

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**

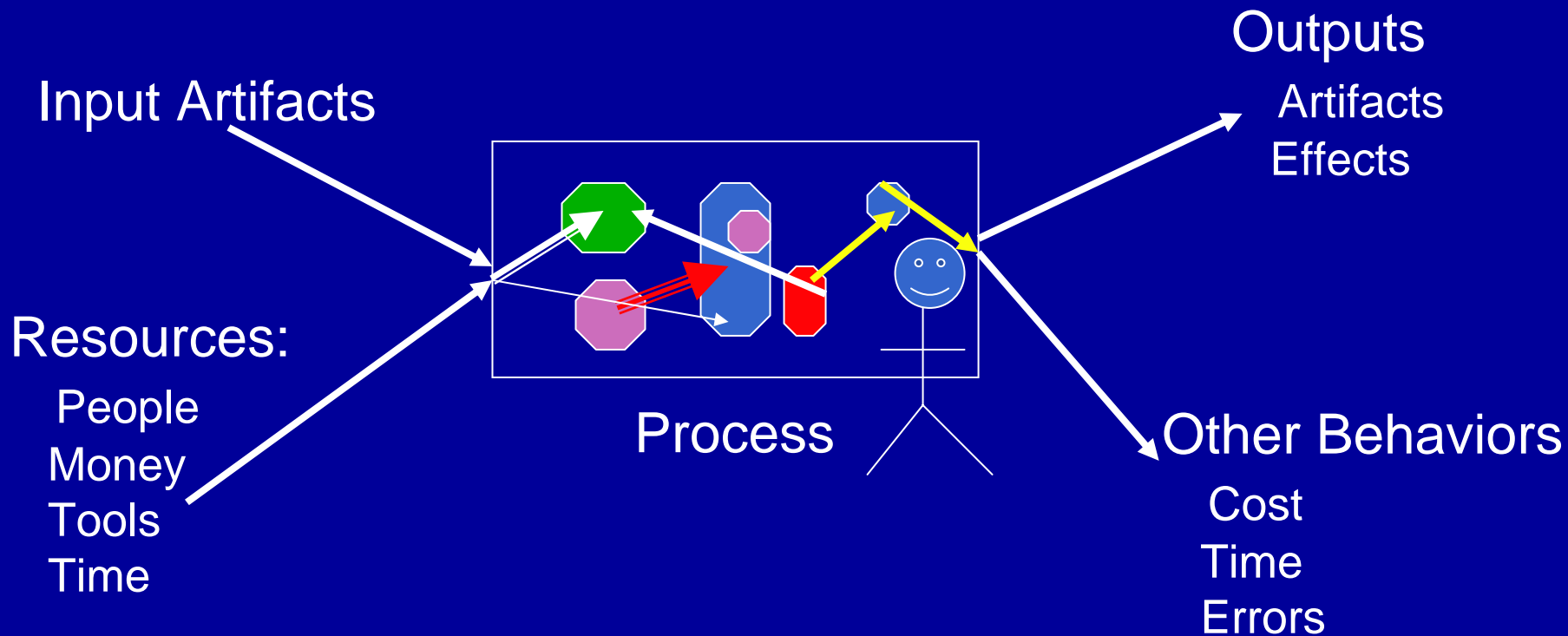
Baystate Hospital Case Studies

- **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

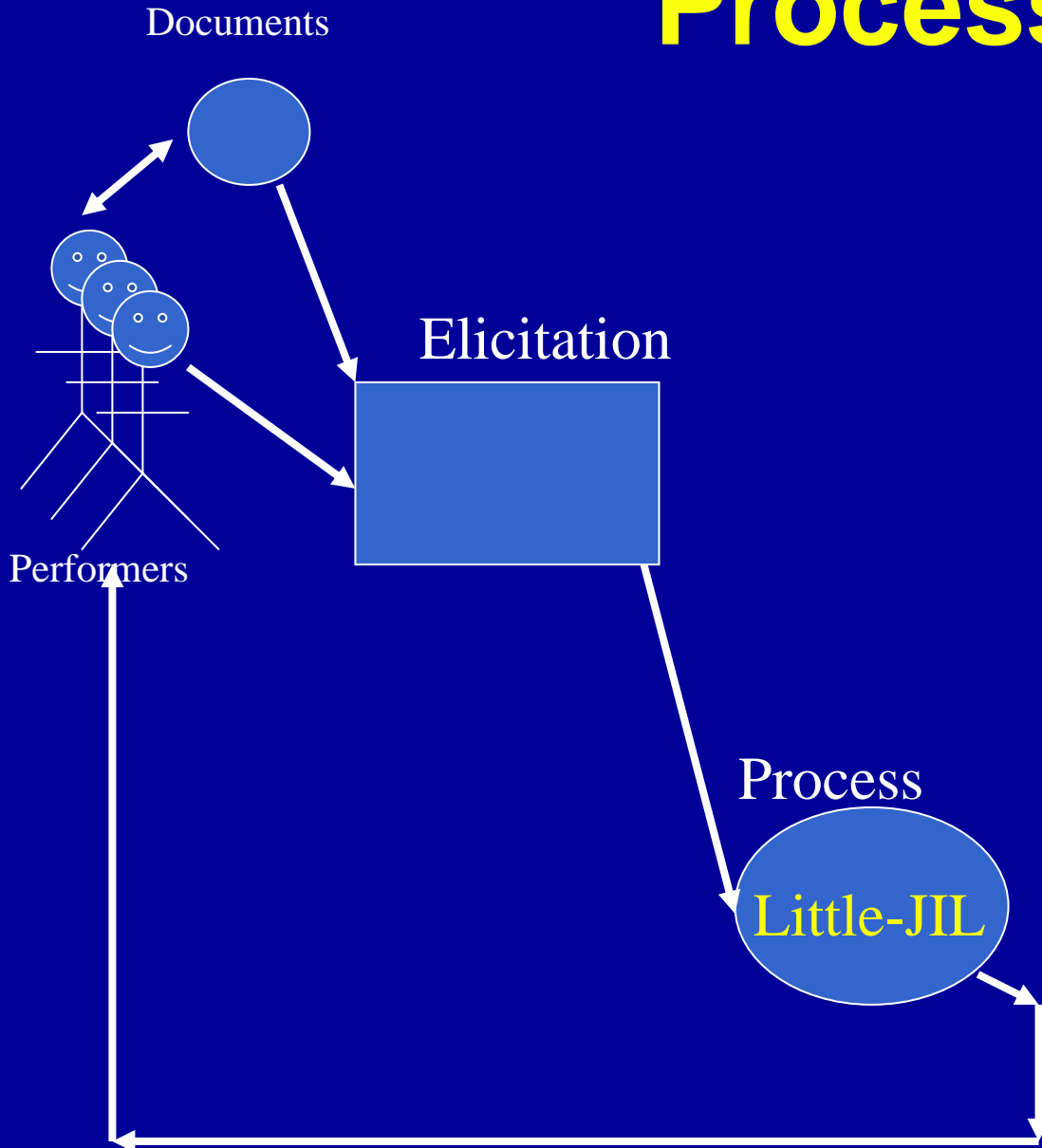
Microprocess Approach



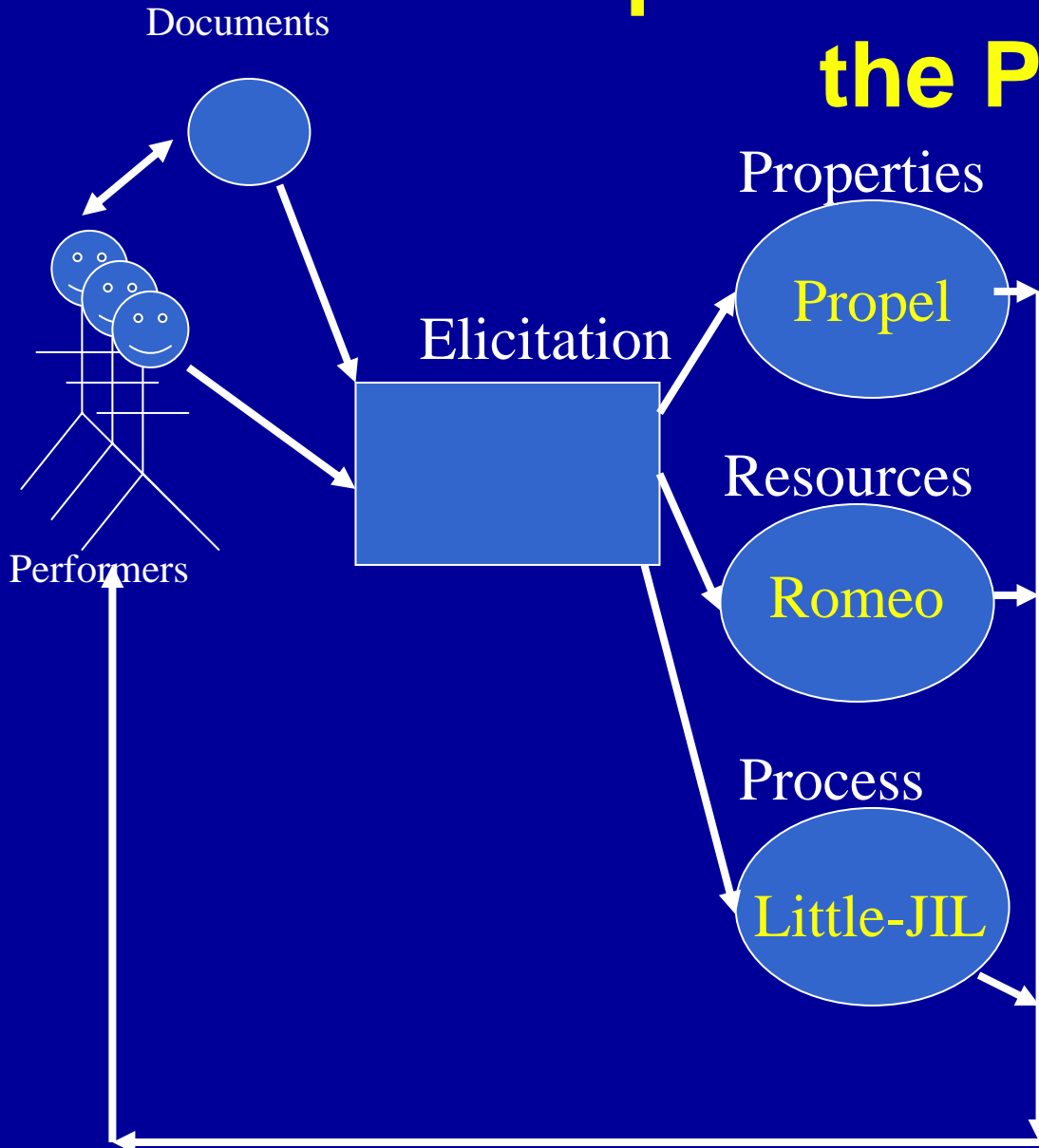
Specifics of Our Approach

- **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



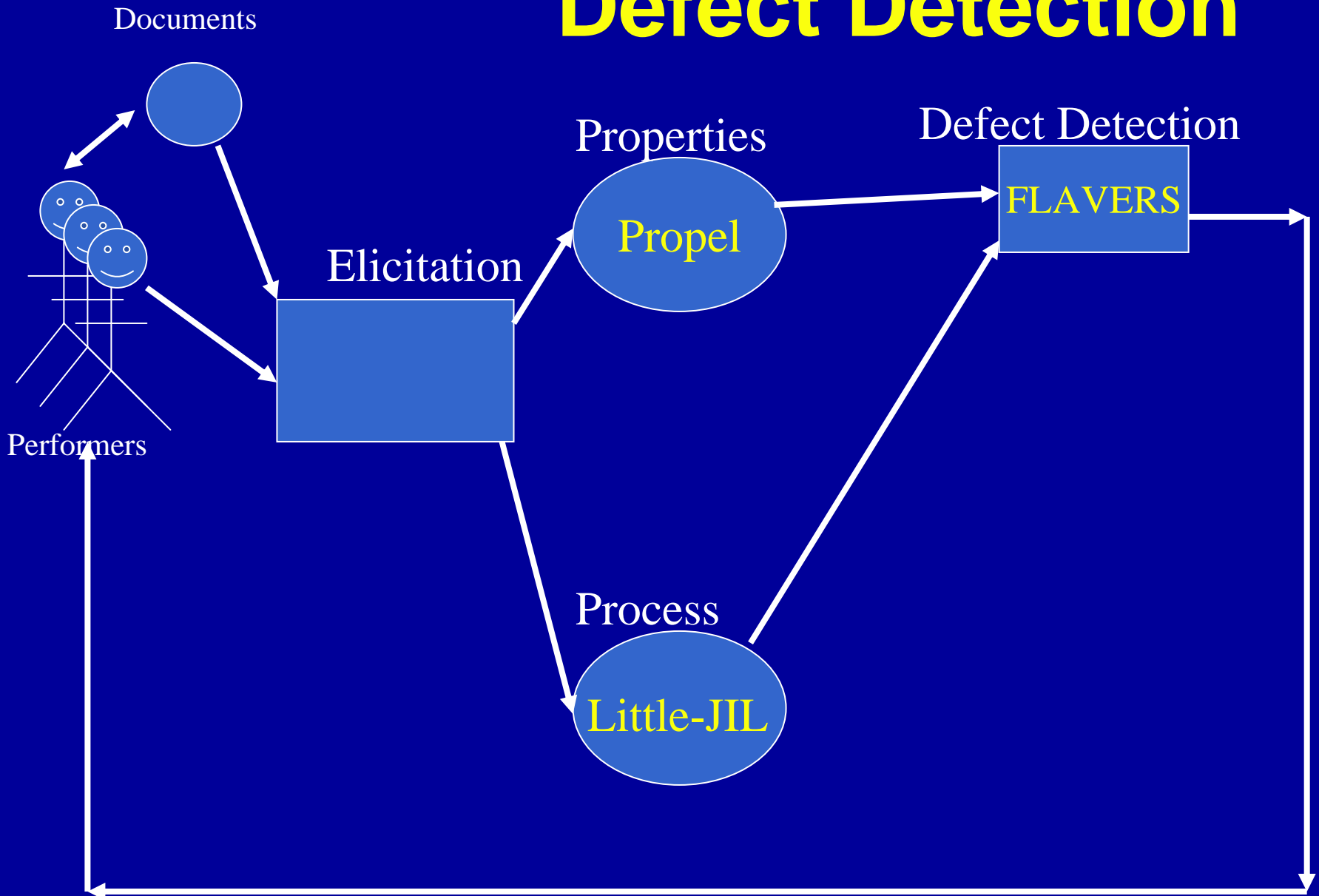
Helps to Elicit more than just the Process



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



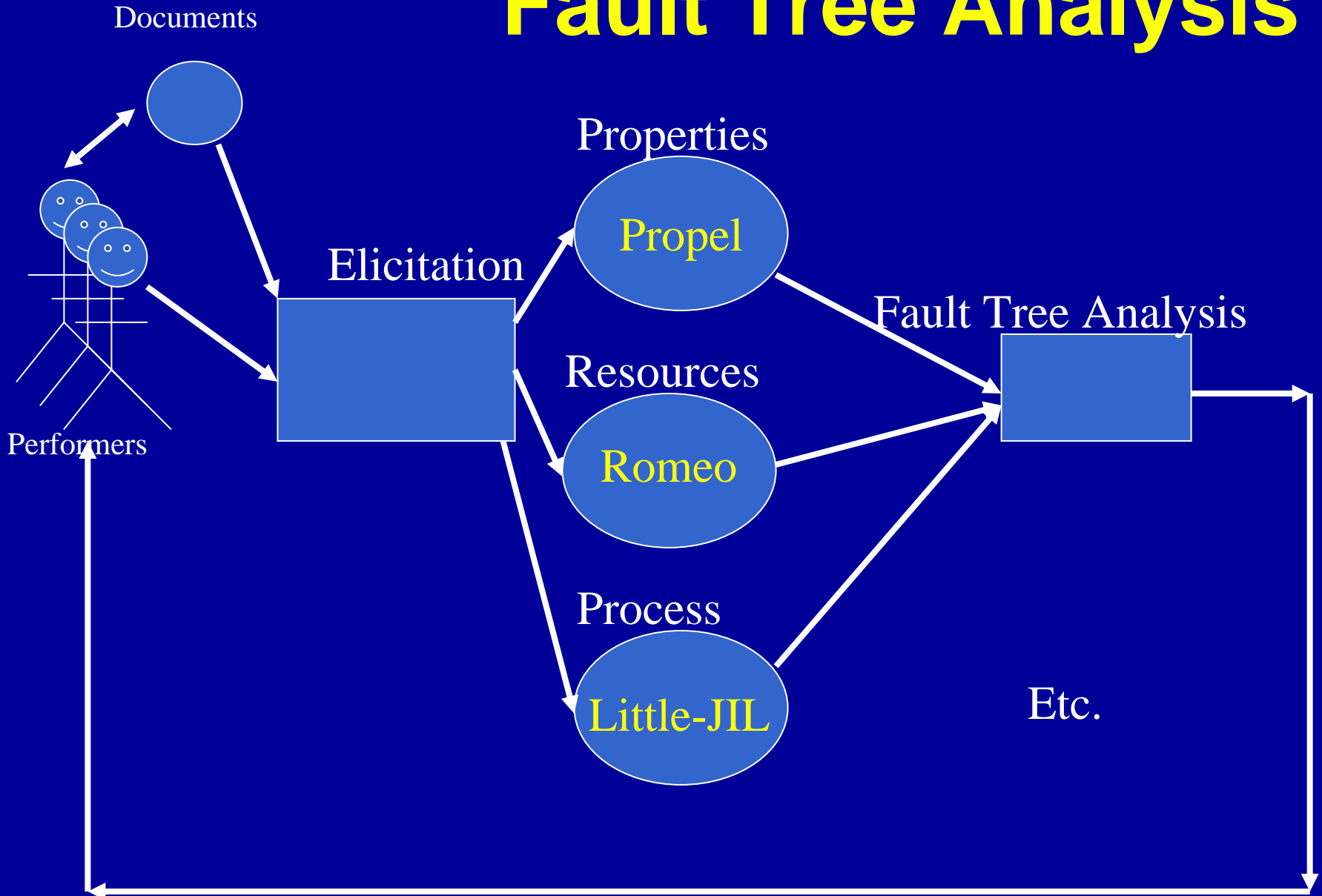
Defect Detection Example: Blood Transfusion

- **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**

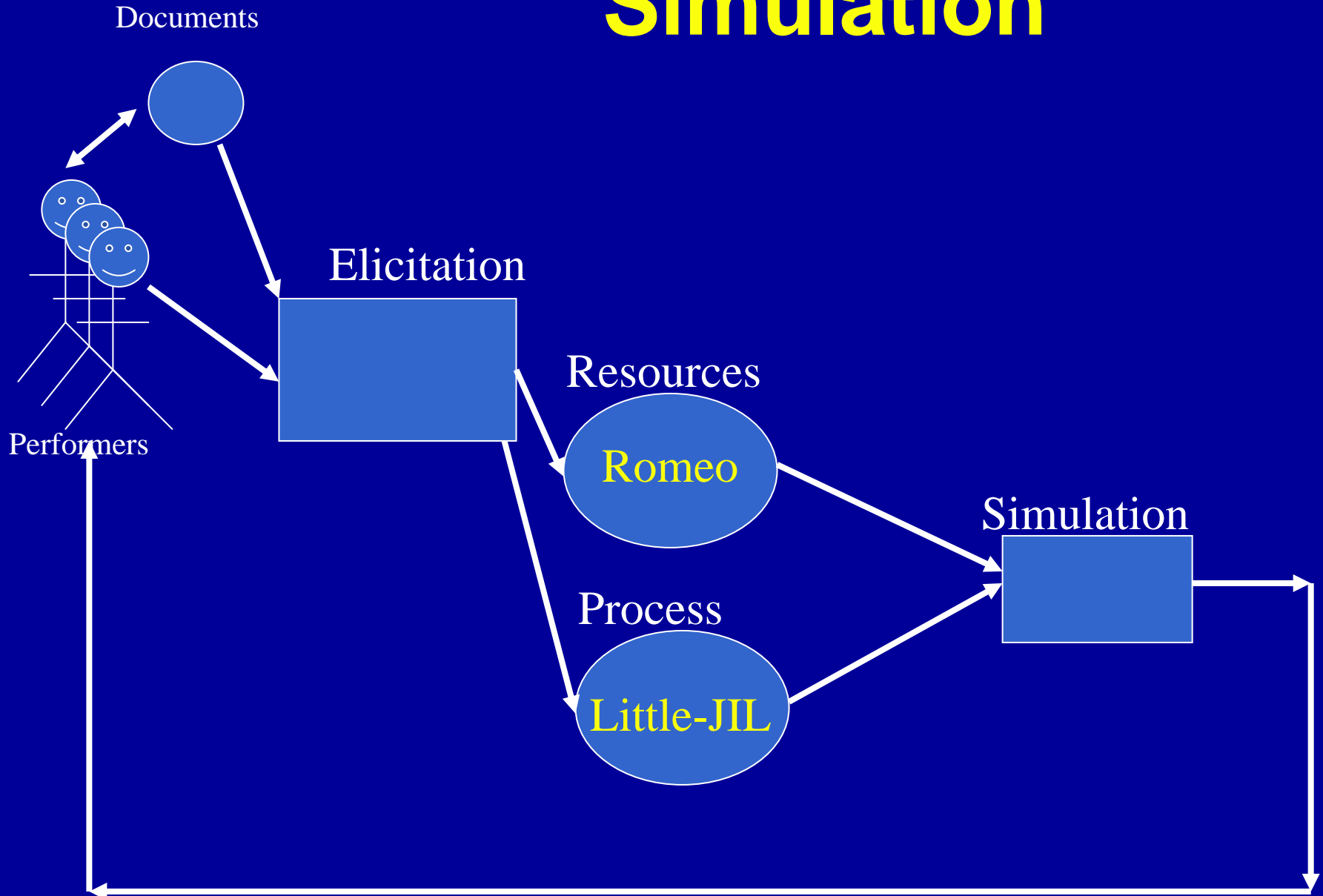
Fault Tree Analysis



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



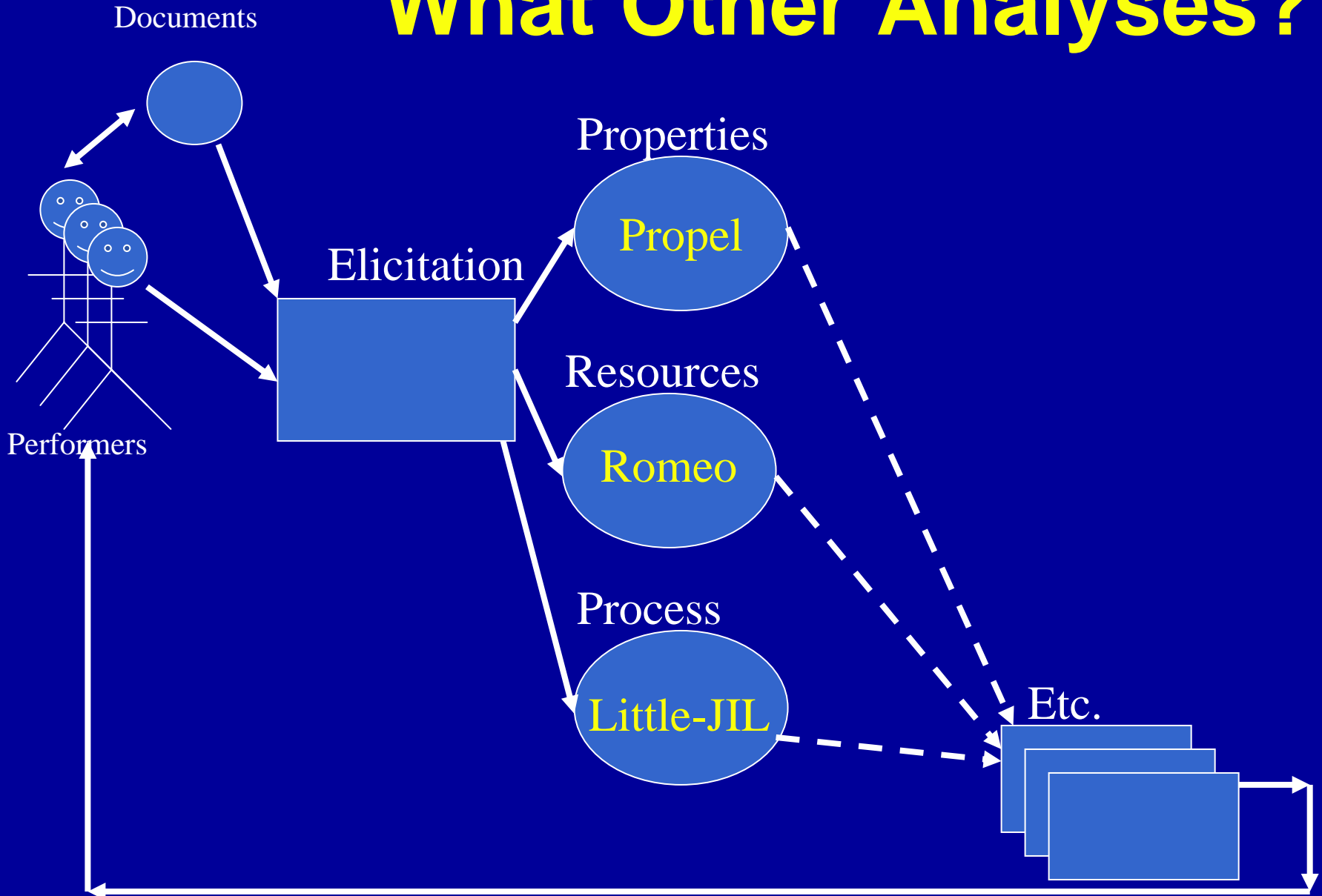
ER Performance Simulation

- **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**

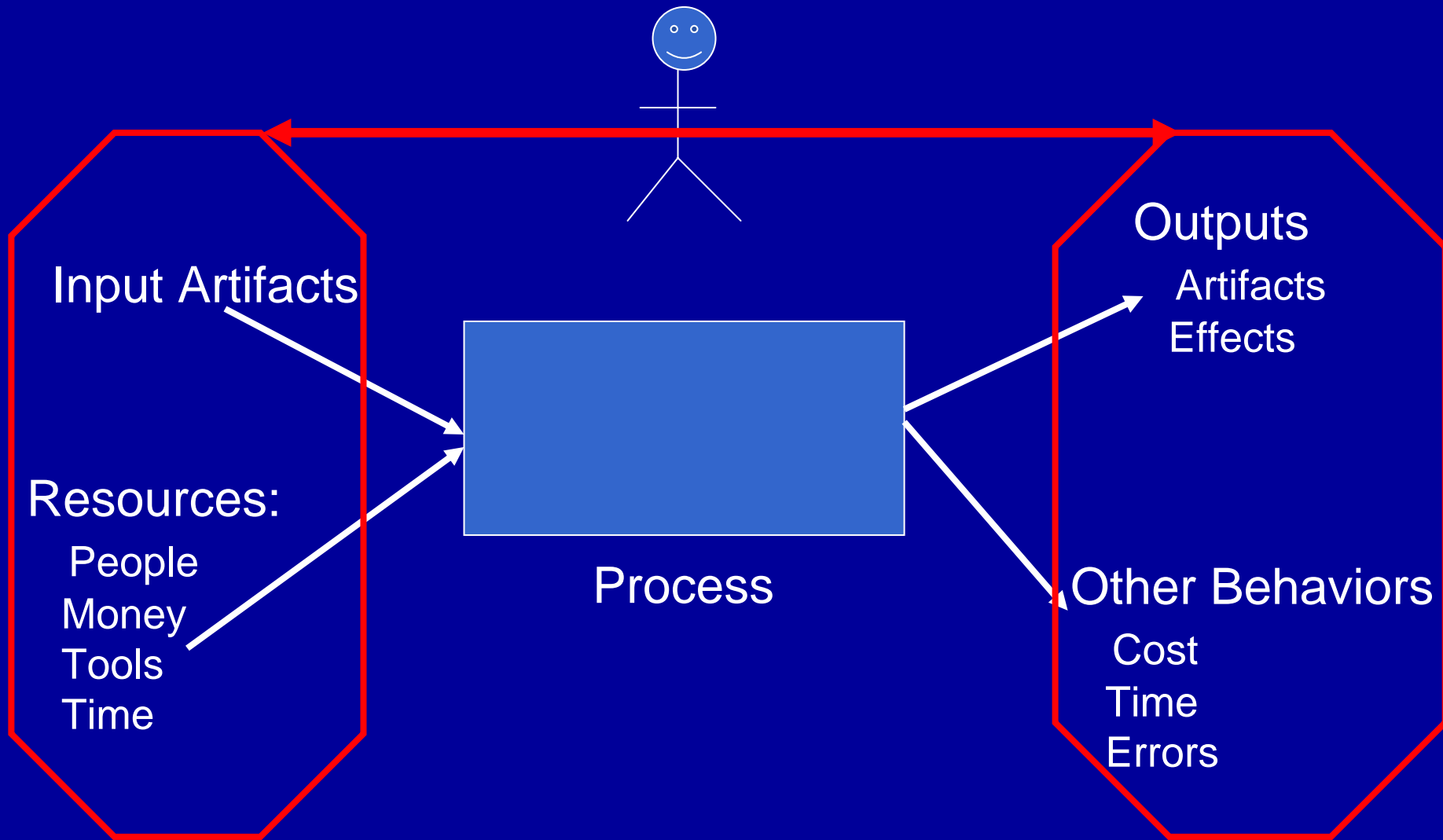
Learning about Analysis

- **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

