Tohoku University

Windnauts

Ryo Hirai, Noritada Ogura, Ryosuke Akaishi
What is Windnauts?

✈ We make the human powered aircraft for participating in the Birdman rally at Biwa lake.
✈ We compete distance from taking off to landing on the water surface.
✈ In 2016, 53 members belonged to our team.

<table>
<thead>
<tr>
<th>Official name</th>
<th>Human-powered flight club</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team name</td>
<td>Windnauts</td>
</tr>
<tr>
<td>Starts</td>
<td>1993</td>
</tr>
<tr>
<td>Project costs for 2016</td>
<td>¥3,500,000</td>
</tr>
</tbody>
</table>
Past Performance of The Team

<table>
<thead>
<tr>
<th>year</th>
<th>event</th>
<th>Aircraft name</th>
<th>Record</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>30th rally</td>
<td>島 <del>echo</del></td>
<td>28,628m</td>
<td>1st /18 team</td>
</tr>
<tr>
<td>2008</td>
<td>32th rally</td>
<td>來(rai)</td>
<td>36,000m</td>
<td>1st /13 team (Tourney record)</td>
</tr>
<tr>
<td>2009</td>
<td>Record Flight</td>
<td>Rera</td>
<td>20,720m</td>
<td>FAI official record</td>
</tr>
<tr>
<td>2011</td>
<td>34th rally</td>
<td>Riih</td>
<td>18,687m</td>
<td>1st /11 team</td>
</tr>
<tr>
<td>2012</td>
<td>35th rally</td>
<td>翠(sui)</td>
<td>14,129m</td>
<td>1st /11 team</td>
</tr>
<tr>
<td>2015</td>
<td>38th rally</td>
<td>鴻(kou)</td>
<td>35,367m</td>
<td>1st /11 team</td>
</tr>
</tbody>
</table>

✈ We have...

• 5 times victory at Birdman rally.
• Tourney record, 36,000m, at Birdman rally.
• 5th victory in last year.
Our target for this year was...

“Back-to-Back Victory”

✈️ But, we had some problems to be solved...
→ We had to flew at high-noon as handicap.
  ▪ High temperature. (Around 33°C)
  ▪ Strong and wild wind. (3~4 m/s)
The Process to Competition

- Design
- Making
- Load Test
- Test Flight
- Competition
Design Concept

Theme

✈ How to win the Birdman rally in bad condition.

✈ To overcome “High Temperature” ...
  Highly efficient air inlet. (NACA ducts)

✈ To overcome “Strong and Wild Wind” ...
  Good steering. (short wing span, high rigidity of tail wing)

This year’s design concept of aircraft

“All Power and Good Steering”
東北大学Windnauts 2016
第39回鳥人間コンテスト選手権大会
怖めず臆せず
万難を排してただ凜然とあれ

凛
The Process to Competition

- Design
- Making
- Load Test
- Test Flight
- Competition
Making Scenery

Wing

Frame

Fairng
Making Scenery

Propeller

Drive
Making Scenery

Steering

Speed • Cadence meter
The Process to Competition

Design → Making → Load Test → Test Flight → Competition
Load Test

✈ To check strength of wing beam...
   Take a load $1 \frac{1}{2}$ times as much weight as steady flight.
The Process to Competition

Design
Making
Load Test
Test Flight
Competition
Test Flight

✈ The purpose of Test Flight is...
  • Training of the Pilot and the members.
  • Check-up of assembly correctness.
  • Training of airplane handling.
‘16.7.11 Test Flight at Kakuda
Advanced Skill of Operating Aircraft

This year, we did Test Flights ahead of schedule.
We trained proper combination of tail wing movement and speed of the aircraft.

The Attack Angle is high

The technique helped us to adjust to strong wind.
Training of Speed Control

Low speed flight
Training of Speed Control

High speed flight
The Process to Competition

Design → Making → Load Test → Test Flight → Competition
Take off
Steady Flight
So Strong Head Wind
Landing on The Water
Result of The Competition

✈ Date: July. 31, 2016
✈ Rank: 2nd
✈ Flight distance: 19,669 [m]
✈ Flight time: 70[min]

<table>
<thead>
<tr>
<th>Rank</th>
<th>Team</th>
<th>Record[m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Nihon University</td>
<td>21,415.53</td>
</tr>
<tr>
<td>2nd</td>
<td>Tohoku University</td>
<td>19,669.59</td>
</tr>
<tr>
<td>3rd</td>
<td>Birdman House Iga</td>
<td>17,854.09</td>
</tr>
</tbody>
</table>

Flying route (Red line is the estimate)
Summary and Next Year

✈ We won the second prize in the competition.
✈ Next year, we will design a higher speed aircraft to overcome strong wind.
✈ We consider using Ice Best.
Thank you for your attention
Additional Slides
## Specifications

### Main Wing

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span</td>
<td>31.6 [m]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>36.42</td>
</tr>
<tr>
<td>Wing Type</td>
<td>DAE-21 - DAE31</td>
</tr>
<tr>
<td>Wing Area</td>
<td>27.42 [m²]</td>
</tr>
<tr>
<td>Average Wing Chord</td>
<td>0.90 [m]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>36.42</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>36.9 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>36.9 - 38.5 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>38.5 - 42.5 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>3.17 [kg/m²]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>4.1 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>4.1 - 3.0 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>3.0 - 1.8 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>4.0 [°]</td>
</tr>
</tbody>
</table>

### Horizontal Stabilizer

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing Type</td>
<td>NACA-0009</td>
</tr>
<tr>
<td>Span</td>
<td>3.32 [m]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>0.415</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>±5 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>5.71</td>
</tr>
</tbody>
</table>

### Vertical Stabilizer

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing Type</td>
<td>NACA-0009</td>
</tr>
<tr>
<td>Span</td>
<td>2.80 [m]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>0.137</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>±10 [°]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>4.03</td>
</tr>
</tbody>
</table>

### Propeller

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>1.56 [m]</td>
</tr>
<tr>
<td>RPM</td>
<td>133 [rpm]</td>
</tr>
<tr>
<td>Thrust</td>
<td>22.2 [N]</td>
</tr>
</tbody>
</table>
Flow of tuning at Test Flight

1. Practice of the departure and taking off
2. Tuning the center of gravity by observing the appearance of steady flight
3. Control of the posture of aircraft by steering horizontal and vertical tails
Appearance of each section

Jig installation
Jig made by ABS resin or balsa

All parts are filed by the hand of workers
Appearance of each section

Carbon cloth impregnated with epoxy

And rapping.

Fillet increase workability
Appearance of each section

Wing

Trailing edge are equal

Intersection plank and fix
Columnar beam made by CFRP

Making columnar beam made by CFRP is most important work of all. So, we set to work it every member. We spend all weekend on making them.

Designing beam efficiency.
Arranging each lamination parts on prepreg

Drawing line using pencils and ruler.
Cutting follow the line using scissors.
Columnar beam made by CFRP

Lamination
Ply1 90°
Ply2 0°
Ply3 45°
Ply4 -45°
Ply5~ base on each design

Cloth is overlaid with prepreg. Cloth absorbs futile epoxy, and beam become light. Surface became rough, and workability are increase.