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reliability designed, reliability delivered

Design for Excellence: Basic Introduction

NCAB Presentation

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Introduction to Design for Excellence

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A Good Way to Begin – Some Cowboy Wisdom

- It ain't what you don't know that gets you into trouble.
- It's what you know that ain't so!

Today's DfX Presentation

- General Concepts and Models
  - Technical Environment
  - Business Environment – $$$
  - And Speaking of Money . . .
- DfM Modules

DfX: Design for the Full Product Life Cycle

Quality – the Essence of Excellence

Which is the higher quality camera?

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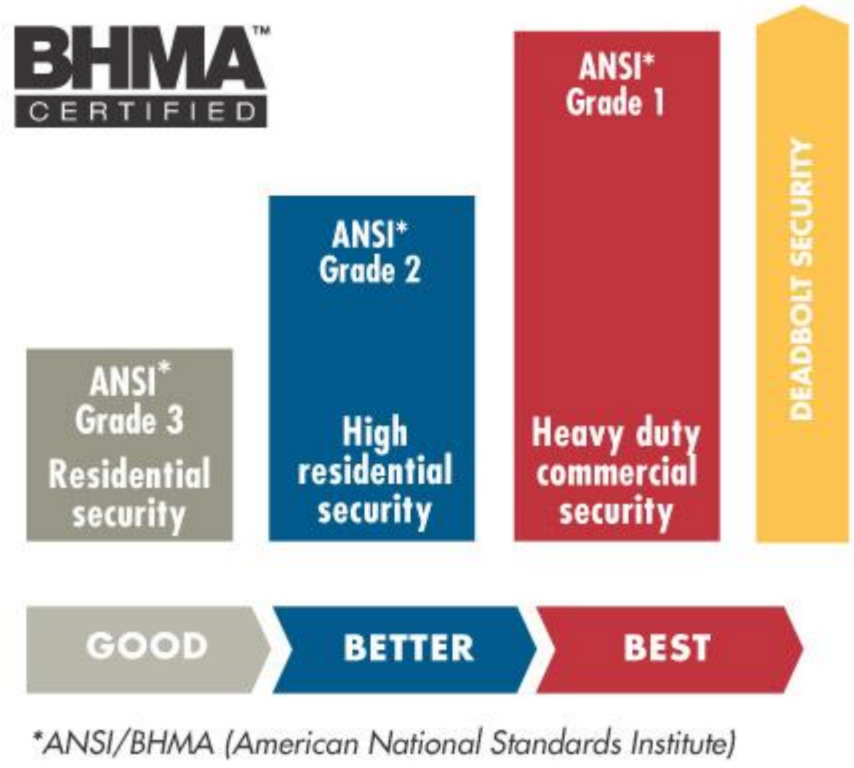
Fitness for Use – ANSI Lock Grades



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Fitness for Use – the Four Product Design Qualities

- Quality of Requirements
- Quality of Design
- Quality of Conformance
- Quality of Support

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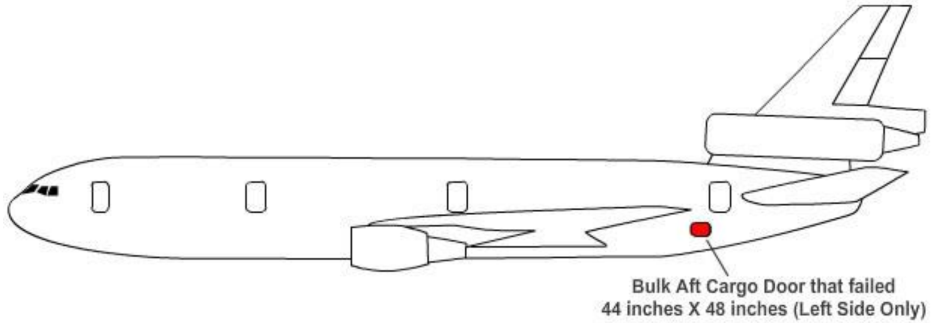
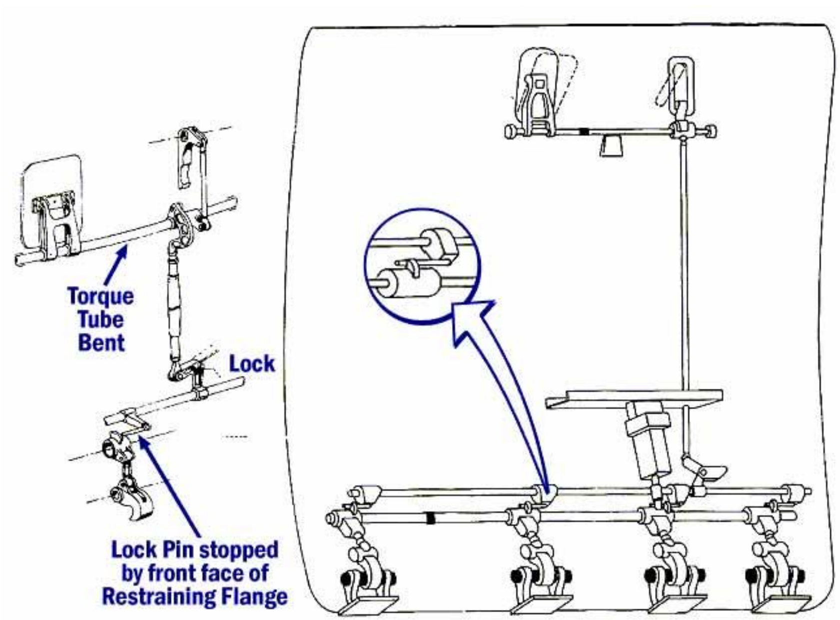
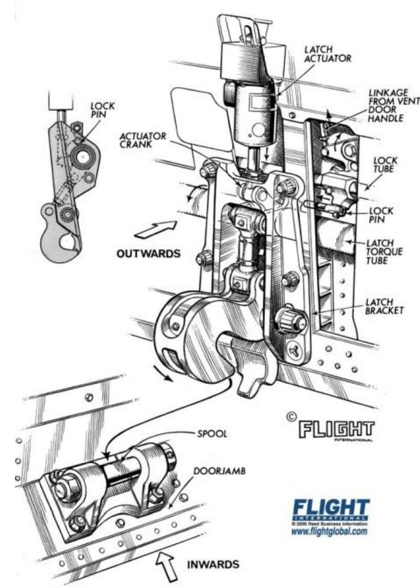
Example: Design of DC-10 Cargo Door







DfX – Central Concept Take-away

"The design must make it easy to do things right and hard to do things wrong for it is fundamental in human nature there is a chasm between what people <u>can</u> do what they <u>will</u> do." John McLucas, Chair, FAA

Quality of Requirements

- Voice of the Customer
  - Paying Customer
  - Permitting Customer
- Types of Requirements
  - Present
  - Future
  - Projected

Quality of Requirements

- Fitness for Use
  - Paying Customer
  - Permitting Customer
- Reasonably Foreseeable Misuse
  - Present
  - Future
  - Projected
- Use/Misuse Conditions

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Attributes of a High Quality Requirement

√	Quality Attribute	Definition
	Structured	<Who shall do What by When> or <When event occurs Who shall do What>
	Implementation-free	States what is required, not how met
	Necessary	If removed, a deficiency will occur
	Concise	States ONE thing that must be done, and only what must be done. Does not state what is NOT done.
	Attainable	Achieved based on an existing design concept
	Complete	Accurate quantitative parametric distribution
	Consistent	Does not contradict other requirements
	Unambiguous	One and only one interpretation
	Verifiable	Can be verified by either analysis, inspection, demonstration or test
	Correct	Accurately describes functionality to be delivered
	Modifiable	Can be easily changed while retaining structure and style

Let's Continue With – A Little Professional Wisdom:

- Commenting on the utility of models; he said,
- "Essentially all models are wrong; however, some are useful."

Risk Assessment Model

Perception/Belief

Reality/Results

		DECISION	
		Reject H_o	*Fail to Reject H_o*
ACTUAL	*H_o True*	Type I Error ***Producer Risk*** **α-Risk** **False Positive**	**Correct Decision** **Confidence Interval = 1- α**
	H_a True	**Correct Decision** **Power = 1- β**	Type II Error ***Consumer Risk*** **β-Risk** **False Negative**

H_o: Null Hypothesis H_a: Alternative Hypothesis

Risk Assessment Model – Technical & Business Risk

Perception/Belief

Reality/Results				DECISION	
				Bad	Good
				Reject H_o	*Fail to Reject H_o*
	Good	ACTUAL	*H_o True*	Type I Error *Producer Risk* α-Risk False Positive	**Correct Decision** Confidence Interval = $1-\alpha$
	Bad		*H_a True*	**Correct Decision** **Power = $1-\beta$**	Type II Error *Consumer Risk* β-Risk False Negative

H_o: Null Hypothesis H_a: Alternative Hypothesis

Reliability Model – Conceptual Product Space

Product Use Conditions & Life Expectations

Environment Stress

							Satellites		Military Aircraft
						Auto Safety		Commercial Aircraft	
				Outdoor Signage	Utility Monitoring	Chemical & Petroleum Production	DHS Monitoring		
				Servers, Routers, Switches, Storage	Auto Entertainment	Telecom Cell Towers			
	Cell Phones	Laptops	Video Games		Microwaves		Washers		
Toys		iPods	Desktop PCs		Televisions	Medical Imaging	Dryers		

Product Lifetime

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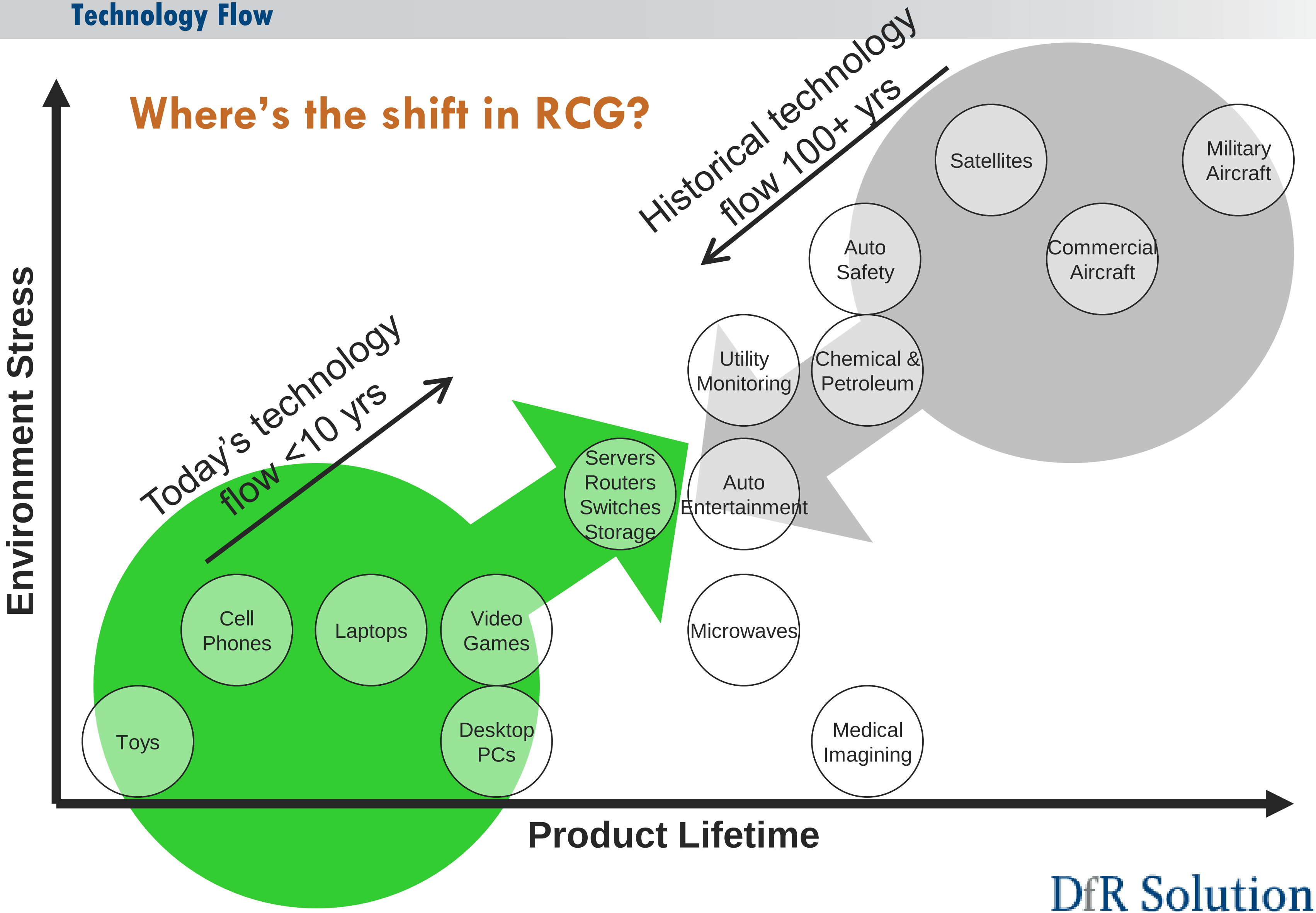
Reliability Model – Conceptual Product Space

Technology Flow



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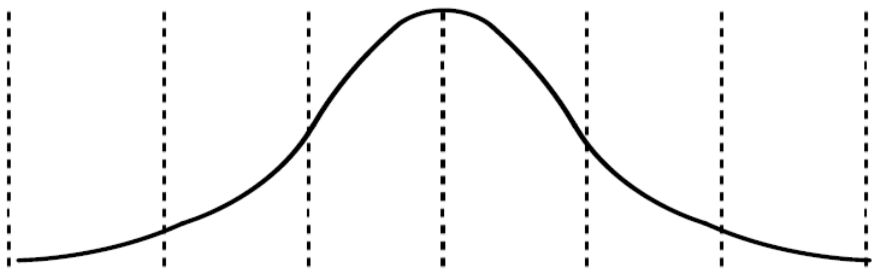
Product Life Cycle Model

GOVERNMENT ELECTRONICS AND INFORMATION TECHNOLOGY ASSOCIATION
A Sector of the Electronic Industries Alliance

ANSI/EIA-724-97 Product Life Cycle Data Model



	Stage 1 Introduction	Stage 2 Growth	Stage 3 Maturity	Stage 4 Saturation	Stage 5 Decline	Stage 6 Phase-Out
Sales	Slow increase	Increasing rapidly	Stable	Leveling out	Decreasing	Lifetime buys offered
Price	Highest	Declining	Stable	Stable	Rising	High
Usage	Low	Increasing	Stable	Stable	Decreasing	Decreasing
Part Modification[1]	Frequent	Major	Periodic changes	Few	Few or none	None
Competitors	Few	High	Stable number	Decline begins	Declining	Declining
Manufacturer profit	Low	Increasing	Stable	Stable	Reasonable for survivors	Reasonable for survivors (aftermarket)

1. Die shrink, mask change, etc.

The Old Electronics Ecosystem

- Ericsson
- Fairchild Camera & Instrument
- General Electric
- Hewlett Packard
- IBM
- ITT
- Marconi
- Motorola
- Mullard
- Panasonic
- Philips
- Plessey
- RCA
- Siemens
- Telefunken
- Texas Instruments
- Toshiba
- Western Electric

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Business Model

- Historical business model
  - Dominated by vertically integrated companies
  - Tech was the darling of the financial markets
  - Well funded science, engineering, manufacturing
  - Significant IP portfolios
  - Used their own parts in their own products
- Baked into belief system
  - High quality
  - High reliability
  - Long component lifecycles per EIA-724
- Today's business model
  - Thinly capitalized e.g. "debt zombie"
  - Heavily outsourced structure
  - Fragile joint ventures

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Roadmaps

Association Connecting Electronics Industries

IPC

IPC INTERNATIONAL TECHNOLOGY ROADMAP
FOR ELECTRONIC INTERCONNECTIONS 2011

Why a Technology Roadmap for Interconnections?

One day Alice came to a fork in the road and saw a Cheshire cat in a tree.
"Which road do I take?" she asked. *"Where do you want to go?"* asked the cat.
"I don't know," Alice answered.
"Then", said the cat, *"it doesn't matter."*

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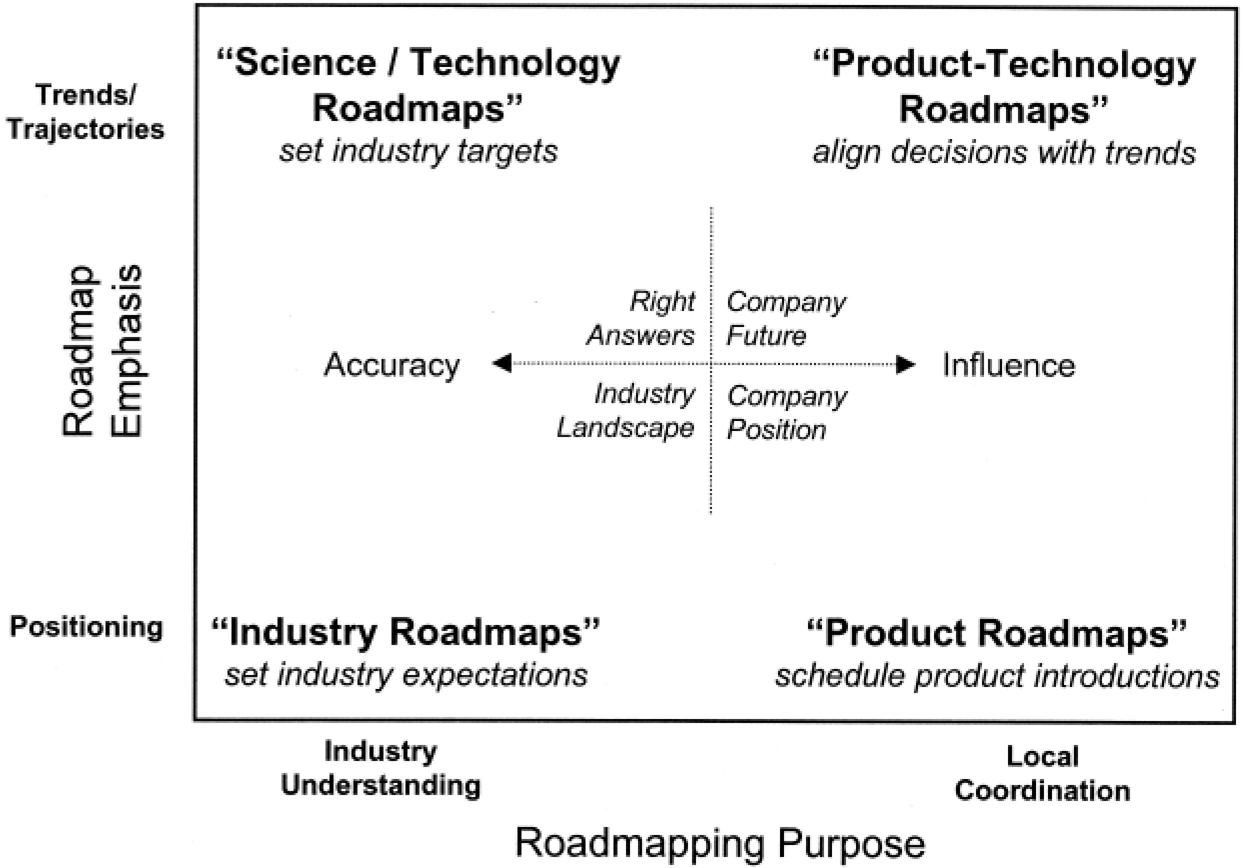
Roadmaps – Business and Technical



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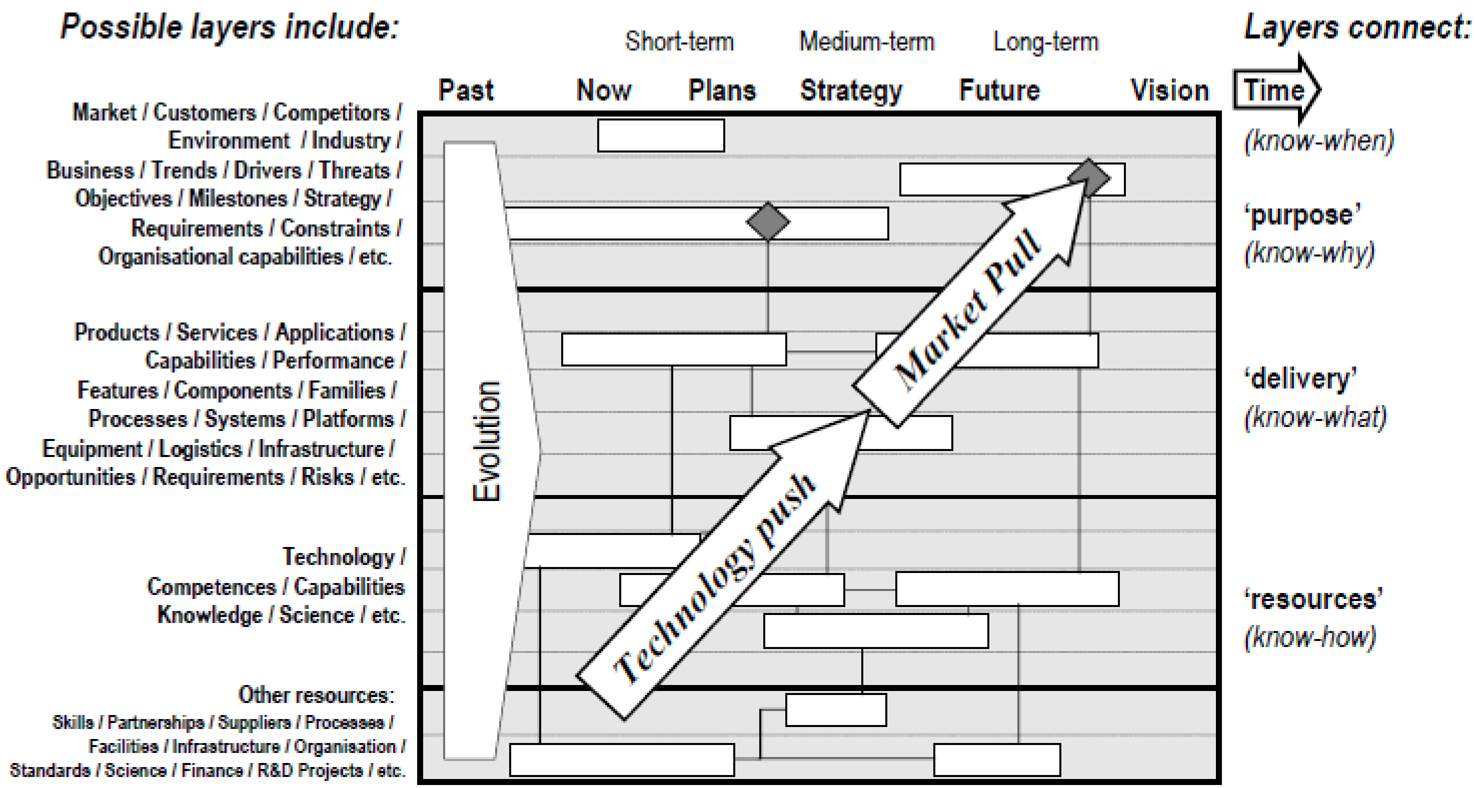
Roadmaps



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Product Life Cycle Model

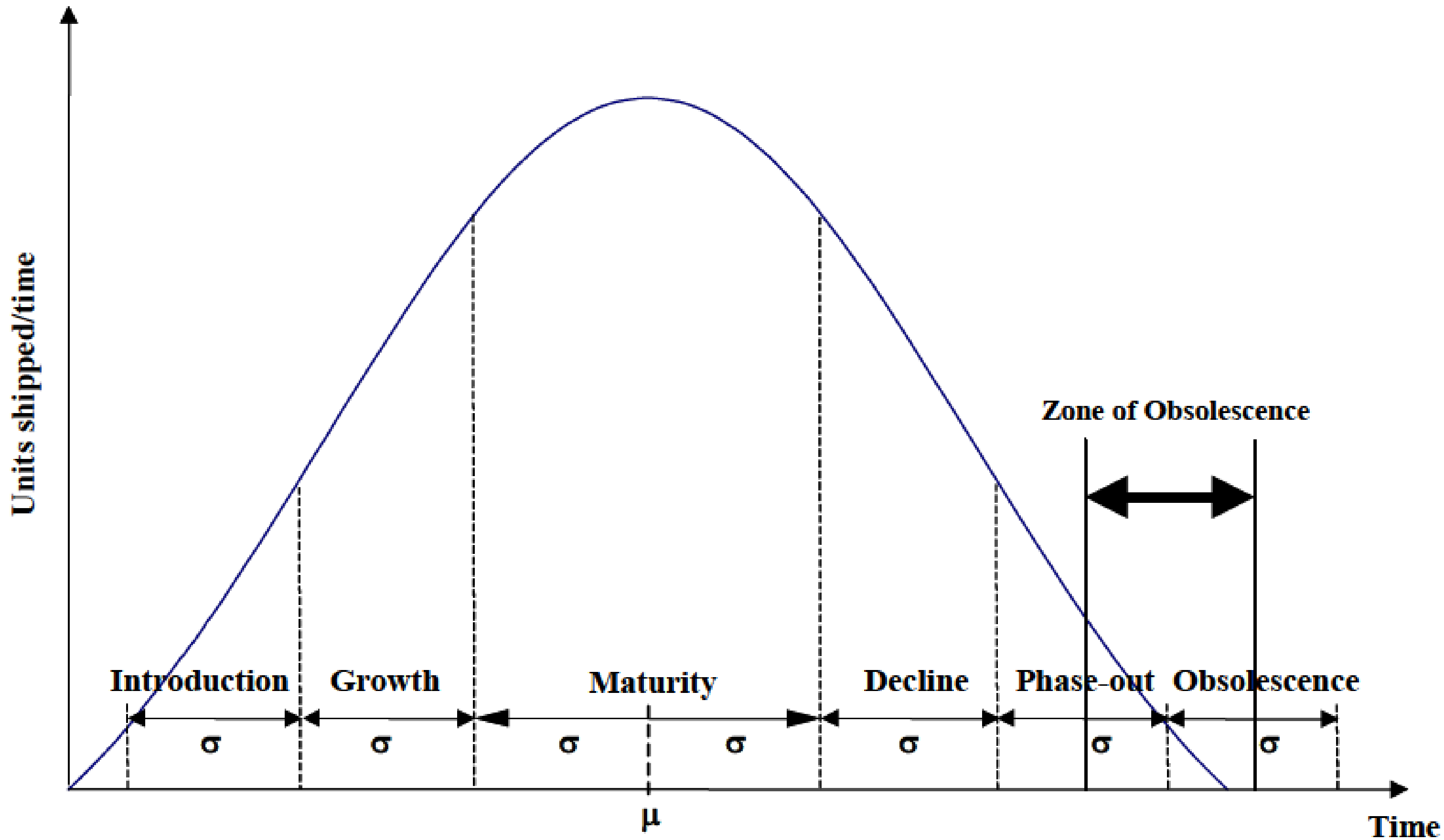

Fig. 1 Definitions for a standardized life cycle curve for a device/technology group. μ and σ represent curve fitting parameters discussed in Section III.

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Product Life Cycle Model

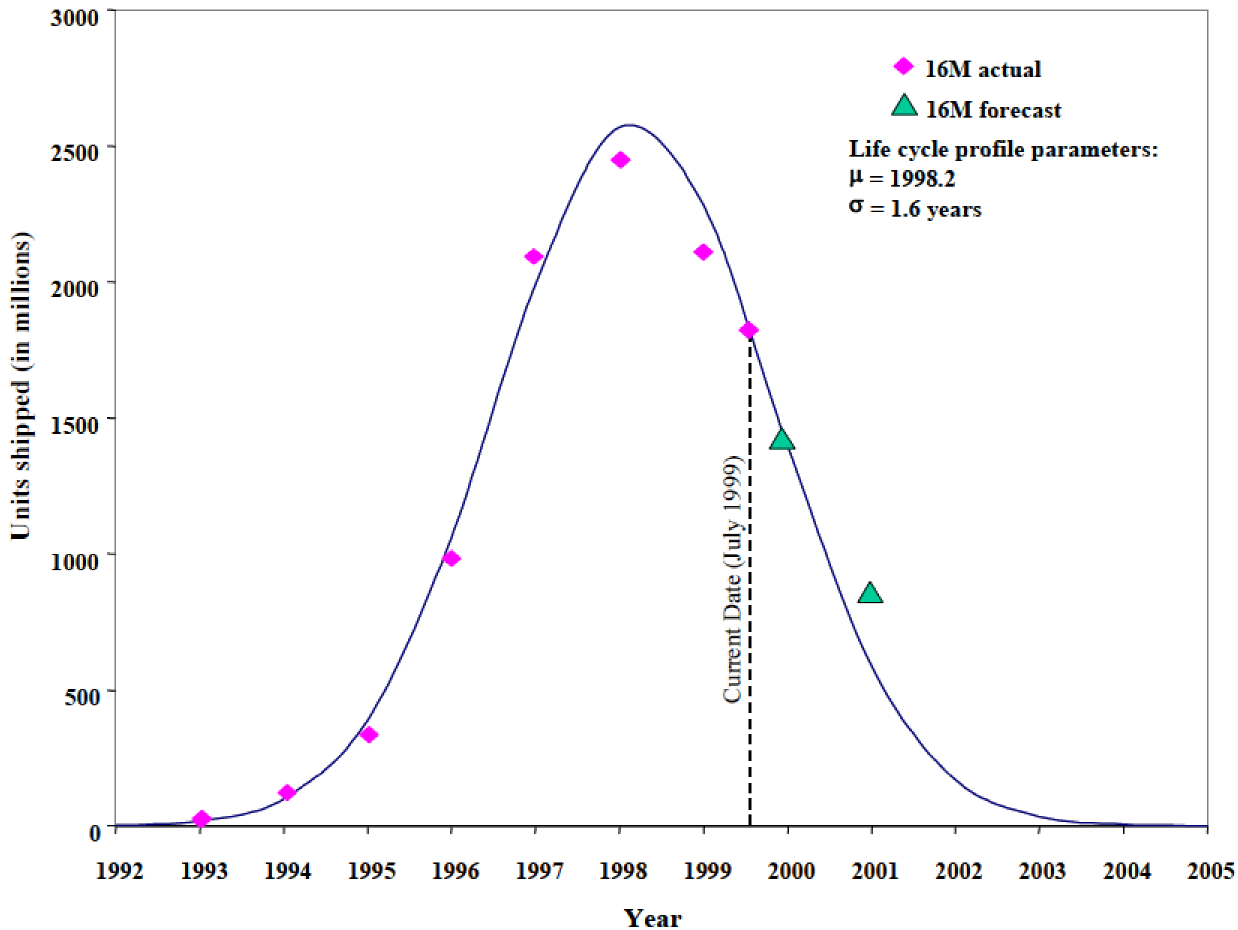

Fig. 3: Life cycle curve of a 16M DRAM. The dashed line marks the current date assumed for this example analysis. Data obtained from Cahner's In-Stat Group [12].

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Product Life Cycle Experience

The model is not the part, the map is not the terrain

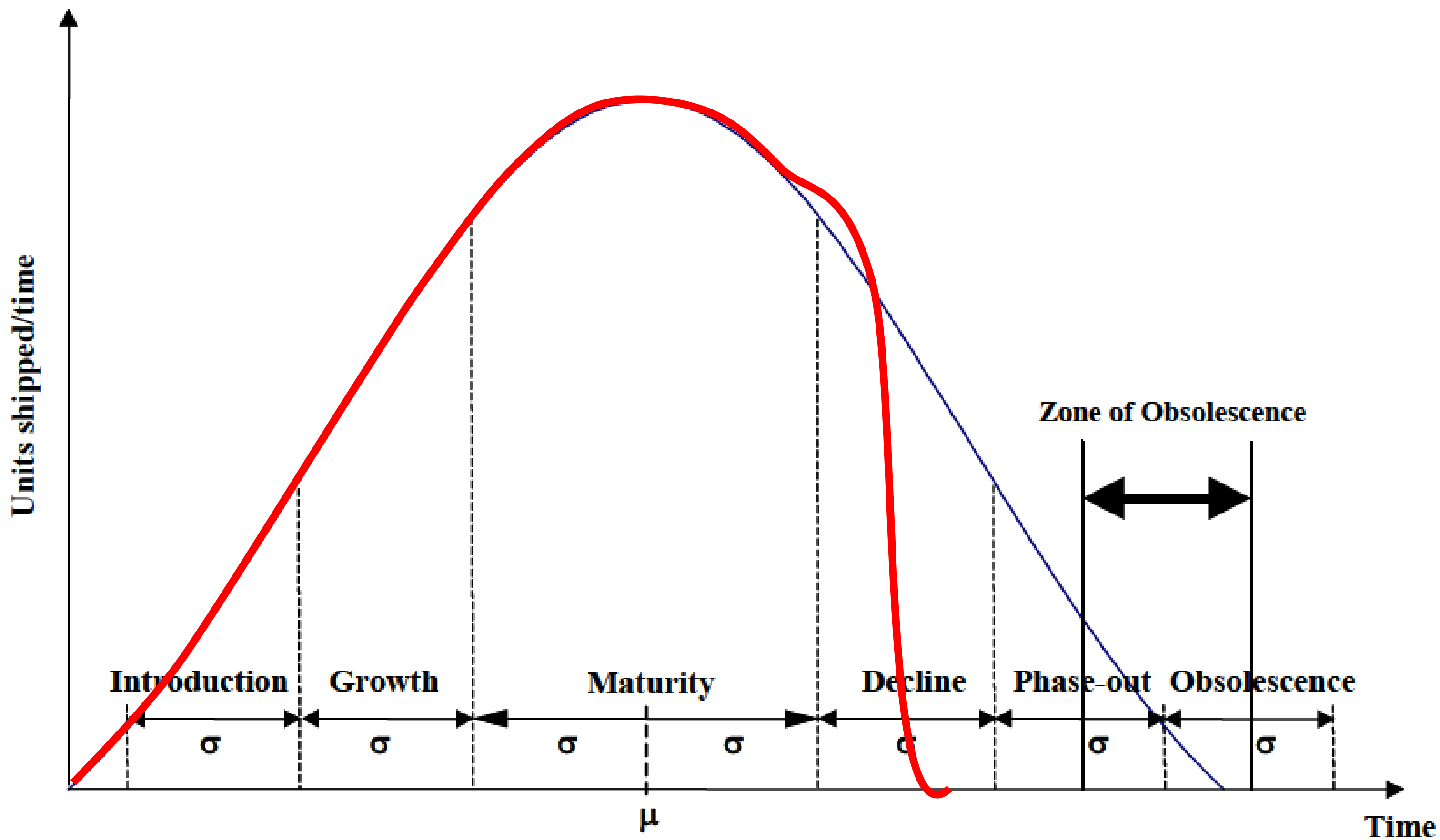


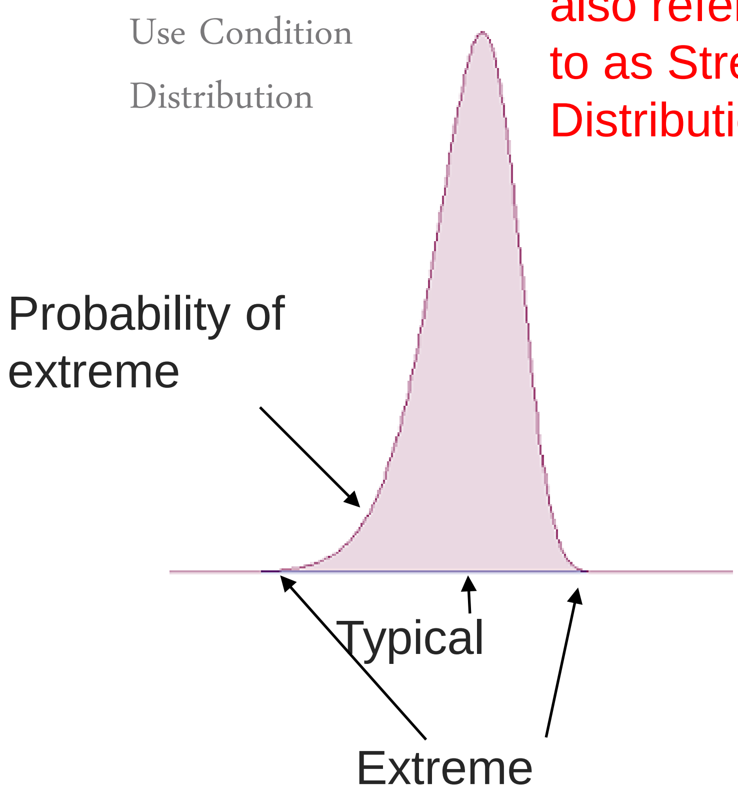
Fig. 1 Definitions for a standardized life cycle curve for a device/technology group. μ and σ represent curve fitting parameters discussed in Section III.

What are Quantitative Parametric Conditions?

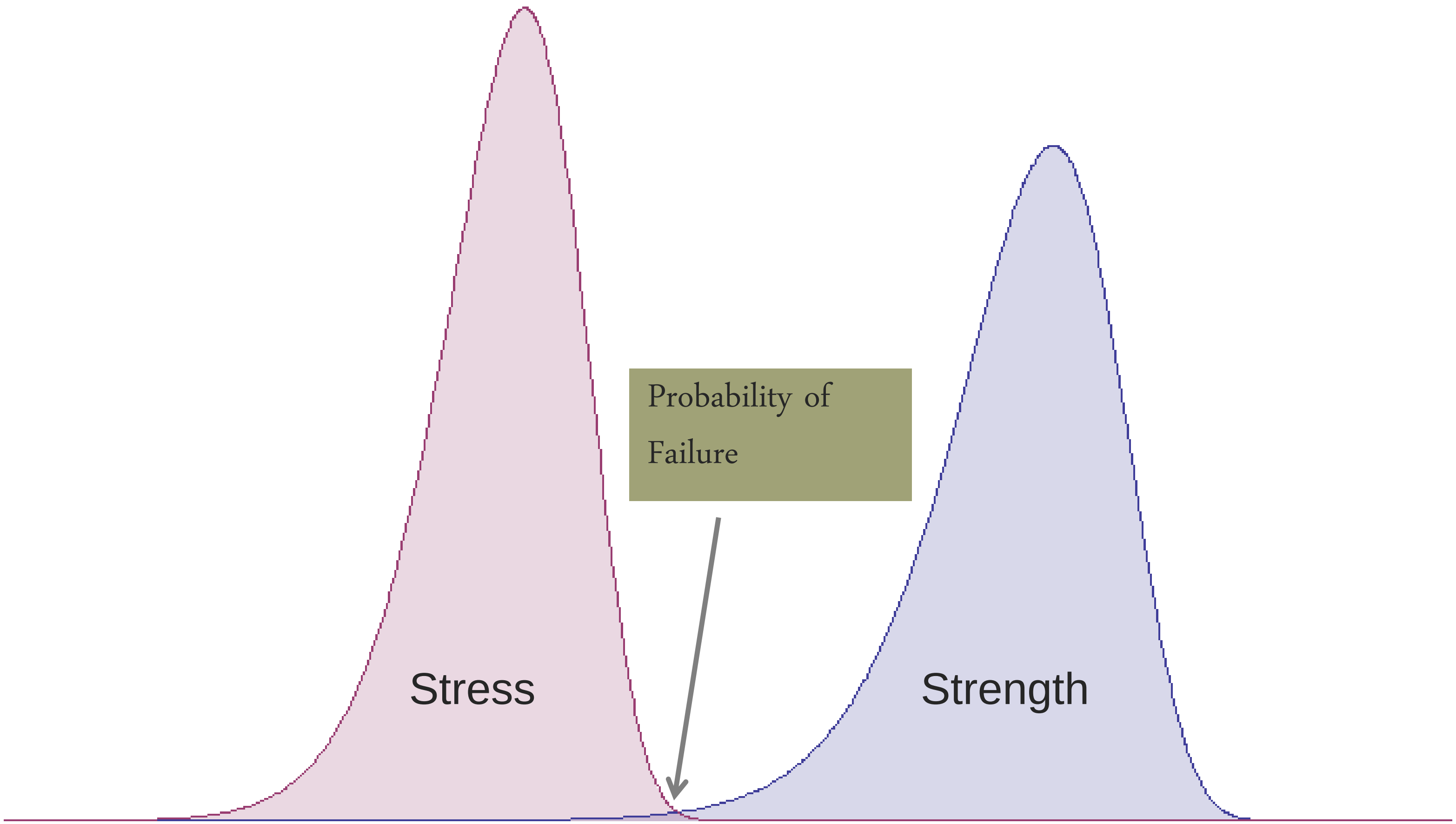
In the knowledge journey toward Quantitative Use/Misuse Conditions we ask the following questions:

1. What is typical?
2. What is extreme?
3. How often does extreme occur?

Why is this also referred to as Stress Distribution?



When do Use Conditions Cause Issues?



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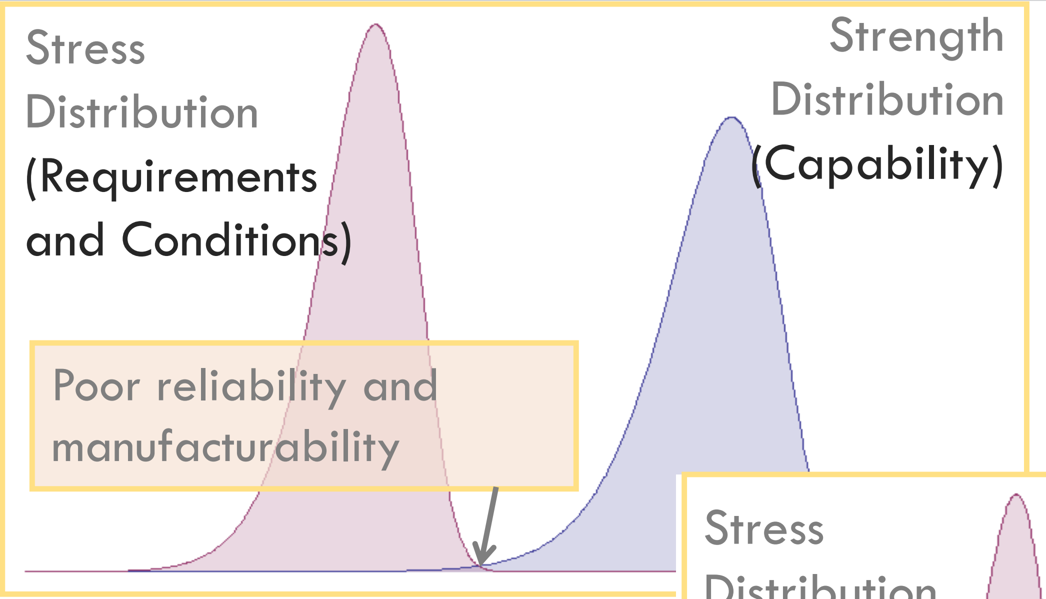
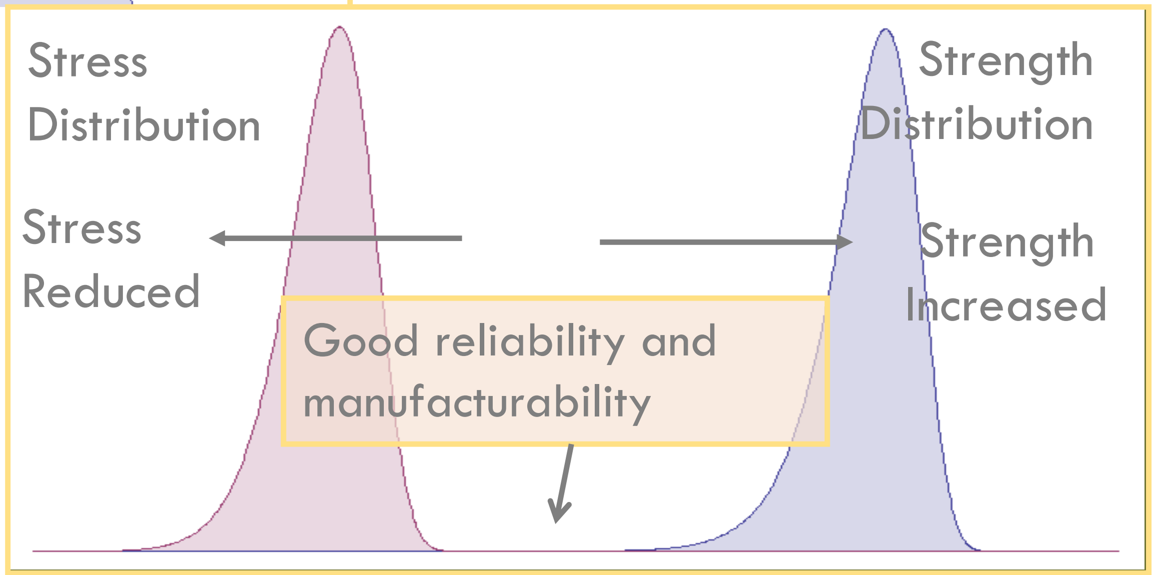
Use/Misuse Condition Knowledge Enables Quality



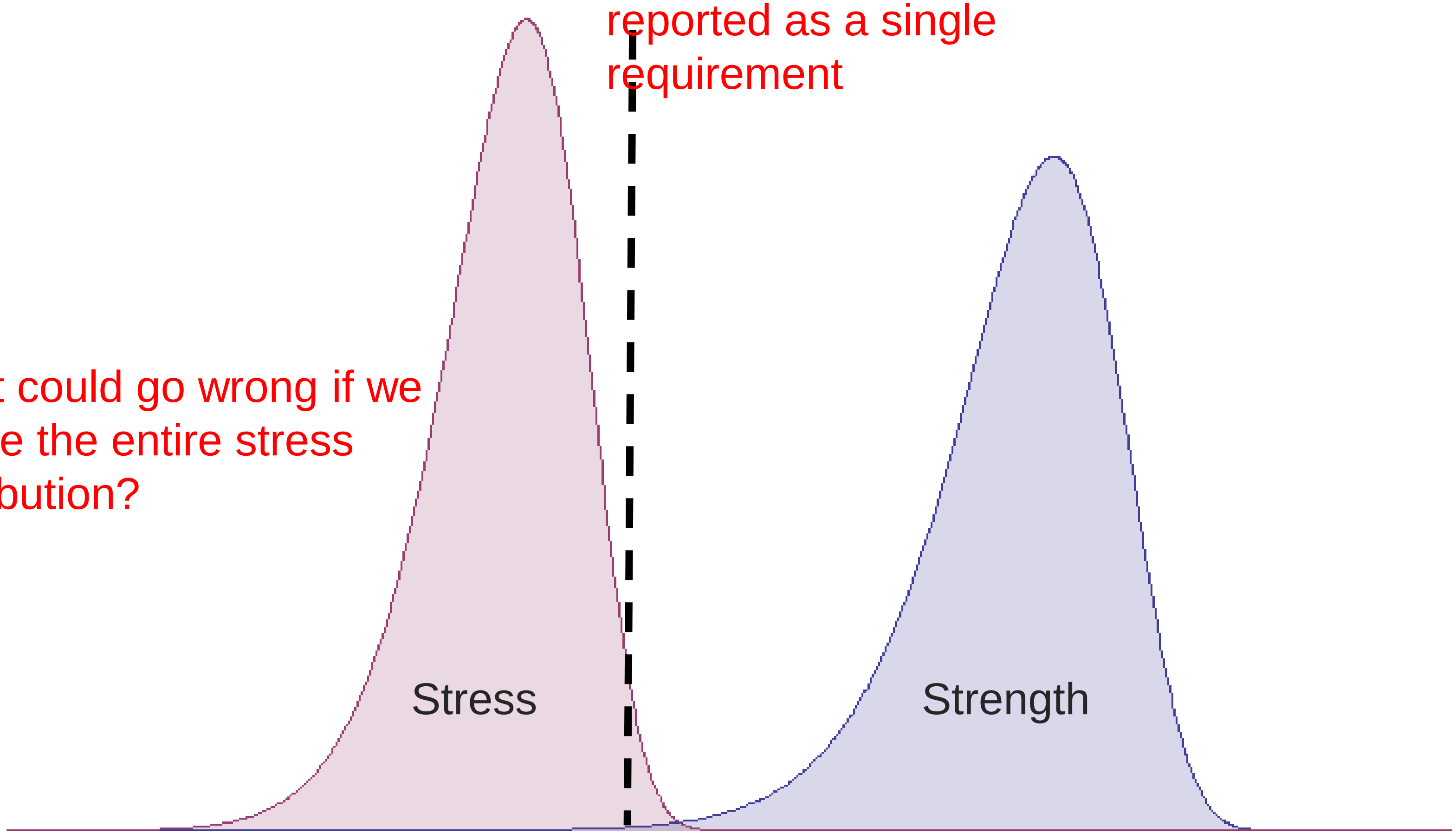
Design and material choices (DFM/DFR) can reduce stress and increase strength.

Control maintains separation of distributions



What is the Consequence of Reducing Use Condition Information to a Requirement?

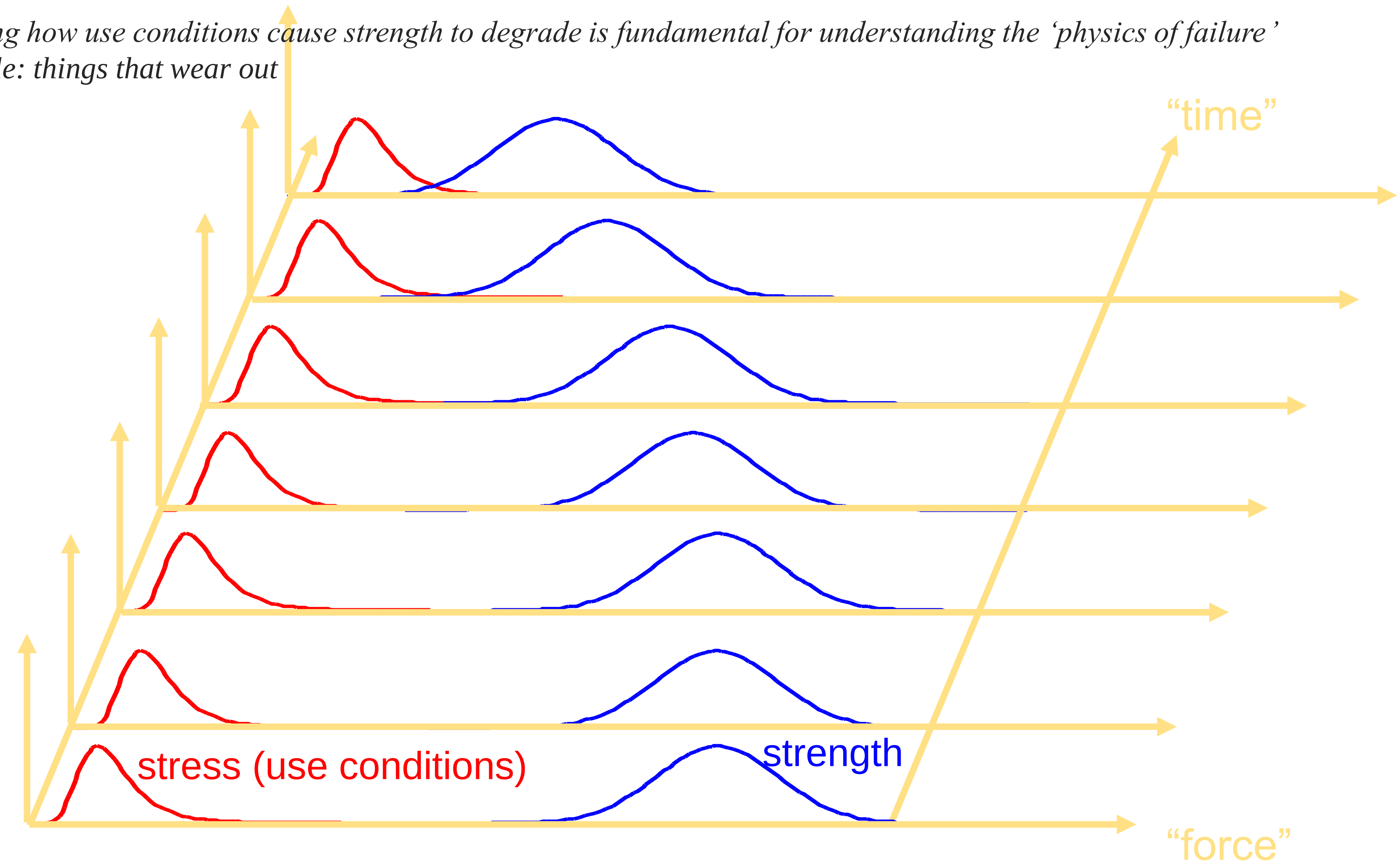
Use Conditions are often reported as a single requirement



What could go wrong if we ignore the entire stress distribution?

Use Conditions Cause Strength to Degrade Over Time

Knowing how use conditions cause strength to degrade is fundamental for understanding the 'physics of failure'
Example: things that wear out



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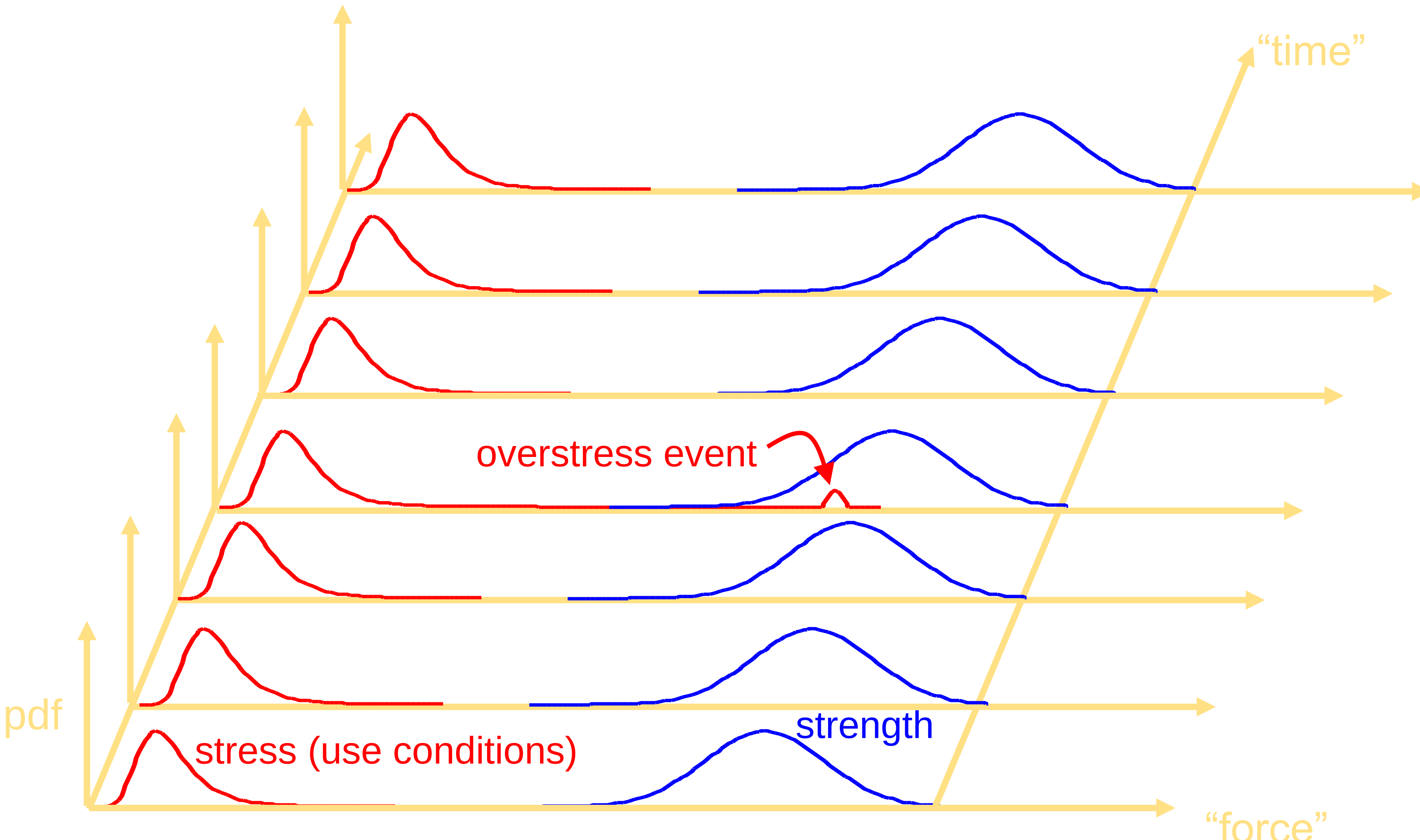
Failure due to sudden overstress (e.g. shock)



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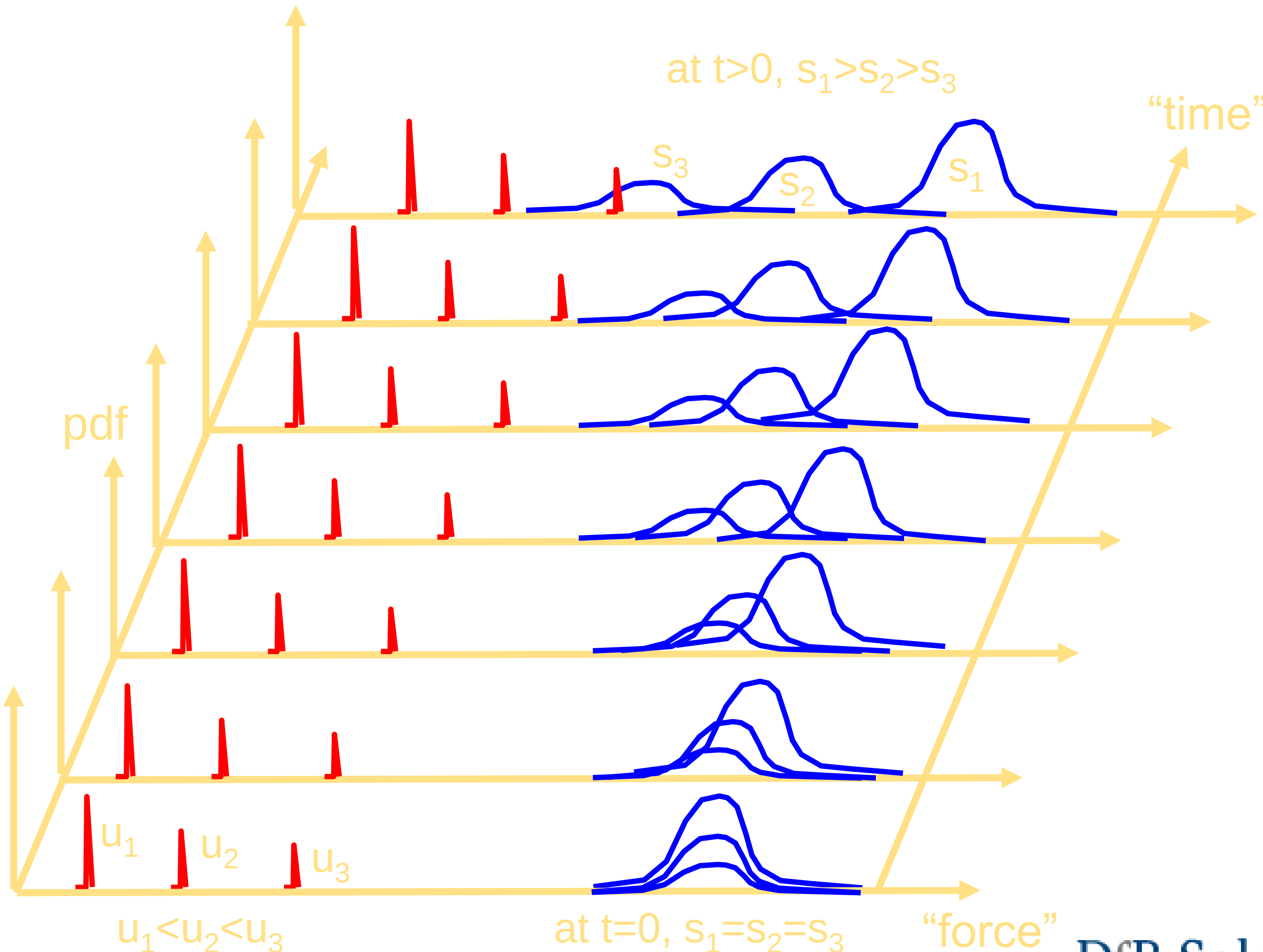
Wear-out phenomena (e.g. fatigue)



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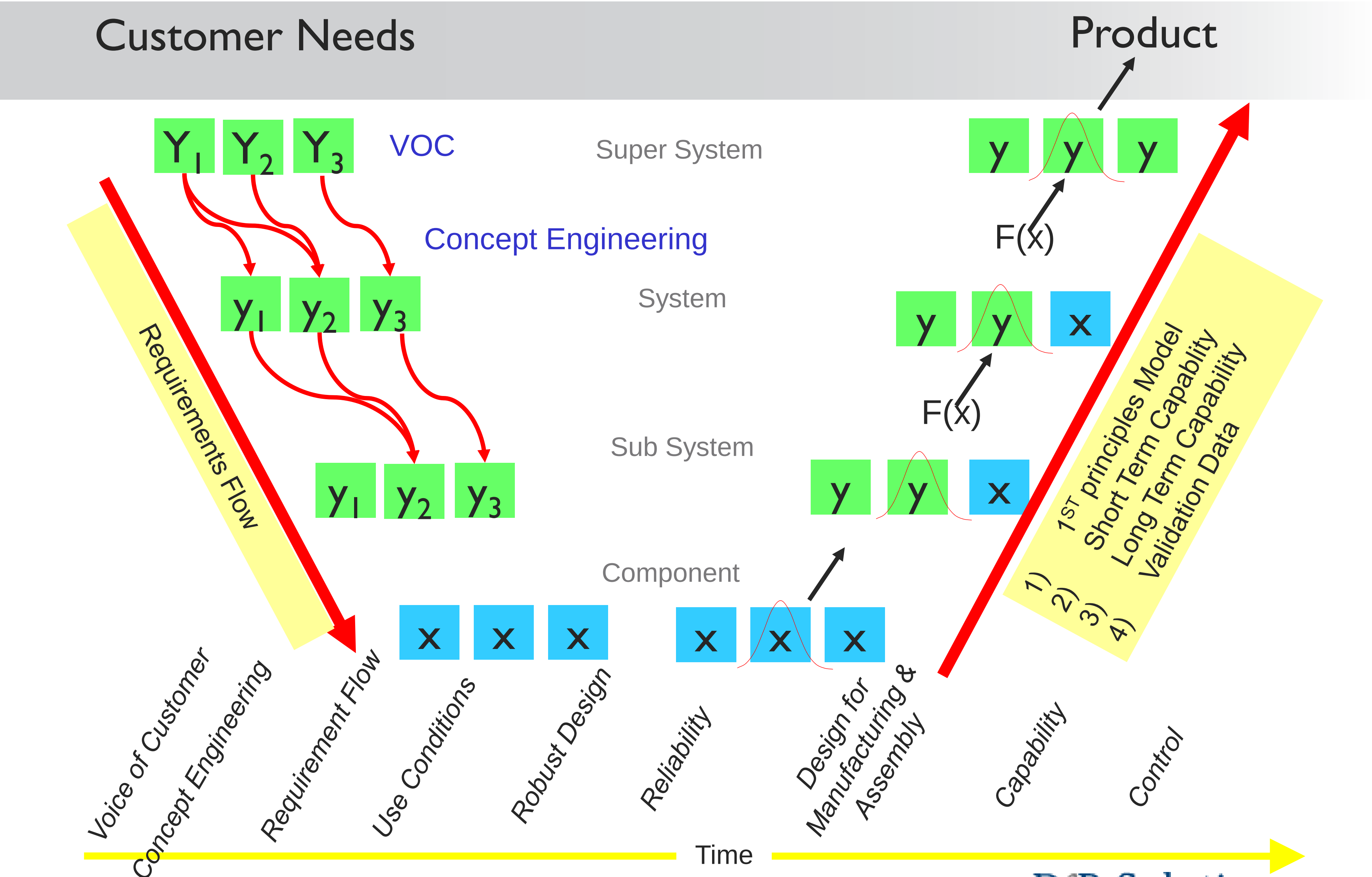

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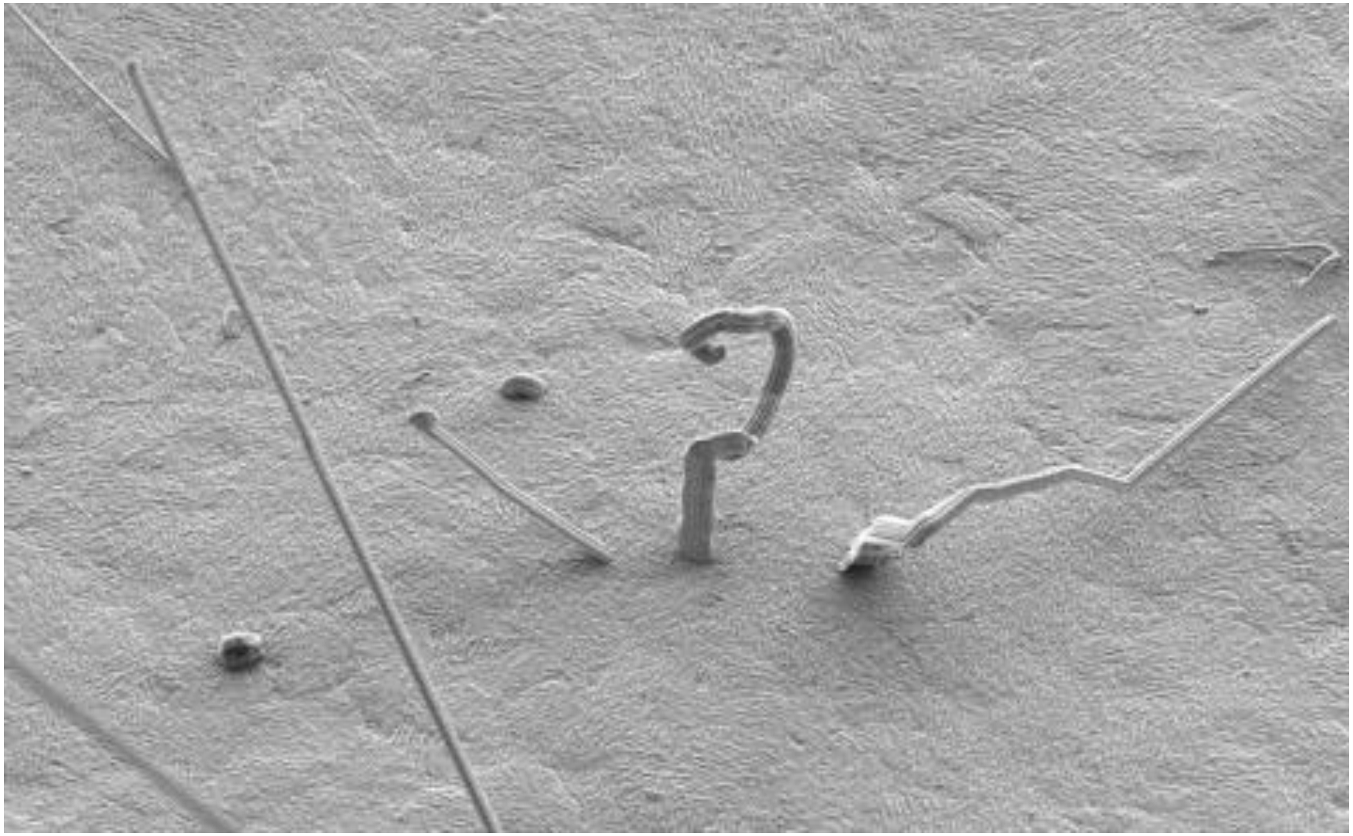
Any Comments, Concerns, or



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Thank you!

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