

# **CETOL 60** <sup>TM</sup>

## **2011 U2U CONFERENCE**

### **TEXAS MOTOR SPEEDWAY, OCT 25-26**

## “The DM Revolution”

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- The last two decades have seen revolutionary change in the methods engineers are using to predict, understand and most importantly, manipulate how minor variations in component size, shape & location affect the overall assembly, operation and performance of the complete product.

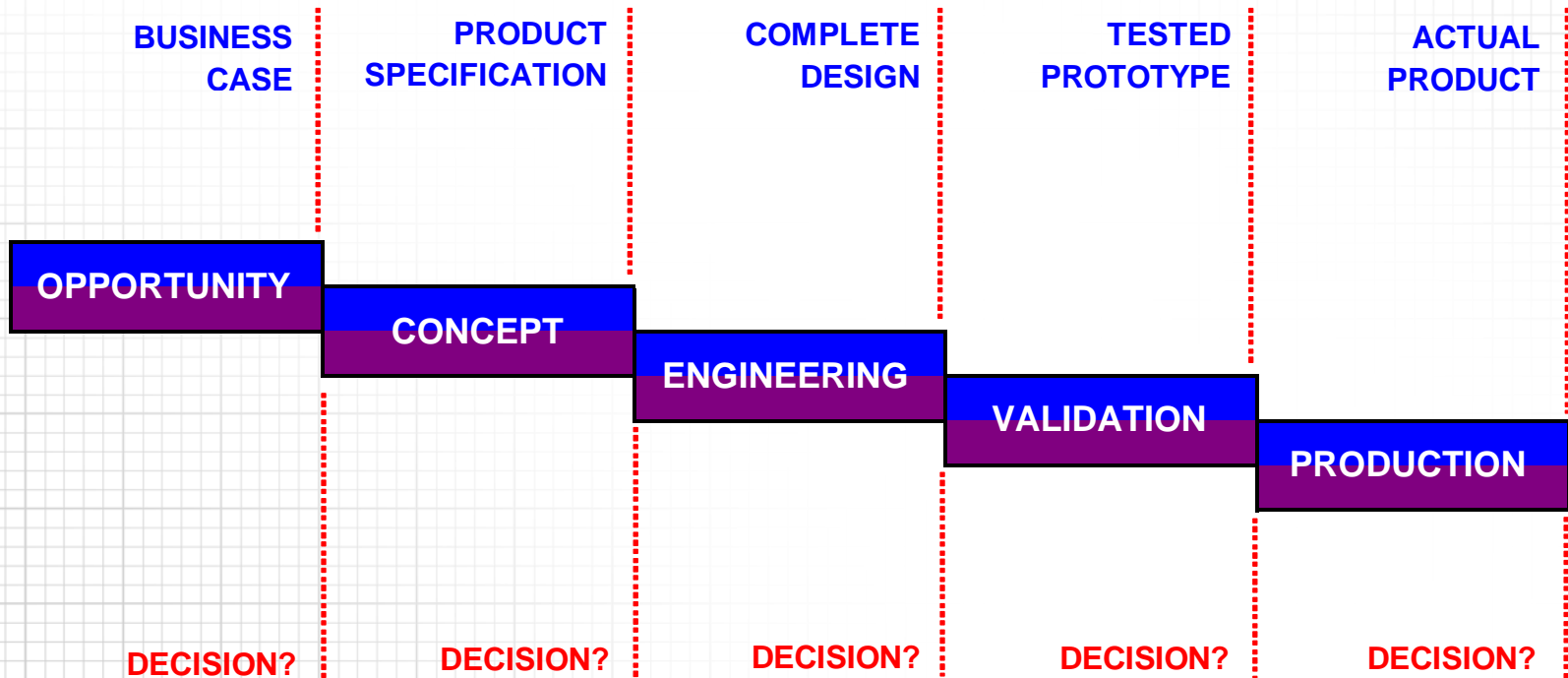
# The DM revolution



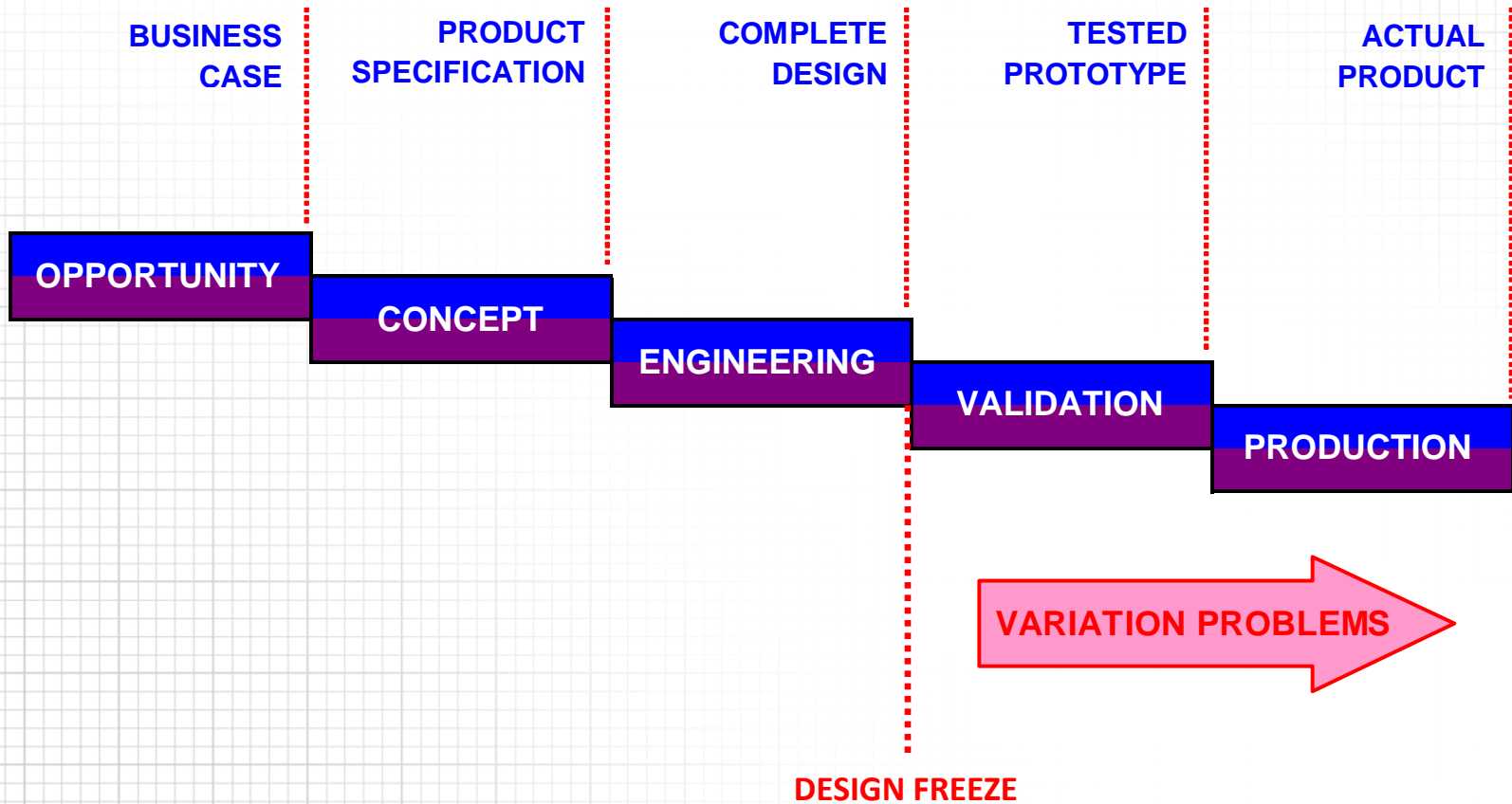
- Cetol gives engineers the capability to simulate variation in component topography and location, enabling engineers to predict the overall 3D geometric variation behavior.

- A good Dimensional Management system provides the structure and organisation to get the best from the Cetol work.
- The role of the DM system is to protect the geometric integrity of the product and production from initial concept, through development and on into full scale manufacturing.

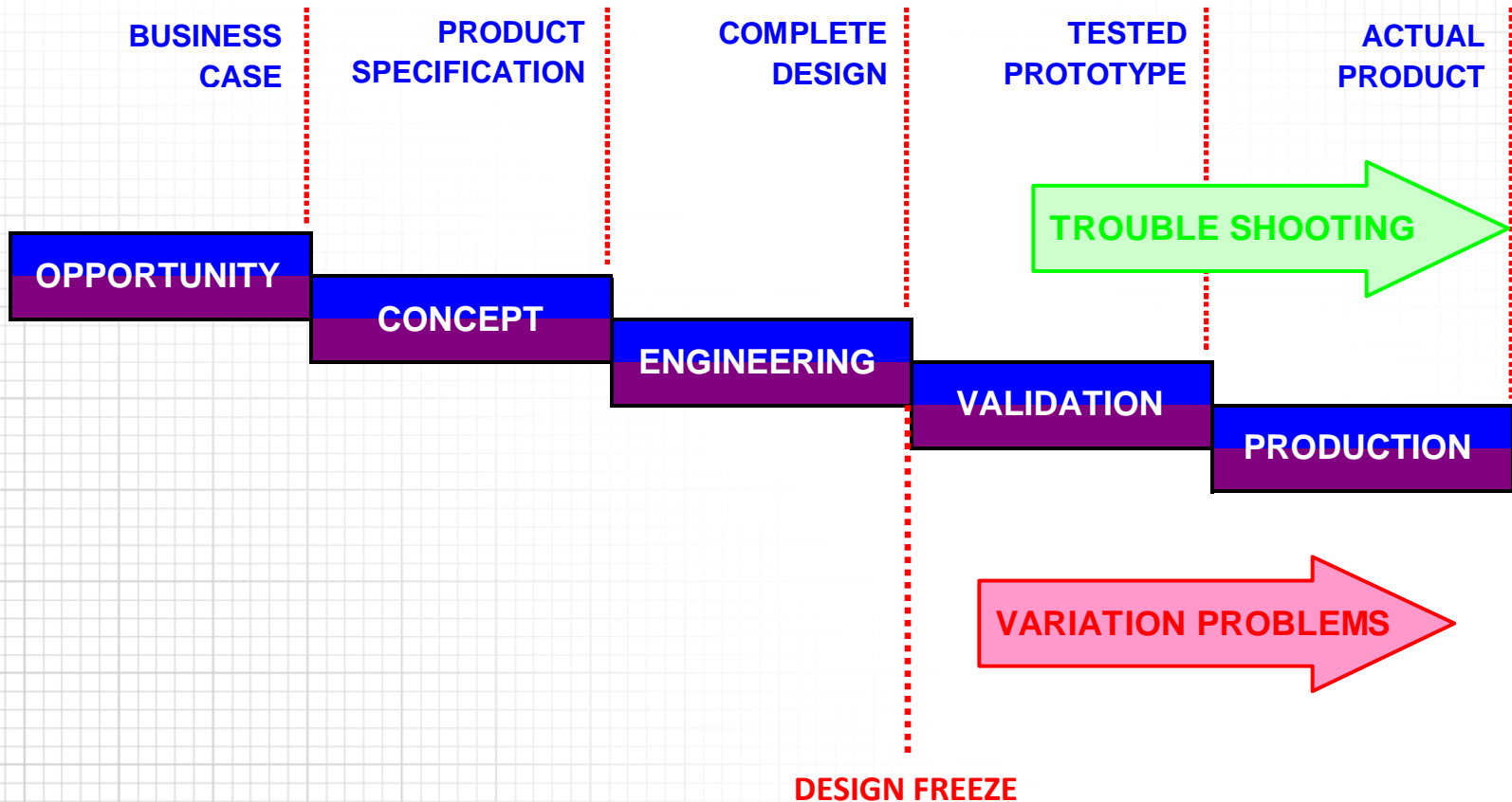
# New product development



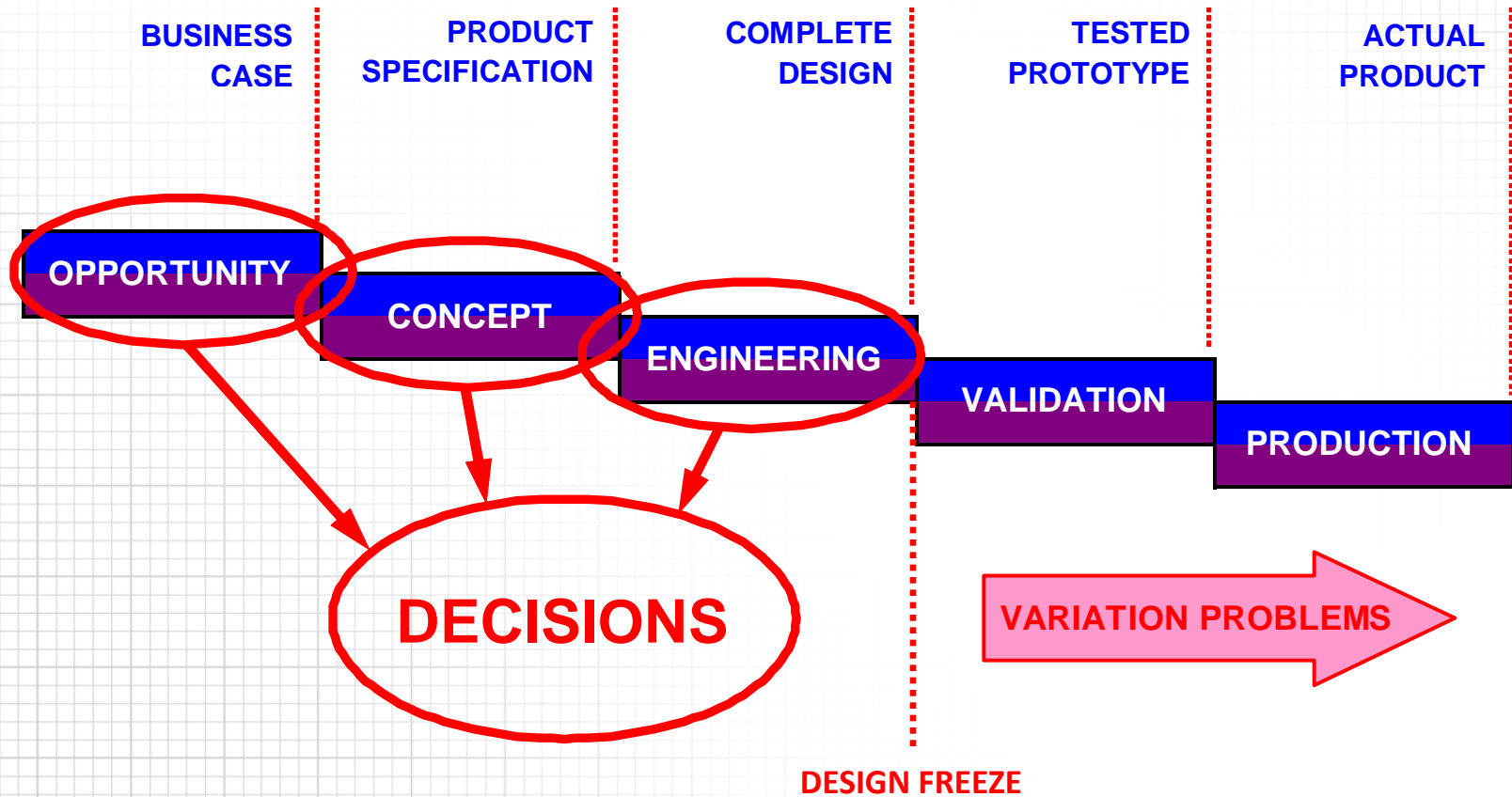
# When do problems occur?



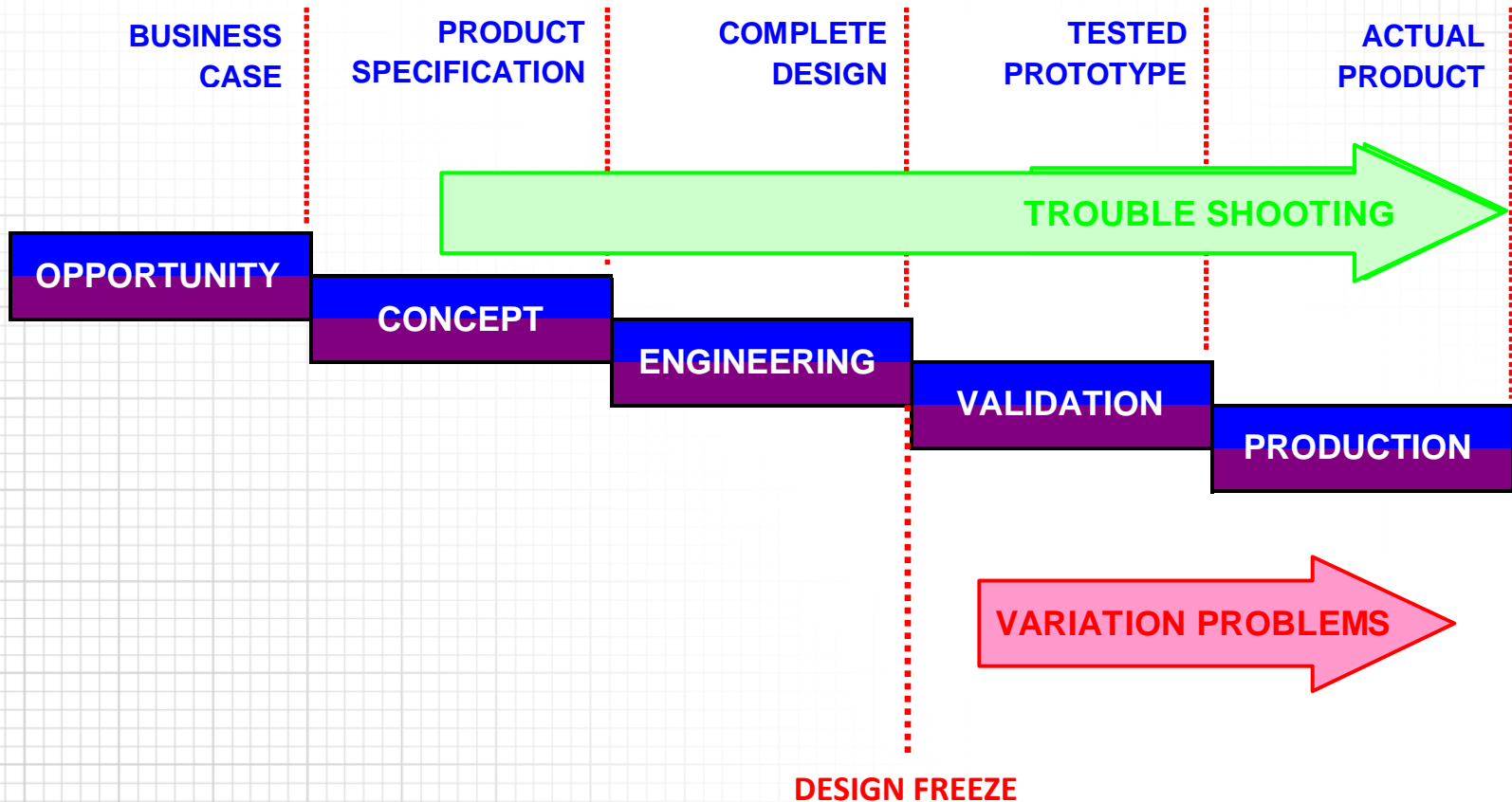
# What happens next?



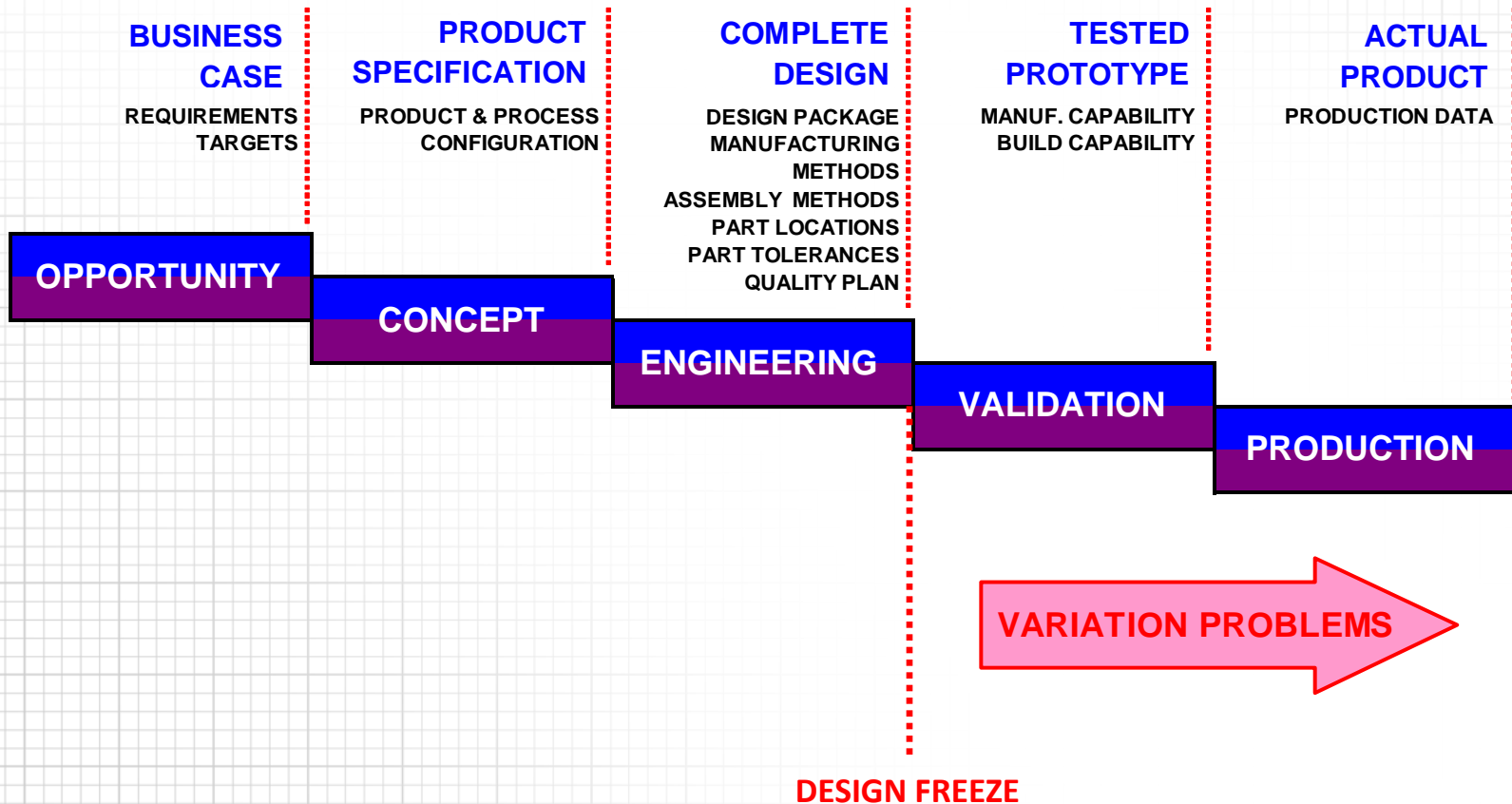
# Why do problems occur?



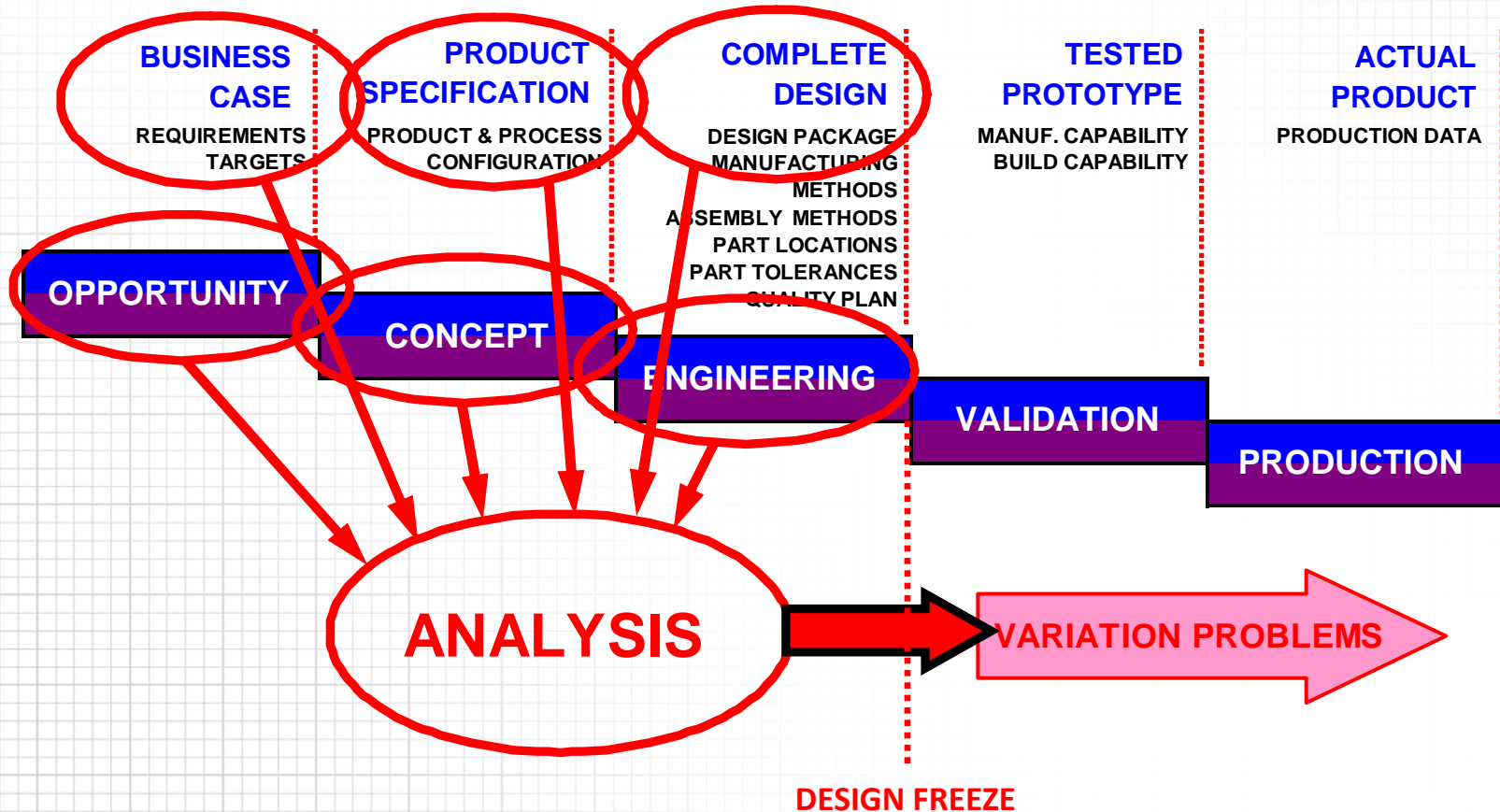
# Become more proactive



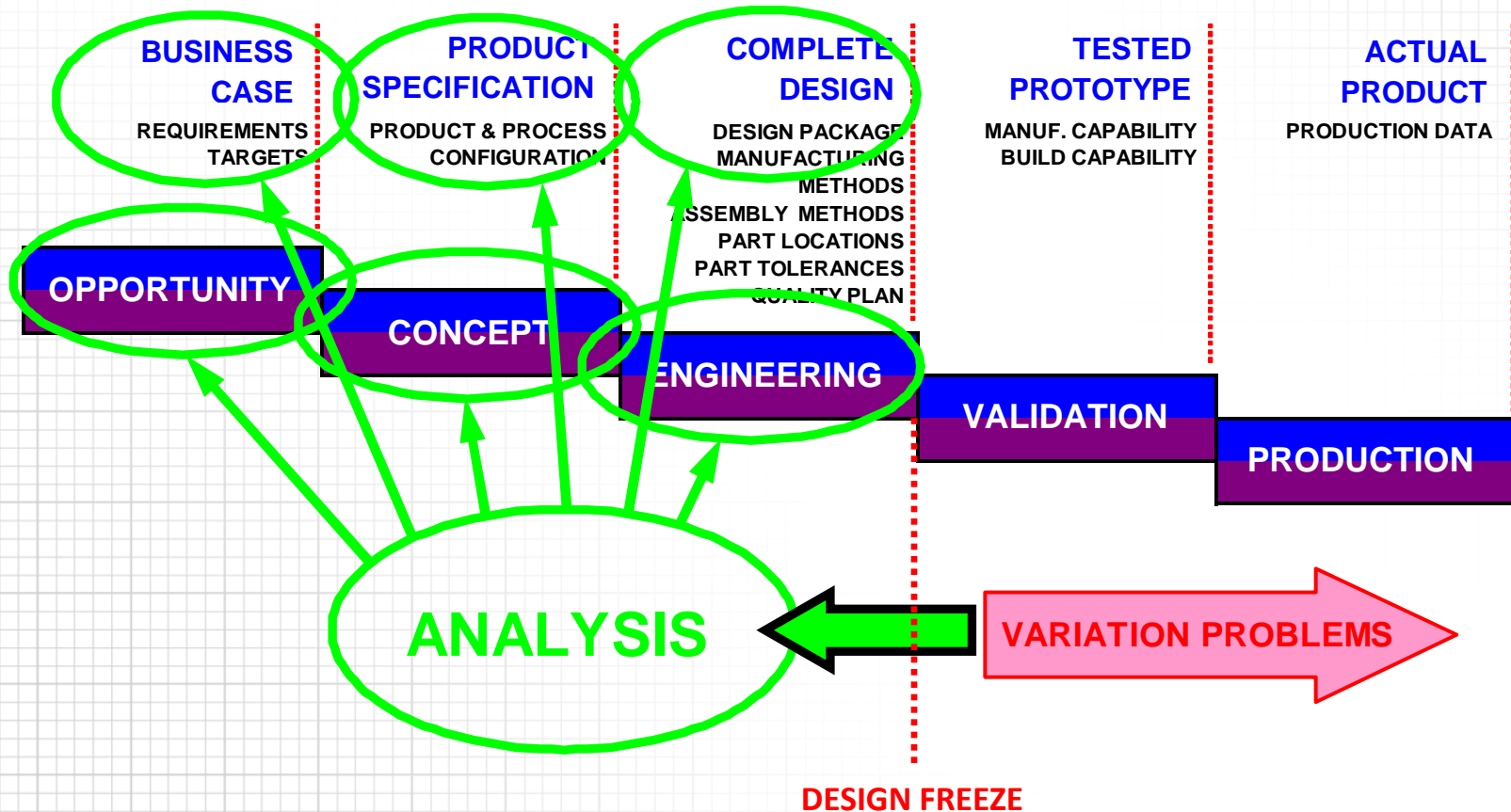
# Make full use of resources



# Identify problems in advance



# Informed decision making



The essential attributes of a good DM system:

- Plan & prepare.
- Apply & involve.
- Analyse & optimise.
- Communicate & document.
- Structure & organise.
- Roles & responsibilities
- Initiate & integrate.

- Advance planning is crucial to keep the DM work moving forwards and on track.
- Cetol models are built to answer questions, so what questions do you want answered?

Five simple planning aids:

- Decide the requirements.
- Agree the scope & content of the Cetol work.
- Cascade the variation measurements.
- Set appropriate targets.
- Prepare the DR book.

# Example: Generic transmission



## Challenge:

- Semi automatic CAD model.
- Three gearbox types.
- 20+ variants.

## Solution:

- Extensive use of cxm functionality.
- Implications for CAD procedures.

# Example: Door click

The door should close with an agreeable click:

- Depends on force needed to close door.
- Depends on compression of door seal.
- Measure seal gap around door opening.
- Set limits according to seal properties.

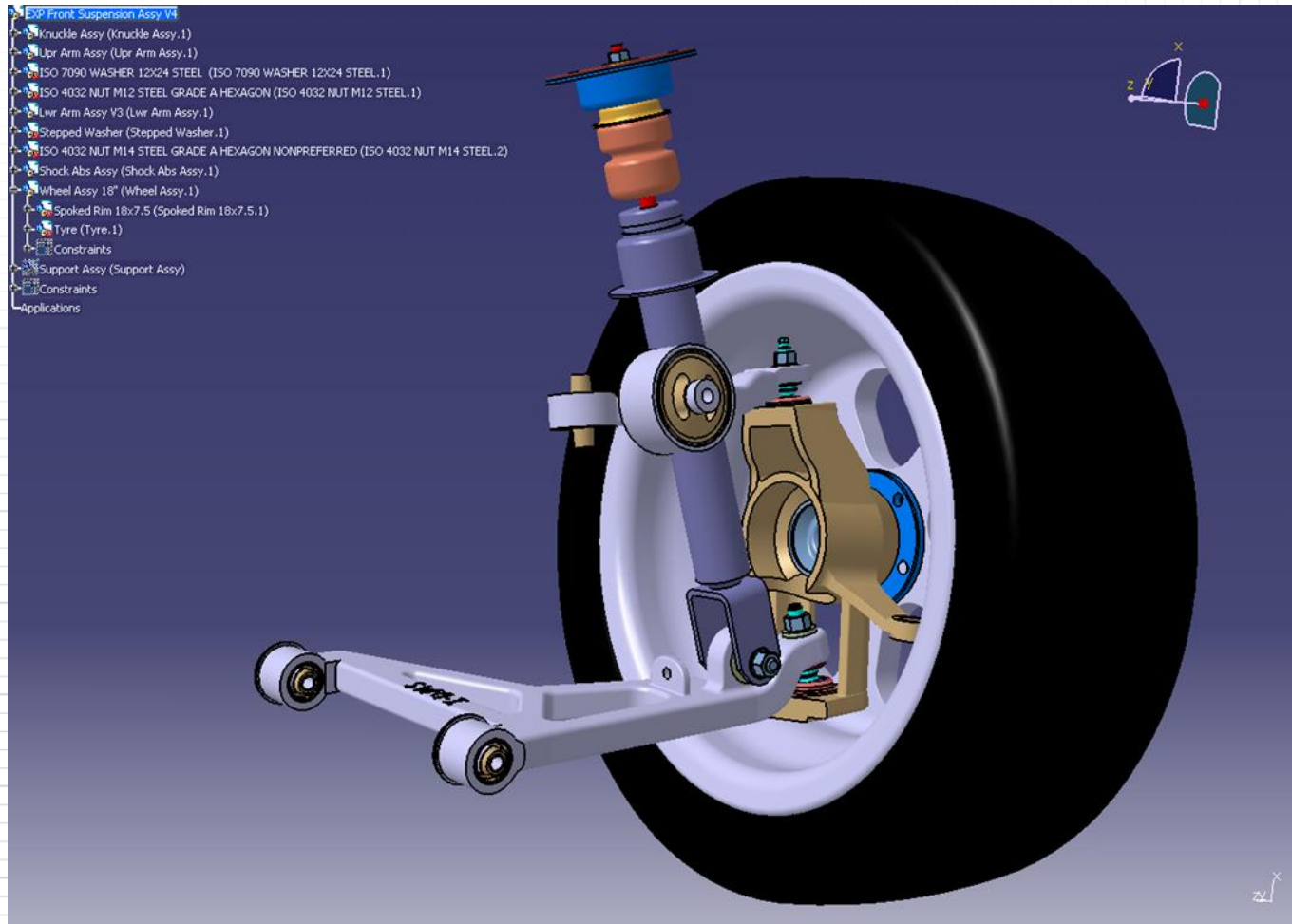
## Six preparation tips:

- Get the component geometry.
- Decide the model configurations.
- Map the assembly sequence.
- Identify the component locations.
- Quantify the known or expected variation.
- Write the model specification.

The Cetol model has to mimic the behaviour of the real system.

- Not always straightforward!
- Can involve multiple levels & sub assemblies.
- Need for secondary models.
- Nested configurations.
- High numbers of measurements.
- Model progression.

# Example: Front suspension



# Example: Front suspension



## Challenge:

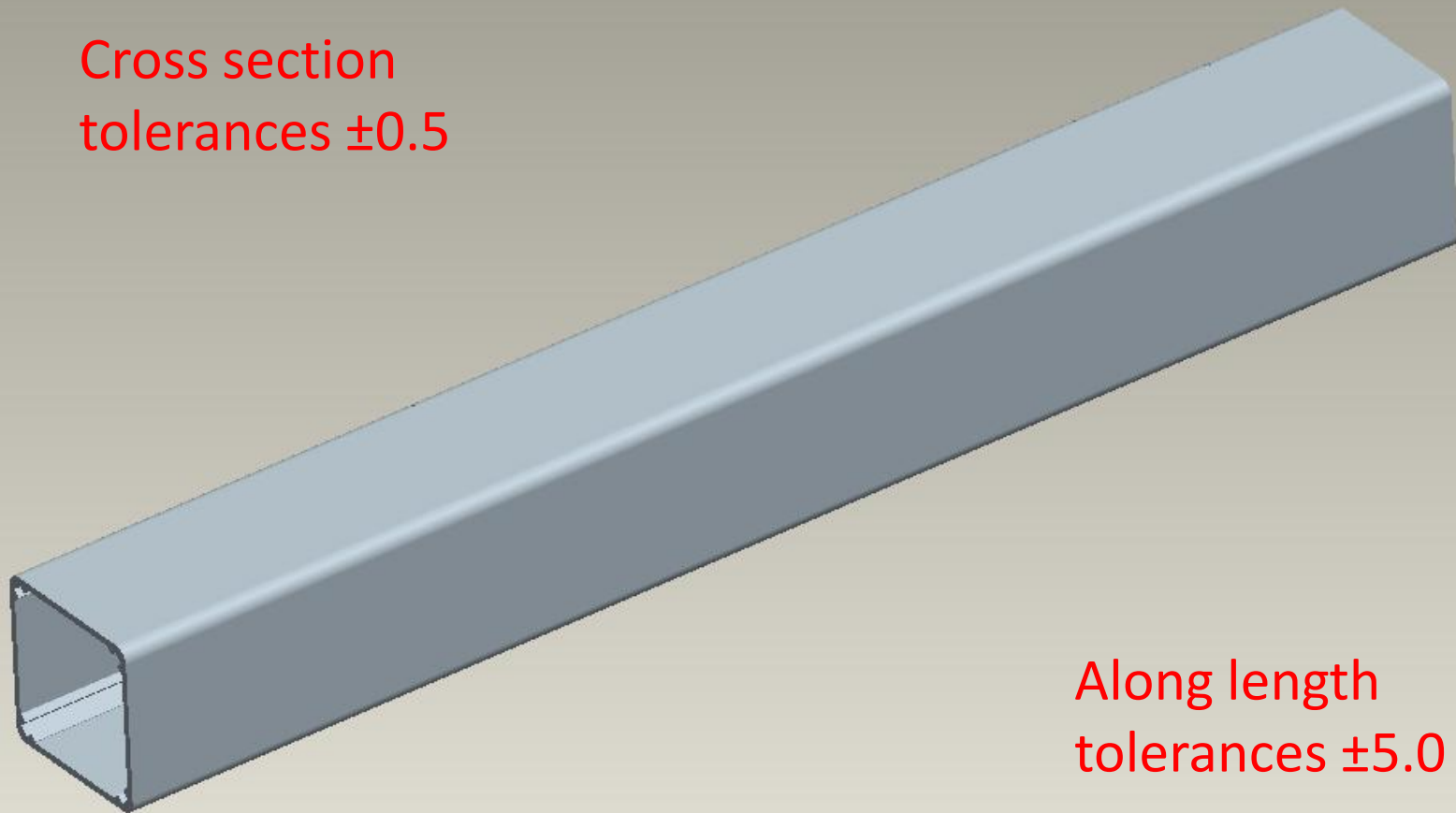
- Kinematic system.
- Full height range.
- Full steering range.

## Solution:

- 100+ configurations.
- 500+ measurements!

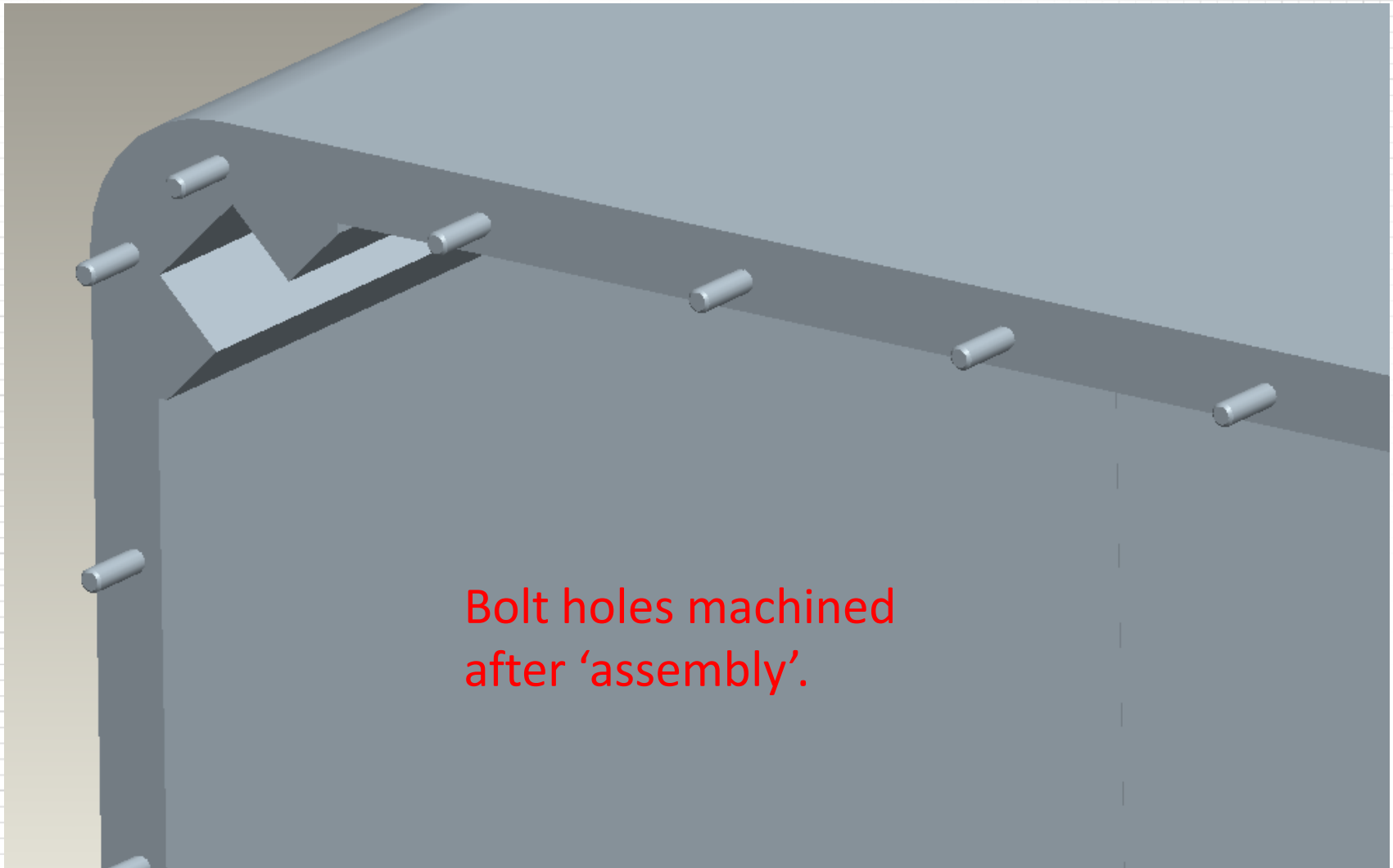
# Example: Composite tube

Cross section  
tolerances  $\pm 0.5$



Along length  
tolerances  $\pm 5.0$

# Example: Composite tube



Bolt holes machined  
after 'assembly'.

# Example: Composite tube



## Challenge:

- Cross section tolerances  $\pm 0.5$
- Along length tolerances  $\pm 5.0$
- End holes machined after 'assembly'.
- Predict alignment of rails and ends.

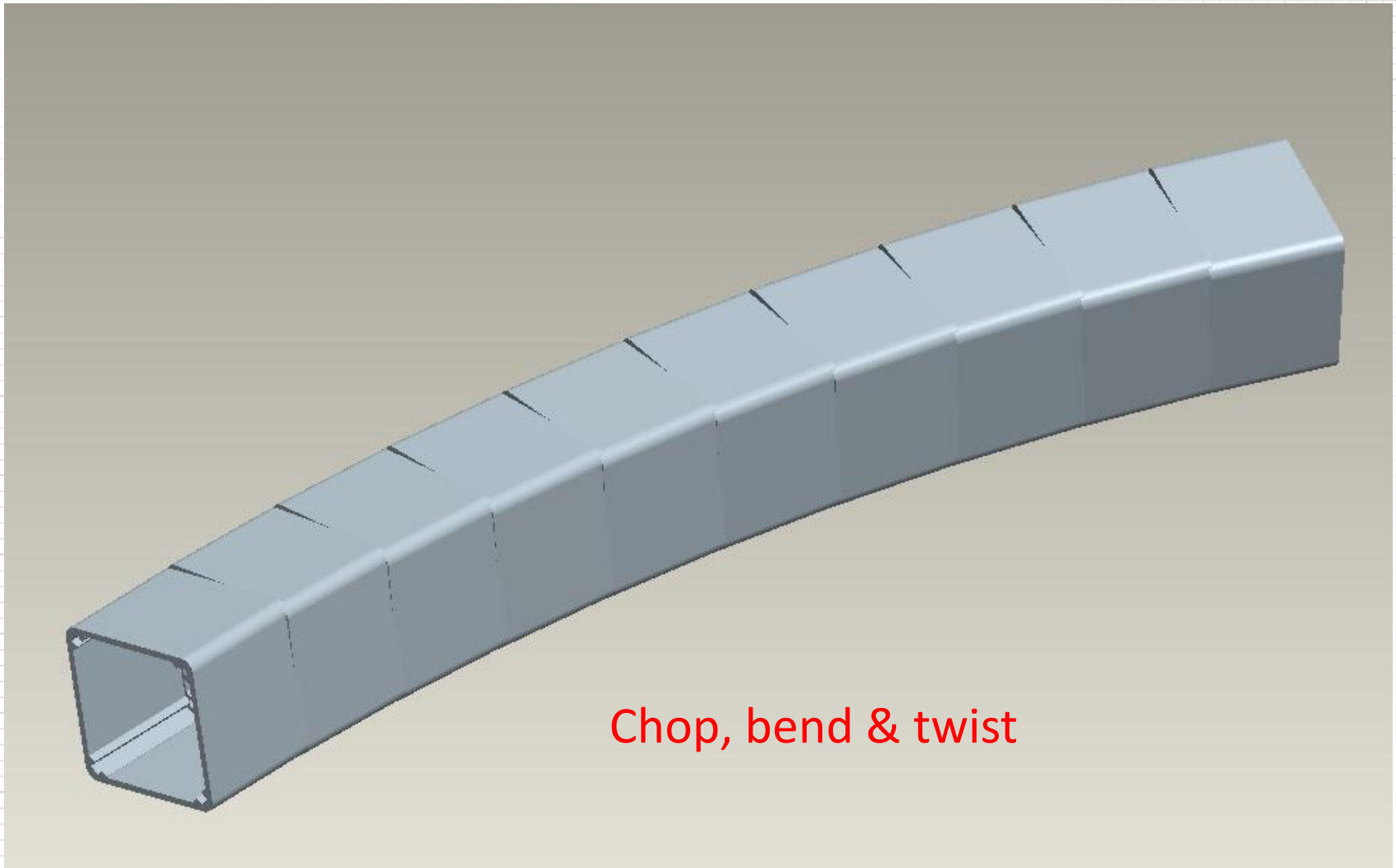
# Example: Composite tube



Solution:

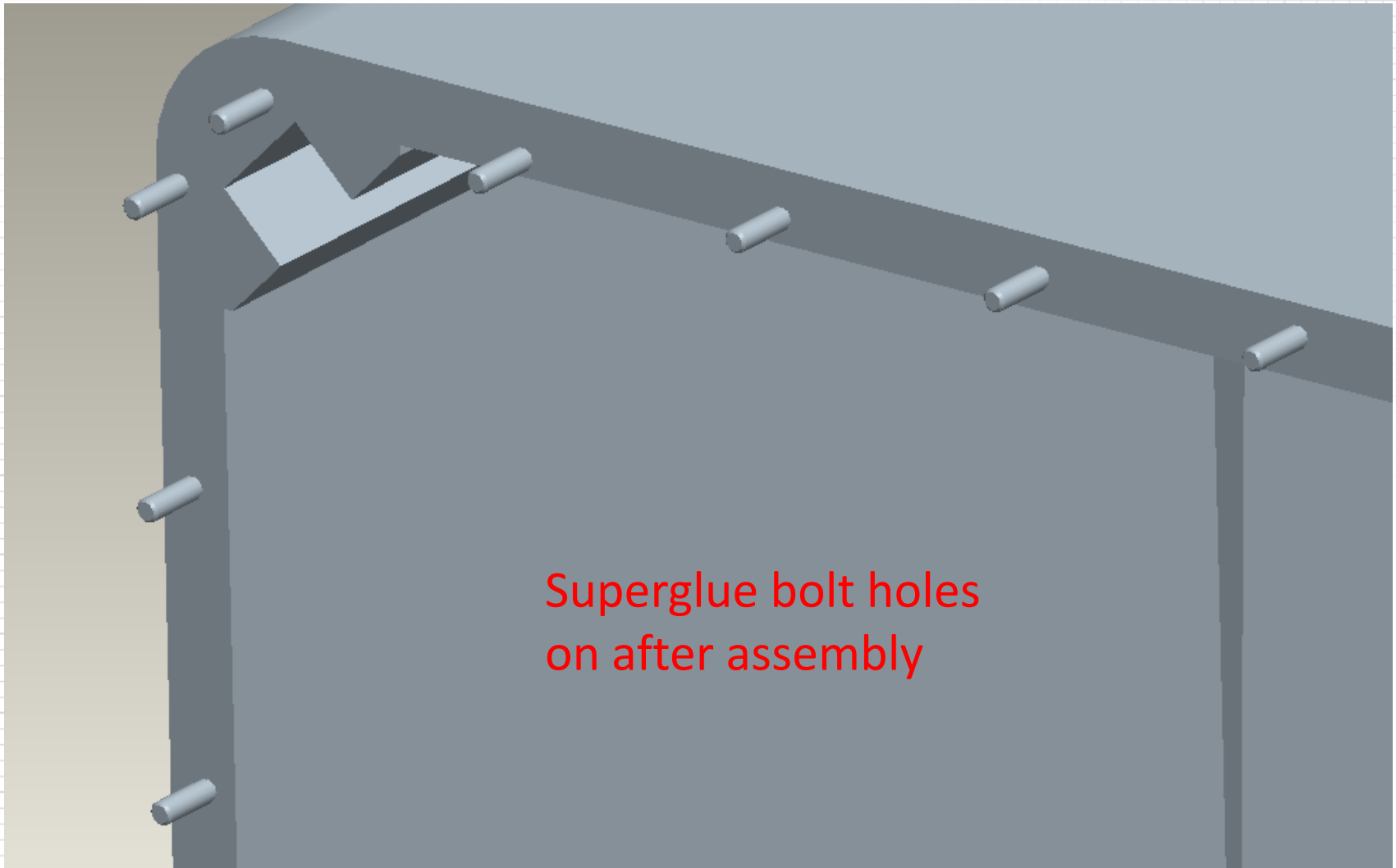
- Chop, bend & twist the tube, differentiates the cross section from along length variation.
- “Superglue” on the end hole patterns.

# Example: Composite Tube



Chop, bend & twist

# Example: Composite Tube



Superglue bolt holes  
on after assembly

# Example: Gear train lost motion



## Challenge:

- Account for lost motion/backlash between gear teeth.

## Solution:

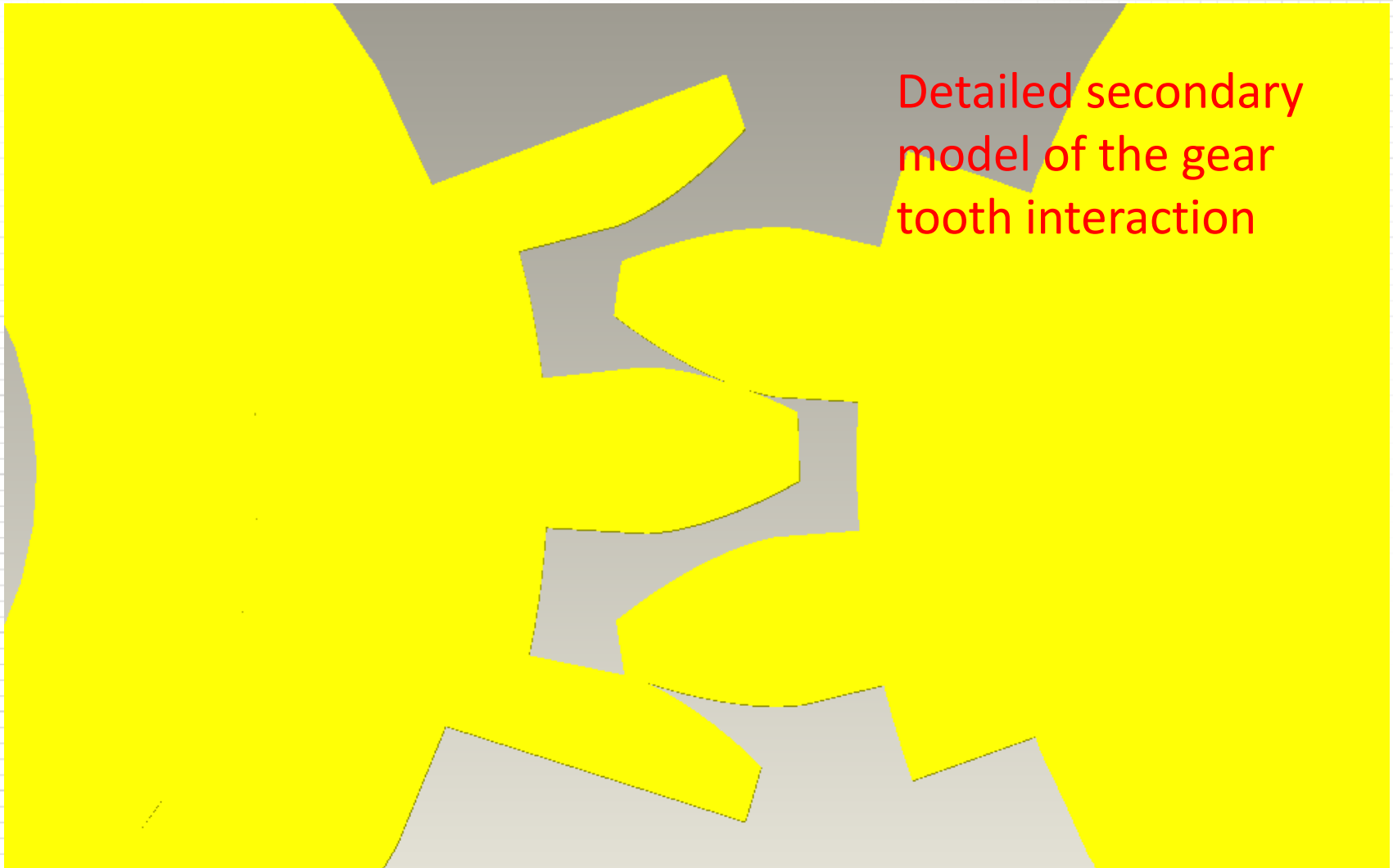
- Detailed secondary model.
- Carry up results into main model.

# Example: Gear train lost motion



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# Example: Gear train lost motion



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# Example: Gear train lost motion



Secondary model accounts for:

- Involute contact.
- Tooth width.
- Design clearances.
- Variation in gear post positions.
- Bearing clearances.
- Tip & root clash.

# Analyse & optimise



- Not part of this presentation.
- Well covered by other people!

Four ways to get people involved:

- Distribute a results summary.
- Use measurement sheets.
- Use component sheets.
- Circulate the CXM file.
- Prepare a measurement/tolerance cross over chart.

- Geometric tolerances provide engineers with a specialist language to concisely and precisely express the acceptable or 'tolerable' variation.
- Electronic data exchange (and a lack of detailed drawings) is promoting the use of geometric tolerances.

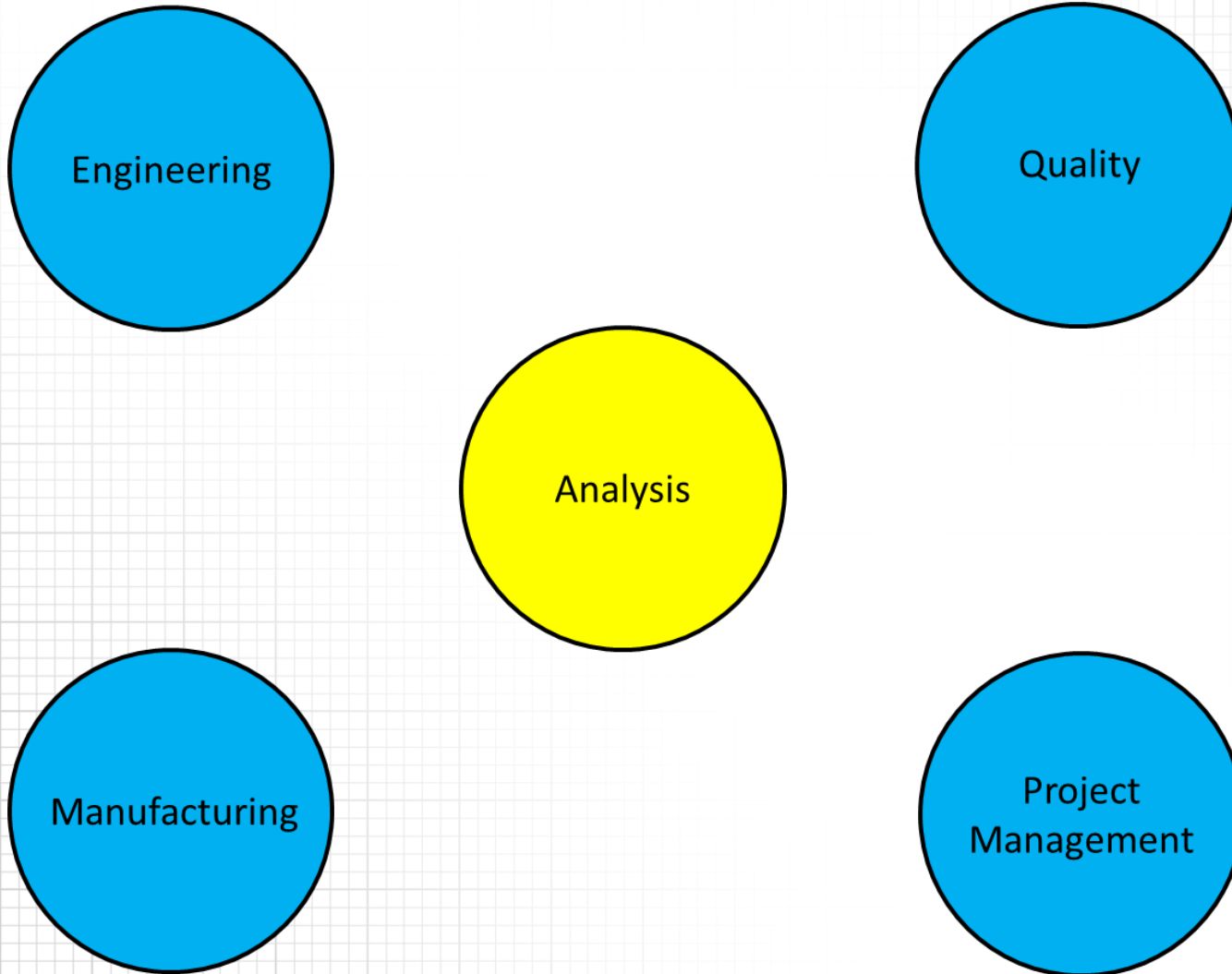
# Geometric tolerances

A dozen dimension tolerances required to define the can surface

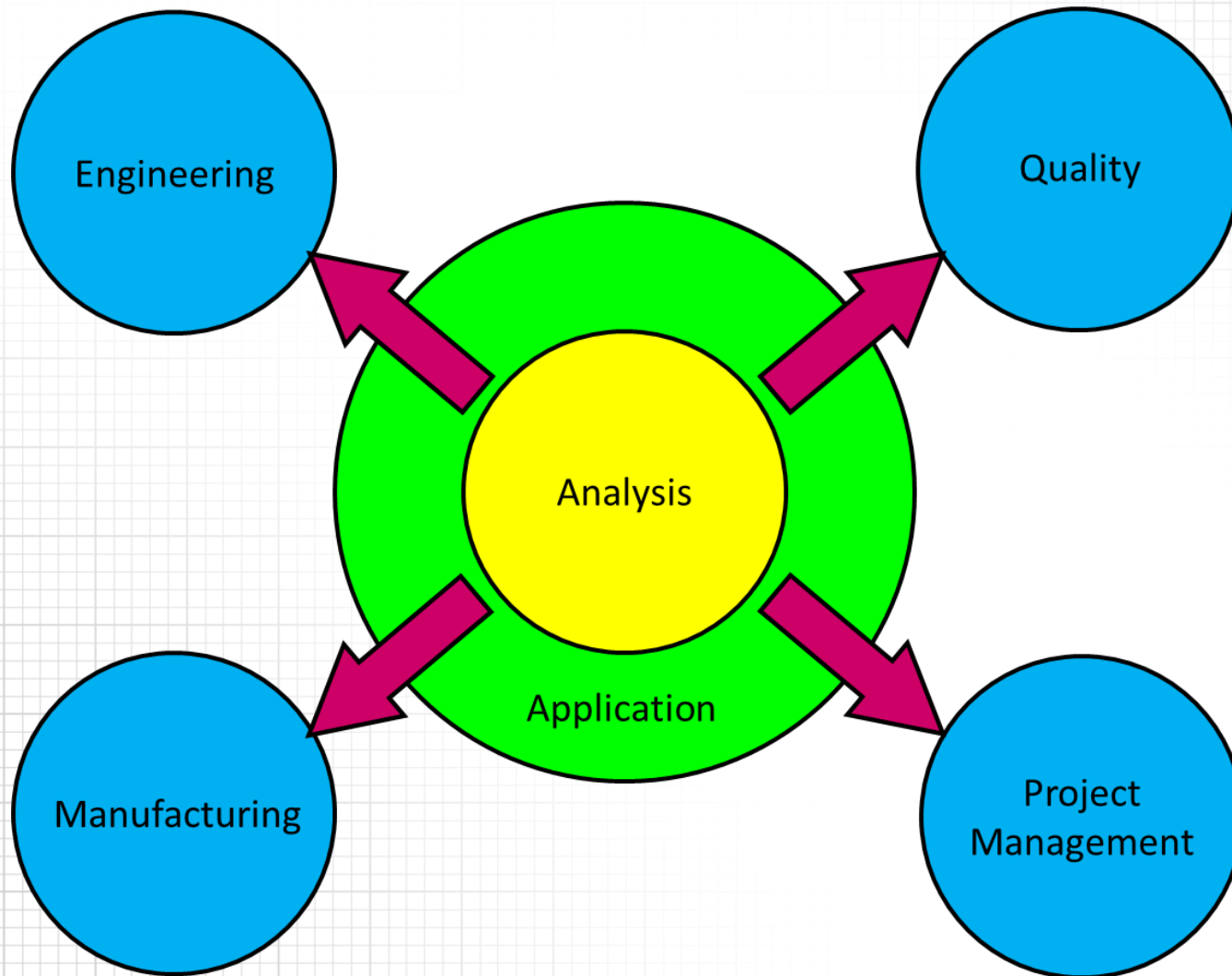


Or one geometric tolerance!

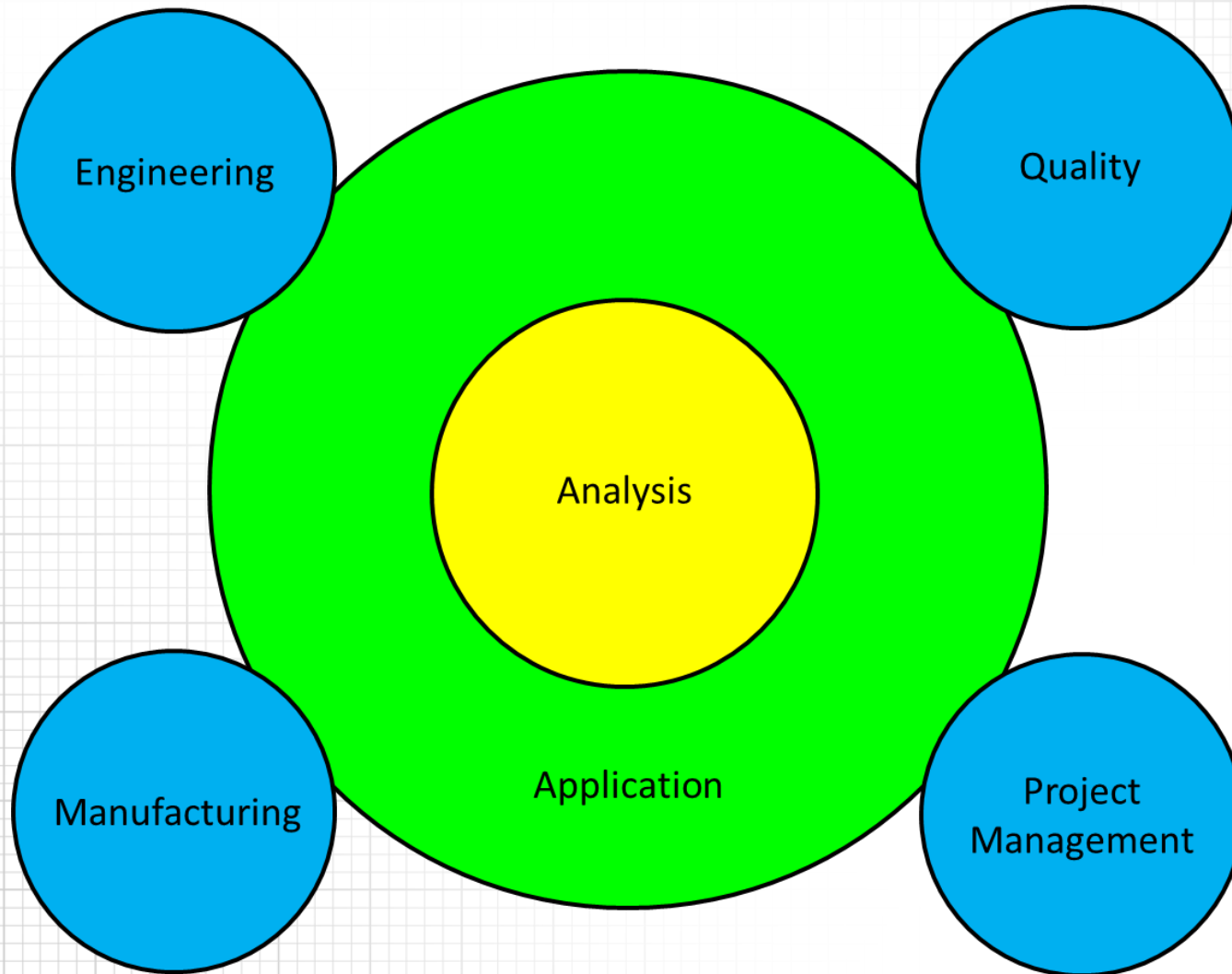
# Structure & organise



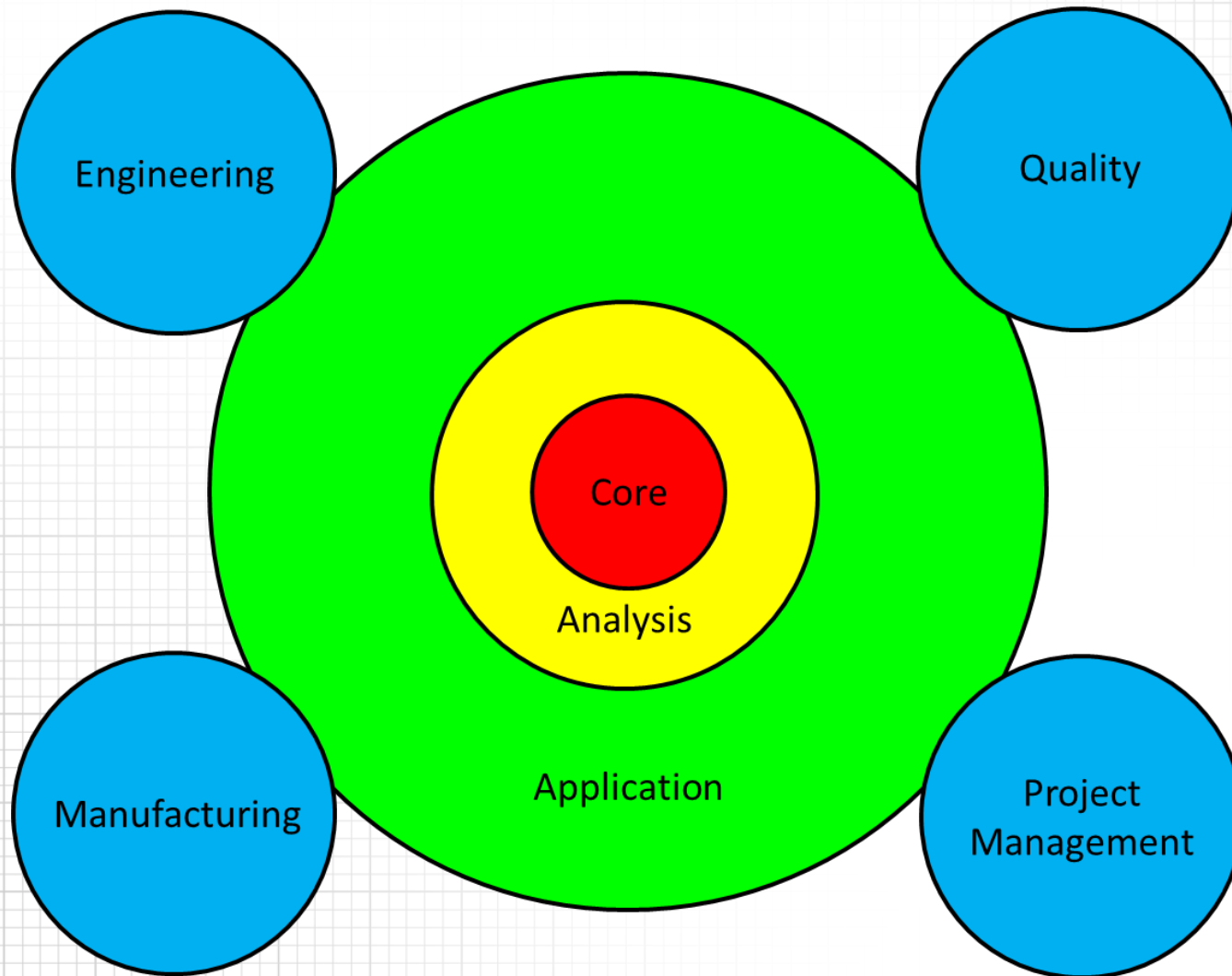
# Structure & organise



# Structure & organise



# Structure & organise



Four key roles:

- DM Analyst - builds the models, runs the simulations.
- DM Engineer, gathers the information, utilises the results.
- DM Manager, runs the DM system.
- DM Specialist, develops the methods.

DM systems are not instant.

- There is no universal DM system, systems are grown to fit the company.
- Learn to walk before trying to run!
- A good pilot project plants the seed.
- As the DM activity grows, add the structure and organisation to support it.

# To Conclude



- DM is not rocket science, it is just common sense and dedication!
- DM is not new, 80% of this you are already doing.
- Analysis, application, operation & integration are the core activities.

- 60 minutes is not enough to say all there is to say about Dimensional Management.
- Hopefully 60 minutes has been enough to convince you that Cetol, in conjunction with a good DM system, can revolutionise the way engineers predict, understand and manipulate overall geometric variation behaviour.

# To Conclude



- Thank you for your time and attention.
- Are there any questions?