Concept of using General Process Capability Data

Andreas Bruun Okholm, s082562
Mathias Rask Møller, s082536[1]
Technical University of Denmark

(Dated: 5 November 2013)

A approach to generate Generalized Process Capability Data in order to populate and add functionality to a Process Capability Database. A description of the concept of generalization, uses and implementation.

I. INTRODUCTION

A Process Capability DataBase (PCDB) is a tool for mechanical designers to get information of what is possible to achieve in the companys production. By applying PC information in the design process it is possible to reduces: rework, cost, failure rate, assembly problems and increases product performance. A in few words a PCDB is a database of variance in features on produced products. Different companies have different index system and standards for what to record.

As mentioned in (**???**) and a number for key challenges has to be addressed to expand the use of PCDB.

- Data Communication: The database has to be populated with the desired data in a understandable manner. From (Tata) we have learned that the data already recorded in the process control is not necessary the desired data for the mechanical designer. Accessing the information should be easy.
- Fragmented Organization: Development department are dependent on data from production.
- Information Technology: Make a database which is fast, live, global, self populating, up to date and live up to the industry criteria of security and anonymity.

Previous attempts on solving these problems (**??**)

II. PREDICTING PROCESS CAPABILITY

The data desired by the designer can be syntetisized to PC data of a geometry, material and process in order to design for what is achievable in production. The data recoded by process control can be processed to describe geometries for the process and material instead of specific features on a specific product thus making the process control data from one product, whose only similarity with the designed product is the geometrical features only, available for use for the designer.

Introduction to the Process of generalization of PCDB

1. Generate component measurement sets.
2. Compute Process Capability Specification Limit (PCSL).
3. Normalize PCSL.
4. Interpret normalised PCSL data.

A. Measurement Sets

Generation of measurement sets might seem trivial but since what you measure is what you get. Teh selection of measurement data is important to the resulting information.

B. Process Capability Specification Limit

The process capability indices (C_p and C_{pk}) described by **?** has been widely adopted in statistical process control, been extended and further researched for better understanding (**?**). Instead of looking at process mean μ, standard deviation σ and specification upper and lower limits USL, LSL using Process Capabilities Indices (PCIs) transforms these values into unit less numbers, which provides a quick overview of how a process is performing.

The PCIs ability to transform process variables of any object into unit less capability index can be reversed to calculate desirable specification limits. For en example the commonly used CPI C_pk

$$C_{pk} = \frac{d - |\mu - m|}{3\sigma} \tag{1}$$

can be reversed

$$d = 3C_{pk}\sigma + |\mu - m| \tag{2}$$

where $d = (USL - LSL)/2$ is half the specification limit and $m = (USL + LSL)/2$ is the midpoint between the specification limits.

The most common PCIs and what they describe (**??**)

- C_a : Closeness of process mean to target
- C_p : Relative size of variation
- C_{pk} : Amount of nonconforming (%NC)
- C_{pm} : Value loss (Taguchi loss function)
- C_{pmk}: Version of C_{pm}, sensitive to mean shift.

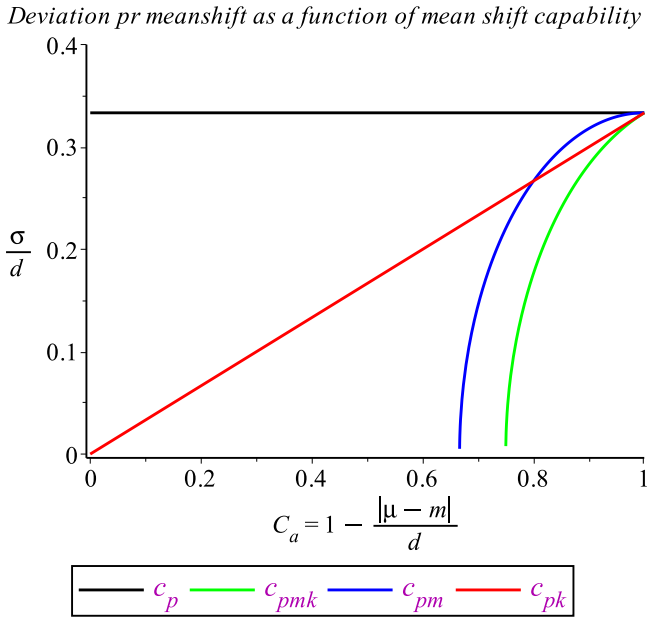

FIG. 1. c_p referens only to the variance of the process. c_{pk} is related to the yield of the product. c_{pm} takes a loss function in to account relates to a target dimension. *cpmk* takes both the yield of the product and a loss function.

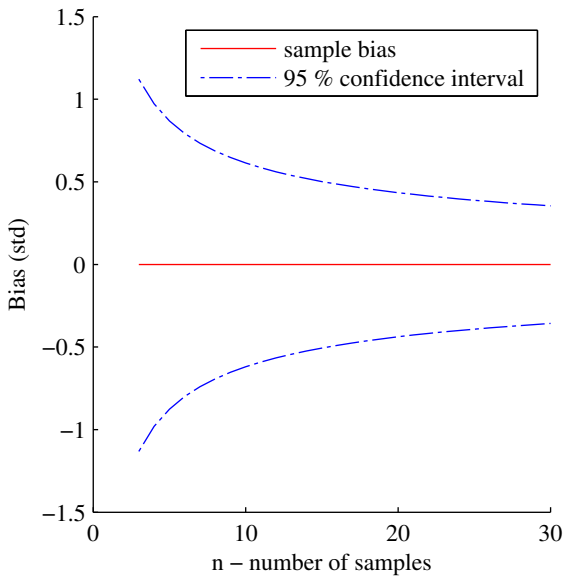

FIG. 2. The uncertainty of the standard deviation estimate is reduced as the number of samples is increased. The increase in accuracy gained per additional decreases with more samples. From the graph we have chosen 12 to be the optimal point for general process capability use.

For the purpose of our database we have chosen to use C_{pk}, since it provides the most easily understandable result. The desired specification limit will result in a maximum percentage of NC products. Using C_{pm} would be sensible sense if the desired tolerances directly influence product performance - for instance in optics construction.

C. Normalization

Comparison of different standard tolerance dimension relations.

ISO 286? describes a non-linear function for comparing tolerances on objects of different dimension. This function used to normalize tolerances and display PC independent of size (with in the limits of the function.)

Tysk og fransk standarder plast støbe standarder finde kilder

ANSI ?!

Choice of ISO based continious function and customary user in industry

D. Analyze normalized data

fit normal distribution of sub groups. find subgroups

extracting data

robustness

visible confidence intervals of interpertation

III. STATISTICAL VALIDITY

measurement sets are assumed to fit a normal distribution.

What you measure is what you get. Each product in the sample set, produces a measurement. From the sample set is a measurement set created.

Confidence intervals - sample size of each measurement set.

Number of measurement sets to predict process capability.

IV. USER INTERFACE

Readability of accumulated normal distribution compared to a bell curve.

Two figures showing the actual interface

General Interactivity in plots Special courses comment of measurement sets.

Group sorting Reference to Thornton graphical display article.

Visible confidence intervals

User can set tolerance (from IT to specific dimentions)

Two views General charts inspired by ANSI Process view inspired by Thornton Graphical display

show current production capability in terms of it-grade

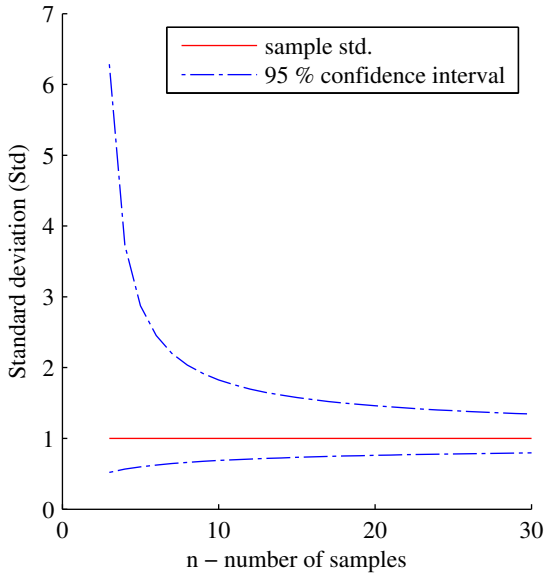

FIG. 3. The uncertainty of the standard deviation estimate is reduced as the number of samples is increased. The increase in accuracy gained per additional decreases with more samples. From the graph we have chosen 12 to be the optimal point for general process capability use.

V. USING THE GENERAL PROCESS CAPABILITY DATA

apply tolrance, By looking at normalized data of the variance of products of the same material and process, it is possible to find a suitable tolerance improvement per rework material selection

VI. DISCUSSION

Using todays techonolgy, generalization of PC data upon request from the user i feasble. A proposed techincal setup is described in **?**.

Initiating PCG is a tough process. The reward for doing robust design engineering is long reach The reward for using PCDB or robust design in general to make changes in early design is a long term and might only benefit the company and not feedback to the designers compared the reward for the hero in production solving the expensive errors in design.

Implementing GPC requires a change economical barrier big company incement from quality department gain: knowlegde of own PC high precision data Extensive knowlegde on causes and problem loss: cross companies diverse data gain: Alot of data knowlegde of processes and matrial outside your field knowlegde of possible to achive in industry Index storing of own data and partially analysed loss: Indusry espiange concerns loss of information due to anonymity

proto running at a university, unbiast.

REFERENCES