

Preface	iii	Zero Angle of Attack	23
Why Two “Books”?	iii		
Why Did I Write This Book?	iii	3 The Rotor Blade	
Keeping Things in Perspective	iv	General	25
Standard Disclaimers	iv	Axes of the Blades	25
Political Correctness	iv	How Lift Gets to the Hub	26
Aim of every flight	iv	Drag on the Whole Blade	27
Terms Used	v	Blade Flapping	27
Dedication	v	A Brief Moment to Study Law	29
Introduction to the Second Edition	v		
Corrections and Additions	v	4 More Basics of the Helicopter	
1 Some Fundamentals		Generic Helicopter	31
Math and Physics Revisited	1	The Whole Rotor	31
Vectors	1	Telling the Blades Apart	31
Newton’s Laws	1	Airframe Relative Airspeed	32
Newton’s First Law	1	Relative Airflow and Disk	32
Newton’s Second Law	1	Forward Flight and Dissymmetry of Lift	33
Newton’s Third Law	2	Cyclical Change of Pitch	34
Other Physics and Maths terms	2	Flapping to Equality	35
Momentum and Inertia	2	Total Lift from the Disk	35
Speed	2	Tip Path Plane	35
Velocity	2	Drag at Different Parts of the Disk	36
Acceleration	2	Total Drag on the Disk	36
Equilibrium	2	Keeping the Blades Clean	37
Vectors, Resultants and Resolving	3	Flapback or Blowback	37
Moments and Couples	3	Rotor Heads and Components	38
Moments	3	Fully Articulated Rotor Hub	38
Couple	4	Control of the Rotor	39
Balance of Forces	4	The Swashplate	39
Dimensional Correctness	4	Phasing of Control Inputs	39
Distance and Time	4	Rotating Scissors Assembly	40
Mass, Force, Energy and Work	4	So What?	41
Mass	4	Tail Rotors	41
Force	5	Anti-Torque Control	41
Energy	5		
Work	6	5 Air, Wind and Weather	
Power	6	Introduction	43
Graphs and Such	7	What Temperature is That?	43
Putting Together Some of the Basics	8	Where do we Measure Vertical Distance From?	43
2 Introduction to Helicopter Aerodynamics		International Standard Atmosphere	43
Terms Used	11	Standard Day	43
Zero Airspeed vs. Zero Groundspeed Hover	11	Pressure Altitude	43
Center of Gravity (CG)	11	Non-Standard Day	44
Aerodynamic Terms	11	Density Altitude	44
Angle of Attack	15	Importance of Understanding Density Altitude	45
Lift	18	The How and Why of Density Altitude	46
More Discussion of Lift	20	Relative Humidity	46
Formula for Lift	21	Wrong Information	47
Drag	22	More Wrong Information	47
		Wind!	48
		Knowing The Wind from Natural Sources	48

Wind Speed Change with Height	49
Wind Direction Change with Height	50
Wind Shift and Turbulence	50
A Lesson from the Birds	50
Weather	51
So What do We Need to Worry About?	51
An Example	51

6 Basic Helicopter Performance

Introduction	53
Airframe Performance Defined	53
Measuring Performance	53
Hover performance	53
Out of Ground Effect (OGE)	54
In Ground Effect (IGE)	54
How Does Ground Effect Happen?	54
Using a Crane to Lift Instead of an Engine	55
Power Required vs. Density Altitude	56
Hover Ceilings	56
Forward Flight Performance	56
Power Required vs. Airspeed	56
What You Can't Do with This Chart	57
The 'Backside' of the Power Curve	58
Low Airspeed Power Required	58
Climb and Descent Performance - Simplified	59
Flight Manual Charts	59
V Airspeeds	59
Load Factors	60

7 Balance and Weight

The Importance of Center of Gravity	61
Calculating Weight and Balance	62
Balance	62
Datum Forward of the Nose.	63
Datum At Rotor Mast	64
Weight and CG Diagram	65
Weight vs. Loaded Moment Method	65
Yet Another Way to Measure CG	65
Longitudinal CG	66
Lateral CG	66
Vertical CG	67
Balance of Forces	68
General	68
Balance of Forces in the Hover	69
Side View Four Basic Forces	69
Top View Balance of Forces - Torque Reaction	69
Rear View of Balance of Forces	69
Trim	71
Balance of Forces - Forward Flight	71
Side View of Balance of Forces	72
Top View of Balance of Forces Forward Flight	73
Inherent Sideslip	73

Rear View of Balance of Forces - Forward Flight	73
---	----

8 The Aerodynamics of Autorotation

Introduction	75
Autorotation Defined	75
Conditions Necessary for Autorotation	75
Lift Vectors Again	76
Effect of Forward Flight	78
How the Blade Works in Autorotation	78
N_R in Autorotation Descent	78
Another Use for the Autorotation RPM Chart	79
Effect of Density	79
Effect of Weight	79

9 Instruments and Warning Systems

Airframe Instruments	81
Sideslip and Side Force	81
What the Slip Ball Measures	81
What is Sideslip?	82
Slip Strings	83
Engine Transmission and Rotor Instruments	84
N_R Warnings	84
Transmissions and Gearboxes	84
Transmission Oil Temperature and Pressure	84
Chip Detectors	85

10 The Piston Engine

Introduction	87
Principles of Operation	87
Components	87
Basics of Carburation	88
Vaporization	89
Piston Engine Helicopter Instruments	90
Manifold Pressure	90
Starting	91
Clutches	91
Centrifugal (or Automatic) Clutch	91
Idle or Manual Clutch	92
Free-Wheel Units	92
Piston-Engine Helicopter Power Control	92
Rotor RPM	93
Power Output	93
Measuring Piston Engine Helicopter Power	93
Same Engine in a Seized Wing Airplane	93
Carburetor Icing	94
Why do Carburetors Ice Up?	94
More Carburetor Icing Explanation	94
Effects of Icing	96
Symptoms of Carburetor Icing	96
Carburetor Heat	97
Prevention of Carburetor Ice	97

Mixture Control	98	Energy and the Rotor System	113
Throttle Handling	98	Pre-Lift-off Checks	113
Over-Pitching	99	Holding the Controls	114
Wrong Side of Torque Curve	99	Light Training Helicopters	114
Only on Some Piston Engine Helicopters	99	Control Pressure, Not Control Movement	114
Coning Angle and Over-pitching	100	Function of Controls	114
Turbine Engines and Over-Pitching	101	Effects of Controls	116
Throttle Co-relators	101	Downwash	116
Fuel Injection	101	Hand Signals	116
Piston Engine Governors	101		
How Does the Governor Work?	101	13 Helicopter Flying - The Basics	
Performance Rules of Thumb for Piston Engines	102	General Introduction	119
Turbochargers	102	Forward Flight	119
Other Components of the Engine	102	Effects of Controls in Forward Flight	119
Oil and Oil Pumps	102	Cyclic stick	119
Generators	103	Collective lever	120
Fans	103	Pedals	120
Fuel Systems	103	Summary of Effects of Controls	121
Operation of the Piston Engine	103	Attitude Flying	121
Pre-Start	103	Cruise	122
Fuel Draining	104	Changing Airspeed in Level Flight	123
Starting	104	Smooth Airspeed Changes	124
Lift-Off	104	Back Side of The Power Curve	124
In-Flight	104	Two Airspeeds for the Same Power!	124
		Climbs and Descents	124
		Turns	125
		A Note	125
		Gentle Turns (up to 20° Angle of Bank)	125
		Nose Drop	125
		Increased Power	126
		A Changed Sight Picture	126
		Slip Ball	126
		Practice	126
		Medium Turns (20 to 45° Angle of Bank)	126
		Steep Turns (Greater than 45° Angle of Bank)	126
		Developing a 'Seat of the Pants' Sense	127
		14 The Divine Art of Hovering	
		Introduction	129
		To the Hover!	129
		Hovering More Easily	129
		Vertical References	129
		Aim of Hovering	130
		Concepts of Hovering	130
		Hover - Zero Groundspeed vs. Zero Airspeed	130
		Effects of Controls - Hover and Low Airspeed	130
		Forward Flight and 'Low Airspeed'	131
		Overcontrolling in the Hover	132
		Cyclic Stick as a Position Controller	133
		N _R Control	134
		Hovering With A Purpose	134
		Partial Control Technique	135
11 Dear Student			
Instructors - What They Know and Don't Know	107		
Personality Differences	107		
The Essential Pre-Flight Briefing	108		
Checklists	108		
For Those Who Make Checklists	108		
All Those Gages and Clocks!	108		
Blindfold Cockpit Checks	108		
For Both Instructor and Student	109		
Transfer of Control	109		
Following Through on the Controls	109		
Where to Look	109		
Outside, Mostly	109		
Look Around	110		
Collision Course	110		
Post-flight	110		
Walkaround	110		
12 Before You Strap In...			
Introduction	111		
Prior to Lift-off	111		
Terms Used	111		
Pre-Flight Actions	112		
Pre-Flight checks	112		
Walk-Around checks	112		
Start-Up checks	113		

Lots of Things to Do	135
Specific Exercises for Learning Hovering	135
Taxing Along a Line	135
Changing Height While Hovering	135
Changing Heading	136
Moving Around	136
Hovering with Different References	136
Back to Flying	136
Turns in the Hover	137
No Wind	137
With Winds	137
In the Low Speed Environment	138
Useful Training Exercises	138
General Handling in the Hover	139
Taxing to the Side or Rear	140
Ground Taxing Skid Helicopters	140

15 'Twixt Heaven and Earth,

Introduction	143
Slipping and Crabbing	143
Transition to Forward Flight	143
Ground Track	144
Translational Lift	144
Other Transitions to Forward Flight	145
Cushion Creep	145
Steep Climbout	145
Running Takeoff	145
Why Running Takeoffs?	145
How It Works	146
How to Carry Out a Running Takeoff	146
Cautions on the Running Takeoff	146
“Maximum Performance Climbout”	146
An Example of Getting Caught	147
Downwind Transition	147
Turns After Transition	148
Approach and Touchdowns	148
Transition Back to the Hover	148
Learning to Judge...	149
...Perspective	149
...Rates of Closure	150
‘Normal’ Approach	150
Suitable Rate of Descent	150
Adding Power	151
Fast Approaches	151
Steep Approach	151
The No-Hover Touch Down	152
Downwind Approach to the Hover	152
Approaches with Turns	152
Line-Up	153
Turning into a Downwind Approach	153
VIP Approaches - Mastery of the Machine	153

Running Landing	153
Traffic Patterns or Circuits	154
What do Traffic Patterns Teach / Show	154
Confined Areas	155

16 Lift-off and Touchdown

Introduction	157
Flat Pitch to Light on the Skids	157
How Do you Know ‘Light on the Skids’?	157
From ‘Light on the Skids’ to the Hover	158
Airborne!	158
Lift-off out of Wind	159
Touching Down From The Hover	159
Flat Surfaces	159
Don’t Overcontrol	160
A Neat Trick for Smooth Touch Downs	160
Sloping Surfaces	161
Tail Rotor Side Thrust	162
While You’re On the Sloping Ground	163
Wind Across the Slope	163
Lift-off from the Slope	163
Nose Upslope / Downslope	163
One Last Word About Sloping Ground	164

17 Introducing Emergencies

Emergencies - General	165
Critical Emergencies	165
Dual Concurrence (or Double Checking)	166
What Emergencies Can Happen	166
Unanticipated Emergencies	166
As a Student	166
Chip Detectors	166
Realistic Emergencies	167
Where to Handle Emergencies	167

18 Engine Failures for Beginners

General	169
Simulated vs. ‘Real’ Engine Failures	169
Warming-up for Autorotations	169
Vertical Landings	170
Engine Failures in the Hover	170
Judging Collective Lever Application	170
High Hover Engine Failures	171
Self-Initiated Engine Failures Hover	171
Quick Stops	171
The Flare	172
So What Should You Do?	173
Flare Effectiveness	173
Collective Check - Why It Works	174
Coupling of Forces in Leveling Helicopter	174
Power Recovery Autorotations	175
Getting Back to the Hover	176

‘Real’ Autorotations	176
Eyes Out of the Cockpit!	176
Autorotative Performance	177
Some Final words	177
Some Words on The Height-Velocity Curve	178

19 Peculiarities of the Helicopter

Introduction	179
Loss of Translational Lift	179
Vortex Ring State	180
Impossible Descent Conditions	180
Not Just in Descent	181
Demonstrating Incipient Vortex Ring State	181
Uncommanded Attitude Changes	181
Making the Situation Worse	182
Recovery	182
Wrong Advice	182
The Why of Vortex Ring State	182
Why The Symptoms?	183
Rollover	183
Static Rollover	183
Dynamic Rollover	184
Dynamic Rollover on Landing	184
Dynamic Rollover on Takeoff	185
Action in Event of Dynamic Rollover	185
Retreating Blade Stall	186
Symptoms	187
Blade Sailing	187

20 Flight Manuals, Rules and Regulations

Why?	189
The Civilian Flight Manual	189
Sections of the FM	189
Emergency Definitions	190
Notes, Cautions and Warnings	190
Procedural Words	191
Performance Data	191
No Altimeter Correction Charts	191
Flight Manual Supplements (FMS)	191
Weight and Balance Information	192
Manufacturer’s Data	192
Individualized Copy of the FM	192
Some Philosophical Words about the Civilian FM	193
More Philosophy...	193
Certification Basis	194
Reasons for Rules	194
Two more Pet Peeves	194
Reasons for Limitations	194
Another Way of Thinking About Limitations	195
Side Wind, Sideward Flight and All That	195

Is it a Limit Because Its in the Limitations Section?	195
Power Ratings and Limitations	196
The Military Flight Manual	196
Visual Flight Rules (VFR)	197
V Speeds	197

21 Miscellaneous

Where the Pilot Sits	199
Radios and Air Traffic Control	199
Negative Radio	199
Safety Statistics	200
Ground Handling Wheels	200
Safety for Others	200
Going Solo	200
Cross Country Flying	201
Single Seat and Ultralight helicopters	201
Inexperienced Pilots Shouldn’t Be Flying Them	201
Get A Private Pilot’s License First	202
Get Experience in Several Different Types	202
General Words of Advice	202
Shutdown	203

22 For the Professional Helicopter Pilot / Instructor

For the Professional Helicopter Pilot	205
Helicopter Pilots Are Different	205
Legal Implications	205
Maintenance	205
Service Difficulty Reports (SDRs)	206
Your Part in Safety	206
Experience	206
Care and Feeding of Passengers / Customers	206
Make a Decision	206
Philosophy of Instruction	207
Measuring or Predicting Pilot Performance	207
More Philosophy	207
Preflight Briefing	208
Preflight Inspection	208
Walkaround	208
Concepts of Controls	208
Cyclic	208
Collective	208
Throttle	208
Pedals	208
Looking Outside	208
Limitations	209
Following Through	209
Checklists	209
Questions and Tests	209
When the Students Ask Questions	209

What are you Really Trying to Teach?	209
Even More Philosophy	210
Specific Exercises	210
Trusting the Student	210
Space Awareness	210
Flying by the Seat of the Pants	211
Written Tests	211

23 **Advanced Helicopter**

Aerodynamics	
Review	213
Hover	213
Review of Lift and Drag	213
Airfoils	213
Non-symmetrical Airfoils	213
Lift and Drag	213
Lift to Drag Ratio	214
Changing N_R	214
Changing Density Altitude	214
Blade and Segment Aerodynamics	215
Blade CG location	215
AoA Changes due to Flapping	215
AoA, Lift and Center of Pressure	216
Pitching Moments	217
Symmetric Section	217
Non-symmetric Section	218
Why the Fuss about Pitching Moments?	218
Blades	218
Blade Root Cutout	218
Blade Tip Shapes	219
Twist	219
Taper	219
Twist and Taper - Again	219
Lift to Drag Ratio Again	220
Disk Aerodynamics	220
Solidity	220
Why 2 Blades May be More Efficient than 4	221
AoA and the Disk	221
Advance Ratio	221
V_{NE} and True Airspeed	222
Retreating Blade Stall Again	222
Coning Angle Again	222
Transverse Flow Effect or Inflow Roll	222
Stick Migration	223
Tail Rotors	224
Location on Fuselage	224
Size, Direction of Rotation	225
Aerodynamics of the Tail Rotor	225

24 **Flight Controls and Rotor Heads**

General	227
Tip Anhedral	227

Blade Inertia	227
More Reasons for Lead-Lag Motion	227
Hook's Joint Effect	227
Other Phase Angles	228
Rotor Heads	229
Lead-Lag Dampers	229
Types of Drag Dampers	230
Droop Stops / Flap Restrainers	230
Droop Stop Pounding	231
Lubrication	232
Disk Axes	232
Shaft Axis	232
Control Axis	232
Yet Another Disk Axis	233
Hinges	233
Flapping Hinge Offset	233
Hinge Arrangements	235
Delta-Three Hinges	235
Elastomeric Bearings	236
Hingeless Rotor Heads	236
New Rotor Heads	237
The Teetering Rotor Head	237
Stabilizer Bars	238
Flap or Hub Restraining Springs	239
Hiller Control System	239
Robinson R-22 and R-44 Hub.	240
MD Series Rotor Head	240
Height of Hub Above the CG	240
Blade Lag Angle	240
Negative Pitch	240

25 **Advanced Performance**

General	241
Factors Affecting Performance	241
Power Loading	241
Induced Velocity	242
Mach Number Effects	243
Hover Performance and Altitude	243
Surface Effect on Hover Performance	244
Vertical Drag	244
Another Look at Hover Performance	244
Typical Civil FM Performance chart	246
Level Flight Performance	246
Indicated Airspeed and True Airspeed	246
Collective Angle vs. Airspeed	247
Power vs. Collective Angle	247
Peculiarities of Low Airspeed IGE	247
Another Look at Power Required to Hover	248
Rotor Efficiency	248
Ground Vortex Roll Up	249
Low Airspeed Power Required - Again	250
Range	251

Range Improvements with Altitude	253	Skis	275
Headwind and Tailwind Effects	253	Full Length Skis	275
Point of No Return	254	Bear Paw Skis	275
Equal Time Point	255	Skis on Mud	275
What If Something Goes Wrong?	256	Floats	275
Endurance	256	Fixed Floats	275
Radius of Action	257	Boating!	276
How to Trick A Navigation System	257	Start-up / shutdown	276
Payload vs. Radius of Action	258	Spray	276
Climb and Descent Performance	258	Taxing on Water	276
Climbs	259	Liftoff and Touchdown from the Water	276
Best Angle of Climb Airspeed	259	Following the Waves	276
Descent Performance	260	Off-Level Touchdowns on Water	276
Whizz Wheels	260	Lift-off and Touchdown from the Ground	277
Rules of Thumb	261	Other Effects of Fixed Floats	277
		Emergency Floats	277
		Use and Problems	277
		Fire Detection and Suppression	278
		Heating and Ventilation	278
		Seats	278
		Compasses	279
		Windshield Wipers	279
		27 Advanced Helicopter Flying	
		So How Do We Fly a Helicopter?	281
		Driving a Car Explained	281
		Compensation	281
		Flying a Helicopter – Hovering	282
		Cruising Flight Example	282
		Other Cue-Related Problems	283
		Why are Helicopters Difficult to Fly?	284
		Slow Response Explained	284
		Cross Coupling	285
		Different Responses from the Pedals	285
		How to Hold the Controls	286
		Cyclic	286
		Overcontrolling	286
		Collective	286
		Pedals	286
		Helicopter Pilots are Easy...	287
		Artificial Control Feel or Trim Systems	287
		Control Forces	289
		Collective Release	290
		Fuselage Attitudes	290
		Pedals Again	291
		The Other Way ‘Round	291
		28 More Instruments	
		Pitot Systems	293
		Altimeters	294
		Corrections to the Altimeter in Cold Weather	295
		Static Port Locations	295
Range Improvements with Altitude	253		
Headwind and Tailwind Effects	253		
Point of No Return	254		
Equal Time Point	255		
What If Something Goes Wrong?	256		
Endurance	256		
Radius of Action	257		
How to Trick A Navigation System	257		
Payload vs. Radius of Action	258		
Climb and Descent Performance	258		
Climbs	259		
Best Angle of Climb Airspeed	259		
Descent Performance	260		
Whizz Wheels	260		
Rules of Thumb	261		
26 Other Components			
General	263		
Fuel Systems	263		
Fuel Valves	263		
Fuel Pumps	263		
Low Fuel Warning Systems	263		
Other Parts of the Fuel System	264		
When is the Fuel Gauge Reading Correctly?	264		
Pounds or Gallons?	264		
Fuel Quality	264		
Fuel Drains and Living in the Field	265		
Fuel Jettison	266		
Transmissions and Drive Shafts	266		
HUMS	267		
Electrical Systems	267		
External Power	267		
Generators	268		
Batteries	268		
DC-Based Electrical Systems	268		
AC-Based Electrical Systems	268		
Electrical Failures	269		
Circuit Breakers	269		
When a Circuit Breaker ‘Pops’	270		
Hydraulic Systems	270		
Reasons For Hydraulics	270		
Typical Hydraulic System	271		
Unpressurized Reservoirs	271		
Hydraulic Emergencies	271		
De-Ice / Anti-Ice systems	272		
De-Ice vs. Anti-Ice	272		
Landing Gear	272		
General	272		
Skids	273		
Wheeled Undercarriage	273		
Retractable Landing Gear	274		
Off-level Landings	274		
Wheel Brakes	275		

So What?	296	Turbine Engine Power Monitoring	320
What Can be Done About This?	296	Topping Checks	320
LORAS (LOW aiRspeed System)	296	Trend Monitoring Checks	320
LASSIE	296	Automatic Relight vs. Manual Air Starts	321
RAH-66 Commanche System	296	Engine-Related Items	322
General Comment on Low Airspeed Systems	296	Intake Protection Systems	322
Another Reason for Low Airspeed Systems	297	Anti-Icing vs. De-Icing	322
Miscellaneous Instruments	298	Bleed Air Systems	322
Outside Air Temperature Gages	298	Bleed valves	323
Radar Altimeters	298	Heaters	323
Waves and Radar Altimeter	298	Air Conditioning	323
Vertical Gyroscopes and Attitude Indicators	298	Performance Effects of Bleed Air Systems	323
Entering the Digital Era	299	Starting Against the Rotor Brake	324
Too Much Accuracy	299	Turbine Engine Cool-Down	324
But Some Good News Too...	299	Emergency Systems	325
		Fixed Shaft Turbine Engines	325
29 The Turbine Engine		30 Advanced Engine Failures	
Introduction	301	General	327
Turbine Engines are Different!	301	Autorotations	327
Typical Free Turbine Engine	301	Sensory Deprived, Multi-Variable Maneuver	327
Ratings and Limitations of Engines	303	The Big Picture	327
Difference between Ratings and Limitations	303	Where to Practice Autorotative Landings	328
How Long is Each Limit Good For?	303	Pre-Nominate the Landing Spot	329
Cycles	303	Autorotations ‘En-Route’	329
Measuring Temperature	303	Closer Look of Autorotative Performance	329
Density Altitude vs. Pressure Altitude and OAT	304	Energy and Autorotations	331
Less Power in Cold Temperatures	305	Cone of Possible Areas	332
Effect of Humidity on Turbine Performance	305	Variations on the Theme	332
Compressor Stalls	306	Zero-Airspeed Autorotations	333
Two Correct Answers Don’t Make a Third...	306	Reverse Cone of Energy	334
Turbine Engine Instruments	307	Landing Site is Straight Ahead	334
Torquemeters	308	Three Basic Locations	335
Use of the Torquemeter	310	Kinetic Energy in the Flare	336
Governing systems	310	Why Try the Variations?	338
Reasons for Installing Governors	311	Other Situations with Respect to the Landing Spot	338
Droop!	311	Combinations!	340
Static Droop	312	Intervention Delay Time	340
Oscillating Governors and Hysteresis	313	Run-Down Time of the Engine	340
Transient Droop	313	Height Velocity (HV) Curves	340
Hydro-mechanical Governors	314	Ignoring A Part of Most HV Curves	341
Electronic Fuel Controls	315	So What’s Missing about the HV Curve?	342
FADEC	315	Development of the HV Curve	342
What Has All This Got to Do With FADECs?	315	Miscellaneous Points About the HV Curve	343
Failures of Digital Fuel Controls	316	Another Type of Autorotation	343
Practical Benefits of FADEC	317		
Change of the Pilots Point of View	317	31 Advanced Emergencies	
Duplication of Sensors	317	General	345
Some Improvements Possible?	317	Tail Rotor Problems	345
Manual Control of the Turbine Engine	318	Loss of Thrust	345
Question Time	318	Loss of Thrust in the Hover	346
Tail Rotors, Governors and Free Drinks	318		
Differences from Piston Engine	319		
Transient Overtorques	319		

Automatic Flight Control Systems and Underslung Loads	395
Uncommanded Jettison of Underslung Loads	395
High Altitude Flying	395
Icing	395
Why is Icing So Bad?	396
So What are 'Icing Conditions'?	396
Snow	397
Flying in Your Own Dust	397
Mast Bumping	397
Causes for Mast Bumping	398
Too Much Sideslip	398
Other Causes of Mast Bumping	399
What to Do In the Event of Mast Bumping	399
Training to Prevent Mast Bumping	399
Design Eye Point	400

35 Other Helicopter Types

Brief history	401
Coaxial	401
Tandem	402
Synchrocopter or Intermeshing Rotors	403
Coanda Effect	404
Main Blades	404
Tail Boom	404
Tip Jets	404
Kaman Servo-Flap Controls	405
Replacing the Tail Rotor	406
Fenestron/Ducted Tail Rotor	406
NOTAR	407
Other Types	407

36 Night and Instrument Flying

Introduction	409
Night Flying	409
Engine Failures at Night	410
Night Vision Goggles (NVG)	410
The Myth of Night VFR	410
Instrument Flying	411
IFR Flight Envelope	411
Why is Helicopter IFR Difficult?	411
Disorientation	412
Useful Instrument Flying Exercises	412
Inadvertent IMC	413
Autorotations at Night, in Clouds, etc.	413
Instrument Flying Rules (IFR)	414
GPS and IFR	414
Helicopter Only Approaches	415

37 Automatic Flight Control Systems

Introduction	417
Definitions	417
Why install an AFCS?	417
Hierarchy of an AFCS	418
AFCS and the Big Picture of Control	418
Internal vs. External Conditions	419
Components of An AFCS	419
Series Actuator	421
Parallel Actuators	422
Combined Systems	423
Types of AFCS	423
Rate Damping Systems	423
Stability Augmentation System (SAS)	424
Pilot Commanded Inputs	424
Retrimming	425
Stability and Control Augmentation Systems (SCAS).	425
Attitude Based Stabilization Systems	426
Hybrid Systems	427
Automatic Trim Systems	427
AFCS 'Upper' Modes	428
Definition Problems	428
Attitude Datum Re-Adjustment	428
Heading Hold and Coordinated Turns	429
Hover and Low Speed	429
Forward Flight	429
In-between Airspeeds	430
Autopilots	430
Basic Autopilot.	430
Operational Autopilot.	430
Altitude or Height Hold	430
Radio/Radar Altitude Hold	431
Speed Hold in the Low Airspeed Region	431
Programmed Maneuver	431
Complex Helicopter AFCS	432
Automatic Transition to the Hover	433
Transition from Cruise to Hover	433
Radio Coupled Operations	434
Advanced Concepts	434
Side Arm Controllers	434
Failures of the AFCS	435
Minimum Height for Engaged AFCS	435
AFCS Disconnect Switches	435
38 Miscellaneous Musings	
Type Ratings	437
How To Survive	437
Technical Examinations	437
Minimum Equipment Lists (MEL)	437
Using GPS Intelligently	438

How Best to Use the Magic	438
Myths of the Helicopter	439
'Tail Rotor Stall'	439
'Pendulum Effect'	439
'Stick Reversal'	439
Torque Limiters	440
Health, etc.	441
Smoking	441
Fluids, Bodily	441
Stress	441
Glasses	441
Safety General	441
Personal Equipment	441
Helmets	441
Immersion Suits	443
The Helicopter is Not a Winch or Bulldozer	443
Good Examples vs. Bad Examples	443
What Good Pilots Do	443
Simulators	444
Learning to Say No	444
Noise	445

INDEX

