



Boeing Commercial Airplanes

Decorative Paint - Needs and Desires

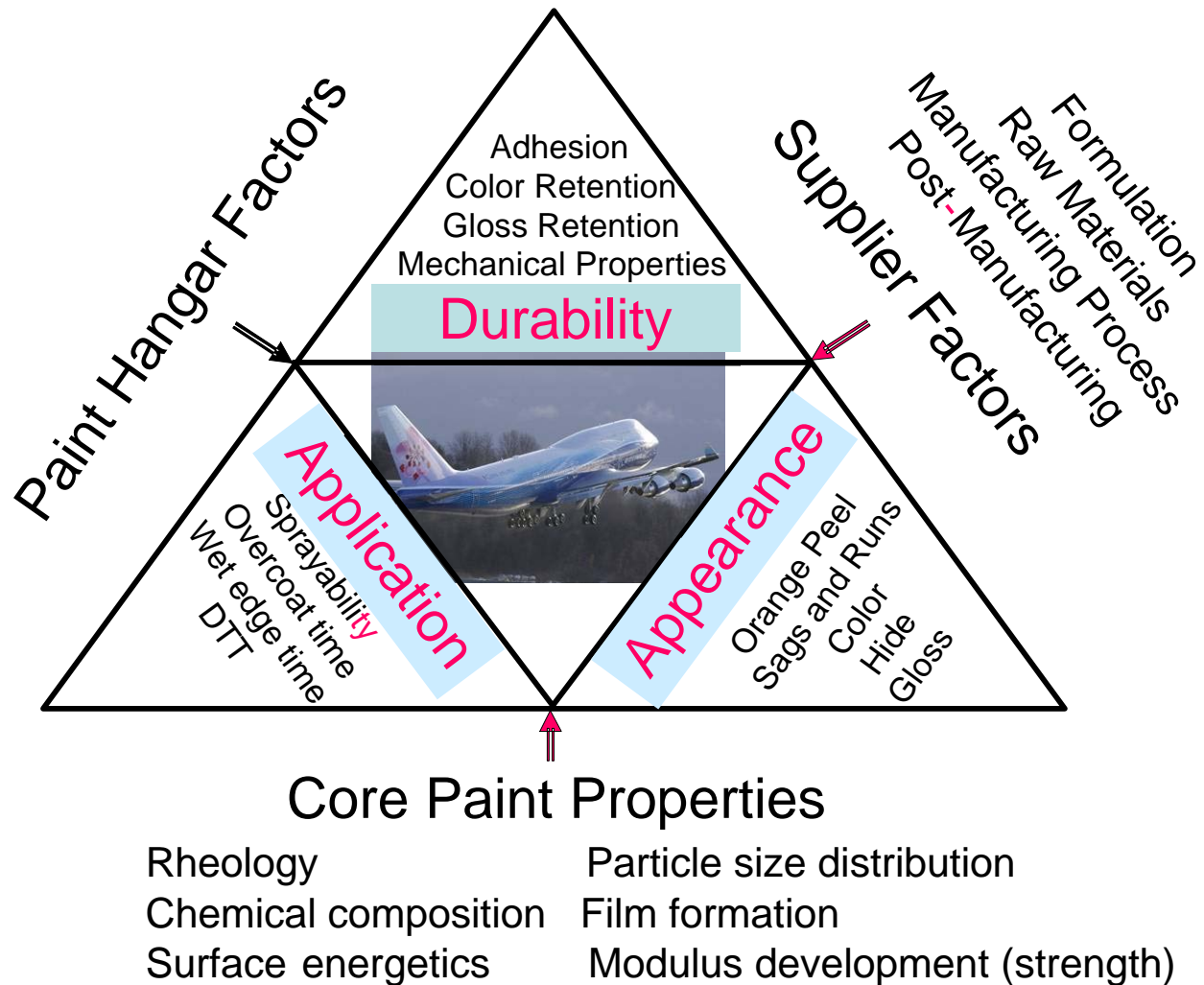
National Shipbuilding Research Program
Technical Panel SP-3 Meeting
Surface Preparation & Coatings
11-1-2006

R Jahren

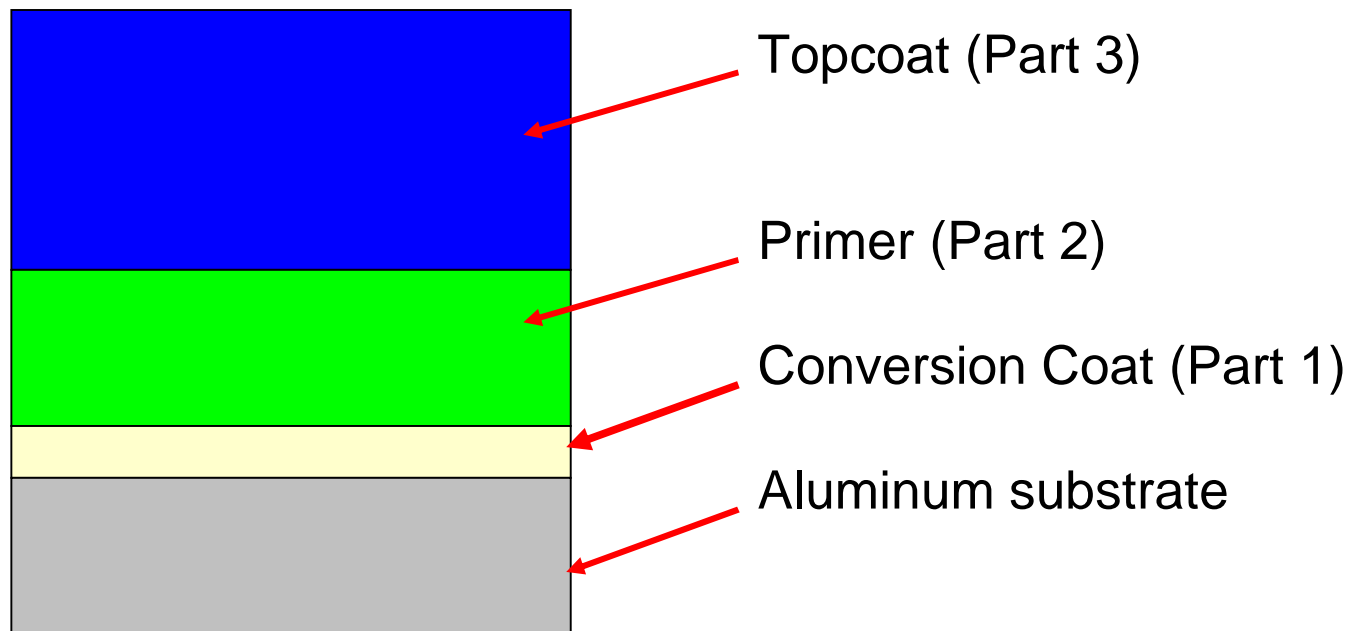
Associate Technical Fellow
M&PT Boeing Commercial Airplanes

- **Current basic design**
- **Coating needs**
 - Attractive
 - Durable
 - adhesion improvements
 - Economic to apply
 - Removable
- **Summary - the Challenge of Balance**

Challenge of Ballance



Boeing Commercial Airplanes Decorative Paint System



Boeing Commercial Airplanes Attractive

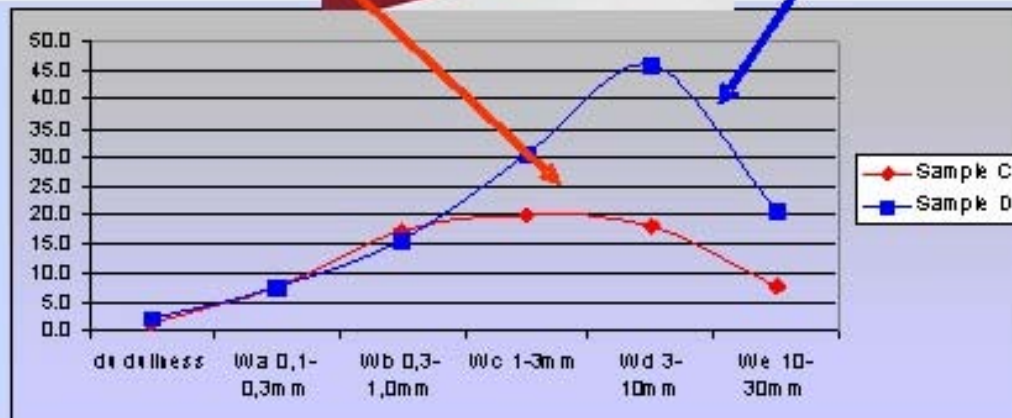
- Provides Airline with distinctive image
- Relative Smoothness
- Retains color and gloss
- Is Clean Appearance in Service



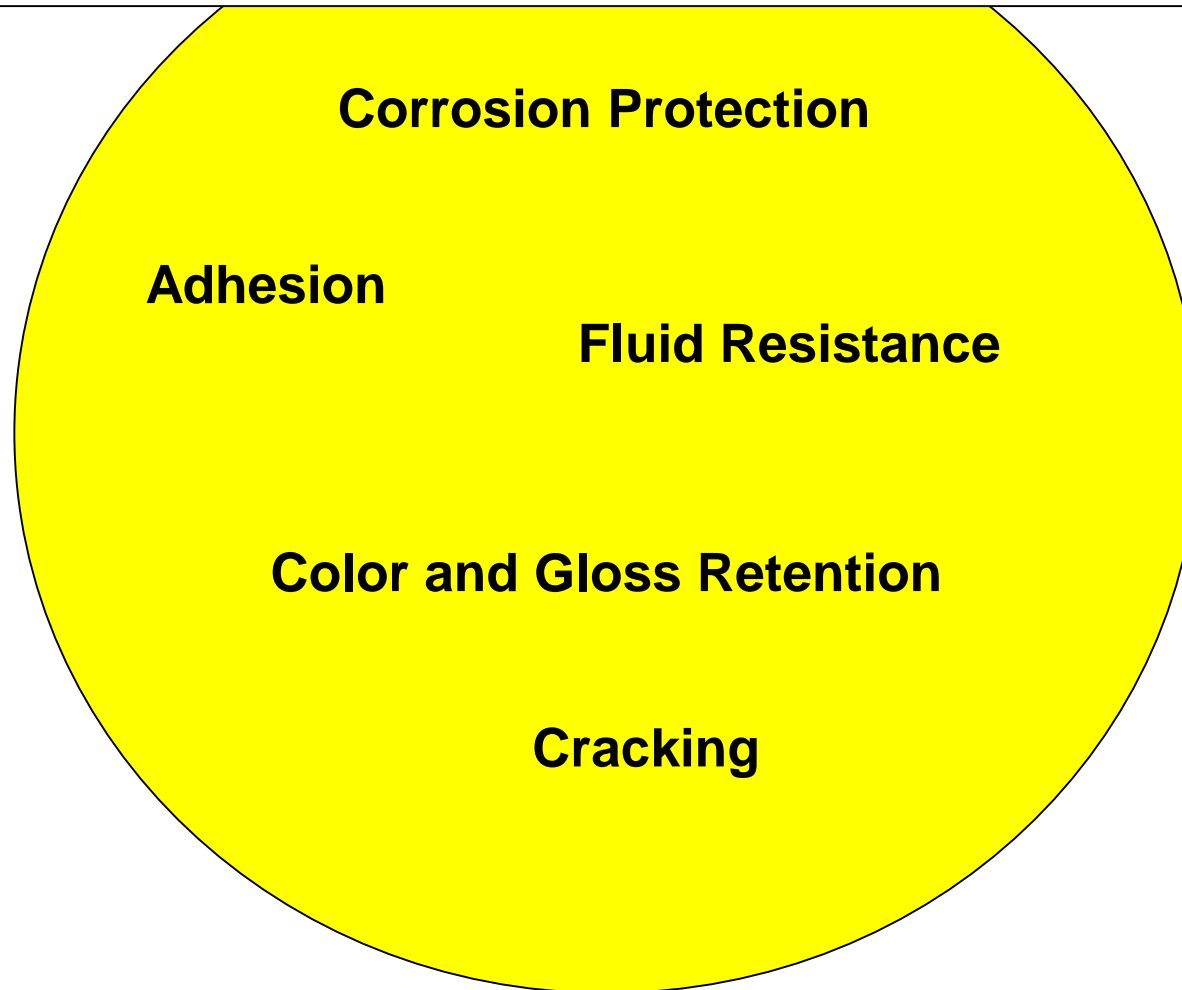
Boeing Commercial Airplanes



Boeing Commercial Airplanes Attractive

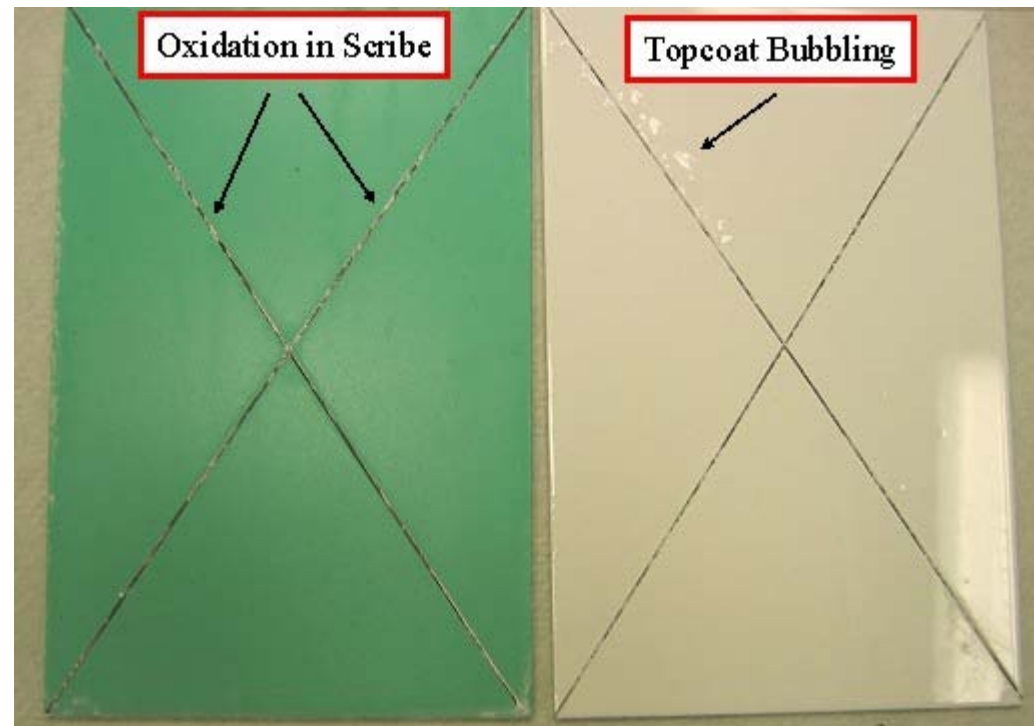


Decorative Coating Requirements are found in BMS 10-72



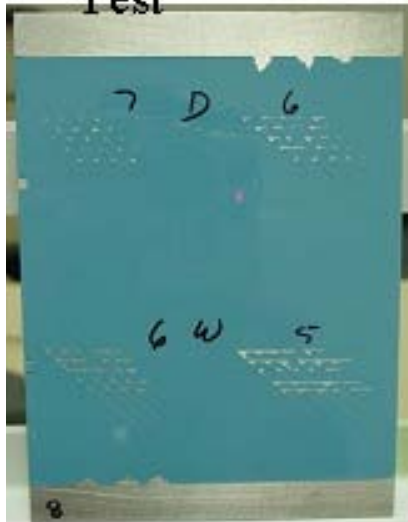
Boeing Commercial Airplanes Durable - Corrosion

- **Good in-service exterior corrosion resistance**
- **Current Measures**
 - Salt Spray – 3000 Hours
 - Filiform
- **Issues**
 - Test time
 - Non-Chrome



- **Paint adhesion is important**
- **Measures** – Scribe Tape Adhesion, Rain Erosion, Gardner Impact, Patty Pull, Conical mandrel, Rod and more

Scribe Tape
Test



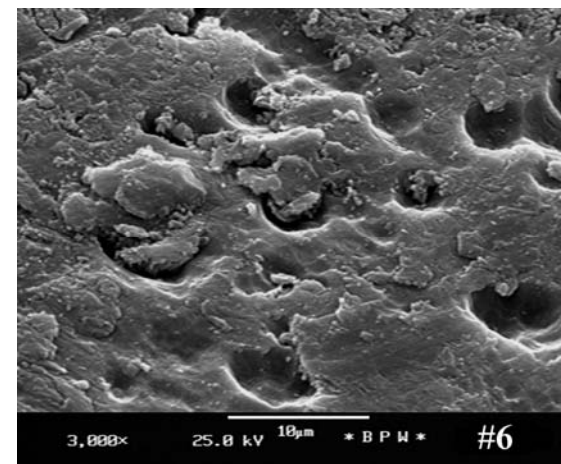
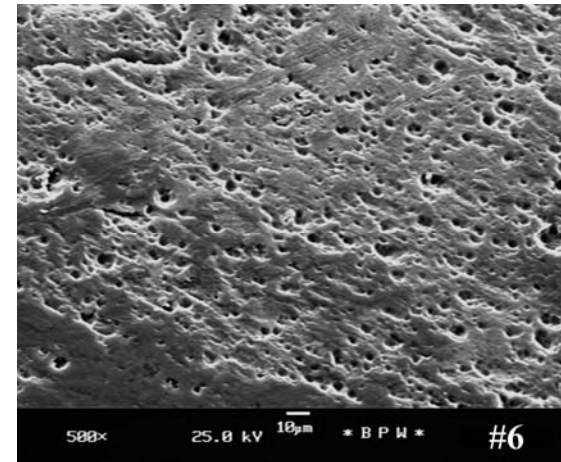
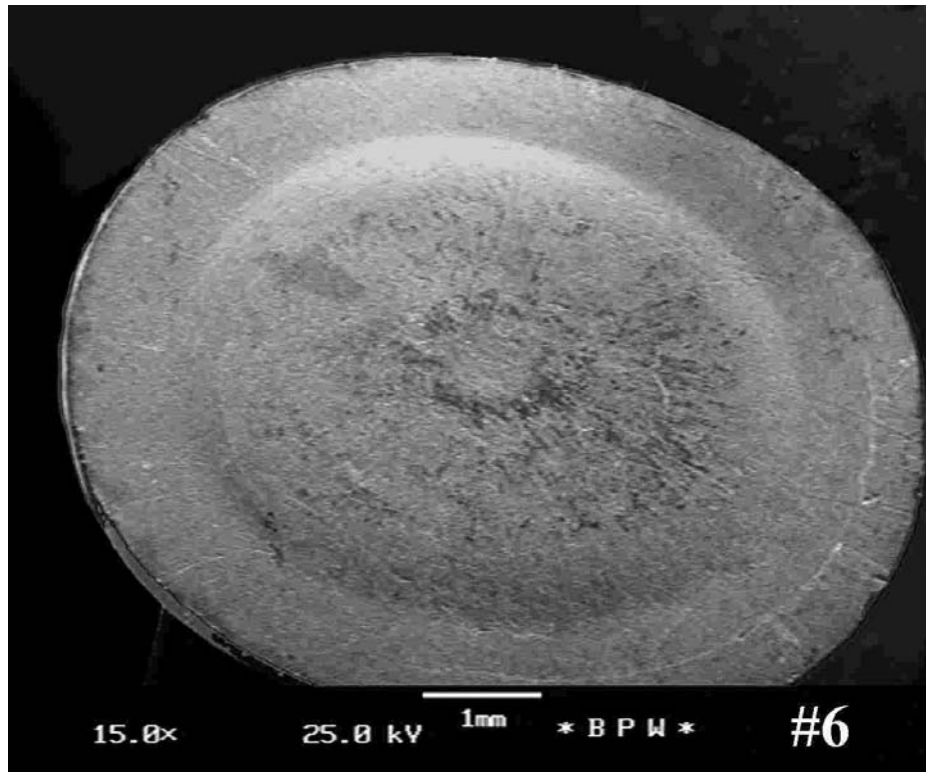
Rain Erosion



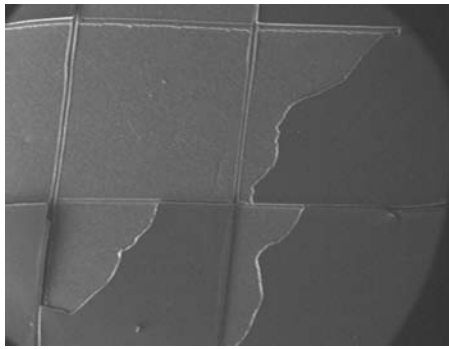
- **Issues**
 - Replication of production and in-service environments
 - Wide variety of potential substrates



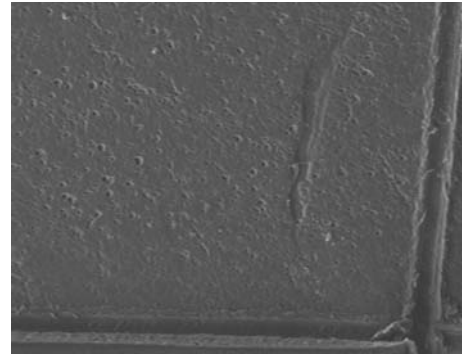
Boeing Commercial Airplanes Rivet SEM



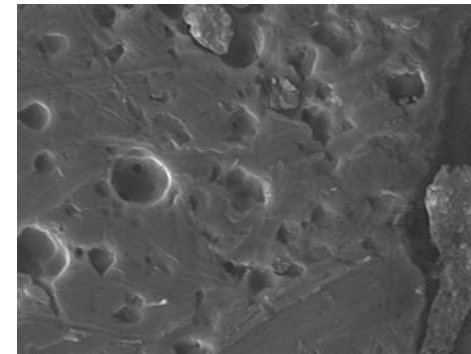
Boeing Commercial Airplanes Failure Analysis



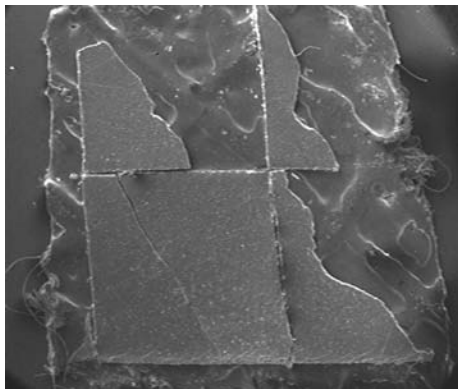
1.0 mm



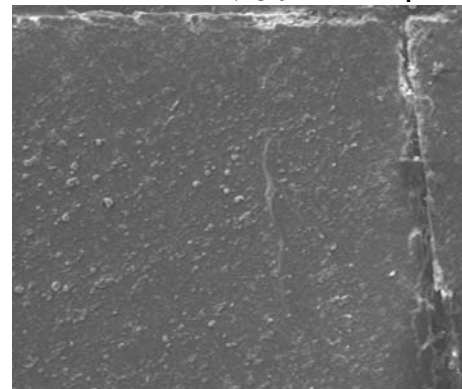
Rivet 100 μm



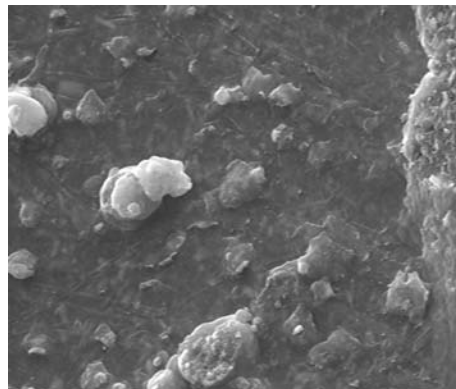
10



1.0 mm

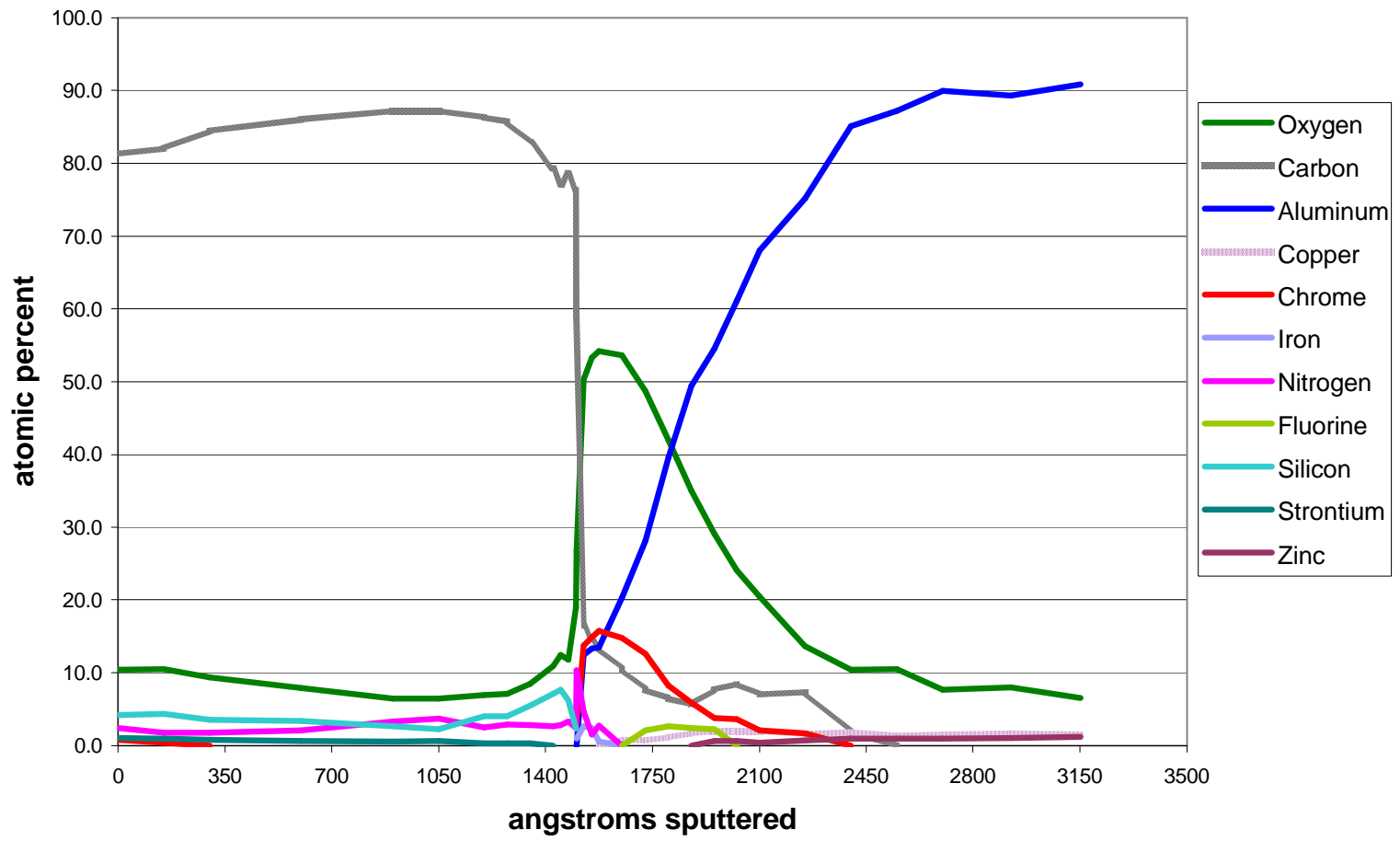


Paint 100 μm

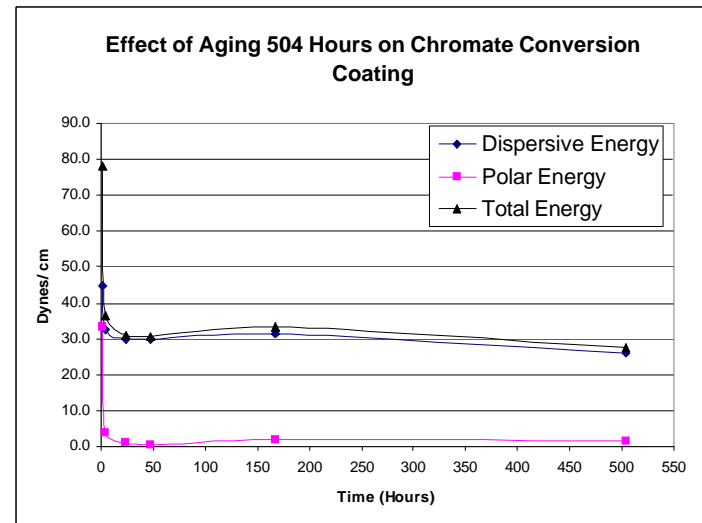
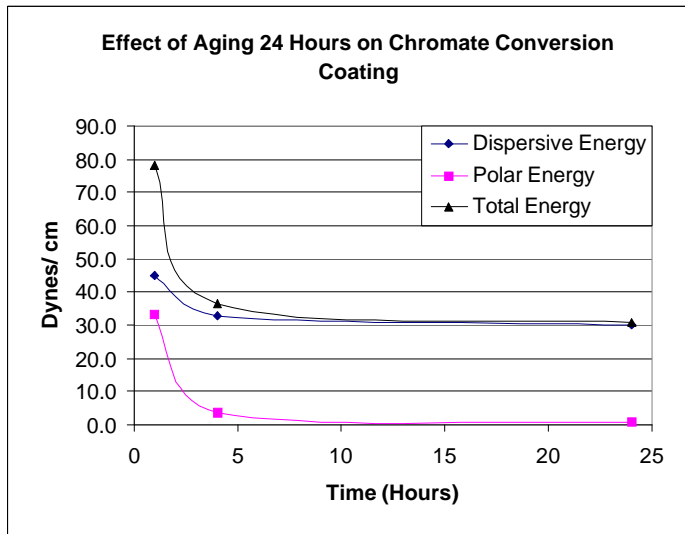
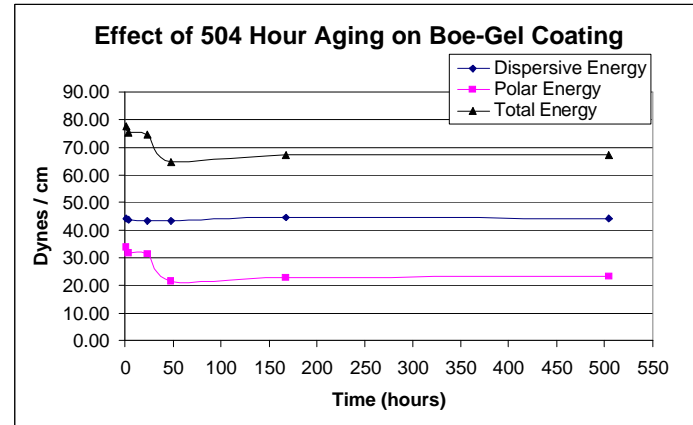
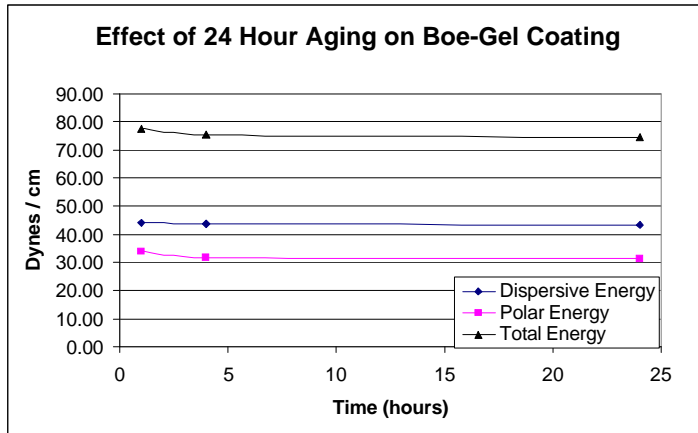


10 μm

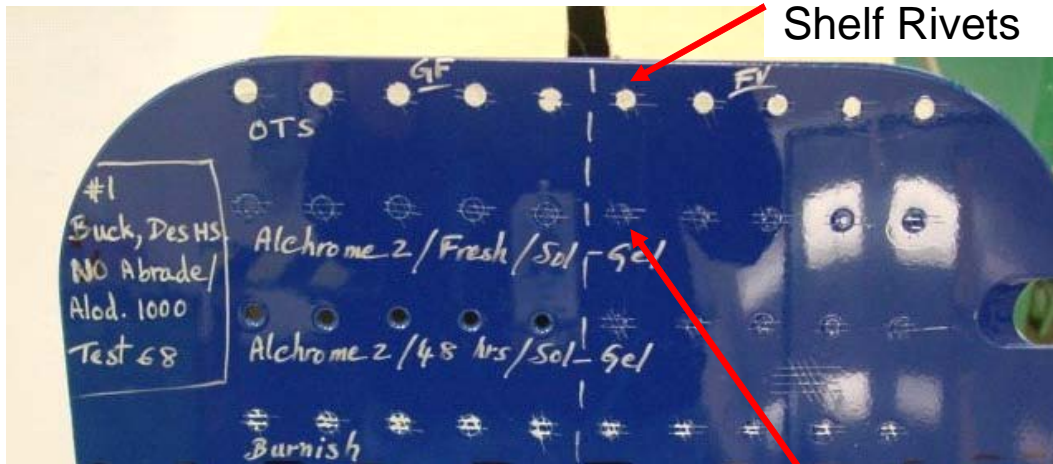
combined interfaces



Boeing Commercial Airplanes Boe-Gel Aging



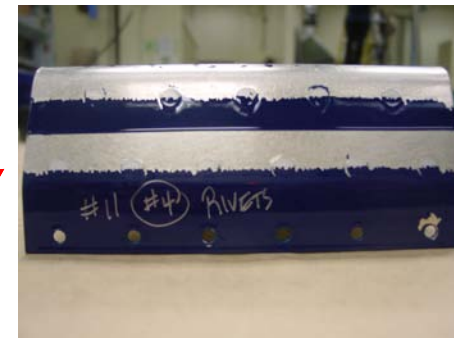
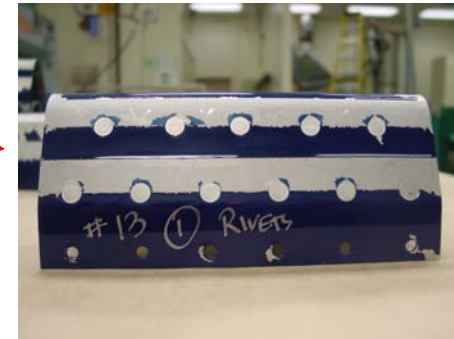
Scribe Adhesion Test



Old Off the Shelf Rivets

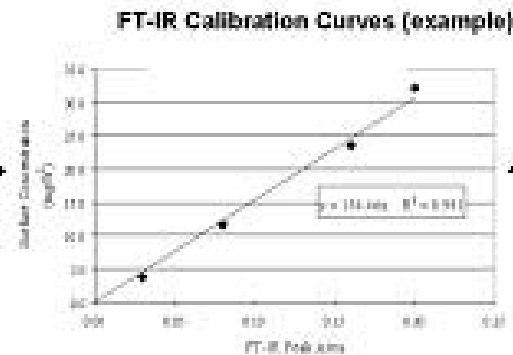
Boe-Gel Rivets

Rain Erosion Adhesion Test



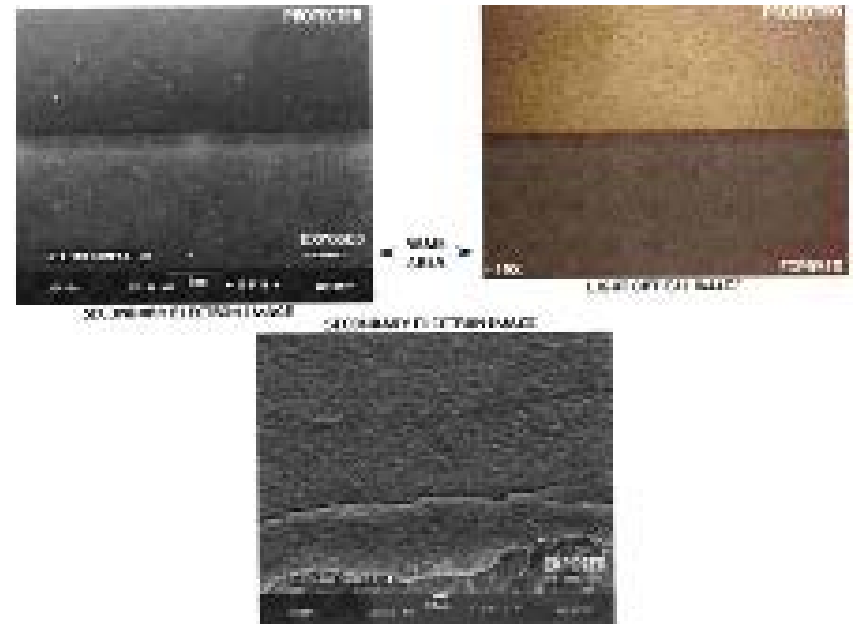
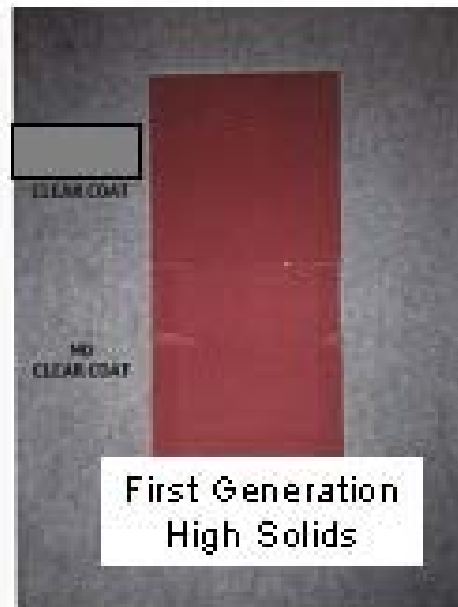
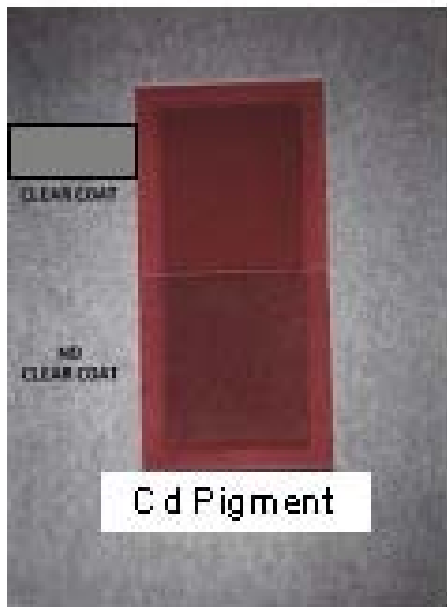
- **Areas of research**

- Correlating degree of contamination to adhesion
 - Develop relationship between FTIR to degree of contamination
 - Measure paint adhesion of contaminated panels

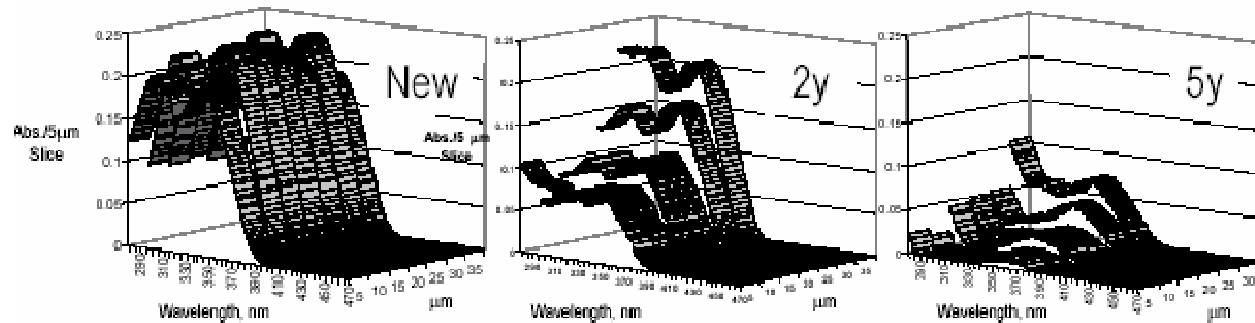
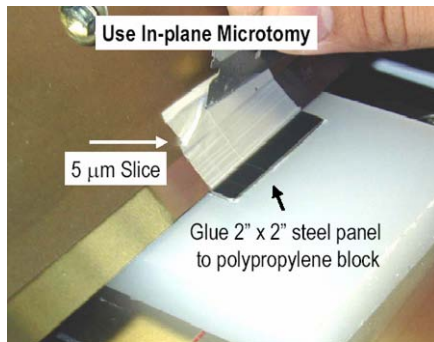


Durability - Color and Gloss

- **Color and Gloss**
- **Tests developed in response to 1990 concerns**
 - Volcanic Activity produced high amount SO_2
 - New high solids paints needed increased stability
 - Xenon/ SO_2 – 4 cycles



- **Opportunities**
 - Work to understand internal coating chemistry
 - Fundamental understanding of what is occurring at the paint's outer surface



Research from Ford Motor Company. Mark Nichols et. al.

- **Application**
 - Consistent
 - Robust
- **Robust to substrate**
- **Minimal manual surface activation**
 - Substrate
 - Primers
 - Enamels

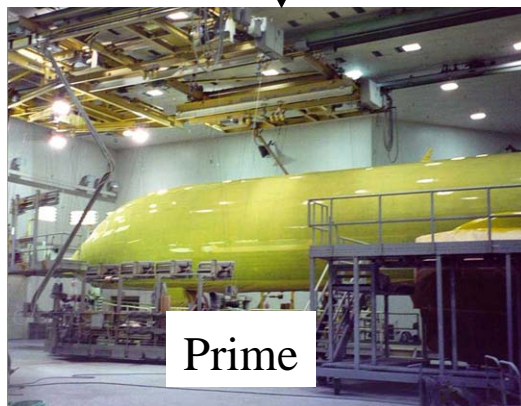


Boeing Commercial Airplanes Applied Economically

Remove Temporary Coating
and Sand Composites



Abrade Surface



Boeing Commercial Airplanes Applied Economically



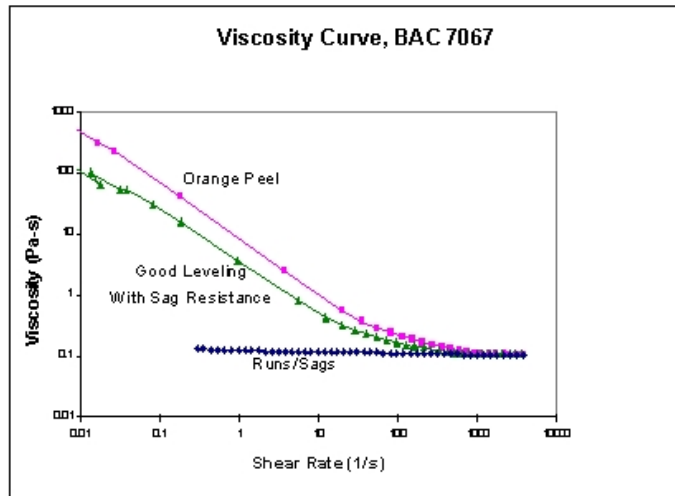
Reactivate, Mask and Topcoat

Boeing Commercial Airplanes
Applied Economically



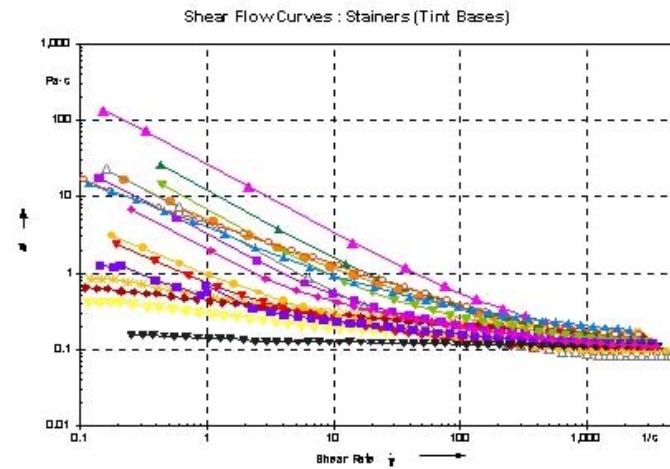
Boeing Commercial Airplanes Applied Economically: Consistent Application

Rheology



11/30/99

Rheology

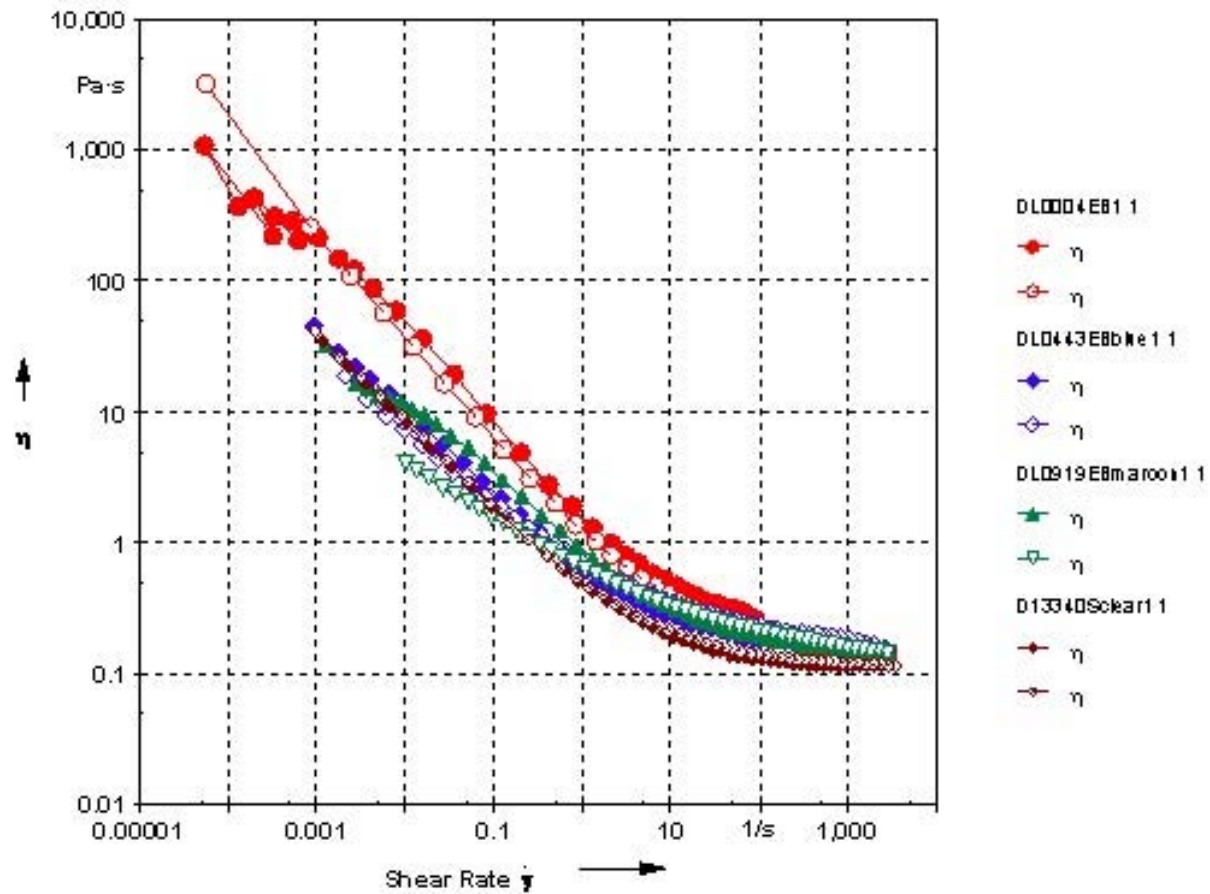


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Boeing Commercial Airplanes
Applied Economically
Consistent Application

Flom dSP5 Shear: : Basecoats, 01/22/04



Boeing Commercial Airplanes
**Applied Economically:
Other Considerations**

- **Compatibility with**
 - Application Equipment
 - Decals
 - Stencils
 - Masking Tape
 - Pre Masks



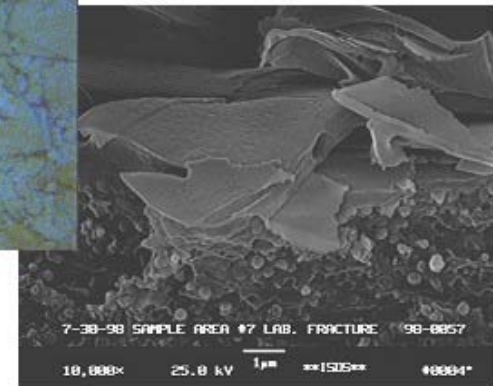
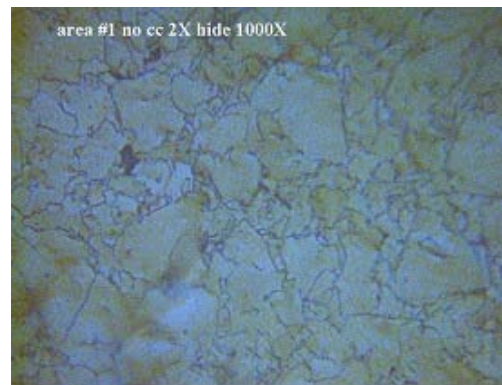
Applied Economically: Micas



Non-Metallics Metallics – Mica

•Application window critical

- Three Coatings (Color: Mica: Clear)
- Set up (Paint Gun: Tip Size/ Pressures/ Flow Rates Distance)
- Repairs



Boeing Commercial Airplanes
De-Painting Metal

Airplanes out of service are not making revenue

Reducing repaint time increases airline revenue



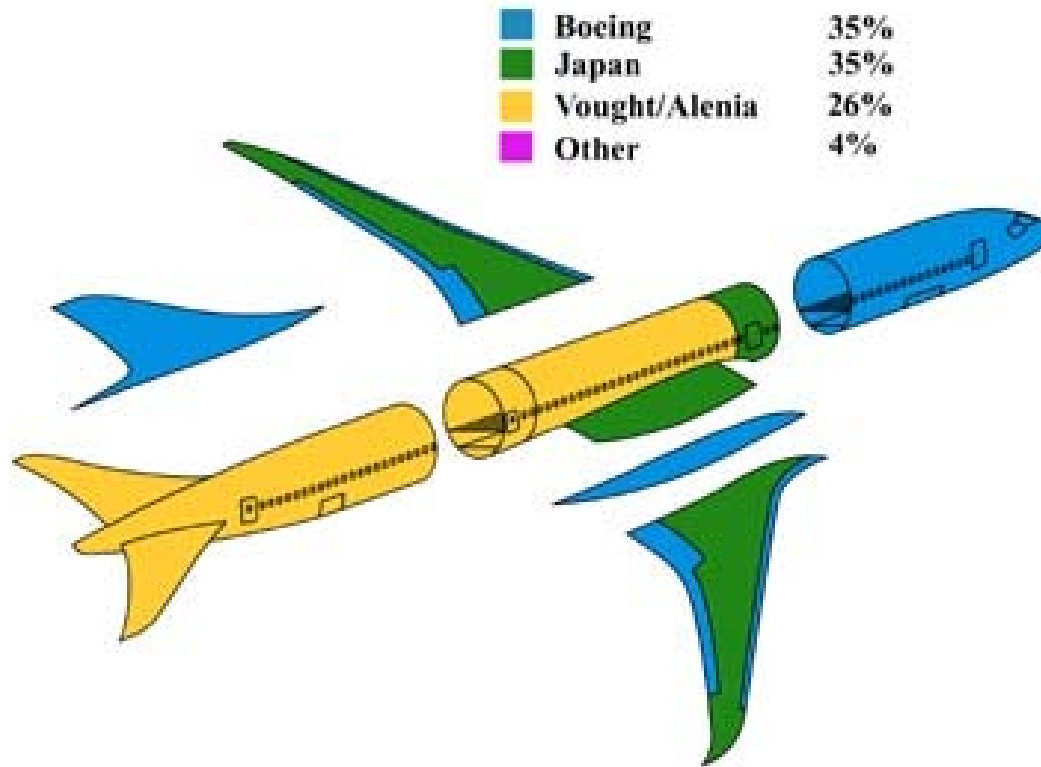
Boeing Commercial Airplanes Demonstration Section 787

- **First full-scale composite one-piece fuselage**
- **22-feet (7-meters) long and nearly 19-feet (6-meters) wide**



Boeing Commercial Airplanes Partners

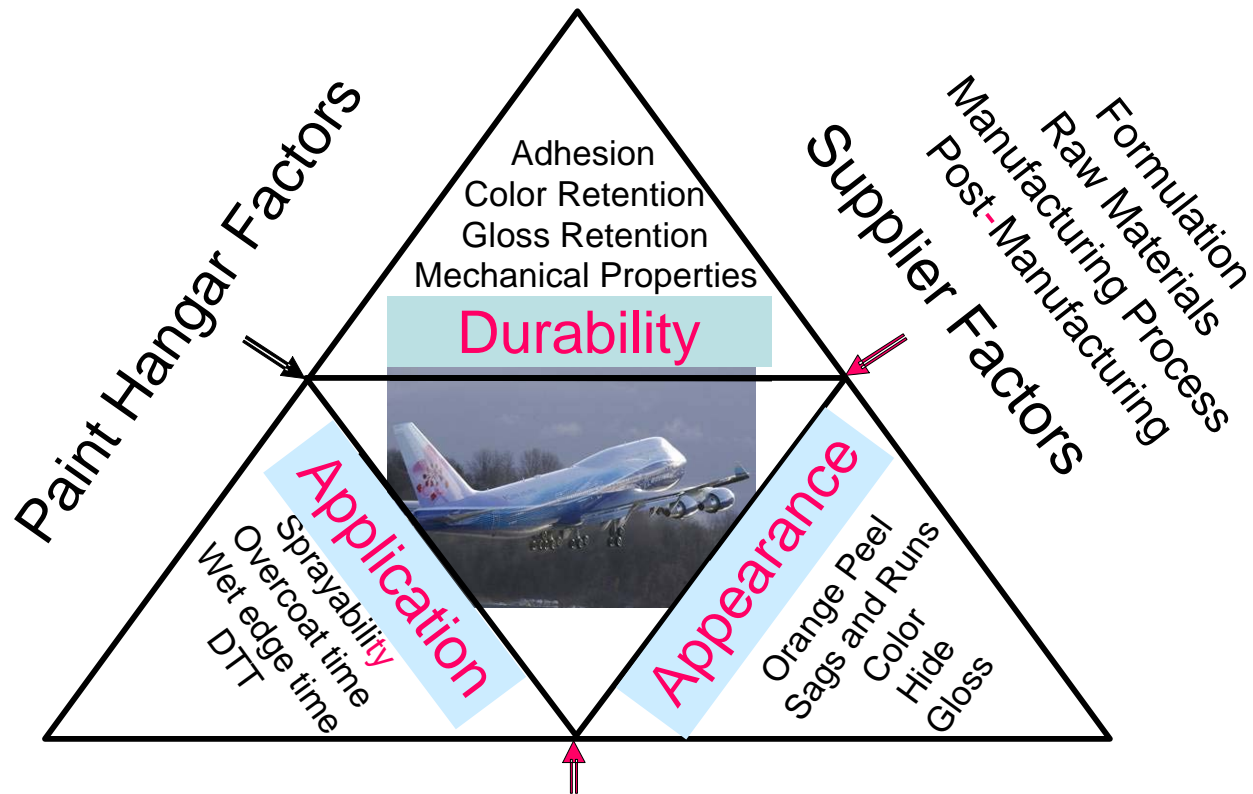
7E7 Structures Work Share



- **Others Desires**
 - Aerodynamic enhancement
 - Low Weight
 - Reduced flow time
 - Increasing the appearance

- **Paints need to add value to the airlines**
- **The market will grow for new airplanes**
- **Coating Needs**
 - Protects the substrate/ Is durable/ Is attractive
 - Can be applied efficiently and are robust
 - Can be removed
- **The challenge is to give the coating the right balance of all the coating needs**

Challenge of Ballance




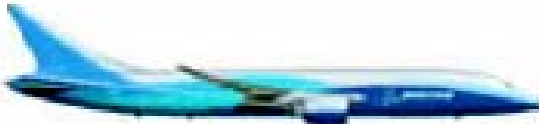




Core Paint Properties

- | | |
|----------------------|--------------------------------|
| Rheology | Particle size distribution |
| Chemical composition | Film formation |
| Surface energetics | Modulus development (strength) |



Boeing Commercial Airplanes **Back Up**

MODEL		SPEED (cruise Mach)	RANGE nmi (km)	CITY PAIRS (longest range)	# OF SEATS
717		0.76	2,055 (3,815)	Chicago - Cancun Beijing - Bangkok Rome - Kuwait	106
737		0.78	3,050 - 3,365 (5,645 - 6,235)	Boston - Berlin Brussels - Dakar Rio de Janeiro - Panama City Singapore - Mauritius	110 - 177
767		0.80	5,645 - 6,600 (10,450 - 12,220)	New York - Tokyo London - Buenos Aires Beijing - Atlanta Sydney - Los Angeles	181 - 245
787		0.85	3,500 - 8,500 (6,482 - 15,741)	Manchester - Hong Kong Washington DC - Rome Helsinki - Shanghai London - Fukuoka	200 - 300
777		0.84	5,210 - 9,120 (9,640 - 16,890)	London - Sydney Los Angeles - Perth New York - Jakarta Singapore - Atlanta Tokyo - Santiago	301 - 368
747		0.85	7,325 - 7,580 (13,570 - 14,038)	London - Honolulu Los Angeles - Melbourne New York - Bangkok Singapore - Los Angeles	416

787 Dreamliner

- **787-3**
 - 296 passengers in two-class configuration
 - 3,500 nautical miles (6,500 km)
 - Wing Span: 165-170 feet (50-52 meters)
 - Length: 182 feet (56 meters)
 - Cross Section: 226 inches (574 centimeters)
- **787-8**
 - 223 passengers in three-class configuration
 - 8,500 nautical miles (15,700 km)
 - Wing Span: 197 feet (60 meters)
 - Length: 182 feet (56 meters)
 - Cross Section: 226 inches (574 centimeters)
- **787-9**
 - 259 passengers in three-class configuration
 - 8,300 nautical miles (15,400 km)

- **Paints need to add value to the airlines**
 - Fit into the airline's business model
 - Fit into the OEMs business
- **Airline's needs**
 - Reliability
 - Distinct Appearance
- **Boeing business model "Lean"**
 - Robust systems and reduced flow
 - Maintain and improve Quality, Safety, Environment

- **First need is for Durable Coatings**
- **When needed: Repairs at Overnight Stations**
- **Touch ups that match**





Boeing Commercial Airplanes **787 Program Milestones**

- Authority to offer Late 2003
- Assembly start 2006
- First flight 2007
- Certification/Entry into service 2008