

# Module Modeling and Analysis: Analysis and Using Models

by *Gerrit Muller* HSN-NISE

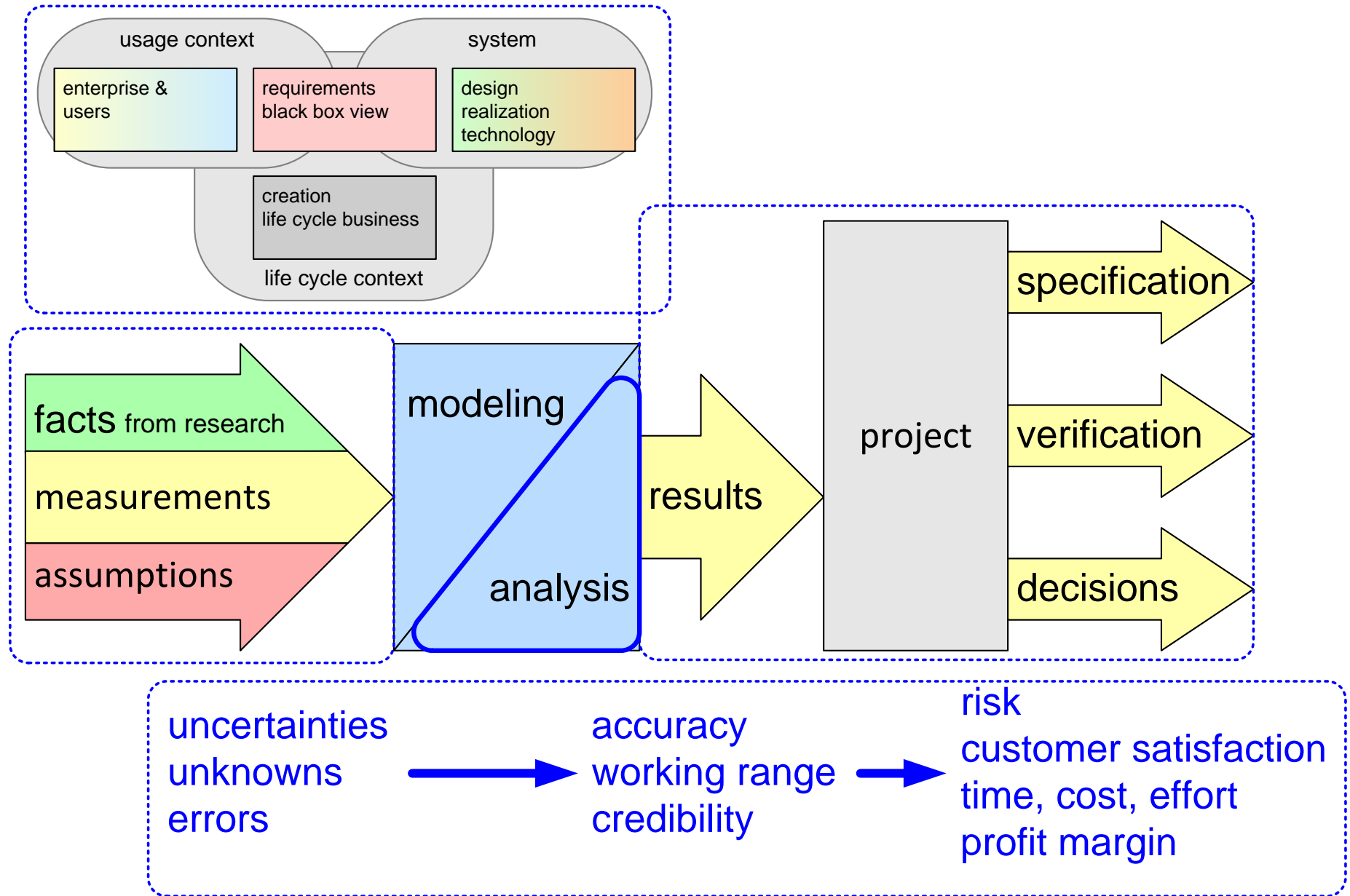
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## **Abstract**

This module addresses the analysis of models and discusses how to use models.

# Where are we in the Course?



# Modeling and Analysis: Analysis

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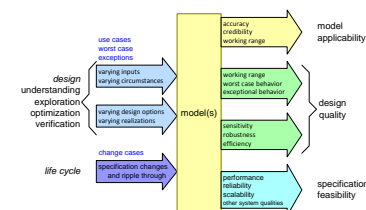
## Abstract

Models only get value when they are actively used. We will focus in this presentation on analysis aspects: accuracy, credibility, sensitivity, efficiency, robustness, reliability and scalability.

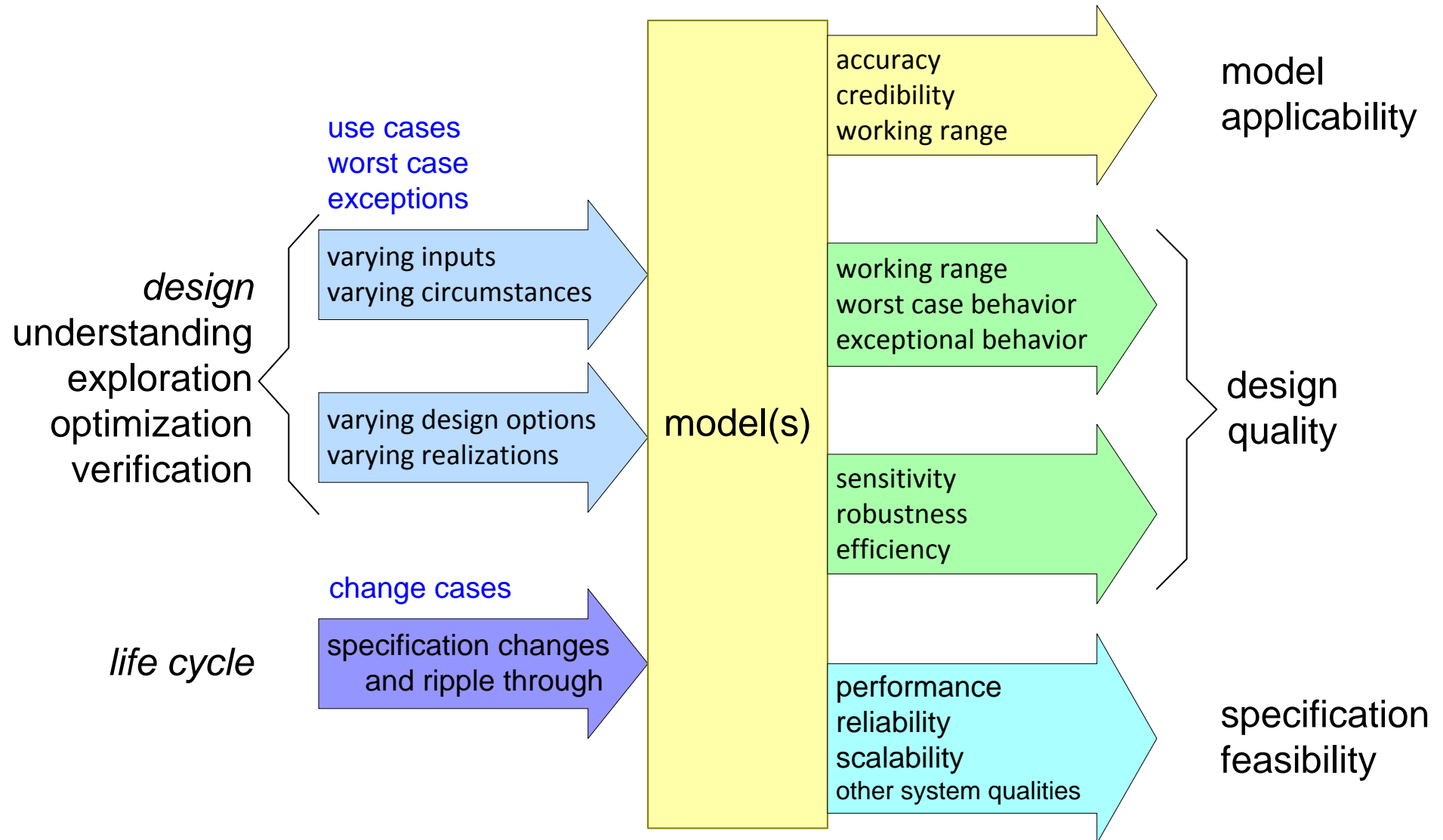
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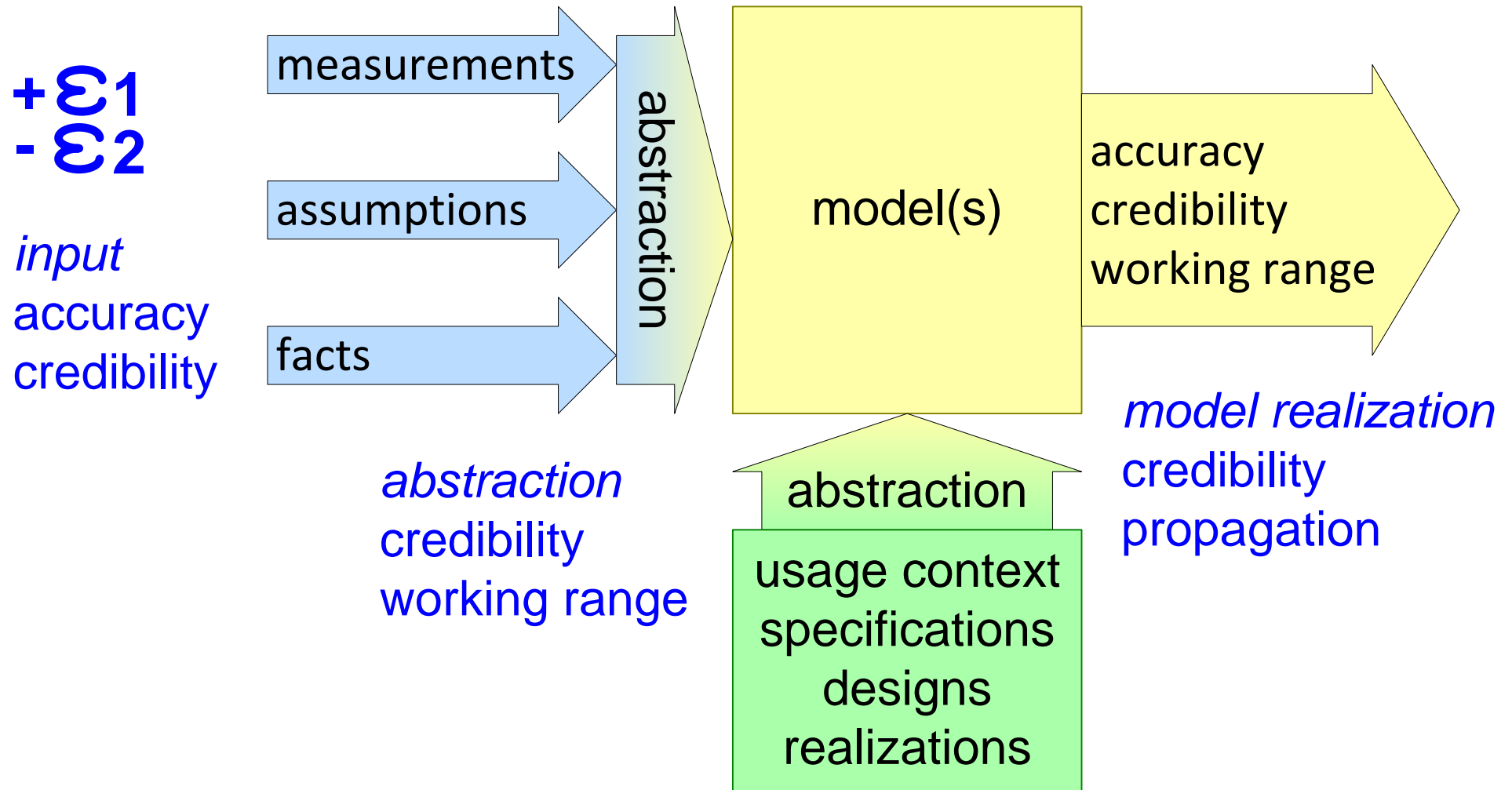
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# What Comes out of a Model



# Applicability of the Model



# How to Determine Applicability

## *try out models*

be aware of accuracy, credibility and working range

## *simple and small models*

### 1. Estimate accuracy of results

based on most significant inaccuracies of inputs  
and assumed model propagation behavior

### 2. Identify top 3 credibility risks

identify biggest uncertainties in  
inputs, abstractions and realization

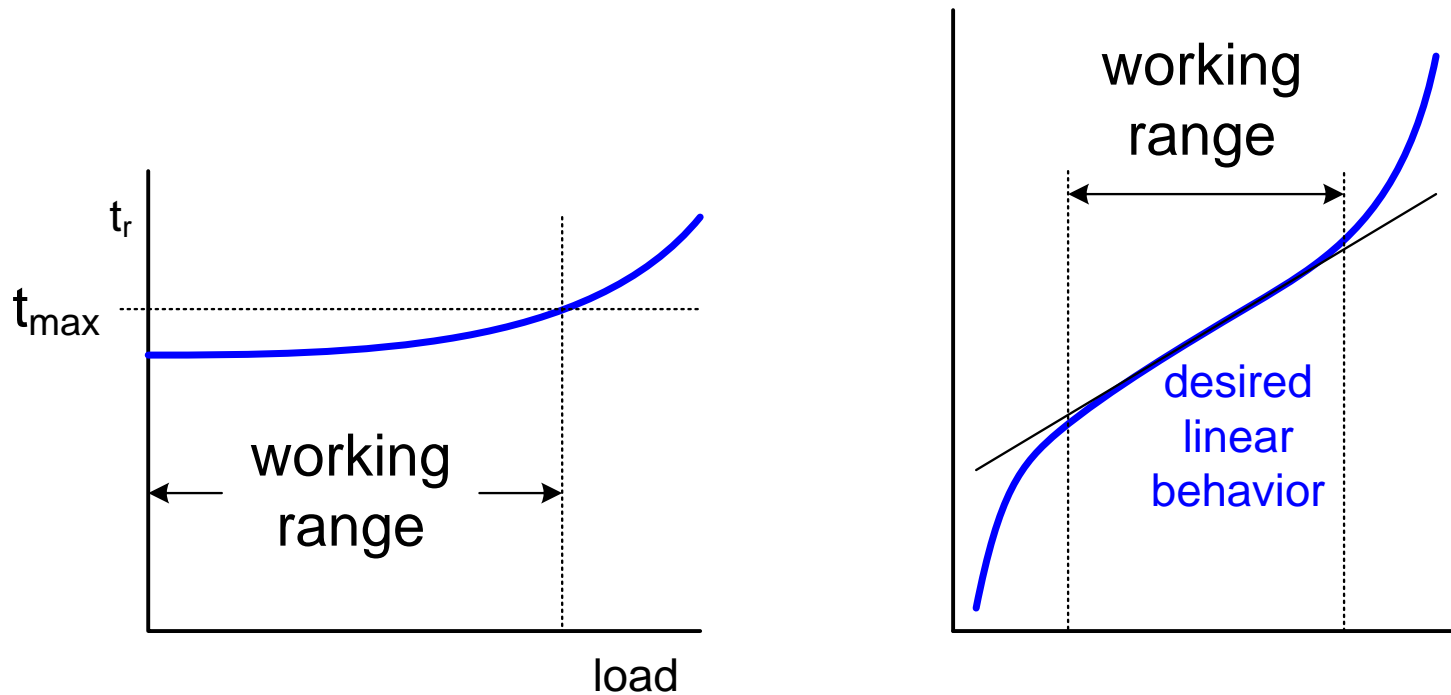
### 3. Identify relevant working range risks

identify required (critical) working ranges and  
compare with model working range

## *substantial models*

systematic analysis and documentation of accuracy,  
credibility and working range

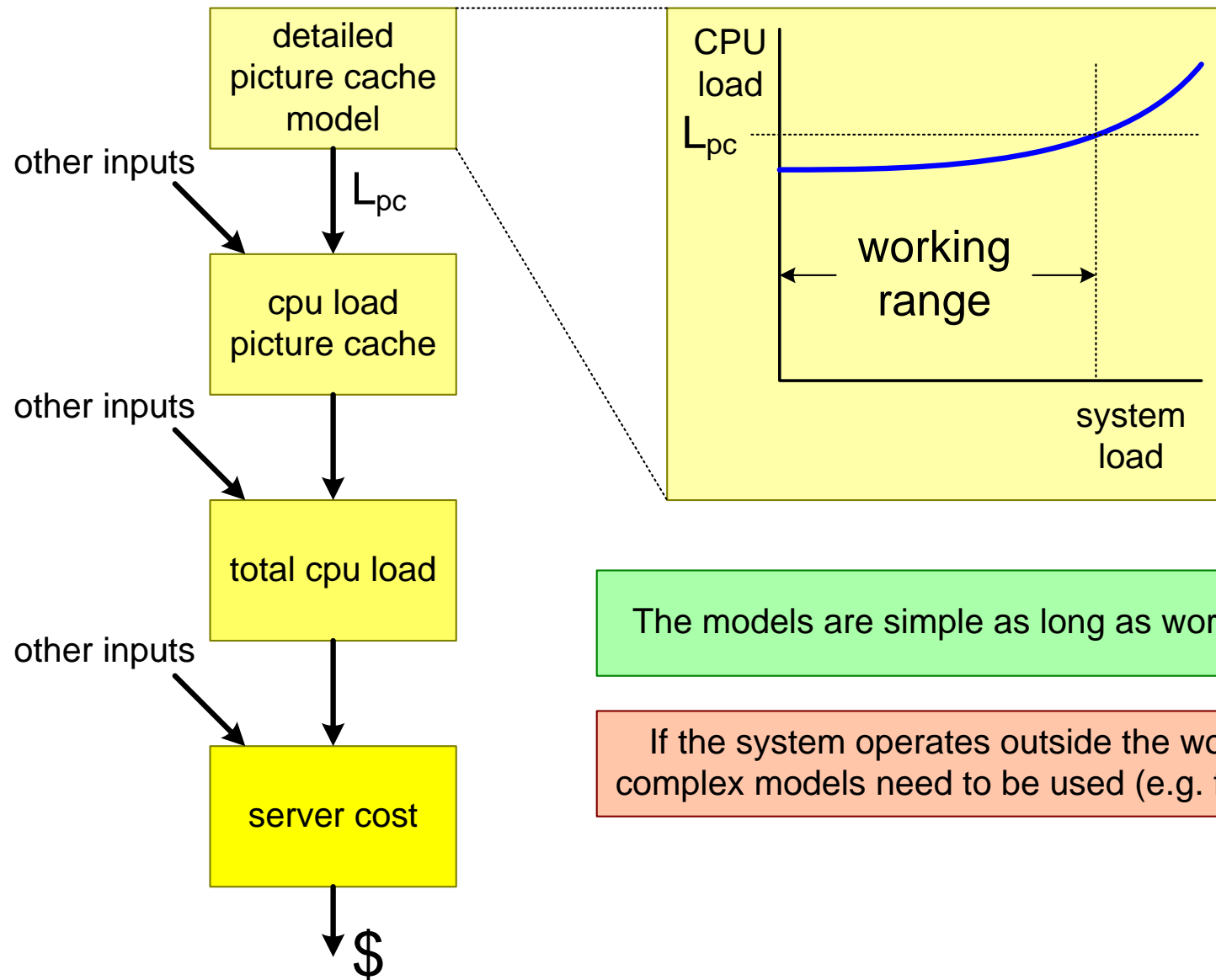
# Working Range examples



A system design assumption is often:  
the performance of this function  
{ is constant | is linear | doesn't exceed x | ... }

The working range is the interval where this  
assumption holds

# Example of Picture Cache Working Range



The models are simple as long as working ranges are obeyed

If the system operates outside the working range then more complex models need to be used (e.g. from 0<sup>e</sup> order to 1<sup>e</sup> order)



# Common Pitfalls

discrete events in continuous world

discretization artefacts  
e.g. stepwise simulations

(too) systematic input data

random data show different behavior  
e.g. memory fragmentation

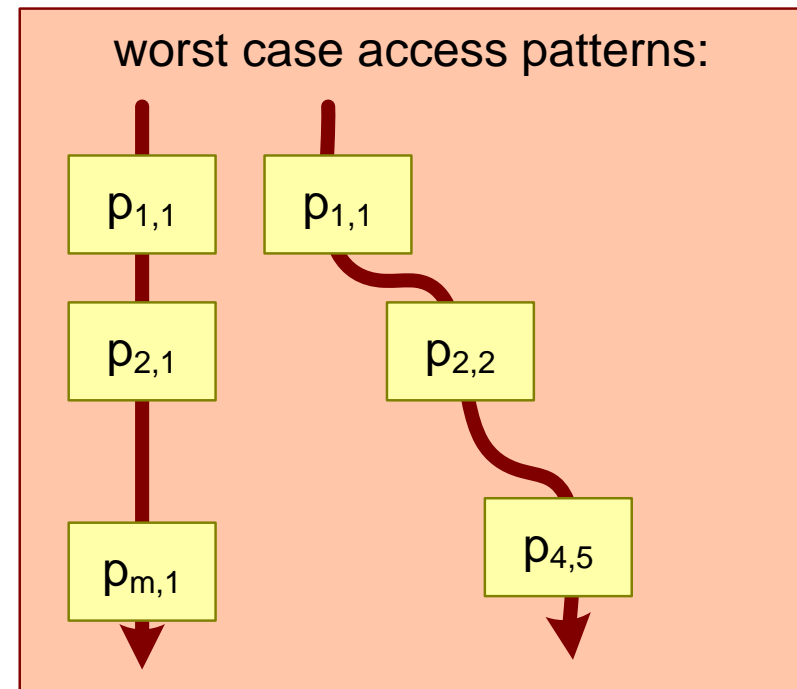
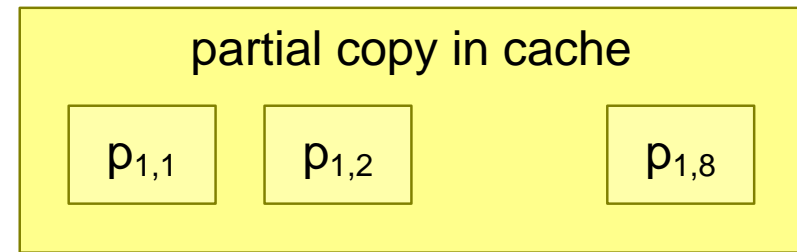
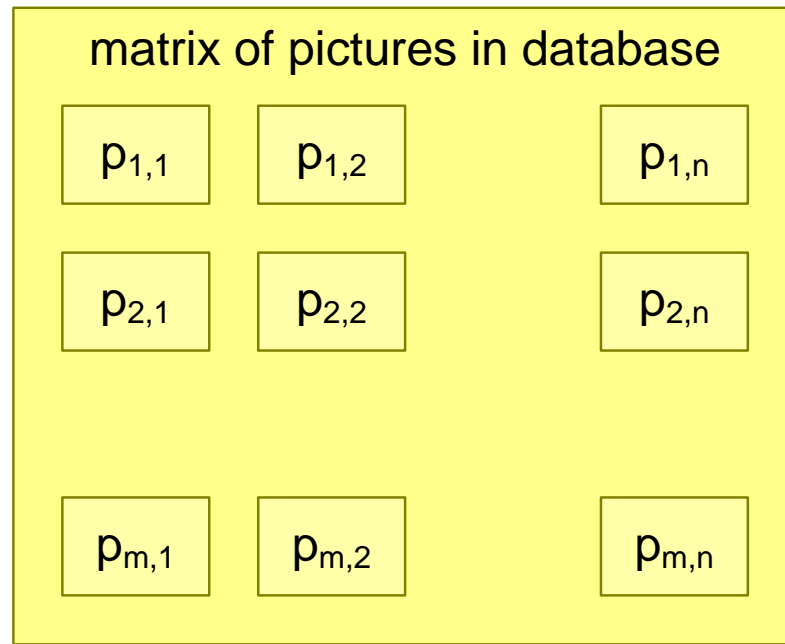
fragile model

small model change results in large shift in results

self fulfilling prophecy

price erosions + cost increase (inflation) -> bankruptcy

# Example of Worst Case Picture Cache



*What is the system behavior and performance for worst case access patterns?*

# Worst Case Questions

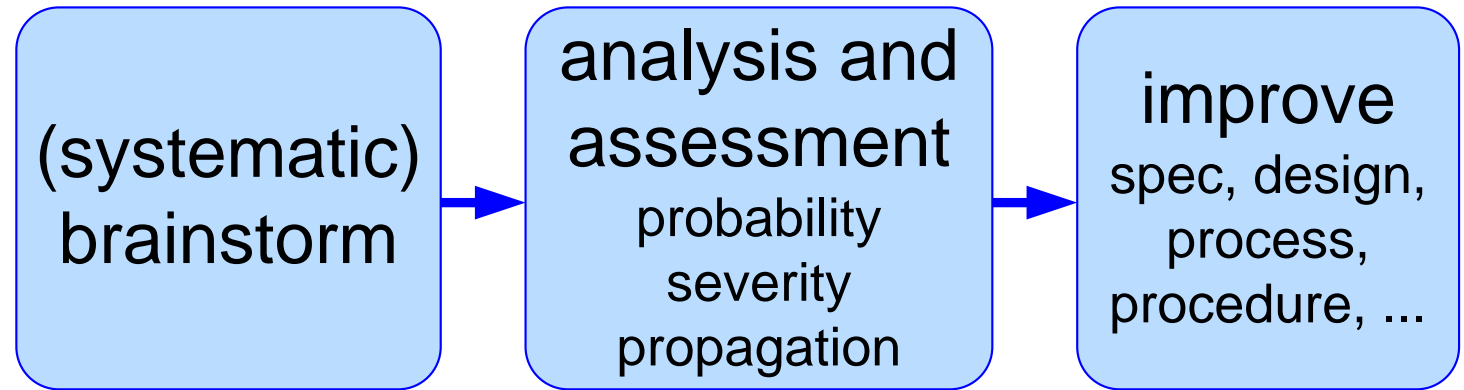
Which design assumptions have a big impact on system performance?

What are the worst cases for these assumptions?

How does the system behave in the worst case?

- a. poor performance within spec
- b. poor performance not within spec
- c. failure -> reliability issue

# FMEA-like Analysis Techniques



<b>safety</b> hazard analysis	potential hazards	damage	measures
<b>reliability</b> FMEA	failure modes exceptional cases	effects	measures
<b>security</b>	vulnerability risks	consequences	measures
<b>maintainability</b>	change cases	impact, effort, time	decisions
<b>performance</b>	worst cases	system behavior	decisions

# Brainstorming Phases

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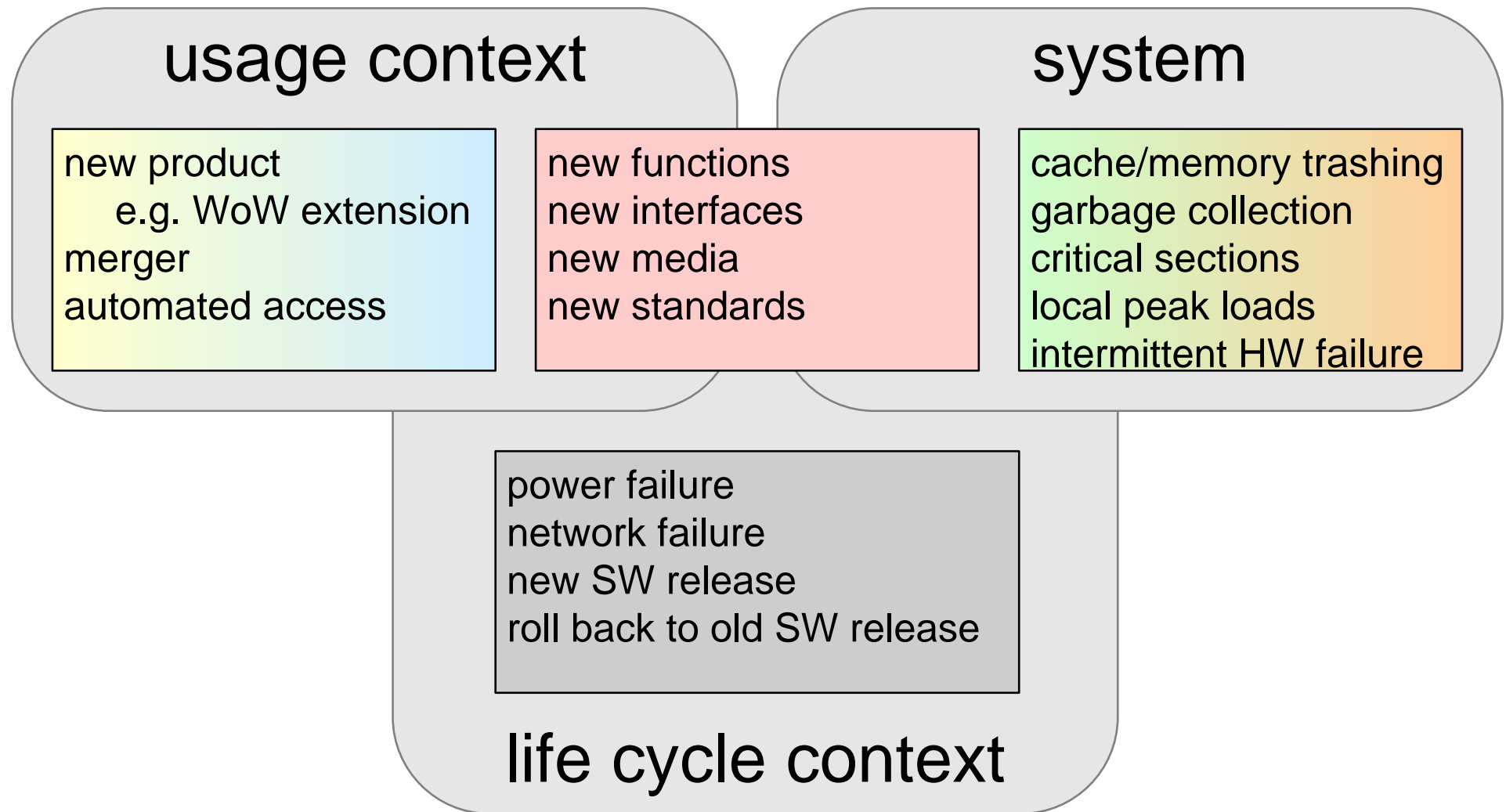
wave 1: the obvious

wave 2: more of the same

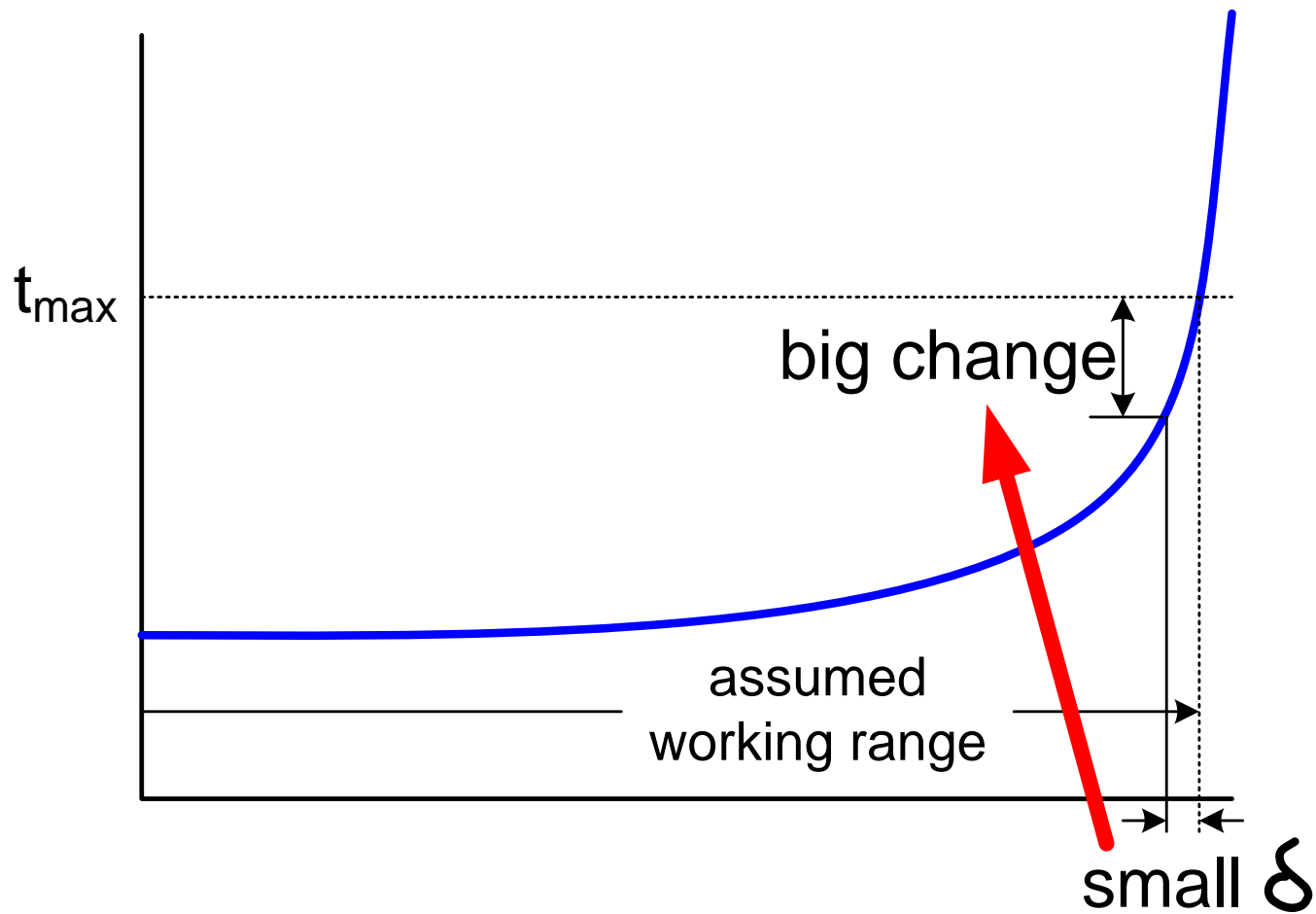
wave 3: the exotic, but potentially important

don't stop too early with brainstorming!

# Different Viewpoints for Analysis



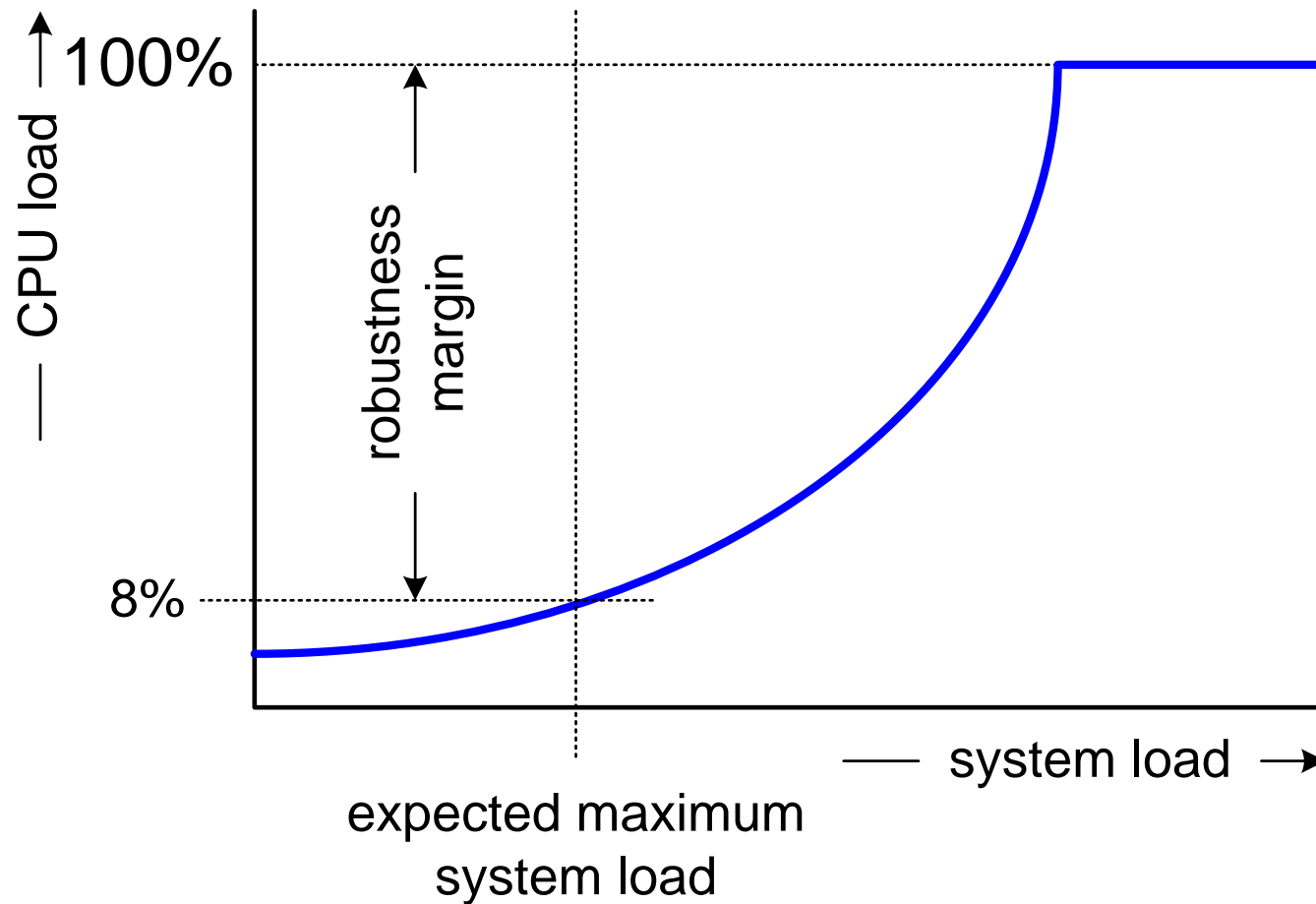
# Example Sensitivity



*sensitivity: how sensitive is the system output for small changes in input or realization?*

# Example of CPU Utilization and Efficiency

*CPU utilization is "only" 8%  
what is the efficiency?*





# Efficiency is Context Dependent!

