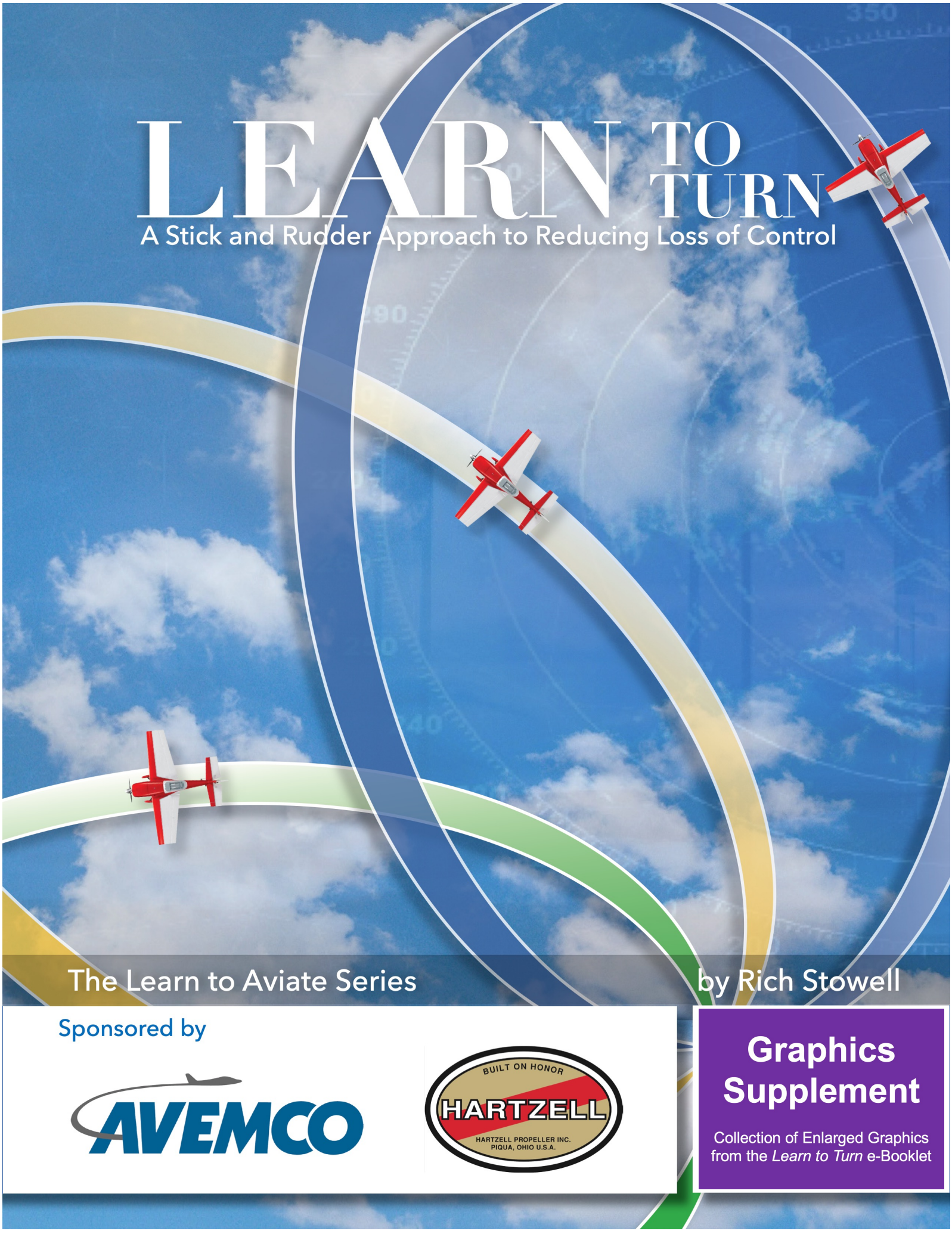
LEARN TO TURN
A Stick and Rudder Approach to Reducing Loss of Control
The Learn to Aviate Series
by Rich Stowell
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Learn to Turn

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Collection of Enlarged Graphics
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Disclaimer

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The assets should be used as a general guide only and not as the ultimate source of aeronautical principles or procedures. The assets are designed to complement and supplement other aviation texts, as well as formal flight instruction. For additional reference materials and recommended reading, refer to the Bibliography provided in the *Learn to Turn* booklet.

Stalls, spins, and other unusual attitudes, whether intentional or unintentional, can be life threatening. The assets are not a substitute for actual flight training or for proficiency in the techniques and maneuvers described. The author and publisher strongly recommend you receive hands-on flight training only from qualified flight instructors experienced in *Learn to Turn* exercises and techniques, using only well-maintained airplanes that are properly loaded and approved for the maneuvers to be flown, with the appropriate safety equipment—including parachutes when required—before attempting any of the maneuvers and scenarios described in the assets.

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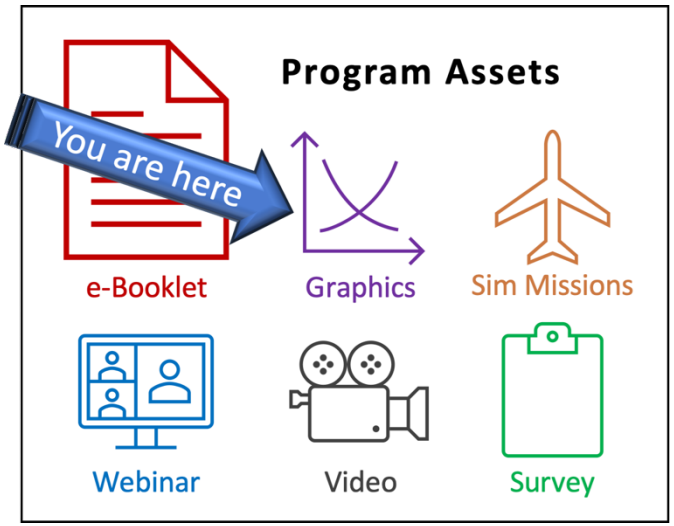
As stated in the Federal Aviation Regulations, Part 91, Section 91.3, Paragraph (a):

> **The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.**

Directory



All the assets in the free *Learn to Turn* program are available online at Community Aviation

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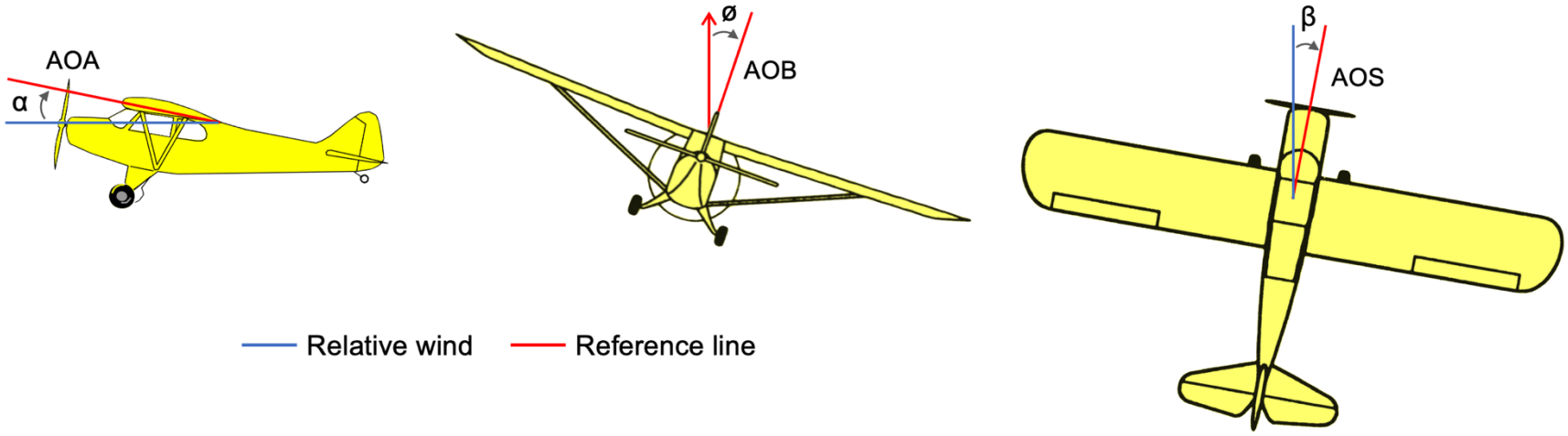
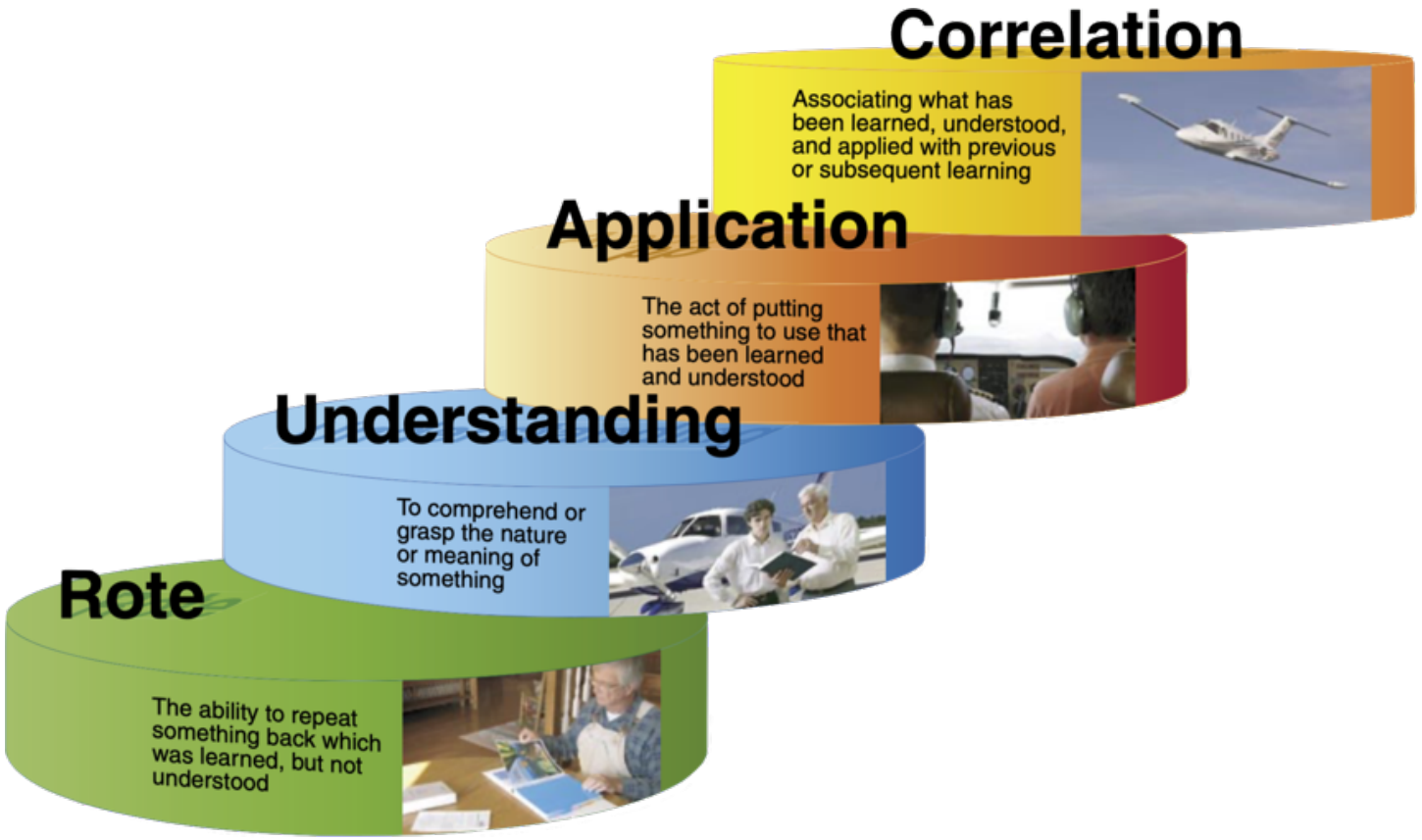
Don't forget to take the survey upon completing the *Learn to Turn* program!

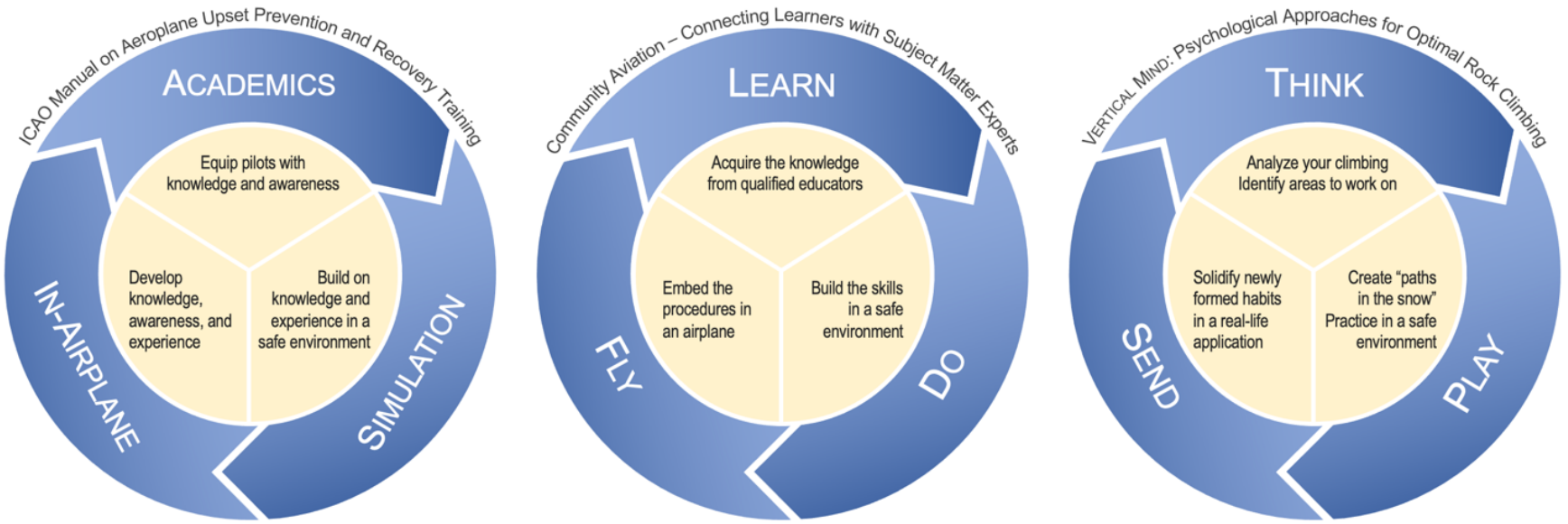


Asset	e-Booklet	Webinar
Reference	1-8	—
Context	Depicting angles of attack, bank, and sideslip per their definitions.	
Source	Rich Stowell.	

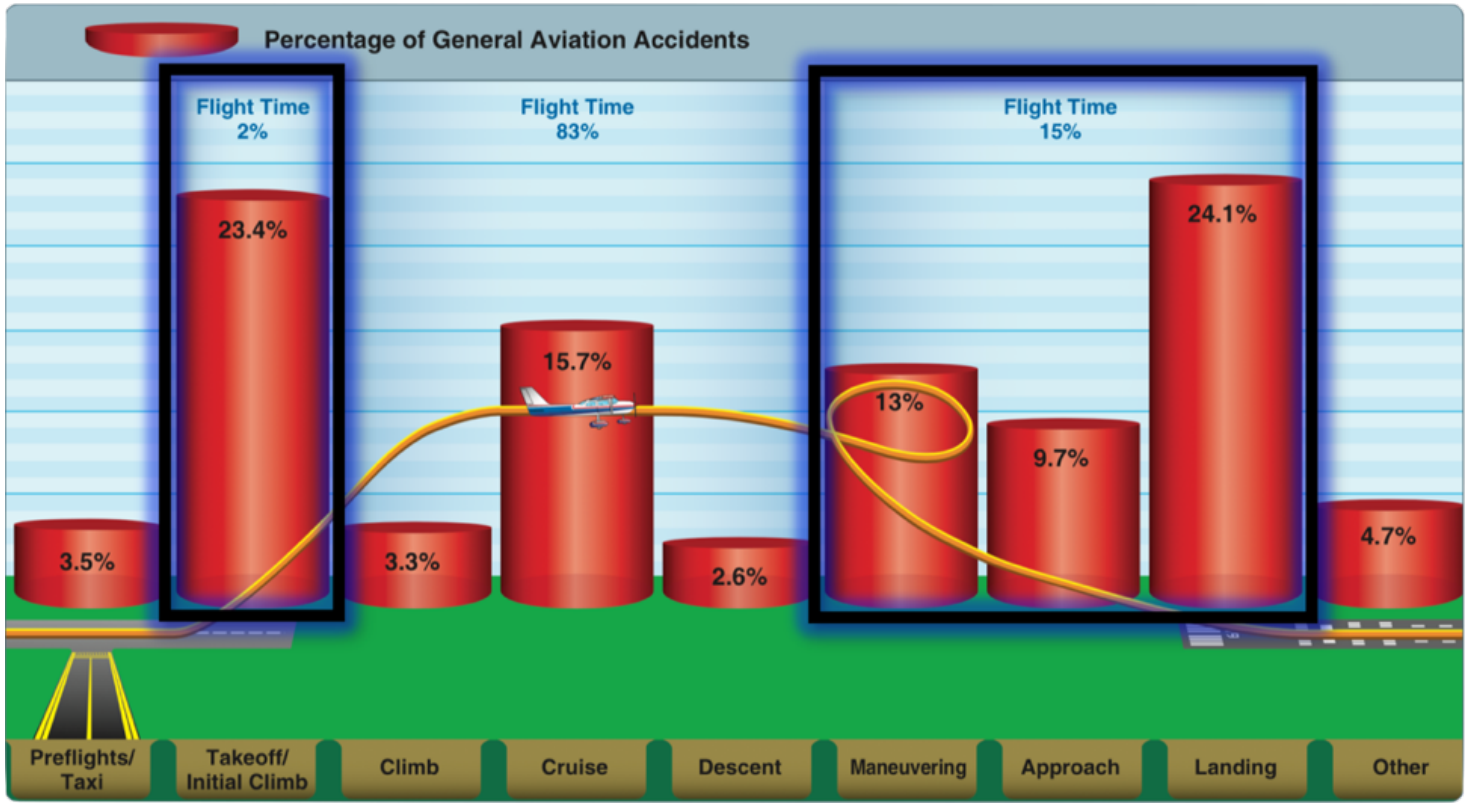
Asset	e-Booklet	Webinar
Reference	2-2	—
Context	Possible reactions to learning that "elevator is the turn control."	
Source	Rich Stowell.	



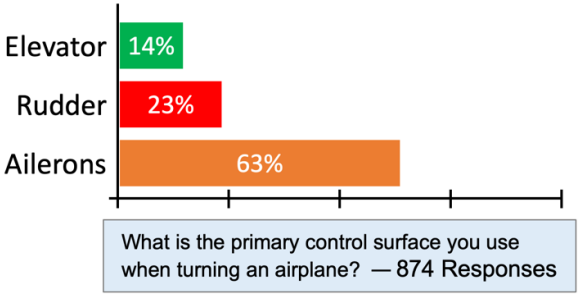
Asset	e-Booklet	Webinar
Reference	2-2	—
Context	Levels of learning taught to instructors.	
Source	*Aviation Instructor's Handbook*, 2008, G-4.	

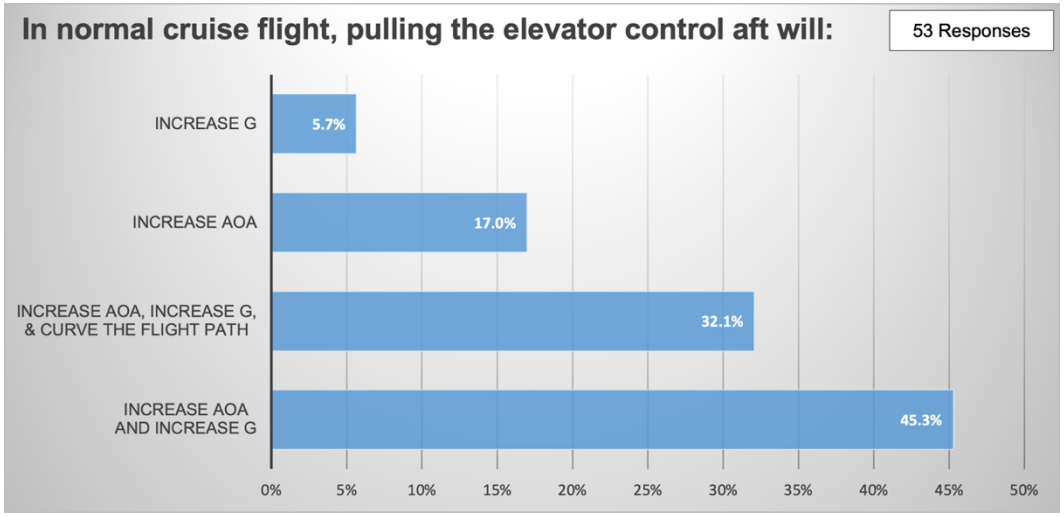


Asset	e-Booklet	Webinar
Reference	2-9	—
Context	Examples of frameworks for optimal learning experiences.	
Source	Adapted from McGrath & Elison, *Vertical Mind*, 2014, 230.	

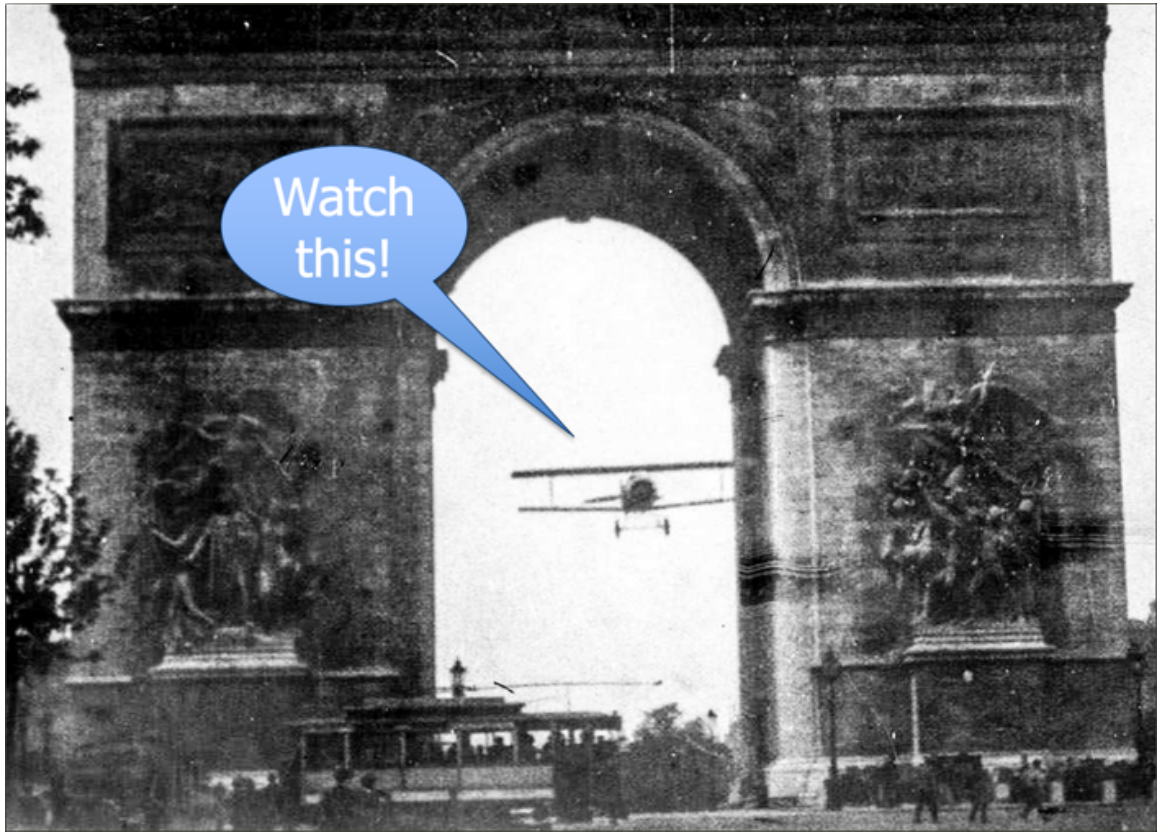


Asset	e-Booklet	Webinar
Reference	3-2	03:04
Context	Distribution of accidents vs. average flight time spent in each phase.	
Source	*Pilot's Handbook of Aeronautical Knowledge*, 2008, 17-2, modified.	

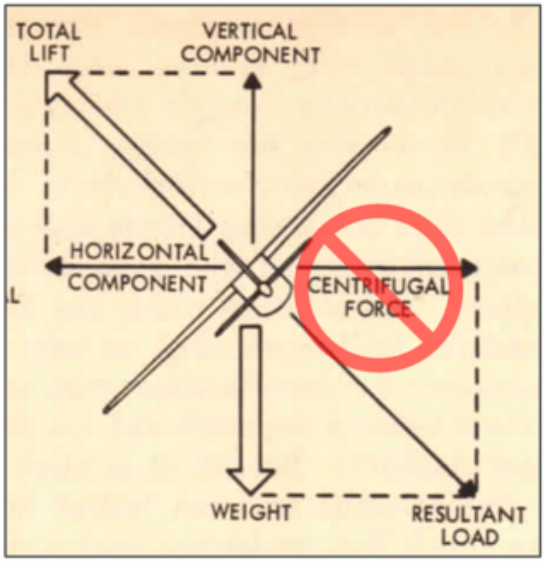




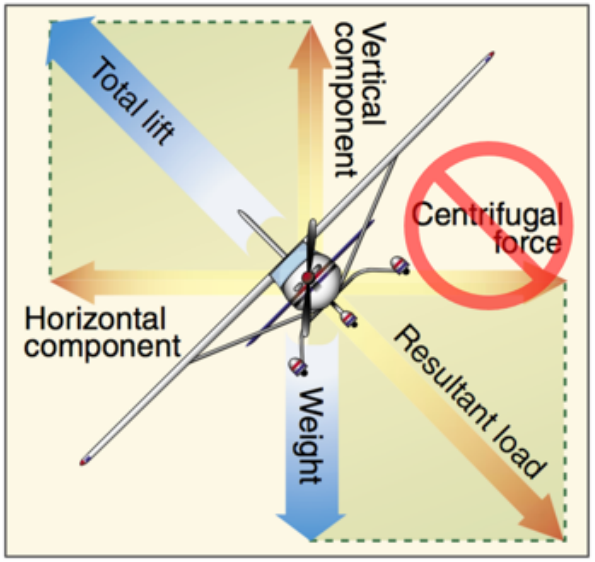
Asset	e-Booklet	Webinar
Reference	3-3	16:58
Context	Results of surveys taken during safety presentations.	
Source	Rich Stowell.	



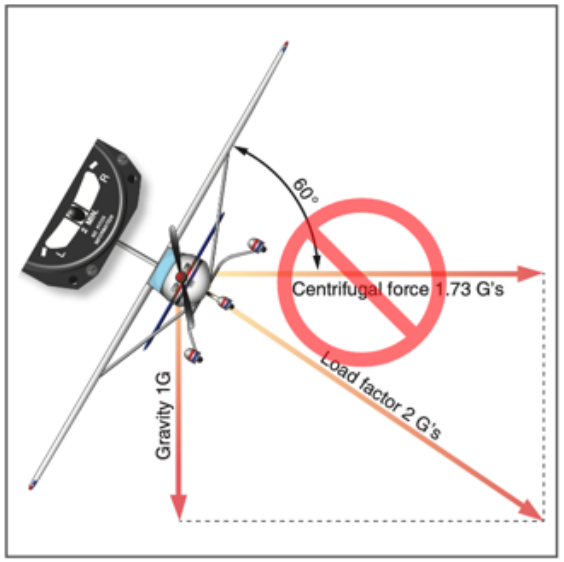
Asset	e-Booklet	Webinar
Reference	3-6	—
Context	A tactical operational error, Arc de Triomphe, France, 1919.	
Source	Wikimedia Commons, modified by Stowell.	



1980

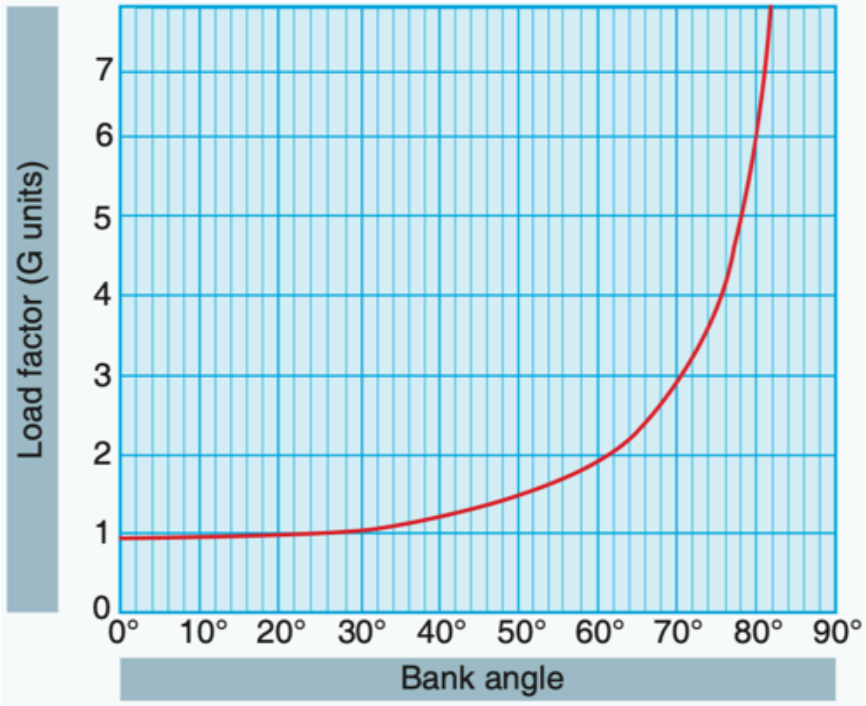


2008

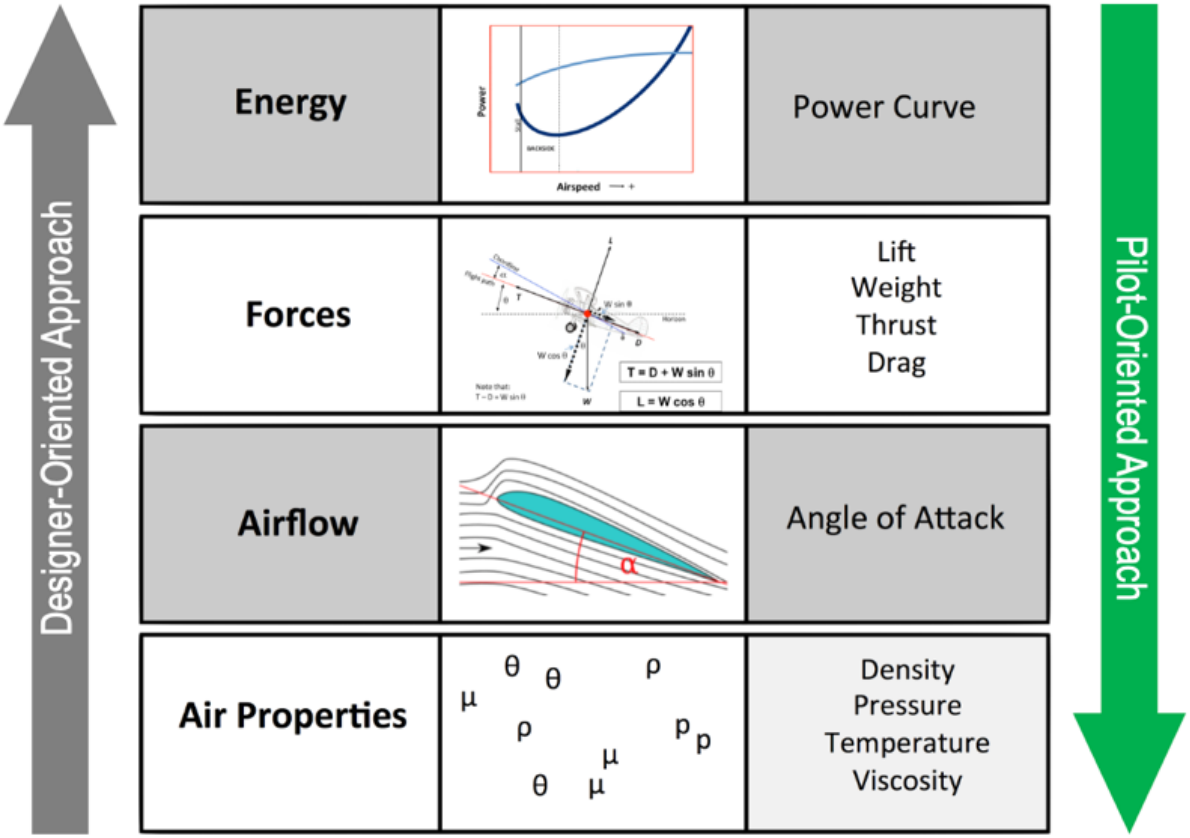


2016

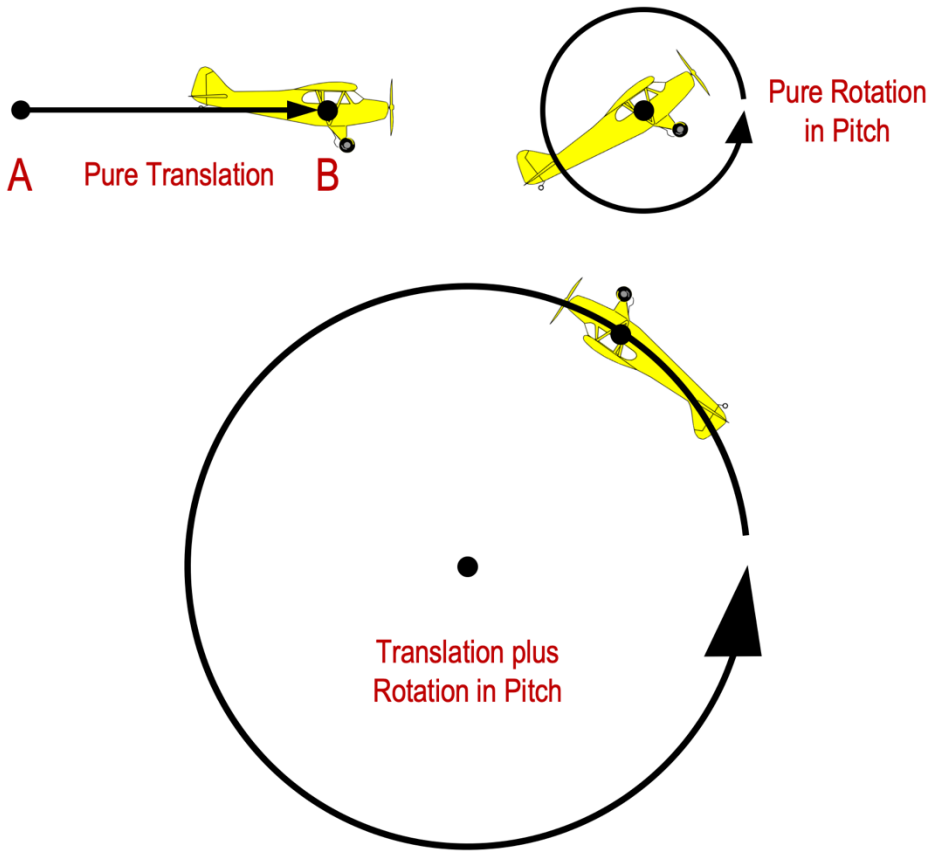
Asset	e-Booklet	Webinar
Reference	3-6	—
Context	Perpetuating the false notion of centrifugal force in level turns.	
Source	Various FAA handbooks, modified by Stowell.	



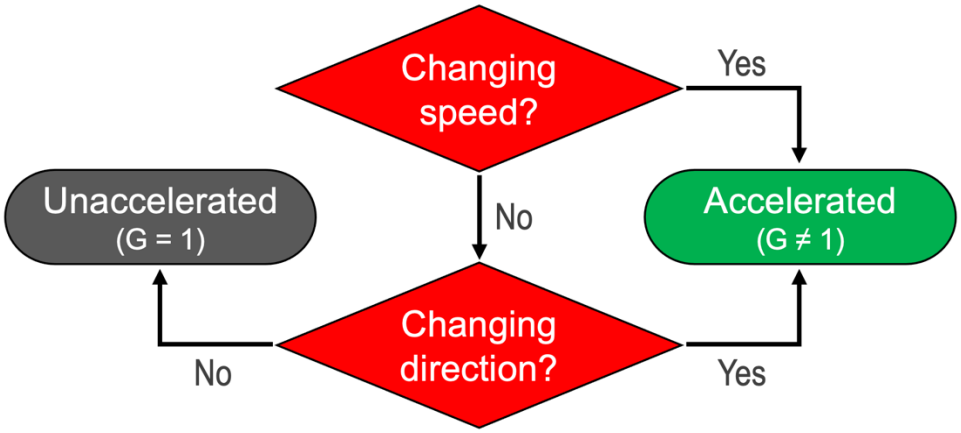
Asset	e-Booklet	Webinar
Reference	3-7	13:35
Context	Typical Bank-G diagram found in FAA handbooks.	
Source	*Pilot's Handbook of Aeronautical Knowledge*, 2008, 4-29 & 2016, 5-34.	



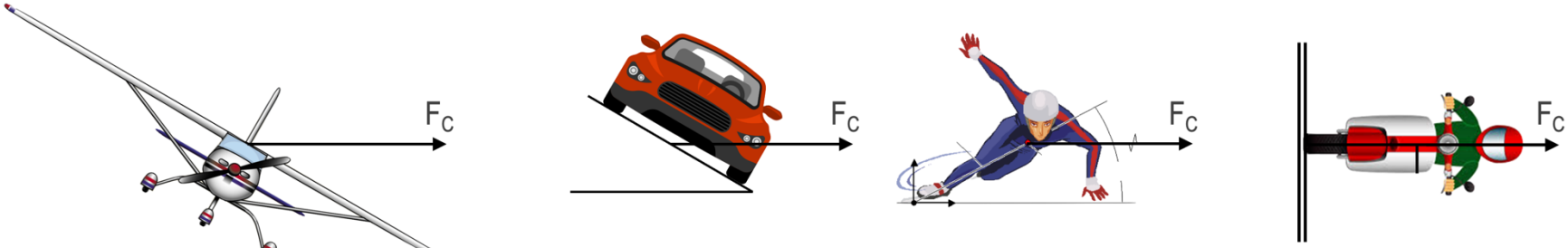
Asset	e-Booklet	Webinar
Reference	3-12	—
Context	Designer-oriented vs. Pilot-oriented approaches to flight training.	
Source	Merkt, *Flight Energy Management Training*, 2013, 33.	



Asset	e-Booklet	Webinar
Reference	4-2	08:55
Context	Examples of basic object motion: translation and rotation.	
Source	Rich Stowell.	



Asset	e-Booklet	Webinar
Reference	4-2	—
Context	Determining if flight is accelerated or unaccelerated.	
Source	Rich Stowell.	



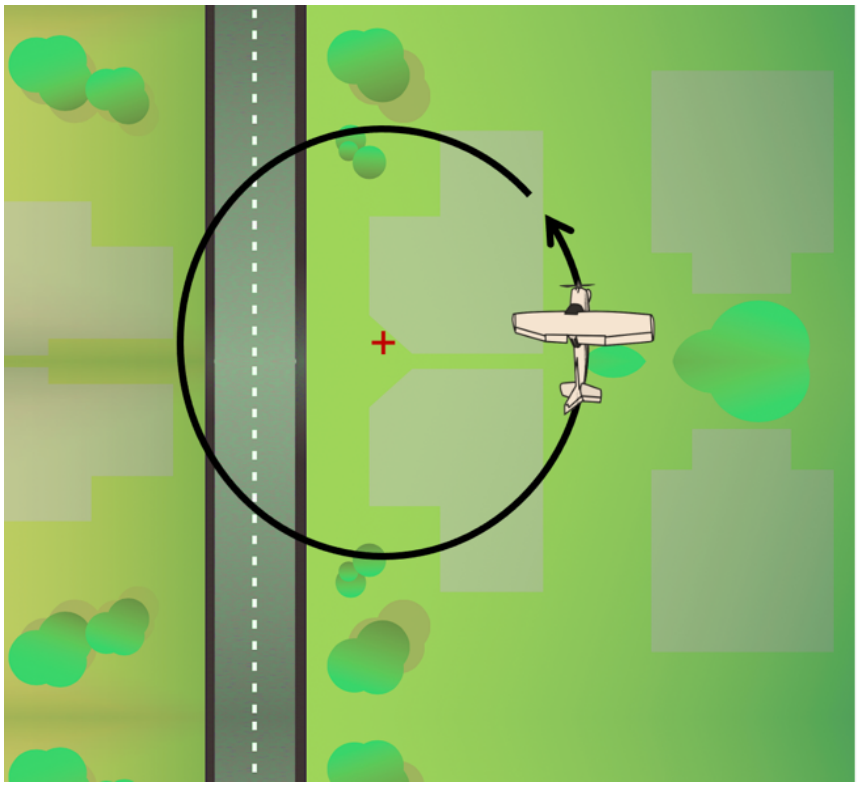
Examples of centripetal force acting on objects in horizontal turns

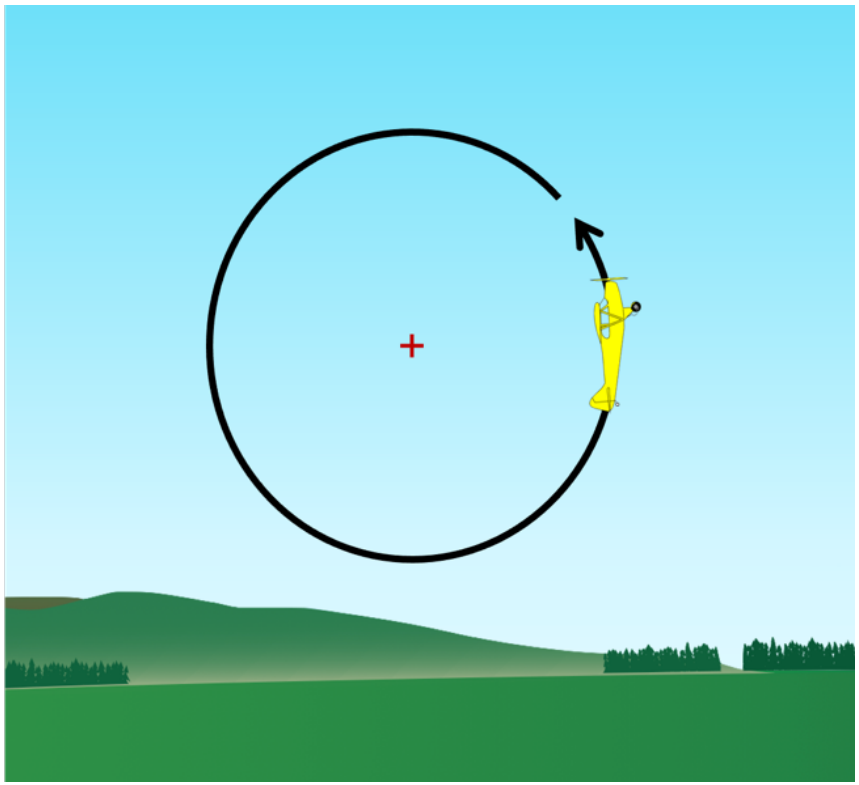
Asset	e-Booklet	Webinar
Reference	4-3	04:49
Context	Centripetal force turning various objects in the horizontal.	
Source	Multiple sources, modified by Stowell.	

Maneuver	Geometric Plane	Attributes			
		G ≠ 1	Curved	Rate	Radius
Level Turn	Horizontal	✓	✓	✓	✓
Chandelle	Oblique	✓	✓	✓	✓
Loop	Vertical	✓	✓	✓	✓

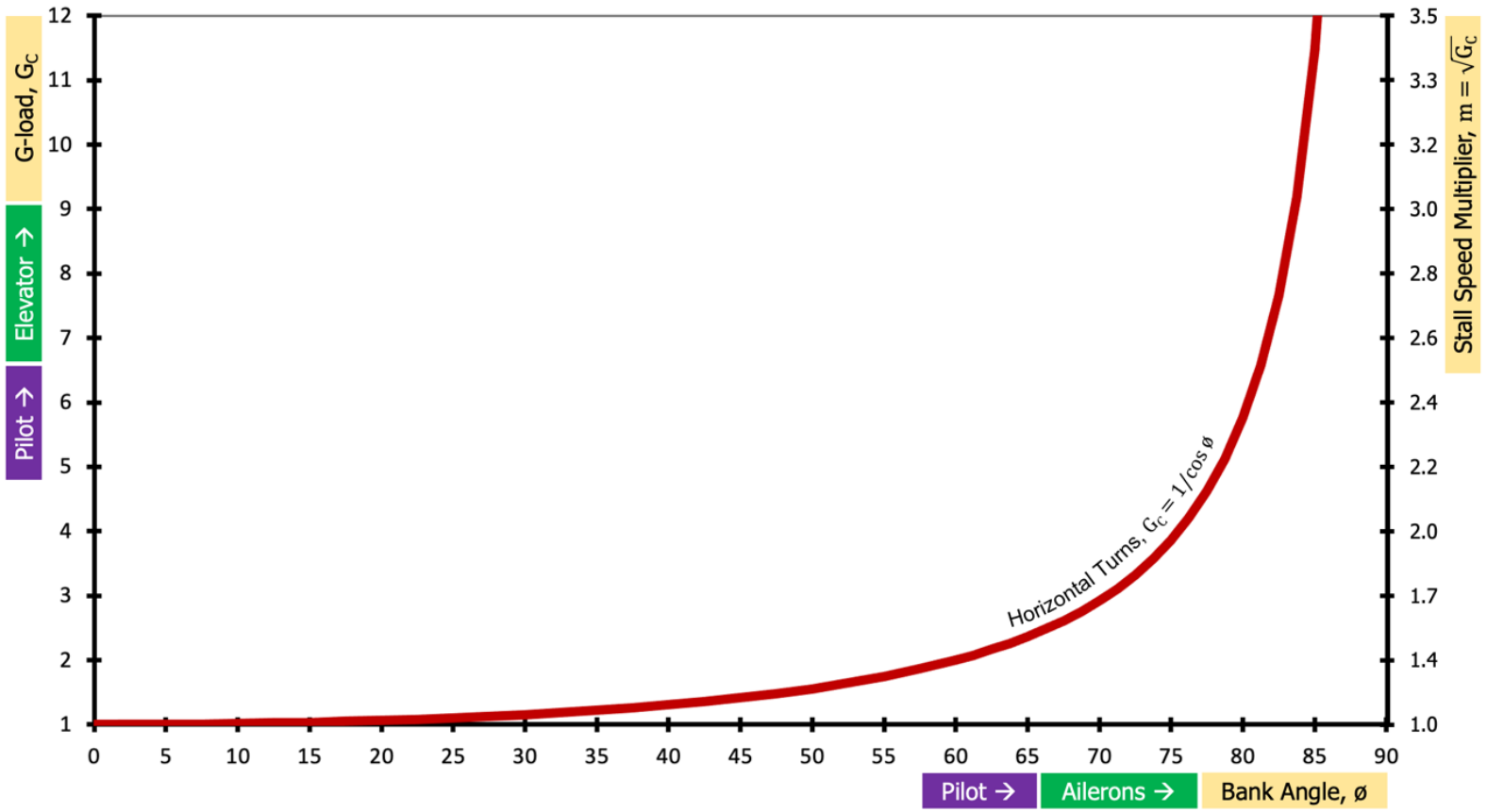
Variable	Change	Effect on Turn		Description
		Radius	Rate	
Airspeed	Increase	Increase	Decrease	Travel slower around a bigger circle.
	Decrease	Decrease	Increase	Travel faster around a smaller circle.
G-load	Increase	Decrease	Increase	Travel faster around a smaller circle.
	Decrease	Increase	Decrease	Travel slower around a bigger circle.

Asset	e-Booklet	Webinar
Reference	5-3	10:56
Context	Common attributes of turns; effects of V and G on radius and rate.	
Source	Rich Stowell.	

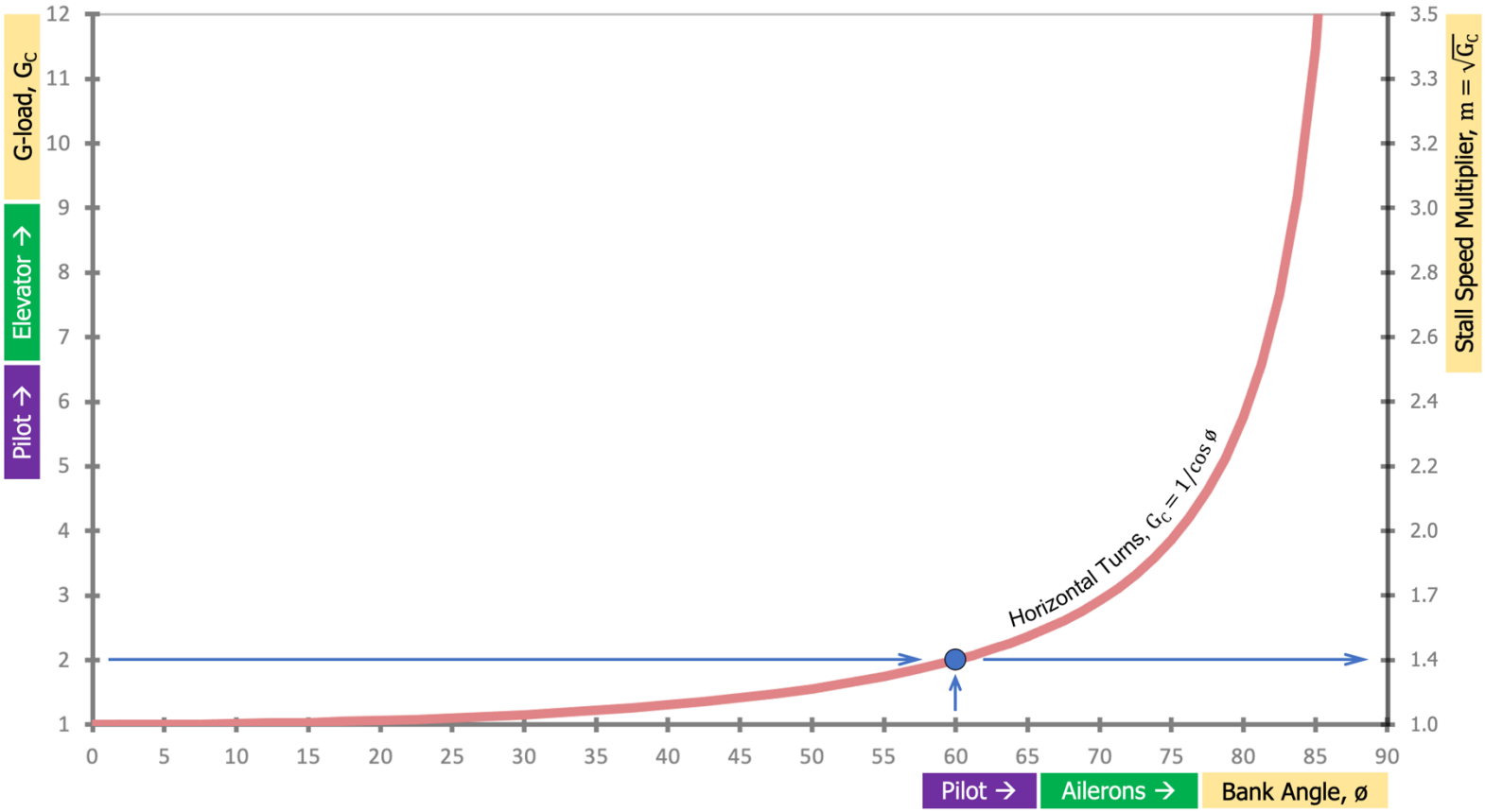




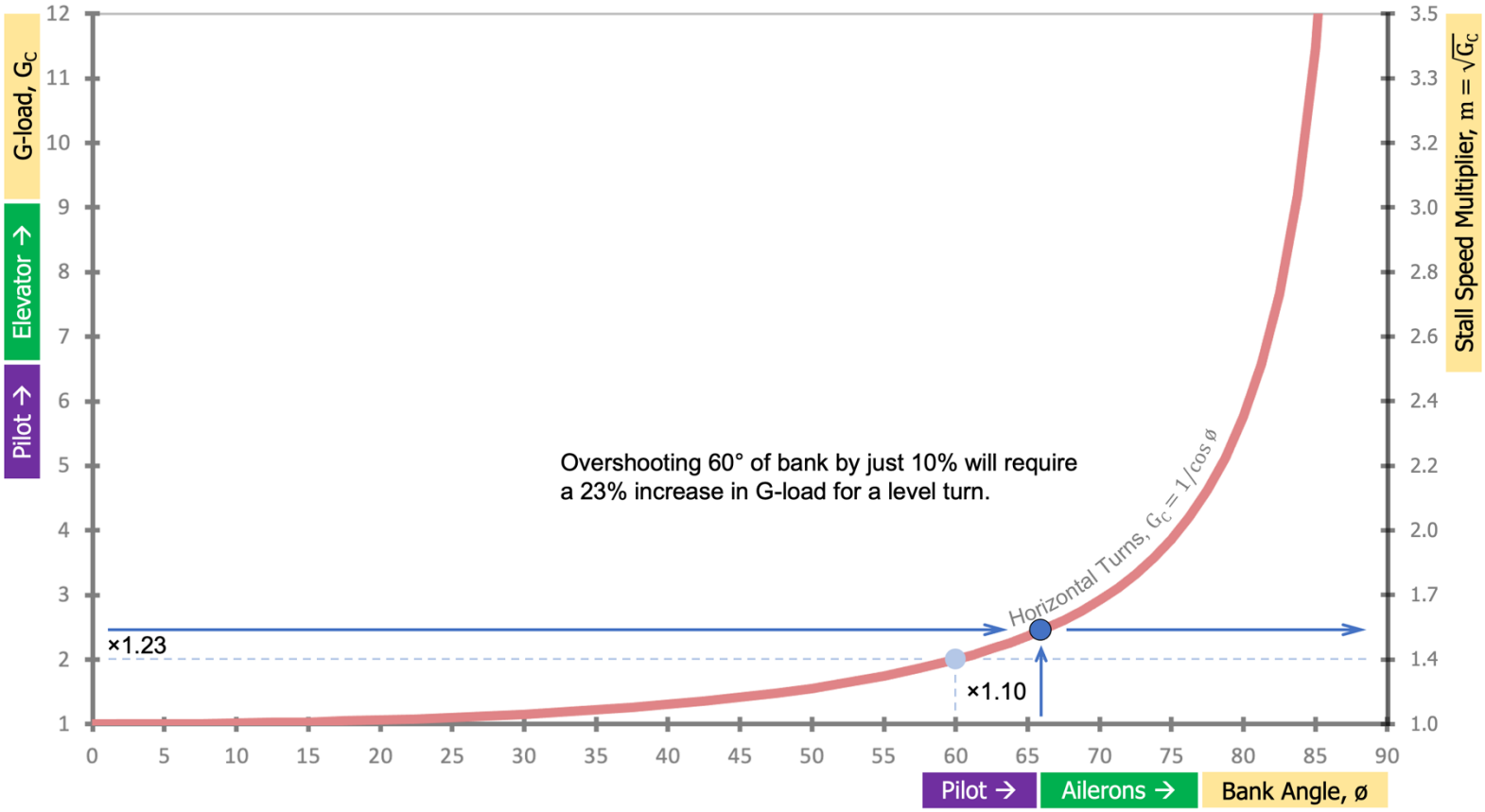
Asset	e-Booklet	Webinar
Reference	5-4	10:28
Context	Different perspectives, yet circular flight paths nonetheless.	
Source	Rich Stowell.	



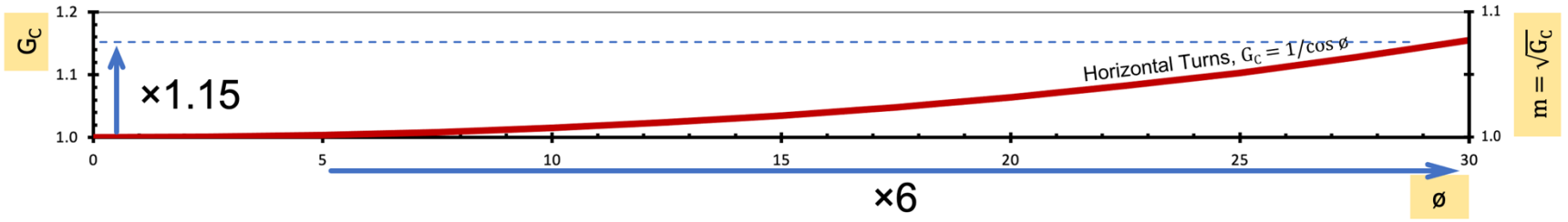
Asset	e-Booklet	Webinar
Reference	5-6	13:58
Context	Basic ø-G diagram with pilot actions and stall speed multipliers.	
Source	Rich Stowell.	



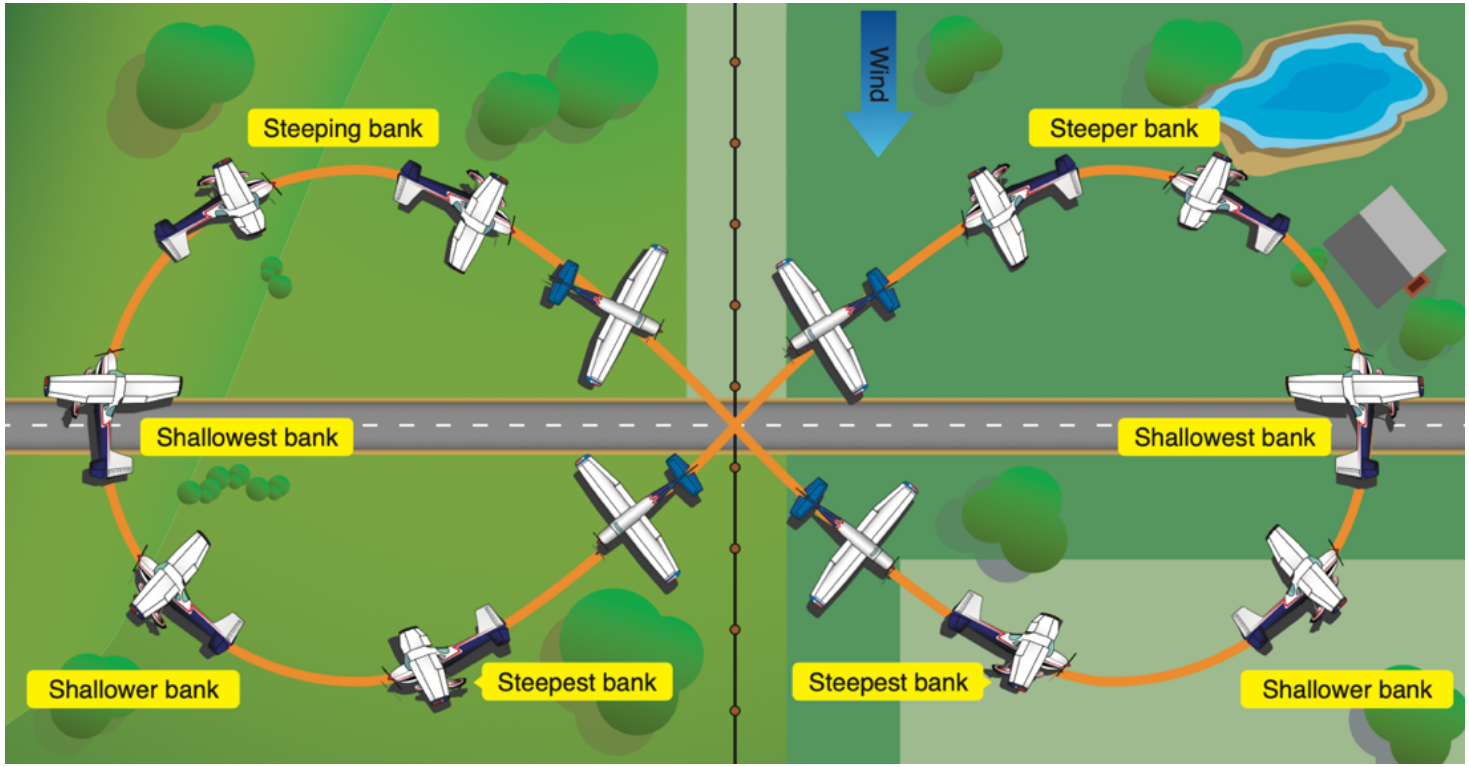
Asset	e-Booklet	Webinar
Reference	5-7	16:12
Context	Mapping out a steep level turn on the ø-G diagram.	
Source	Rich Stowell.	



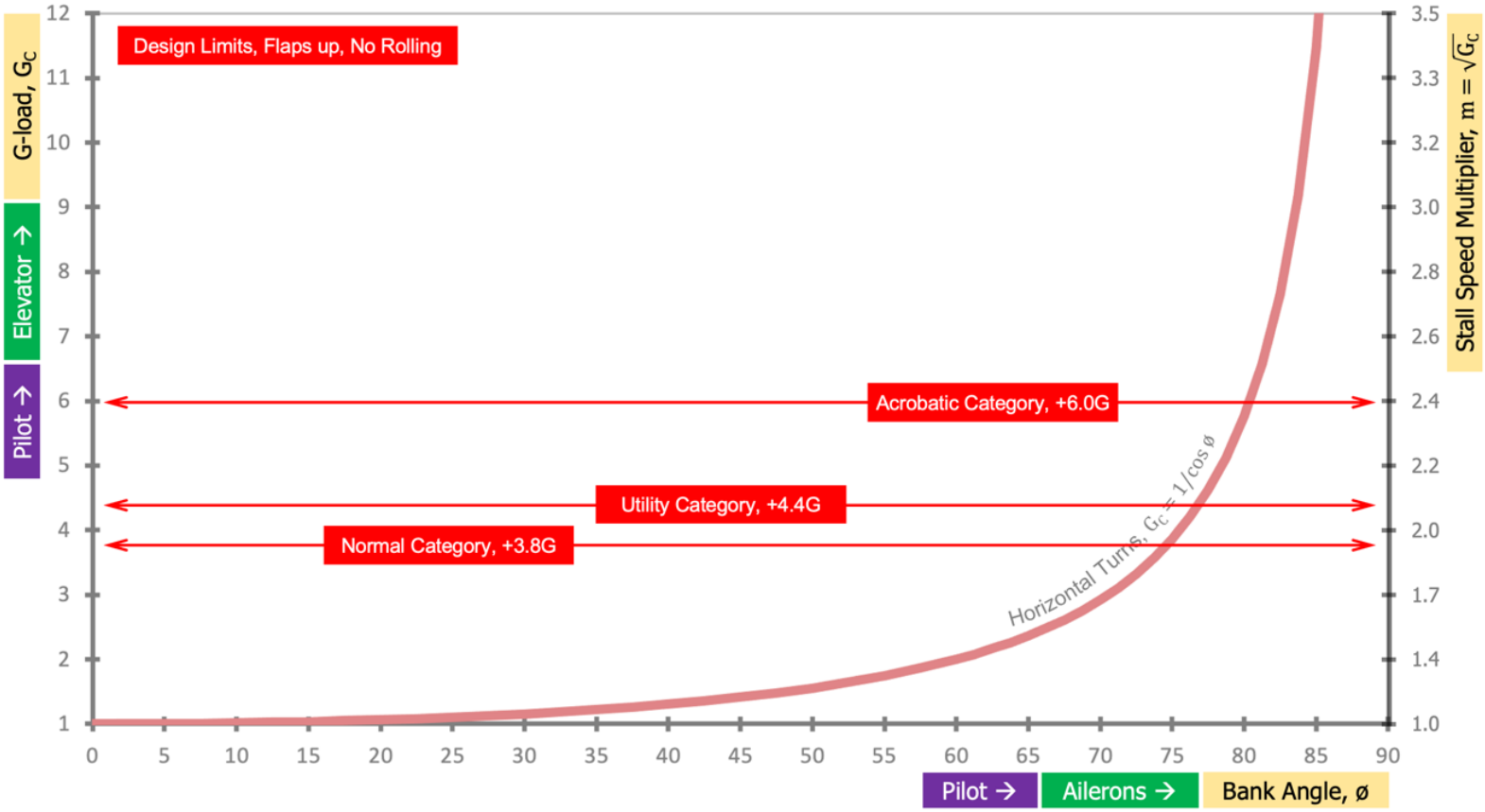
Asset	e-Booklet	Webinar
Reference	5-8	—
Context	Consequences of overshooting 60 degrees of bank on level turning.	
Source	Rich Stowell.	



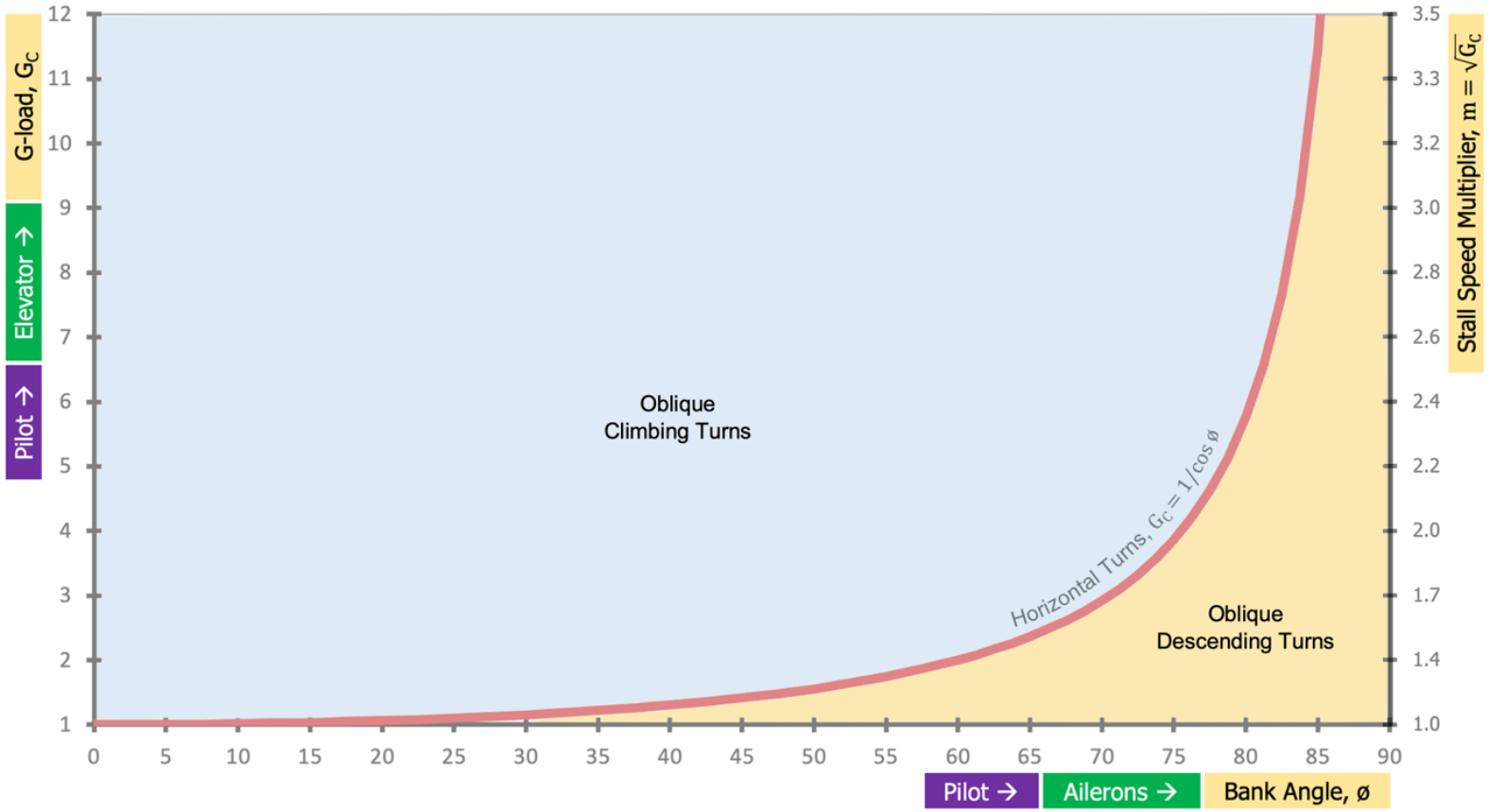
Asset	e-Booklet	Webinar
Reference	5-8	17:10
Context	Shallow banks, small changes in G, and Just Noticeable Difference.	
Source	Rich Stowell.	



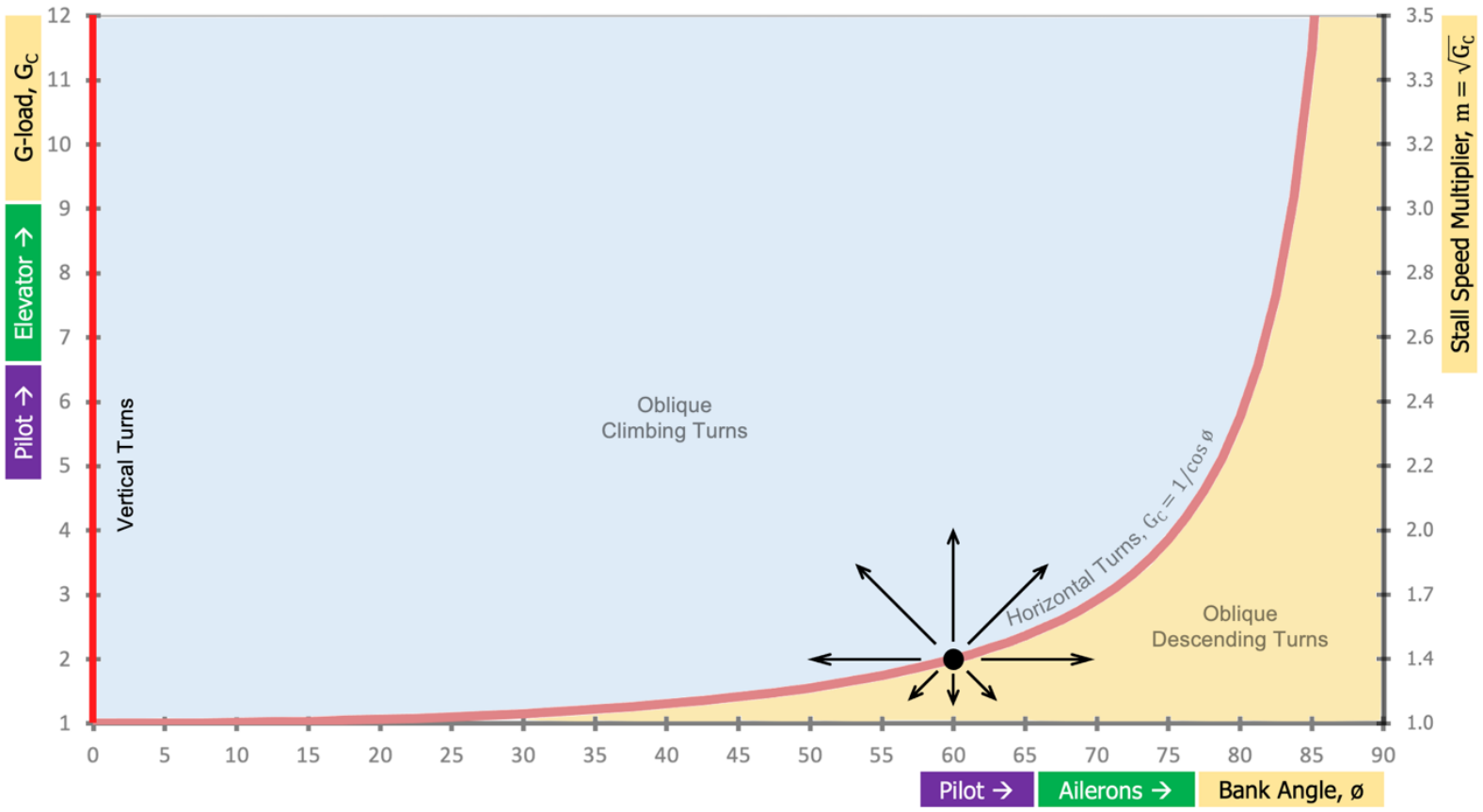
Asset	e-Booklet	Webinar
Reference	5-9	—
Context	Eights across a road described as “loops” with variable bank and G.	
Source	*Airplane Flying Handbook*, 2016, 6-13.	



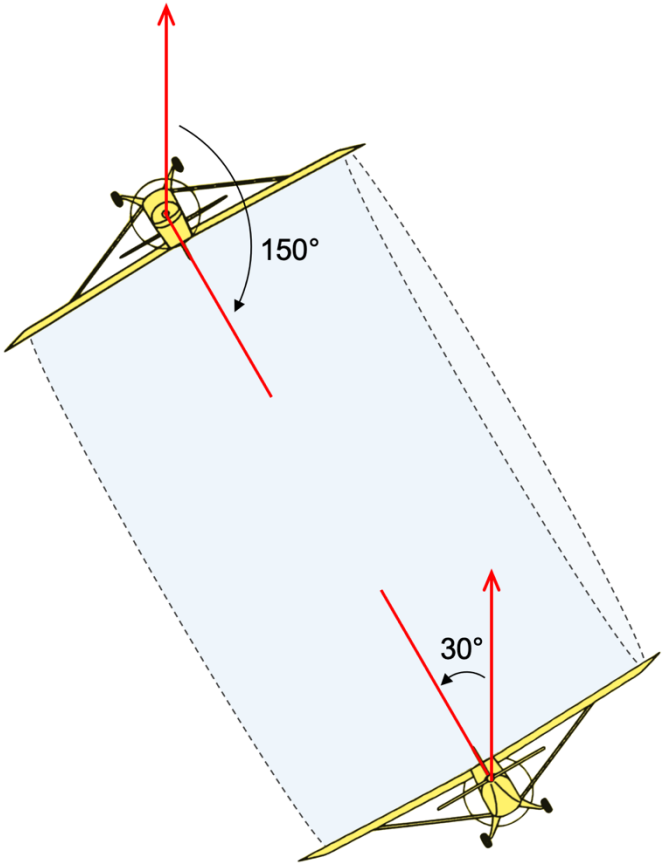
Asset	e-Booklet	Webinar
Reference	5-11	20:12
Context	ø-G diagram enhanced with airplane design limits.	
Source	Rich Stowell.	



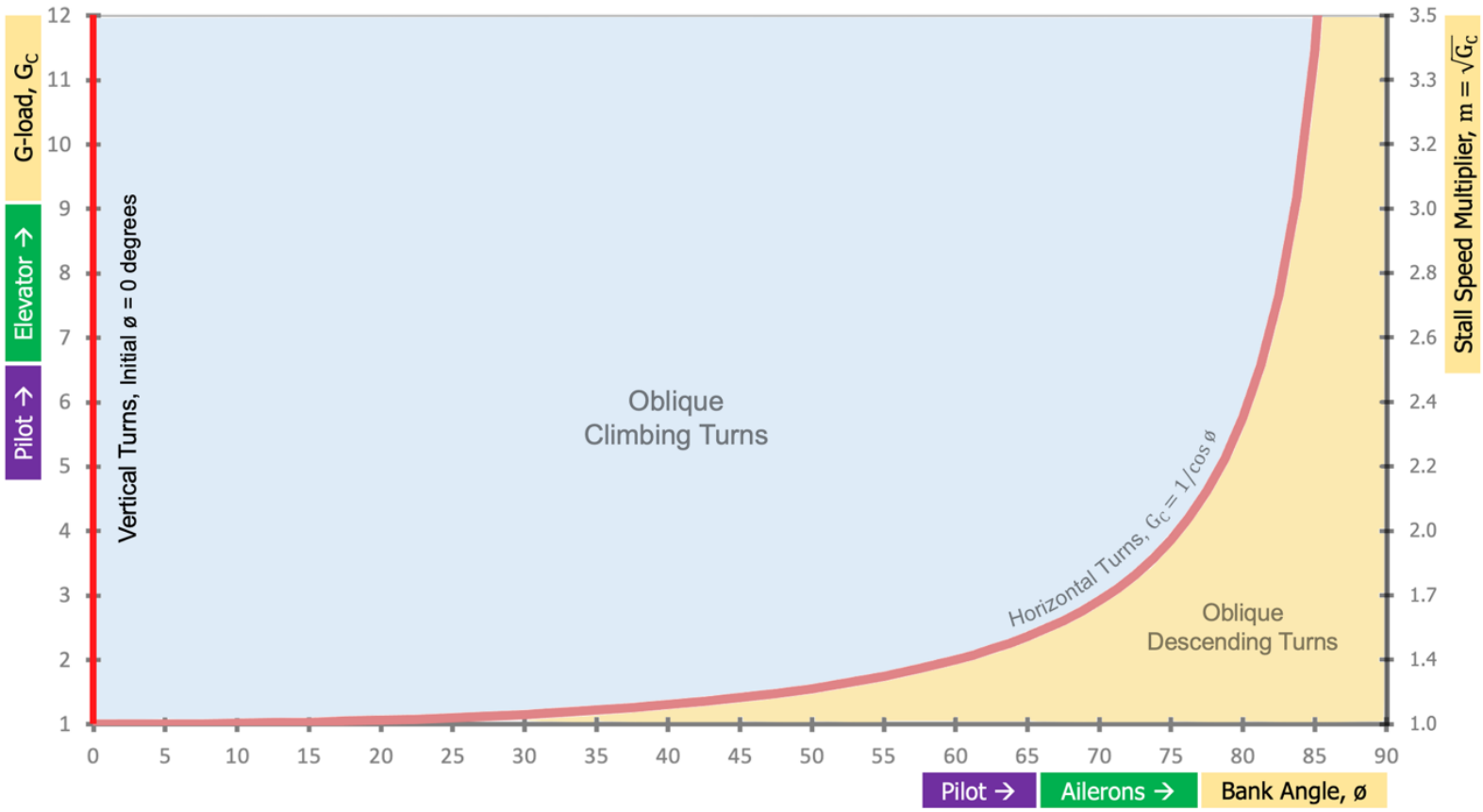
Asset	e-Booklet	Webinar
Reference	5-12	18:45
Context	Oblique climbing and descending turns on the ø-G diagram.	
Source	Rich Stowell.	



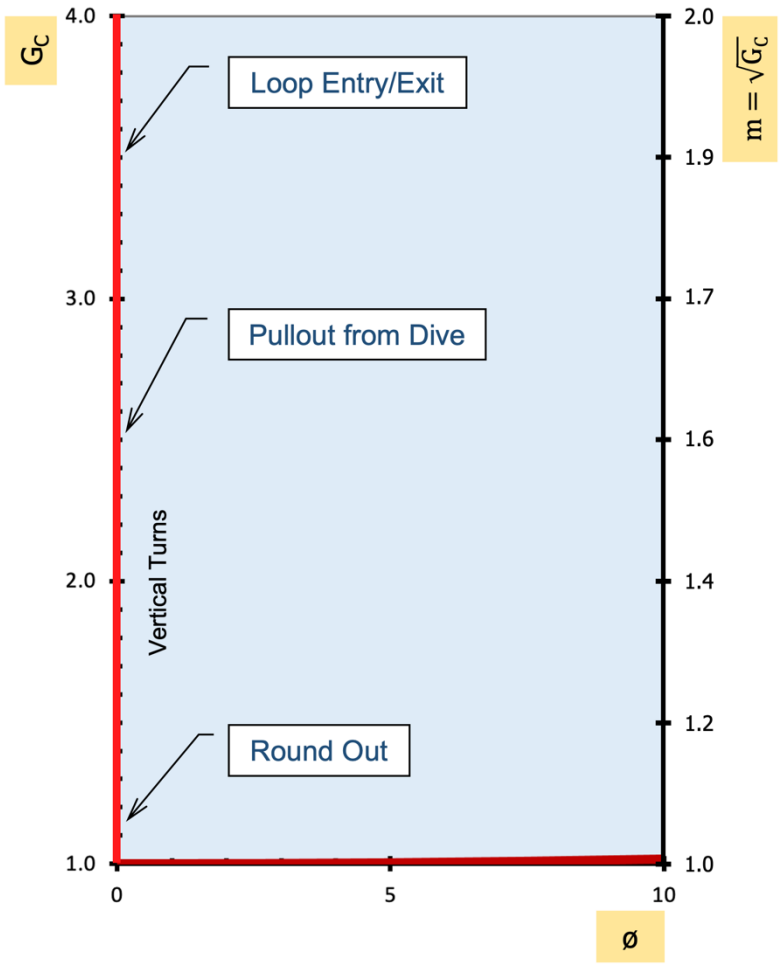
Asset	e-Booklet	Webinar
Reference	5-13	—
Context	Performance consequences of tinkering with values of bank and G.	
Source	Rich Stowell.	



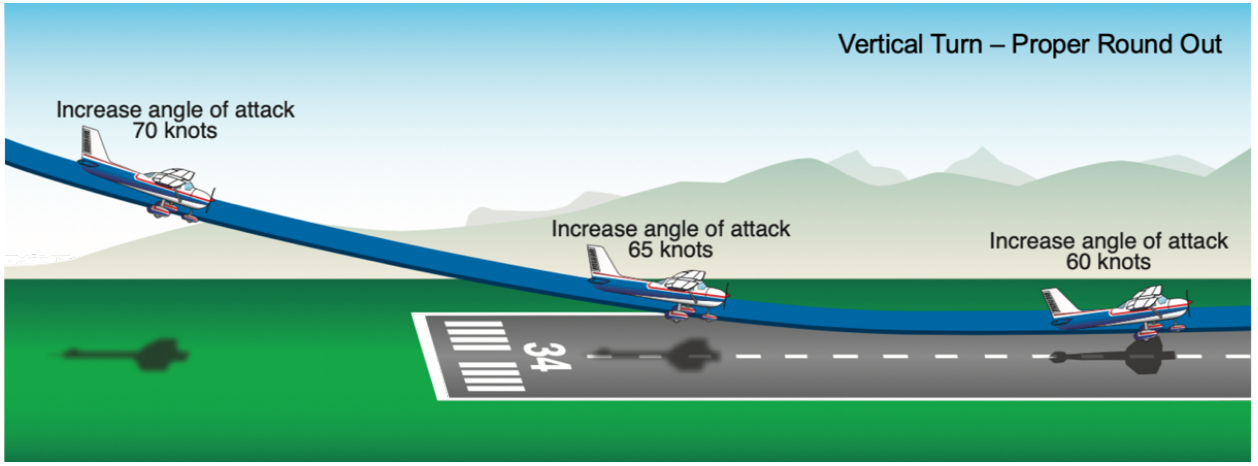
Asset	e-Booklet	Webinar
Reference	5-14	—
Context	Pitching into the oblique and vertical planes affects angle of bank.	
Source	Rich Stowell.	

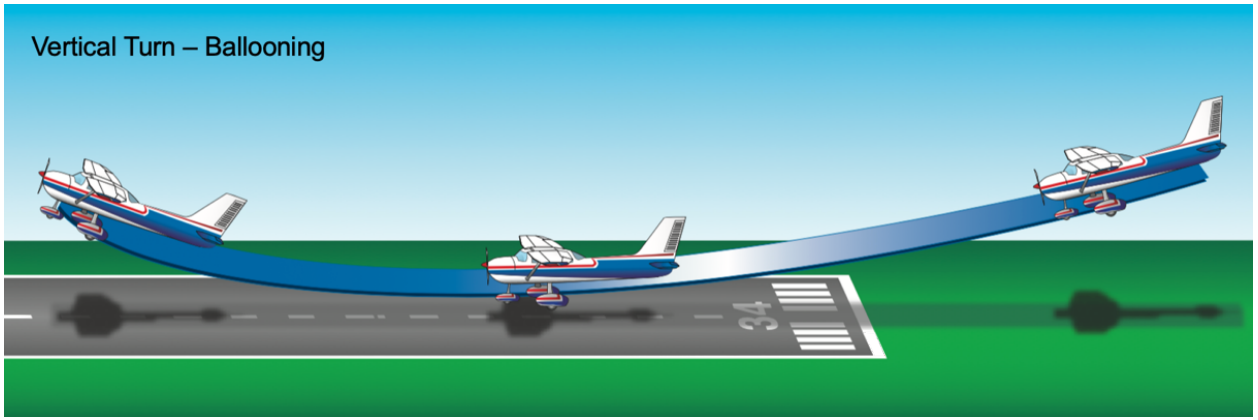


Asset	e-Booklet	Webinar
Reference	5-15	19:28
Context	Depicting vertical turns on the ø-G diagram.	
Source	Rich Stowell.	

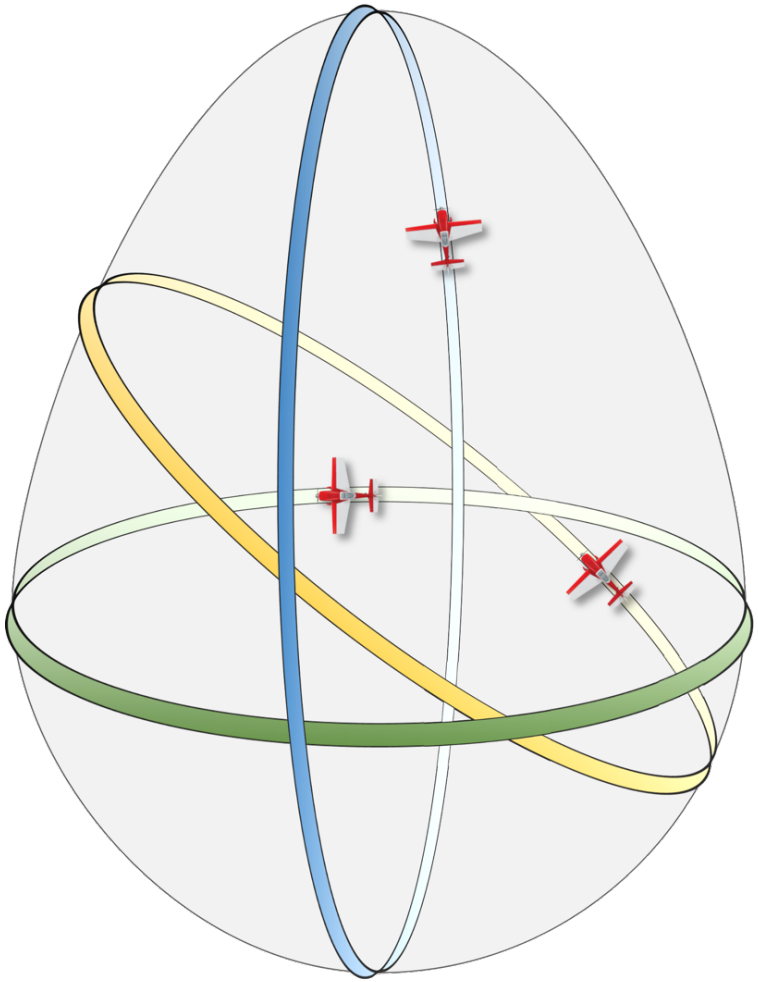


Asset	e-Booklet	Webinar
Reference	5-16	19:39
Context	Mapping out some vertical turns on the ø-G diagram.	
Source	Rich Stowell.	





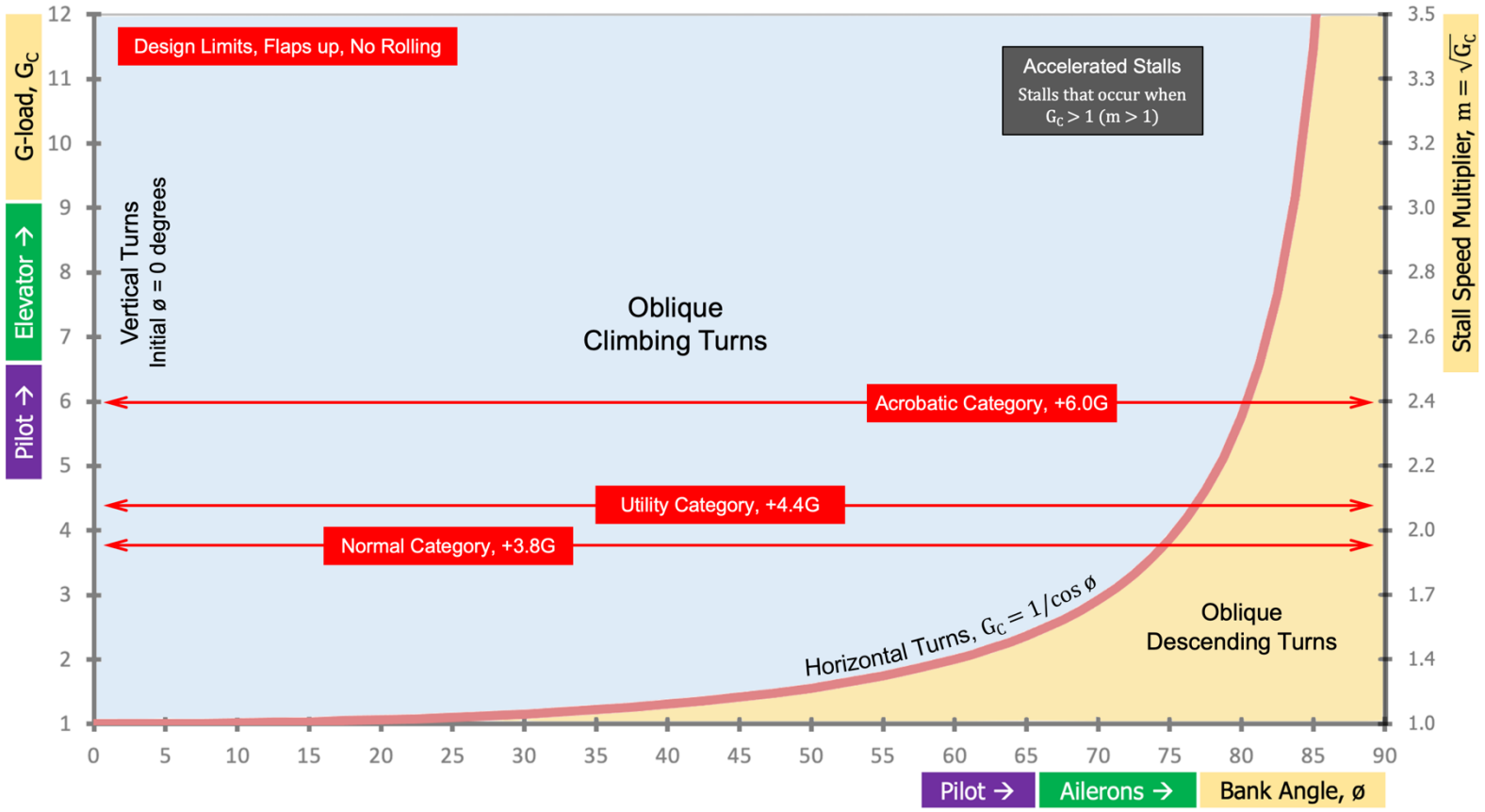
Asset	e-Booklet	Webinar
Reference	5-16 & 5-17	—
Context	Managing the vertical turn during the round out for landing.	
Source	*Airplane Flying Handbook*, 2016, 8-6 and 8-31, modified by Stowell.	



Asset	e-Booklet	Webinar
Reference	5-18	—
Context	Conceptualizing turning flight in three dimensions.	
Source	Adapted from *Air Combat Maneuvering…*, 1998, 5.	

FLAPS	ANGLE OF BANK							
	0°		30°		45°		60°	
	1.00G		1.15G		1.41G		2.00G	
	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS	KIAS	KCAS
UP	38	48	41	51	45	57	53	67
DN	33	43	35	46	39	51	46	60

Asset	e-Booklet	Webinar
Reference	5-19	26:52
Context	Example of stall speeds at different bank angles with G-load added.	
Source	Rich Stowell.	

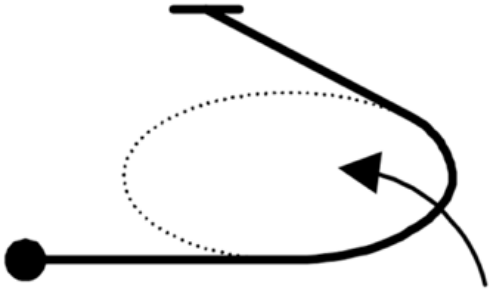


Asset	e-Booklet	Webinar
Reference	5-21	20:12
Context	Example of a fully developed ø-G diagram.	
Source	Rich Stowell.	

Segment		Flight Path[1]	Accelerated[2]
#	Name		

[1] Flight Path Key: SL = Straight Level; SC = Straight Climb; SD = Straight Descent; TH = Turn Horizontal; TO = Turn Oblique; TV = Turn Vertical.
[2] Accelerated Key: Yes; No

Asset	e-Booklet	Webinar
Reference	5-23	—
Context	Traffic pattern challenge: identify all the segments (a sketch helps).	
Source	Rich Stowell.	



Asset	e-Booklet	Webinar
Reference	5-23	—
Context	Rolling turn challenge: puzzle out how this maneuver is done.	
Source	*IAC Contest Rules 2020*, 61.	

Correlation: Bend or straighten the flight path with elevator inputs.

Application: Must apply the elevator correctly for the desired performance.

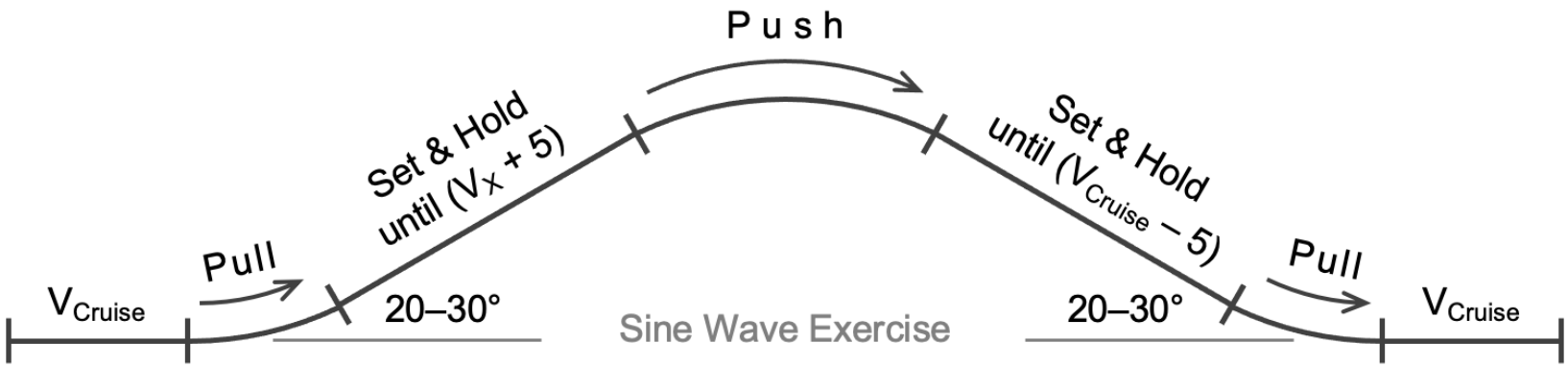
Understanding: It's about manipulating the magnitude and direction of lift.

Rote: The horizontal component of lift turns the airplane.

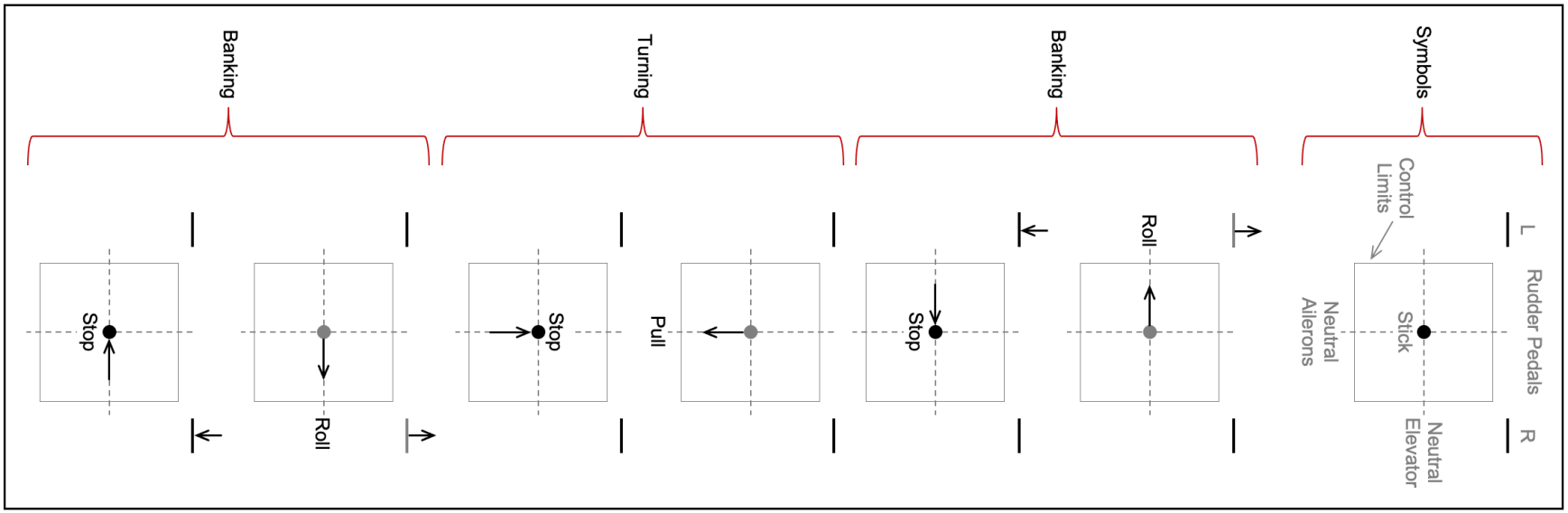
Asset	e-Booklet	Webinar
Reference	6-2	01:27 & 24:32
Context	Levels of learning vis-à-vis turning flight.	
Source	Rich Stowell.	

LEVEL TURNS: Connecting Bank Angle, G-load, Stall Speed per the ø-G Diagram							
ø	0°	10°	20°	30°	40°	50°	60°
Sight Picture	Constant • Bank Angle • Altitude • Nose Position Relative to the Horizon Line Means • Constant & Correct G-Load for the Bank 						
G_C $(= 1/\cos ø)$	1.00	1.02	1.06	1.15	1.30	1.56	2.00
m $(= \sqrt{G_C})$	1.00	1.01	1.03	1.07	1.14	1.25	1.41
Stall Speed $(= mVs, CAS)$	1.00Vs	1.01Vs	1.03Vs	1.07Vs	1.14Vs	1.25Vs	1.41Vs
Awareness	Likely unable to feel differences in G-load due to JND			Tendency may be to under-G as bank angle approaches 60°			

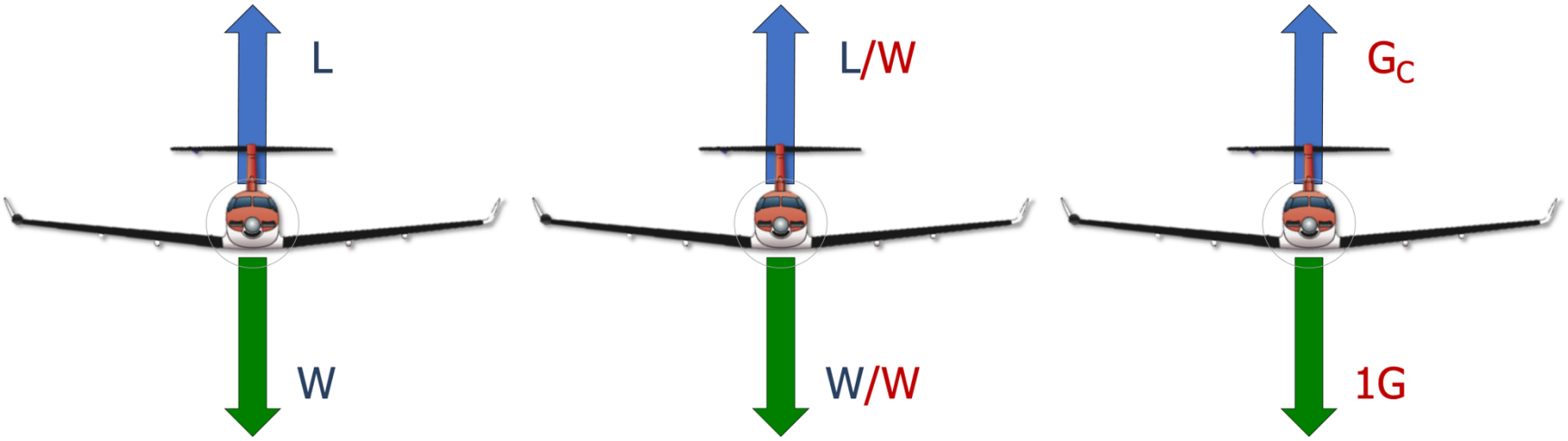
Asset	e-Booklet	Webinar
Reference	6-10	—
Context	Level turn training in the Learn-Do-Fly framework.	
Source	Rich Stowell.	



Asset	e-Booklet	Webinar
Reference	6-15	—
Context	Visualizing the Sine Wave exercise.	
Source	Rich Stowell.	



Asset	e-Booklet	Webinar
Reference	6-17	—
Context	Visualizing the Acro-Style Turn exercise.	
Source	Rich Stowell.	



Lift and Weight forces converted to G-loads by dividing by Weight

Asset	e-Booklet	Webinar
Reference	7-4	12:05
Context	Converting the standard forces to the more intuitive G-loads.	
Source	*Airplane Flying Handbook*, 2004, 3-8, modified by Stowell.	

For More Information

Other *Learn to Turn* assets: https://www.CommunityAviation.com/Learn-to-Turn

Rich's books and other information: https://www.RichStowell.com

Courses and learning opportunities with Rich: https://www.CommunityAviation.com/Expert/Rich-Stowell

Avemco Safety Rewards Program: https://www.avemco.com/news-events/safety-rewards

FAA Wings Program: https://www.faasafety.gov

EAA Proficiency365™ Missions: https://store.communityaviation.com/collections/eaa-proficiency365

Emergency Maneuver Training – *The original UPRT program since 1987*: https://www.cpaviation.com

Expanded Envelope Exercises® by Ed Wischmeyer:
lecture https://www.youtube.com/watch?v=8k8PeC9n_8Y || email E3@greatusermanuals.com

AOPA Air Safety Institute: https://www.aopa.org/training-and-safety/air-safety-institute

Aviators Code Initiative (Model Codes of Conduct): https://www.secureav.com

Society of Aviation and Flight Educators: https://www.safepilots.org