



# 21st Century **flight training**



## **General Aviation Manual for Primary Flight Training in the New Millennium**

**Sean E. Lane**

Foreword by Richard A. Skovgaard, Col., USAF (Ret.)

*21st Century Flight Training*  
by Sean E. Lane

Aviation Supplies & Academics, Inc.  
7005 132nd Place SE  
Newcastle, WA 98059  
(425) 235-1500  
Email: [asas@asa2fly.com](mailto:asas@asa2fly.com)  
Internet: [www.asa2fly.com](http://www.asa2fly.com)

© 2009 21st Century Aviation, LLC; [www.XXIaviation.com](http://www.XXIaviation.com)

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopy, recording or otherwise, without the prior written permission of the copyright holder. None of the material in this book supersedes any operational documents or procedures issued by the Federal Aviation Administration, aircraft and avionics manufacturers, flight schools, or the operators of aircraft. While the author has made every effort to ensure accuracy of the information in this book, the information herein is sold without warranty, either implied or expressed.

Printed in the United States of America

2013 2012 2011 2010 2009 9 8 7 6 5 4 3 2 1

**ASA-C21FT**

ISBN 1-56027-720-3  
978-1-56027-720-0

Cover photo courtesy Cirrus Design

*Library of Congress Cataloging-in-Publication Data:*

Lane, Sean.

21st century flight training : general aviation manual for primary flight training in the new millenium / by Sean Lane.  
p. cm.

Includes bibliographical references and index.

ISBN-13: 978-1-56027-720-0 (soft cover)

ISBN-10: 1-56027-720-3 (soft cover)

1. Flight training—Handbooks, manuals, etc. I. Title.  
II. Title: Twenty first century flight training.

TL712.L36 2009

629.132'52071—dc22

2009008281

<b>one</b>	<b>Introduction.....</b>	<b>1</b>
<b>two</b>	<b>Visual Situational Awareness .....</b>	<b>19</b>
	General Aviation Accident Trends Analysis.....	20
	Impact Factors .....	23
	<i>Airspace Complexity .....</i>	23
	<i>Proliferation of Technology.....</i>	33
	<i>Cockpit Task Loading .....</i>	37
	Training in Visual Environments .....	39
	Conclusion.....	41
<b>three</b>	<b>The Mental Airplane .....</b>	<b>43</b>
	Memory and Learning .....	44
	<i>Understanding the Human Brain and How it Functions .....</i>	44
	<i>Memory and the Science of Thought .....</i>	47
	<i>Reasoning and Problem Solving .....</i>	51
	<i>Neurolinguistics .....</i>	53
	Memory and Learning Knowledge Applied to Flight Instructing.....	54
	<i>Visualization .....</i>	56
	<i>Visualizing Flight Lessons.....</i>	58
	<i>Kinesthetic Kinematics .....</i>	60
	Human Factors .....	61
	<i>Biomechanics and Anthropometry .....</i>	62
	<i>Ergonomics and Environment.....</i>	63
	<i>Automation.....</i>	66
	<i>Mental Airplane Readiness.....</i>	69
	Health .....	69
	Sleep .....	70
	Nutrition .....	71
	Hydration.....	73
	<i>Psychosocial Elements.....</i>	73

# contents

<b>four</b>	<b>Integrated Sensory Flying .....</b>	<b>79</b>
	Integrated Sensory Flying Defined.....	79
	<i>Background</i> .....	79
	Integrated Sensory Flying .....	84
	<i>Flying by Sight</i> .....	85
	<i>Flying by Sound</i> .....	85
	<i>Flying by Touch</i> .....	89
	<i>Flying by Intuition</i> .....	90
	<i>Periperceptual Awareness</i> .....	91
	Aircraft Control by Integrated Sensory Flying .....	92
	<i>Aerodynamics</i> .....	92
	<i>Basic Integrated Sensory Flying</i> .....	100
	Pitch .....	101
	Bank .....	102
	Power .....	104
	Trim.....	107
	<i>Fundamentals of Integrated Sensory Flying</i> .....	109
	Straight, Level, and Unaccelerated .....	109
	Turns.....	110
	Climbs .....	114
	Descents .....	117
	<i>Applying Integrated Sensory Flying to Correction of Trainee Errors</i> .....	118
<b>five</b>	<b>Pre- and Postflight Lessons.....</b>	<b>119</b>
	Establishing the Need .....	119
	<i>Levels of Learning</i> .....	120
	<i>Domains of Learning</i> .....	122
	<i>Fiscal Dynamics</i> .....	123
	Revisiting the Fundamentals—In Classrooms.....	126
	<i>Classrooms</i> .....	127
	<i>Basic Teaching Formats</i> .....	128
	<i>Getting Set-Up</i> .....	129
	<i>Getting Started</i> .....	130
	<i>Trainee Preparation</i> .....	131
	<i>Starting Lessons</i> .....	132
	Preflight Lesson Plans .....	132
	<i>Introducing Lessons</i> .....	137
	<i>Development</i> .....	139
	Ingredients of Instructional Knowledge .....	140
	Integrated References .....	141
	<i>Common Errors</i> .....	144
	<i>Completion Standards</i> .....	146
	<i>Conclusion</i> .....	146

Postflight Lessons .....	147
<i>Reviewing Intermediate Performance Based Objectives</i> .....	148
<i>Trainee/Instructor Performance Critique</i> .....	148
<i>Instructor Evaluation</i> .....	149
<i>Homework</i> .....	150
<i>Documentation</i> .....	150
More About Pre- and Postflight Lessons .....	151
<i>Big Money/Long Time vs. Small(er) Money/Less Time</i> .....	152
<i>Responsibilities and Priorities</i> .....	155
<i>Encouraging Trainee Participation</i> .....	157
Practical Test Standards.....	158
<b>six</b> <b>Flight Phases and Respective Task Priorities</b> .....	<b>161</b>
Standard Training Flights.....	162
<i>Phase One: Ramp Operations</i> .....	166
<i>Phase Two: Preflight and Engine Start</i> .....	166
<i>Phase Three: Taxi-Out</i> .....	168
<i>Phase Four: Run-Up</i> .....	169
<i>Phase Five: Takeoff</i> .....	170
<i>Phase Six: Departure</i> .....	171
<i>Phase Seven: Cruise</i> .....	172
<i>Phase Eight: High Altitude Maneuvers</i> .....	172
<i>Phase Nine: Emergency Operations</i> .....	174
<i>Phase Ten: Ground Reference Maneuvers</i> .....	176
<i>Phase Eleven: Airport Arrival</i> .....	177
<i>Phase Twelve: Pattern Operations/Landing</i> .....	178
<i>Phase Thirteen: Taxi-In</i> .....	179
<i>Phase Fourteen: Parking and Securing</i> .....	180
<i>Phase Fifteen: Return to Operations Area</i> .....	181
Cross-Country Flights.....	181
<b>seven</b> <b>Flying and Flight Maneuvers</b> .....	<b>187</b>
Fundamentals of 21st Century Flight Training— In Flight.....	187
<i>Maintaining Safety</i> .....	191
<i>Converting Accident Investigation Into Accident Prevention</i> .....	195
<i>Checklists, Do Lists, and Memory Items</i> .....	198
<i>Wind</i> .....	201
<i>Critique and Criticism</i> .....	202
<i>Responsibility In Flight</i> .....	203
<i>Basic Integrated Sensory Flying</i> .....	206

Deconstructing Ground Reference Maneuvers.....	207
<i>Rectangular Course</i> .....	209
<i>Turns Around a Point</i> .....	214
<i>S-Turns</i> .....	218
<i>Correlating Private Pilot Ground Reference Maneuvers</i> .....	221
<i>Eights Around Pylons</i> .....	224
<i>Eights-On-Pylons</i> .....	227
Performance Maneuvers .....	234
<i>Steep Turns</i> .....	238
<i>Chandelles</i> .....	243
<i>Lazy Eights</i> .....	246
Slow Flight and Stalls .....	253
<i>Slow Flight</i> .....	254
<i>Stalls</i> .....	260
Proficiency Stalls .....	261
Demonstration Stalls .....	265
Takeoffs, Landings, and Go-Arounds.....	269
<i>Takeoffs</i> .....	270
<i>Pattern</i> .....	278
<i>Approach</i> .....	281
<i>Landings</i> .....	288
<i>Go-Arounds</i> .....	291
Emergency Operations .....	295
<i>Emergency Approach and Landing</i> .....	298
Multi-Engine Operations.....	303
<i>Single Engine Operations in Multi-Engine Aircraft</i> .....	305
<i>Critical Engine</i> .....	309
<i>Operating an Engine With a Variable Pitch Propeller</i> .....	310
<i>V<sub>MC</sub> Demonstration</i> .....	311
<i>V<sub>YSE</sub> Demonstration</i> .....	318
Technically Advanced Aircraft.....	321
Postflight Briefings.....	324
Practical Test Standards.....	325
<b>eight 21st Century Flight Instructor .....</b>	<b>329</b>
Managing Your Training Program.....	329
CFI Ground Lessons.....	330
<i>Tools for Training</i> .....	331
Cognitive Tools .....	332
Psychomotor Tools .....	335
Evaluative Tools.....	337

CFI Flight Lessons.....	339
CFI Checkrides.....	342
<i>Practical Test Standards</i> .....	343
After CFI Checkrides.....	345
<i>Technically Advanced Aircraft</i> .....	348
<i>Taking Lessons from the Airlines</i> .....	352
<i>Aircraft Checkout and Transition Training</i> .....	357
<i>Flight Reviews</i> .....	365
<i>Pilot Proficiency Award Program</i> .....	371
<i>Endorsements</i> .....	372
FAA/Industry Training Standard—FITS.....	374

## **appendix**

i. FAR ↔ AIM Reference Integration.....	383
ii. FAR ↔ Advisory Circular Reference Integration.....	389
iii.a. FAA Advisory Circular Index.....	401
iii.b. FAA Aviation Safety/Accident Prevention Program Publications Index.....	411
iiic. U.S. Government Aviation Related Publication Internet Resource Index.....	413
iiid. AOPA Air Safety Foundation Publications Index.....	419
iv. Rating Requirements & Instructor Endorsements Quick Guide.....	421

<b>acronyms</b> .....	<b>439</b>
-----------------------	------------

<b>notes</b> .....	<b>443</b>
--------------------	------------

<b>bibliography</b> .....	<b>453</b>
---------------------------	------------

# chapter one

## introduction

The twenty-first century aviation system is growing increasingly and irreversibly complex. Technological adaptations like GPS, radar, and glass cockpits that were once found only in the most advanced aviation sectors are now becoming increasingly commonplace in the general aviation (GA) arena. Airspace regulation and infrastructure modernization proliferate in many of the areas where GA pilots fly. Yet far from offering seamless functionality transparent to end-users, system enhancements present ever greater challenges to today's aviators. Defined airspace increases workload and technically advanced, higher-performance aircraft demand new and greater skill proficiencies. Unfortunately, for GA pilots at the dawn of this new century, these changes are contributing to diminishing accident reduction trends.

High-tech infrastructure with collated monitoring, computerized hardware components, advanced software applications, and improved weather detection and prediction are all being applied to increase aviation safety and utility. A growing body of aviation knowledge and experience is being produced in an effort to grasp and embrace these changes. Manufacturer publications, military and civil airline protocols, technically advanced aircraft safety initiatives, engineering human factors design standards, advisory circulars (AC), and various studies flood the industry. Practices derived from these concerns are being co-opted by the GA community.

Twenty-first century opportunities bring expanding privileges to GA aviators, and those privileges impose new and different skill demands. Increasingly, these skill demands involve judgment and problem solving as much as they involve physical airplane control. With changing pilot skill demands come changing ways of managing aircraft and flight missions. Crew resource management (CRM), single pilot resource management (SRM), risk assessment, and aeronautical decision making (ADM) are concepts relatively new to GA pilots that must be learned and applied.

With these new piloting techniques comes new training content that often calls for new teaching methods. Twenty-first century demands impose greater challenges on today's GA aviators, calling for not just new, but improved training content and methods. And that is the purpose of this book: to advance, deliver, integrate, and apply new information through demonstration of improved general aviation training methods and models to meet the growing challenges faced by today's GA aviators.

Turn-of-the-century aviation changes and innovations have profoundly altered the aircraft GA pilots fly, the ways pilots fly those aircraft, the systems they operate in, and the airspace and airports where they takeoff and land. These changes are rapidly outpacing entrenched GA training practices, guidelines, and expectations. While current training methods are firmly rooted in historical doctrine endorsed by some of aviation’s most noted pioneers, these methods are, nonetheless, outdated.

No matter how vigorously those practices may be defended, changes in the aviation system have undeniably altered what needs to be taught and how instructors teach. Content changes are so profound they cannot continue to be added to existing curriculums as simple, ad hoc addendums to existing programs. Instead, a quantum shift is needed in the ways we conceive flight training: our understanding of what GA pilots need to know and need to be able to do in order to be safe aviators; the training content, the ways pilots learn to fly, and the means instructors deploy to teach flying skills; and what evaluators pursue when examining pilot abilities in the context of today’s highly-evolved aviation system.

By advancing evolved training techniques *21st Century Flight Training* fills the burgeoning gap between current primary flight training protocols and twenty-first century aviation system demands. One of its purposes is to teach pilots how to move certain airplane control functions to the type of automatic, subconscious mental processes used by experts. This frees mental capacity for assignment to twenty-first century system challenges. *21st Century Flight Training* was written specifically for general aviation instructors, pilots, and pilots-in-training of today’s airplanes. It is expressly intended for pilots flying in visual conditions, whether or not those pilots are instrument rated. Much of the content is oriented toward the instructor’s perspective, but all of it supplies valuable training information to every pilot and pilot-in-training of primary pilot certificates, from Private to Commercial to Multi-engine Instructor.

Flight instructors, ground instructors, and trainee pilots will all benefit from reading this book. Insights found in this book transcend pilots of all levels and will pay dividends throughout readers’ lives irrespective of how far they progress in ratings and certificates. Leaders of training organizations, by integrating this material into their instructor and student regimens, will improve their product, the productivity of their instructors, and the success of their customers, achieving training efficiencies and improving pilot performance and safety. Throughout its chapters, this book addresses the ongoing concerns of Federal Aviation Administration (FAA) Safety Team (FAAS Team) members and Designated Examiners (DE), who have long sought to have such material effectively addressed by GA flight training organizations. *21st Century Flight Training* spans the full spectrum of GA airplane flight training: from student, single engine pilot to commercial, multi-engine pilot; from Certified Flight Instructor (CFI) to multi-engine instructor (MEI).

For the first time in a flight training text, this book weaves relevant source materials directly throughout the content—particularly FAA references, federal aviation regulations, practical test standards, advisory circulars, and industry-provided materials. It correlates when, why, and how regulatory guidance applies to the training process. Special attention is paid to incorporating and proliferating “new-century” FAA special emphasis agendas, such as FAA/

Industry Training Standards (FITS), the *Technically Advanced Aircraft Safety Study*, the *Human Factors Design Standard (HFDS)*, single-pilot resource management, aeronautical decision making, and scenario-based training, along with National Transportation Safety Board (NTSB) contributions. All of these concepts are applied from an aviation system standpoint.

Cementing the argument that these changes are necessary, Chapter 2 begins with a statistical review of GA accident rate trends and associated factors as we turn the corner of a new century. Diminishing downward trends in accident rates are shown, validating the need for new methods and new techniques in GA primary flight training. Potential reasons for accident rate plateaus are highlighted, including modernization of the aviation system, proliferation of twenty-first century technology, increased cockpit task loading, and expanding airspace complexity.

In Chapter 3, “The Mental Airplane,” readers learn how better to cope with these changes. Introducing twenty-first century discoveries in the field of human cognition (the science of thought and thinking), readers take a virtual tour of the mind, examining the routes of sensory interpretation and how they correlate to learning and skill development. All pilot perceptions, decisions, and control inputs are shown to spring from these all-important interpretations of the flight environment.

Twenty-first century advances in neuroscience and cognitive psychology have led to significant discoveries in the field of learning. Researchers can now trace the formerly elusive pathways of human thought, illuminating the structure of the human mind and mapping its function. They can now see, in real time, the brain in action, generating thoughts.

What does this mean to today’s aviators? It means we can now learn how pilot thoughts interface with flying environments to determine performance. Just as we strive to understand the mechanics of every other component of the interdependent aviation system, better understanding of how pilots function in the system is critical. For the first time in an aviation text, the mechanics of pilots’ thought processes are explained. From this readers gain better understanding of memory, learning, and thinking. And it means we can trace, for the first time ever, the very origins of pilot judgment, problem solving and aeronautical decision making that ultimately form the basis of all pilot actions.

In accident investigation reports it is no longer enough simply to claim “pilot error.” Nor is it enough to claim, “seventy-plus percent of all accidents stem from pilot error.” These are far-too-simple summaries of the many dynamic factors contributing to pilots’ decision making processes. Complete diagnosis of “pilot error” calls for an involved process of working backward from the scene of an accident, through the flight controls to the pilot’s biomechanical inputs that led to the accident, and onward into the mind of the pilot. It is there where we find the ingredients that produce accident-provoking decisions.

Ultimately, for a truer understanding of accidents, we must deconstruct faulty reasoning and problem solving processes all the way down to their core elements: the sensory mechanisms and pilot judgments that produce accident-inducing flight control inputs. We must continue past *the what and how* of pilot error until we arrive at *the why* of pilot error. Only then can we achieve the real aim of accident investigations: prevention.

Accident investigation integrity and final conclusion accuracy depend on seeking out the root causes of accidents. Then new methodologies can be developed to transform causal discovery into accident prevention. Only by doing so can we hope to have an impact on GA accident rates. Later, in Chapter 7, that is exactly what readers learn how to do. Applying newly-developed methodology, readers learn to break the links of accident chains using reverse introspection of NTSB accident investigation classifications. In the process, pilots learn another valuable skill: how better to avoid accidents.

After traveling this new road of *real* understanding of memory's role in learning, readers arrive at complete awareness of how they solve problems while flying. This permits the introduction of a more conscious, directed approach toward the decisions they make as pilots. Chapter 3 then defines and applies concepts from cognitive psychology, teaching readers different ways information is stored and processed by the brain. This provides more thorough understanding of those concepts presented in the *Aviation Instructor's Handbook (AIH)*, supplying instructors with better methods for structuring aeronautical knowledge materials and for demonstrating aerial maneuvers. This is followed by a thorough explanation and differentiation of reasoning and problem solving. Then we show how instructors can use neurolinguistics (literally, mind-language connections) to their advantage while communicating with trainees. All of the information in Chapter 3 has radical implications for our understanding of how pilots learn flying skills (and how instructors teach them), ultimately revealing the first of many new training techniques: visualization and kinesthetic kinematics.

Visualization is explained in Chapter 3, showing first how it fires the neuronal circuitry of sensory record and response in pilots' minds, then how it activates a new method for economically replicating flight lessons. This section teaches readers remarkable new ways to instantly improve pilot performance, enhance training efficiencies, and save money. Pilots taught these methods gain, literally, a whole new mindset emanating from the twenty-first century world of scientific discovery. Eventually, visualization is coupled with kinesthetic kinematics (a study of bodies in motion) to create "muscle memories," enabling the nearly subconscious aircraft control that marks expert proficiency.

This is followed by a discussion of human factors advances, bringing into play the twenty-first century redesign of aviation's *Human Factors Design Standard*. A wealth of information about how pilots interface with physical airplanes is stored in this vital document. Although used routinely by nearly every other aspect of the aviation system, including engineering, manufacturing, systems development and operational design, this information has been slow to reach the pilot training community. Readers learn how aircraft are shaped and modified in manufacturer engineering stages to accommodate unique human features in flight. We explore the effects of pilot physical characteristics from an engineering standpoint (biomechanics and anthropometry) to reveal how awareness of these design features creates opportunities for improved skill in how pilots manage "the physical airplane."

Next, environmental influences, including ergonomics, are added to the mix to understand fully how pilots function in cockpit work environments. Then, automation takes center stage—or rather, how the stage must be set *before* automation is used takes center stage. Pilots of today's aircraft encounter at a

# 21st Century **flight training**

## **General Aviation Manual for Primary Flight Training in the New Millennium**

**Sean E. Lane**

Help for flight instructors and their students in an increasingly complex aviation system

Effective flight training in this advanced technological age calls for improved teaching methods. Sean Lane's *21st Century Flight Training* discusses core concepts such as flight phases, task prioritization, proficiency segments for performance maneuvers, as well as visual situational awareness—all of which lead to improved training efficiency and intelligent aeronautical decision making. At the center of this discussion is Integrated Sensory Flying (ISF): a concept that answers a long-awaited call for a visual flight instruction program similar to that of Basic Attitude Instruments (BAI).

*21st Century Flight Training* teaches all the primary flight training maneuvers from the perspective of an examiner with countless checkride insights, guiding readers from initial flight instructor lessons to conducting flight reviews on their own. Flight instructor candidates are led through the development of a complete set of lesson plans, along the way learning how to teach maneuvers, and navigating through oral examinations, practical tests and on to certification as twenty-first century flight instructors.

This book shows how to apply visualization and psychomotor techniques as flight instruction tools, and integrates references, scenario-based training, and FAA special-emphasis programs—including the TAA Safety Study and the Human Factors Design Standard—into instructional lessons. *21st Century Flight Training* will help instructors train a new generation of aviators to handle the complex airspace of our era.



*Sean Lane is an 8,000 hour, ATP-rated Part 121 Captain, Gold Seal CFI with over 1,100 hours dual-given, former Part 141 Check Instructor, and former U.S. Air Force mechanic. He lives near Superstition Mountain in Arizona.*



**Aviation Supplies & Academics, Inc.**

7005 132nd Place SE | Newcastle, Washington 98059  
1-800-ASA-2-FLY | [www.asa2fly.com](http://www.asa2fly.com)



PNR ASA-C21FT

ISBN 978-1-56027-720-0



9 781560 277200



5 2 9 9 5