

University of Groningen

The flapping flight of birds

Thielicke, William

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2014

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Thielicke, W. (2014). *The flapping flight of birds: Analysis and application*. [S.n.].

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Propositions belonging to the thesis

The Flapping Flight of Birds Analysis and Application

by William Thielicke

1. Leading-edge vortices are highly relevant in the slow-speed flapping flight in birds. Their relative importance for the generation of lift scales with the effective angle of attack, the amount of wing camber and to a lesser extent with wing thinness (this thesis).
2. Bird wing morphology is optimized to promote attached flow aerodynamics at the arm wing by having thick and cambered wing sections, and to promote the development of leading-edge vortices at the hand wing by having thin wing sections with low camber (this thesis).
3. Twisted wings can be very disadvantageous in slow speed flight, but advantageous in faster flight (this thesis).
4. The beneficial effect of wing twist may be the increase of the effective angle of attack at the wing base, and not the decrease of the effective angle of attack at the wing tip (this thesis).
5. Flapping flight can be more manoeuvrable than fixed wing or rotary wing flight due to the possibility to generate higher instantaneous peak forces (this thesis).
6. A steady-state blade-element analysis can be used to model the forces of a flapping wing when the force coefficients include the effect of the enhanced lift enabled by leading-edge vortices (this thesis).
7. Artificial flapping wing devices are very well suited for complex missions when they benefit from the high efficiency of attached flow aerodynamics as well as from the increased forces of vortex-enhanced lift (this thesis).
8. Although the accuracy of direct cross correlation and multiple pass direct Fourier transform correlation is very comparable in synthetic images where single parameters are modified, the latter algorithm yields more robust and accurate displacement estimates under challenging conditions and when the dynamic range of velocities is large (this thesis).
9. Approaching a performance limit from below, as well as overshooting it and approaching from above, is advantageous for the progress of one's skills - even if it sometimes results in broken equipment or broken bones.
10. Practical tests suggest that the amount of parental sleep scales with 0.6 to the power of the amount of babies.