The Future for Robust Design Research

The First International Symposium on Robust Design

Thomas J. Howard

Head of Robust Design Group

DTU Mechanical Engineering
Department of Mechanical Engineering
How much force to press on a lid?
Robust Design: The Transfer Function

FR

Press on Force (N)

DP

Lid Ø (mm)

8.0 8.1 7.9

10.0 10.1 9.8
Robust Design: The Transfer Function

The relationship between variation in multiple DPs and multiple functional performance (FP) parameters.

WP2 (PhD 2)
Robust Design: Quality loss function

The relationship between variation in multiple DPs and multiple functional performance (FP) parameters

WP2 (PhD 2)
Robust Design: Quality loss function

The relationship between variation in multiple DPs and multiple functional performance (FP) parameters

from Forslund, Karin, M. Karlsson, and Rikard Söderberg (2013)
Robust Design: Quality loss function

WP1 (PhD 1)

The relationship between variation in the FRs and the perceived quality of the product (Q)

WP2 (PhD 2)

The relationship between variation in multiple DPs and multiple functional performance (FP) parameters

Customer satisfaction (%)

Press on Force (N)

7.9 8.0 8.1

95% 89% 55%

Lid Ø (mm)

10.0 9.8 10.1
Robust Design: Process Capabilities

WP1 (PhD 1)
The relationship between variation in the FRs and the perceived quality of the product (Q).

WP2 (PhD 2)
The relationship between variation in multiple DPs and multiple functional performance (FP) parameters.

WP3 (PhD 3)
Robust Production and Process Capabilities Data Bases and Design Guide.

The relationship between variation in multiple DPs and multiple functional performance (FP) parameters.

The relationship between variation in the FRs and the perceived quality of the product (Q).
Robust Design: Costing Variance

WP1 (PhD 1)
The relationship between variation in the FRs and the perceived quality of the product (Q)

WP2 (PhD 2)
The relationship between variation in multiple DPs and multiple functional performance (FP) parameters

WP3 (PhD 3)
Robust Production and Process Capabilities Data Bases and Design Guide

WP4
Tradeoff and decision making on the cost of variation

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Press on Force (N)

Lid Ø (mm)

Mould Core Ø (mm)

FR

Customer satisfaction (%)

Q

DP

PV

98% 89% 55%

10.1

10.0

9.8

7.9 8.0 8.1

8.2

8.12

8.28

-$$ -$$ -$$
Join our team?
Vacancies in Robust Design Research

1. Senior Researcher in Robust Design
   *(Equivalent to Associate Professor without teaching)*

   Responsible for driving the research content of the robust design programme with Novo Nordisk and PhD project supervision.

2. PhD Researcher in Robust Design and Process Capability assessment

   Good knowledge of Mechanical and Production engineering required.

   Contact Tom Howard – thow@mek.dtu.dk
Horizon 2020 Bid: A global Process Capability Database

Thomas J. Howard & Tobias Eifler

DTU Robust Design Group

DTU Mechanical Engineering
Department of Mechanical Engineering
The traditional approach to tolerance design

1. Designer decides on concept
2. Sets geometry to meet specification
3. Sets the tolerance limits to hold within specification
4. Passes to production
5. Production may decide/find-out that the design is out of process capability
6. Designer re-designs.
Design to Process Capability (DtPC)

1. Designer decides on concept
2. Sets geometry to meet specification
3. Checks that the features are within process capabilities of the production
4. Redesigns if required
5. Sends to the production for approval.

How do we do this?

• We need good data, and
• An easy way to use the data in design
Current approaches include

Tolerance standards and guidebooks
- Conflicting data between standards
- Old data
- Only on Linear dimensions and Holes/Shafs

Asking Process Capability Expert for opinion
- Subjective
- Relies on expert’s availability
- Relies on whether expert can recall a similar case
How to **GET** the data:
Populating a process capability database base
How to **USE** the data:
Populating a process capability database base

- Planning
- Concept Design
- System Design
- Detail Design

**Process Capability Database**

- Measurement reports
- Design Guide or Interface/CAD plugin

**Product development**

- Manufacturing processes
- Assembly processes
Bringing Big Data into Manufacturing
The motivation

• To create a new and superior Danish/European Tolerance Standard, based on big data.

• To allow of Process Capability Benchmarking

• To enable a Process Capability Certification Programme to certify sub-suppliers in the supply chain.

• To develop an interface that Designer can Design to Process Capability (DtPC)

• To have living/updating process capability data
Principle agreement

Expression of Interest

Hopeful 😊

Looking for interested partners to join the proposal.
Closing of ISoRD14
The First International Symposium on Robust Design

DTU Mechanical Engineering
Department of Mechanical Engineering
Robust Design Methods, Activities and Software

• Large spread in used methods
  – Most used are Tolerance design, DOE and kinematic design

• Low knowledge and usage on VMEA and Functional failure design

• Excel is by far the most used software tool for most activities

• VMEA and axiomatic design is not well supported by software
The proceedings – Open Access 😊

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Thankyou to the ISoRD14 Organising Committee:

Thomas J. Howard (Chair)
Tobias Eifler (Co-Chair)
Søren Pedersen
Martin Ebro
Moritz Göhler
Andreas Rafn
Aryan Christiansen
Jonas Olesen
We’d like to thank two people in particular

Andreas Rafn

&

Aryan Christiansen
DTU ROBUST DESIGN DAY 2015

The Robust Design Day will be an Annual, Single Day event for on Danish Industry and Academia.

The event will feature invited speakers and interactive discussions and activities as with ISoRD.

Please expect an invitation, we look forward to your participation!
ISoRD16 ????
The 2\textsuperscript{nd} International Symposium on Robust Design
Prof. Wartzack and the Chair of Engineering Design proudly welcomes you to the ISoRD 2016 in Erlangen!

- ...in the “center” of Europe (Nürnberg region)
- ...in one of the economically strongest regions of Germany

Selected Topics of the ISoRD 2016:
- Robust Design Methodology
- Tolerance Management / Analysis
- Design for Six Sigma
- Process Capability Evaluation
- ...

Further Information:
- robustdesign.org/ISoRD
ISoRD 2016 in Erlangen

Impressions

From the creative idea to the systematically optimized product

Bearings and Mountings

Tribological Coating Systems

Dimensional Management

Virtual Product Development

Teaching and Education

Lightweight Design

Tribological Coating Systems
ISoRD 2016 in Erlangen
Tolerancing Research

Systems in Motion

Tolerance Analysis and Tolerance Synthesis for Systems in Motion

Discrete Geometry TA

Tolerance Analysis based on discrete Geometry Representations

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Prof. Dr.-Ing. Sandro Wartzack
ISoRD 2016 in Erlangen
Partners…

… in the science world

… and with industry sector

… international