



# Smart Manufacturing Workgroup

## The Motivation, Vision and Call to Action for Capital Programs and Process, Batch and Discrete Manufacturing

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# Safety Contact



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# The “Big” Business Case

- Economic viability
- National security

*Manufacturing ...central and irreplaceable core of a strong, secure economy.*

# The Business Case from SPM Workshops

- Increased focus on EH & S compliance and risks of non-compliance
- Increased pressure to manage risk and uncertainty
- Heightened need for more than incremental energy and raw materials reductions
- Faster and more product transitions to realize economic value
- Enterprise management in response to globalization
- Changing workforce and need to use workforce more strategically
- Pressures to minimize environmental impacts
- Heightened social conscientiousness
- Resiliency - pressure to increase responsiveness to faults and changing conditions

*Dynamic demands accelerating on manufacturing*

# OPERATIONALLY EXCELLENT COMPANIES OUTPERFORM



# The Business Case for a User-Provider Approach

## Industry

- Global competitiveness of existing assets
- Installed base of equipment nearing obsolescence
- High capital and operations costs
- Energy and sustainability issues
- Multi faceted objectives
  - Zero EH&S and Process incidents
  - Reliability and risk management
  - Effective risk management
  - Resilient/fault tolerant operations
  - Quality of products
  - Cost Effectiveness
  - Asset productivity

## Provider

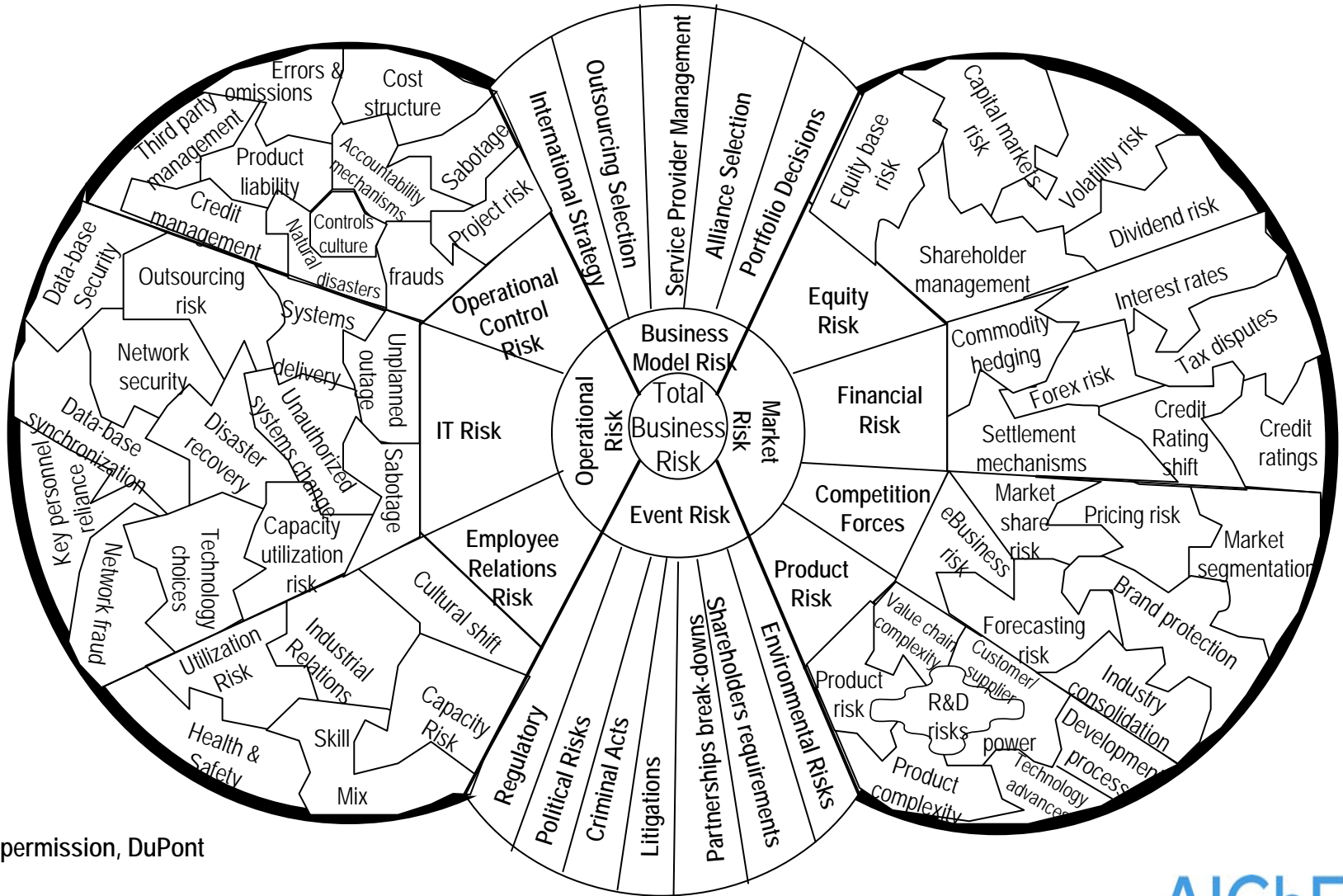
- Must understand multi-company “industry vision” for future facilities
- Large percentage of installed base of automation equipment nearing obsolescence
- Must understand how safe, reliable, quality and profitable interrelate
- Teaming with users on early development and co-development leverages and lowers total cost
- Must understand own future resource needs

# Managing Risk & Uncertainty

- Business decisions should be informed with both business and operational uncertainty and risks
- Plant operations should be able to “dial in” along the spectrum of risk
- Grade and product transitions should be optimized for situational economic, environmental and energy impacts
- Operational decisions should be informed by risk of instability
- Responses to abnormal situations should be informed by risk and uncertainty in operating limits and constraints

***Resilient Operations Requires Increased Emphasis  
on Risk Management***

# Risk Domains



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# Risk Management Transformation

## Traditional Risk Management

## Enterprise Risk Management

- Risks as individual hazards → • Risk in context of business strategy
- Risk identification and assessment → • Risk “portfolio” development
- Focus on all risks → • Focus on critical risks
- Risk mitigation → • Risk optimization
- Risk limits → • Risk strategy
- Risks with no owners → • Defined risk responsibilities
- Haphazard risk quantification → • Monitoring and measurement
- Risk is not my responsibility → • Risk is everyone’s responsibility

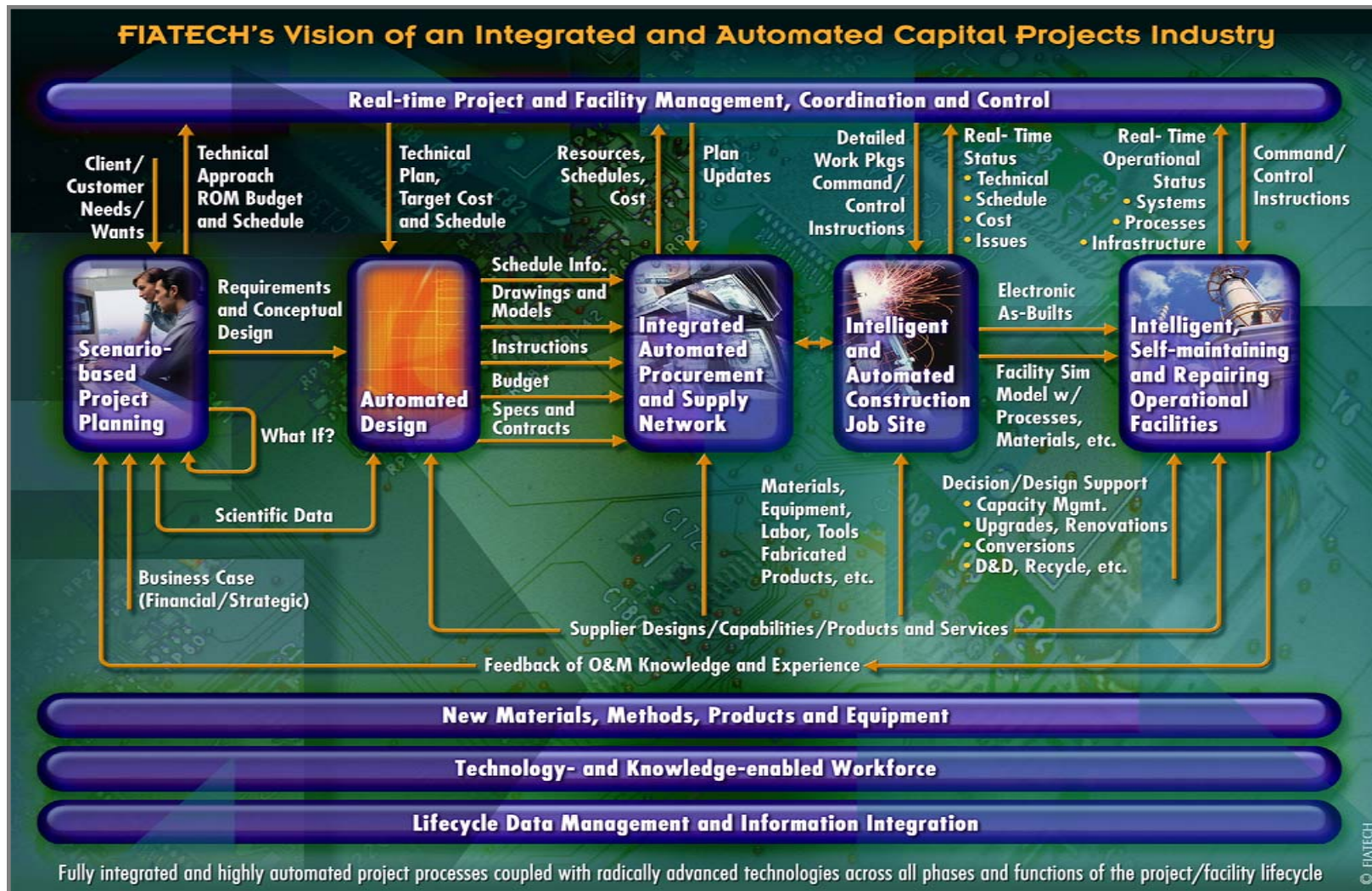
# Key Business Transformations

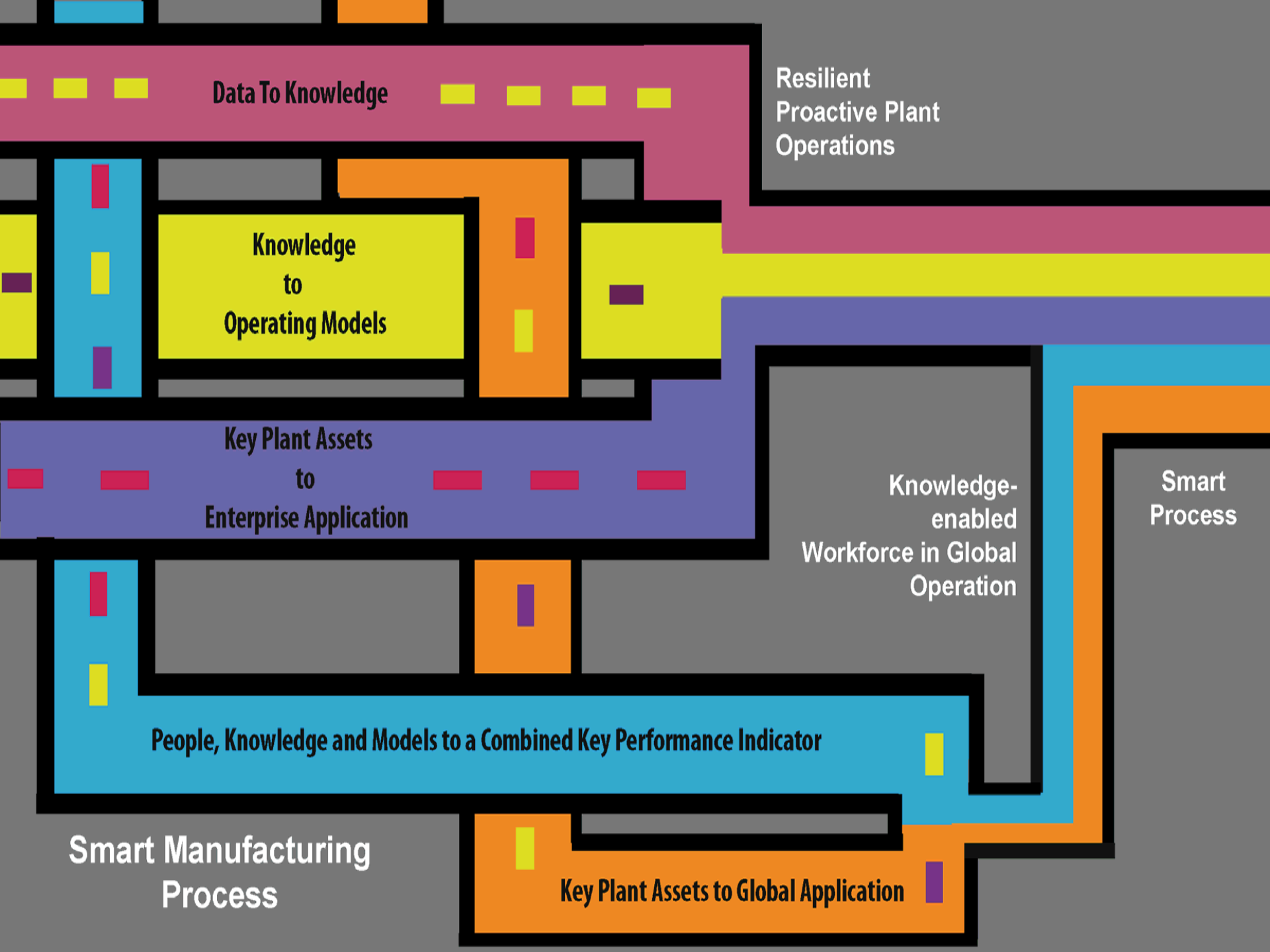
From	To	Results
<b>Investment in Facilities</b>	<b>Investment in Knowledge-Embedded Facilities</b>	<b>Investment and management of facilities and knowledge are equally important.</b>
<b>Reactive</b>	<b>Proactive</b>	<b>Economic optimization is achieved by anticipation and decision, understanding probability, risk and impact.</b>
<b>Response</b>	<b>Prevention</b>	<b>Sensing, modeling and analysis are used to predict events and operations are controlled to mitigate the impact.</b>
<b>Compliance</b>	<b>Performance</b>	<b>Zero-incident EH&amp;S is part of the performance culture.</b>
<b>Tactical</b>	<b>Strategic</b>	<b>Requirements become opportunities, optimizing total enterprise operation.</b>
<b>Local</b>	<b>Global</b>	<b>Every decision must be made in the context of a globally competitive environment.</b>

# Key Technical Transformations

From	To	Result
<b>One-off Models in Operations</b>	<b>Models integrated into Operations</b>	<b>Pervasive, coordinated, consistent and managed application of models</b>
<b>Dispersed Intelligence</b>	<b>Distributed Intelligence</b>	<b>Data, information, knowledge, models and expertise available and used to make decisions at the right time and place</b>
<b>Unintelligent systems</b>	<b>Self-aware Systems</b>	<b>Autonomous systems that understand role and performance in enterprise; systems that take action to optimize role</b>
<b>Proprietary Systems</b>	<b>Interoperable Systems</b>	<b>Systems that communicate through standard protocols for information sharing, capability and best-in-class components</b>
<b>Unpredictable Industry</b>	<b>Predictable Industry</b>	<b>Operations within defined operating envelopes with predictable impacts</b>

# Excellent Work Underway





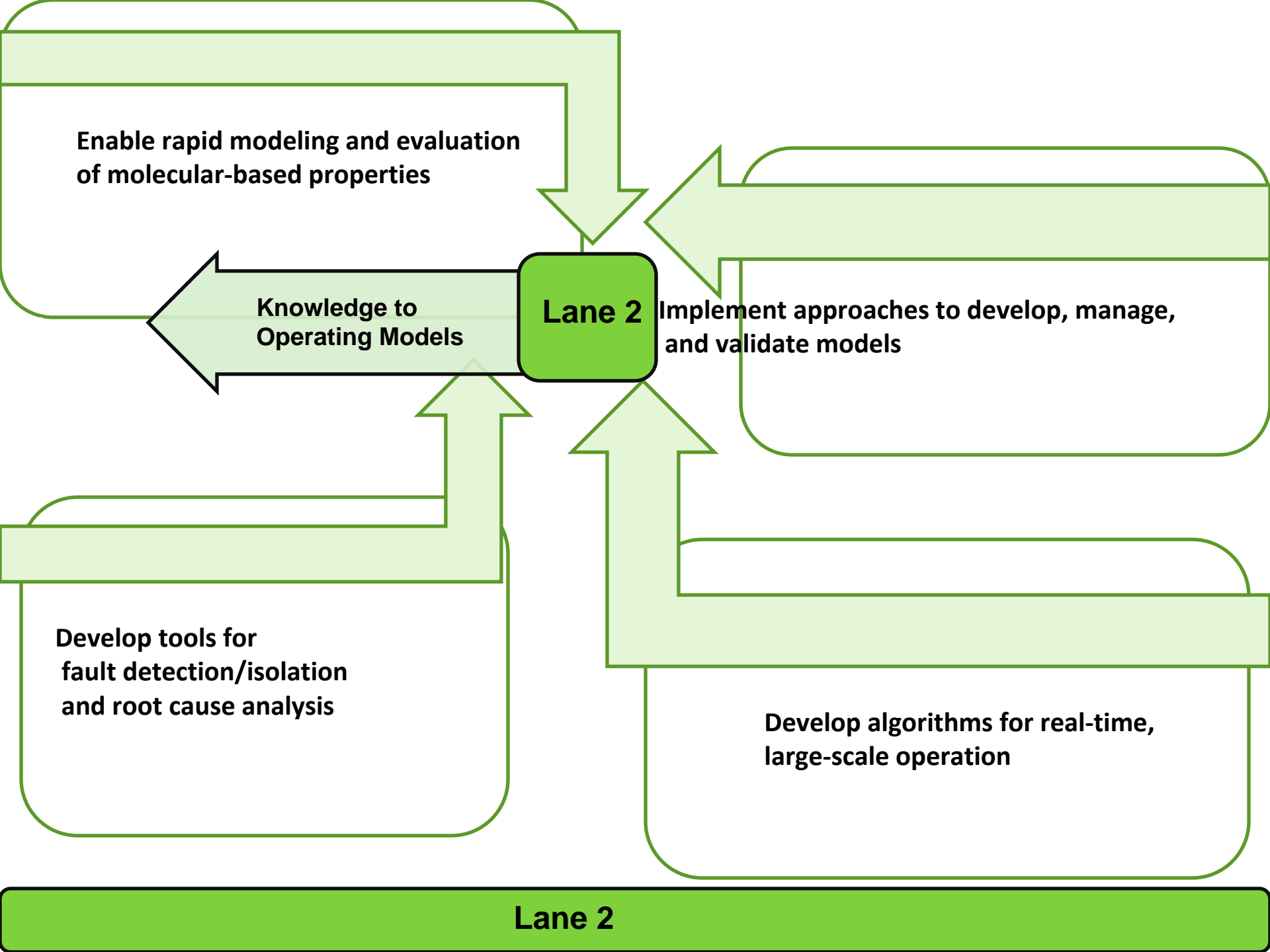
**Develop standards and tools to enable communication in process manufacturing**

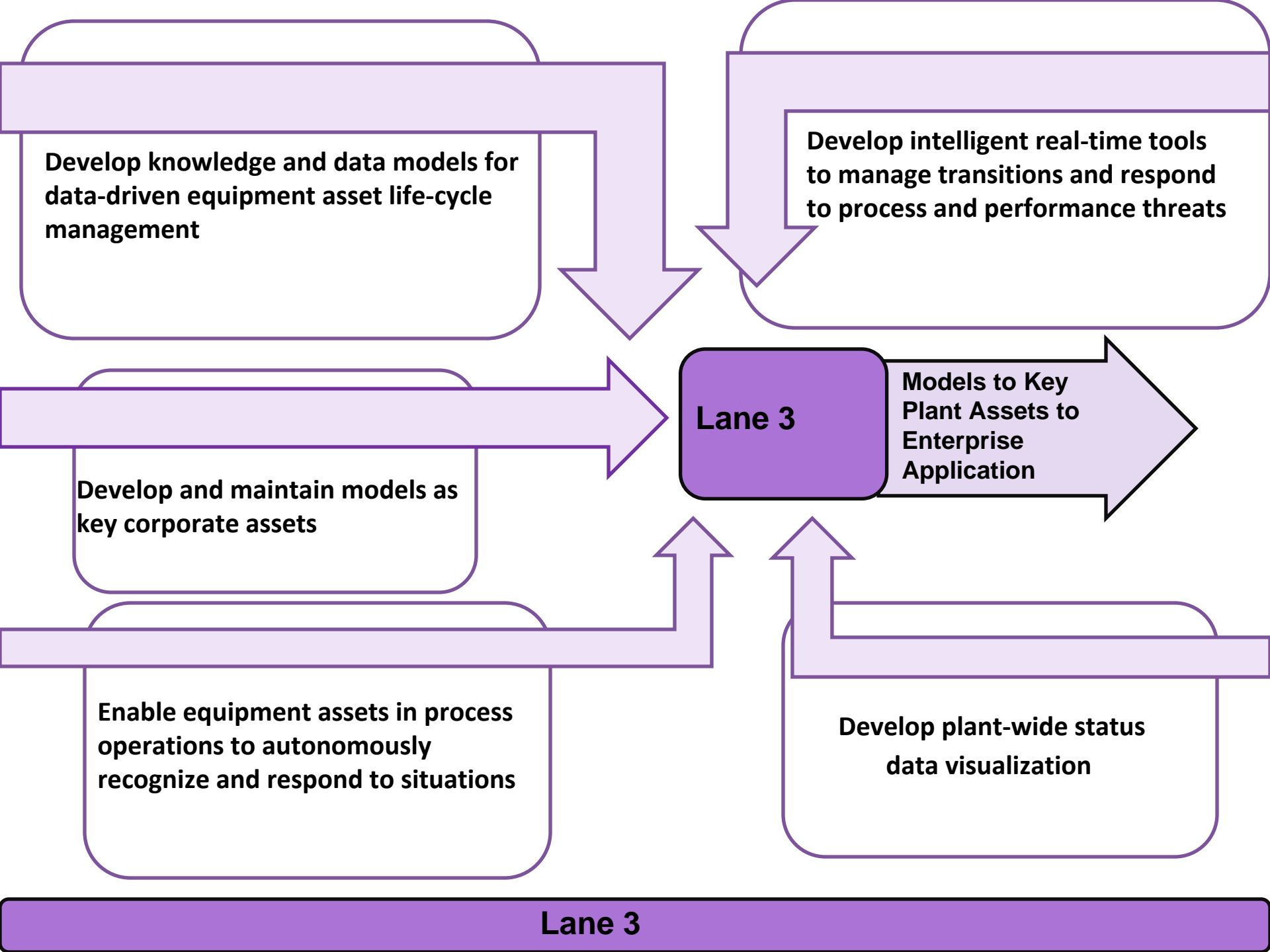
**Get the data. Enable better control, design next-generation actuator/sensor networks for improved model-based state estimation and bias detection knowledge**

**Apply standard approaches to model the process manufacturing enterprise and its activities**

**Lane 1**

**Data to Knowledge**





Develop knowledge and data models for data-driven equipment asset life-cycle management

Develop intelligent real-time tools to manage transitions and respond to process and performance threats

Lane 3

Models to Key Plant Assets to Enterprise Application

Develop and maintain models as key corporate assets

Enable equipment assets in process operations to autonomously recognize and respond to situations

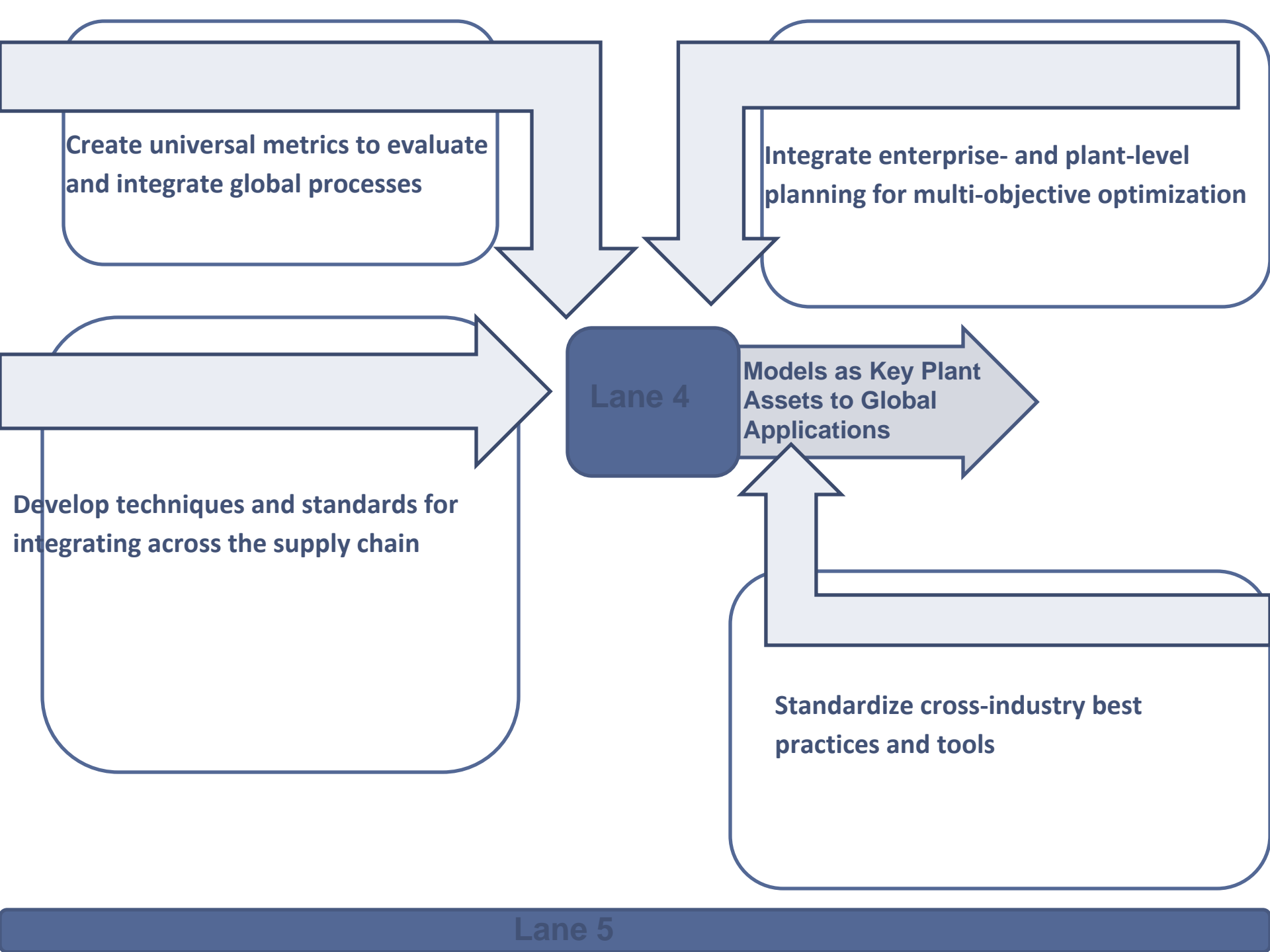
Develop plant-wide status data visualization

Lane 3



# A Fundamental Transformation Results

- **Distributed intelligent manufacturing**
- **Explicit management of risk and uncertainty**
- **Distributed business and operating intelligence to units through integrated models**
- **Resilient Plant Operation**



Create universal metrics to evaluate and integrate global processes

Integrate enterprise- and plant-level planning for multi-objective optimization

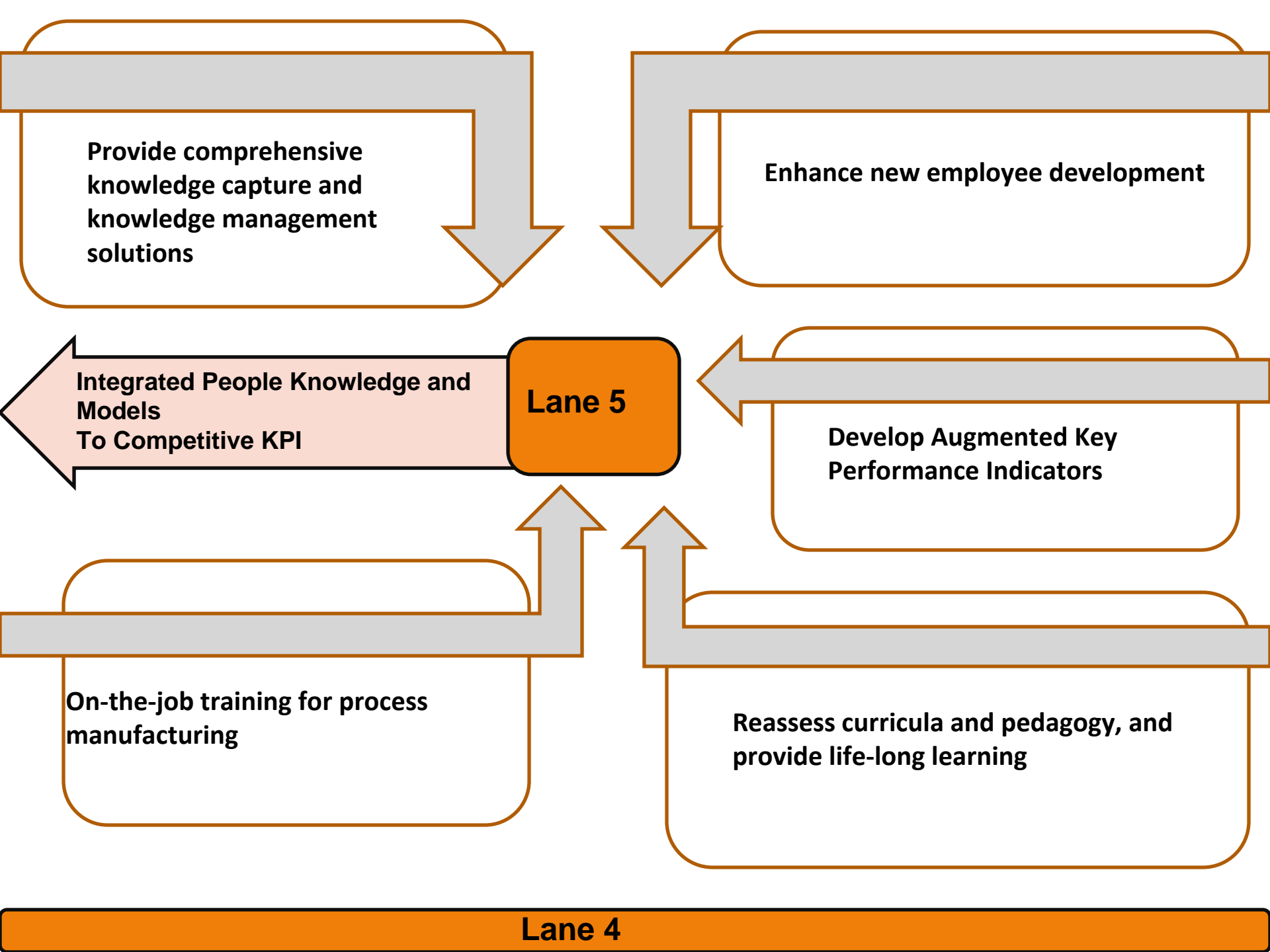
Lane 4

Models as Key Plant Assets to Global Applications

Develop techniques and standards for integrating across the supply chain

Standardize cross-industry best practices and tools

Lane 5



Provide comprehensive knowledge capture and knowledge management solutions

Enhance new employee development

Integrated People Knowledge and Models To Competitive KPI

Lane 5

Develop Augmented Key Performance Indicators

On-the-job training for process manufacturing

Reassess curricula and pedagogy, and provide life-long learning

Lane 4

# Smart Manufacturing Transformation

- Ultimate “**meaningful use**” is to create significant and measurable improvements in U.S. manufacturing competitiveness through highly-optimized, dynamic demand-driven and sustainable industrial plants and supply chains enabled by information and knowledge technologies.
- Key goals:
  - Move to proactive operations and life-cycle management to optimize manufacturing economics, quality, safety and efficiency
  - Drive energy, sustainability, EH&S and economic agility into meaningful integrated manufacturing performance criteria
  - Transform manufacturing from fixed, supplier-driven production to dynamic demand-driven production
  - Enable sustainable production of nationally strategic goods (e.g., Bio/Nano, Clean Energy, Green/Tech, and DOD needs.)
  - Increase U.S. manufacturing competitiveness and exports
  - Revitalize the 21<sup>st</sup> Century industrial community model

# Longer-term Smart Manufacturing Metrics & Goals

- **Workplace and Process Safety:** Zero injuries or incidents by 20xx
- **Competitiveness:** Average cost of manufacturing in key U.S. industrial sectors equivalent to average costs in other nations (*level the playing field with Smart Manufacturing efficiencies*)  
40% higher exports by 20xx
- **Flexibility:** 30% faster time-to-market by 20xx
- **Energy:** 20% reduction by 2020
- **Environmental:** Zero emissions by 20xx
- **Water:** XX% reduction by 20XX
- **Information Flow:** Carbon footprint listed on 60% of product packaging which enables customer demand for less carbon intensive production
- **Production Safety:** Track & trace in minutes vs. months by 20xx
- **Sustainability:** 25% of production recycled and/or reused by 20xx
- **Automatic Reporting** - Eliminate unnecessary reporting burden for data use by government agencies by 20xx
- **Verification** of metrics to be performed by appropriate federal government agencies as required by regulations and/or other requirements: FDA, EPA, DOC, DOE, etc.

**A Good Start!!!**

**We are all in the Smart  
Plant business, now!!!**