

# From customer requirement to product requirement with Comsol.

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# Presentation Outline



- BD Overview
- From Customer Requirement to Model
- From Model to Product Requirement
- Methodology
- FE-model in COMSOL
- Validation
- Virtual DOE
- Transfer function
- Variation in inputs to transfer function
- Monte Carlo simulation
- Example of usage

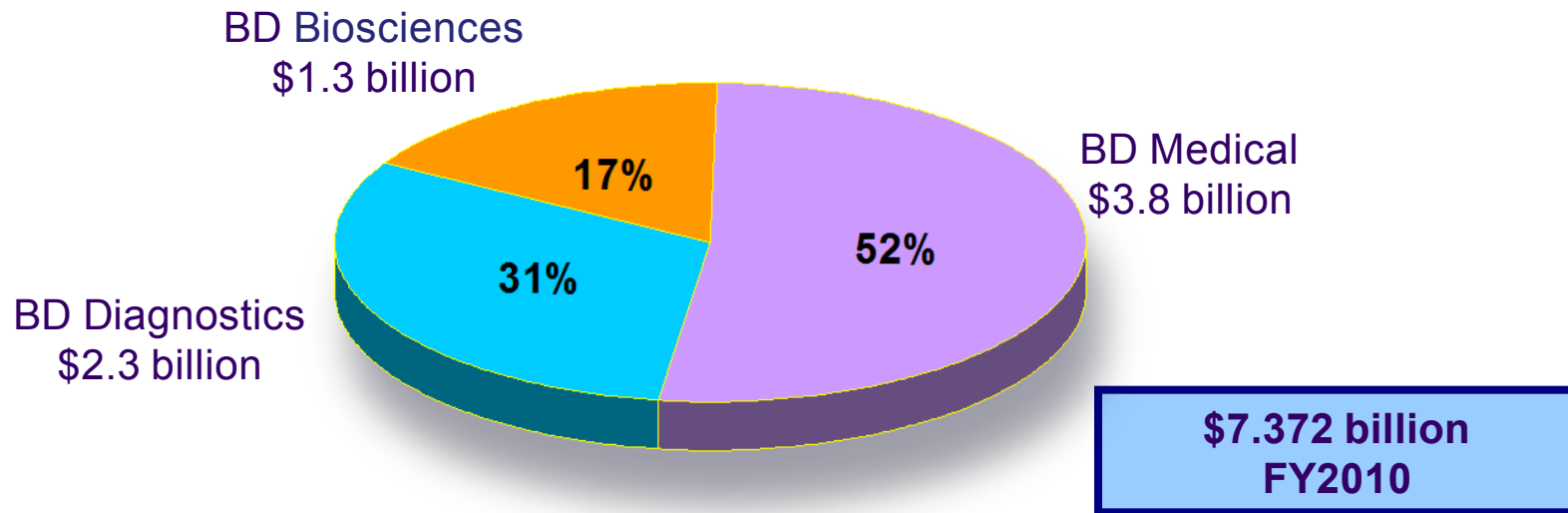
## Who is BD?



- **FORTUNE 500** company (#312)
- Locations in **more than 50 countries**
- Approximately **29,000 associates** worldwide
- Serves healthcare institutions, life science researchers, clinical laboratories and the general public
- Sells a broad range of medical supplies and services, devices, laboratory equipment and diagnostic products

[www.bd.com](http://www.bd.com)

# Revenues by Segment



[www.bd.com](http://www.bd.com)

# Strategic Focus



- Reducing spread of infection
- Advancing global health
- Enhancing therapy
- Improving disease management



[www.bd.com](http://www.bd.com)



# BD Medical – Product Highlights



BD SafetyGlide™  
Injection Needle



BD Venflon™ Pro Safety  
Safety engineered ported  
single use intravenous (IV)  
catheter



BD™ Insulin Syringes



BD Hypak™ Glass Prefillable  
Syringes

[www.bd.com](http://www.bd.com)



BD™ Pen Needles



BD Nexiva™ Closed IV  
Catheter System



BD PosiFlush™  
Heparin-filled  
Flush Syringe



BD Micro-Delivery  
System



Focuses on providing innovative solutions to **reduce the spread of infection, enhance diabetes treatment, advance drug delivery and improve ophthalmic surgery outcomes.**

## Products

- Needles and syringes
- Intravenous catheters
- Safety-engineered auto-disable devices
- Prefillable drug delivery systems
- Prefilled IV flush syringes
- Insulin syringes and pen needles
- Regional anesthesia needles and trays
- Surgical blades and scalpels
- Ophthalmic surgical instruments

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## Customers Served

- Hospitals and clinics
- Physicians' office practices
- Consumers and retail pharmacies
- Government and nonprofit public health agencies
- Pharmaceutical companies
- Healthcare workers

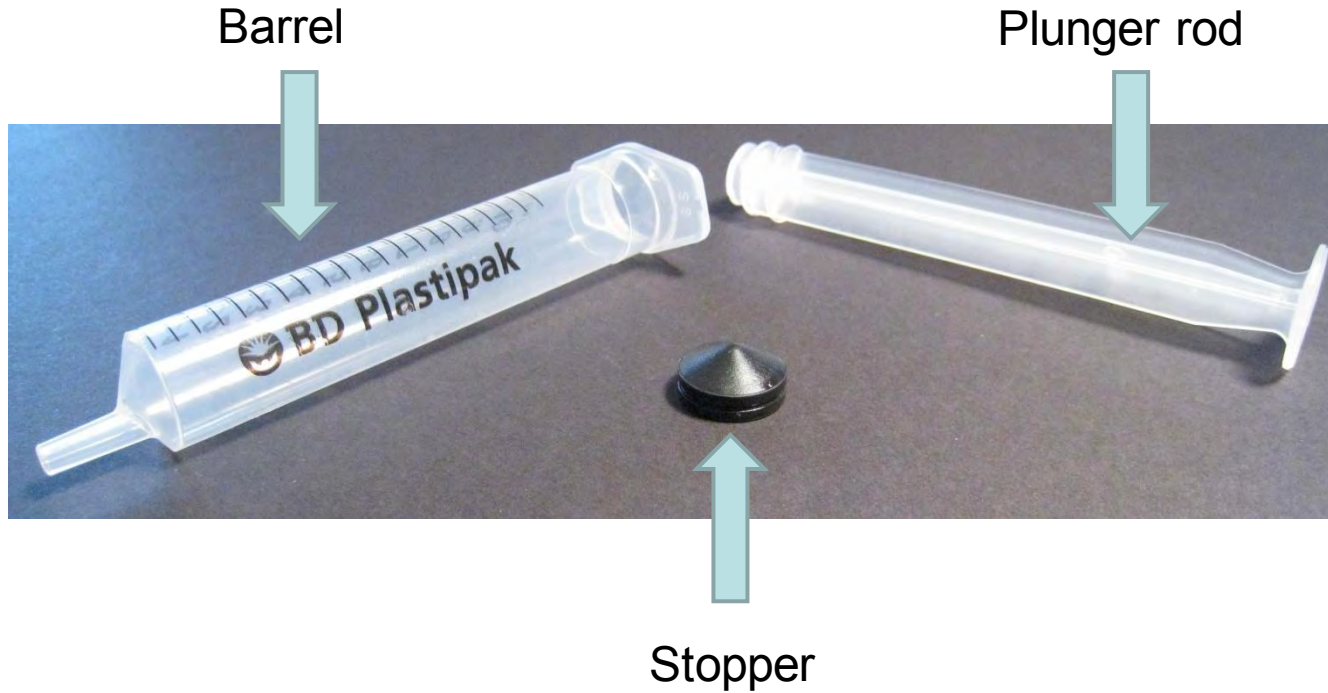


# From Customer Requirements to Model

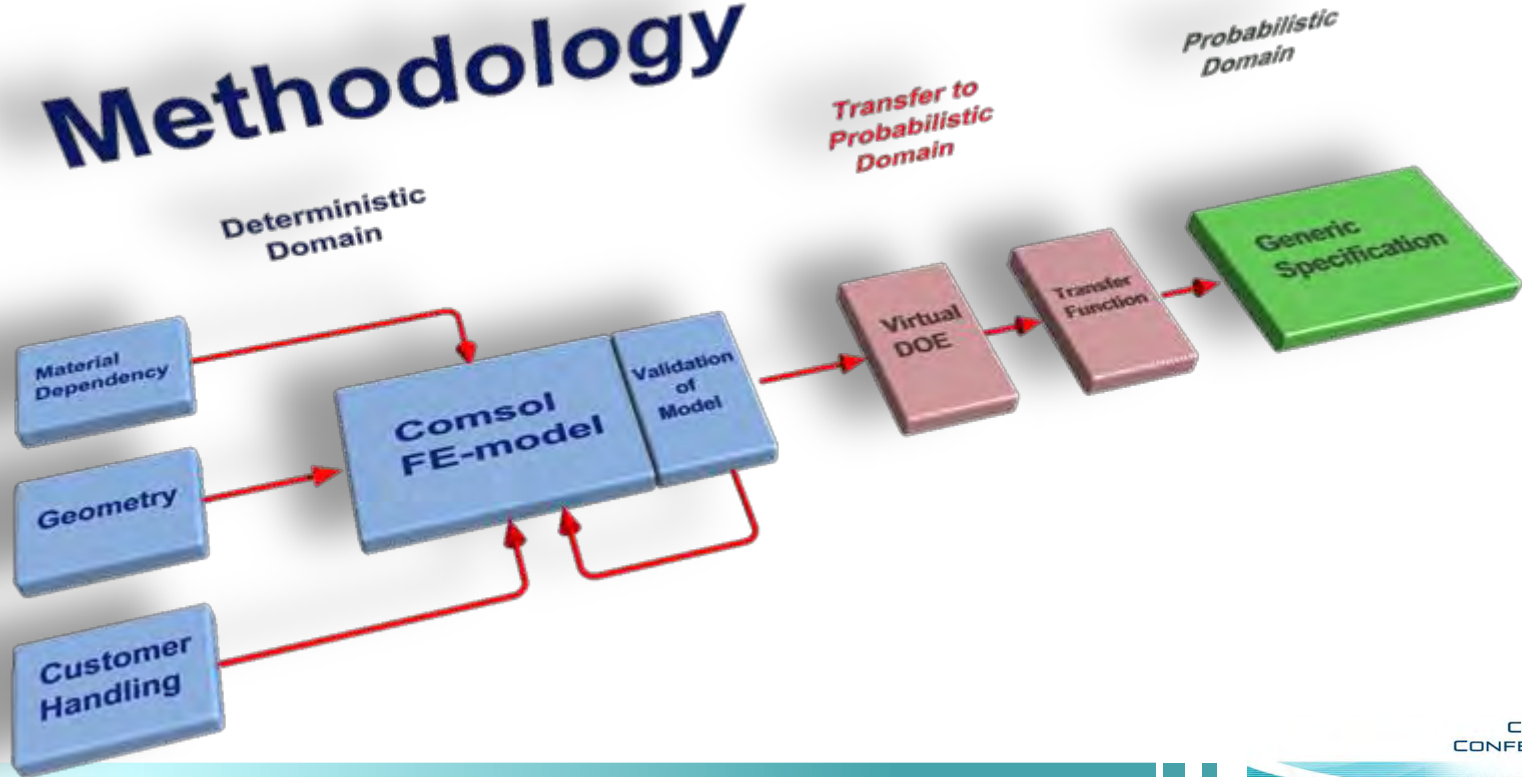




# 3-piece syringe

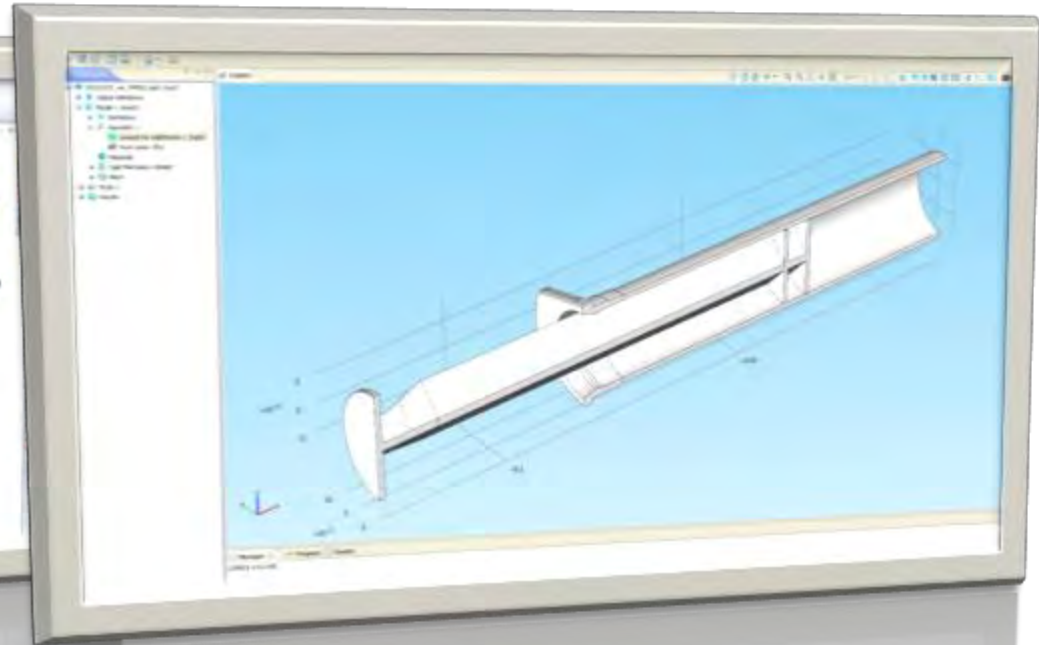
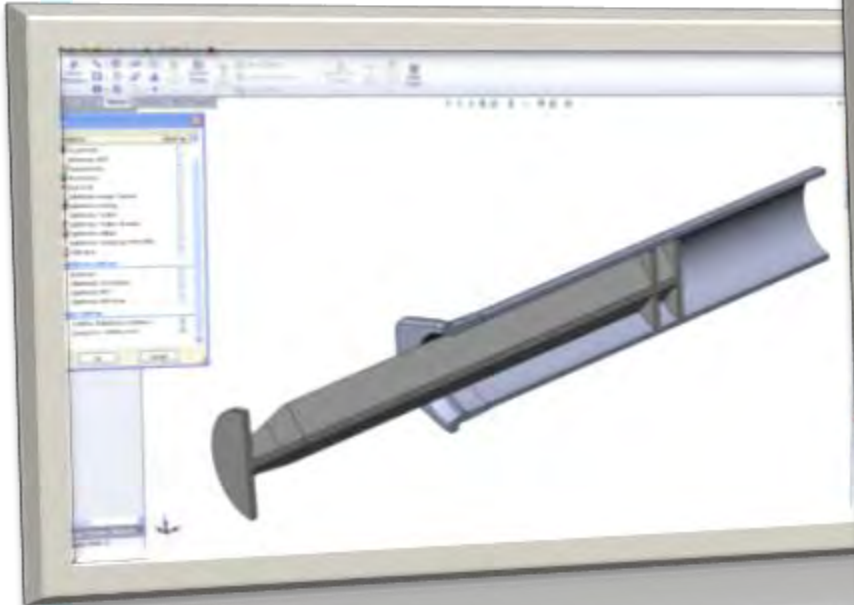


## Methodology



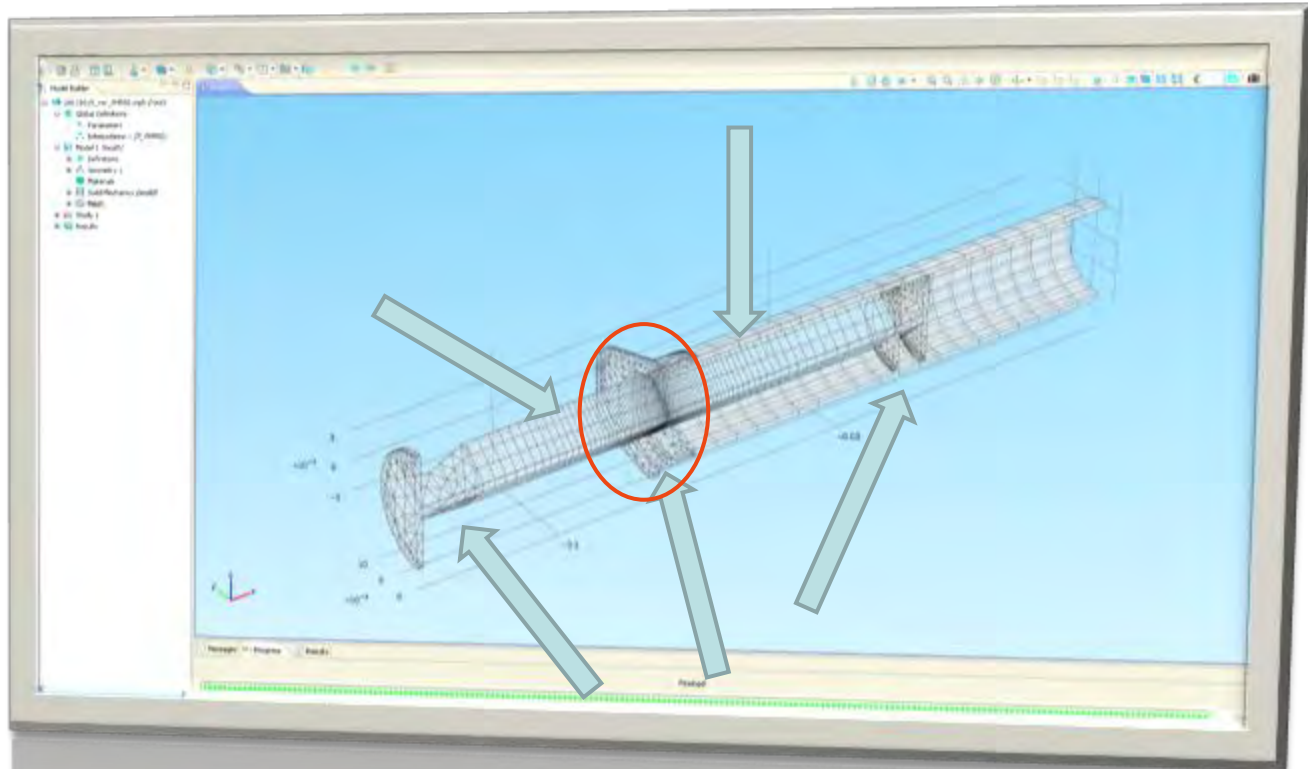


# FE-model in COMSOL Solid



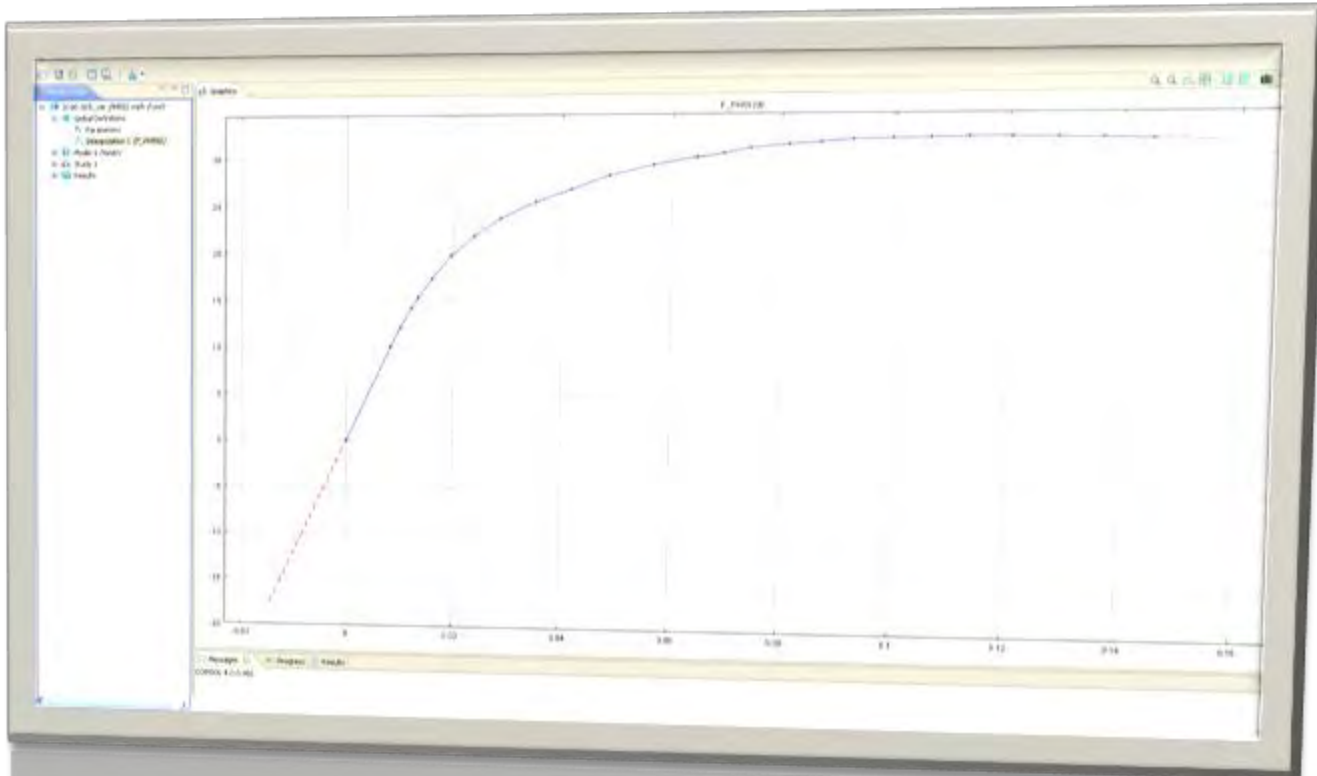


# FE-model in COMSOL Mesh



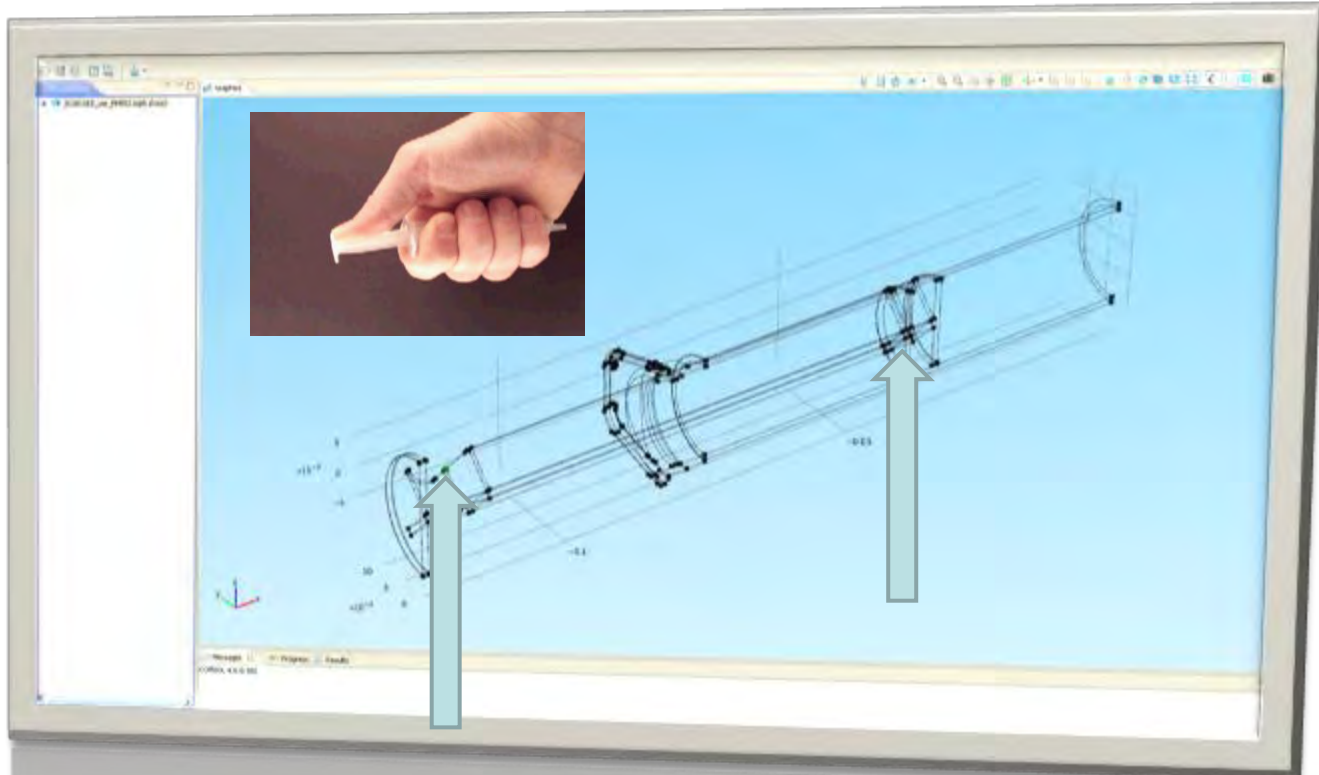


# FE-model in COMSOL Material



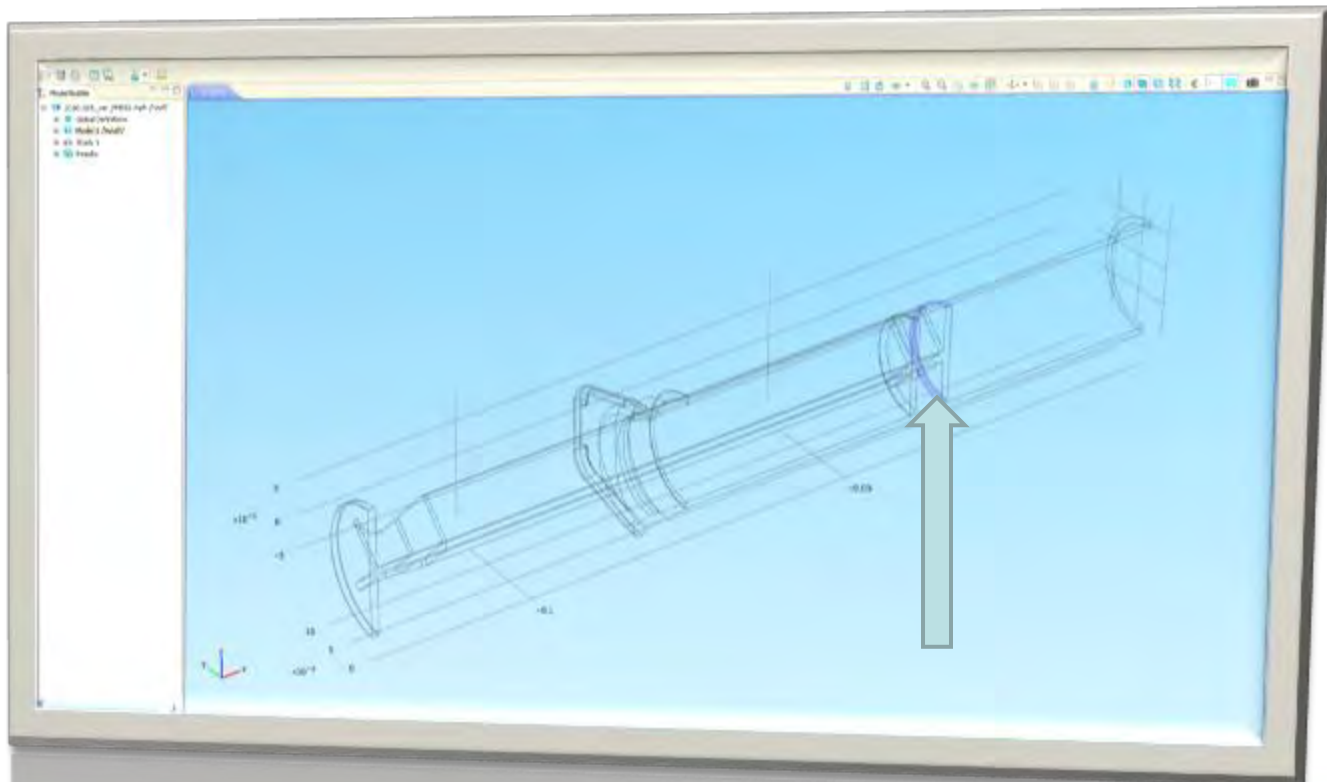


# FE-model in COMSOL Loads



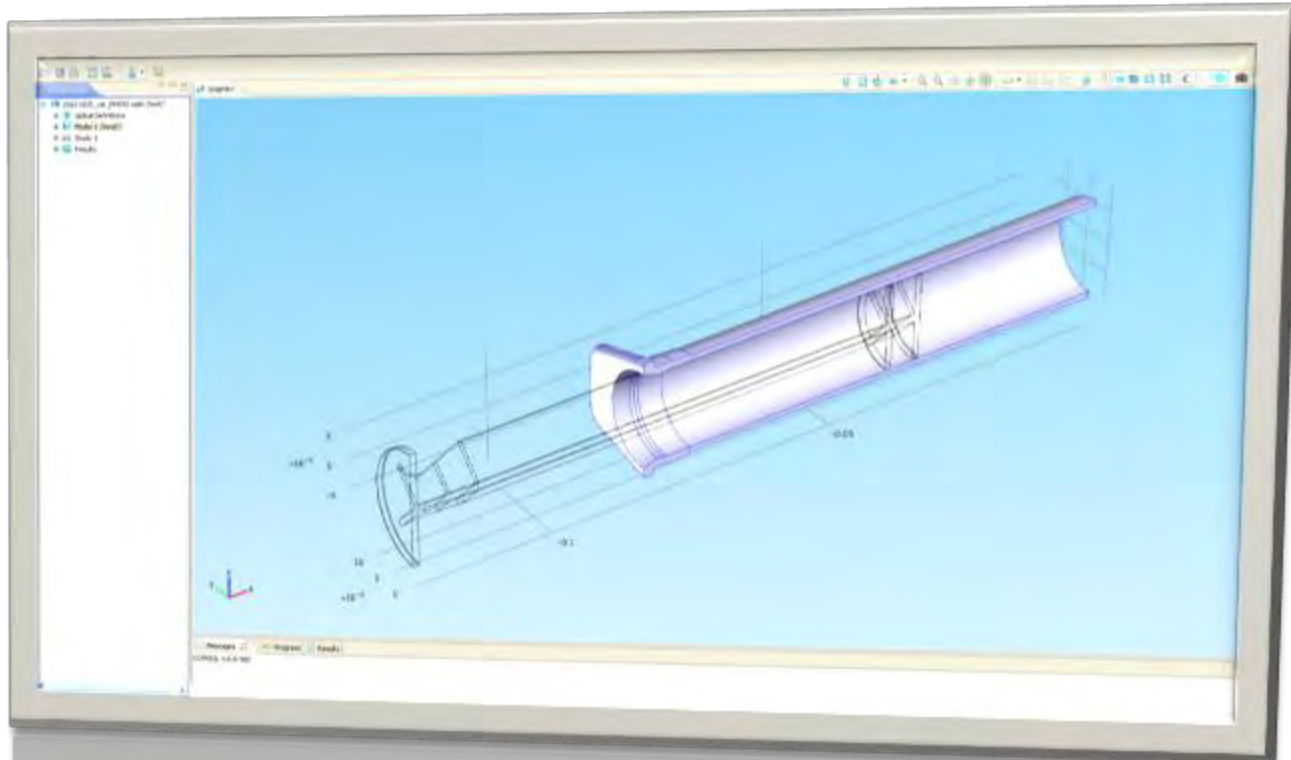


# FE-model in COMSOL Boundary





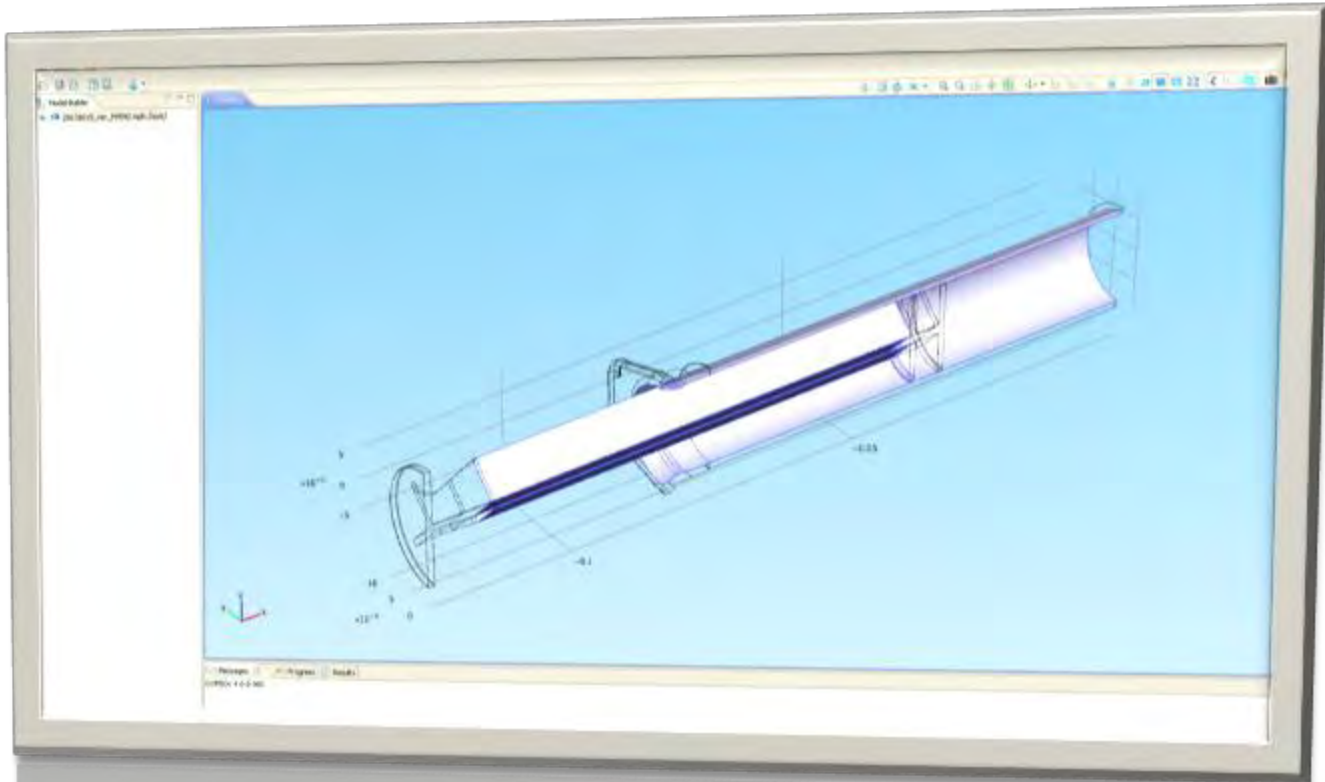
# FE-model in COMSOL Constrain





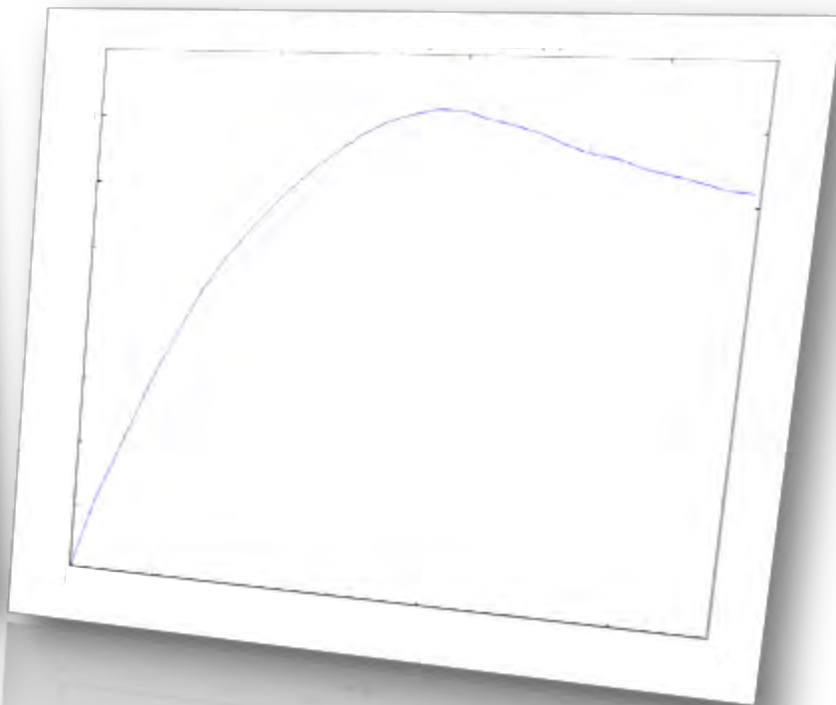
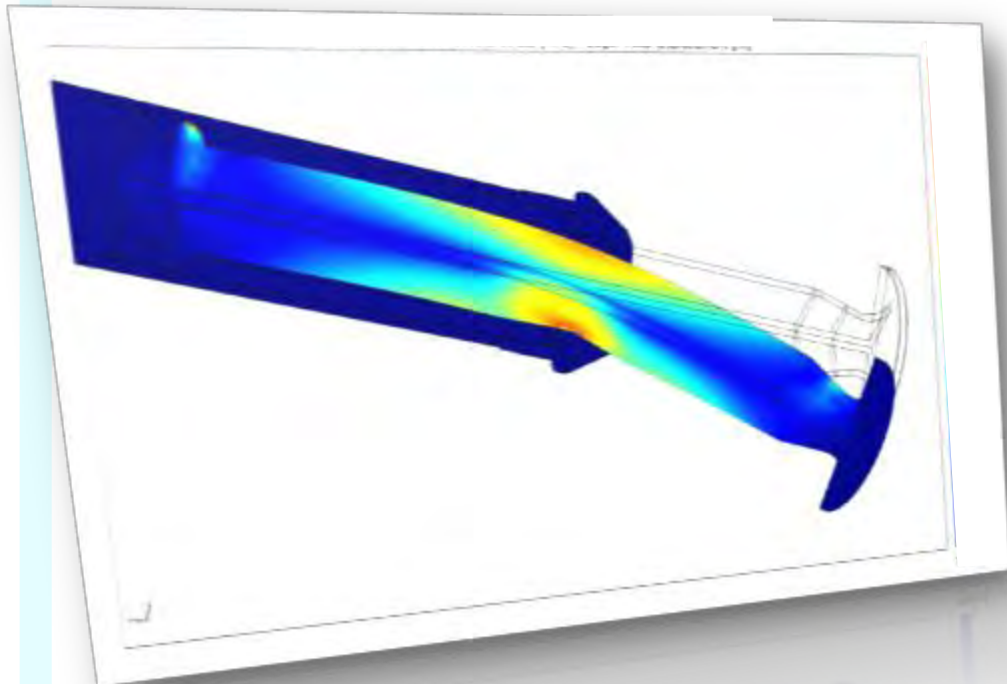


# FE-model in COMSOL Contact condition





# FE-model in COMSOL Response from model





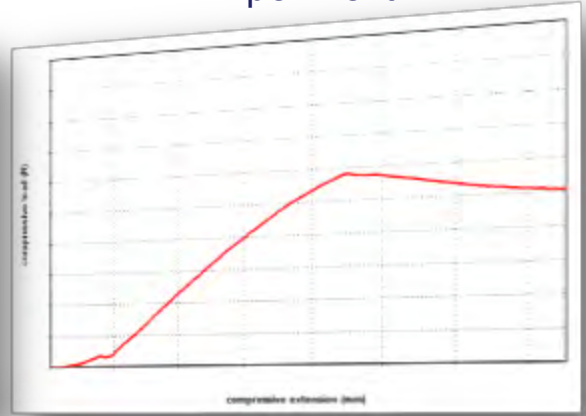
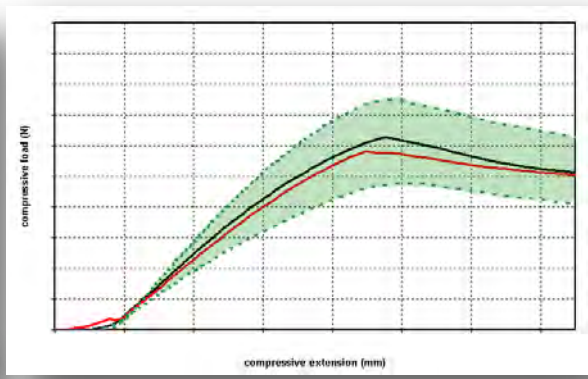
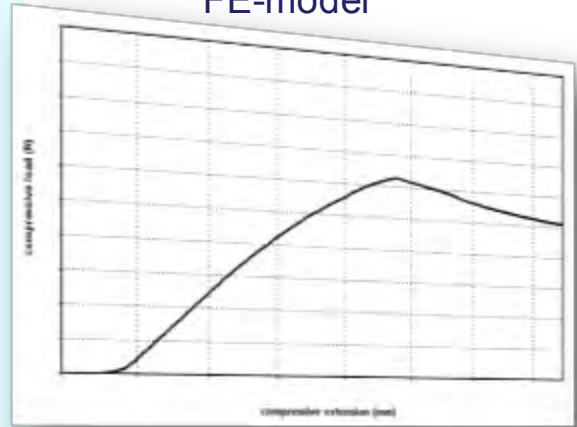
# Validation



### FE-model

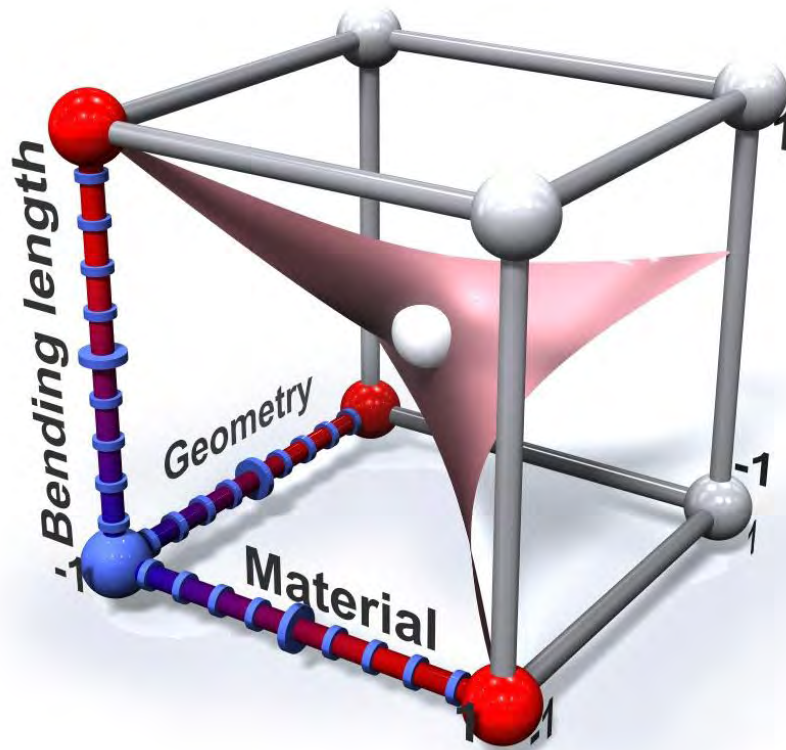
### Acceptance criteria

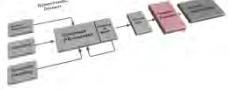
### Experiment





# Virtual Design of Experiment (DOE)





# Building Transfer function



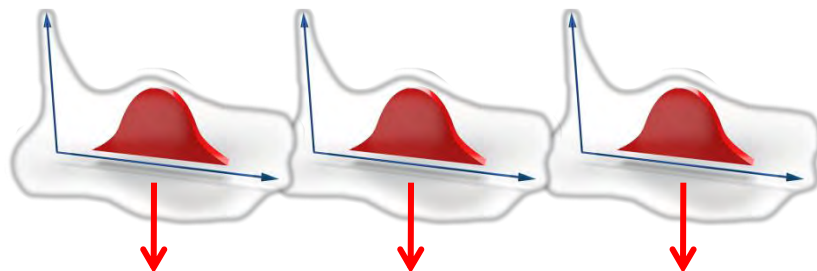
$$y = f(x_1, x_2, \dots, x_n)$$

Mathematically relates the system's critical parameters (the X's) to the system's critical responses (the Y's)

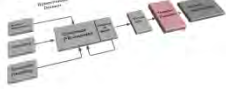
$$\text{Force} = f(\text{Material}, \text{Geometry}, \text{Bending length})$$



# Variation in inputs to transfer function



$$\text{Force} = f(\text{Material}, \text{Geometry}, \text{Bending length})$$

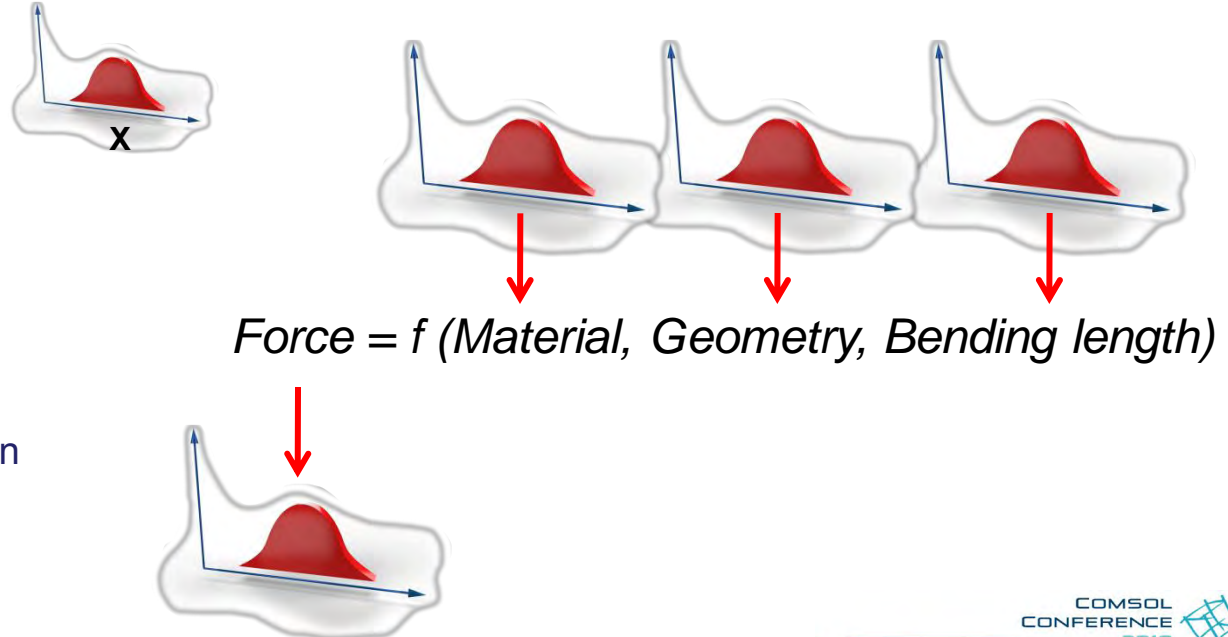


# Monte Carlo simulation

The input variables in the transfer function can vary over a range  
The variability are described by probability distribution

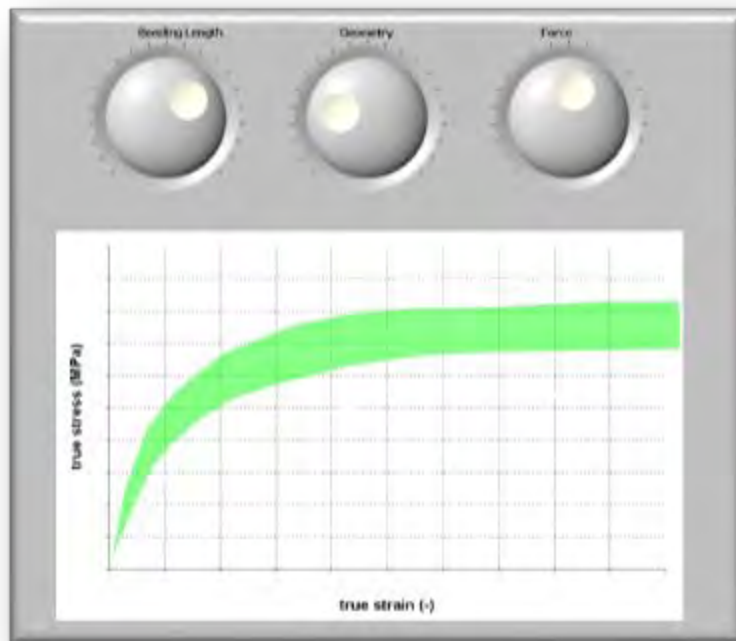
$$\Delta y = f(\Delta x)$$

A forecast of the force distribution is created by sampling values from material, geometry and bending length distribution and making repeated calculation of the result.



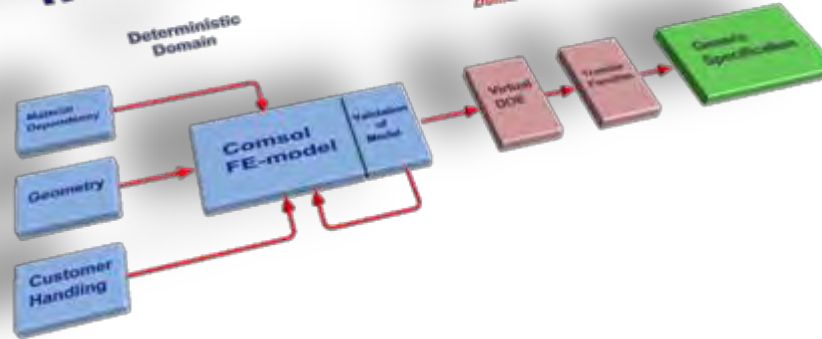


# Example of usage: Generic material specification





## Methodology



Vendor and Material change  
Cost Benefit Analysis  
Reduce time and cost  
Sensitivity Analysis

**Questions?**

**Thank You  
for  
Your Attention!**

**Acknowledgment**

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