LEVELS OF DESIGN
ROBUSTNESS

SIX THETA® DESIGN

By
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VALCON DESIGN IS A MEMBER OF THE VALCON CONSULTING GROUP.
ONE ASPECT OF ROBUST DESIGN?

A SIMPLE EXAMPLE: THE ROCKING CAFE TABLE

NON-ROBUST DESIGN SOLUTION

FOUR-LEGGED DESIGN CAUSES TABLE TO ROCK DUE TO AMBIENT CONDITIONS AND REQUIRE STRICT TOLERANCES ON GEOMETRY OF LEGS

ROBUST DESIGN SOLUTION

A THREE-LEGGED DESIGN WILL NEVER ROCK (NO OVER-CONSTRAINTS)
PRODUCTS FROM WIND TURBINES TO INSULIN PENS FACE SIMILAR CHALLENGES
ONE TYPICAL INTERFACE OUT OF 5,000 IN ONE OUT OF MILLIONS OF COMPANIES
>100 MILLIONS OF THESE COMPONENTS ARE PRODUCED
INJECTION MOLDING PROCESS STRETCHED TO THE LIMIT TO ACHIEVE A VARIATING SCRAP RATE IN AVERAGE 5 %
SIX THETA® COMPLIANT DESIGN DEMANDS

- Non functional surfaces clearance is increased to ISO 286 IT15
- No functional surfaces between tooling half's
- No geometrical demands beside length for the functional surfaces
- Minimum tolerance usage for this process 0,08 mm (three times higher than present design)
SIX THETA® COMPLIANT ASSEMBLY ILLUSTRATION
SIX THETA® COMPLIANT COMPONENT ILLUSTRATION
SIX THETA® COMPLIANT COMPONENT ILLUSTRATION
INJECTION MOLDING PROCESS FAR FROM ITS LIMIT TO ACHIEVE A STABLE SCRAP RATE BELOW 0,01 %
SIMILAR EXAMPLES
MANY COMPANIES HAVE ACHIEVED SIGNIFICANT RESULTS BY INTRODUCING SIX SIGMA METHODOLOGY
SIX SIGMA METHODOLOGY – A PRODUCTION MINDSET

SIX SIGMA STRIVES TO REDUCE VARIANCE BY OPTIMIZING PRODUCTION TECHNOLOGIES AND PROCESSES

BUT RESULTS IN HIGH COMPONENT TOTAL COSTS

SIX SIGMA

SOPHISTICATED PRODUCTION TECHNOLOGY PROCESSES

HIGH COMPONENT COST

REDUCE VARIANCE
SIX THETA® METHODOLOGY – A DESIGN MINDSET

SIX SIGMA

- SOPHISTICATED PRODUCTION TECHNOLOGY PROCESSES
- HIGH COMPONENT COST

DESIGN FOR SIX SIGMA

- Six Theta® compliant design
- REDUCED COMPONENT COSTS

Six Theta® DESIGN STRIVES TO REDUCE VARIANCE BY A DESIGN APPROACH

RESULTS IN EASED TOLERANCES AND REDUCED COMPONENT COSTS
SIX THETA® DESIGN REPRESENTS A BLIND SPOT IN THE INDUSTRY AND THAT IS A MAJOR OPPORTUNITY TO INCREASE THE LEVEL OF PRODUCT ROBUSTNESS
ROBUSTNESS DESIGN LEVEL IN THE INDUSTRY

BASED ON MORE THAN 20,000 ANALYZED INTERFACES IN MEDICAL, AUTOMOTIVE, AEROSPACE, ENERGY, DEFENSE AND CONSUMER INDUSTRY?
PREDICTABILITY INDEX
EXAMPLE: MEDICAL DEVICE

OVER-CONTRAINTS IN HOUSING INTERFACE

• LOCKING OF UPPER AND LOWER PART REQUIRES 6 CONSTRAINTS (3 TRANSLATIONS AND 3 ROTATIONS)
• PRESENT DESIGN HAS 29 CONSTRAINTS CORRESPONDING TO 23 OVER-CONTRAINTS

CONSEQUENCES

• VASTLY INCREASED NUMBER OF CRITICAL DIMENSIONS ON DRAWINGS
• INCREASED COMPLEXITY IN PRODUCTION PROCESS WITH TIGHT TOLERANCE DEMANDS
• STRESSES FROM MISALIGNMENTS AND CHANGES IN AMBIENT CONDITIONS
PREDICTABILITY INDEX
EXAMPLE: MEDICAL DEVICE

THE PREDICTABILITY INDEX OF THE PRODUCT IS DETERMINED AS THE RATIO BETWEEN # OF OVER-CONTRAINTS AND # OF INTERFACES

Number of over-contraints
101

Predictability Index
14
# Predictability Index

Valcon Design’s Predictability Index can be used to rank and compare the robustness of products.

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Predictability Index</th>
<th>Typical Symptoms</th>
<th>Typical Cost Saving Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>World-class</td>
<td>0 – 5</td>
<td>Minimum effort no surprises</td>
<td>0 – 5 %</td>
</tr>
<tr>
<td>Above average</td>
<td>5 – 10</td>
<td>Large effort on several but repetitive issues</td>
<td>5 – 15%</td>
</tr>
<tr>
<td>Average</td>
<td>10 – 20</td>
<td>Very large effort on many and changing issues</td>
<td>15 – 25%</td>
</tr>
<tr>
<td>Below average</td>
<td>Above 20</td>
<td>Very large issue driven effort on constant new and changing problems</td>
<td>&gt; 25%</td>
</tr>
</tbody>
</table>

Strong correlation between Predictability Index and Cost Saving Potential arising from:

Less complex production processes
Looser tolerance demands
Higher material utilization

*Based on analysis of 100’s of interfaces in products across 10 industries, incl. automotive, process, medical devices, consumer, energy, etc.*
HAVE A NICE ROBUST DESIGN DAY 2015