Ubiquitous Process Engineering:
Applying Software Process Technology to Broader Domains

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The Bottom Line

Our work in Software Process has much value to give and receive from its application to problems in the broader areas of society

Some Other Domains

- Medicine
- Government
- Science
- Engineering
- Manufacturing
- Business

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Just about everything…..

Example: Medical Domain

- Over 98,000 deaths/year in US Hospitals from avoidable errors (1999 IOM Report)
  - Probably underestimated by factor of >2
  - Many more errors are nonfatal, but
    - Costs in dollars: hundreds of billions of USD
    - Cost in pain and suffering are greater
- Urgent demands for improvement
  - Much focus on “IT”
  - Much purchase of expensive HW and SW
  - But Process could be the key issue

Some Specific Problems

- Costs are out of control
- Labor is increasingly scarce
- Death, injury rates are unacceptable
- Workload is growing fast
- Teams poorly coordinated (hierarchical)
- Expensive automation adds risk
- Many errors (even fatal ones) preventable
- Reinvention is needed and sought
- Culture needs to be changed
- Expectations are very high

Does this sound familiar?

Example: Government Domain

- Government IS a set of processes
  - Elections
  - Legislation
  - Enforcement
  - Judiciary
  - Disaster Recovery
  - Data Collection
  - Military Activities
  - Budgeting

Some Specific Problems

- Laws are ambiguous, unclear, incorrect
  - How to develop, verify them
- Bureaucracy needs streamlining
  - How to verify it is consistent with laws
- Election improvement increasingly urgent
  - Make them fraud resistant
  - Assure effective use of voting machines
- Need automated support for dispute resolution
  - Better mediation, arbitration
  - More effective staffing
  - Increase trust (through process transparency)

Other Areas

- Scientific Investigation
  - Define processes for gathering, analyzing, reusing data
    - To assure it is valid, provide automation
  - Enable results to be reproduced
- Management
  - Business Processes
- Manufacturing
  - Manufacturing Processes
- Engineering
  - Integrated Product Team Processes
  - Design assistance

Common Set of Familiar Needs

- Good Communication
- Effective Coordination
- Greater efficiency
- Effective use of automation
- Better Education and Training
- Continuous Improvement
- Reinvention thru understanding

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Our work can help

Benefits From Applying Our Work

- Our approaches and technologies can meet needs in these domains
  - Improve the way the world works
- Doing so provides us with insights
  - Evaluation of our work
  - In domains where sense of process is
    - More accepted
    - More intuitive
- These are REAL processes developed over decades in the REAL WORLD

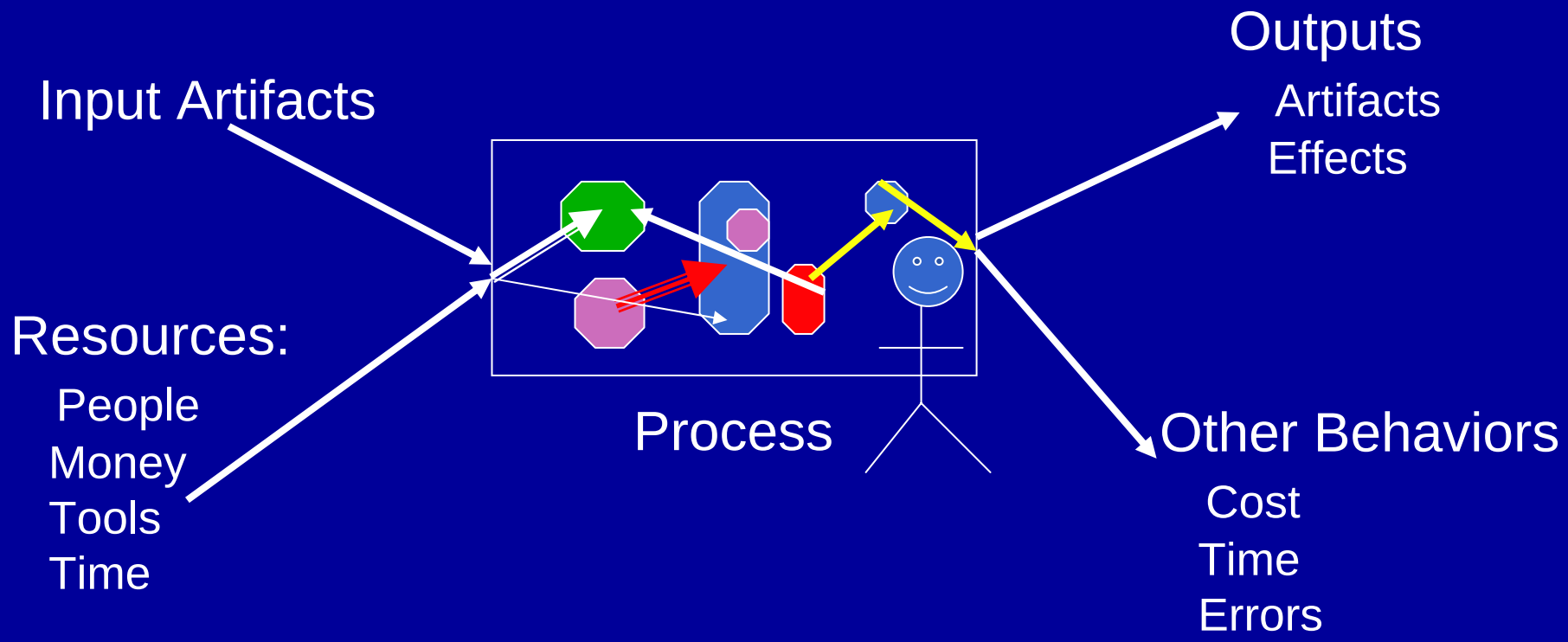
Baystate Hospital Case Studies

- Blood transfusion
- Chemotherapy
- Emergency Room Management

Focus on Emergency Room

- Average waiting time is ~6 hours
  - About 15% “walk outs”
- Errors occur
  - Eg. Transfusion of blood with incorrect type
- Need to increase capacity
  - How to meet “surge” and predict it
  - How to invest most effectively
- Personnel cross training complicates resource allocation
- Reliance on automation can be risky
- Need improvements
  - Incremental and radical

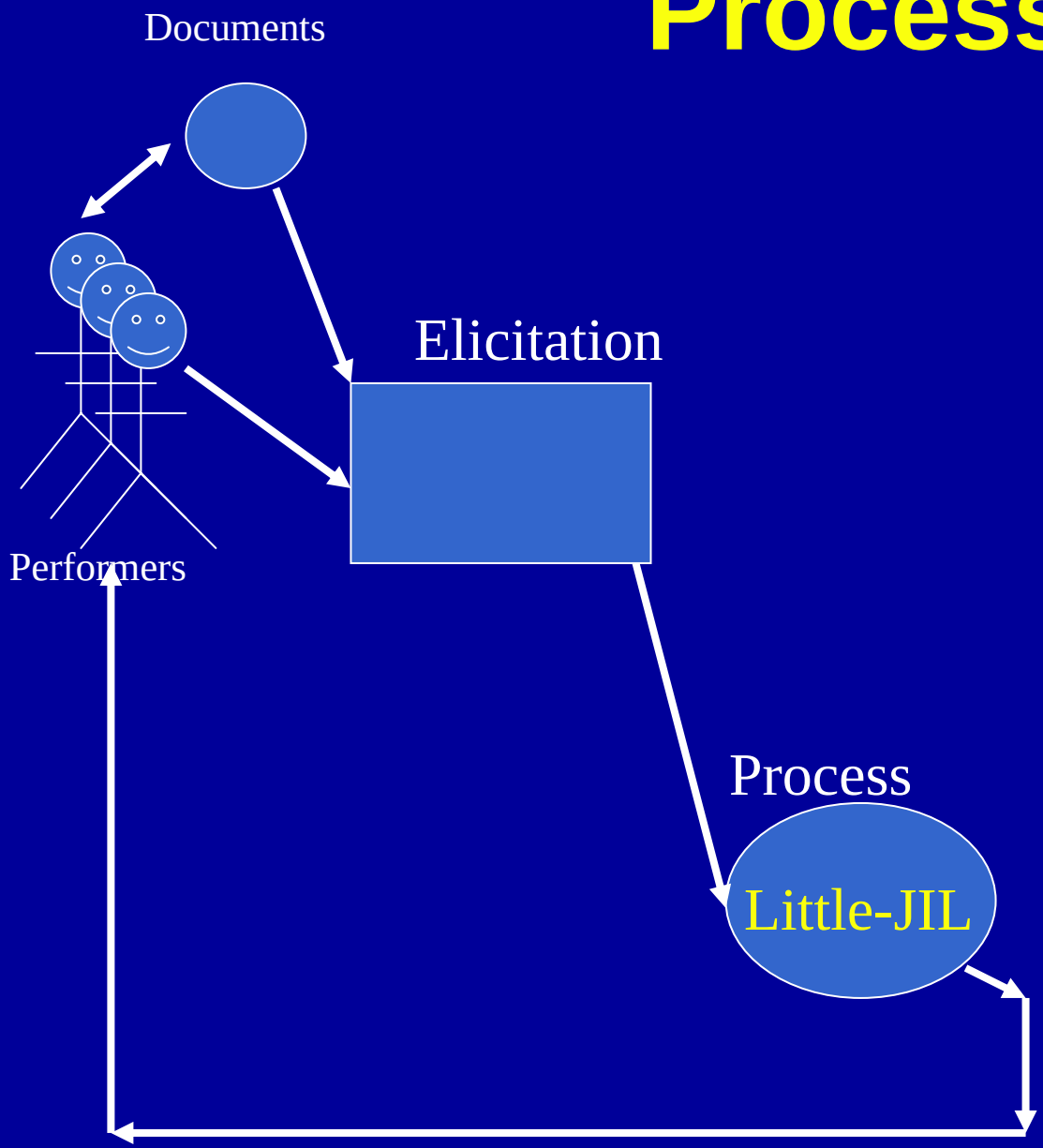
Microprocess Approach



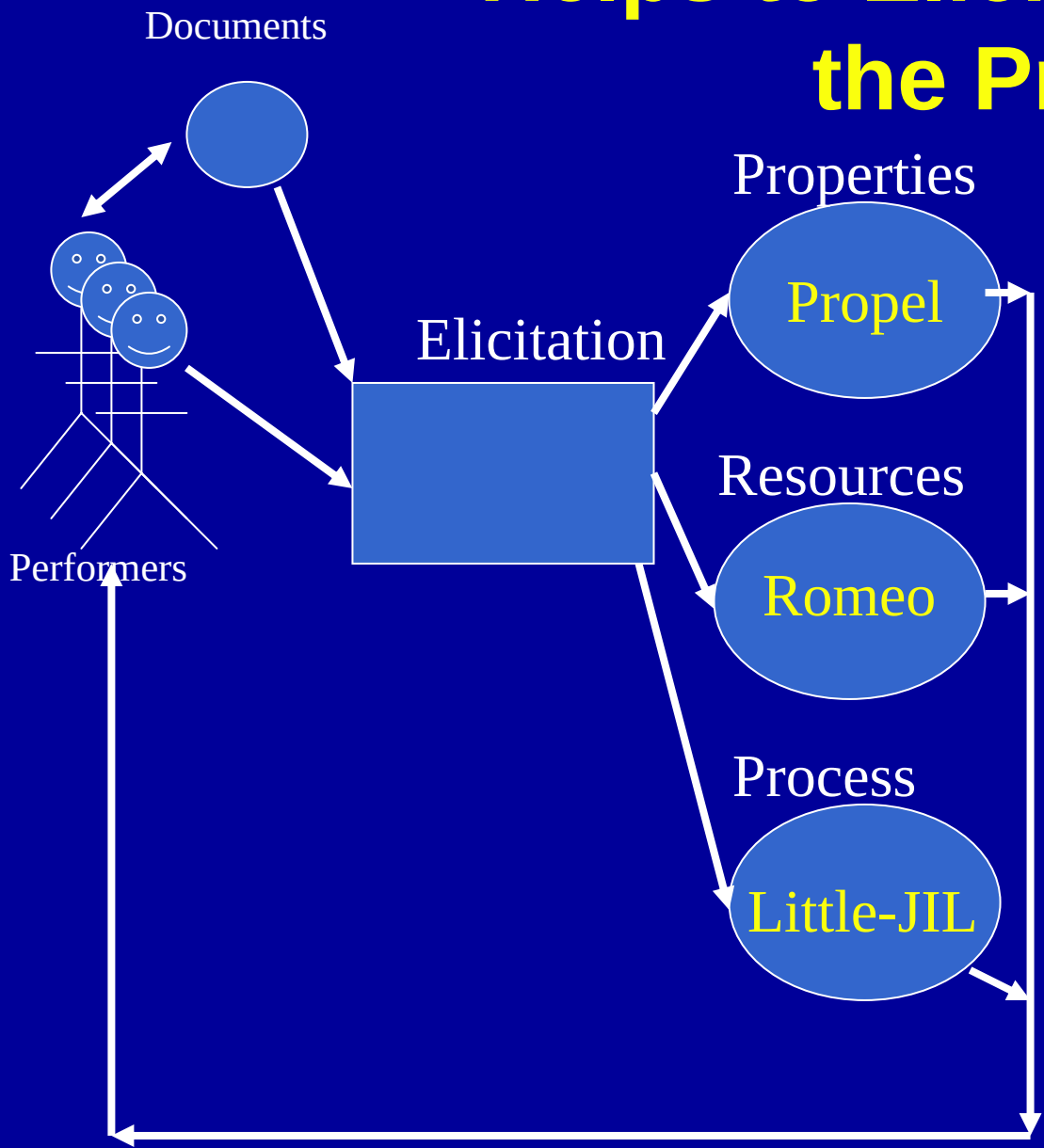
Specifics of Our Approach

- Define process rigorously
  - Process elicitation
  - Define
    - Process in rigorous language (Little-JIL)
    - Properties in rigorous notation (Propel)
    - Resources and Agents rigorously (Romeo)
- Apply tools to get definitive results
  - Defect detection
    - Apply finite state verification (FLAVERS)
  - Fault tree analysis
    - Automatic FT generation from Little-JIL
  - Simulation
    - Automatic generation from Little-JIL, Romeo

Process Elicitation



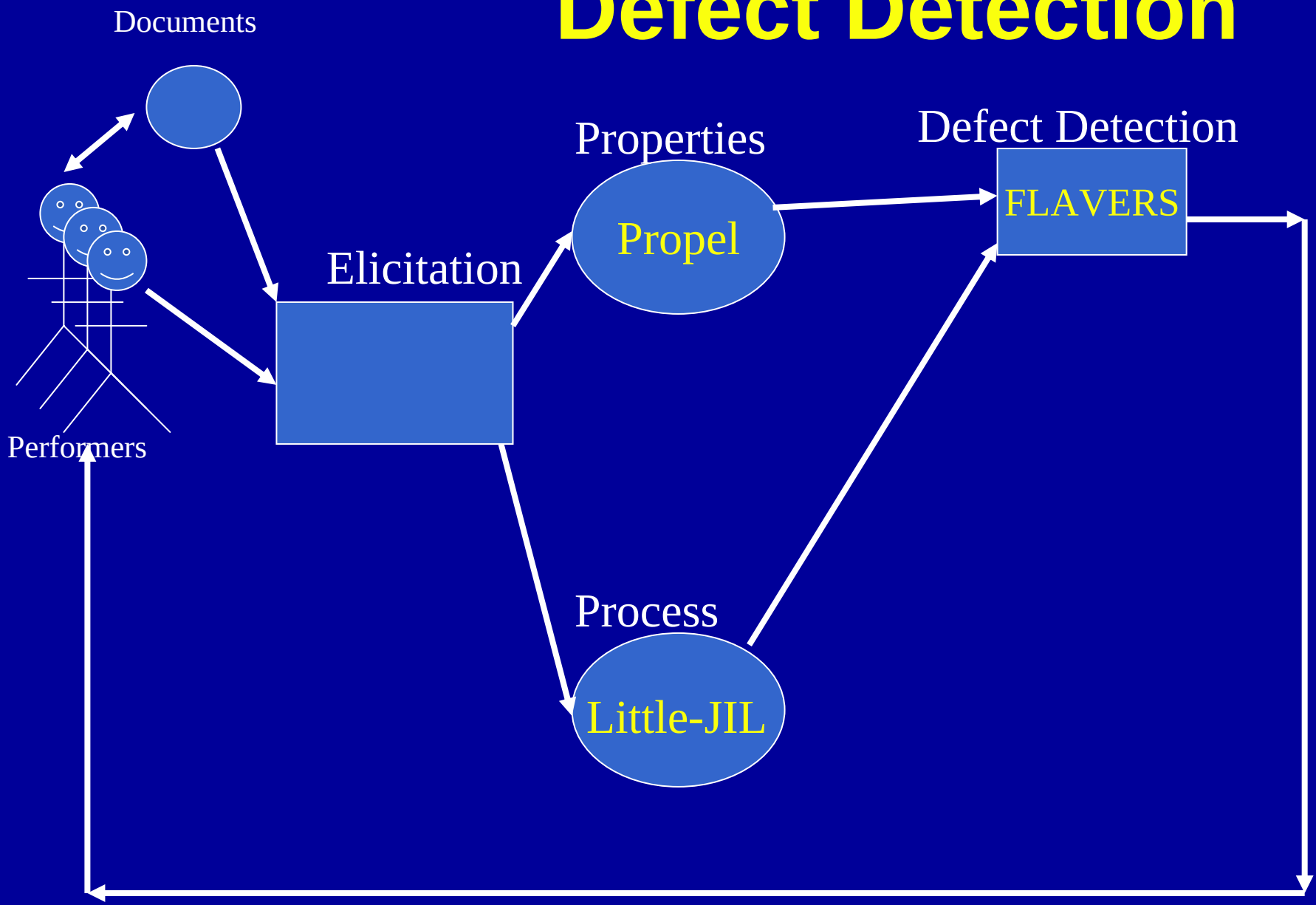
Helps to Elicit more than just the Process



Eliciting the Baystate ER Process

- Exceptions everywhere
  - Mostly not documented
- Pervasive concurrency
  - Especially in an emergency
- Constraints very important
  - Especially resource constraints
- Resource and property constraints elicited along with process
- Different performers have different views
  - Which (if any) is the “real” process?
- Process changed as elicitation revealed defects

Defect Detection



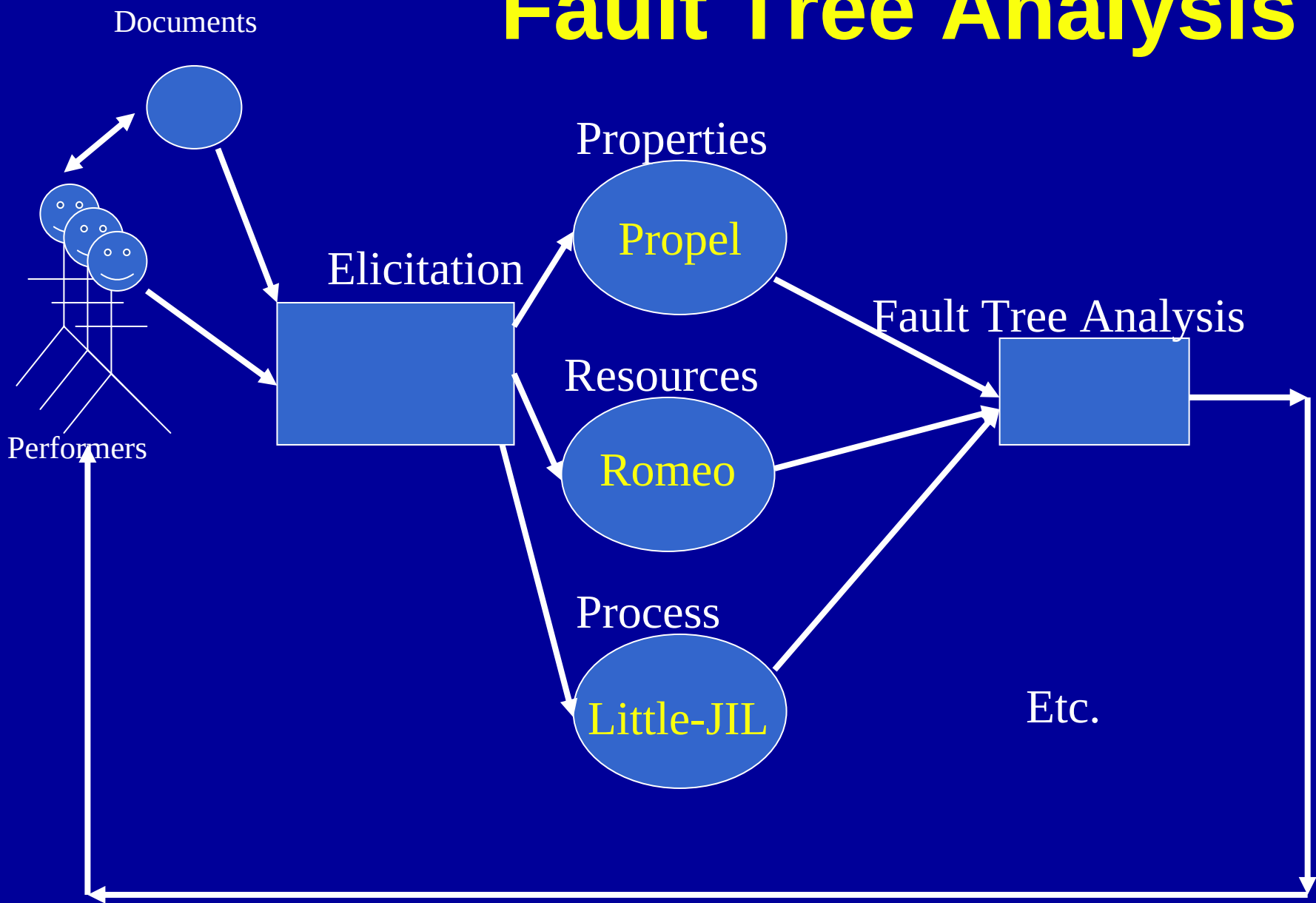
Defect Detection Example: Blood Transfusion

- Signed permission is required before transfusion
  - What does this requirement really mean?
  - Many exceptions, concurrency make this process hard
    - To Define
    - To Verify
- Blood type must match patient type
  - How to be sure the blood is labeled right?
  - How to be sure the patient is labeled right?
  - Two nurses must concur
    - Cannot be interrupted or distracted

What We Learned

- Property and Process definition reinforce each other
- Need for
  - Powerful exception specification
  - Powerful concurrency specification
  - Transaction semantics
- Verification state explosion
- Problems in “baselining” process

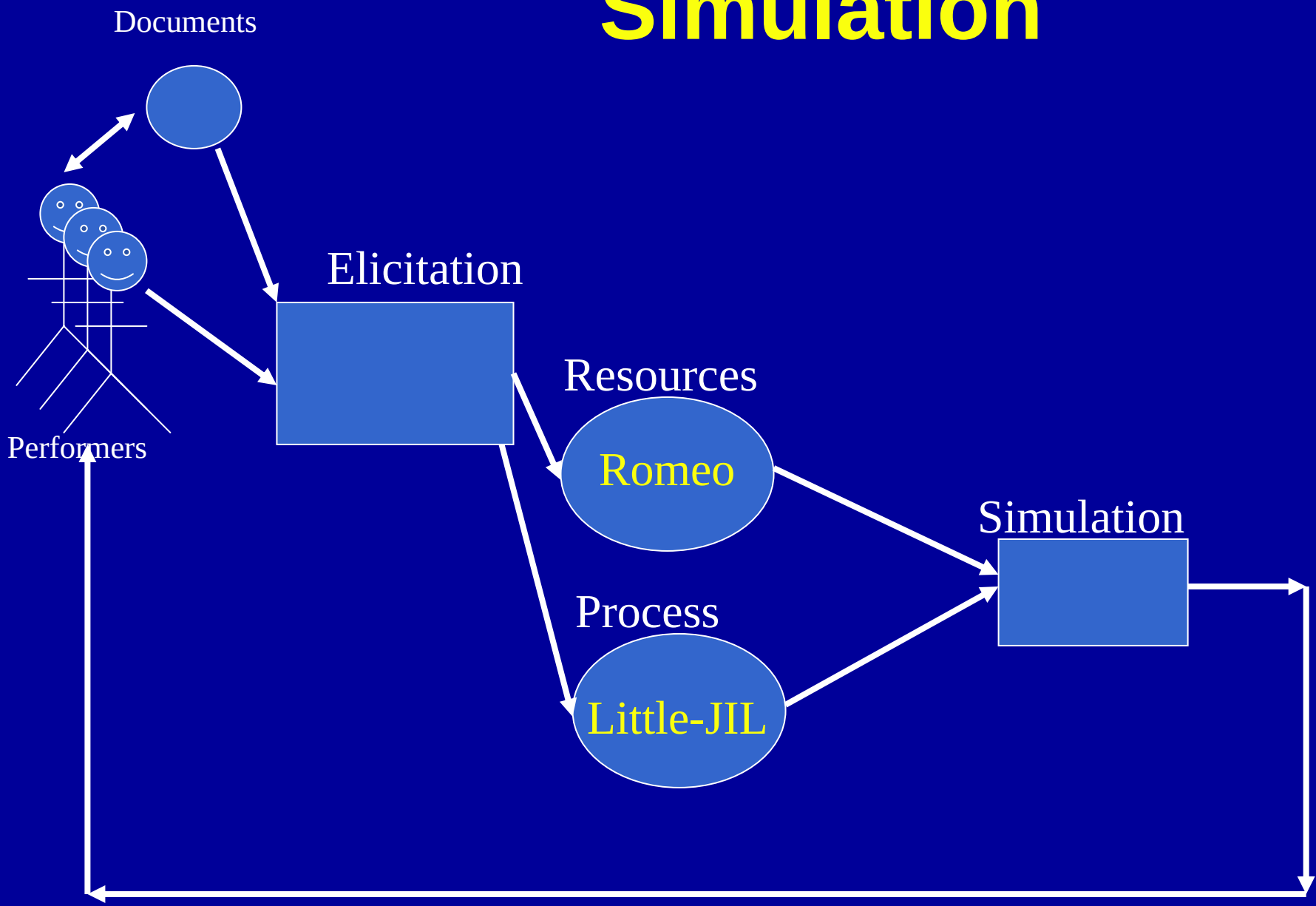
Fault Tree Analysis



Help Medical People Address Their Problems Better

- Their remedies are intuition-driven
- They are often ineffective
- They need help
- Talk later on
  - From Bin Chen

Simulation



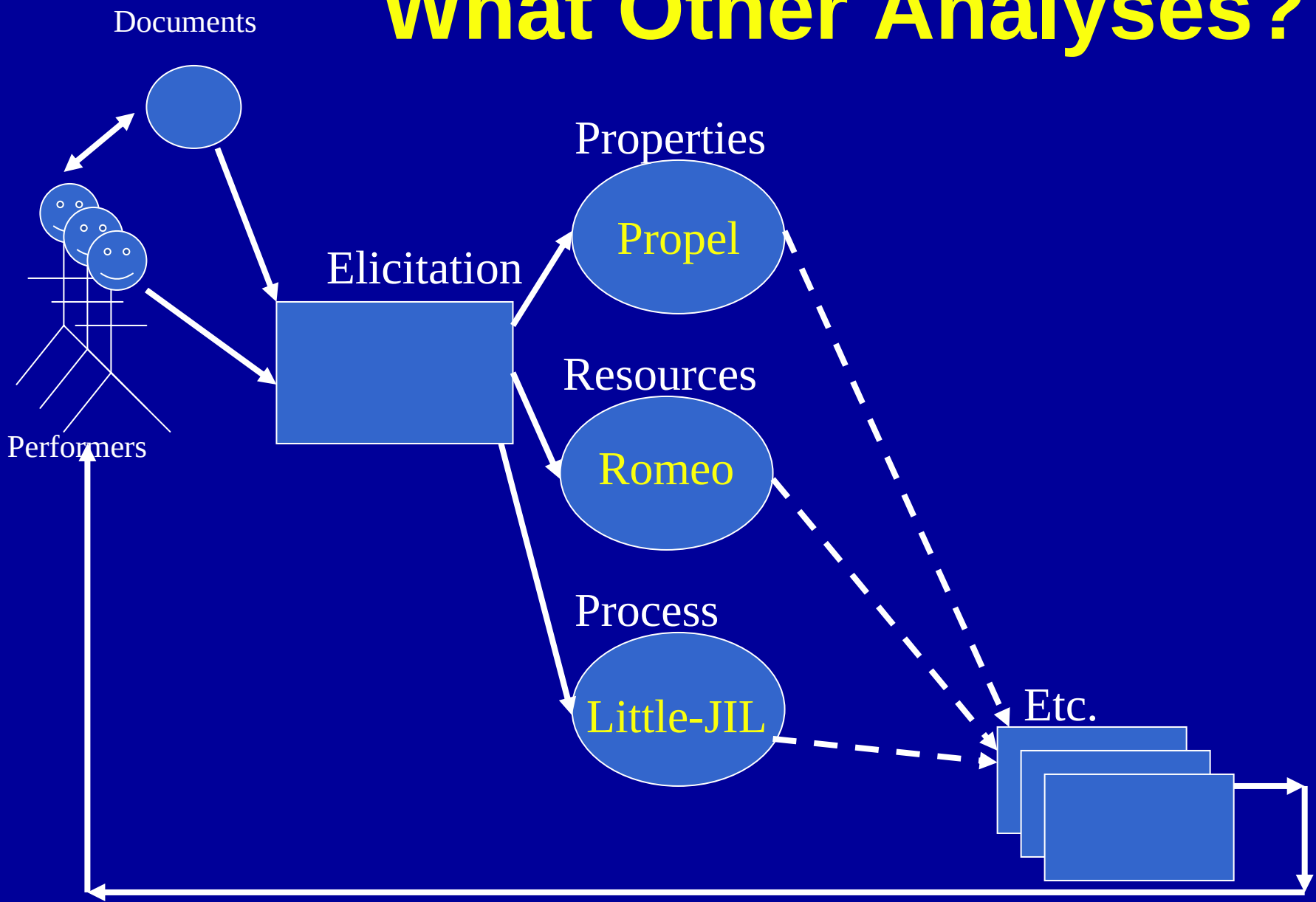
ER Performance Simulation

- Some specific questions
  - Why do patients wait so long?
    - And how to break bottlenecks
  - What is “surge” capacity?
    - And how to increase it
    - How to predict surges
  - What are optimal resource mixes?
  - What is the most cost effective way to increase capacity, reduce waiting time?
- Simulate various resource mixes against various process variants
- Resource model is key

What we Learned

- Value of automatic generation of simulation
- Need for powerful resource model
- Need for powerful concurrency
- Need for powerful timing specification
- Simulation validation is hard
- Defining customer questions is hard

What Other Analyses?



Driven by Other Issues

- Effective use of automation
  - Huge expenditures on new equipment
    - Some not well matched to needs
  - Huge costs for DB, communications
    - Are they well matched to processes?
- Education and Training
  - Natural language used mostly
    - Misunderstandings
    - Vital details (eg. exceptions) omitted
  - Diagrams are primitive
    - Semantics lacking or unclear
    - Exceptions generally not included

Other Case Study Domains

- Elections
  - Raunak presents later
- Dispute Resolution
- Engineering Design
- Etc.

Studying Real Processes is Really Useful

- Important learning in key areas
- Validation of some of our approaches
- Demonstration of shortcomings too

Learning about Process Definition Language

- Strong needs for
  - Exception management
  - Concurrency specification
  - Timing specification
  - Transaction semantics
- Rigor is essential
  - To support definitive analysis
- Need for Process Families

Learning about Resource Specification

- Resource hierarchy is useful
  - Multiple inheritance needed
  - Maybe not sufficient
- Separation of resource concern is useful
- Blocking calls for resources needed
- Resource preemption needed
- Need for Domain-specific Ontologies

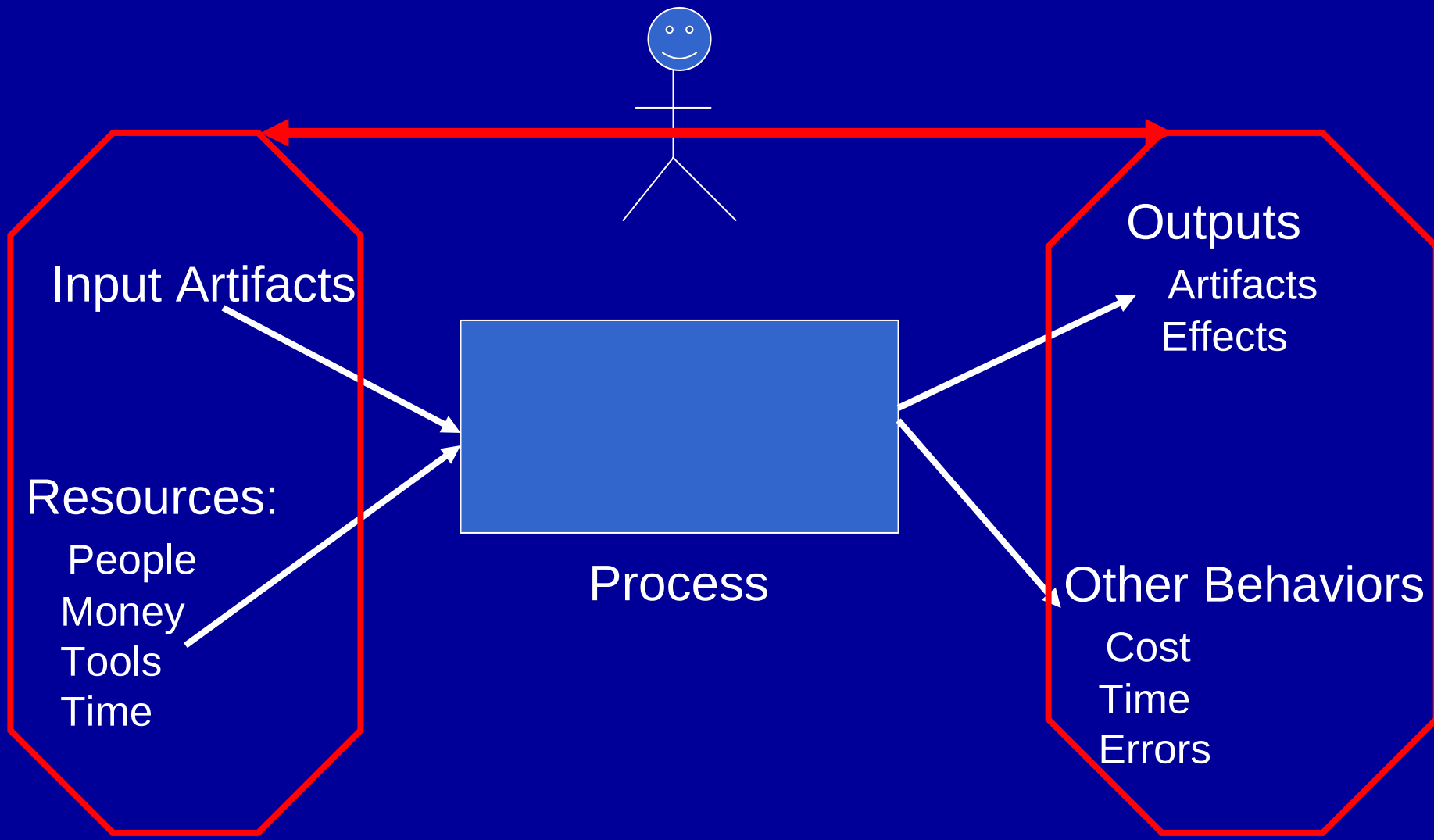
Learning about Analysis

- Relies upon rigorous definition
- Processes have huge state spaces
  - Due to concurrency and exceptions
- Effective in identifying defects
  Critical step in process improvement

Important Macroprocess Role Too

- **Not pursued in these case studies**
  - **Yet**

Macroprocess Focus



Medical Macroprocess Issues

- Problems in
  - Baselining processes
  - Process configuration management
  - Process deployment
  - Statistics gathering/application
- How to Establish Medical Process Teams?
- Medical Culture Problems
  - Very hierarchical
  - Errors are embarrassing, hidden
  - Statistics are fragmentary, unreliable
  - How to instill “culture of quality”?

Future Work

- More processes in these domains
- More resource modeling
- More analysis
- More domains
- Outcomes:
  - Improvements in domains
  - Improvements in our process technologies

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Overall Research Approach