The Boeing Perspective on Titanium Development

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Titanium Strategies

- Reduced Cost
  - Nearer Net Forgings
  - Extrusions (including nearer net)*
  - Rolled Shapes*
  - Welding*
  - SPF, SPF/DB
  - Single Melt
  - Coil*
  - Enhanced Machinability*

Hot Stretch Forming
Improved Performance

- Higher Strength Alloys*
- Improved Oxidation Resistance*
- High Strength Fasteners/Rod Ends
- Fine Grain Sheet
- Hydraulic Tubing*
- High Strength Castings
- More Robust Alloys/Processes
Reduced Cost Extrusions

737 Seat Tracks

Greater extrusion utilization

Near-Net Extrusion Goal: 2 surfaces net
Reduced Cost
Rolled Shapes

Lower Buy: Fly than extrusions for simple shapes

Hot Stretch Forming at Cyril Bath
Reduced Cost
Linear Friction Welding
Boeing Concept
P&W Disks
Reduced Cost

WHY?
- Long lengths (floor structure)
- Reduced cost
- Better tolerance control?

Requirements
- Properties equivalent to or close to Ti64
- Good formability
- Weldability

ATI 425 could be attractive
Improved Performance
Higher Strength Alloys

- **Forgings** – 220ksi UTS
  - Ti-5Al-5Mo-5V-3Cr vs 4340M (180 vs 280 ksi) 8% weight advantage
  - Ti at 220ksi 15% weight advantage
- **Reduced maintenance cost**
Improved Performance

Improved Oxidation Resistance

- Temperatures for plug and nozzle and heat shields continue rising.
- Oxidation resistance becoming more of a concern
  - Improved alloy
  - Tough durable coating
Improved Performance
hydraulic tubing

- Want to enable reducing wall thickness, thus weight
- Collaborative effort with Airbus to develop Ti-6Al-4V tubing allowables
- Concern with single source situation
- Formability/workability of ATI 425 could provide a more reproducible alternative
Improved Performance
High Strength Fasteners

- Fasteners >180ksi UTS
- Ti-5Al-5Mo-5V-3Cr vs. EN6114/5 steel
  40% weight advantage
- Avoid hazardous coatings
- Prototypes successfully manufactured by AFS

Aero-Lite 7/16”
Flush head shear pin
Conclusions

- Premised on success of Boeing 787 and other airplane programs, there should be a high demand for titanium for the next few years.
- Primary emphasis will be on technologies which will result in reduced cost.
- Improved performance will still be of interest with emphasis in the areas discussed.