

Blended Winglets on an E-Racer Canard Aircraft

Performance Increase?

Marc J. Zeitlin / Jack Morrison

July 26th, 2007

2:30 PM – 3:45 PM

Forum Tent 06 – Sporty's Pavilion

What Will I Talk About?



- *Introduction*
- *Who Am I?*
- *Who's Plane Is It?*
- *Consulting Process*
- *Aerodynamics of Canard Aircraft Winglets*
- *Modification Process*
- *Aircraft Configuration* – *Before / After*
- *Aircraft Testing*
- *Aircraft Performance* – *Before / After*
- *Performance Graphs*
- *Other Performance Differences?*
- *Extension to Other Canard Aircraft?*
- *Questions and Answers*

Who The Heck Am I?



- Biography / Resume'
 - <http://www.mdzeitlin.com/Marc/bio.html>
- Loved planes since 3 years old - Built zillions of model aircraft
- Thesis - “Design, Construction and Testing of an Electromagnetically Launched Model Glider”
- Built Quickie Q2
- Built COZY MKIV #386, N83MZ – ~500 flying hours
- Started / Administer Unofficial COZY Builders Web Page and COZY Mailing List
- Work for Scaled Composites as Mechanical Engineer – in charge of transitioning SS2/WK2 from prototype to production by “The Spaceship Company”
- Do Homebuilder Aircraft consulting **for folks I like** on the side ☺

Who's Plane Is It?



- Jack Morrison's E-Racer
- Built 1996
- Lindy Award winner – OSH 2000
- Over 300 hours on airframe



Who's Plane Is It?



July 19, 2007

Canard Forum Slide Show

Slide #5

Consulting Process



- Jack approached me for engineering assistance with winglet modification – he had a couple of ideas
- Wanted blended winglet like 737-800 – thought would provide drag reduction
- Discussed two approaches for mods – settled on one
- Determined modification process
 - removal of old winglets
 - wing preparation
 - fabrication of new winglets
 - attachment of new winglets
 - Ensure adequate strength/stiffness
- Discussed appropriate flight testing after modifications



Aerodynamics of Canard Aircraft Winglets



- Nominally Whitcomb winglets, BUT...
- **Not** used for L/D improvement (efficiency) as on commercial airliners and gliders
- Merely convenient place for vertical stabs/rudders
- Lower winglet on LE/COZY has aerodynamic purpose, but not pertinent to this issue
- Intersection not optimal – lots of separation drag
- E-Racer intersection **especially** non-optimal drag-wise (looks good, though) – more room for improvement with E-Racer

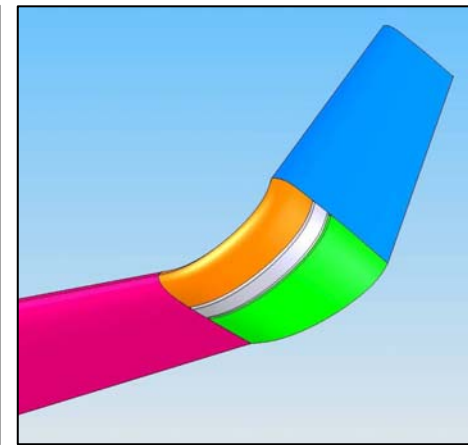
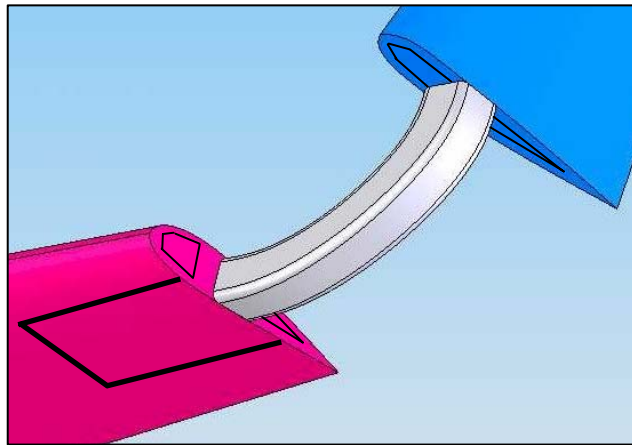
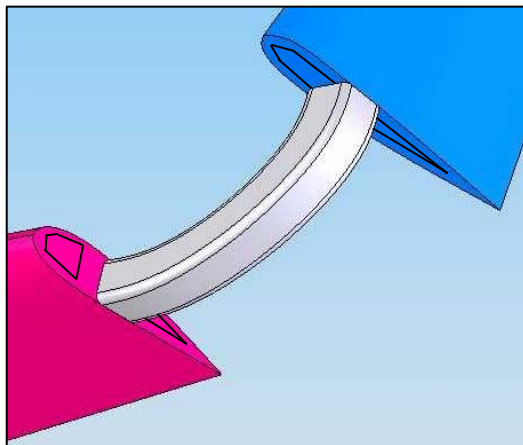
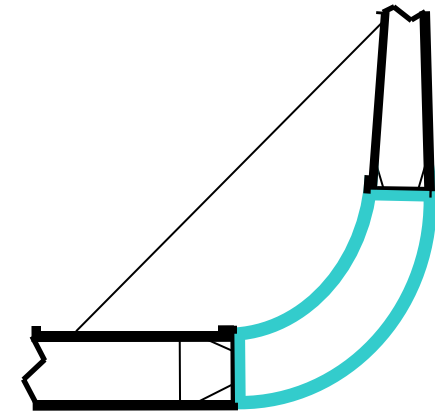
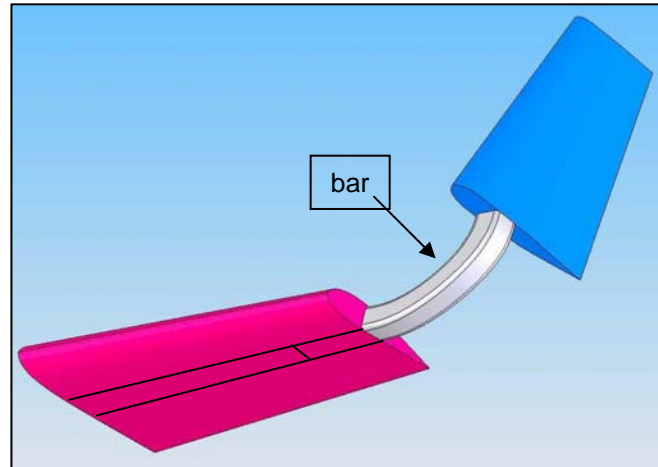
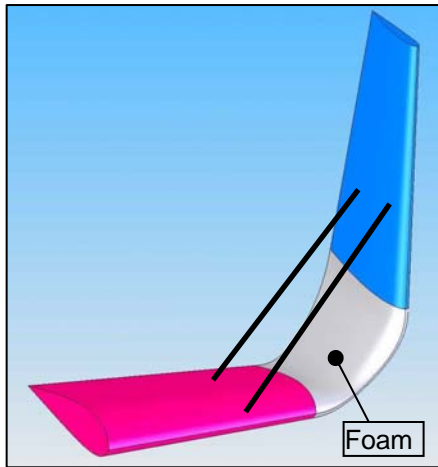


E-Racer

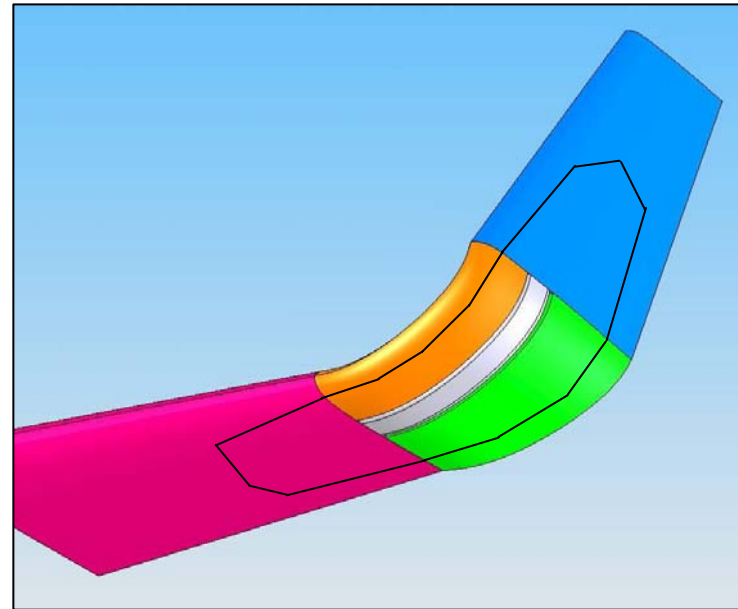
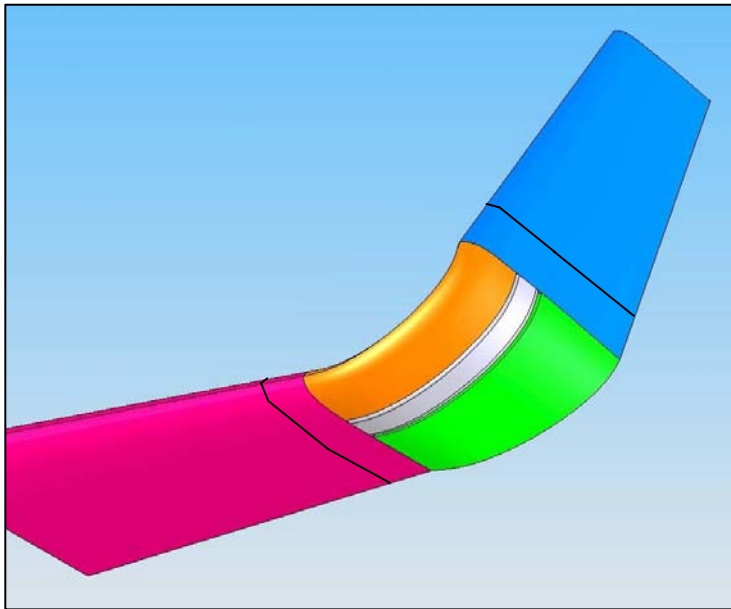


Long-EZ / COZY

Modification Process - #1



Modification Process - #2



Aircraft Configuration - Before



- Standard E-Racer Airframe
- First flew 1996 with Chevy 4.9L V6 Supercharged engine
- Changed to IO-540 - Supercharged with Auto Ignition system
- Retractable gear per E-Racer plans
- Stock E-Racer winglets



Aircraft Configuration - After



- New Paint
- New Winglets
- That's it
- Easy to compare – only one major aerodynamic change



Aircraft Testing



- Tuft Testing – notice attached flow in intersection region – tufts flowing straight back
- Speed / Performance Testing
- Stall Testing



Aircraft Performance



Original Winglets				
RPM	MP	Pre-Blend IAS	Pre-Blend TAS	Normalized Power (%)
2310	29.4	175	179	68
2400	31.0	180	188	74
2400	31.6	180	186	76
2400	31.8	183	188	76
2400	32.5	184	189	78
2410	32.6	181	183	78
2400	32.8	178	183	79
2400	32.8	180	188	79
2400	33.0	182	189	79
2440	32.5	185	191	79
2400	34.4	180	186	82
2420	34.2	180	188	83
2400	34.6	180	188	83
2500	35.4	189	196	88
2500	36.2	190	195	90
2500	36.8	188	191	92
2520	36.6	181	190	92

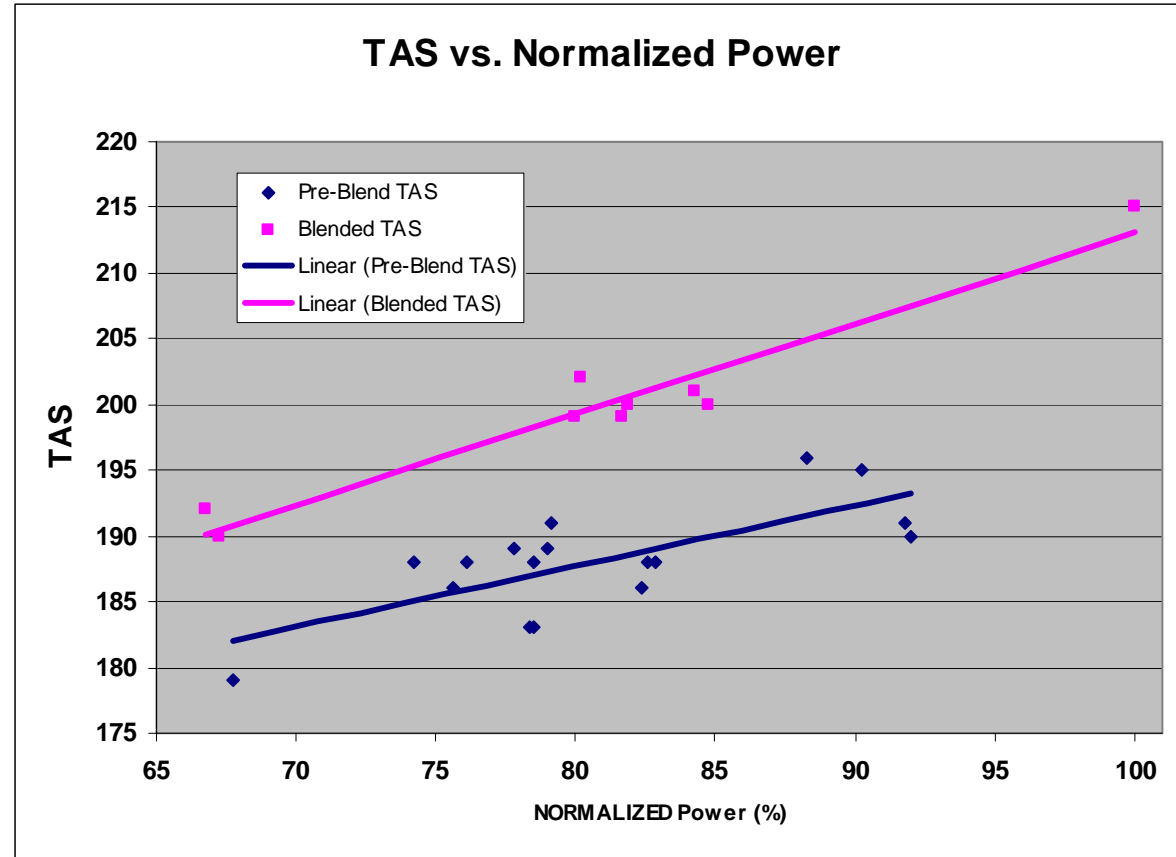
Blended Winglets				
RPM	MP	Blended IAS	Blended TAS	Normalized Power (%)
2300	29.1	189	192	67
2300	29.3	183	190	67
2400	33.4	189	199	80
2400	33.5	190	202	80
2400	34.1	192	199	82
2400	34.2	190	200	82
2400	35.2	192	201	84
2400	35.4	191	200	85
2500	40.1	208	215	100

- Speed vs. Power data @ NORMALIZED power settings (NOT % power available!!!)
- Highest power USED in testing set to 100%, just for comparison purposes

Performance Graphs



- Blended winglets on E-Racer provide ~10 kt. TAS increase at equivalent power settings
- ~ Equivalent to wheel pants on L.E. / COZY
- Greater than gear leg fairings on L.E. / COZY
- Linear Curve fit NOT accurate, just allows for simple comparison – need more data points for polynomial fit



Other Performance Diffs.



- None
- No major flight characteristic changes
- No pitch, roll, yaw issues
- No stall differences

Extension to Other Canard Aircraft?



- **LE/VE** – maybe
 - Standard aircraft probably not fast enough to see much advantage
 - Better winglet intersection than E-Racer to start with leaves less room for improvement
 - CG issues possibly not AS sensitive to lower winglet disappearing
 - Might be more work than it's worth, but could gain a few 2 to 4 kts.
- **Berkut** – most likely candidate
 - Fast enough to get advantage
 - Better winglet intersection than E-Racer to start with leaves less room for improvement but ...
 - CG issues possibly not AS sensitive to lower winglet disappearing
 - Could be worth a try – might gain 5 to 10 kts.
- **COZY III/MKIV (and other 3/4-seat canards) – NOT RECOMMENDED**
 - Need a great deal of experimentation on CG issues / lower winglet loss compatibility
 - Standard aircraft probably not fast enough to see much advantage
 - Better winglet intersection than E-Racer to start with leaves less room for improvement
 - Probably 2 to 4 kts. max. gain
 - Concomitant deep stall issues at the slow end due to lower winglet disappearance

Questions? (& Answers)



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