step S is wrong
(P is an Out parameter of Step S)
 - Type2: Artifact p to Step S is wrong
(P is an In parameter of Step S)
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Identify the Failure Mode (s)



- Failure modes:
 - Artifact “Patient Name” to “Obtain patient’s blood type” is wrong
 - Artifact “Blood Type” from “Obtain patient’s blood type” is wrong
 - ...

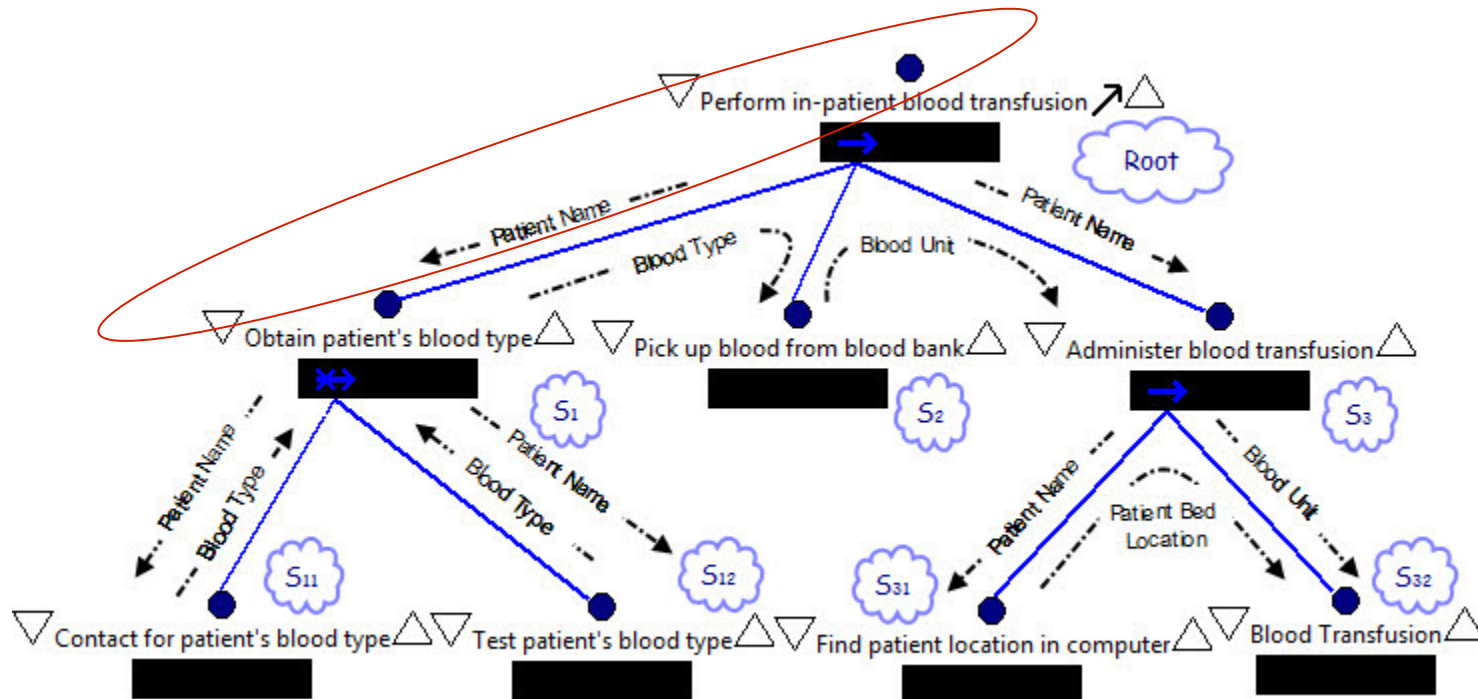
Automatic FMEA for Little-JIL Process

- Identify the failure mode (s)
 - **Identify the effect (s) for each failure mode**
 - Identify the cause (s) for each critical failure mode
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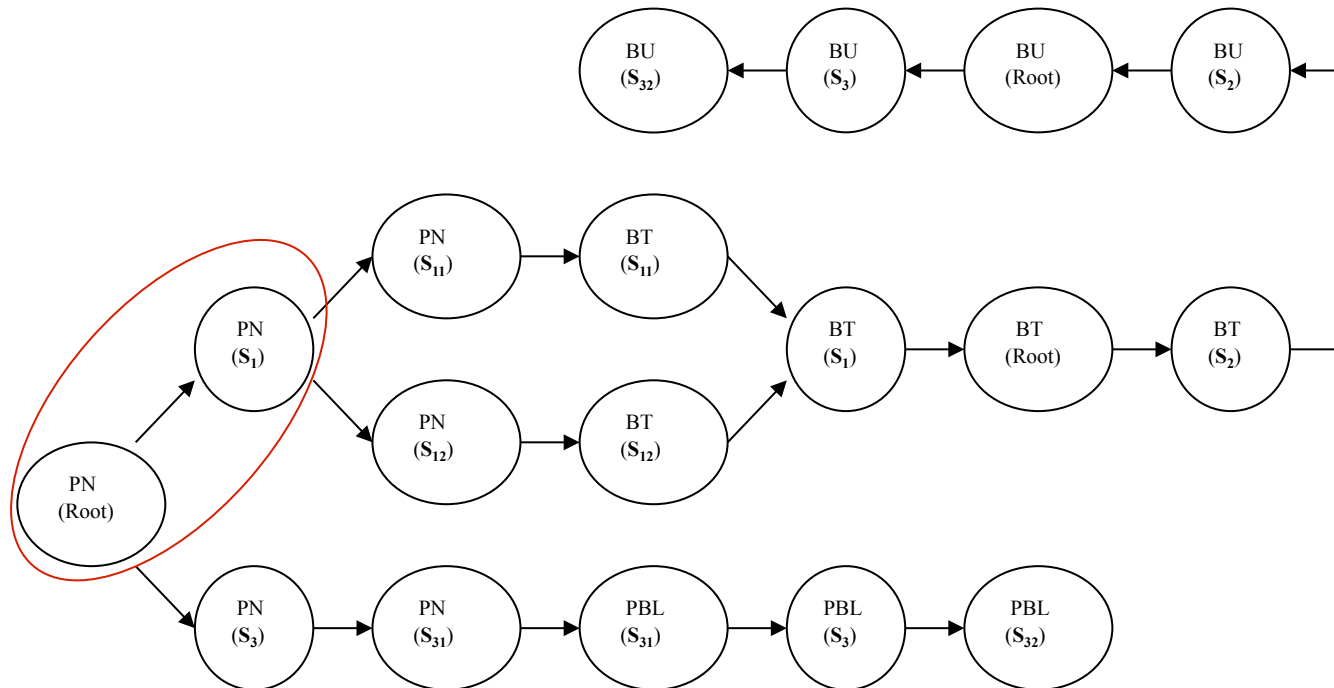
Artifact Flow Graph (AFG)

- AFG is used to decide whether an artifact is data dependent on another
 - Artifact Flow Graph (AFG): <Node, Edge>
 - Node: artifact
 - Edge: data dependence between two artifacts
 - E.g. There is a parameter binding from p_1 to p_2
 - E.g. p_1 is an IN parameter of S , p_2 is an OUT parameter of S
- p_2 is potentially data dependent on p_1
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Artifact Flow Graph (AFG)

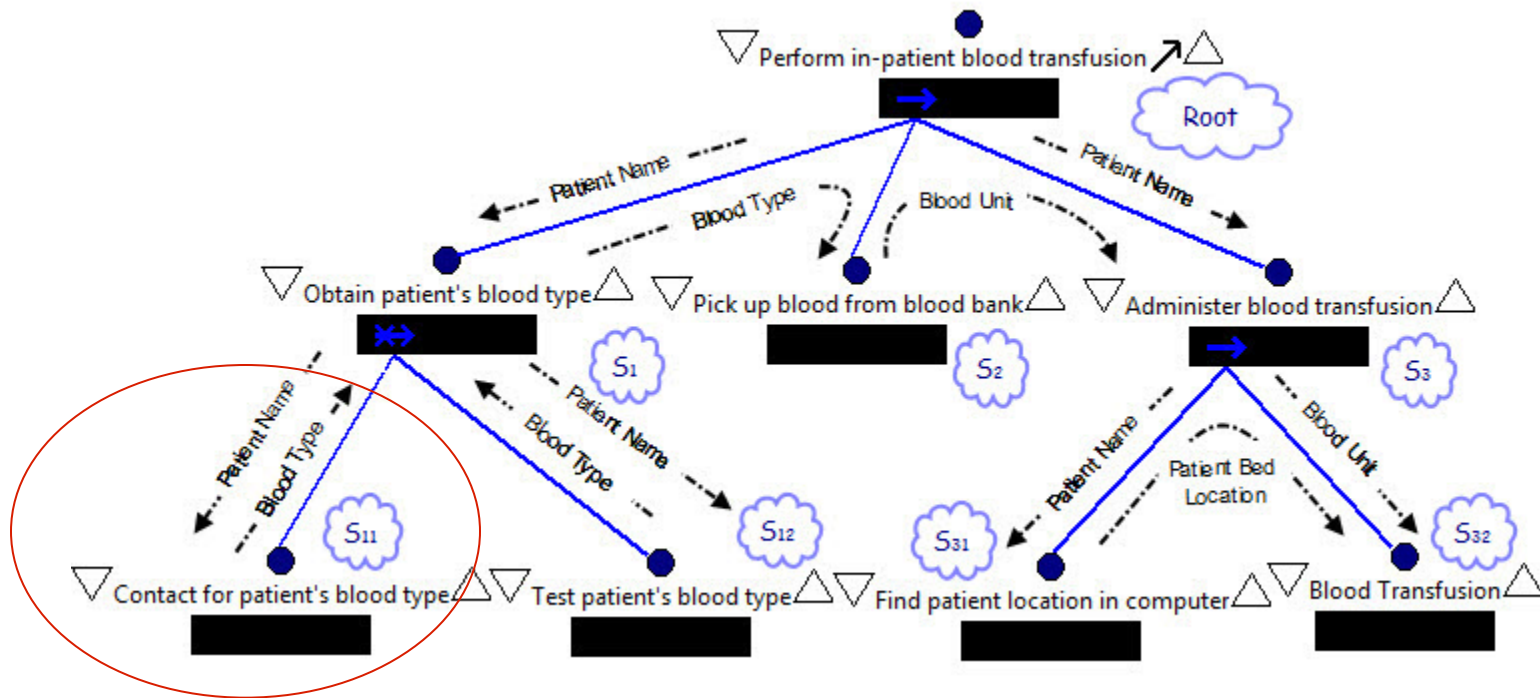


Artifact Flow Graph (AFG)

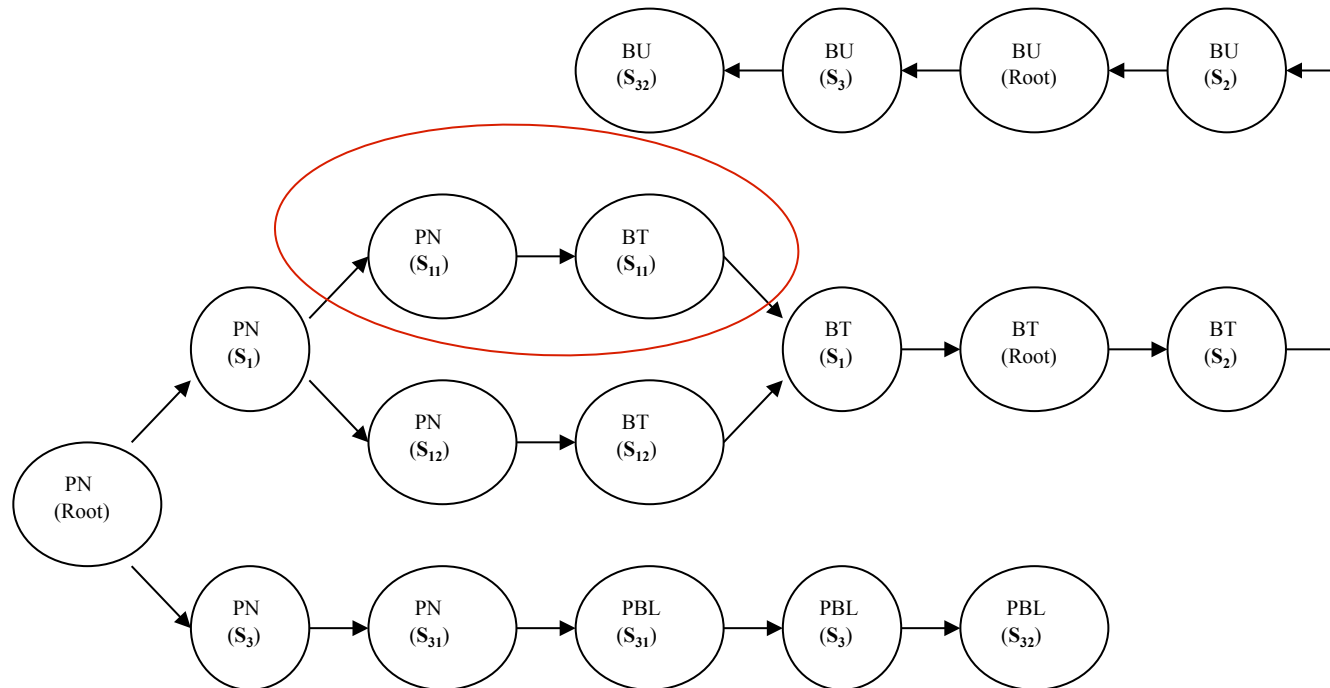


- Annotation: PN-Patient Name, BT-Blood Type, BU-Blood Unit, PBL-Patient Bed Location. Root-Perform in-patient blood transfusion, S₁-Obtain patient's blood type, S₁₁- Contact for patient's blood type, S₁₂-Test patient's blood type, S₂-Pick up blood from blood bank, S₃-Administer blood transfusion, S₃₁-Find patient location in computer, S₃₂-Blood Transfusion

Artifact Flow Graph (AFG)



Artifact Flow Graph (AFG)

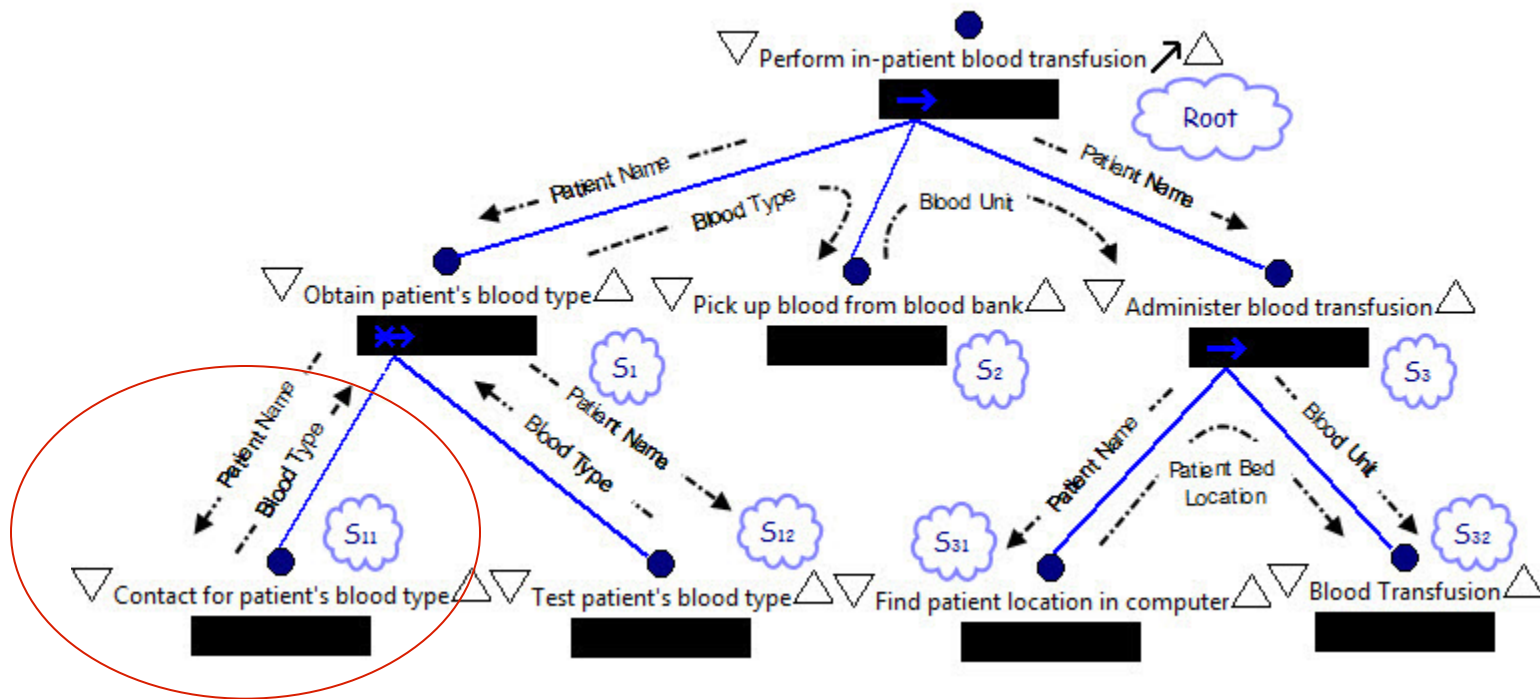


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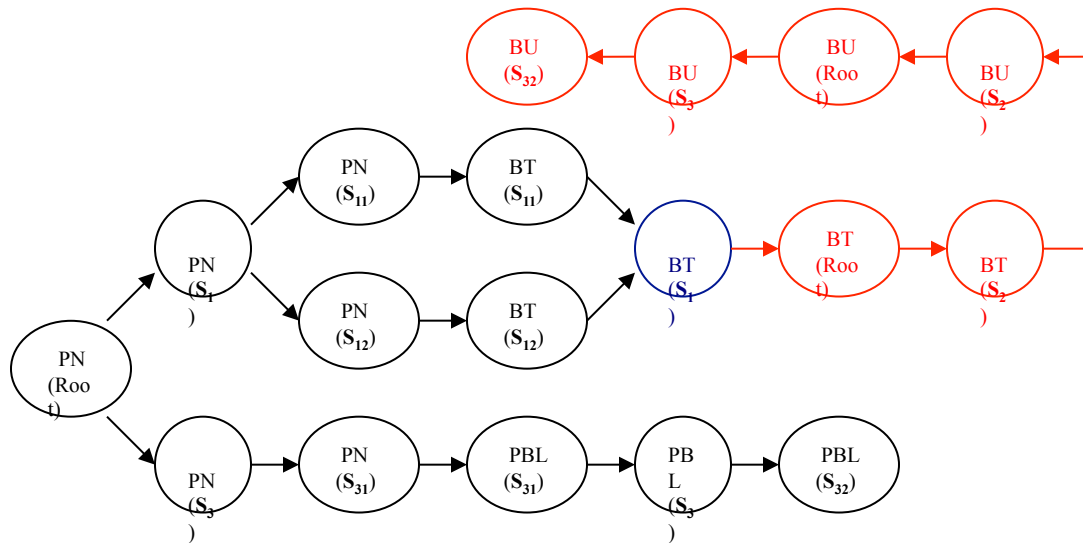
Identify Effect (s) for Each Failure Mode

- Given a failure mode “Artifact p to Step S is wrong” or “Artifact p from Step S is wrong”, can determine all artifacts that p can flow to by traversing the AFG of the process.
 - Faults of these artifacts are defined as effects of the failure mode.
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Identify Effect (s) for Each Failure Mode



Identify Effect (s) for Each Failure Mode



Failure Mode:
Artifact "Blood Type" from "Obtain patient's blood type" is wrong

- ▲ Obtain patient's blood type Step
 - ▲ Artifact "Blood Type" from "Obtain patient's blood type" is wrong Failure Mode
 - ▲ Artifact "Blood Type" to "Perform in-patient blood transfusion" is wrong
 - ▲ Artifact "Blood Type" from "Perform in-patient blood transfusion" is wrong
 - ▲ Artifact "Blood Type" to "Pick up blood from blood bank" is wrong
 - ▲ Artifact "Blood Unit" from "Pick up blood from blood bank" is wrong
 - ▲ Artifact "Blood Unit" to "Perform in-patient blood transfusion" is wrong
 - ▲ Artifact "Blood Unit" from "Perform in-patient blood transfusion" is wrong
 - ▲ Artifact "Blood Unit" to "Administer blood transfusion" is wrong
 - ▲ Artifact "Blood Unit" from "Administer blood transfusion" is wrong
 - ▲ Artifact "Blood Unit" to "Blood transfusion" is wrong Final Effect
- Effects

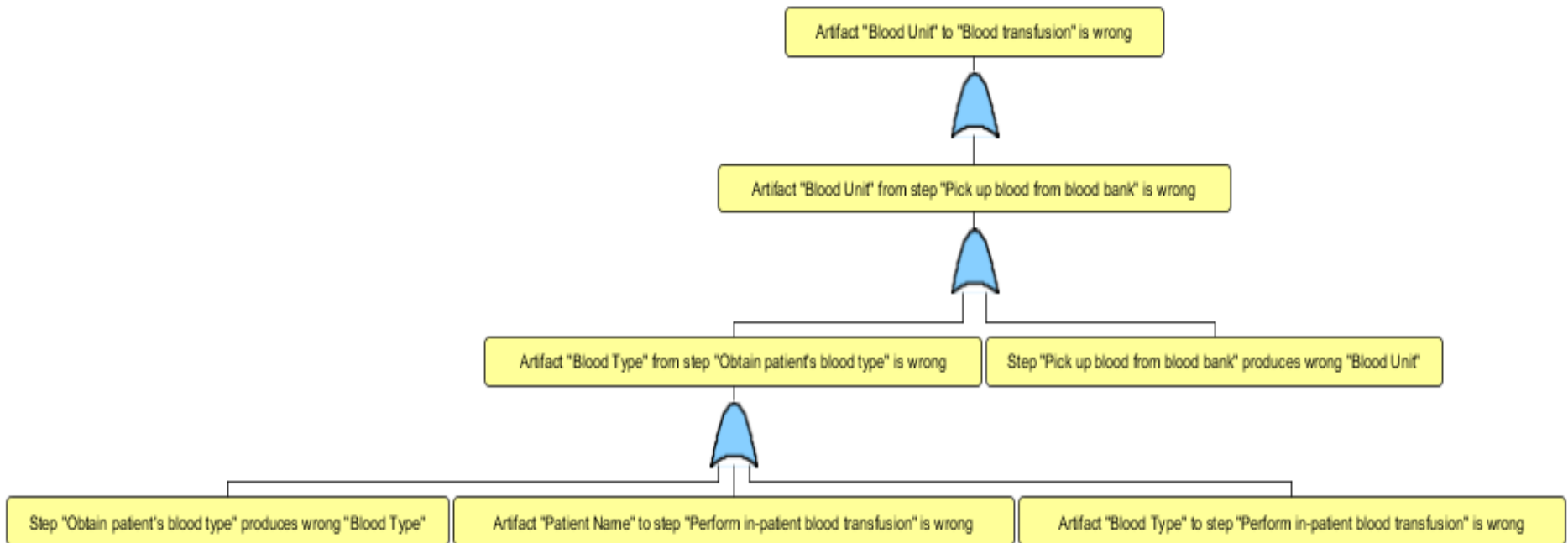
Automatic FMEA for Little-JIL Process

- Identify the failure mode (s)
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 - **Identify the cause (s) for each critical failure mode**
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Identify Cause (s) for Critical Failure Mode

- Critical failure modes can be used as the TOP-events of fault trees
 - Fault tree provides a graphical depiction of all possible parallel and sequential combinations of events that could cause that top event to occur
 - Used our fault tree derivation tool to generate the fault tree for each critical failure mode
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Identify Cause (s) for Critical Failure Mode



Future Work

- Resource related failure modes
 - Agent related failure modes
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Thank you!
