

Berichte des Instituts für Mechanik und Flüssigdynamik
Heft 20 (2015)

Diving-flight aerodynamics of a peregrine falcon

Aerodynamik beim Sturzflug des Wanderfalken

Benjamin Ponitz

Contents

List of acronyms	xi
List of figures	xiii
List of tables	xv
1 Introduction	2
1.1 Peregrine falcon.....	3
1.2 Outline of this work.....	4
2 Free-flight investigations.....	8
2.1 Experiment	8
2.1.1 Ethics Statement	8
2.1.2 Diving-flight location: Dam wall Olef-Talsperre Hellenthal	8
2.1.3 Experimental Set-up	9
2.2 Results	12
2.2.1 Detail studies of body shapes	13
2.2.2 3-D Flight Trajectory.....	14
2.2.3 Flight parameters: velocity, acceleration and angle of attack	15
3 Falcon model geometry	20
4 Wind-tunnel investigations	24
4.1 Experiment	24
4.2 Results	28
4.2.1 Drag and lift forces (polar diagrams)	28
4.2.2 Influence of the leather strap on the falcon aerodynamics	30
4.2.3 Near-surface flow visualization via oil-based painting method	31
5 Water-tunnel investigations.....	36
5.1 Experiment	36
5.1.1 Standard PIV on rigid falcon model.....	37

5.1.2	Spatio-temporal PIV on moving falcon model.....	38
5.2	Results	40
5.2.1	PIV-based flow visualization of the suction side of the model.....	40
5.2.2	Multiple-exposure imaging and particle-image-velocimetry	42
5.2.3	3-D Spatio-temporal visualization of wake turbulences.....	45
5.2.4	Trefftz-plane (Induced drag)	46
6	Numerical simulations.....	50
6.1	Numerical model.....	50
6.2	Results	54
6.2.1	Drag and lift forces.....	54
6.2.2	Surface pressure and wall shear stress.....	56
6.2.3	Vortex detection via Q -criterion.....	57
7	Conclusions	60
8	Outlook	64
8.1	Peregrine falcon investigations in future.....	64
8.2	Aviation research roadmap 2050.....	70
Appendix	73
A1 - Intrinsic and Extrinsic Camera Parameters	73	
A2 – Level of turbulence intensity distribution of wind-tunnel cross-section	75	
References	77