

A white high-wing aircraft is shown in flight, banking to the left. The aircraft has a distinctive shape with a high wing and a long tail boom. The background is a vast, green landscape with patches of brown and blue, suggesting a rural or agricultural area. The sky is clear and blue.

# **COZY AIRCRAFT FORUM**

**Soup to Nuts?**

**Marc J. Zeitlin**

**July 31<sup>st</sup>, 2009**

**1:00 PM – 1:45 PM**

**Forum Tent 02 – GAMA Pavilion**

# What Will I Talk About?



- ***Introduction – 15 min.***
  - *Who Am I?*
  - *What's a COZY MKIV?*
  - *Why a COZY MKIV*
  - *COZY Plans*
  - *COZY Cost*
  - *COZY Support*
  - *COZY Parts Vendors*
  - *How Many COZY's Under Construction / Flying?*

- ***Further Topics – 30 min:***
  - *COZY Aircraft Structures*
  - *Flight Testing Methods*
  - *COZY Engine choices*
  - *Fuel Compatibility*
  - *Strake Mod. Aerodynamics*
  - *Common Modifications*
  - *Performance Mods*
  - *COZY Safety Record*
  - *Safety Mods/Issues – Aging of Fleet*
- ***Futures / State of Design***
- ***Questions and Answers***

# Who The Heck Am I?



- Biography / Resume'
  - <http://www.mdzeitlin.com/Marc/bio.html>
- Built Quickie Q2
- Built COZY MKIV #386, N83MZ – ~640 flying hours
- Started / Administer Unofficial COZY Builders Web Page and COZY Mailing List (~610 members)
- Work for Scaled Composites as Mechanical Engineer/Manager – Currently Lead Project Engineer for SS2 Rocket Motor Development

# What's a COZY MKIV?



- History
  - Designed by Nat Puffer
  - Derivative of Burt Rutan's Long-EZ
  - Evolved from 3-place to current 4-place in early 1990's
- Type
  - Canard – big wing in back, small wing in front
  - 4 place, or 2+2, or 2 + LOTS of baggage
  - Efficient, fast, long distance cruiser
- Aerodynamics – Nat's 2005 Oshkosh Forum
  - [http://www.cozybuilders.org/Oshkosh\\_Presentations/Nats\\_OSH2005\\_Presentation.pdf](http://www.cozybuilders.org/Oshkosh_Presentations/Nats_OSH2005_Presentation.pdf)

# Why a COZY MKIV?



- Want to **BUILD**
- Use-Model comparison
- Economics
- Carrying Capacity
- Safety Features
- Composites



# COZY Plans Availability



- Cozyaircraft Corp.  
now owned by ACS



- Plans available  
through ACS

<http://www.aircraftspruce.com>

Vendor Display Building at OSH

# COZY MKIV Cost



- Low End - \$35K to \$50K
  - High Time Engine (maybe Auto Conversion)
  - Good Scrounging
  - Minimum Instruments - VFR Only
- Mid-Range - \$50K to \$75K
  - Some Prefab (not much)
  - Rebuilt Engine
  - High end VFR - Low End IFR Panel
- High End - \$75K to \$120K
  - Lots of Prefab components / paid help
  - New Lycoming
  - Complete Latest IFR Stack Panel
- Plans – NOT A KIT!!!

# COZY Support Methods



## No Official Support from ACS, But:

- COZY Newsletter archives
  - <http://www.cozybuilders.org/newsletters/>
- COZY Mailing List
  - [http://www.cozybuilders.org/mail\\_list/](http://www.cozybuilders.org/mail_list/)
- Unofficial COZY Builders Web Page
  - <http://www.cozybuilders.org/>
- Builder's Web Pages (links from **UCBWP**)
- Canard Aviator's Mailing List
  - <http://groups.yahoo.com/group/canard-aviators/>
- CSA Newsletter
  - [http://www.cozybuilders.org/ref\\_info/other\\_news.html](http://www.cozybuilders.org/ref_info/other_news.html)
- Freeflight Composites (Burrall Sanders)
  - <http://www.freeflightcomposites.com/services.htm>

If you're a current or prospective COZY builder or flyer and believe that official support from a sanctioned ACS/Nat Puffer avenue would help convince you to build this plane:

**Let Jim Irwin  
at ACS know!**

# COZY Parts Availability



- ACS, Wicks, etc.
- Two main vendors provide metal parts:
  - CG Products
    - <http://www.cozygirrrl.com/aircraftparts.htm>
  - EZ Noselift
    - <http://www.eznoselift.com/>
- Other part vendors for miscellaneous items – see:
  - <http://www.cozybuilders.org/newsletters/suppliers.html>
  - [http://www.cozybuilders.org/newsletters/na\\_suppliers.html](http://www.cozybuilders.org/newsletters/na_suppliers.html)

# How Many COZY's?



- ~ 2000 Rutan Derivative Canard Aircraft flying (VariViggen , V.E., L.E., Defiant, Berkut, E-Racer, SQ2000, Velocity, COZY III, COZY MKIV)
- ~ 220 - 300 flying COZY's all over the globe
- ~1600 COZY MKIV plans sold
- ~ 600-800 actually under construction
- 5-10 new COZY MKIV first flights per year

# COZY Aircraft Structures



- Lack of structural failures in type is **NOT** a license to make structural mods, **HOPING** that the (**UNKNOWN**) safety factor will save your butt!
  - Only known testing **to failure** are on L.E./V.E. canard – one failed at 14G, another at 6 – 7G's – shows variability in MFG and structural capabilities
  - At least one L.E. wing test done – no details known
  - **NO COZY** structural testing has **ever** been done!!! Do you know the safety margins? I don't!
  - Modifications to composite structures are far more complex and difficult to analyze than with metal structures
- Wing/Canard:
  - Spars: Carry bending loads in wings
  - Shear Webs: Carry shear loads in wings – transfer loads from top to bottom
  - Skins: Carry twisting loads in wings
- Fuselage:
  - Bulkheads: Stiffen fuselage in bending (sideways) and twisting
  - Sides: Stiffen fuselage in bending and twisting
  - Longerons: Help stiffen – mostly act as mounting “hardpoints”
  - Reinforcements: On LG Bulkheads/Firewall/Seatbelt Attach/Canard Attach  
- Thicken, hardpoints, transfer loads between major structures

# Flight Testing Methods



- **Purpose of Phase I Flight Testing:**
  - Determine **ALL** performance characteristics of airplane at **ALL** corners of the performance envelope
    - Calibrate Pitot Static System – CAS vs. IAS (MUST understand difference between CAS/IAS/TAS/GS)
    - Rotation speeds
    - Climb performance
    - Cruise performance
    - Descent performance
      - gear retracted, extended
      - LB retracted, extended
    - Landing speeds
    - Stalls
    - accelerated stall (more than 1G – performed in 15, 30, 45, 60 degree banked turns)
    - Deep stall susceptibility
    - Pitch stability
    - Lateral Stability (spiral, Dutch Roll, Roll/yaw coupling)
    - Flutter (stick raps)
- **Performance Envelope Includes:**
  - Forward, Mid, Aft CG
  - MGW, Middle Weights, Light Weights
  - Full, Mid, Low Fuel
  - Speeds from Vs to Vne+10%
  - Altitudes from GL to Service Ceiling (or max desired altitude)
  - ANY AND ALL maneuvers that may be attempted in Phase II
- **Flight Test Guidelines:**
  - See **AC90-89A – EXCELLENT** guide
  - Use a Test Pilot if not completely capable and current
  - Should take 30-35 hours **AT LEAST** to perform all required tests – if you're done after 15 hours, you haven't done enough
  - Flying around in circles for 40 hours at one CG is **NOT** flight testing, no matter how many people **SEEM** to get away with it
- **CG Determination:**
  - Need **ACCURATE** empty CG – implies accurate weighing
  - Bathroom scales are **NOT** accurate enough
  - Can weight with ballast / passengers / pilot for more accurate station information
  - Use accurate spreadsheet / calculations to determine flight CG
  - Use weights (lead, steel, sandbag, water container) at appropriate station to set CG for testing
- **Procedures:**
  - Start testing in **CENTER** of CG range
  - Slowly add weight and move forward and aft within CG range
  - Start with mild maneuvers
  - Start with short flights
  - Runway flights OK if have **LONG** runway
  - Gear stays down on first few flights

# COZY Engine Choices



## FLYING:

- Lycoming O-360 / O-320 – many variants
  - Hundreds flying successfully
- Lycoming O-540 (only marginally “alternative”)
  - Three flying successfully (Jannie Versfeld / Chris Esseltstyn / Scott Carter)
- Jabiru 5100
  - One flying successfully
- Subaru -
  - Two flying (different variants) semi-successfully
- Twin Suzuki -
  - One flying successfully in Venezuela
- Rotary (Mazda 13B variants) -
  - Two “flying” – very little flight time, numerous engine related incidents (John Slade / Steve Brooks)
  - Two others removed for Lycomings after minimal flight time (Joe Hull / Bulent Aliev)
- V8 variants -
  - One flying in South Africa (few hours due to accident – not engine related)
  - One removed long ago and replaced with Lycoming
- Turbo-prop (Allison) -
  - One flew – crashed during Phase I in 2008 (cause unknown)
- Jet Turbine -
  - One flying successfully (Greg Richter)

## IN DEVELOPMENT:

- One Continental IO-360
- Numerous Mazda 13B and 20B variants
- Different Subaru (H3.0 turbo)

## POSSIBILITIES:

- New Lycoming Variants (not major stretch)
- Deltahawk Diesel (expensive & not available)
- Mistral Rotary (VERY EXPENSIVE)

## AUTO CONVERSION ISSUES:

- Difficult development – every one different than all others
- Hard to compete with simplicity of air cooled Lycoming, for all its faults
- Potential? **YES**. Actuality? **NOT YET**. Needs a **LOT** more development work

# Fuel Compatibility



## Aircraft Gasolines:

- 100 LL
  - Thousands of examples flying
- 100LL Successor – probably 94 octane no-lead
  - In development – same as 100LL but no lead
  - 80% of aircraft engines can use – only very high compression engines cannot

## Mogas:

- Alcohol Free
- Alcohol
- All have unknown additives

## Diesel:

- One EZ flying
- Bio-Diesel
- Jet-A

## Swift Fuel, etc. (synthetic)

- In development – not available

## Epoxy Tank Sealants:

- EZPoxy with slow hardener (EZ87) is best
- Other EZPoxy's next
- MGS, etc. – seem to work with 100LL – no degradation seen

## Other Tank Sealants:

- Pro-Seal polysulfide – best (890 Type A or equivalent)
  - Used in industry
  - Meets MIL Spec requirements
- Jeffco (epoxy – not polysulfide)
  - One Velocity had major peeling problems – unknown cause



# Strake & Strake Modification Aerodynamics



- **Basic Strake Aerodynamics:**
  - Common misconception that strakes do not produce lift – **NOT** just a fuel/storage tank
  - Flat top/bottom or not, strakes **DO** produce lift
  - **EVERYTHING** produces lift if at AOA to relative airstream – hold your hand out a car window, or watch a mattress on top of a car
  - Not most efficient lifting surface, but it **IS** a wing
  - Different shape/incidence angle than rest of wings, so will not follow wing's lift curve slope – has it's own
    - strakes will produce substantial lift at low airspeeds/high AOA's
    - little at high speeds/low AOA's (due to lack of camber / different incidence angle)
- **What is the Modification?**
  - Kick out straight LE of COZY strake
  - Shape like Long-EZ strake
- **Why Do It?**
  - Elbow/storage room for front seaters
  - Not enough work in the standard build
- **What's the Effect (Aerodynamically)?**
  - Small (area-wise)
  - Close to Fuselage (not very efficient lifting area anyway)
  - Very swept – low lift curve slope
  - Basically, Nothing Measurable



# Common Modifications



- **Major:**

- Remove Lower Winglets (mandatory to have on COZY!)
- Raised Canopy (1” – 2”) (approved)
- Widened (Aerocanard “style”) Canopy
- Forward Opening Canopy, a-la Cosy Classic
- Long-Eze type (“Cozygirrrl”) strake L.E. (mandatory to cut 6” from original – possible safety issue with rear CG, & rotation, but numerous flying)
- Original Length Canard (not recommended, but there are a few flying)
- Retractable Main Gear

- **Minor:**

- Electric Nose Gear (approved)
- Electric Landing Brake (approved)
- Move Landing Lights
- Hanging Rudder Pedals (Velocity Style)
- Eliminate Fuselage Access Door
- Etc., etc., etc.

# Performance Modifications



- Wheel Pants (size / design) - 8 to 12 kts
- Gear Leg Fairings - 3 to 5 kts
- Retractable Landing Gear - 0 to 20 kts
- Cowling/Cooling (airflow / boat-tail / exhaust) - 0 to 15 kts  
**potential**
- Nose Wheel Door - ?? (small)
- Winglet Intersection Fairings - 1 to 4 kts (est.)
- Spinner - 0 to 1 kts
  
- Appropriate VG's (per Mark Beduhn's installation):
  - Decrease landing speed - 7 to 10 kts
  - Decrease top end speed - 1 to 3 kts

# COZY Safety Record



- NO accidents caused by structural/aerodynamic failure of properly built and flown COZY aircraft – in fact, of **ANY RUTAN/DERIVATIVE CANARD**
- Since 1989, 23 total accidents - 16 reported accidents in USA, 1 in Canada, 1 in Mexico, 3 in France, 2 in South Africa

• 8 Fatal Accidents		• 15 Non-Fatal Accidents	
– <b>Phase I</b>		– 4 engine failure / fuel system failure	5/7/1996 - N86LM
• COZY MKIV - poor approach and hard landing	9/21/1994 - N151JE	2/11/1997 - N34PC	
• COZY MKIV (turbine) - 1 Unknown cause – crash into water	5/4/2008 - N14GG	5/30/2003 - N94WD	
– <b>Phase II</b>		11/5/2008 - N637PS	
• COZY MKIV - low approach snagging wires	1/1/1995 - N5037	– 3 poor approach / landing	1/22/2003 - N96PJ
• COZY III - severe wind shear - Mexico	1/18/2002 - N41CZ	1/26/2003 - N320FR	
• AeroCanard - takeoff problem / possible prop fouling from open canopy	12/12/2007 - N199JW	11/15/2008 - N149CZ	
• COZY MKIV – Pilot error at low altitude	7/24/2008 - N500K	– 2 fuel exhaustion	12/2/2003 - N238CZ
• COZY III – suspected prop fouling / open canopy in France	2001 - builder: Soria	2/25/1989 - N611CZ	
• COZY Classic <improper build / CG problems?> in France	2004 - F-PSCF	– 1 GU canard contamination / CG related	6/23/1995 - N84CZ
		– 1 CG related deep stall	10/4/1996 - N96PJ
		– 1 rudder flutter (improper build) in France (2004)	
		– 1 overtightened bolts and/or wheel pant tangled in wheel in South Africa	
		– 1 poor takeoff / no rotation in South Africa	
		– 1 Winglet problem in Canada?	

Accident **RATE** – Assume 110 flying (avg.), 50 hrs/yr (avg.), 18 years – 99K hrs total

- **8.0/100K** hrs **fatal** (**6.0/100K** w/o Phase I)      – GA is **1.26/100K** hrs
- **22/100K** hrs total      – GA is **6.32/100K** hrs

# Safety Modifications/Issues



- **Flying/Landing Techniques / Judgment:**
  - Single largest factor – almost ½ of all COZY accidents
  - Under our control – must actively manage and learn
  - Giving presentation on “Judgment” at COZY dinner tonight
- **Actual Issues:**
  - Nose Strut safety bolt – broken struts
  - Safety wire/hose clamp exhausts – broken exhaust through prop
  - Composite props (Catto/Hertzler) – MUCH more resistant to FOD
  - Forward Hinge Canopy – have lost canards due to canopy opening upon takeoff – FLY THE PLANE (does prevent bailing out, but who flies with a parachute?)
  - Brake sizing / system components – have been fires, lost brake effectivity
  - Nose gear rigging (shimmy reduction)
- **Potential Issues:**
  - Roll bar – have been rollovers, but no injuries
  - Control System play – torque tube mounts / bolted joints
  - Other?

# Futures / State of Design



- **Future of COZY:**
  - Very active community: plans sales still ~30-50/year
  - New completions all the time
  - Slow evolution of derivatives beginning
    - Chris Esselstyn's stretched retract
    - Other O-540 variants
    - Wider fuselages, etc.
  
- **State of Design Questions:**
  - Extremely well developed design/plans – however...
  - Official Builder Support?
    - Nothing now
    - If you believe so, tell ACS a paid position is needed and should be supported from plans/parts sales
  - Official Designer (qualifications)?
  - Who Approves Vendors/Parts?
  - Who Approves Modifications/Design Changes/Fixes?
  - How is Design Advancing?
    - Fits and starts
    - Randomly
    - Little good testing of mods, per Nat's example
    - Lots of non-engineered mods occurring – worrisome to me

# Questions? (& Answers)



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- Website: <http://www.cozybuilders.org/>