Dimensional Management: The Reasons For Change
Airbus Product Line

Number of Seats (typical two or three class layout)

(Aircraft nose indicates position on Graph) Range (nm)
Why Are We Here?

• Airbus UK is committed to a high level of Dimensional Management to facilitate the “Right First Time” principle of design and manufacture

• Committed to use 3DCS as our main dimensional control tool

• Meet users and discuss processes and methods utilised

• Meet and discuss possible software enhancements
Old Design Department

• Design in isolation
• Little discussion with Manufacturing
• Little discussion with Tooling Department
• Little discussion with Quality Department
• G.D. & T inherited from previous aircraft
• “If I can draw it, they can make it”
Old Tooling Department

- Tooling designed and created with little consultation with Design Department.
- Limited consultation with Manufacturing Department
- Work from released drawings
- Requirements of GD & T not clearly understood
- Modifications inevitable
Old Manufacturing / Assembly Departments

- Limited discussions during concept stages with Design Department
- Limited discussion with Tooling Department
- No certainty that design will work
- No means to check G.D. & T requirements
- Make to print
Summary of Old Design / Manufacturing Cycle

Tooling

Design

Manufacturing
Reasons for Change from Old Methods

• Components do not always fit together as intended
  ‣ Loss of production time
  ‣ Cost of concessions
  ‣ Modifying tooling
  ‣ Increase in manufacturing cycle time
  ‣ Overall unnecessary added cost to building aircraft

• Rework also creates environmental issues
  ‣ Fettling of aluminium
  ‣ Fettling of carbon fibre
  ‣ Controlled heating of liquid shimming
  ‣ Local shot peening
Additional Reasons Why We Had to Change

• Unable to verify and validate designs before going into manufacture

• Collecting vast amounts of SPC data but not using it to the advantage of the business

• Not identifying Product Key Characteristics at the outset

• Not always achieving Product Key Characteristics without costly rework

• Spending too much time solving problems during manufacture instead of designing them out at the start
How Are We Doing It?

- Design
- Manufacturing
- Tooling

Component Design
Build Teams

- Deploying SPC
- Deploying FMEA
- Deploying DFSM
- Deploying 3DCS
Key Characteristics and Tolerances

MODULE 1 — Select PKCs by Function

MODULE 2 — Select PKCs by WP / Zone

Aerodynamics
Stress
Weights

MODULE 3 — Cascade KCs & Tolerances

Product Cascade Tool

MODULE 4 — Validate and Refine KCs & Tolerances

3DCS Dimensional Management

MODULE 5 — Implement KCs & Tolerances

Embody KC’s and Tolerances

MODULE 6 — Feedback KCs & Tolerances

Statistical Process Control
Example of Product Key Characteristics

Product Key Characteristics Identification - Plan View

**Key**

- **A** - Twist
- **B** - LE sect profile (20% upr / 5% lwr)
- **C** - TE sect profile (15% upr / lwr)
- **D** - Mid upper sect profile
- **E** - Parasitic drag items ie steps, gaps etc
- **F** - Twist symmetry
- **G** - Mid lower sect profile
- **H** - Sweep
- **I** - Dihedral
Summary - At this stage assembly KC’s effect only steps / gaps, and leading edge section profile.

<table>
<thead>
<tr>
<th>Sub assy</th>
<th>PKC Item</th>
<th>Affecting Feature on Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>KC1</td>
<td>B,E</td>
<td>Assembly datum</td>
</tr>
<tr>
<td>KC2</td>
<td>B,E</td>
<td>Slat alignment / rigging</td>
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</tbody>
</table>
Assembly Key Characteristics

Generic Fixed Leading Edge

Stage 1 - Add covers / D nose

<table>
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<tr>
<td>KC1</td>
<td>A,B,D,E,G</td>
<td>Assembly datum</td>
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<tr>
<td>KC2</td>
<td>A,B,D,E,G</td>
<td>Covers alignment</td>
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<td>KC3</td>
<td>B,E</td>
<td>L/E panels alignment</td>
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<td>KC4</td>
<td>B,D,E,G</td>
<td>Spreader plate location</td>
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<tr>
<td>KC5</td>
<td>B,E</td>
<td>‘J’ nose part to part assy</td>
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Summary - At this stage assembly KC’s effect steps / gaps, L/E, and mid upper and lower section profiles. Twist is locked into w/box section

Stage 1 - Add Ribs

<table>
<thead>
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<th>Affecting Feature on Part</th>
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<tr>
<td>KC1</td>
<td>B,D,E,G</td>
<td>Assembly datum</td>
</tr>
<tr>
<td>KC2</td>
<td>B,D,E,G</td>
<td>Assembly &amp; tooling datum holes</td>
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<tr>
<td>KC3</td>
<td>B,D,E,G</td>
<td>Spar flange / rib alignment</td>
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Summary - At this stage assembly KC’s effect steps / gaps, L/E, and mid upper and lower section profiles.
Manufacturing Key Characteristics

• Typical D-Nose Rib

Datum Plane A is constructed from the underside surface at the datum target areas A1, A2, and A3.
3DCS Used on A400M Leading Edge Attachment

Components being assembled in process sequence
Measurement of Leading Edge to Lower Cover Step

Step variation being measured
• Instances of into wind step highlighted in red

• Highlighted step was compensated for by a protective coating around the laminations.

### 3DCS Output of Step Variation

#### Meas4: KC4 - Distance Between KC4a and KC4b
--- Step from Upp w/skin to D/Nose Skin

<table>
<thead>
<tr>
<th>Measure</th>
<th>Tolerance</th>
<th>Point</th>
<th>Range</th>
<th>Percent</th>
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<tbody>
<tr>
<td>1</td>
<td>Profile</td>
<td>2uhs Upp_Skin_1</td>
<td>M:0.665 mm</td>
<td>22.66%</td>
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<tr>
<td>2</td>
<td>Profile</td>
<td>1uhs Upp_Skin_1</td>
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<td>9</td>
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<tr>
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<td>Profile</td>
<td>2ls Spar_Assy_1</td>
<td>M:0.200 mm</td>
<td>0.97%</td>
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Sum Of Rest 36 Contributors = 6.810000%
Why 3DCS?

- It suits our business needs
  - Embedded in Catia v5
  - Robust and user friendly
  - Gives excellent graphics visualisation
  - Results are easily downloaded into report form
  - Excellent responsive customer support
  - Understand our requirements
What Dimensional Management Does For Us

• Gives detailed statistical data to Design and Manufacturing to both influence decisions and base any subsequent required changes on

• It verifies and validates designs so we are confident they can be manufactured right first time

• It can be utilised to investigate current production problems, map the processes and then deliver solutions

• Allows us to use actual SPC data to assess its impact on manufacturing
New Manufacturing Cycle

Design Engineering

+ 

Manufacturing Engineering

+ 

Tooling Design and Manufacturing

= 

- SPC
- FMEA
- DFSM
- 3DCS