



Modeling the Product Development Enterprise

Methods, Decisions and Metrics

Presented By
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LAI – Product Lifecycle
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Joao Castro

- **Education**

- EE+CS from Porto, Portugal
- MSc Engineering Design from Lisbon, Portugal

- **Professional Experience**

- 2001 – Cisco Systems, San Jose, CA
- 2002 – Metro do Porto, PT
- 2003-2005 – UMIC, Portuguese Gov.



Sid Rupani

- **Education**

- **BS in Mechanical Engineering (Concentrations in Design and Aerospace) from WPI**
- **MS program in ME at WPI**

- **Experience**

- **Intern at DEKA Research and Development, Summer 2003**
- **Research Assistant, Duke University Aeroelasticity group, Summer 2004**



Who We Are

Advisors

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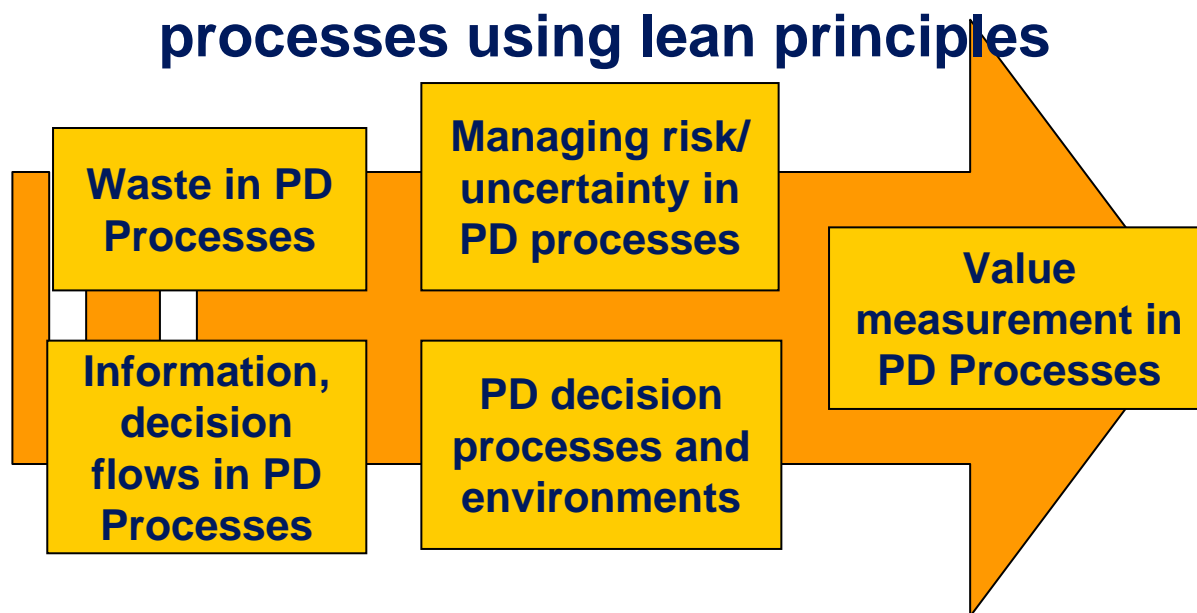
Motivation

- **Understand how Lean principles apply to PD**
- **Extend PD analysis to the enterprise level**
- **Extend understanding beyond mapping flows of information**
- **Focus on creating streams of successful products, not one-off product successes**

Synthesize cumulative knowledge from LAI and other research on product development to achieve these goals

Recent LAI Lean PD Research

- Focus has been on reducing waste, improving the flow of information, and improving the performance of PD programs
- Research and efforts focused on developing insights, knowledge, and tools to enable better management of PD processes using lean principles



Lean PD Execution

- Flow and pull of Information and decisions based on customer value
- Value-driven lean management metrics
- PD process/state awareness and transparency
- Effective value stream mapping, improvement activities and processes

* Many additional past LAI theses address waste, value, and uncertainty management in PD

<http://lean.mit.edu>



Major Research Insights

The key insights that emerge from the numerous studies in these areas are:

- **Value in PD** is poorly/inaccurately measured currently, and **better metrics**, preferably leading or real-time, are needed to **enable better management** of PD processes.
- Information is a carrier of value, but the key operators of interest in PD are the **decision processes** that transform information into more valuable forms (greater specification of the product, higher levels of certainty in the outcomes).
- **Handoffs** across boundaries (functions, organizational, temporal, etc.) are a major source of **delays and waste**, suggesting increased performance from better design of PD enterprise architecture, interfaces, and processes.

Findings highlight key issues—value, decisions, boundaries—and next steps in our understanding of lean enterprise PD



What we did when we came in

- Iteratively developed an enterprise framework
- Each team member studied 5 or 6 books
- Each book studied by 2 team members
- Collectively captured 150 best practices
- Grouped them by enterprise discipline





“Design is a decision process”

Herbert Simon, Nobel laureate



Product Development Decisions: A Review of the Literature

V. Krishnan, Karl T. Ulrich

- **“...product development as a deliberate business process involving hundreds of decisions, many of which can be usefully supported by knowledge and tools.”**
- **Examples:**
 - **What is the core product concept?**
 - **Which components will be shared across which variants of the product?**
 - **What are the values of the key design parameters?**



**Decisions yield streams of information
which enable subsequent decisions**

**The Enterprise achieves its objective by
making decisions and pursuing their
consequences**



- **There is a method associated with every decision**
- **Examples of methods:**
 - Risk-Reward Bubble Diagram,
 - NPV analysis,
 - Stage-Gate,
 - House of Quality
 - Power rules



What is a method?

- A **method** transforms defined inputs to desired outputs
- Our literature review suggests that good methods accomplish a defined goal via an orderly structure of actions (process)



What is a proverb?

- Proverbs usually address the ‘what’ but not the ‘how’
- Proverbs are adages collected from experience that gained credence through widespread or frequent use
- For example, “an enterprise should have free and open channels of communication”



	Methods	Proverbs
Enterprise Strategy	17	18
Portfolio Development	41	50
Technology Development	5	3
Production	0	1
Sales & Distribution	6	3
The “Verticals”	4	9
TOTAL	73	94



Modeling the Enterprise



The Enterprise is made up of disciplines

- **Enterprise Strategy**
- **Customer Interface**
- **Technology Development**
- **Product/Portfolio Development**
- **Production**
- **Distribution and Life Cycle**
- **The Verticals**
 - **Finance**
 - **Human Resources**
 - **Infrastructure**
 - **Others**



The Enterprise Matrix

	<i>Enterprise Strategy</i>	<i>Customer Interface</i>	<i>Technology Development</i>	<i>Product/Portfolio Dev.</i>	<i>Production</i>	<i>Distribution and Lifecycle</i>	<i>Finance</i>	<i>Human Resources</i>	<i>Infrastructure</i>	<i>Quality</i>
Enterprise Strategy										
Customer Interface										
Technology Development										
Product/Portfolio Dev.										
Production										
Distribution and Lifecycle										



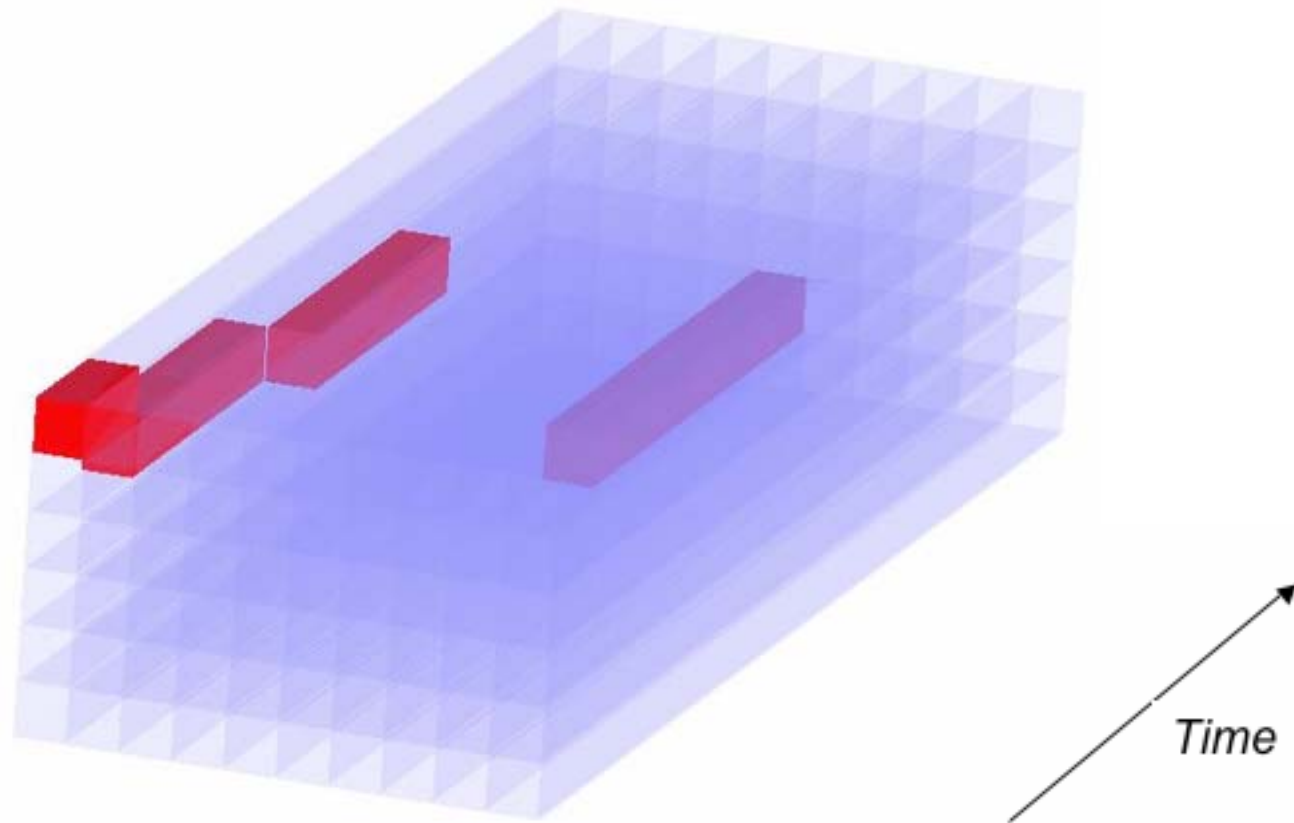
A Medical Devices Company Product Development Process

Stage-gate
Risk Reward Bubble Diagram

	Enterprise Strategy	Customer Interface	Technology Development	Product/Portfolio Dev.	Production	Distribution and Lifecycle	Finance	Human Resources	Infrastructure	Quality
Enterprise Strategy									2	
Customer Interface	5	7		4	1	7			2	1
Technology Development			1	1						
Product/Portfolio Dev.	2	8	2	49	3	5	1	1	7	23
Production	2			2	12			1		3
Distribution and Lifecycle		2				5			3	



The activities of the Enterprise can be captured as the extrusion of the Enterprise Matrix over time

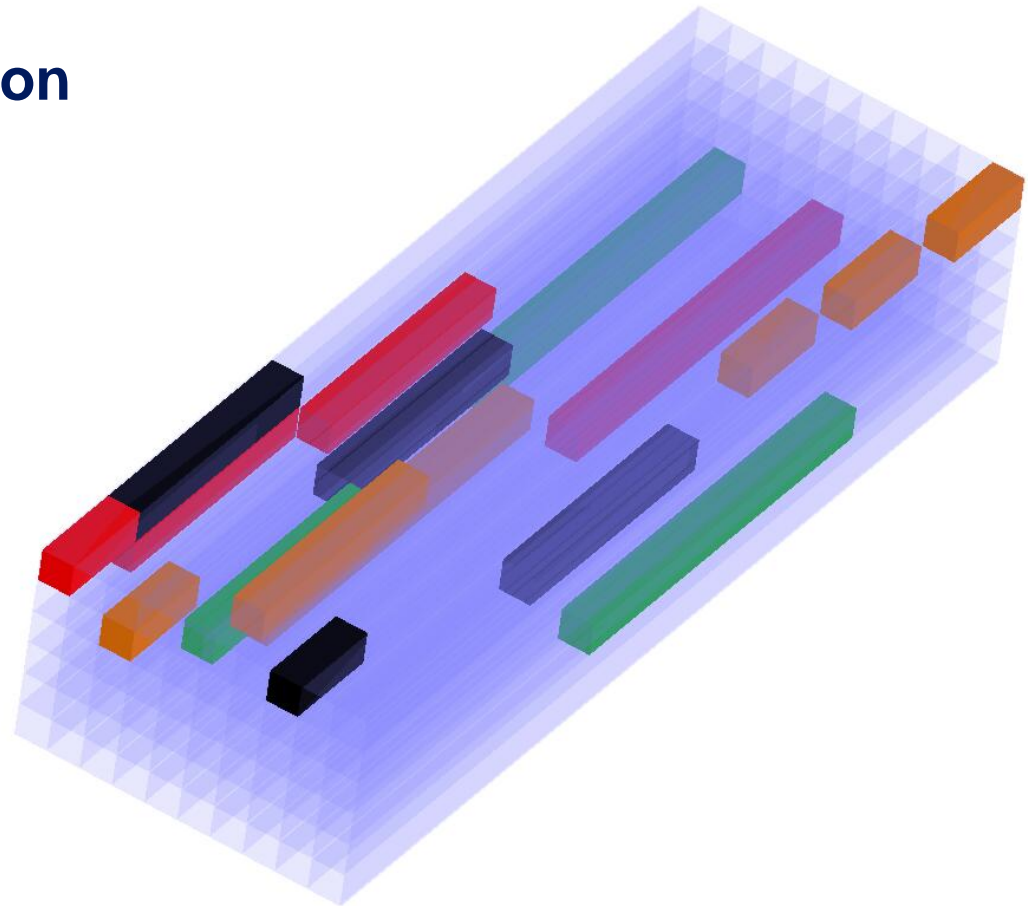




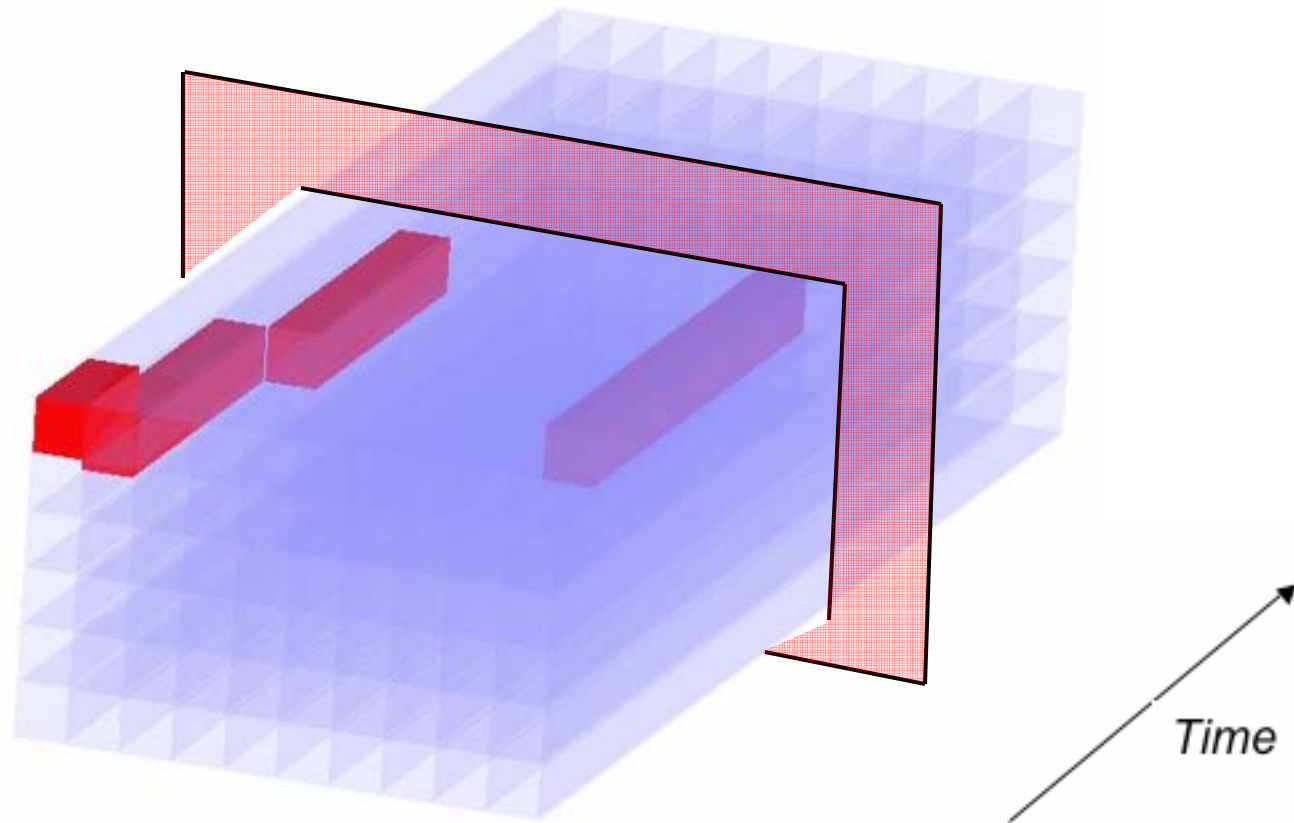
Representation of the entire Enterprise

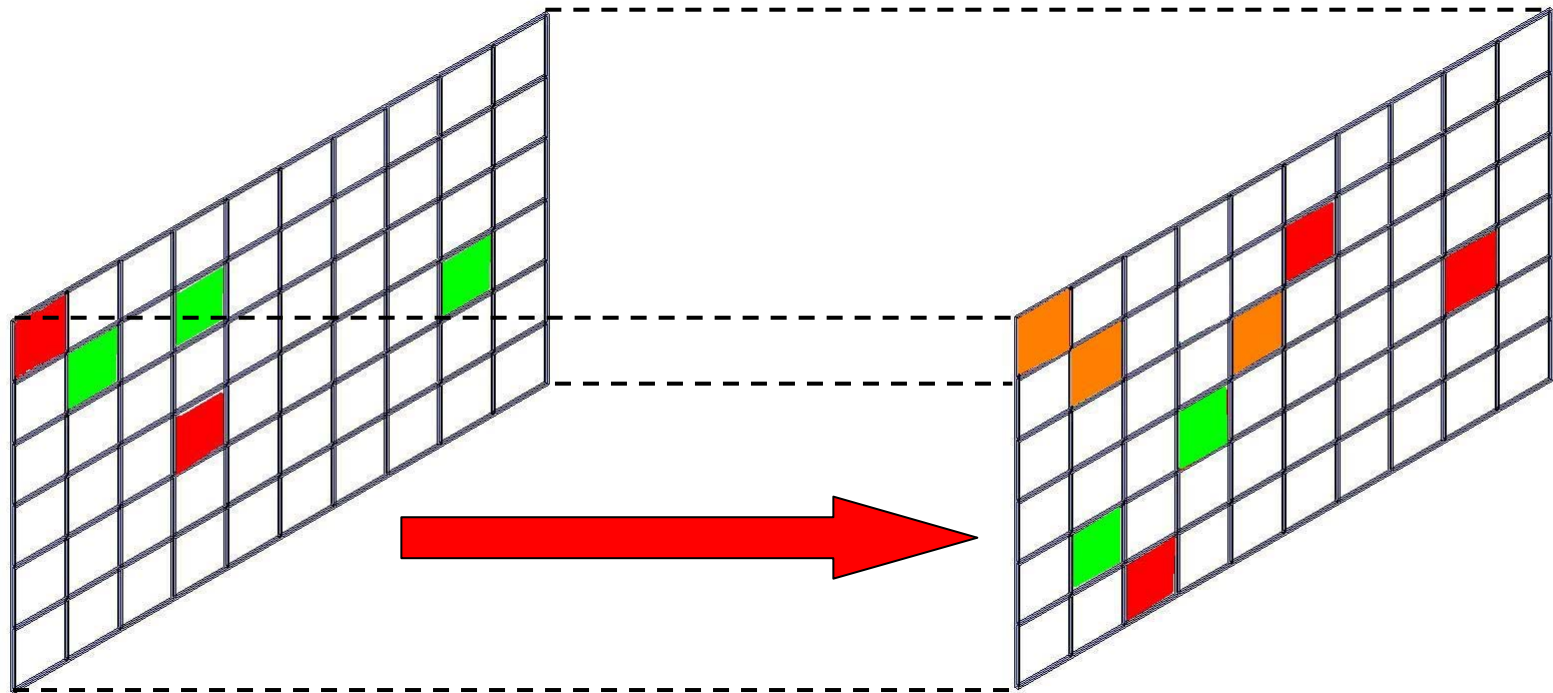
Notional Representation

Multiple Projects



States of the enterprise are slices through the extrusion





State of Enterprise at time t

State of Enterprise at time $t + \Delta t$

Each decision environment is made up of
Methods, People and Culture

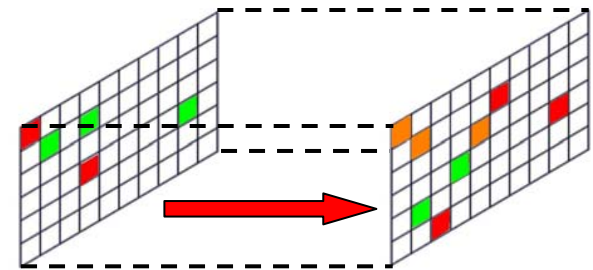
Working Definitions for Metrics

Quality

- Measures the degree of effectiveness of a method in a decision environment.
- Captures the strengths and weaknesses of the method.

Capability

- Measures the extent to which
 - people are equipped with the skills necessary to execute, and
 - culture supports the execution of methods within a decision environment.





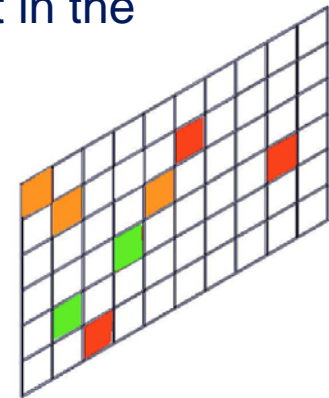
Working Definitions for Metrics

Capacity

- Measures whether the enterprise has the resources (i.e. time, money, people, etc.) required to do a job on schedule and on budget that meets customers' needs at a specified risk level. This is measured across all decision environments.

Compatibility

- Measures the agreement/consistency/harmony in the information at a state. Incompatibility refers to the amount of conflict in the information at a state.





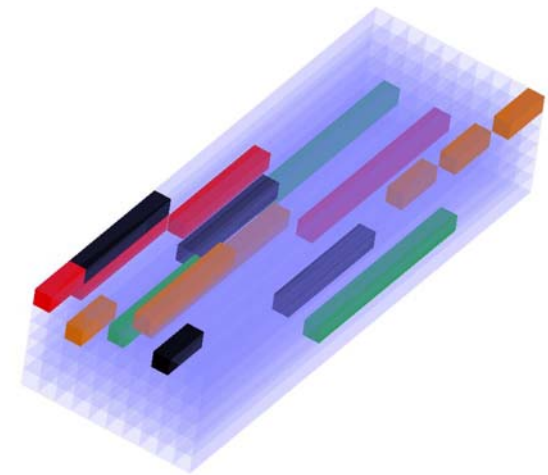
Working Definitions for Metrics

Continuity

- Measures the ratio of information that is available but unused vs. the information that is being used at a state.

Alignment

- Measures the agreement/consistency/harmony of the methods and objectives across all decision environments at a state.





Summary

- **Conducted a literature review**
- **Began a taxonomy framework**
- **Applied the framework while reviewing the enterprise development activities of two companies**
- **Developed a set of Metrics to analyze the enterprise**



- **The framework is not an end in itself**
- **Based on a lot of the research done at LAI and grounded on other studies and real examples**
- **Next steps**
 - **Continue to flesh out methods/framework**
 - **Continue metrics development**
 - **Refine research topics**
 - **Author paper on the framework**
- **Get into the field for observation and measurement**



Preliminary Research Topics for Dissertations

Sid

Examining the intersection and dependencies between **Decision Making** Processes and Metrics in PD.

Joao

Team organization and alignment, compatibility and continuity

Dan

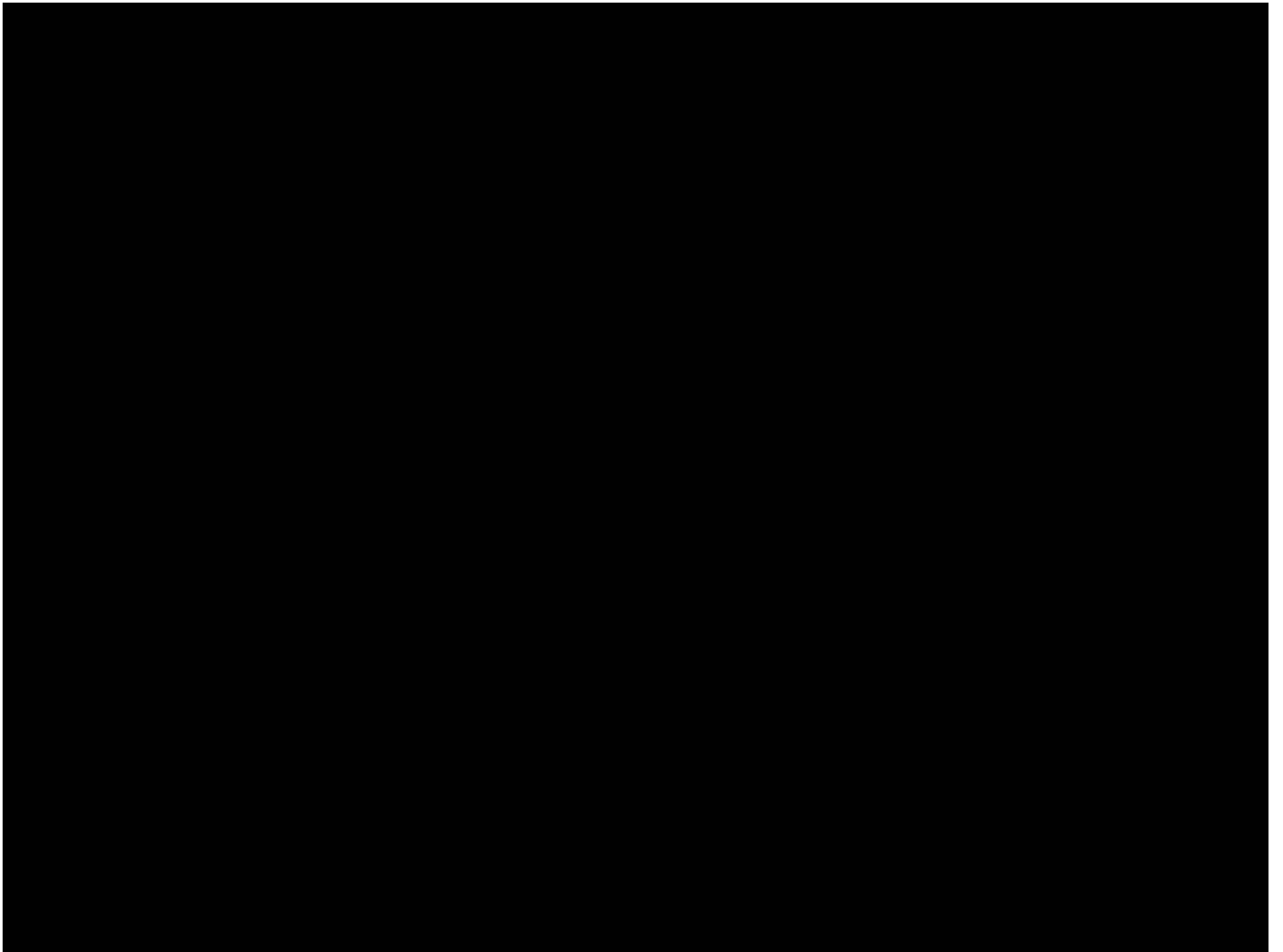
Methods to measure and support **alignment of stakeholders** over multiple projects

Robb

Managing **Risk and Uncertainty**- Traditional Methods and the Lean Enterprise

Dave

Platform management and design to improve cost, schedule and performance using lean enterprise techniques





BACK-UP SLIDES



Enterprise Strategy

sets and executes the vision, mission, goals, and accompanying strategies for the Enterprise.

Customer Interface

gathers and maintains the corporate knowledge of customers' needs and desires, and of market conditions.



Technology Development

identifies candidate technologies, prepares them for transition into products, and maintains the corporate knowledge of relevant technologies.

Portfolio Development

identifies and defines the portfolio of products that best implement the Enterprise strategy.



Production

creates the products defined by Portfolio Development.

Distribution and Life Cycle

sells, delivers, and maintains the product through its normal life cycle.