The Future of BWB

7th International Workshop on Aviation & Climate Change

Mark A. Page

Founder & Chief Scientist DZYNE Technologies

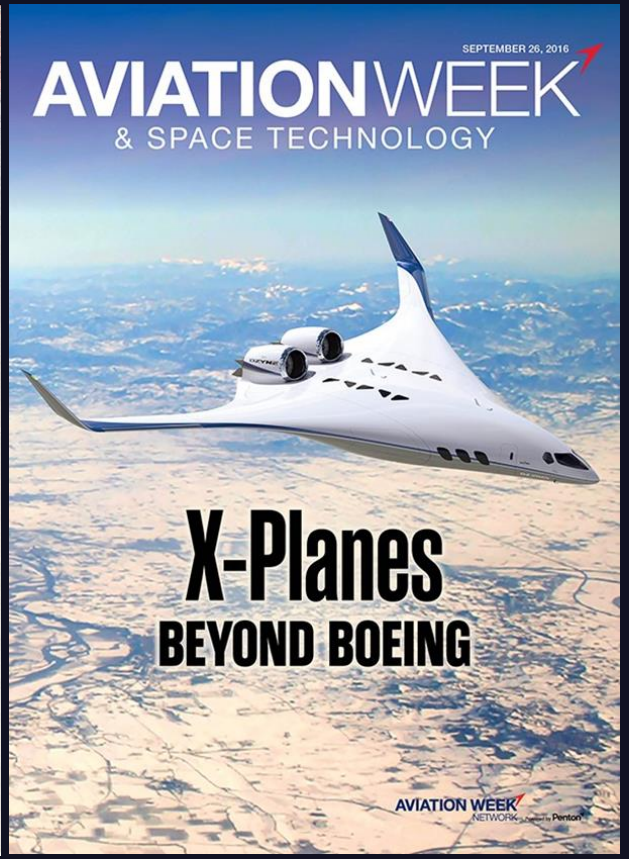
Blaine Rawdon
Mark Page
Bob Liebeck

Fathers of the Modern BWB (above)

Dr. Ben Tigner amd Bob at right with other Stanford Students and the BWB-17 demonstrator


Popular Science
A Times Mirror Magazine
Surgery By Robot
1995's Concept Cars
MEGAPLANES
The New 800-Passenger Jetliners
APRIL 1995
$2.50


FACE TO FACE
WITH STEVEN UDVAR-HAZY Page 57
You made it start & happen Bill Yost
$6.00 AUGUST 6, 2007
AVIATION WEEK
& SPACE TECHNOLOGY
X-48B
NEW REALITIES FOR UAVS
Page 48
Mark, Congrats to you as well! Mike Kelly
ESA'S EARTH EXPLORERS
Page 61
Mark, You started it. Dean
Mark - You are part of this, Thanks. Bob
The McGraw-Hill Companies
www.aviationweek.com/awst


SEPTEMBER 26, 2016
AVIATION WEEK
& SPACE TECHNOLOGY
X-Planes
BEYOND BOEING
AVIATION WEEK NETWORK

Swift KillerBee and Northrop BAT


Ascent1000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Super Regional Jet Interior

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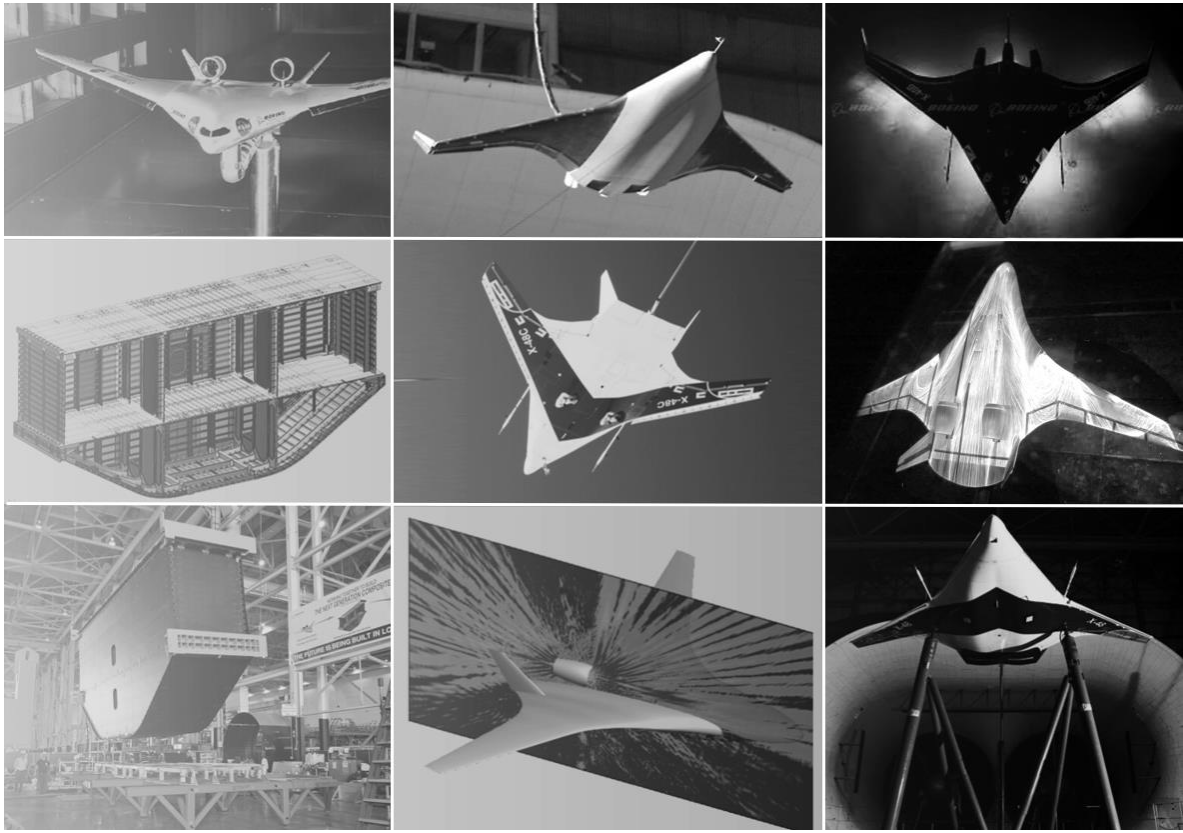
BWB TECHNOLOGY

25 Years of NASA Research

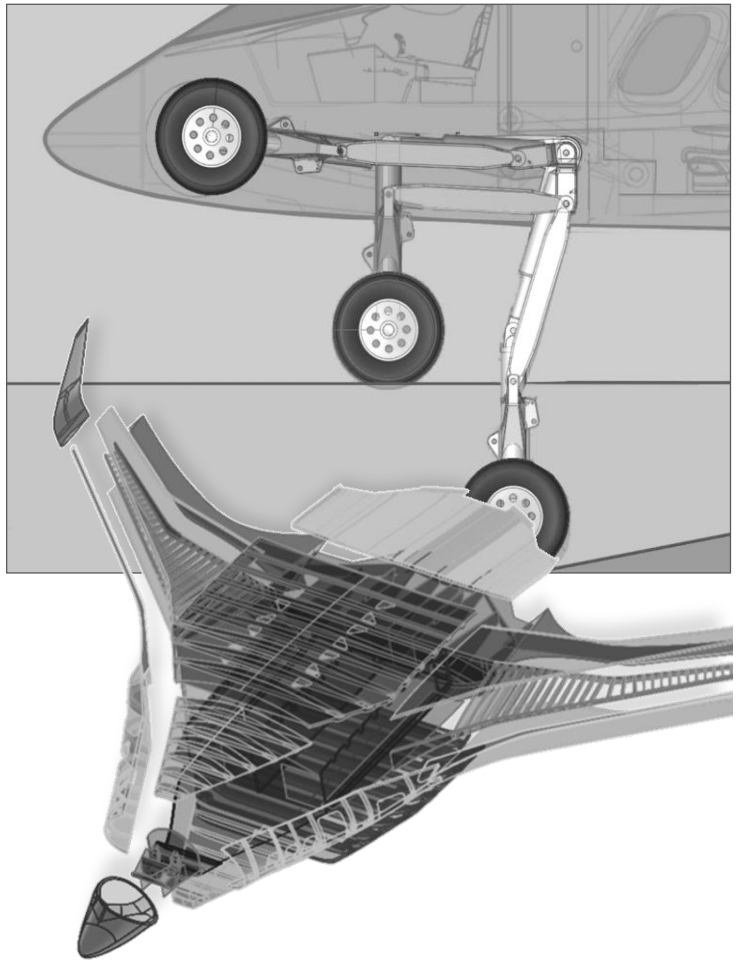
- Transonic Wind Tunnel Tests
- Low-Speed Wind Tunnel Tests
- Powered Wind Tunnel Tests
- Spin and Tumble Tests
- Fuselage Structure Tests
- Flight Tests
- Acoustic Tests
- **15-20% Efficiency Gain**
- **Achieved TRL 6/7**

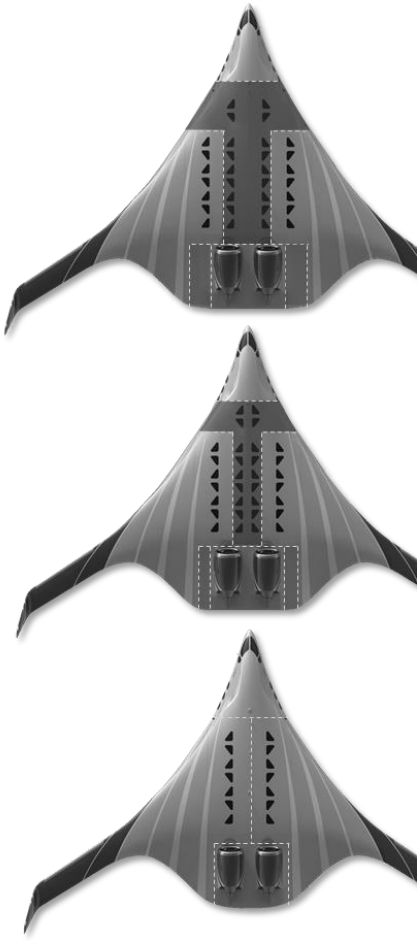


DZYNE BWB IP

Building since 2012

- Single-Deck Design
- Pivot-Piston Landing Gear
- T-Plug Family Growth
- Structural Optimization
- Aerodynamic CFD Optimization
- ANOPP Acoustic Analysis
- NASA/Boeing Tool Correlation
- **30% Efficiency Gain**
- *New IP = 50%>BWB gain …TRL 2/3*

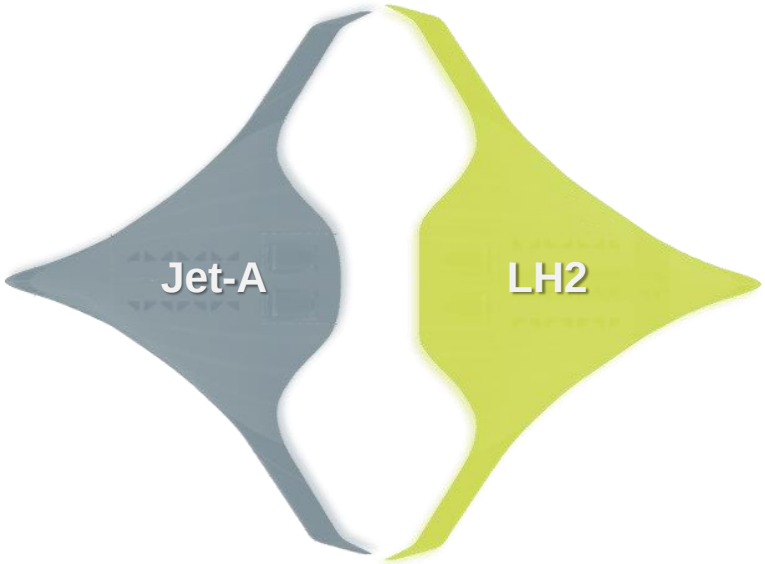




KEY ENABLER BWB Enables LH2 Adoption

BWB benefits for LH2 Adoption – Typical Transport

- LH2 Cryo-tanks — Located outside the cabin
- Span — Small Increase
- TOGW — 5% more
- TOFL — Slightly longer
- LFL — Slightly longer
- Cabin layout — No Change
- Loading — No change

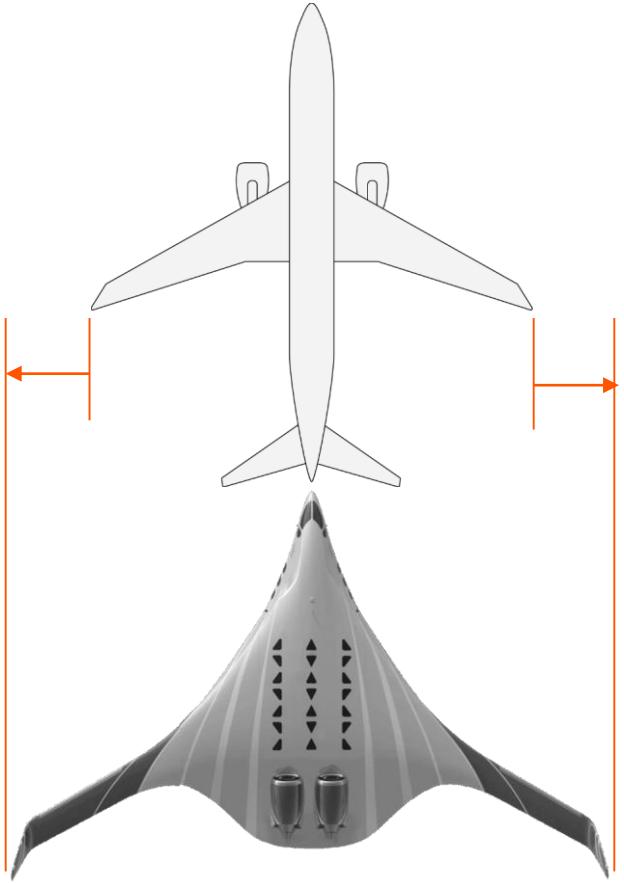


- Far more encouraging than current EASA projections for LH2 adoption

BWB TECHNOLOGY FOR EVERYONE

Significant benefit to all stakeholders

1. Save the Planet with 30% lower emissions
2. Serve the public with dramatically lower noise
3. Serve the Airlines with 30% less fuel-burn



Aerodynamic Efficiency = K*$\mathbf{Span}/\sqrt{\text{surface area}}$

“How do we make BWB a reality”

Technical Advisors

BOB LIEBECK

BLAINE RAWDON

BRYAN MOSS

PRES HENNE

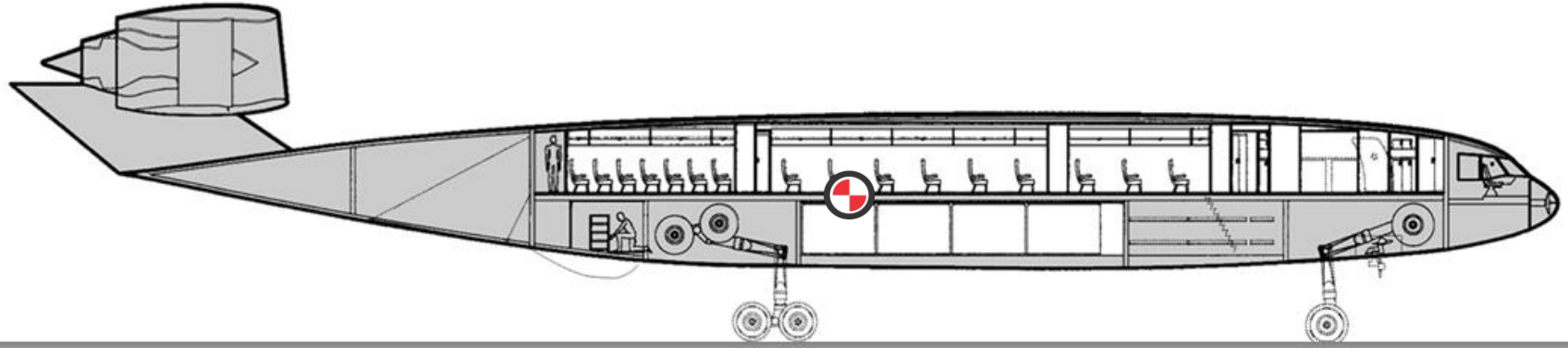
WARREN WILLITS

ILAN KROO

“Launch now – finish the research – and Go”

TAKEOFF ROTATION THE FLYING WING CHALLENGE

- Main-gear needs to be near the CG
- This allows rotation and de-rotation
- Solution – main-gear below the cabin
- Double-Deck works, but it makes a big BWB
- Double-Deck too big for “Single-Aisle” market
- Single-Deck needed for smaller BWB’s



PIVOT-PISTON ENABLES A SINGLE-DECK BWB

- Pivot-Piston main-gear is behind cabin
- "Virtual" rotation about the CG
- Nose and Mains hydraulically linked
- Passive hydraulics - no pumps
- Main-gear squat powers nose-gear extension
- Minimal elevon download to rotate the plane

SURPRISE BENEFITS

- Cargo beside cabin = better span-loading
- Reduced wing bending-loads
- Much less elevon needed for rotation
- Better max lift at rotation (C_{LVMU})
- 15kt better liftoff = 2,000ft less ground-roll
- Nosewheel brakes = 30% less stopping distance

PIVOT-PISTON SCALE DEMONSTRATOR

DEMONSTRATION OBJECTIVES

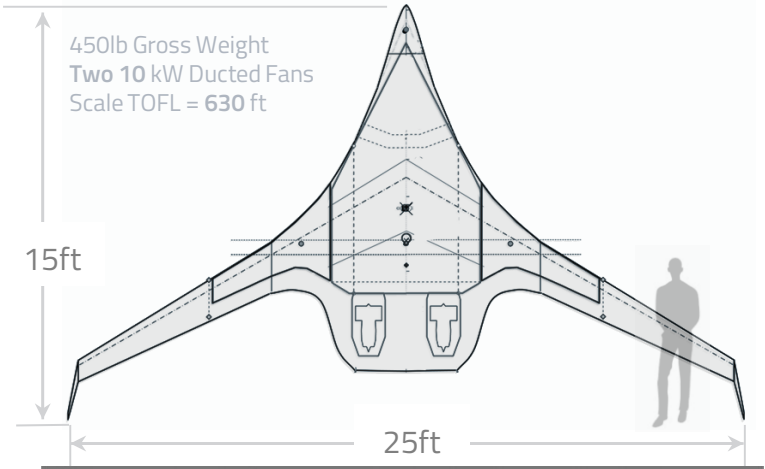
- Pivot-Piston functionality
- Off-design & failure cases
- Performance relative to conventional gear

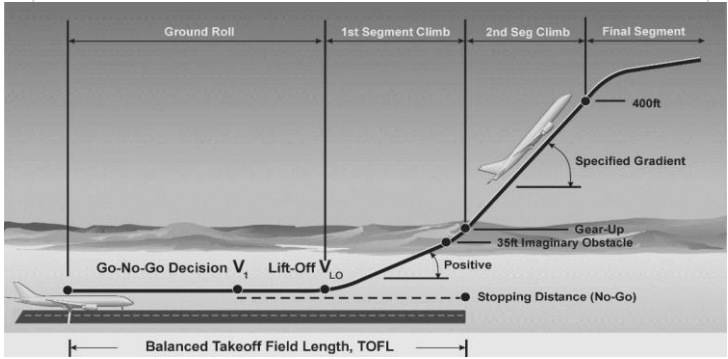
TEST ARTICLE

- 14% dynamically-scaled flight test model
- Fully articulated Pivot-Piston landing gear

TEST OUTLINE

- Takeoff rotation, lift-off, retraction
- Landing, extension, touchdown, de-rotation
- FAR25 takeoff performance
- Extreme conditions & failures





PIVOT-PISTON FULL-SIZE GEAR DEMO

VALIDATION OBJECTIVES

- Critical FAR25 load conditions
- Shimmy-free
- Fail-safe

TEST ARTICLE

- Full-Scale gear assemblies
- Individual gear test fixtures
- 3 gear armature for combined testing

TEST OUTLINE

- Isolated gear static load, & shimmy
- Total armature rotation & drop testing
- Failure-mode testing

TEST FACILITY

- Example: Goodrich Super Rig, Oakville, Ontario

A380 gear testing at Oakville Super Rig

A NEW GENERATION OF FLIGHT

GEN I - PROPELLER

- Propeller powered
- Low speed, low altitude
- Dirty, very loud, inefficient

GEN II - JET AGE

- Jet powered
- High speed, high altitude
- Dirty, loud, inefficient

GEN III - SUSTAINABLE

- Clean Propulsion
- High speed, high altitude
- Clean, quiet, efficient

“We need your help”

mark@bwai.co

Thank you!