the Energy to Lead

IGRC Seoul 2011
International Gas Union Research Conference

# Maximizing Critical Infrastructure Performance with Probabilistic Methods

**IGRC 2011 - Seoul, Korea**

**Presented By:**
Eddie Johnston
Managing Director
Infrastructure Sector, GTI

gti

# Gas Technology Institute (GTI)

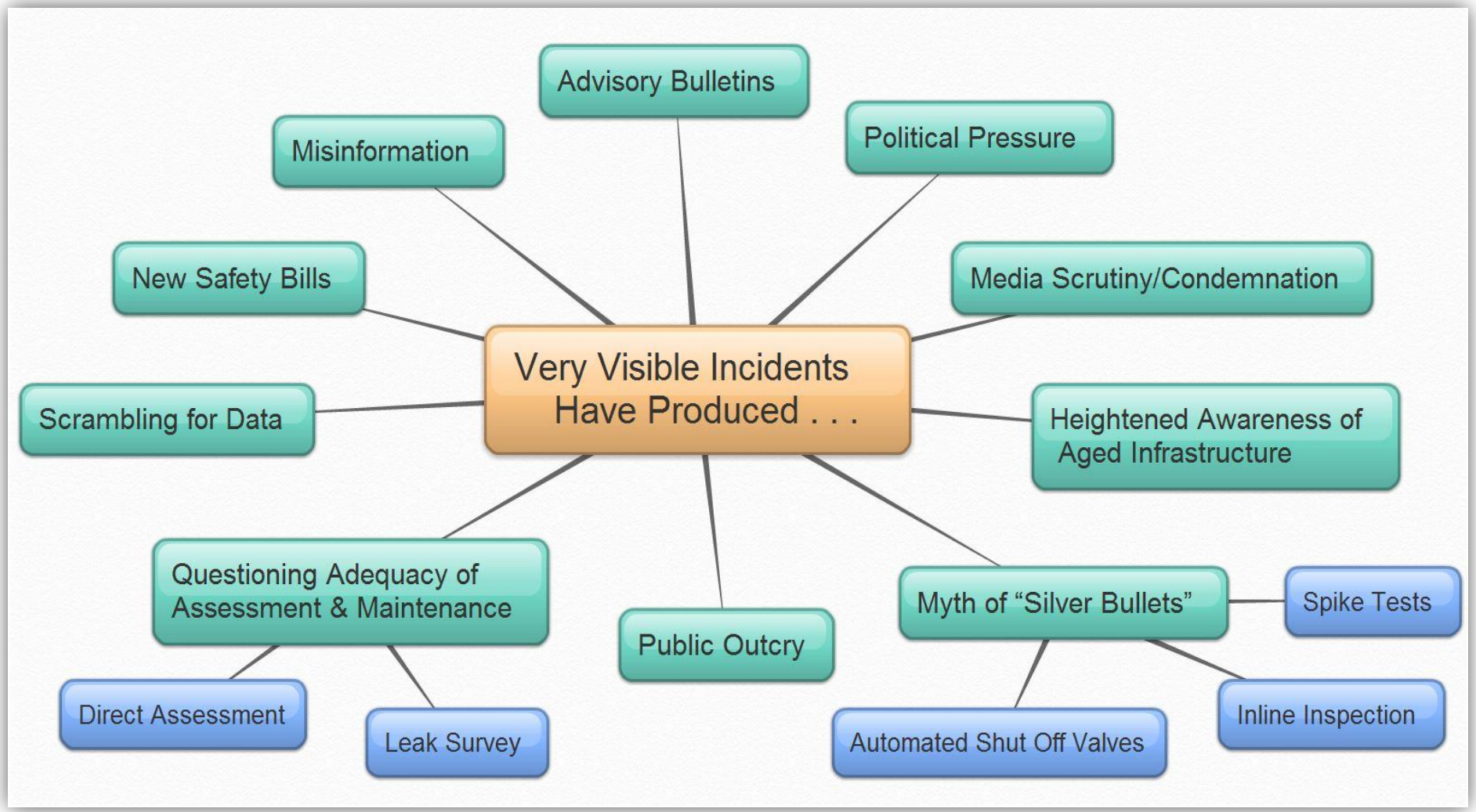
- Not-for-profit research, with 70 year history
- Facilities
  - 18 acre campus near Chicago
  - 200,000 ft$^2$, 28 specialized labs
  - Other sites in Oklahoma and Alabama
- Staff of 250
- Market opportunities are creating substantial growth
- 1,200 patents; 750 products


**Offices & Labs**

**Flex-Fuel Test Facility**

**Energy & Environmental Technology Center**

# Current Landscape in U.S.



# Normative Expert Systems

## Sound Science + Applied Models = Good Decisions

> **Develop NORMATIVE expert systems that:**

1. Act rationally according to the laws of decision theory,
2. Use the formalism of Bayesian networks to efficiently represent and reason with uncertain knowledge, and
3. Do not attempt to mimic human thought processes.

> **These systems will:**

- Accept human subject matter expert knowledge as their start point,
- Are capable of learning as live data is added, and
- Converge to an accurate representation of actual system behavior.

# Practical Infrastructure Considerations

IGRC Seoul 2011
International Gas Union Research Conference

## PROBLEM

- Aging System/Pipes
- Urban Congestion
- Zero Error Tolerance
- Information Overload
- Data Mining/Tracking
- QA/QC
- Knowledge Retention
- Natural Gas on the Ascent as Energy Source of Choice
- Safely Exploiting Abundant Worldwide Shale Gas Deposits

## CONSTRAINTS ($)

- Design
- Construction
- Operations
- Maintenance
- Restoration
- Labor
- Permits
- Materials
- Fines
- Liability
- Mandates
- Decommissioning

## SOLUTION

- Scientific Methods
- Advanced Modeling Approach (probability and multi-physics simulation)
- Sound Engineering Design
- Deployment of Normative Expert Systems

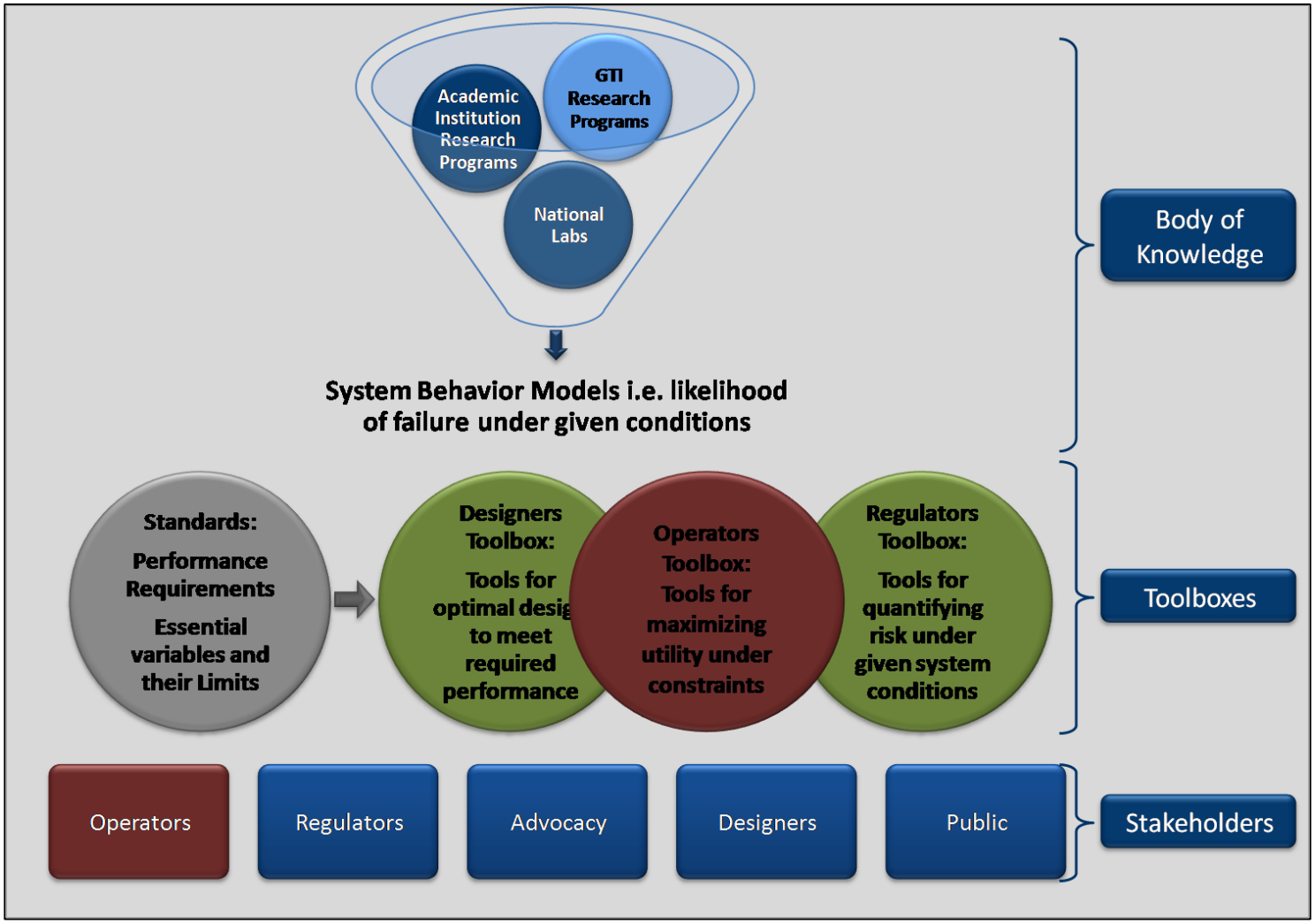
## RESULTS

- Explicitly Address the Uncertainty and Unknowns
- Optimization of Policy: Balance Between Risk and Cost
- Improved Knowledge Management (i.e., Data Capture and Interpretation)

# Research Strategy

- Research is needed to ensure that the current body of knowledge is leveraged and transferred into a useful set of tools.
- This additional research must focus on:
  - Infrastructure threats
  - Probabilistic models
  - Operations research methods to maximize utility and optimize policy
- GTI uses advanced modeling and analysis tools to:
  - Enhance the level of infrastructure understanding, and
  - To allow operators to predict asset performance and calculate system risk.

# Coordinated Research and Development

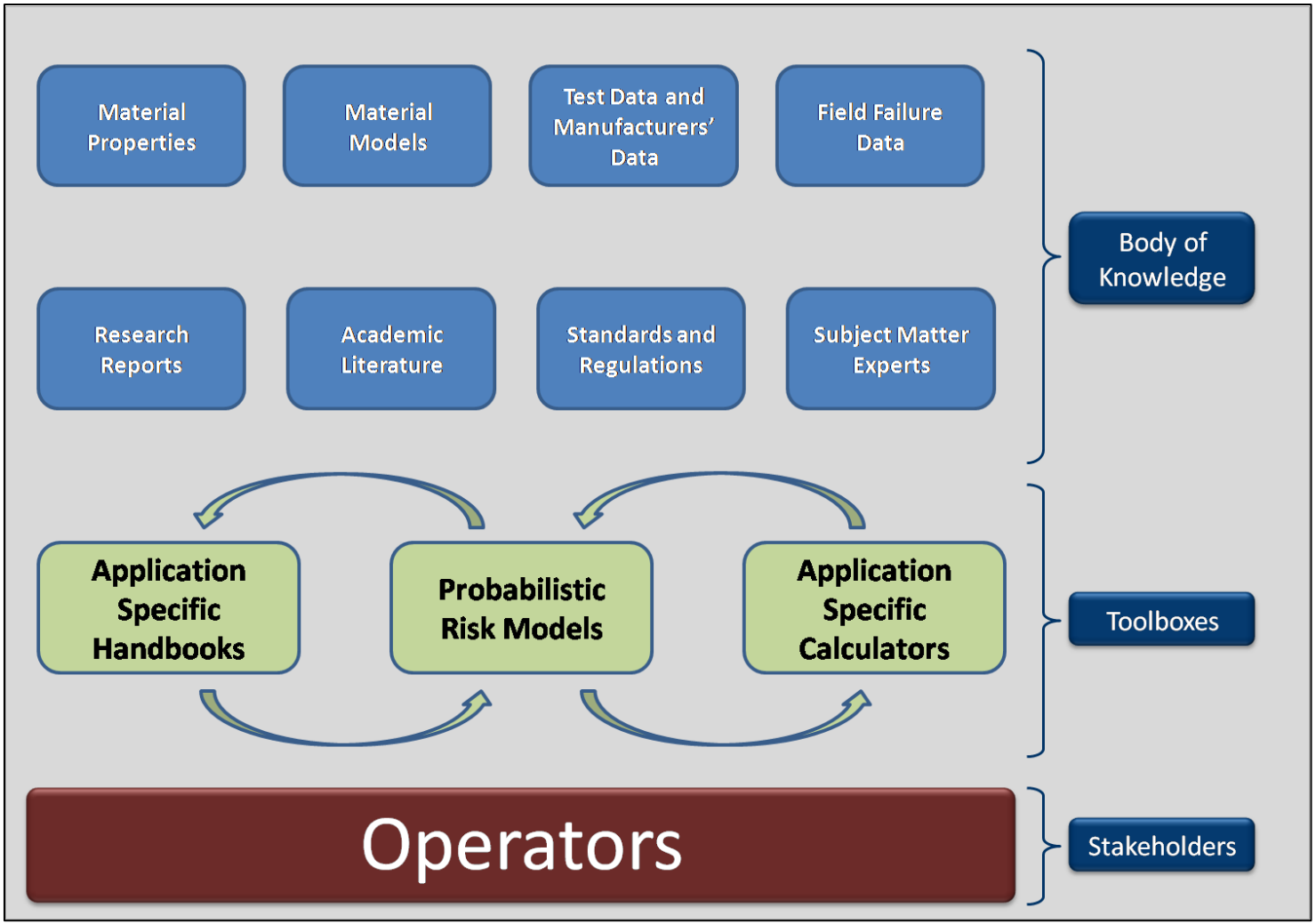


# Incorporating Results into Industry Guidelines and Standards

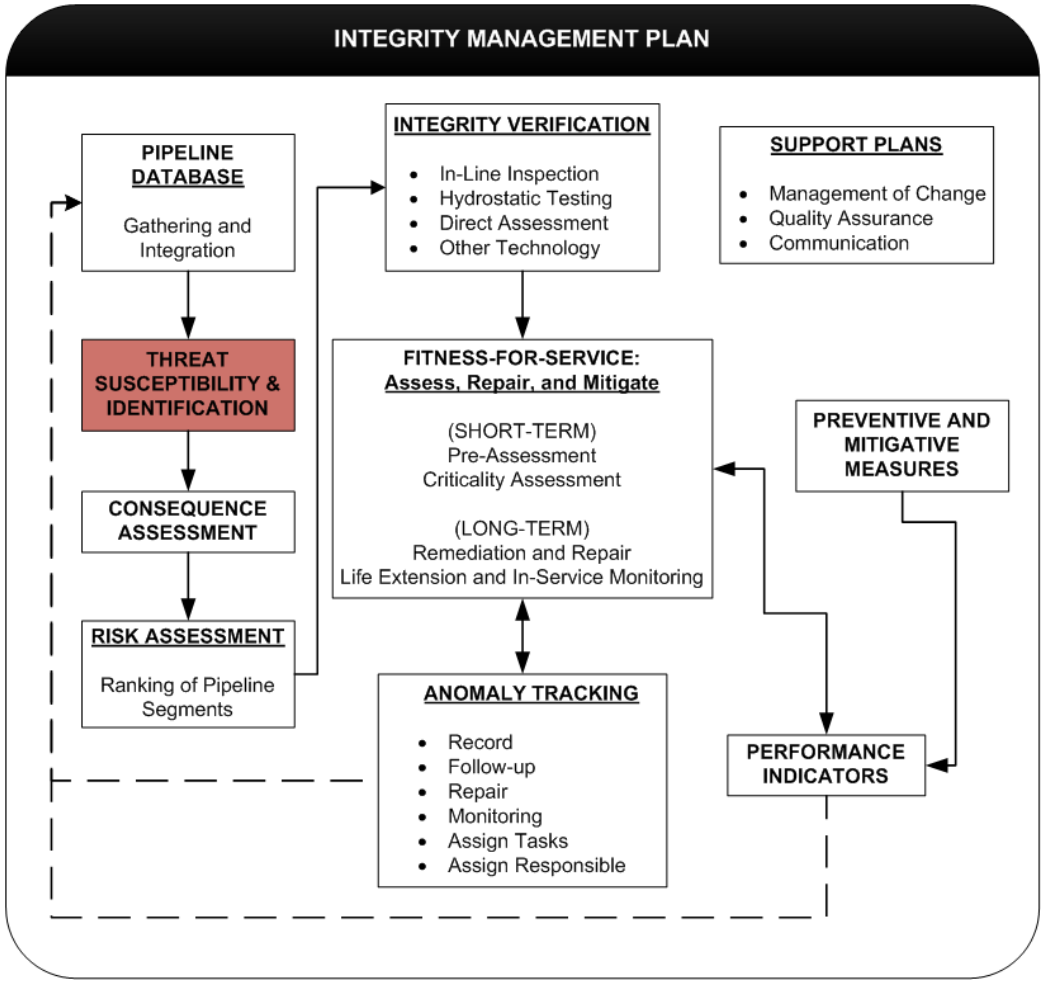
- The full potential of the proposed body of research can only be realized if it finds its way into industry guidelines, standards, and regulations.
- Presenting the results in draft standard form to the appropriate committee along with a supporting data set and GTI's active technical support will facilitate this objective.

# Operator Specific Deliverables

## Body of Knowledge and Toolboxes



# Typical Tasks Contained within an Integrity Management Plan



# Example - Understanding Threat Interactions


- Can individual threats each be at "acceptable" levels but when added together (superimposed) result in a significant threat to the pipeline or even a failure?
- What combinations of threats are most important to understand and control?
- How should threat interactions be calculated and dealt with?
- What process should an operator go through to identify unknown or hidden threats and how should they be worked into the pipeline integrity assessment?
- Can a process or methodology be employed to continuously monitor these threat interactions and flag concerns at trigger points?

# What Will It Take?

- Alignment with stakeholders to ensure critical needs are met
- Research results targeted to agreed upon deliverables
- Dedicated team to build, organize, and maintain applications
- Funding and in-kind support

# Thank You !

# Questions ?