Delfly

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Intro Control & Simulation

Delft University of Technology

- Faculty of Aerospace Engineering
  - Division of Control & Simulation

- Simona research simulator
- Man-Machine lab
- Cessna Citation
- Aerospace Software & Technologies Institute
  - MAV-lab (Delfly & other UAVs/MAVs)

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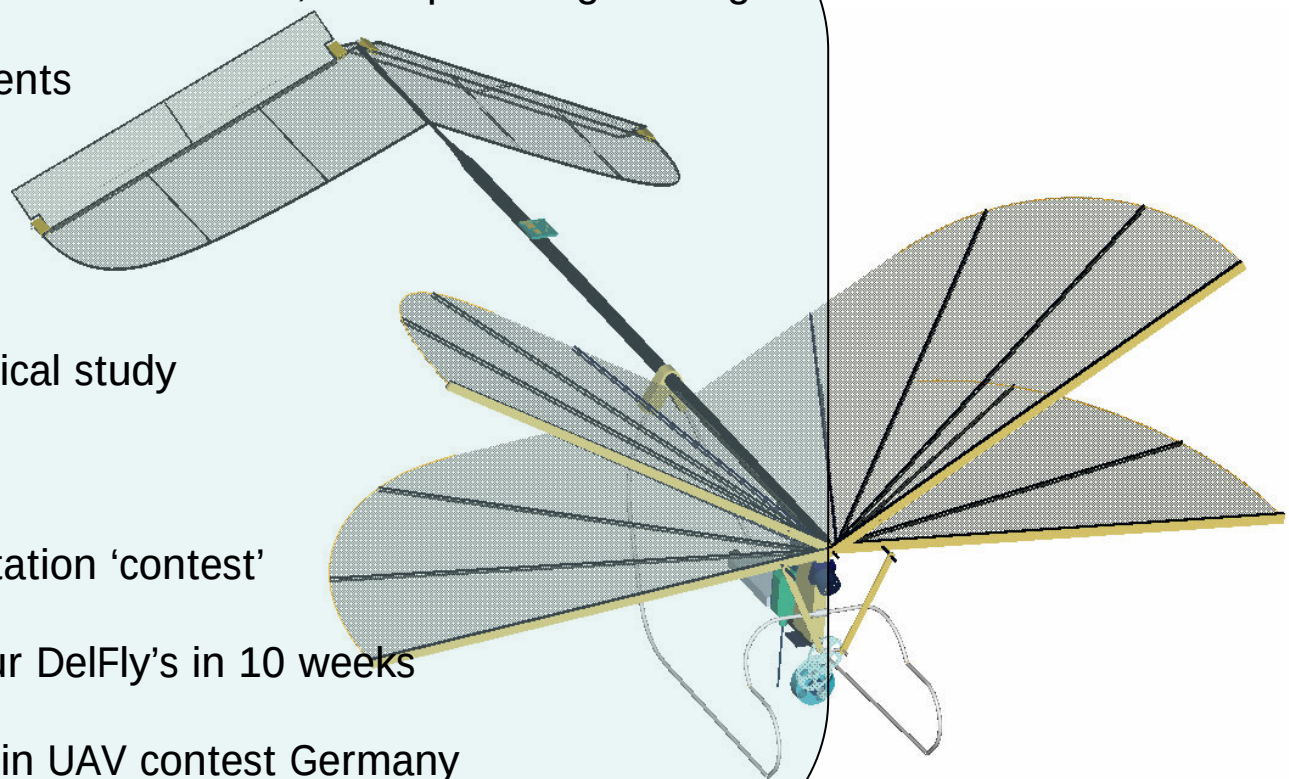
Delfly: history and design

- 3rd year design synthesis exercise TUD, Aerospace Engineering
- 15 teams of ± 10 students
- 10 Weeks full-time
- Result:
  - Design + Theoretical study
  - Presentation
- DelFly won the presentation ‘contest’
- Afterwards building four DelFly’s in 10 weeks
- Participation and Prize in UAV contest Germany



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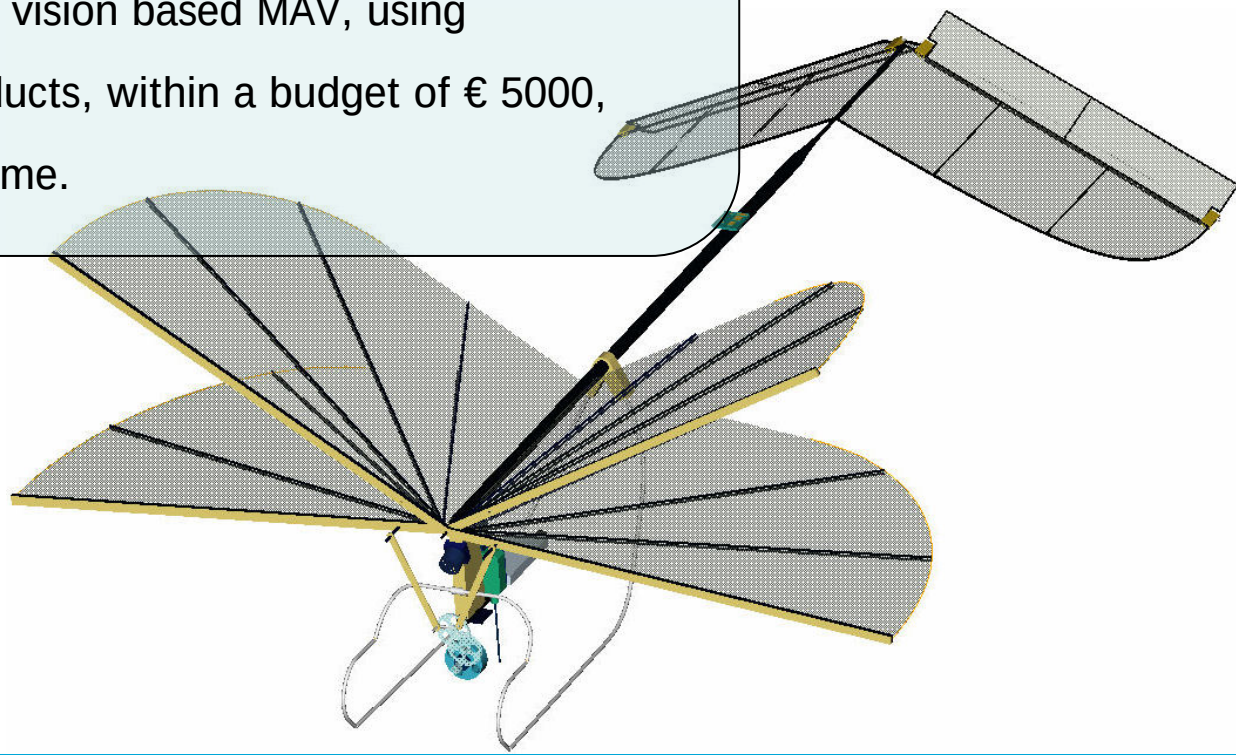
Delfly: history and design

Mission Need Statement

Impress the jury of the first US-European Micro UAV Competition by designing a flapping wing, vision based MAV, using commercial off-the-shelf products, within a budget of € 5000, by 11 students in 10 weeks time.



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Delfly: Requirements and contraints

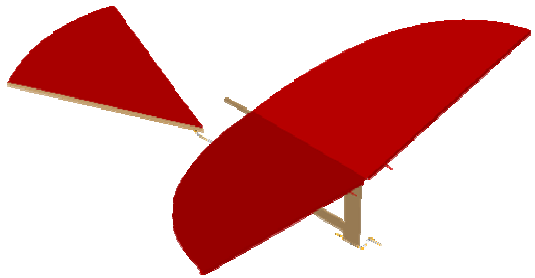
Requirements:

- Flapping wing
- Vision-based control

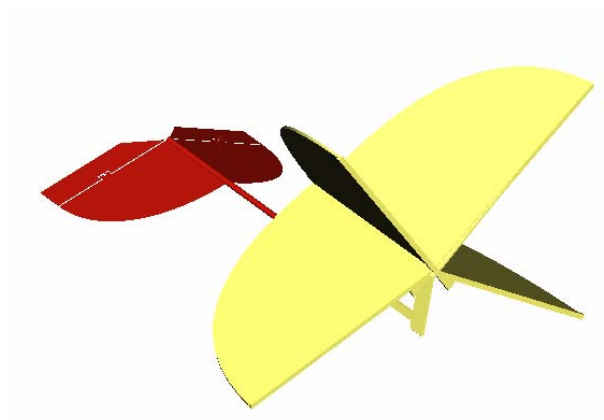
Constraints:

- Slow flight (< 5 m/s)
- Wing span (< 450 mm)
- Cost budget (< € 5000)
- Noise level (< 60 dB)
- Flight endurance (> 5 min)
- Weight (± 15 grams)

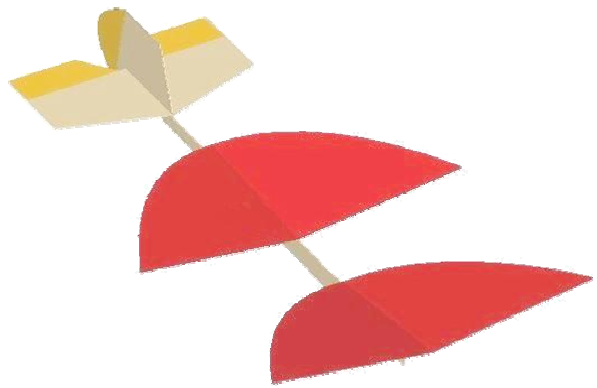
Concept design



Monoplane



Biplane



Tandem

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Concepts: flight test

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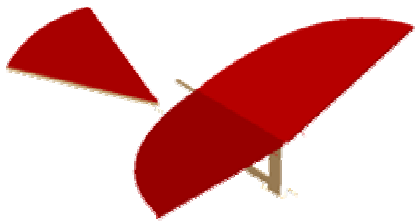
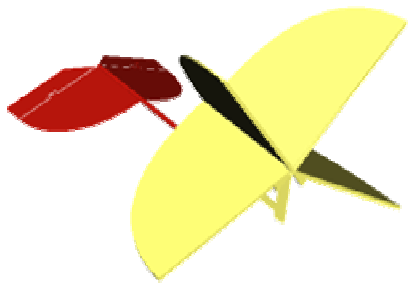
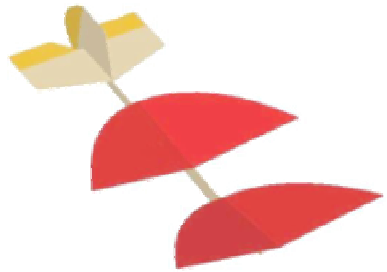
Concepts

	Monoplane	*Biplane*	*Tandem*
			
Average flight speed	2.35 m/s	1.40 m/s	1.36 m/s
Power Consumption	0.75 W	0.69 W	1.00 W
Rocking amplitude	80 mm	± 0 mm	± 0 mm

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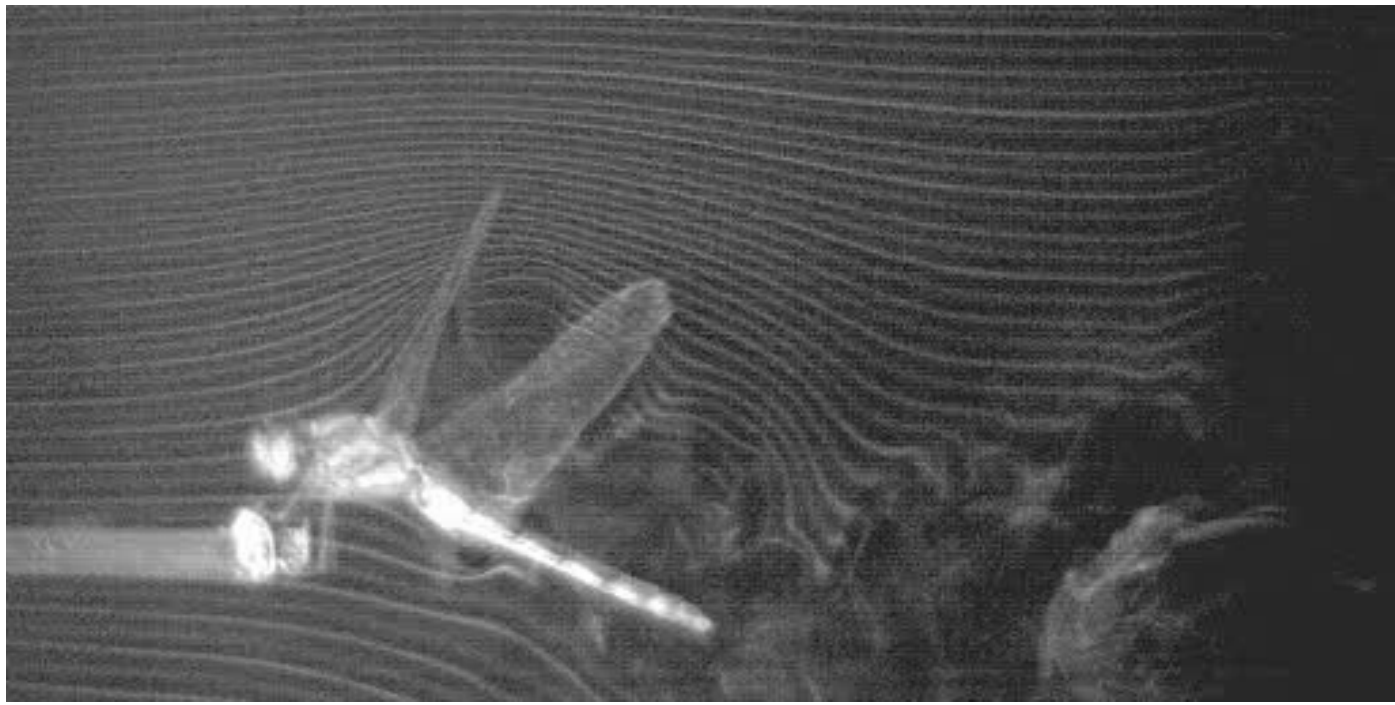
Delfly: aerodynamics

- Leading edge vortex
- Dynamic stall
- Wake capture



http://fluid.mech.kogakuin.ac.jp/~iida/mav/dragonfly.html

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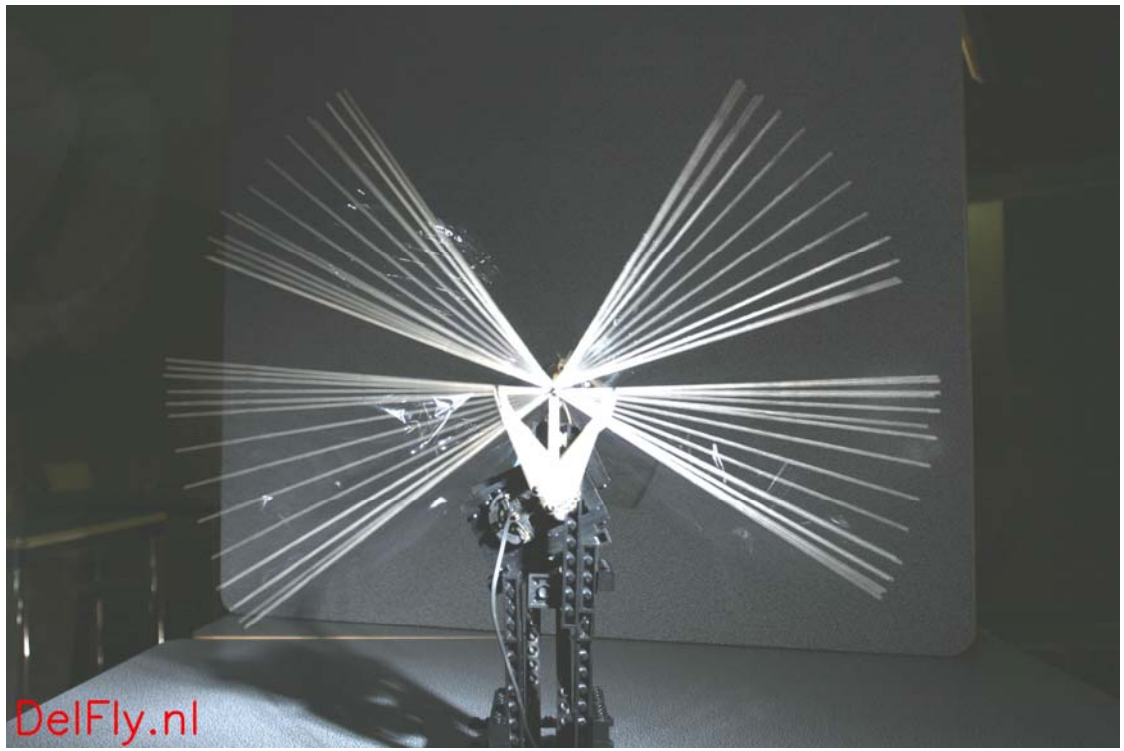
Delfly: aerodynamics

- Flap frequency
  According to required power
- Flap angle
  Compromise = 35 °
  Less for efficiency
  More for thrust
- Dihedral for stability
  2 x 6°



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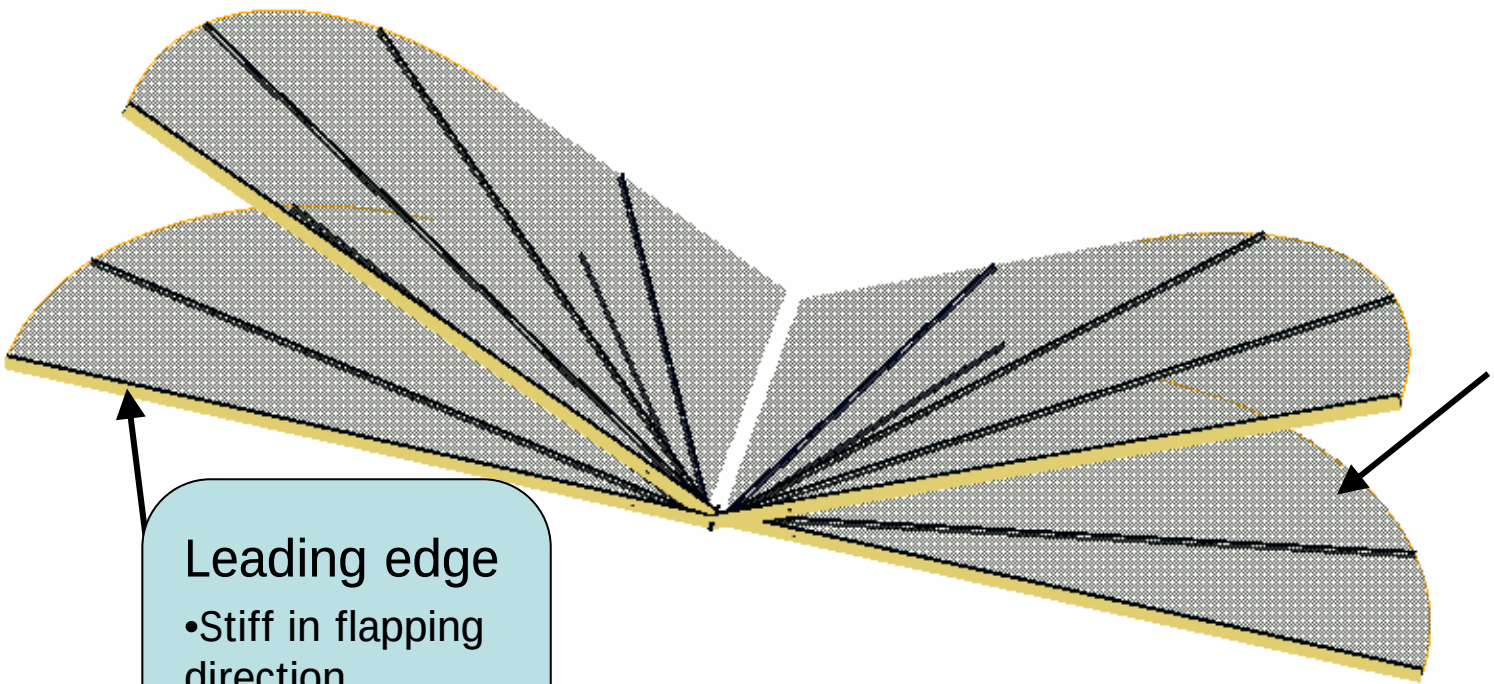
Delfly: wing design



Mylar foil

- Controlled stiffness with carbon rods

Leading edge

- Stiff in flapping direction
- Flexible in flight direction for wake recovery

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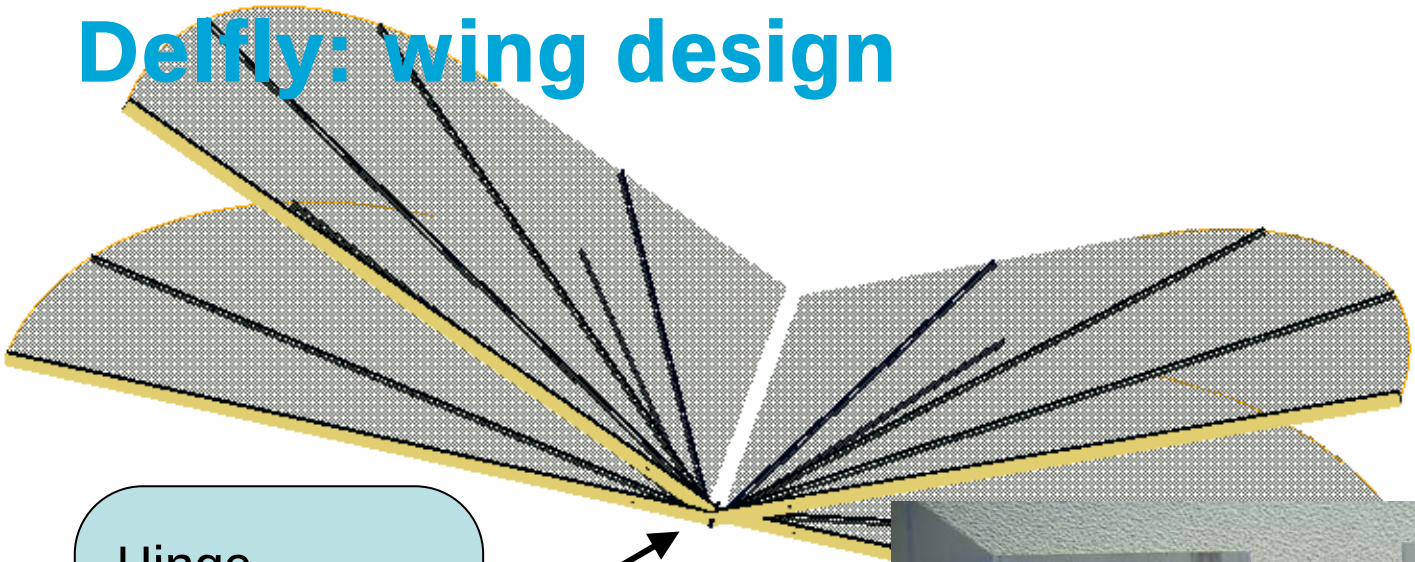
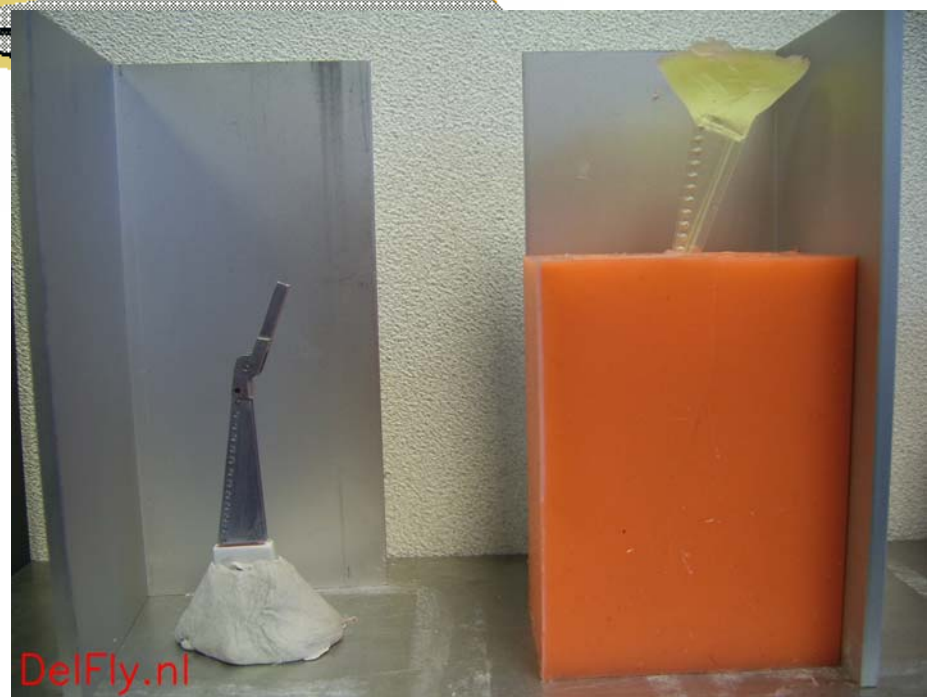
Delfly: wing design



Hinge

- Moulded in silicone rubber
- Carbon + epoxy
- Weight 0.3 g



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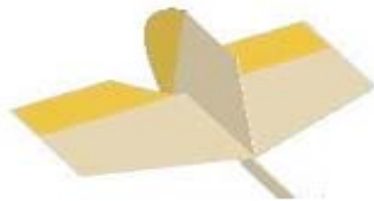
Delfly: Trade-off

Conventional tail and V-tail

	V-tail	Conventional tail	
			Weight factor
Stability and controllability	+	+	25%
Weight	+	+	15%
Design complexity	+	-	15%
Power efficiency	-	+	15%
Structural integrity	-	-	10%
Elegance	+	-	10%
Repair and maintenance	+	+	5%
Drag	+	-	5%

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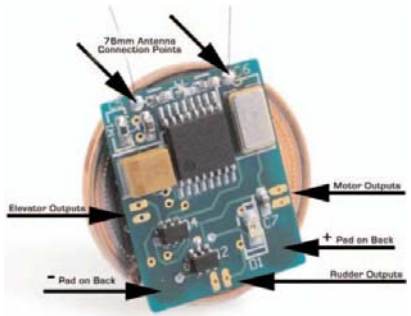
Delfly: main components

Battery	Receiver	Camera	Motor
			
3.5 grams	0.38 grams	1.2 grams	1.5 grams
High energy density	Fast data link	High resolution colour	High efficiency

Total weight of all components: 12.5 grams

Total weight of complete MAV: 17 grams

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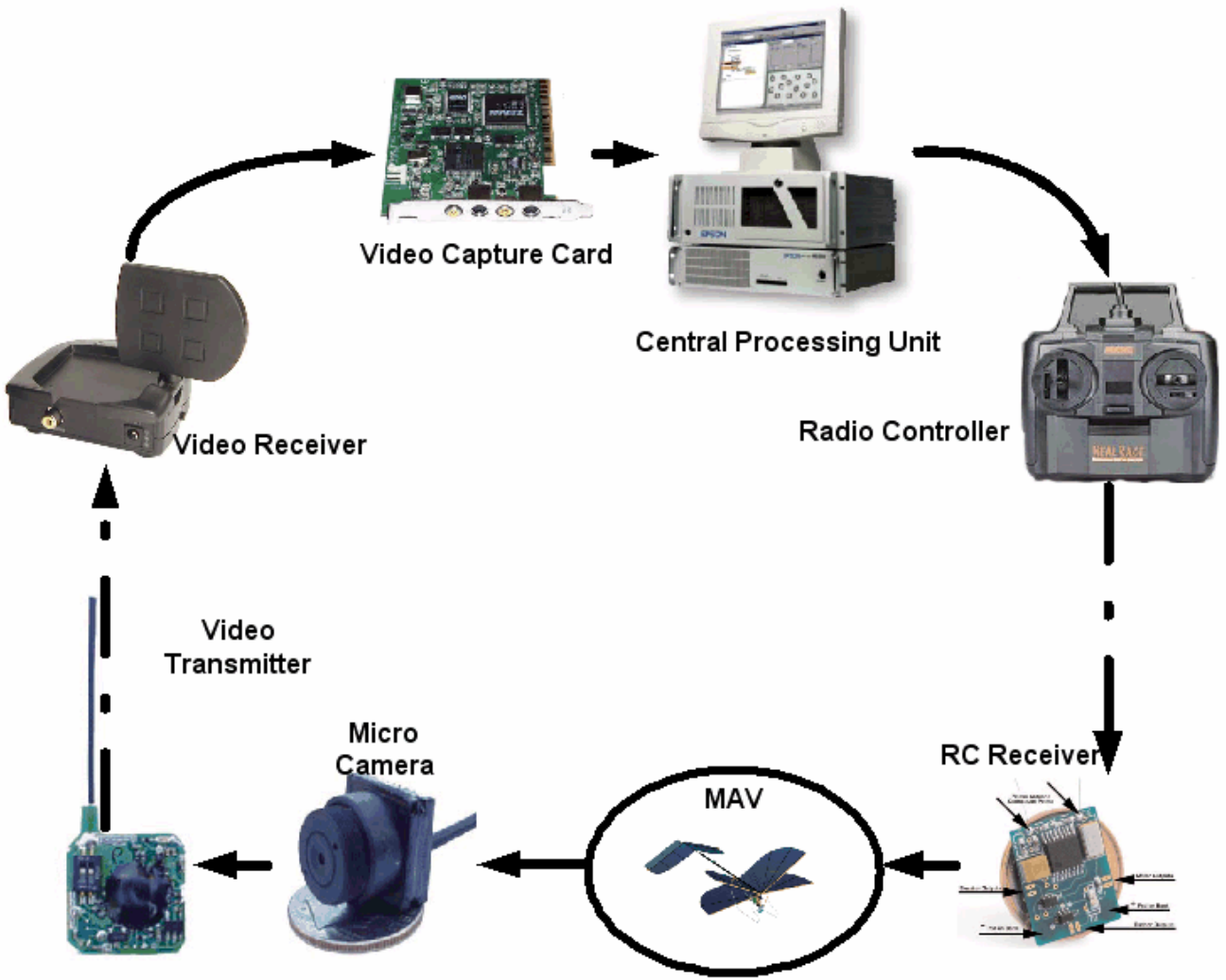
Delfly: vision techniques



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Delfly: dynamics, slow motion (1 : 4)

Result of wing design with controlled stiffness distribution

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Delfly: onboard camera

- Onboard Camera

- High detail
- Streamed to ground station
- Used as vision software input

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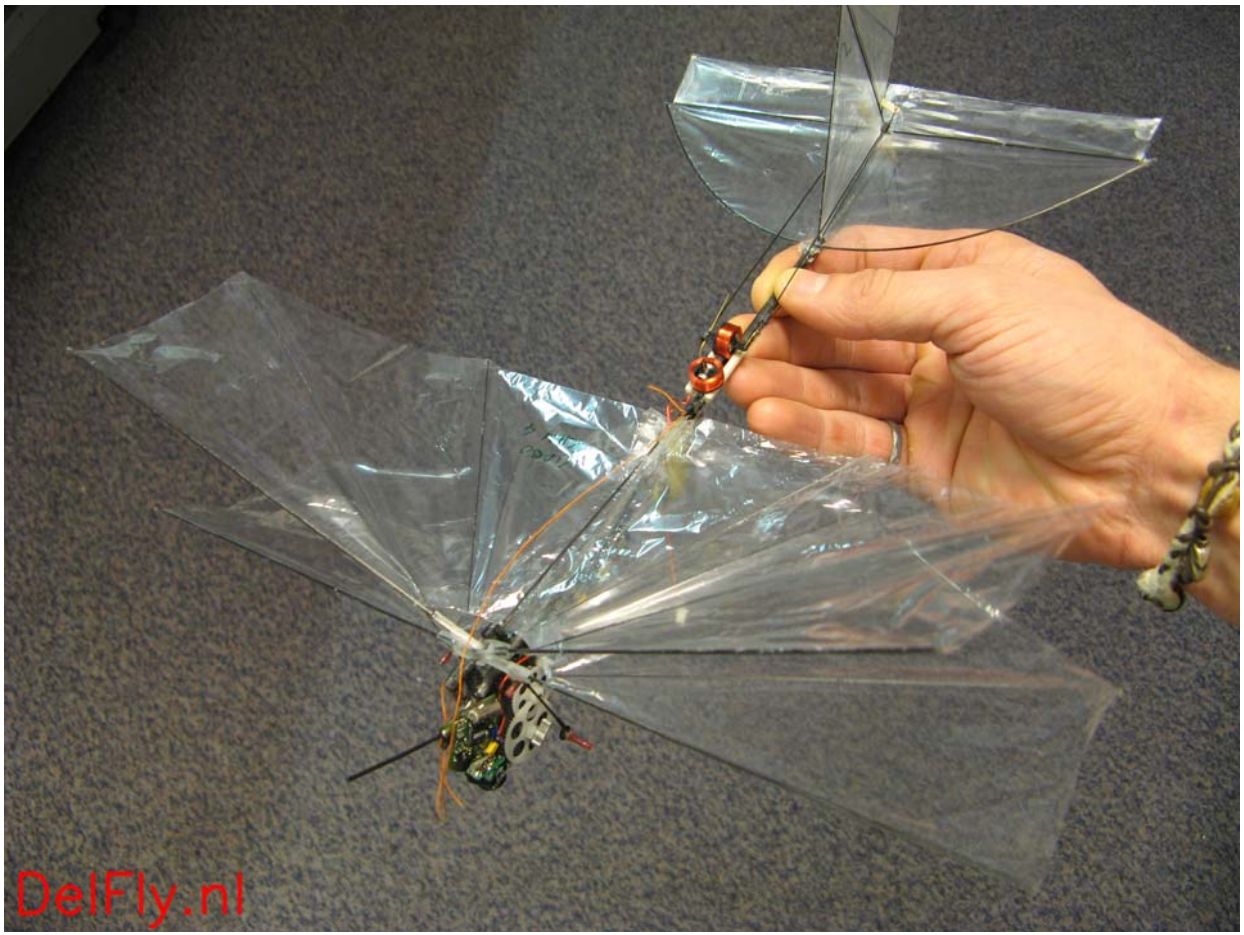
The final product



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The camera

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The DelFly II

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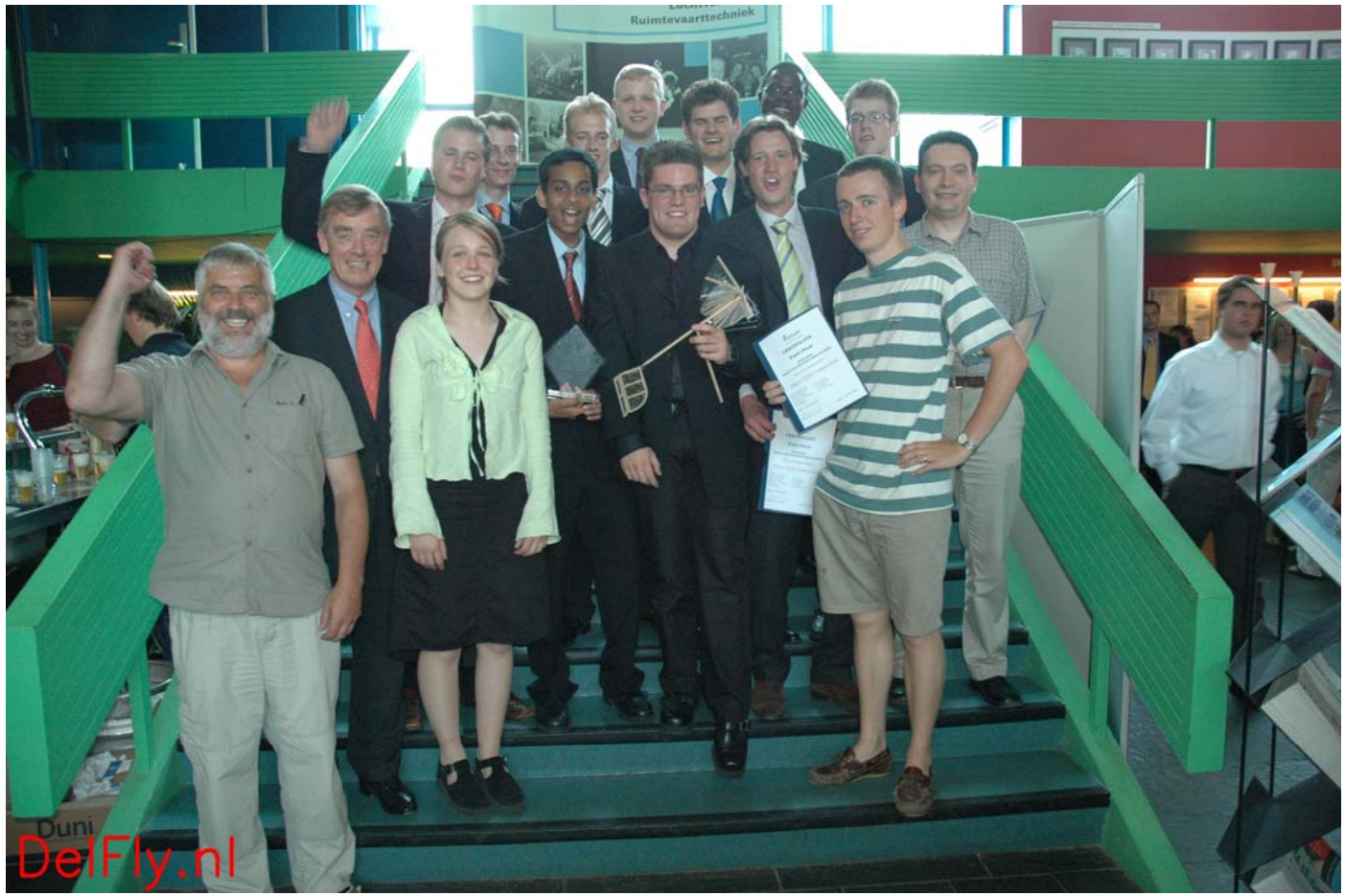
The group



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The end

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