



# 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



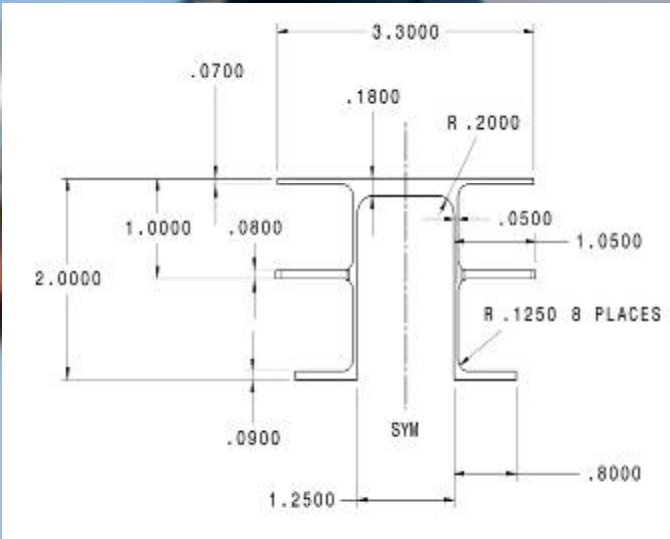
# Improved Performance

- 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



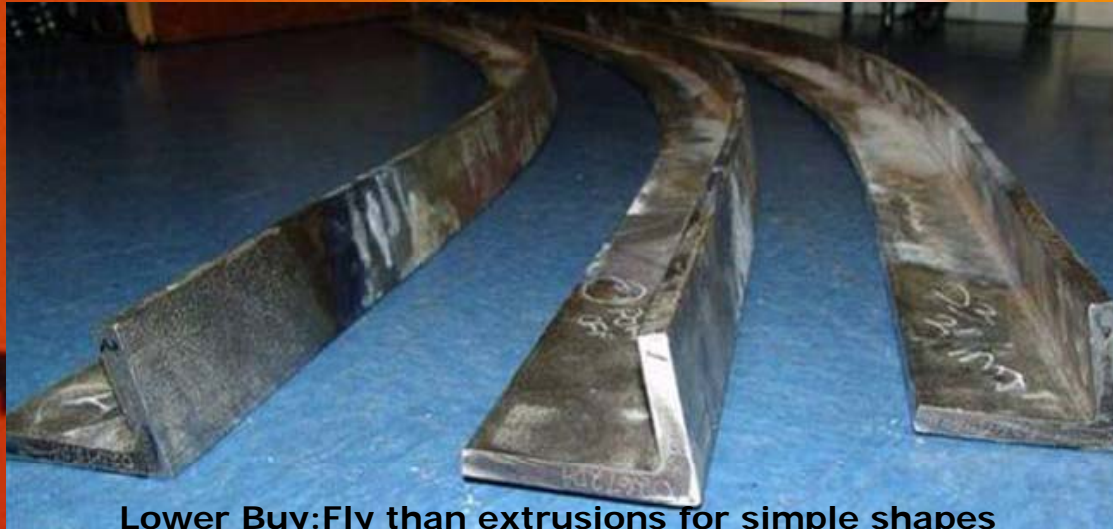
Greater extrusion utilization



Near-Net Extrusion  
Goal: 2 surfaces net



# Reduced Cost Rolled Shapes

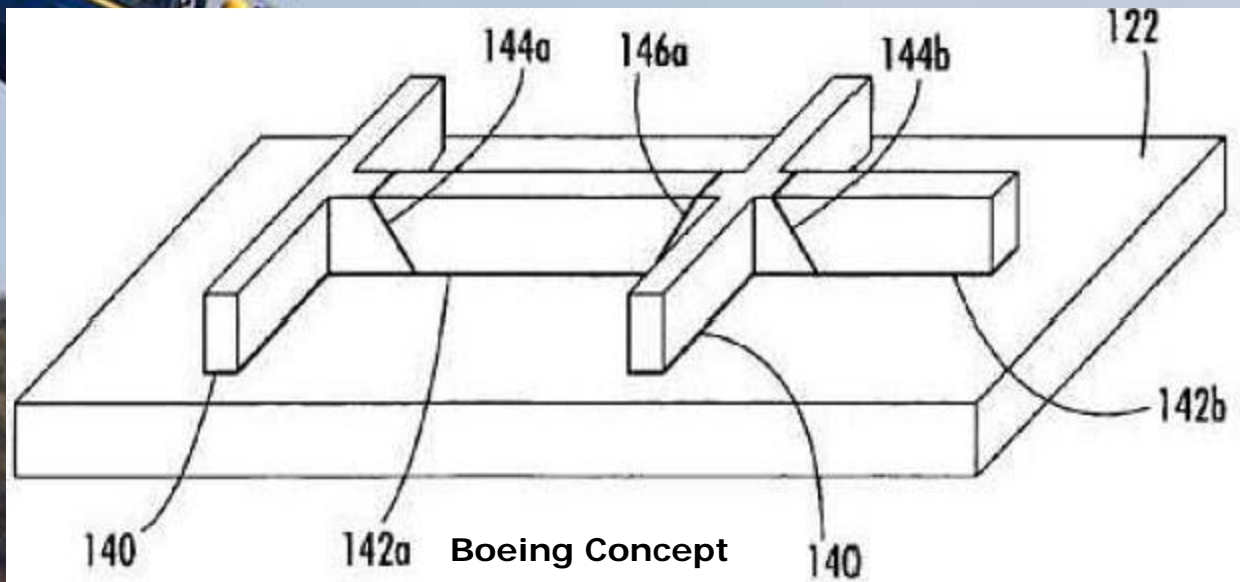


Lower Buy: Fly than extrusions for simple shapes



Hot Stretch Forming at Cyril Bath

# Reduced Cost Linear Friction Welding



P&W Disks

# Reduced Cost Coil

## → 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