

New Conception for Air-to-Air Combat

John R. Boyd

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Produced and designed by Ginger Richards

For information on this edition, please
see the last page.

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Content

- Ambiguity
- Generalization
- Idea Expansion
- New Conception

Maneuverability

Radius - Rate - g

Background

- Energy-maneuverability (EM)
- Manned simulation
- Real (mock) world

Original Purpose

Reduce ambiguity associated with relative importance of turn radius, turn rate and/or g in air combat maneuvering.

Maneuverability Definition

Ability to change altitude, airspeed, and direction in any combination.

Questions

- How is turn radius related to changing direction?
- How is turn rate related to changing direction?
- How is g related to changing direction?

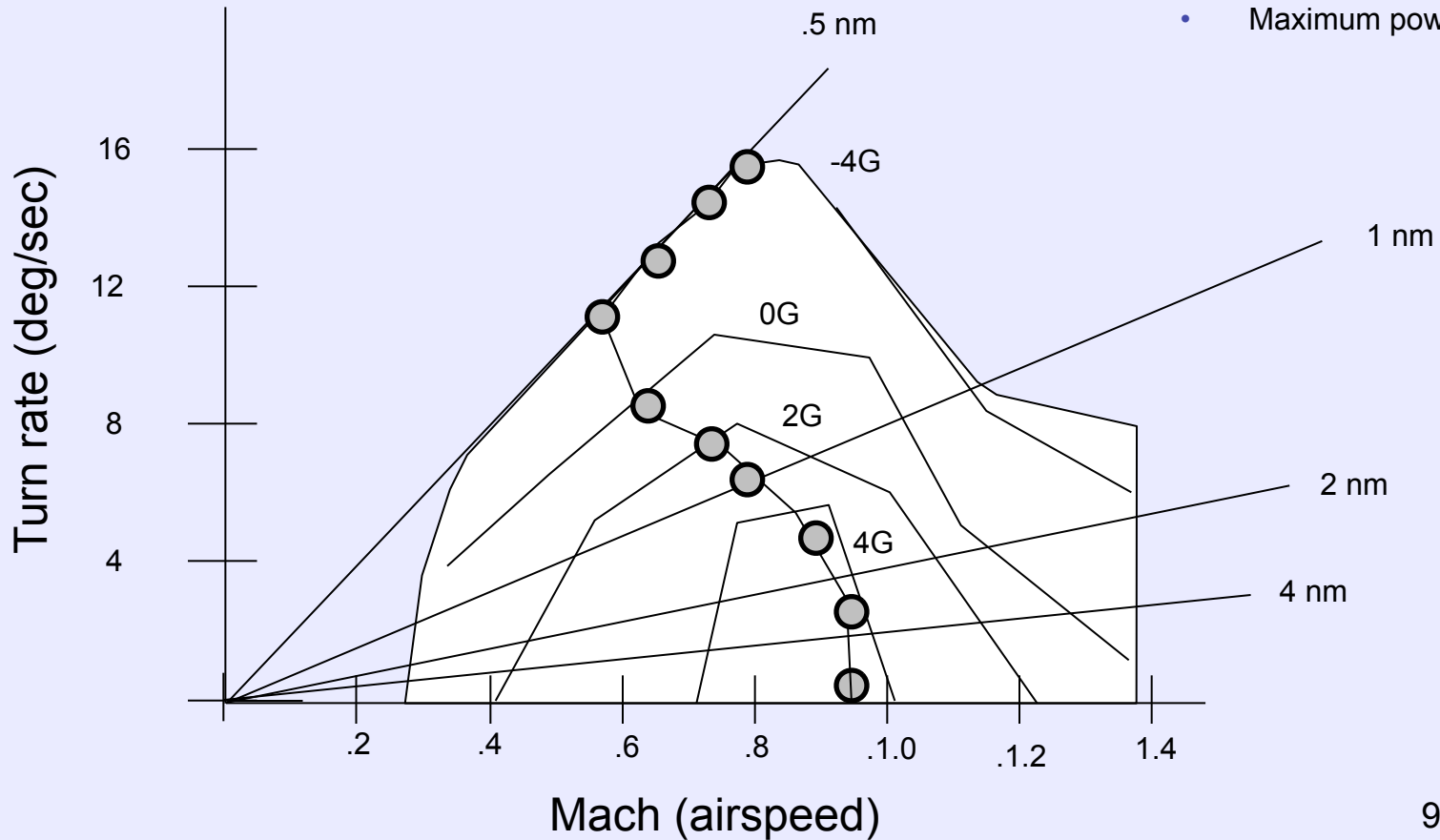
First Cut (Simple Minded) Response

- Turn radius represents how small an area or volume in which a directional change can be achieved.
- Turn rate represents how quickly a directional change can be achieved.
- G represents directional change as an acceleration perpendicular to the present line of flight.

Maneuver Diagram

(Greatly simplified by editors)

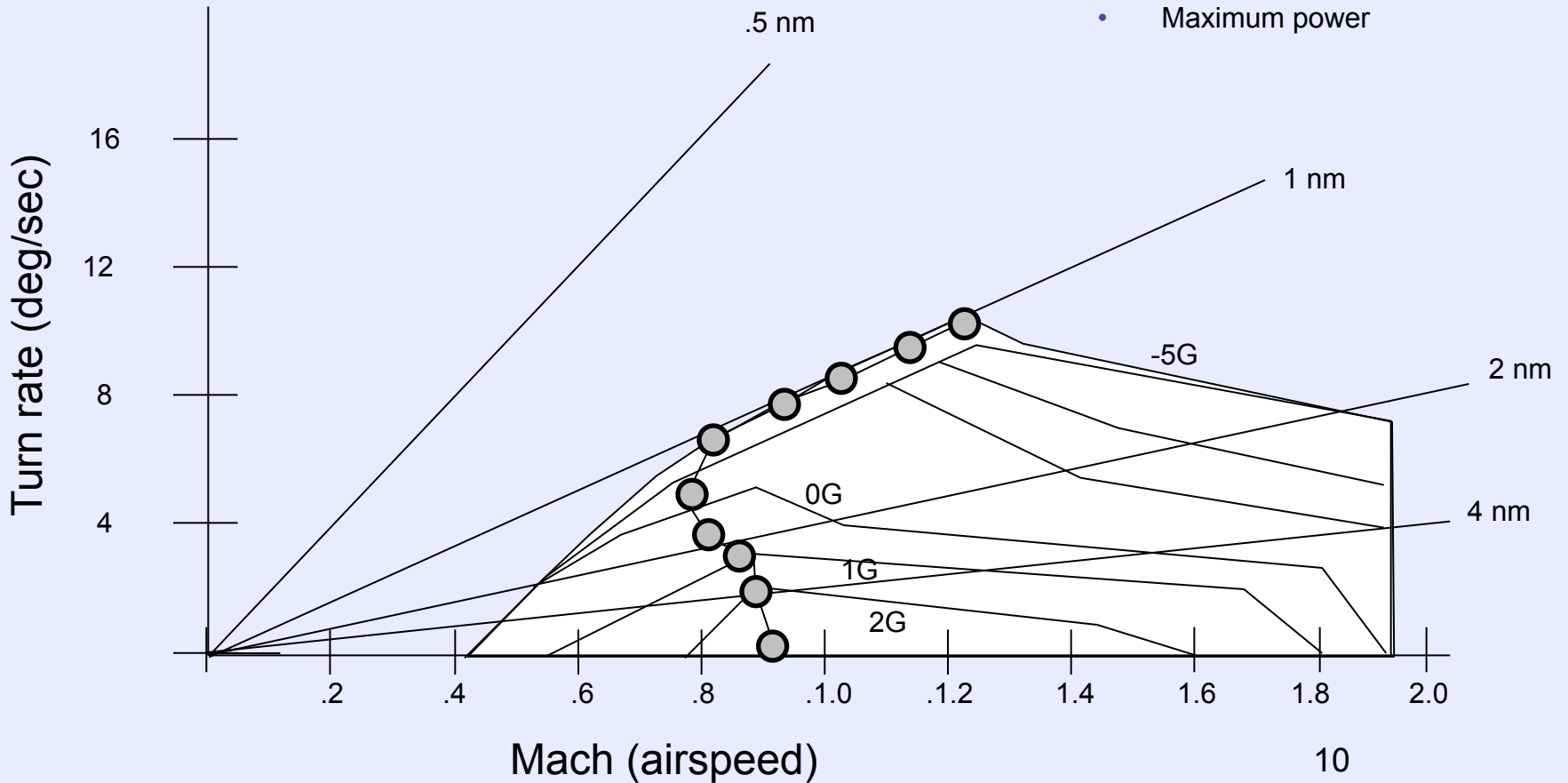
- **Altitude: 10,000 ft**
- F-4E (LES) (U) 9/74
- 4 AIM-7E
- Maximum power



Maneuver Diagram

(Greatly simplified by editors)

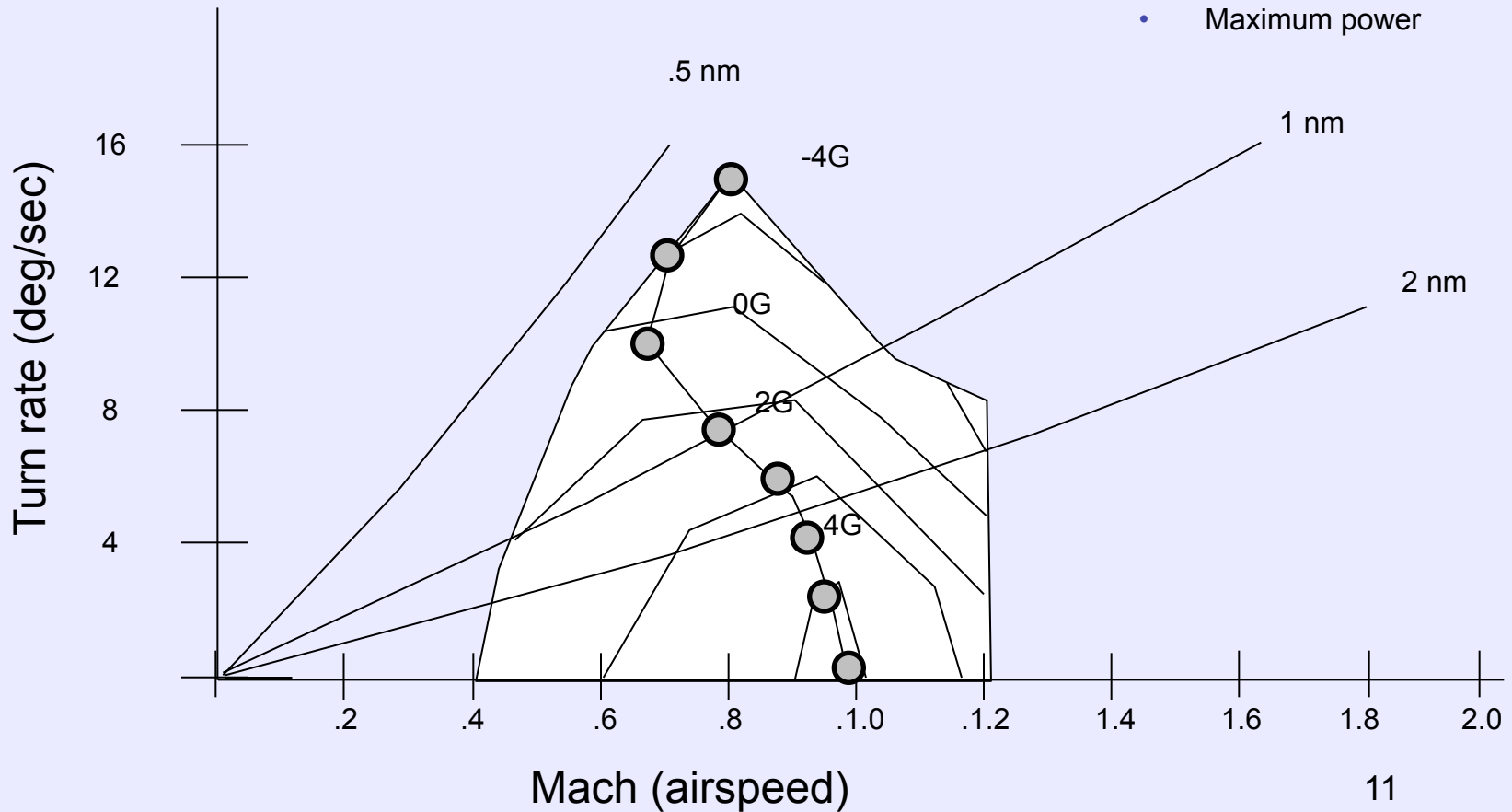
- **Altitude: 30,000 ft**
- F-4E (LES) (U) 9/74
- 4 AIM-7E
- Maximum power



Maneuver Diagram

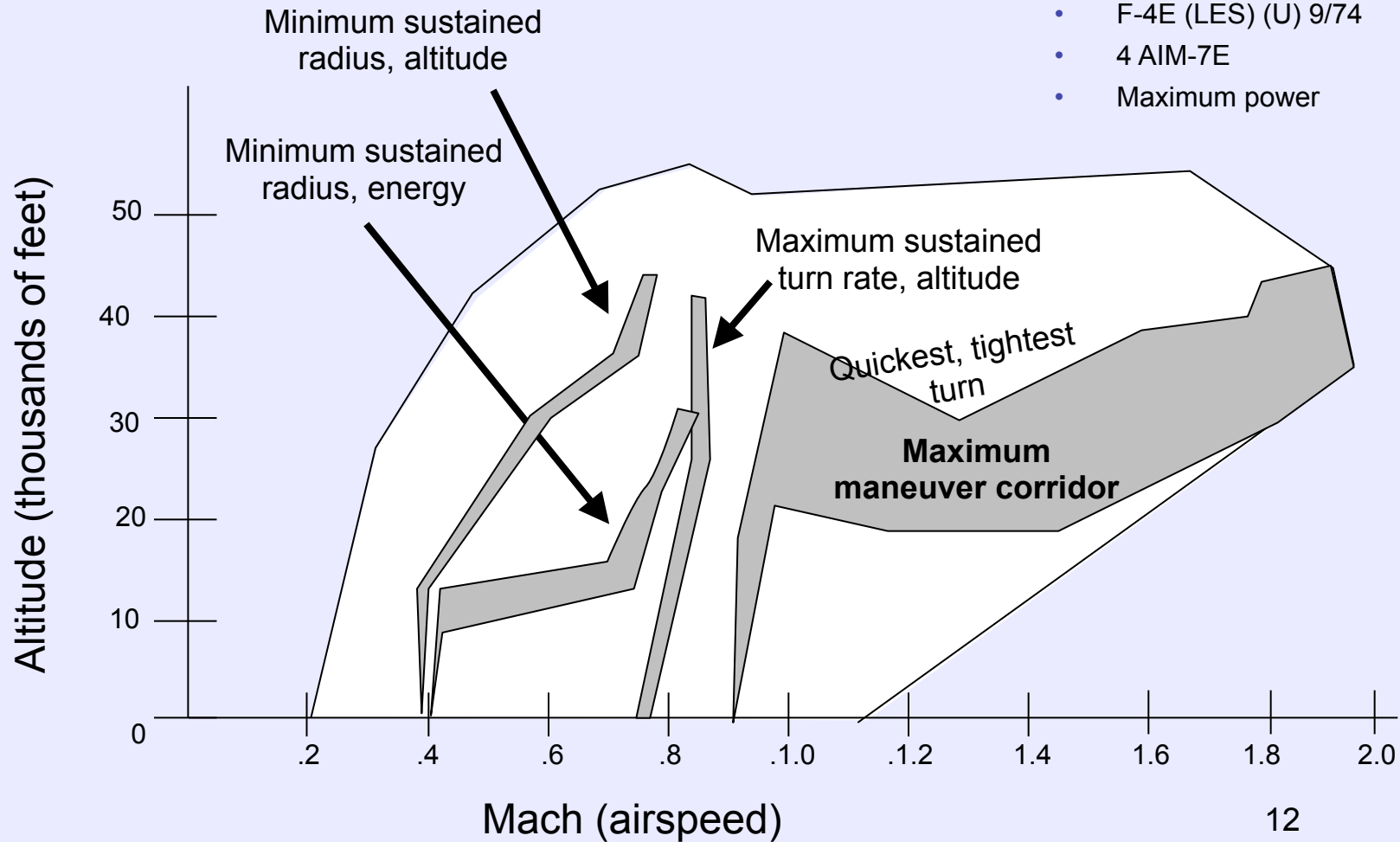
(Greatly simplified by editors)

- Energy level: 30,000 ft
- F-4E (LES) (U) 9/74
- 4 AIM-7E
- Maximum power



Air Battle Arena

- **Return: 500 nm**
- F-4E (LES) (U) 9/74
- 4 AIM-7E
- Maximum power



Manned Simulation

- Environment
 - Altitude ambiguous
 - Attitude ambiguous

} Get lost in vertical

 - Rate of closure unlike actual situation

} Contributes to overshoot
- Suggested Results
 - Use of vertical maneuvers and high overtake is inhibited because of ambiguous cues
 - Taken together, these inhibitions suggest emphasis on horizontal, slow speed fights

Maneuverability Observations

- Manned simulation



Losing energy and walking down left side of envelope

- Real world

- F-100 vs. F-86H
- F-5A vs. F-86H
- F-105 vs. MiG-17 (1965)
- Harrier vs. all comers
- YF-16/17 vs. F-4E
vs. Type I and II



- Losing energy but gaining position—end game
- Gaining energy for new set-up

Current Generalization

Warp I

- Should be able to out-turn an adversary at any energy rate within the air battle arena

Or stated another way,

- Need fighter that has a higher energy rate for any turn rate/radius, or a higher turn rate/lower turn radius for any energy rate, within the air battle arena.

Suspicion

Current generalization (Warp I) does not seem to be **in complete harmony** with EM, simulation, and real (mock) world evidence.

Why? ...

Observations seem to suggest

- Lower turn radii, coupled with higher negative energy rates, seem to be the drivers for end-game plane-of-action maneuvering.
- Higher turn rates/energy rates seem to be more important in out-of-plane maneuvering.
- Both lower turn radii/higher turn rates at higher negative energy rates, coupled with higher turn rates/lower turn radii at positive energy rates, seem to provide advantages when maneuvering the vertical plane.

Deeper Generalization

Warp II

- Need fighter that can both lose energy and gain energy more quickly while out-turning an adversary
- Suggests a fighter with a higher g $[(CL\ Max)/(W/S)]$ and higher turn rates/lower turn radii for positive energy rates—but not necessarily higher turn rates/lower turn radii for negative energy rates.
- In other words, suggests a fighter that can be used to initiate and control engagement opportunities—yet has a **fast transient** (“natural hook”) that can be used to either force an overshoot by an attacker or to stay inside a hard turning defender.

Idea Expansion

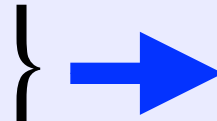
- Idea of **fast transients** suggests that in order to win or gain superiority, we should operate at a **faster tempo** than our adversaries or inside our adversaries' **time scales**.
- Why? Such activity will make us appear **ambiguous** (non-predictable) thereby generate **confusion** and **disorder** among our adversaries in accordance with Gödel's Proof, the Heisenberg Principle, and the Second Law of Thermodynamics.

Examples

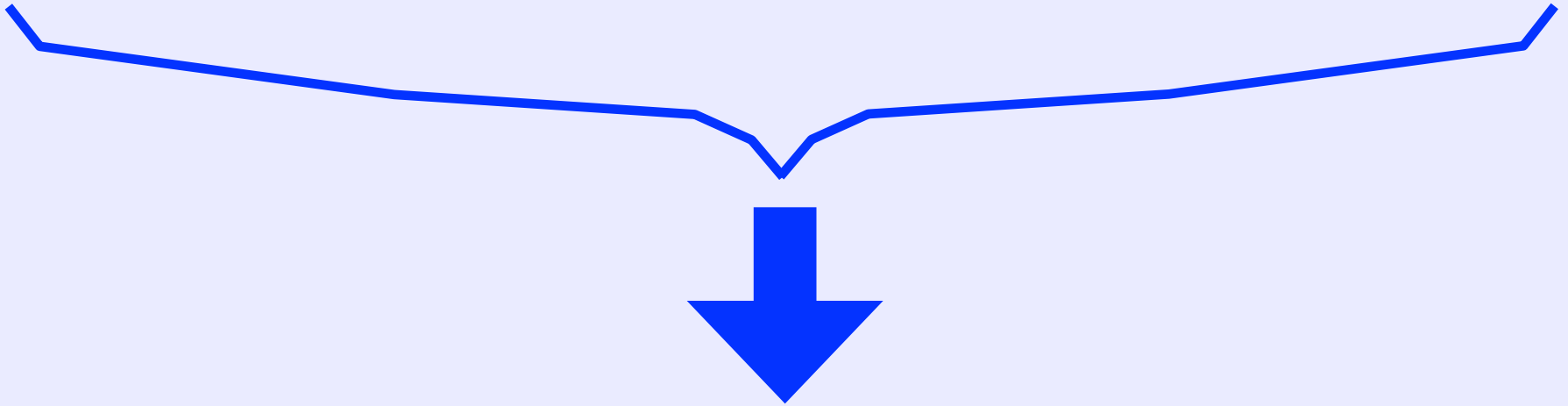
- Blitzkrieg vs. Maginot Line mentality (1940)
- F-86 vs. MiG-15 (1951-53)
- Israeli raid (1976)

Illumination

- Gödel's Proof
- Heisenberg Principle
- Second Law of Thermodynamics



We cannot determine the character of nature of a system within itself, and efforts to do so will only generate **confusion** and **disorder**.



Fast transients (faster tempo) together with synthesis associated with Gödel, Heisenberg and the Second Law suggest a new conception for air-to-air combat and for waging war.

New Conception

Action: Exploit operational and technical features to:

- Generate a rapidly changing environment (quick/clear observations, fast tempo, fast transients, quick kill).
- Inhibit an adversary's capacity to adapt to such an environment (suppress or distort observations).

Goal: Unstructure adversary's system into a "hodge podge" of **confusion** and **disorder** by causing him to over and under react because of activity that appears **uncertain, ambiguous, or chaotic**.

Recipe for Generating Confusion and Disorder

Air-to-Air and Air-to-Ground

Observations

- Quick/clear scanning sensors
- Suppressed/distorted signatures

Activity

- Quick and precise performance
 - Supercruise
 - Rapid energy gain and rapid energy loss coupled with high turn rates and low turn radii
 - High pitch rates/high roll rates/high yaw rates coupled with ease of control
- Kill mechanism
 - Quick shoot weapons and fire control system
 - Off boresight

Message

He who can handle the quickest
rate of change survives.

About this edition

This edition of *New Conception for Air-to-Air Combat* is a PDF of the briefing rendered into Apple Keynote. The original signed by John Boyd carries the date “4 August 1976.” Although Boyd had been thinking about many of these ideas for a long time, the catalyst for this presentation was a small contract Boyd had with NASA shortly after his retirement.

New Conception was not included in the *Discourse on Winning and Losing*, but it is an important piece in its own right, even for people who are not interested in air combat conducted with guns and short-range missiles. Although it can be considered as the first step towards what became *Patterns of Conflict*, it also illustrates Boyd’s ideas on analysis / synthesis, mismatches, and novelty, ideas that remain constant from his paper “Destruction and Creation” (also 1976) through his final work, the *Essence of Winning and Losing* in 1996.

About the Editors

Chuck Spinney was a colleague of Boyd’s both in the Air Force and in the Office of the Secretary of Defense, where he participated in every edition of the *Discourse*. Chuck is the author of *Defense Facts of Life* and numerous monographs and op-eds. His commentaries on defense issues appear from time to time in his blog, <http://chuckspinney.blogspot.com/>.

Chet Richards worked with Col Boyd on his first paper, “Destruction and Creation,” on his later presentations, *Conceptual Spiral* and *The Essence of Winning and Losing*, and near the end of Boyd’s life, on business applications. He is a retired colonel in the Air Force, and wrote a book, *Certain to Win (2004)*, that applies Boyd’s concepts to business. He is also the author of three books on defense policy.

Ginger Richards was co-owner and president of Kettle Creek Corporation and created the layouts for the PowerPoint and Keynote versions of all Boyd’s briefings.