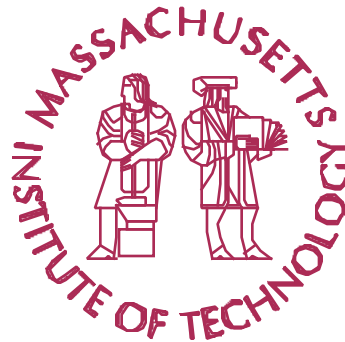


# **Lean Aerospace Initiative Plenary Workshop**

## **Key Characteristic Maturity Model**



**March 31- April 1, 1998**

**Presented By:**

**Basak Ertan**

**MIT**

Research Sponsored By Lean Aerospace Initiative



# Presentation Outline

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- **Key Characteristic(KC) Overview**
- **Benchmarking and KC Maturity Model**
- **Company Assessment Using KC Maturity Model**
  - KC practices for enhanced supplier interaction



## **Key Characteristics**

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**Critical few product features that significantly affect the quality, performance, or cost of the product**

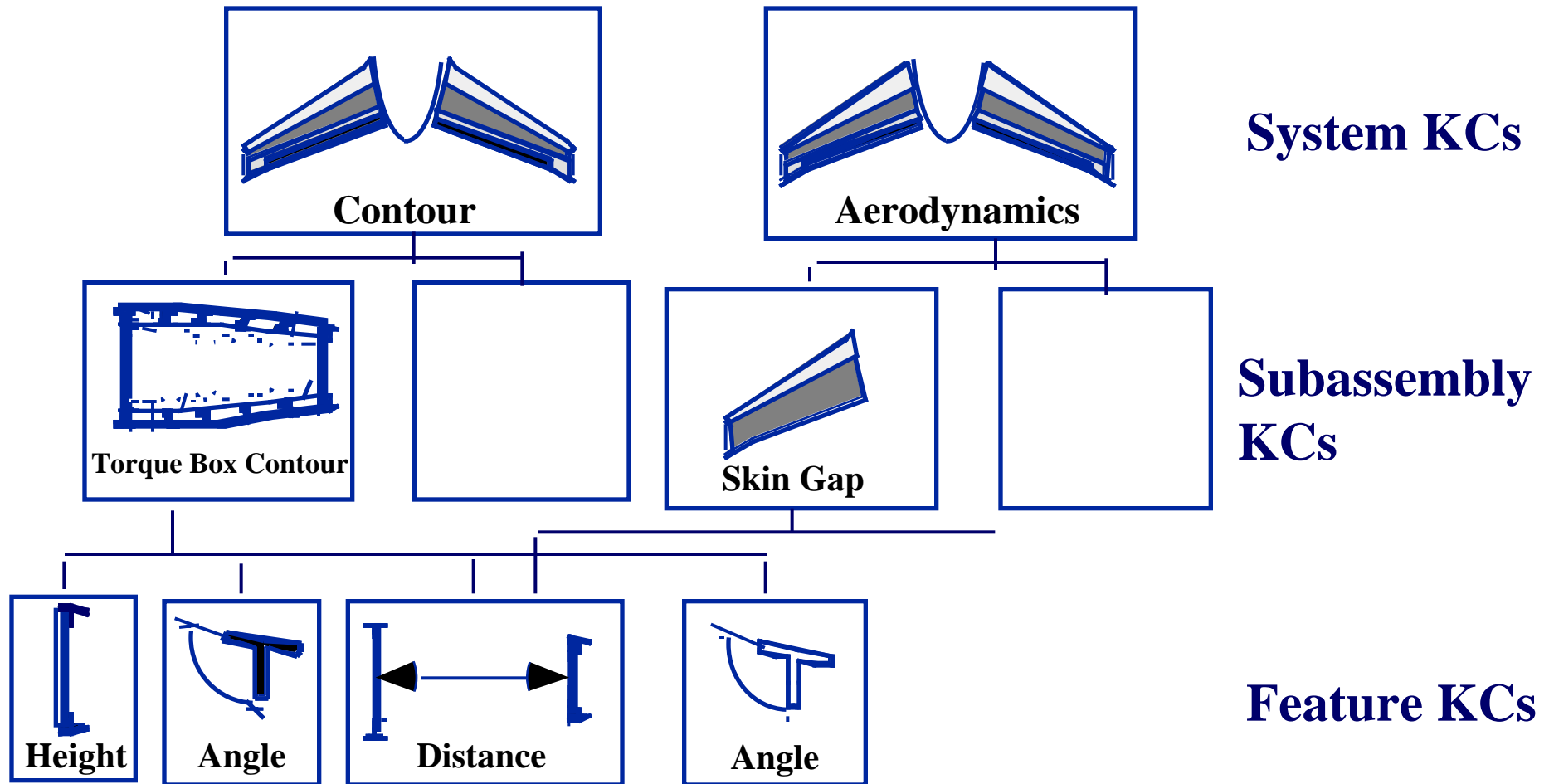
**Critical parameters that cannot withstand variation – thus causing a loss (rework, scrap, repair, or failure).**



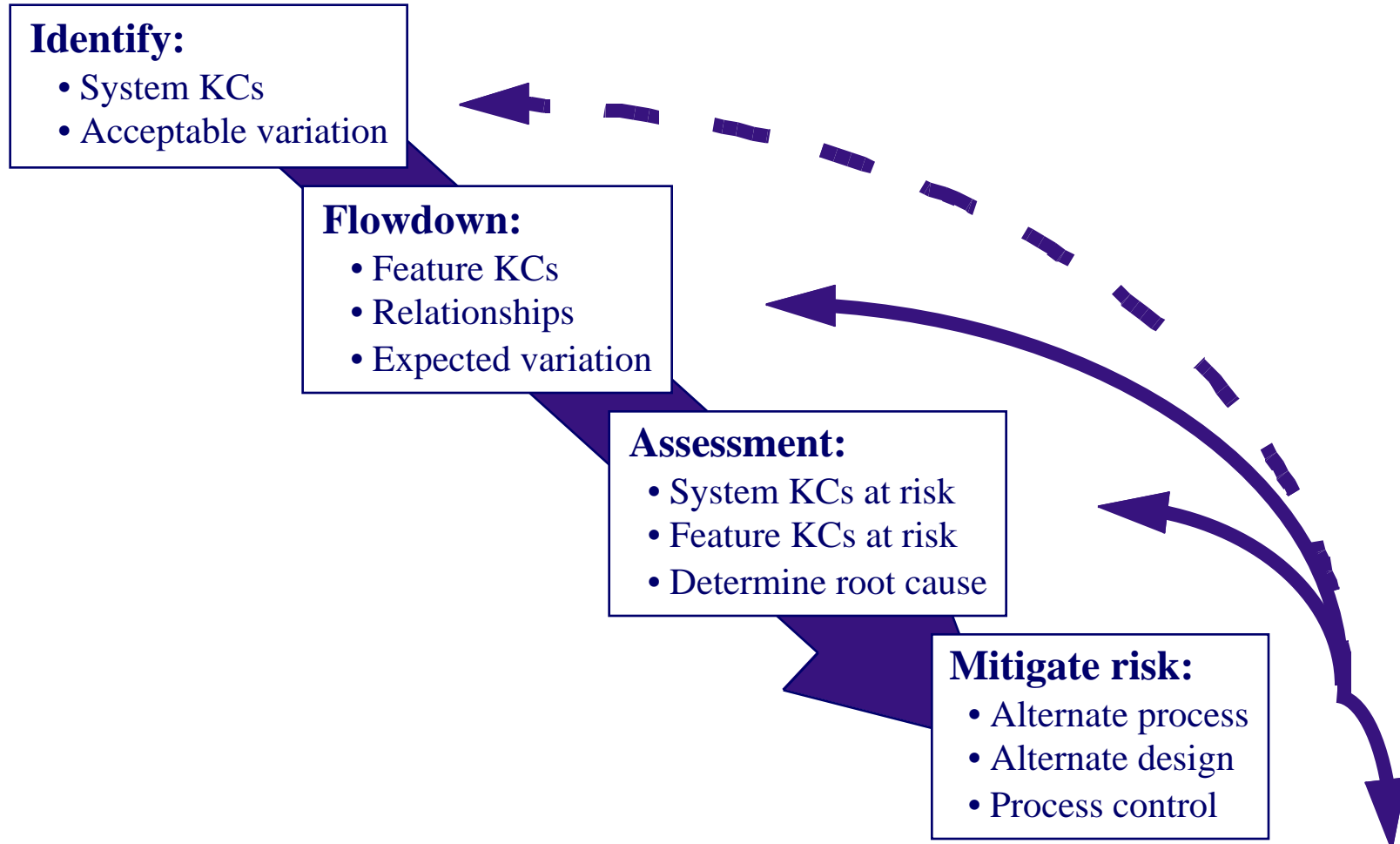
## KC Flowdown Examples

	<b>System</b>	<b>Subsystem</b>	<b>Feature</b>
<b>Automotive</b>	<b>Door Sealing</b>	<b>Door shape – Frame shape</b>	<b>Stamping precision</b>
<b>Aircraft</b>	<b>Horizontal Stabilizer -- Contour</b>	<b>Main Torque Box -- Contour</b>	<b>Front Spar Angle</b>
<b>Defense Electronics</b>	<b>Night vision goggle image resolution</b>	<b>Image Intensifier tube S\N ratio</b>	<b>Microtube -- center to center spacing</b>
<b>Copier</b>	<b>Copy uniformity</b>	<b>Film voltage</b>	<b>Power supply current</b>

# KC Levels



# KC Identification Process



***Variation risk management involves identification, assessment, and mitigation***



# Key Characteristic Research Topics at MIT

- **Capturing Design Intent Using Key Characteristics**
  - Mark Ardayfio
- **Aligning Organizational Structures and KC Processes**
  - Basak Ertan
- **KC Methods: Utilization of KC Tools and Techniques**
  - Don Jay
- **Variation Risk Management for Key Characteristics**
  - Tony Chen
  - Young J Jang
- **KC Maturity Model**
  - KC Group
- <http://cardamom.mit.edu/KC/kc.html>



# Research Approach

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- **Data Gathering**
  - 15 Site Interviews (86 people)
  - 2 Key Characteristics Symposia
  - 3 Intern-based Assessments
- **Develop KC Maturity Model**
  - Tool to qualitatively evaluate the maturity of KC efforts within an organization
  - 22 supporting practices for assessment
    - Description of practice
    - 4 levels of maturity
  - Relationship of the practices
- **Company assessments**
  - KC Maturity Model Survey
  - Questionnaire





# ***KC Maturity Model***

## **Areas of Assessment**

- **KC Definitions and Methods**

- KC Identification Phase
- KC Definition and Methods
- KC Validation
- KC Prioritization
- Documentation
- Modeling
- KC Flowdown

- **Measurement and Feedback**

- Measurement Plans
- **Capability Feedback**
- Capability Uncertainty

- **Organization**

- Customer Interaction
- Integrated Product Teams
- **Supplier Interactions**
- Management Support
- Incentive Structures
- KC Training
- **Existence of KC Objectives**

- **Design Process**

- Design Changes/Robust Design
- New Technology
- Cost Tradeoffs
- Reuse/Legacy Data
- Tolerancing & Dimensioning



# KC Maturity Model Example: Process Capability Feedback

	Level	0	1	2	3
	Definitions	Not used at all	Reactive	Semi-Proactive	Fully Proactive
<b>Process Capability Feedback</b>	The process by which historical data on process capability is made available to functional organizations outside the manufacturing group.	No feedback into design.	Capability fed back when problems occur.	SPC data captured and recorded for a variety of features, but data is hard to find and isn't used throughout the organization.	SPC data fed back to design, updated, and is available electronically in a form that is simple to incorporate in a design.



## Surveyed Companies

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- **Aerospace**

- Boeing (Commercial, D&S, St. Louis, Long Beach)
- Northrop Grumman
- British Aerospace
- Lockheed Martin (JSF)
- AlliedSignal Engines
- Pratt & Whitney
- Textron
- ITT (Aerospace/Communications)

- **Non Aerospace**

- Ford
- GM
- Chrysler
- Xerox
- Eastman Kodak

- **KC Assessment Sample Size 25**
- **Additional Survey Sample Size 41**



## *What were issues examined*

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- **Differences between Aerospace companies and Non Aerospace companies**
- **Existence of organizational support and processes**
- **Consistency in definitions and methods**
- ***Usage of process capability***
- **...**



## ***Process Capability: How is it being used***

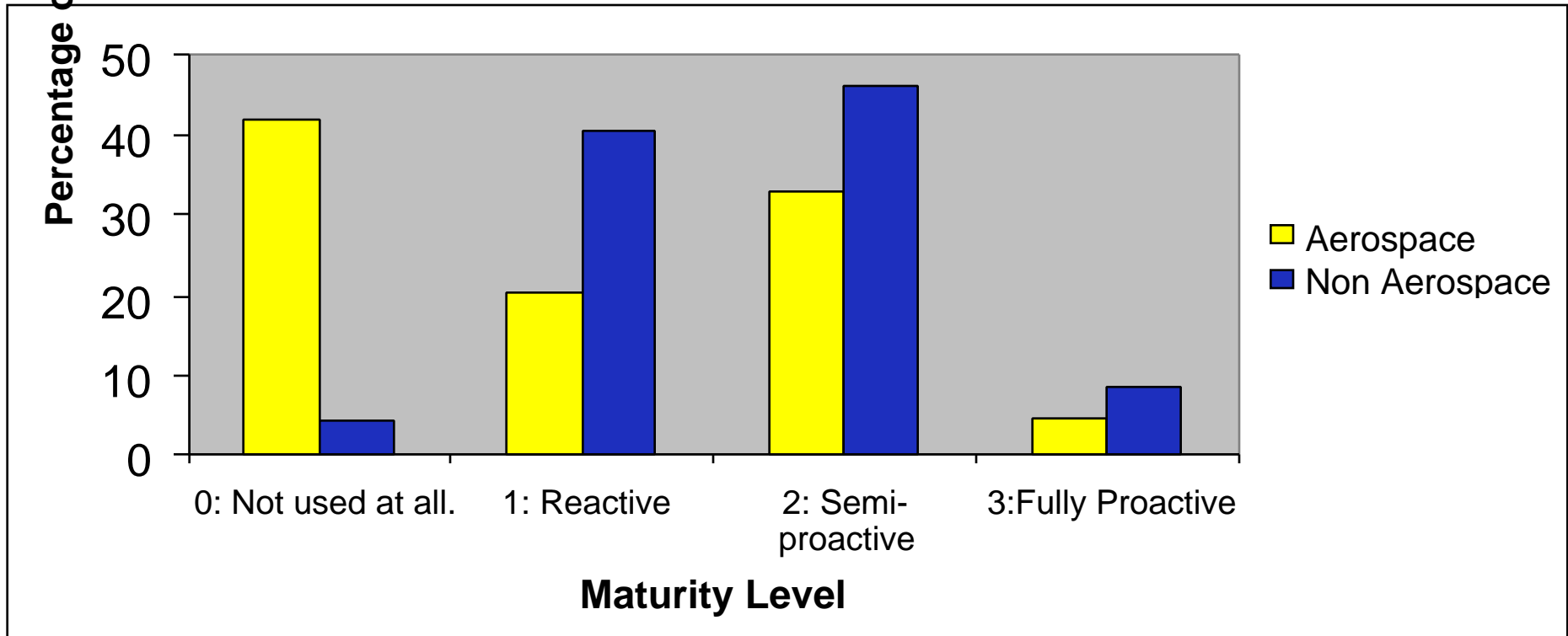
***Is process capability from suppliers used in new designs, derivative designs, and redesigns?***

- **Comparison of Aerospace to Non Aerospace companies**
- **Comparison of Internal to External suppliers**
- **Level and stage of supplier interaction**



# Process Capability Feedback

**The process by which historical data is made available to functional organization outside of the manufacturing group.**



*No data requested.*

*Data requested only when problems occur.*

*Data fed back but hard to find and use.*

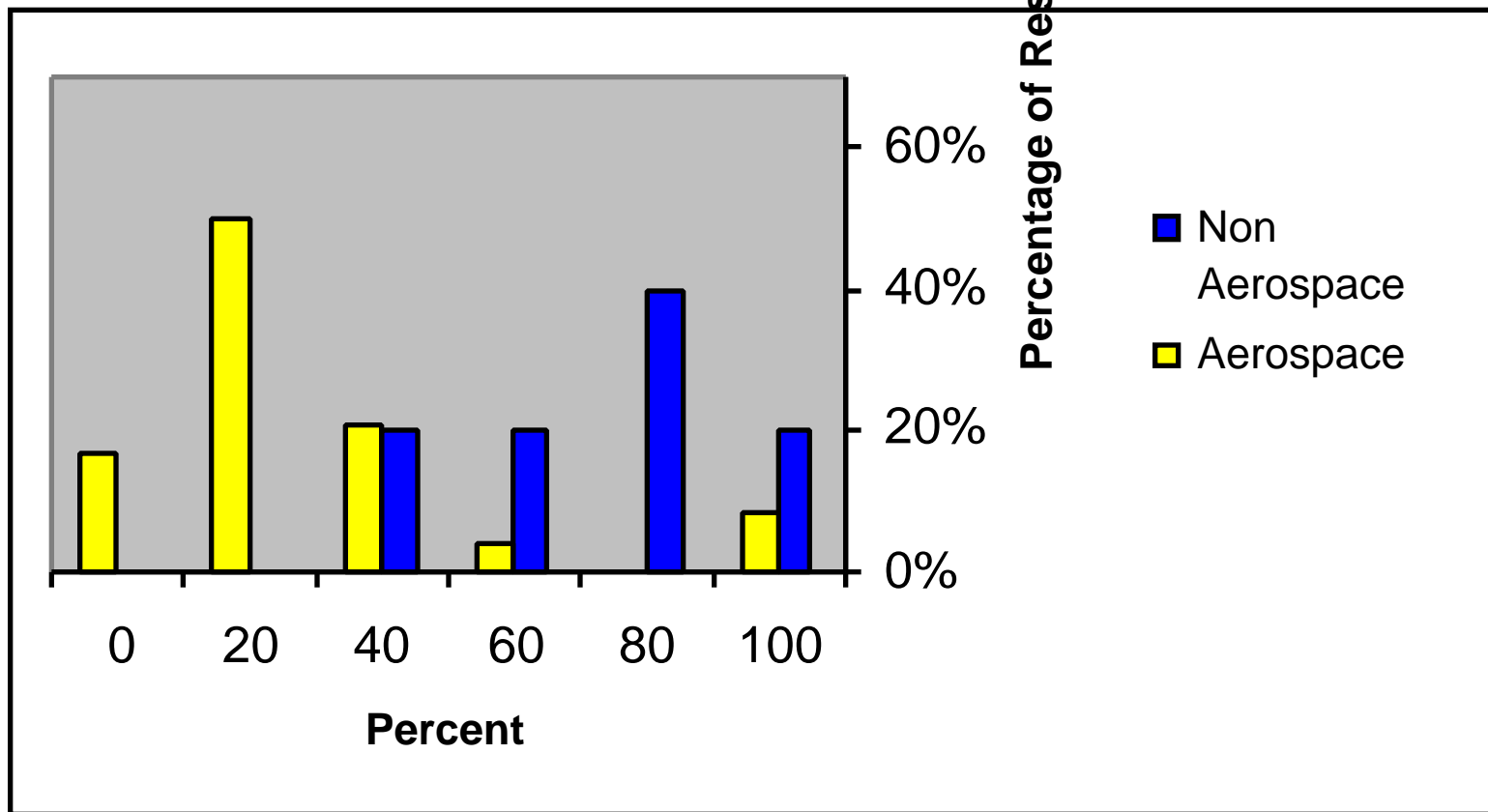
*Data fed back, updated, and is available electronically in a easy to use form.*

Source: KC Maturity Model Survey



# Supplier Process Capability Feedback

**What % of the time is KC supplier data fed back to the organization?**

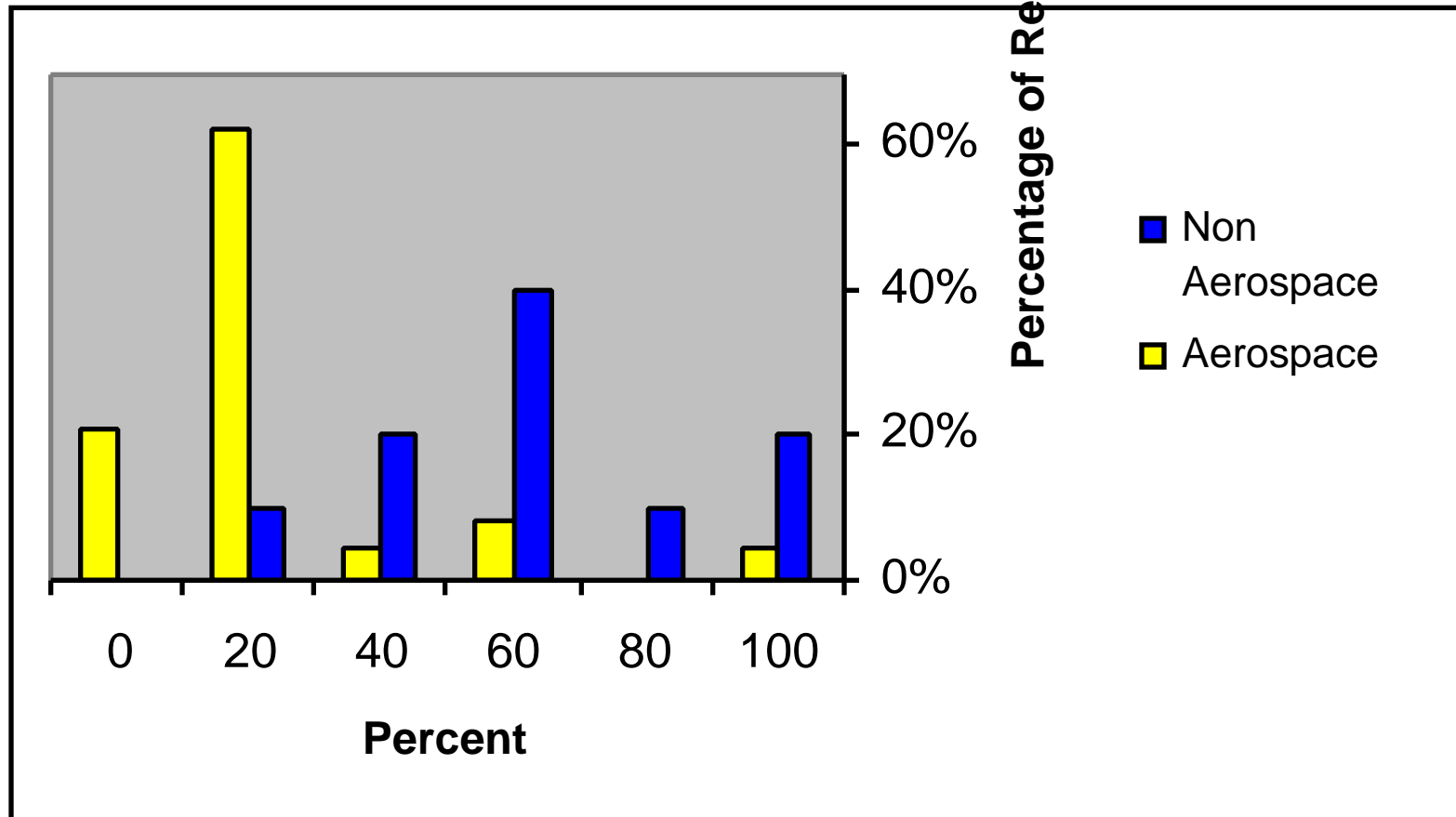


Source: Additional Questionnaire



# Supplier Process Capability Reuse

*How often is KC supplier data reused by design?*



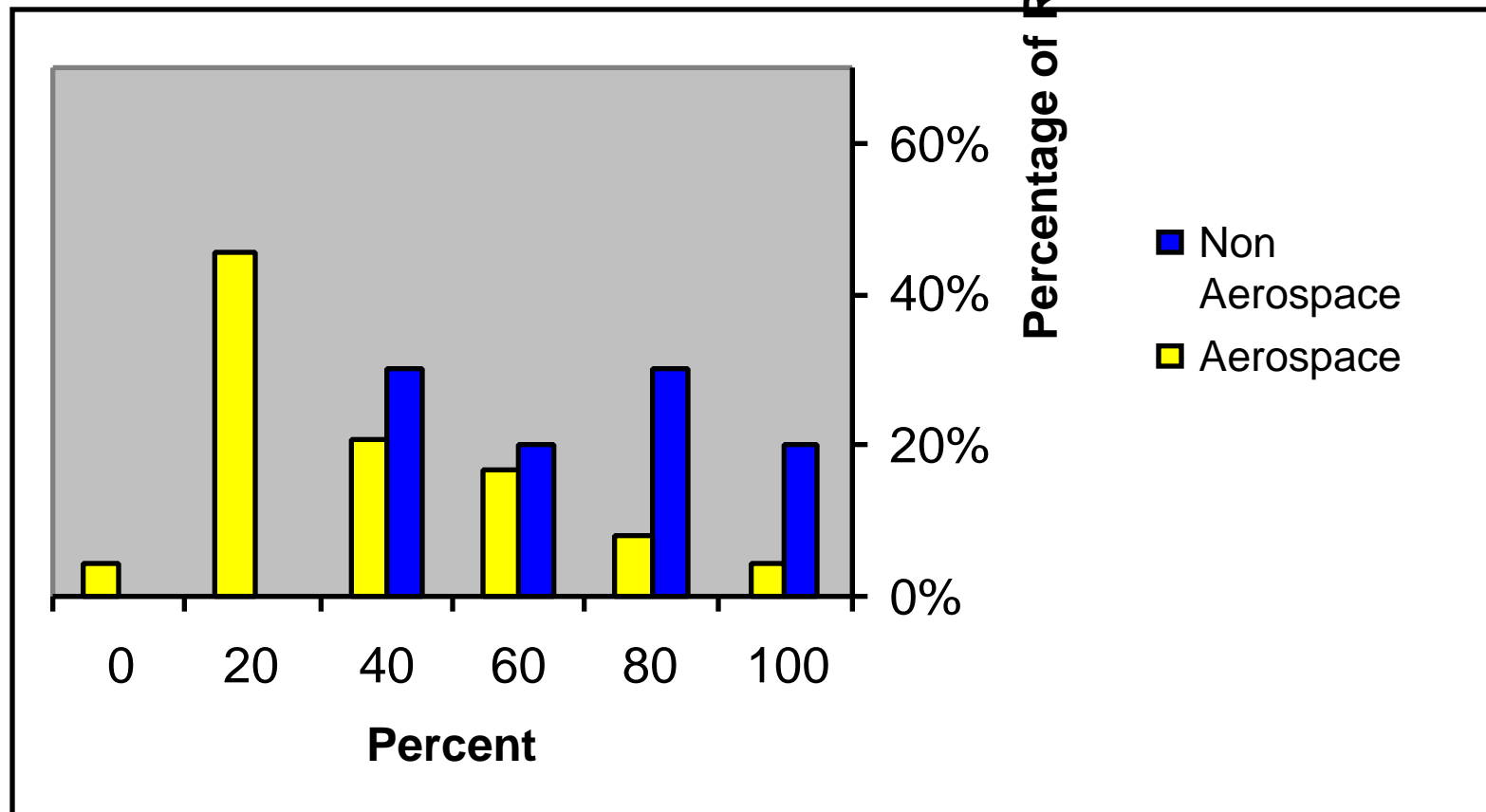
Source: Additional Questionnaire





# Internal Process Capability Feedback

**What % of the time is internal capability data fed back to the organization?**

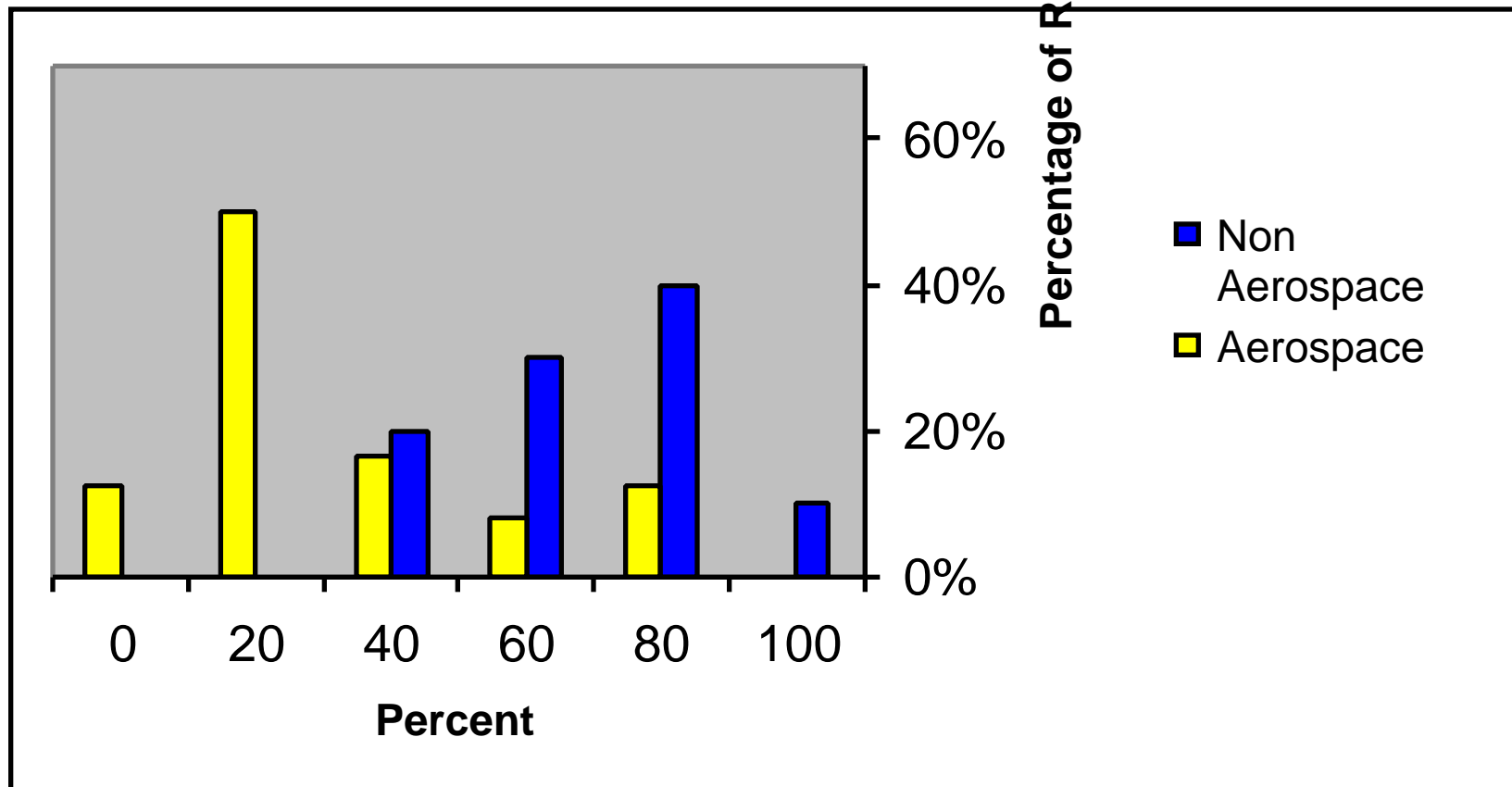


Source: Additional Questionnaire



# Internal Process Capability Reuse

*How often is internal capability data reused by design?*

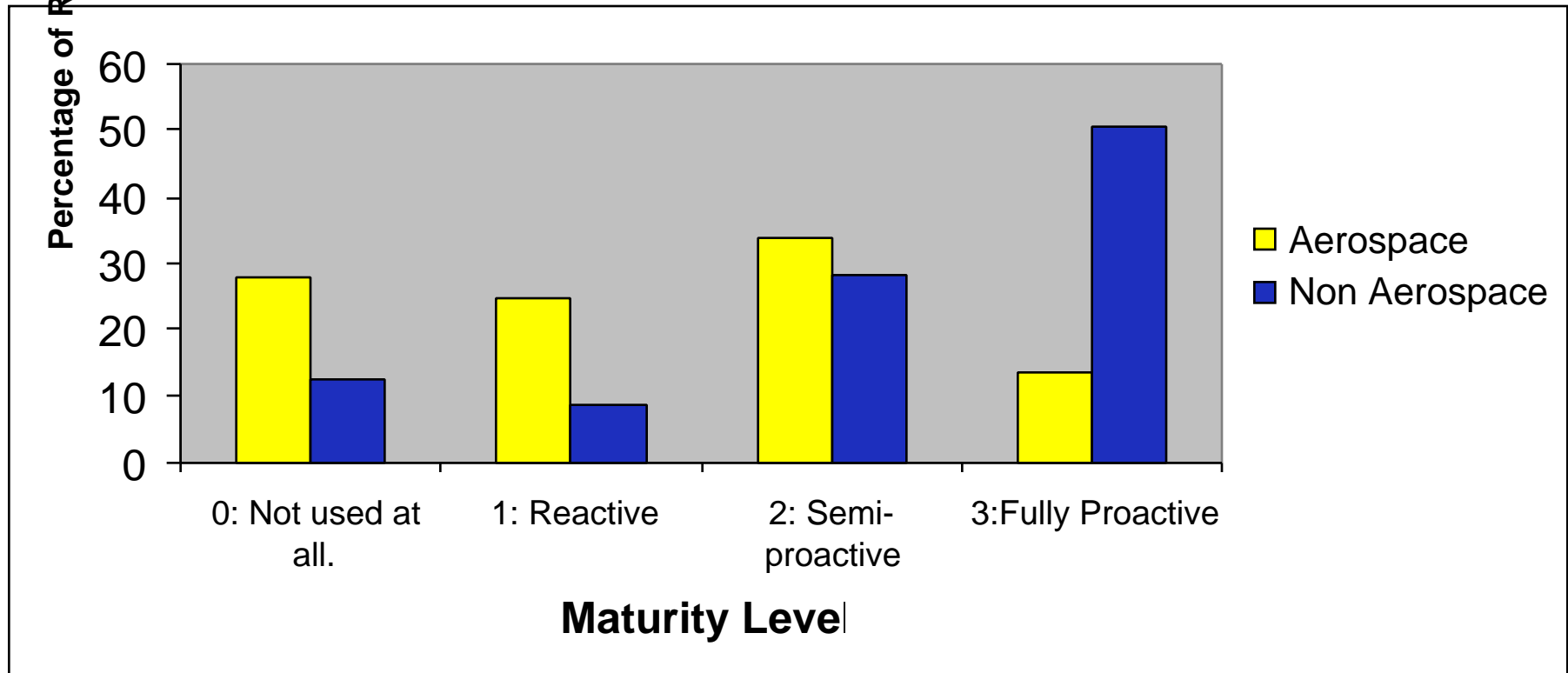


Source: Additional Questionnaire

# Supplier Interaction

Percentage of Respondents

The interaction between the supplier and the product development organization.



*Drawings and designs handed over the wall.*

*Suppliers brought in only if problems occurs.*

*Suppliers brought in at end of design to verify producibility.*

*Suppliers are integrated into IPT to evaluate producibility during design.*

Source: KC Maturity Model Survey



## Conclusions

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- **To reduce late design iterations due to variation quality problems, suppliers need to be proactively included in early stages of KC identification**
- **The successes in KC implementation which non-aerospace companies have experienced needs to be translated to aerospace companies**
- **KC Maturity Model provides an indication of where a company is and direction for continuous improvement**



## ***Other Practice Results from KC Maturity Model Survey***

	<b><u>Aerospace</u></b>	<b><u>Non Aerospace</u></b>
● <b>Existence of Objectives</b>	<b>Level 1</b>	<b>Level 2</b>
● <b>KC Definitions and Methods</b>	<b>Level 1</b>	<b>Level 2</b>
● <b>Management Support</b>	<b>Level 1</b>	<b>Level 2</b>
● <b>KC Training</b>	<b>Level 1</b>	<b>Level 2</b>
● <b>Incentive Structures</b>	<b>Level 1</b>	<b>Level 2</b>
● <b>Customer Interaction</b>	<b>Level 1</b>	<b>Level 3</b>



# Research Deliverables

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- **KC Maturity Model**
  - Description of the Practices
  - Proposed Core of Practices
- **KC Survey Data**
- **Case Study**
  - Importance of Information Flow and Team Structure to Successful KC Implementation
- **LEM will be linked to KC Maturity Model**

- **Disseminate best practices**
  - System view of variation
  - Modeling and simulation techniques to prioritize and validate KC selection
  - Selection of appropriate variation mitigation techniques
- **Wider testing of KC Maturity Model**
- **Develop solutions to gaps in current practices**
  - Clear objectives, common definitions, and improved methods KC implementation
  - Tools to enable a system view to variation
  - Tools to enhance communication and documentation throughout the process and organization



# Relationships

	Objectives	KC Definition and Methods	Management Support	KC Training	Incentive Structures	Customer Interaction	KC Identification Phase	KC Flowdown	Integrated Product Teams	Documentation	Supplier Interactions	Capability Feedback	Capability Uncertainty	Modeling	Tolerancing & Dimensioning	Cost Trade Offs	KC Prioritization	Measurement Plans	KC Validation	Reuse/Legacy Data	Design Changes/Robust Design	New Technology
Objectives	•																					
KC Definition and Methods	x	•																				
Management Support	x		•																			
KC Training	x	x	x	•																		
Incentive Structures	x	x			•																	
Customer Interaction	x	x	x	x		•																
KC Identification Phase	x	x	x	x	x	x	•		x													
KC Flowdown	x	x	x	x	x	x		•	x	x												
Integrated Product Teams	x	x	x	x	x	x		x	•	x	x				x							
Documentation			x	x	x		x	x	x	•												
Supplier Interactions	x	x	x	x	x	x	x	x	x		•											
Capability Feedback								x	x	x		•										
Capability Uncertainty													x	•								
Modeling					x			x						x	x	•						
Tolerancing & Dimensioning		x	x	x		x	x	x			x	x										
Cost Trade Offs			x	x	x		x	x		x	x	x	x									
KC Prioritization			x	x	x		x	x	x	x	x	x	x						x	•		
Measurement Plans		x	x	x			x		x	x	x	x	x	x	x	x						•
KC Validation		x	x	x		x		x	x	x	x	x	x						x		•	
Reuse/Legacy Data	x	x		x				x	x											x		•
Robust Design		x	x	x	x	x	x	x	x		x	x	x	x	x	x						•
New Technology			x	x		x	x	x					x	x	x	x			x		x	•

Recommended order of implementation



Preliminary Capabilities

Tools & Methods

Benefits

\* Matrix represents the observed dependencies that support the recommended order of implementation