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Next Generation Simulation - Engineering Beyond Just Validation

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Team Sky's success story

Dave Brailsford's theory for improvement (rephrased):

"If you break down everything you could think of that goes into riding a bike, and then improve it by 1%, those small gains would add up to a remarkable improvement"

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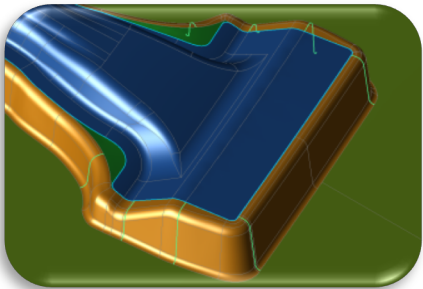
Parameters 'Team Sky' worked on

- Weekly training program for riders

- Weight of the bicycles

- Design of the bicycles

- Rider's posture

- Extreme weather conditions

- Road conditions

- Health of the riders

Robust Process Improvement for stamping process

Robust Process Improvement

Systematic Process Improvement (SPI)

Robustness/Stability

Design variables

(Controllable parameters)

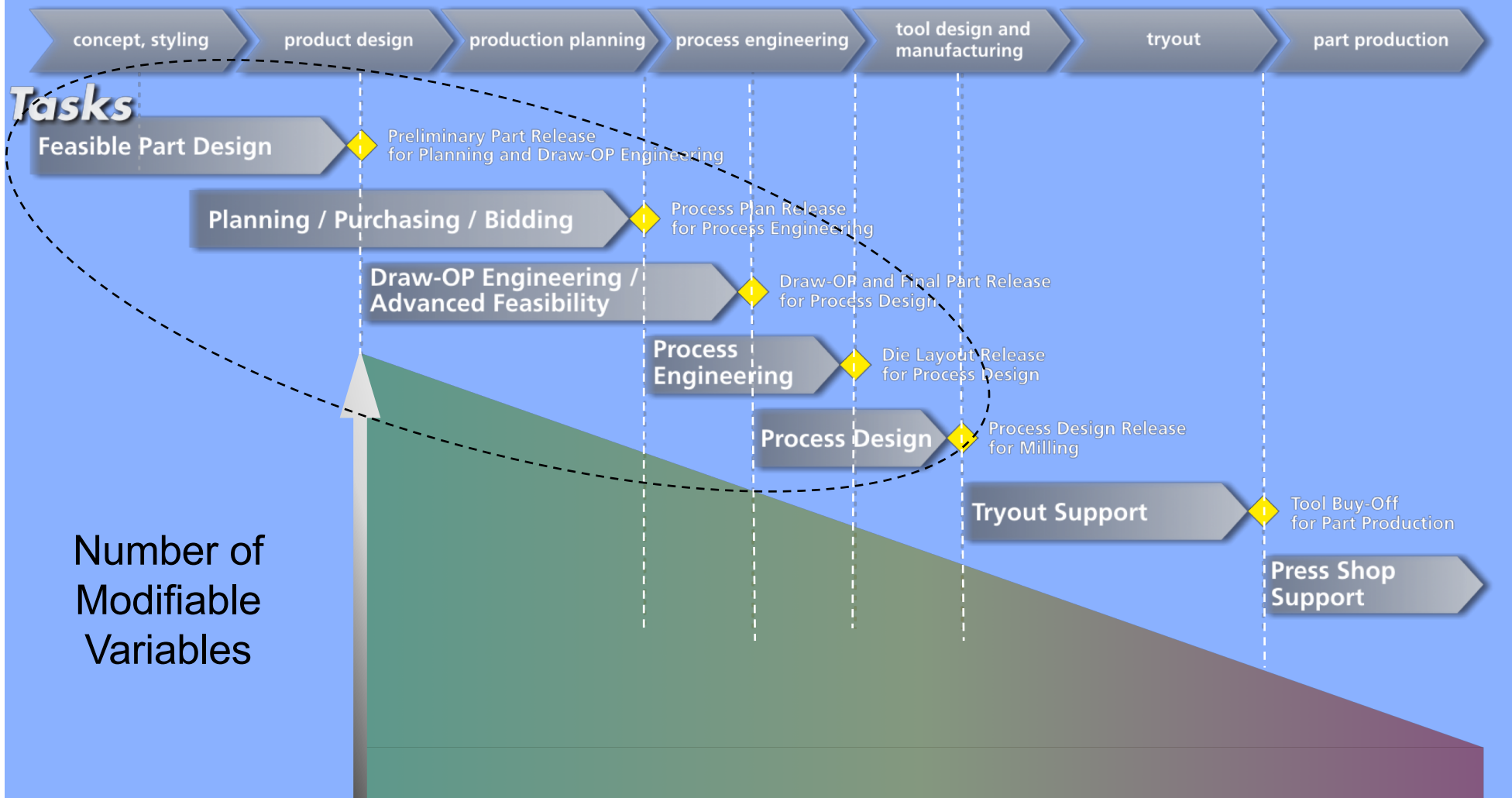E.g. Blank shape, Drawbeads

Noise variables

(Uncontrollable parameters)
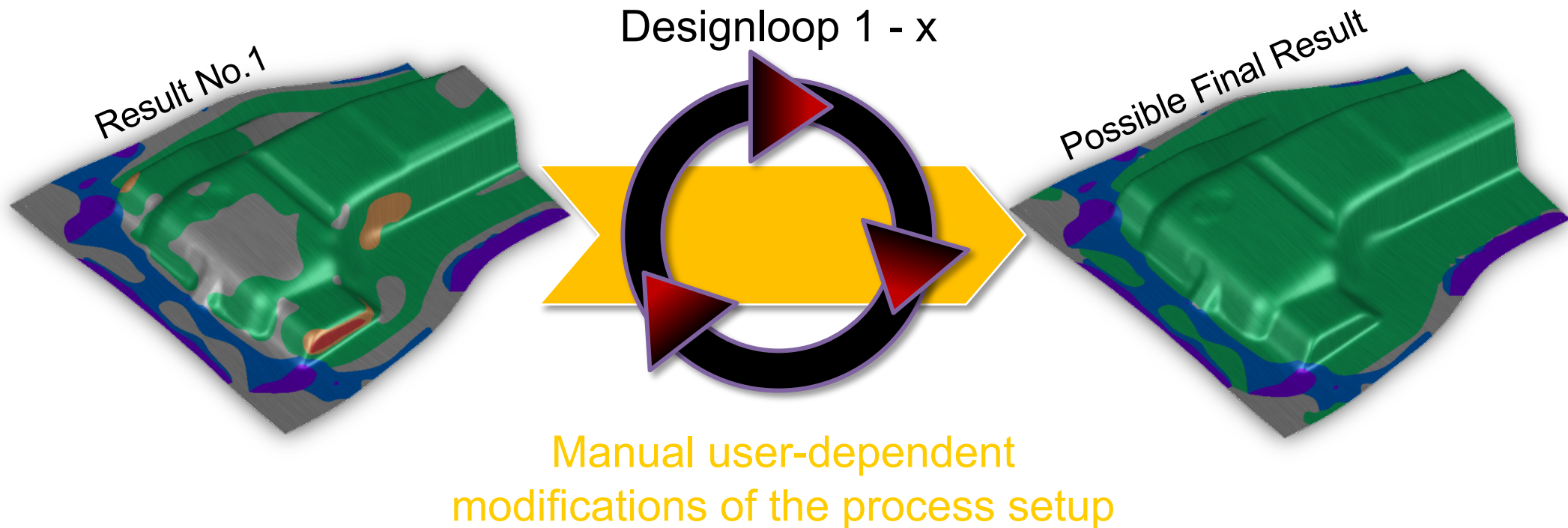
E.g. Variation in material properties

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SYSTEMATIC PROCESS IMPROVEMENT (SPI)

Die-Design Software and Simulation-Technology Experience

SPI implementation

Most of the Design changes take place between Concept styling till Tool design

| concept, styling | product design | production planning | process engineering | tool design and manufacturing | tryout | part production |

Tasks

Feasible Part Design — Preliminary Part Release for Planning and Draw-OP Engineering

Planning / Purchasing / Bidding — Process Plan Release for Process Engineering

Draw-OP Engineering / Advanced Feasibility — Draw-OP and Final Part Release for Process Design

Process Engineering — Die Layout Release for Process Design

Process Design — Process Design Release for Milling

Tryout Support — Tool Buy-Off for Part Production

Press Shop Support

Number of Modifiable Variables

Trial and Error Vs. Sigma

Classical **Trial-And-Error** - Approach

Designloop 1 - x

Result No.1

Possible Final Result

Manual user-dependent
modifications of the process setup

With no documentation of changes, or a global process window, Trial & Error comes with severe limitations

Die-Design Software and Simulation-Technology Experience

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SPI during Early feasibility (Part modifications?)

During early feasibility, you'd want to tweak certain part geometry features for improved results

Product Engineering Team

Range

0   X- units

Where is the best result??

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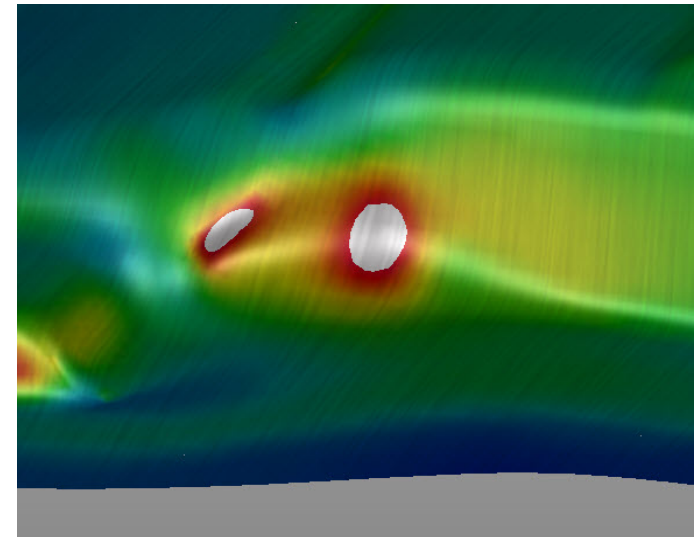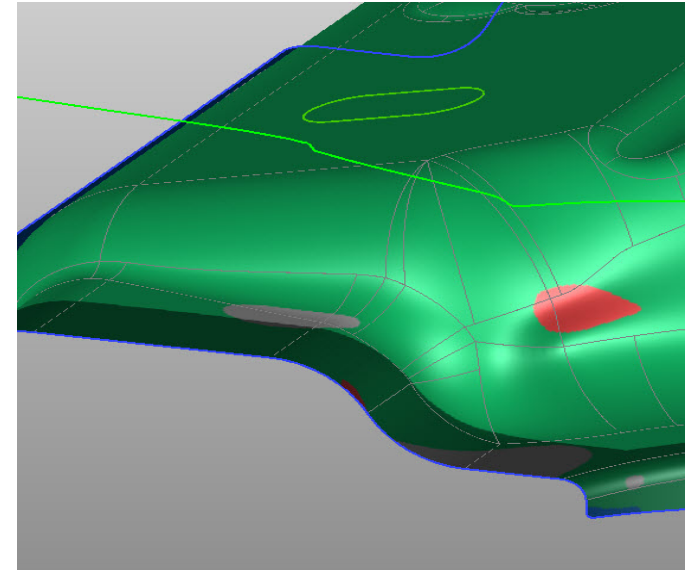
Advanced feasibility

After the early feasibility, some of the basic issues, the advanced feasibility and further process planning must address are:

➢   Splitting

➢   Wrinkling

➢   Draw-in

➢   Springback

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Advanced feasibility – Handling multiple inputs

What would improve my splitting???.

Bead strength

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Advanced feasibility - Multiple Issue types

If splitting issue is fixed, what about
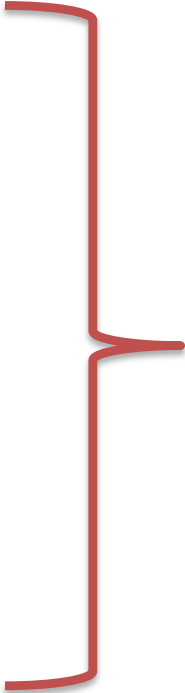
➢Wrinkling ✖

➢Draw-in ✖

➢Springback✖

➢….

Advanced feasibility - Systematic Process Improvement

Systematic Process Improvement

➢ Global process window that addresses all issues

➢ Documentation of changes

➢ Information about possible process window

Identifying that a solution may not exist with current parameters is as important as having a good solution

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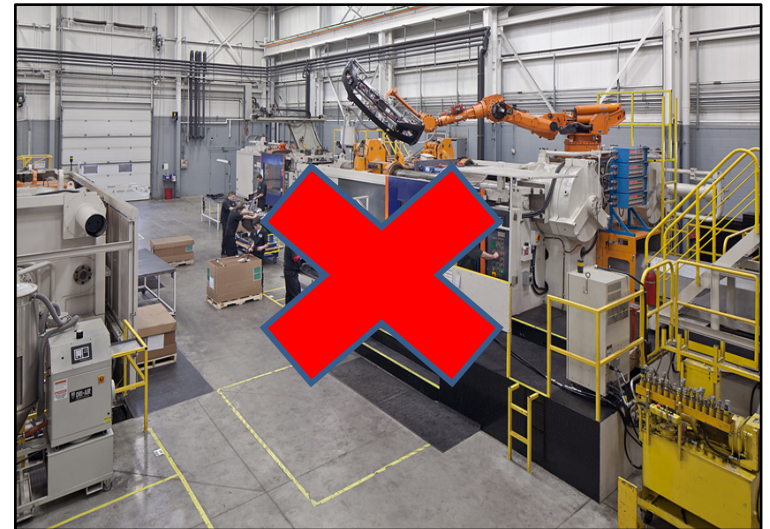*Forming Reality*

ROBUSTNESS / STABILITY

Robustness - Introduction

It's not uncommon to see defects occur in Tryout or production in spite of 'green' nominal simulation

Simulation

Tryout

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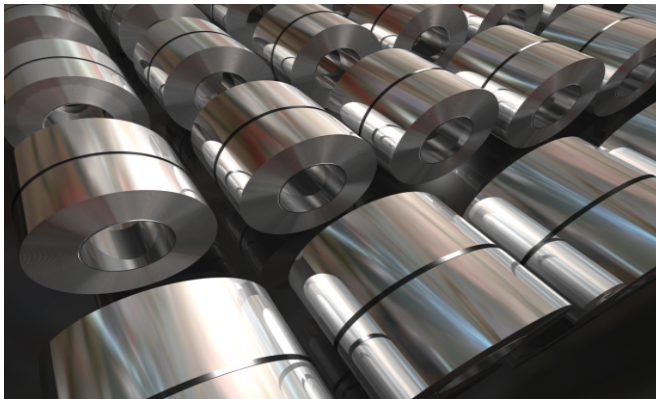
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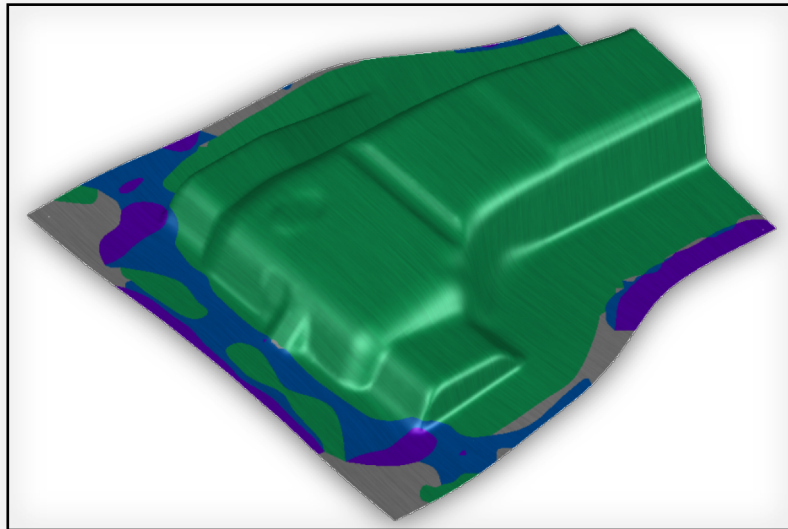
Robustness - Introduction

- Why Does that Happen In Spite of An "All Right" Simulation?

- Process parameters scatter from stroke to stroke (lubrication, binder force, blank position, ...).


- Material properties scatter from coil to coil and within the coils (supplier, supply, ...).

A successful simulation does not always result in a successful tryout/

production because ...

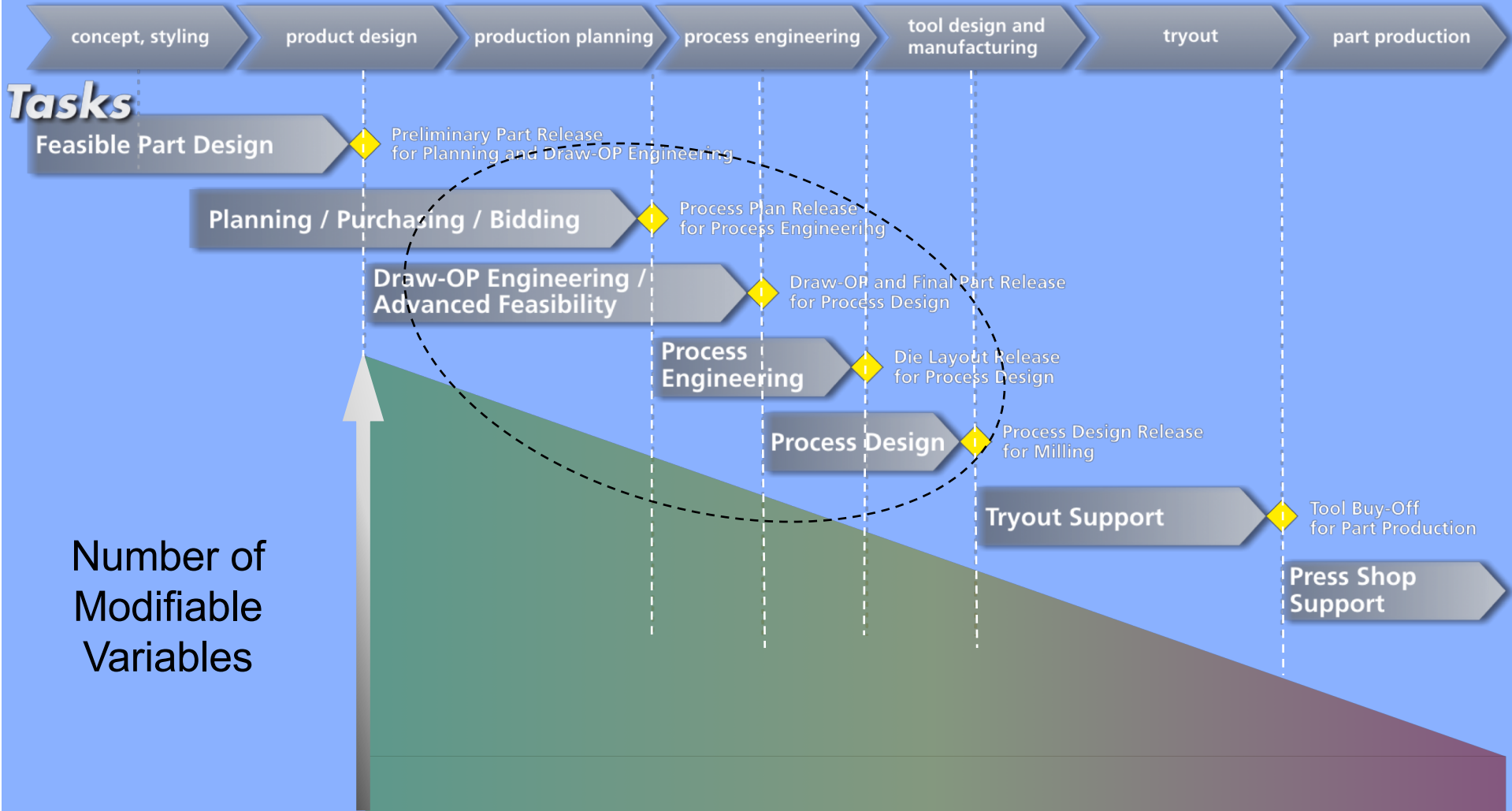a single simulation provides a process point, but ...

a successful tryout/production requires a process window.

Process window

Incremental:
σ_0:   254MPa
Rm: 370MPa

AutoForm-Sigma:
σ_0 : 220-280MPa
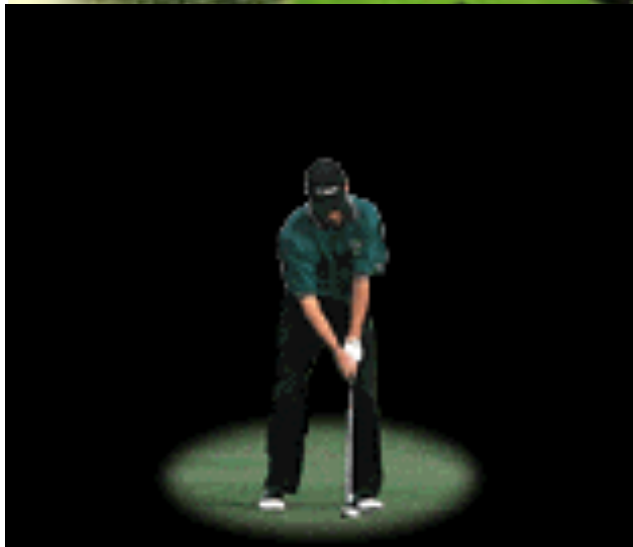Rm: 340-400MPa
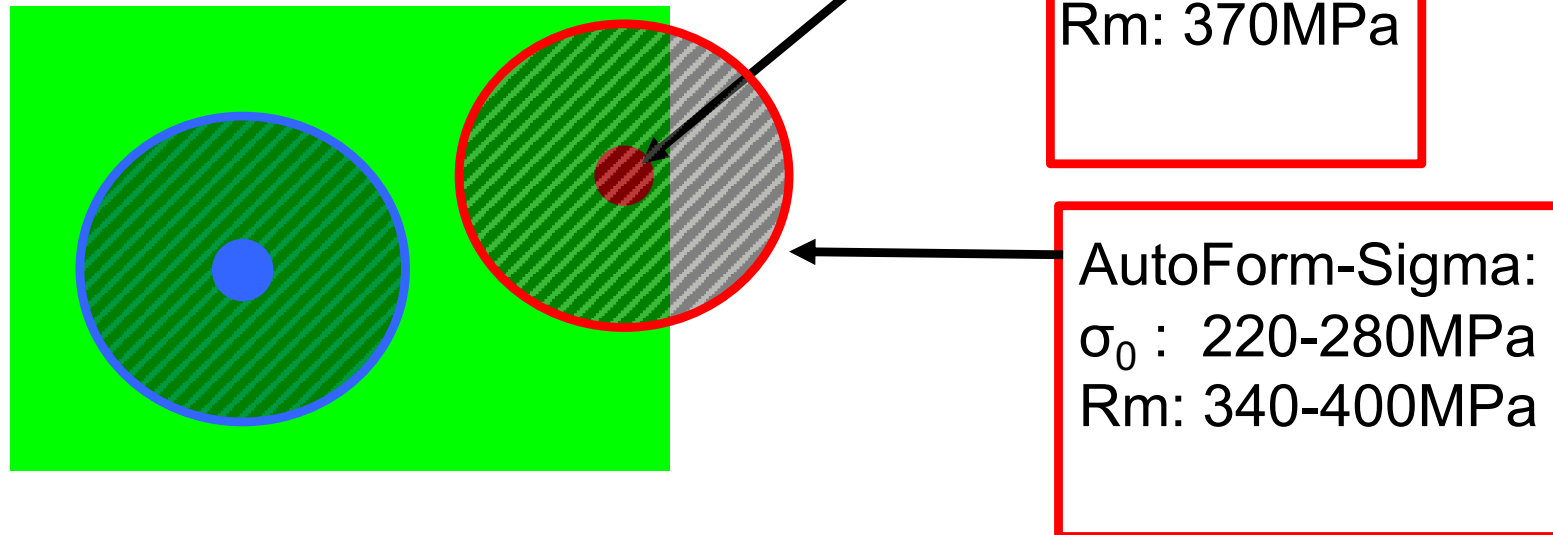
Robustness implementation

A good stability check can be implemented in the advanced feasibility stage

Essence of AutoForm Robustness – Cp and Cpk

- Simply observe how much you missed target by
- adjust by the opposite

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Essence of AutoForm Robustness – Cp and Cpk

- But what if the response is not repeatable?
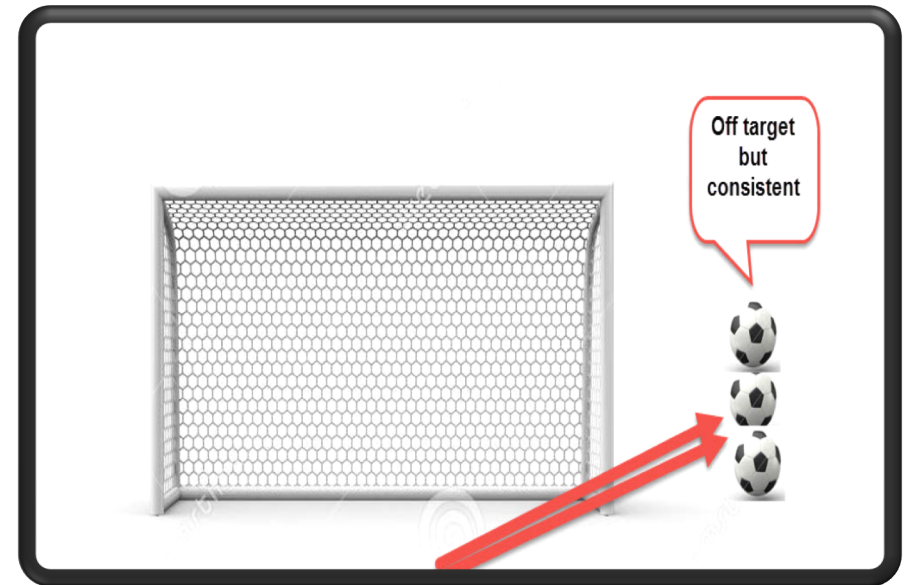
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Robustness -Cp

Cp is a measure of consistency and doesn't tell you how much you are off target!

This works great for Compensation, wherein you need to check if the Springback results are consistent.

Which means, even if you're off target, but consistent – Cp shows it's a good process.

Off target but consistent

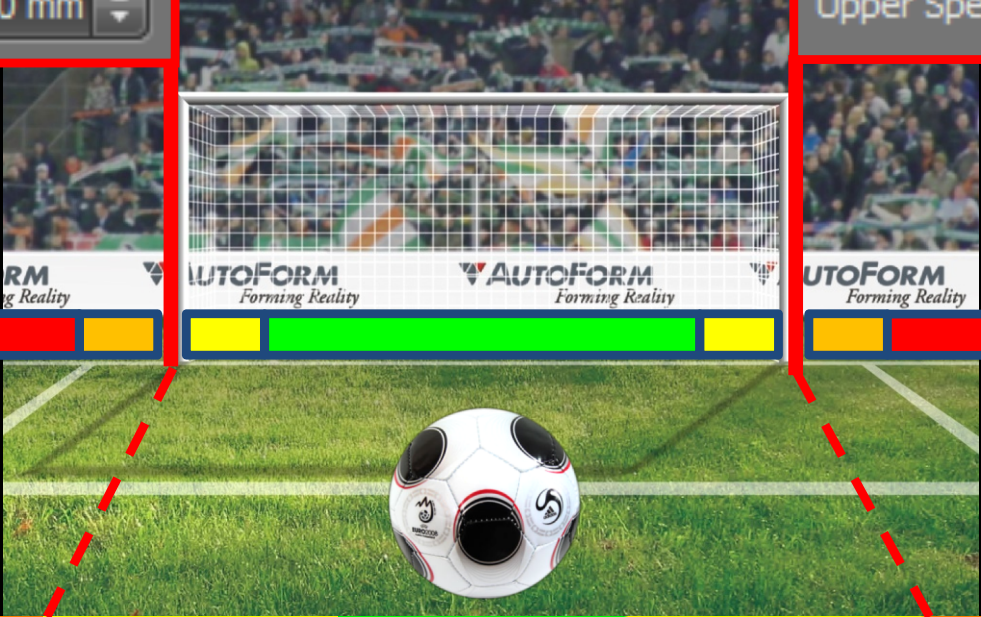AUTOFORM
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Robustness - CPk

Is the process reliable (within the tolerance limits)?

Check Cpk (process precision):

If reliable (Cpk only green and yellow)

If unreliable (Cpk also orange and red)

Lower Spec Limit   -0.500 mm

Upper Spec Limit   0.500 mm

| unacceptable | unreliable | control required | reliable | control required | unreliable | unacceptable |

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SPI with Noise

Having established the robustness of the process, it's now on the user to stabilize the process so that even the uncontrollable variation, the results always lie within the Green process window
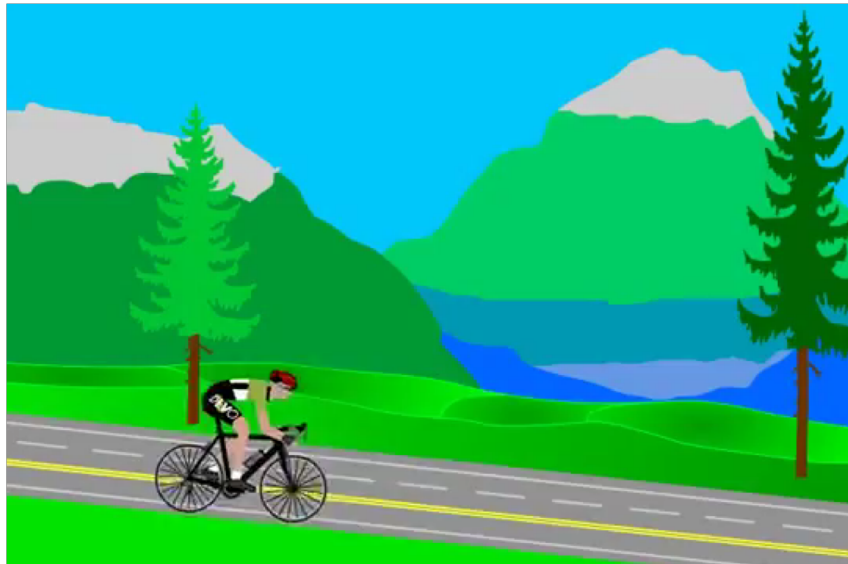
Process window

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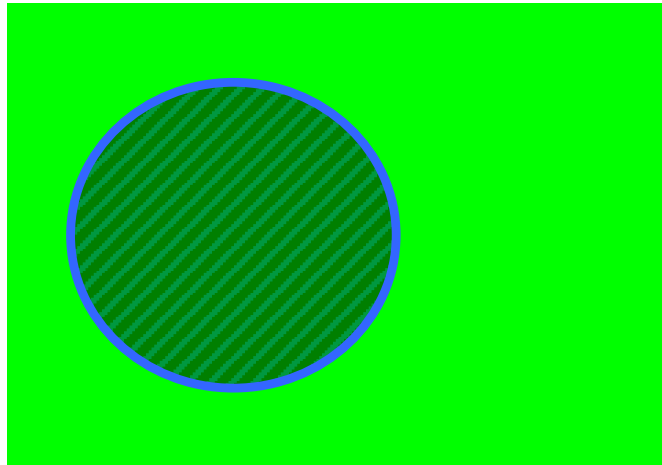
Robustness with SPI

Ideal Scenario with no variation

Noise variation

What we really want even with Variation

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THANK YOU

ANY QUESTIONS?

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