THE FUTURE OF VERY LARGE SUBSONIC TRANSPORTS

R. Steven Justice, Anthony P. Hays, & Ed L. Parrott

Lockheed Martin Aeronautical Systems

Advanced Design
The Vision

Bel Geddes Air Liner Number 4 (1929)
VLST - Past & Present
Today's Situation

- Slot Limits At Existing Airports
- Traffic Growth Outpacing New Airport Development
- Bigger Aircraft Required To Increase System Capacity & Productivity
- Heavy Airlift Military Aircraft To Be Replaced In Early 21st Century

Lockheed Martin
Airport Congestion
Kennedy International Airport
International Passengers Vs Aircraft Movements

Millions of Pax

Thousands of A/C


SCH INT PAX  SCH INT A/C

NASA Transportation Beyond 2000 Workshop
How Did We Get Here?

- No Significant Increases In Aircraft Capacity Since Early 1970’s

Aircraft Size Growth Since 1940

<table>
<thead>
<tr>
<th>Year</th>
<th>Passengers (Standard)</th>
</tr>
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<tbody>
<tr>
<td>1940</td>
<td>50</td>
</tr>
<tr>
<td>1950</td>
<td>150</td>
</tr>
<tr>
<td>1960</td>
<td>200</td>
</tr>
<tr>
<td>1970</td>
<td>250</td>
</tr>
<tr>
<td>1980</td>
<td>300</td>
</tr>
<tr>
<td>1990</td>
<td>350</td>
</tr>
<tr>
<td>2000</td>
<td>400</td>
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VLST Missions

- Passenger Transport
  - 600 to 800 Passengers Over Global Distances

- Commercial Freighter
  - 6.5% Annual Cargo Growth
  - Increased Use Of ISO & Intermodal Containers

- Military Airlift
  - Payload Of C-5 Over Global Distances
Key Design Challenges

- Size Issues & Constraints
  - Clearances At Gates, Taxiways, & Runways
  - Ground Loading & Floatation

- Increased Aircraft Separation Requirements
  - Increased Power In Wing Vortex
  - Increased Separation Will Reduce Aircraft Throughput At Airport
Key Design Challenges

- Taxiway Clearance

**Diagram:****

**PANY&NJ Aviation Department**

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Key Design Challenges

- Loading & Servicing
  - Compatibility With Current Gates
  - Servicing Vehicle Congestion
  - Longer Time Required For Loading & Servicing
Key Design Challenges

- Ground Support

"Airport Support", December 1994
Key Design Challenges

- Gate Compatibility
Key Design Challenges

- Emergency Systems
  - Emergency Exit/Slide Height
  - Passenger Escape From Emergency Site
  - Emergency Systems Must Handle Up To 1,600 Victim Event (2 Aircraft)
Key Design Challenges

- Aircraft Noise Requirements
- Fabrication Of Large Composite Structures
- Control Of A Large Flexible Structure
Enabling Technologies

- Fly-By-Light/Power-By-Wire
- Active Control Systems
- Simple, Effective High Lift Systems
- Laminar Flow (Hybrid & Natural)
- Flight Deck Systems
- Modular Design
Options For VLST

**Boeing 747-400F**
- Wing Span: 212 ft
- Length: 233 ft
- Maximum Payload: 280,000 lb

**Lockheed Very Large Airplane**
- Wing Span: 227 ft
- Length: 262 ft
- Maximum Payload: 300,000 lb

**McDonnell Douglas Blended Wing-Body**
- Wing Span: 280 ft
- Length: 270 ft
- Maximum Payload: 300,000 lb

**Lockheed Spanloader**
- Wing Span: 257 ft
- Length: 265 ft
- Maximum Payload: 600,000 lb

**Airbus Super Transporter A380-600ST**
- Wing Span: 247 ft
- Length: 260 ft
- Maximum Payload: 500,000 lb

**Molniya 1000 Heracles**
- Wing Span: 250 ft
- Length: 260 ft
- Maximum Payload: 912,000 lb

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Options For VLST

- Sea Based Vehicles
  - Conventional Seaplane
  - Wing In Ground-Effect (WIG)
- No Runway Construction
- Use Existing Cargo Port/Terminals
- Increased Emergency/Alternate Landing Sites
Options For VLST

- Lockheed/Dornier Sea-Based VLST
  - 3,500 Nm Range With 882k lb Payload
  - 2.2M lb MTOW
Options For VLST

- Lockheed Martin Sea-Based WIG
Who Will Build The VLST?

- McDonnell Douglas
- Boeing
- AIRBUS
- Lockheed Martin
LMAS VLST

- 1.4 Million Pound Takeoff Weight
- 282 ft Wing Span (211 ft Folded)
- 262 ft Length
- 4 GE90, RR Trent, Or PW4000 Class Engines
- 3,200 Nm Range With Over 400k lb Payload
LMAS VLST

- Comparison To C-5
LMAS VLST

- Passenger Layout (950 Passengers)
LMAS VLST

- Cargo Layout (16 ISO 40 ft Containers)
LMAS VLST

- Low Wing Concept
LMAS VLST

- Blended Wing/Body Concept
Routes That Could Use A VLST Today

- London - Tokyo
- London - Hong Kong
- London - Singapore
- New York - London
- New York - Paris
- New York - Frankfurt
- Tokyo - San Francisco
- Tokyo - Los Angeles
- Tokyo - Honolulu
- Hong Kong - San Francisco

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VLST Market
(By 2010)

- Big Enough For More Than One Aircraft?

<table>
<thead>
<tr>
<th>Region</th>
<th>Number</th>
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<tbody>
<tr>
<td>Asia/Pacific</td>
<td>160-200</td>
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<tr>
<td>USA</td>
<td>70-100</td>
</tr>
<tr>
<td>Europe</td>
<td>50-70</td>
</tr>
<tr>
<td>Total</td>
<td>280-370</td>
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(British Airways Forecast)
How Much Money?

- $8-15 Billion Development Cost
  - More Than One Company Can Handle
- $200-300 Million Unit Cost
  - Larger Than Annual Profits For Many Airlines
  - Unlikely To Be Internally Financed By Airline & Leasing Companies
  - Resulting High Capital Cost For Operator
Summary

- VLST Is Technically Possible Now
- Airline Interest Has Decreased Recently Due To Financial Difficulties
- Major Aircraft Manufacturers Are Poised To Act Once Economics Improve
VLST - Argosies Of The Sky!

“For I dipt into the future, far as the human eye could see, 
Saw the Vision of the world, and the wonder that would be; 
Saw the heavens fill with commerce, argosies of magic sails, 
Pilots of the purple twilight, dropping down with costly bales.”

Lord Tennyson