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Causal Risk Analysis

Presented at JOWOG31
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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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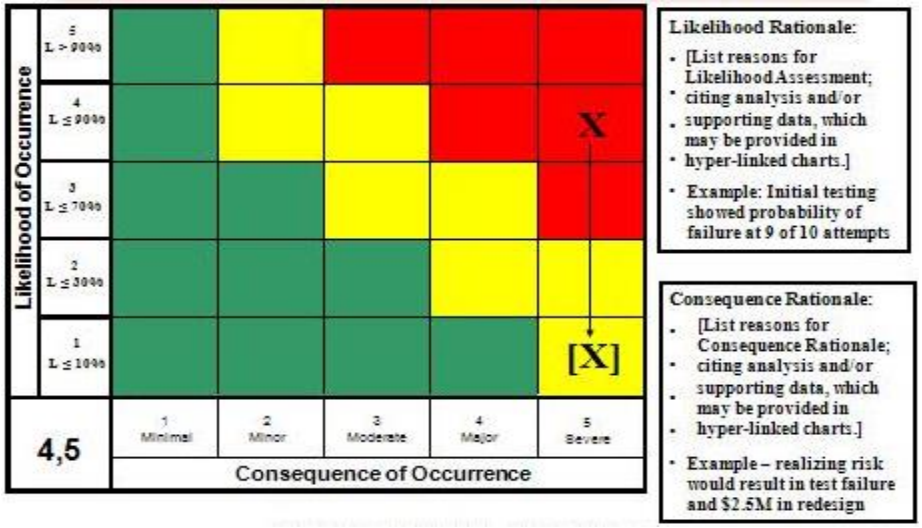
Causal Risk Analysis

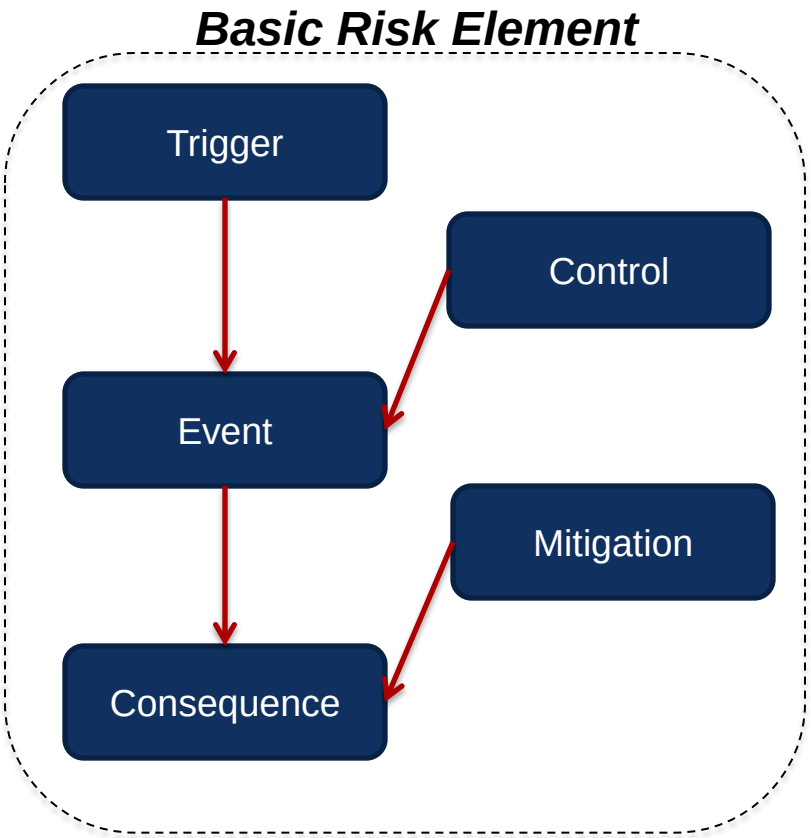
- A slightly different approach than the 5x5 “heat map”
  - Can be used to augment traditional methods
- When applied simply can provide insight on residual risk



- A thorough application could really change the way we ***manage*** program risk.
- Requires more thought, effort and “data engineering”
  - But therefore provides an opportunity for more insightful decision-making.

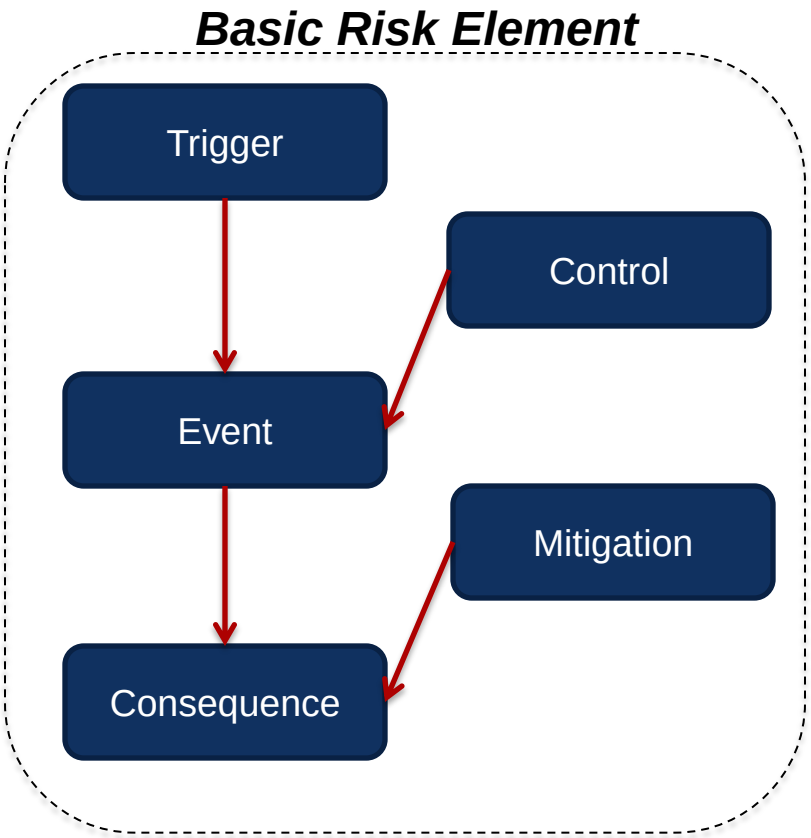
The Basic Risk Element

- Allows better understanding and management of the components of risk
  - Focuses on causes, not events
  - Separation, clarification of control and mitigation and the benefits of each
  - Enables cost/benefit of different approaches to handling risk
  - Separation of causes and events
    - Allows that the Event might not occur even if the Trigger does
  - Separation of events and consequences
    - Allows for treatment of uncertainty in consequences

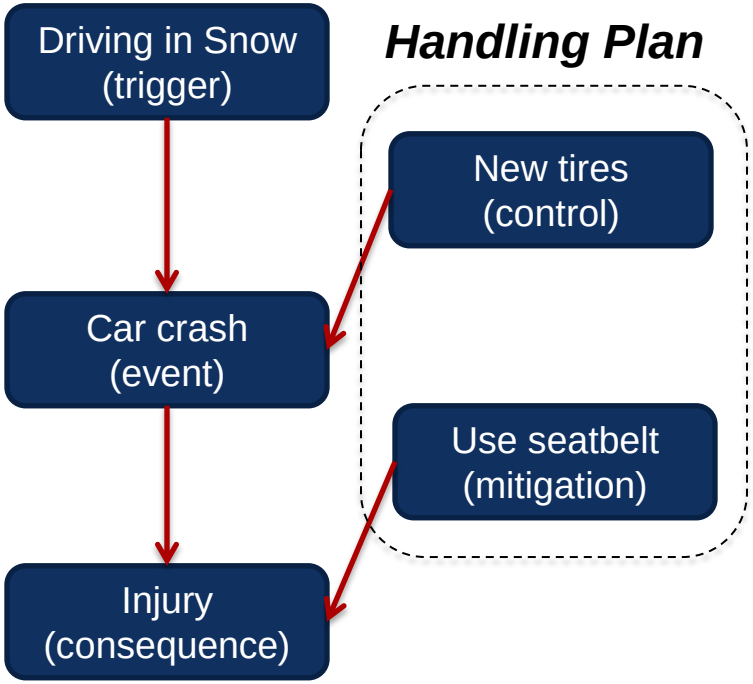


Definitions

- **Trigger**
  - Occurrence that may, or may not, lead to an undesirable set of circumstances
- **Event**
  - The undesirable circumstances that come about because Trigger=TRUE
- **Control**
  - Actions one takes to *prevent* the Event, given that the Trigger=TRUE
- **Consequence**
  - The measurable outcomes (cost, schedule, performance) of the event, given that the Event=True
- **Mitigation**
  - Actions one takes to ameliorate the consequences, given that the Consequence=TRUE

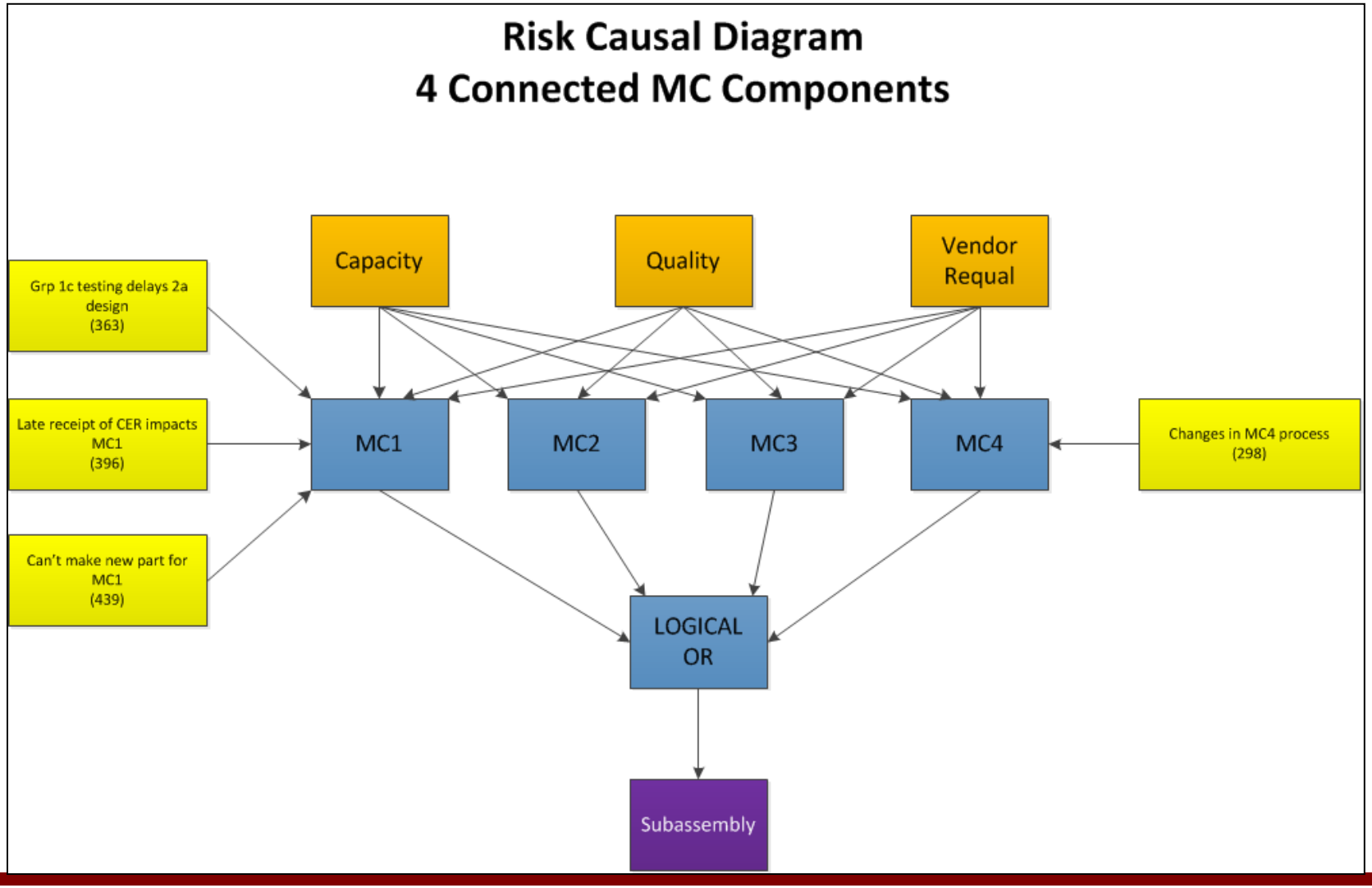


A Simple Example



Real-life Example

- The risk data was analyzed for coupling between risks



Real-life example

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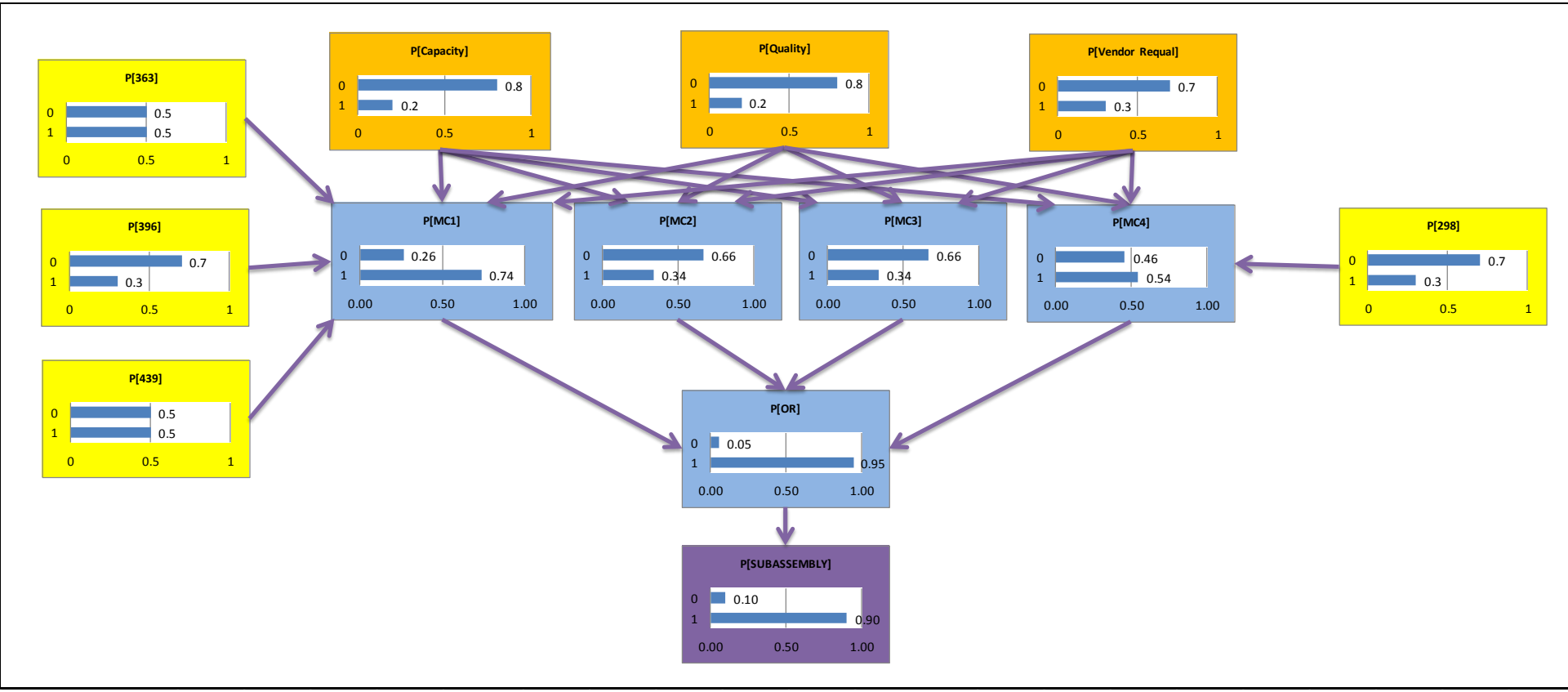
Risk	Handling Plan	Handling Cost	Monetized Impact
MC1 Testing Delays	Purchase additional test equipment	$500,000	$15,000,000
MC1 Late CER	Add labor	$100,000	$15,000,000
MC1 Can't fab parts	Purchase new equipment	$300,000	$15,000,000
MC4 process change	Requalify current process	$250,000	$15,000,000
Capacity	Qualify new test houses	$250,000	$15,000,000
Quality	On-site QE	$300,000	$15,000,000
Vendor Requal	Pay vendor to remain in current facility	$500,000	$15,000,000

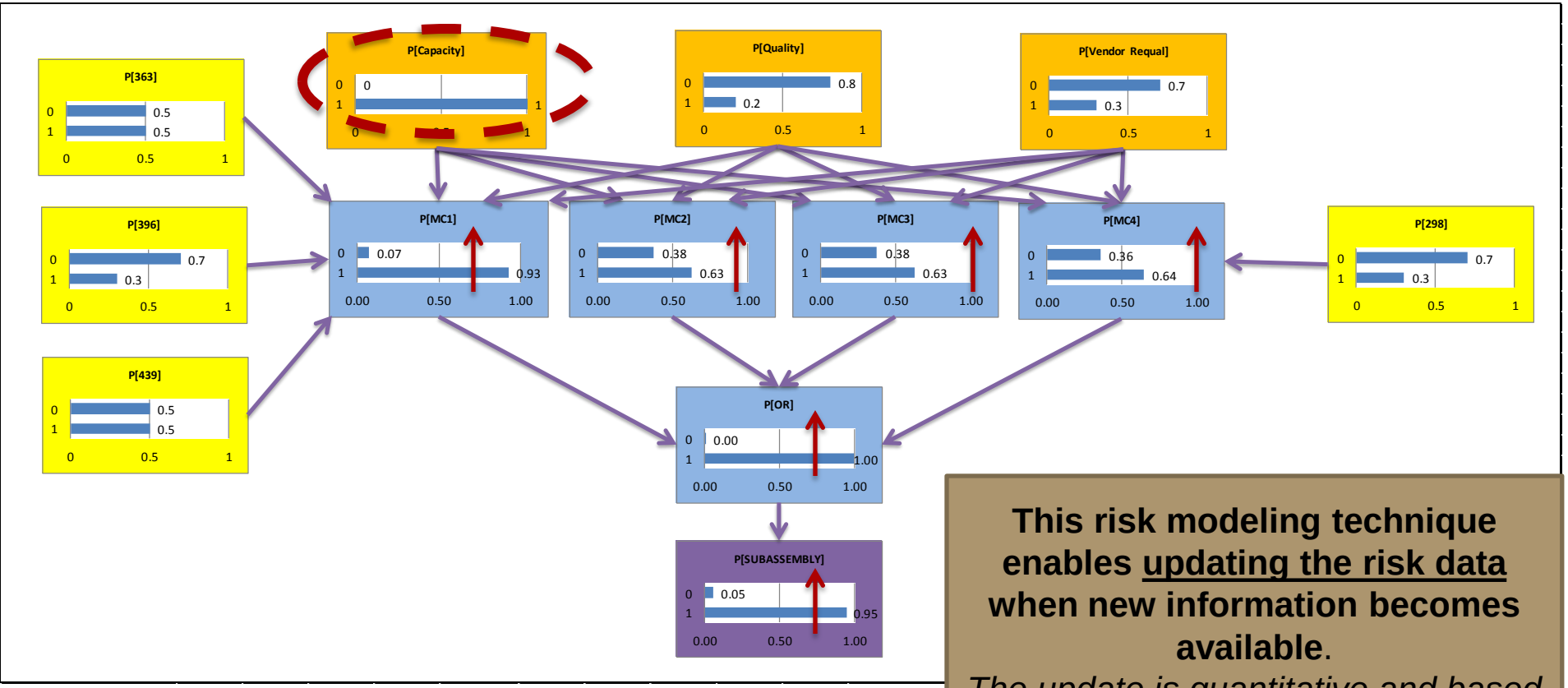
Real-life Example

- Baseline risk state from SME input
- Structure based on Risk Engineer analysis and SME concurrence



Real-life Example

- "Entering evidence"
  - ***Update*** the risk data based on the observation that "CAPACITY" issues are in effect

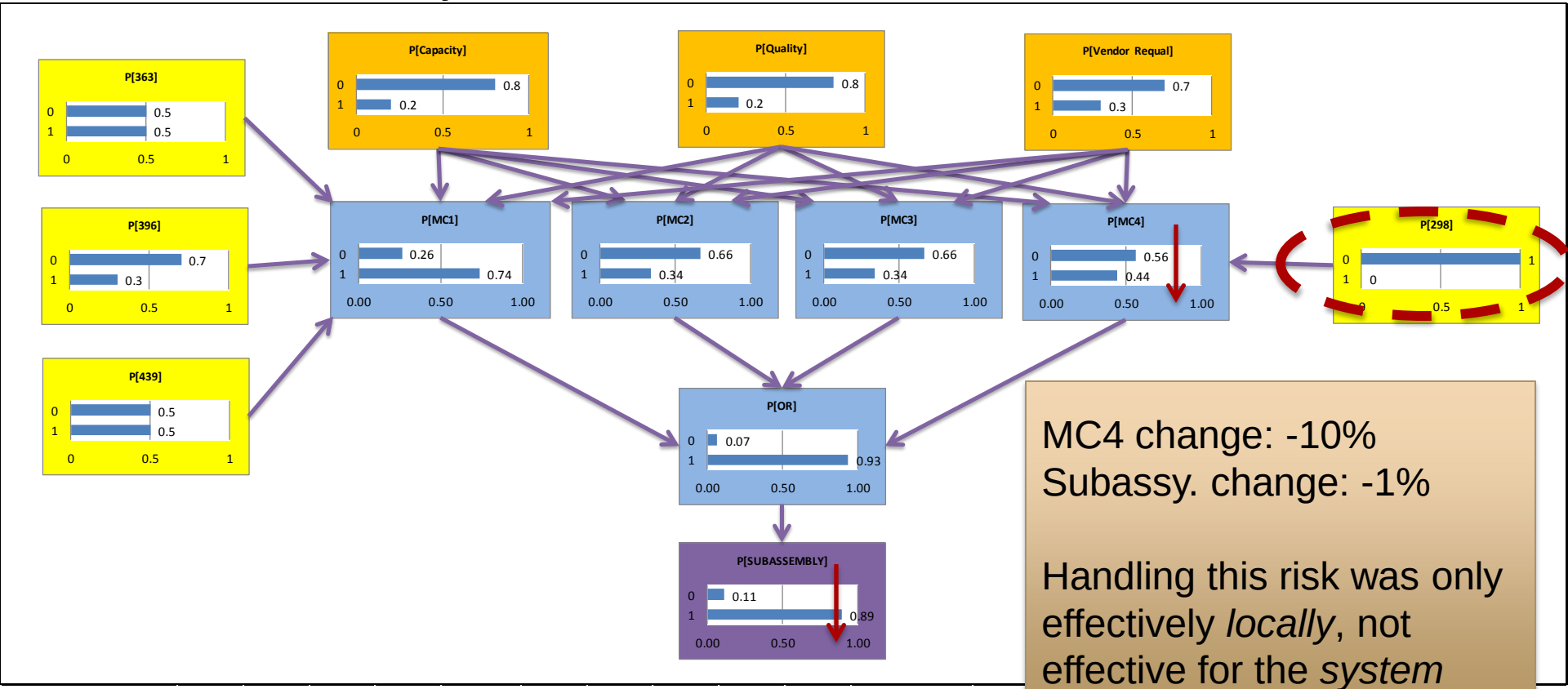


This risk modeling technique enables <u>updating the risk data</u> when new information becomes available.

The update is quantitative and based on a rigorous methodology.

Real-life Example

- Handling plan: **prevent MC4 process change**
- From a system perspective, the cost/benefit is very small.
  - ***Is the money worth it?***

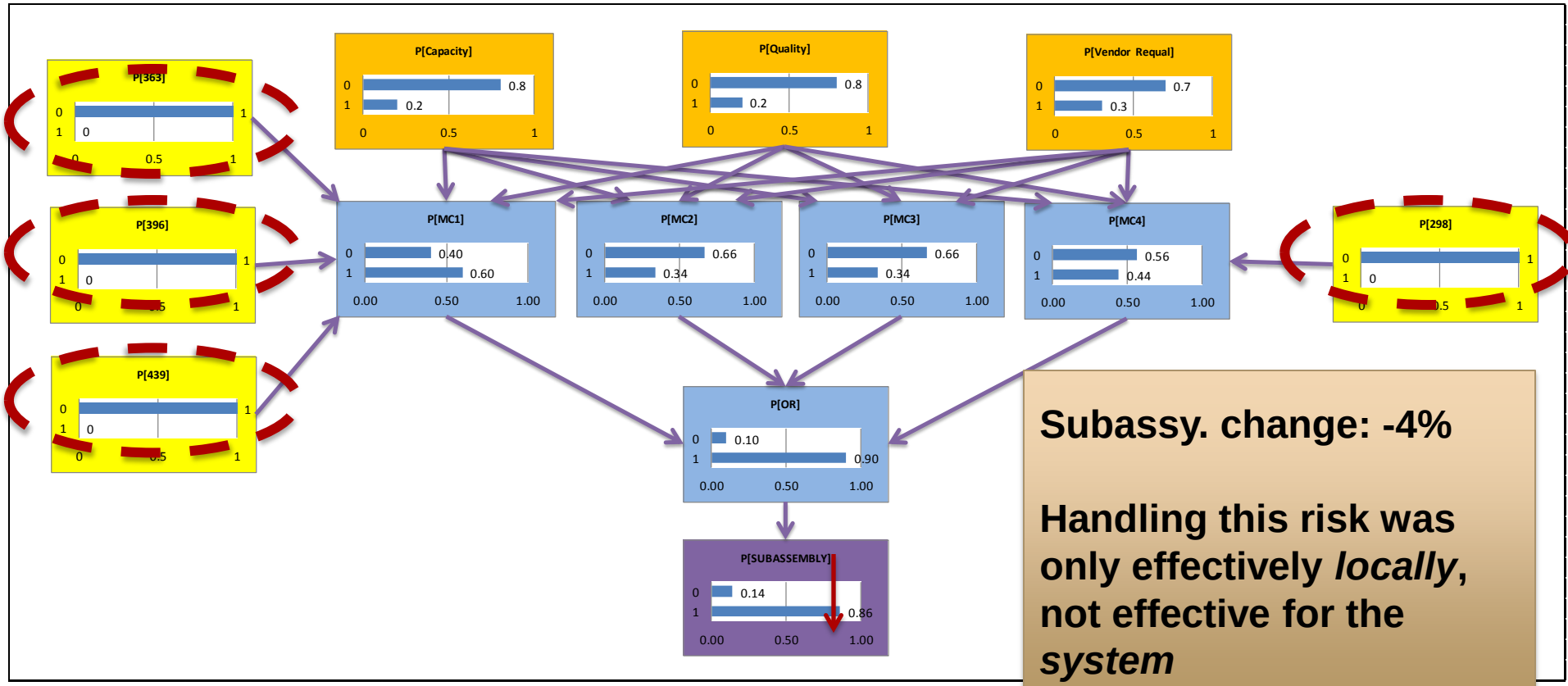


MC4 change: -10%
Subassy. change: -1%

Handling this risk was only effectively *locally*, not effective for the *system*

Real-life Example

- Handling plan: **address only risks that are decoupled**
- Again, the system-level cost/benefit is very small.
  - ***Is the money worth it?***

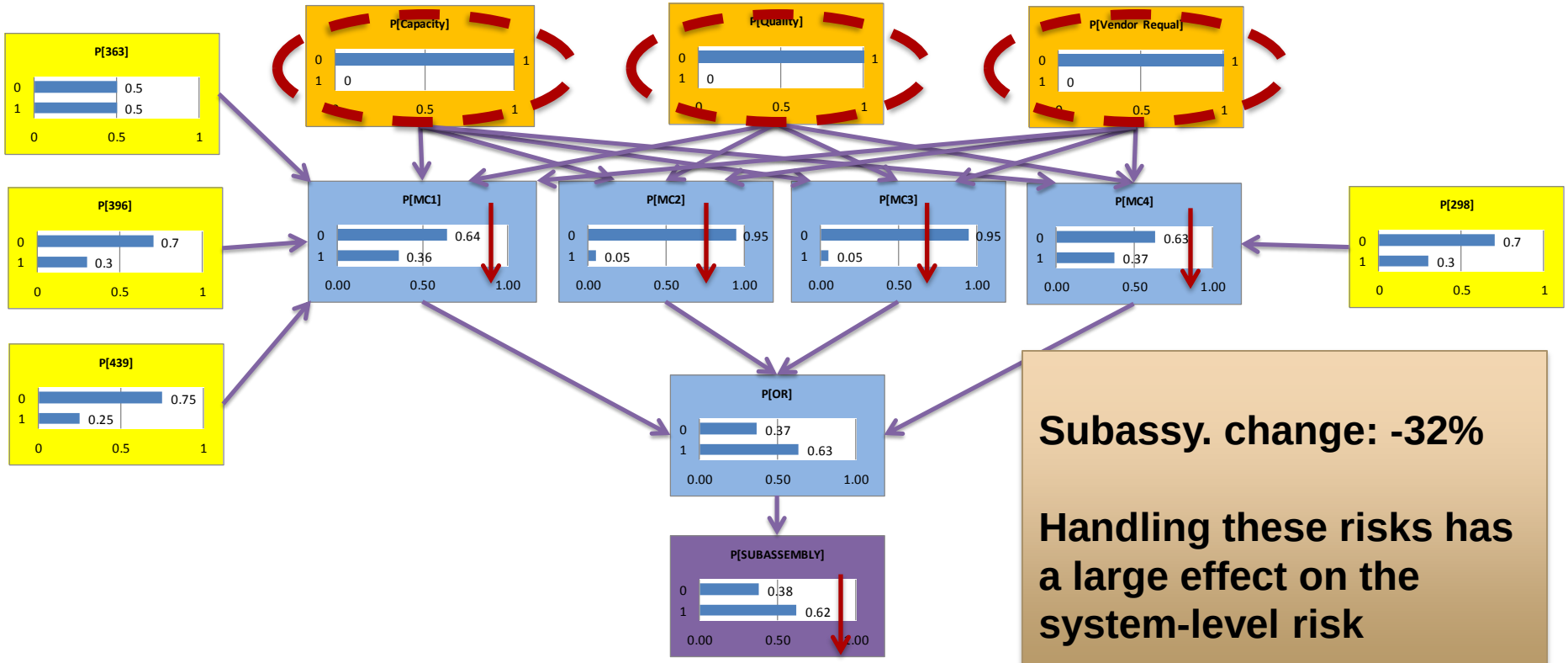


Subassy. change: -4%

Handling this risk was only effectively *locally*, not effective for the *system*

Real-life Example

- Handling plan: **address only risks that are highly coupled**
- Again, the system-level cost/benefit is very small.
  - ***Is the money worth it?***



Real-life Example

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- *Decisions on handling investments should be based on expected return on investment*

Option	Cost	Expected Benefit	Net
Option 1 Handle MC4 risk	$250,000	+$150,000	**-$100,000**
Option 2 Handle all uncoupled risks	$1,150,000	+$600,000	**-$550,000**
Option 3 Handle all coupled risks	$1,050,000	+$4,800,000	**+$3,750,000**

- The risk *relationships* dominate the problem
- **Only one option has a positive return on investment**

Causal modeling illuminates important structures in the risk data that dominate program risk

Summary

- Addressing risks in an *ad hoc* fashion, without understanding their interdependence may lead to wasted resources.
- Modeling risk connectivity can add actionable insight.
  - Structures in the risk data can dominate program risk
- The decision space is clarified through analysis within a quantitative framework that can be
  - Debated openly
  - Analyzed for sensitivity effects

It's important to see the forest through the trees

Insight → ***Action***