

1

NEW CONCEPTION

FOR

AIR-TO-AIR COMBAT

4 Aug 76

John Boyd

## CONTENT

- AMBIGUITY
- GENERALIZATION
- IDEA EXPANSION
- NEW CONCEPTION

## MANEUVERABILITY

RADIUS - RATE - G

## BACKGROUND

- ENERGY-MANEUVERABILITY
- 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 PRESENT LINE OF FLIGHT.



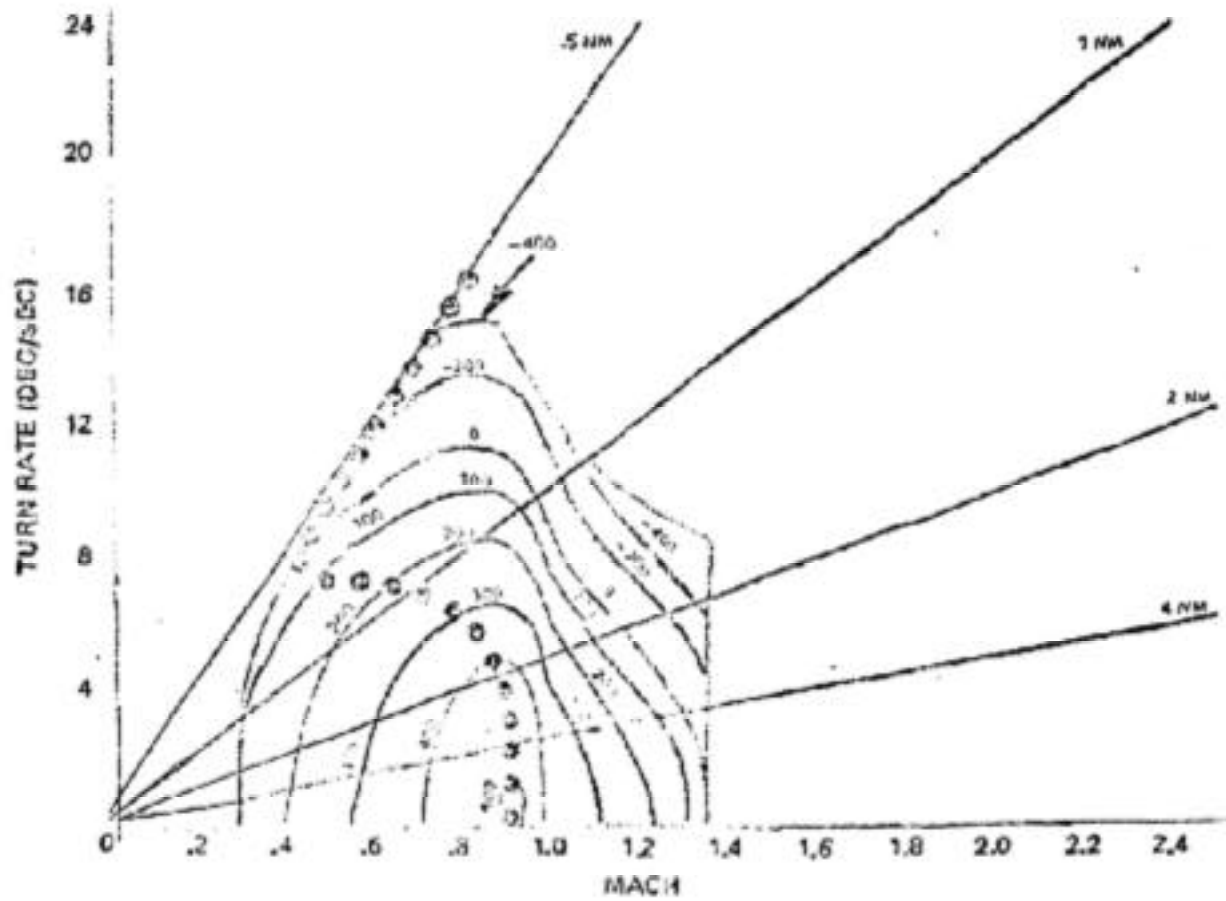
# MANEUVER DIAGRAM

ALTITUDE: 10000 FT

F-4E (LES) (U) 9/74

4 AIM-7E

MAXIMUM POWER



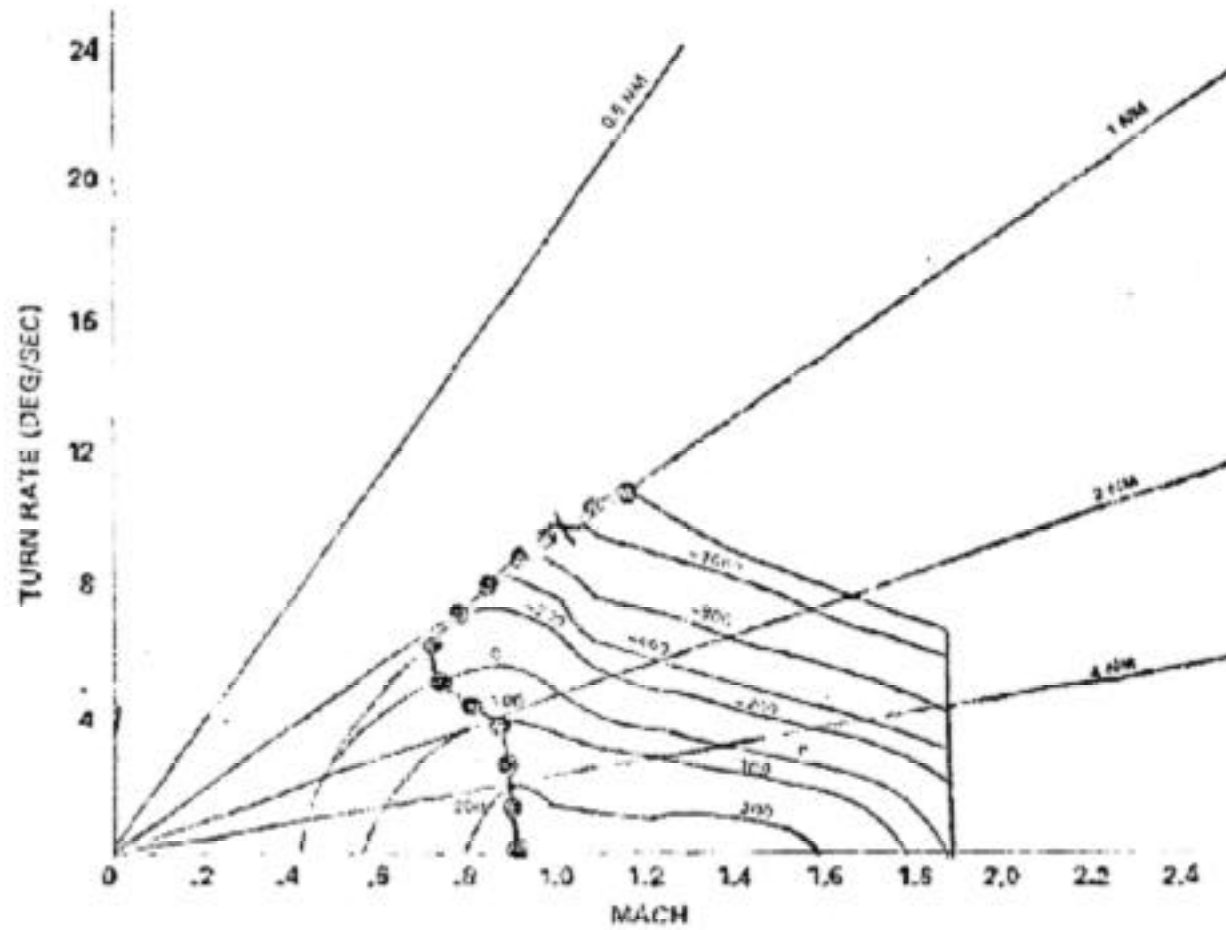
# MANEUVER DIAGRAM

ALTITUDE: 30000 FT

F-4E (LES) (U) 9/74

4 AIM-7E

MAXIMUM POWER



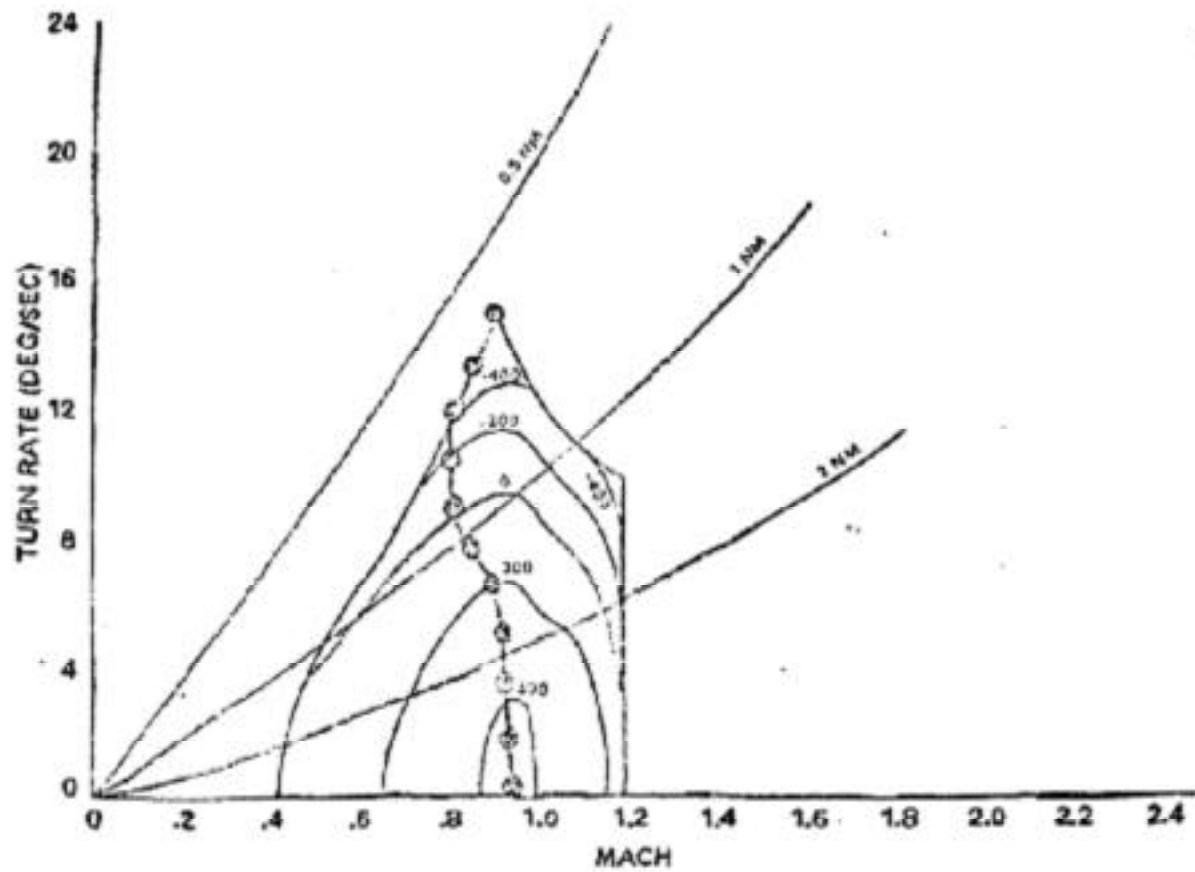
# MANEUVER DIAGRAM

ENERGY LEVEL : 30000 FT

F-4E (LES) (U) 9/74

4 AIM-7E

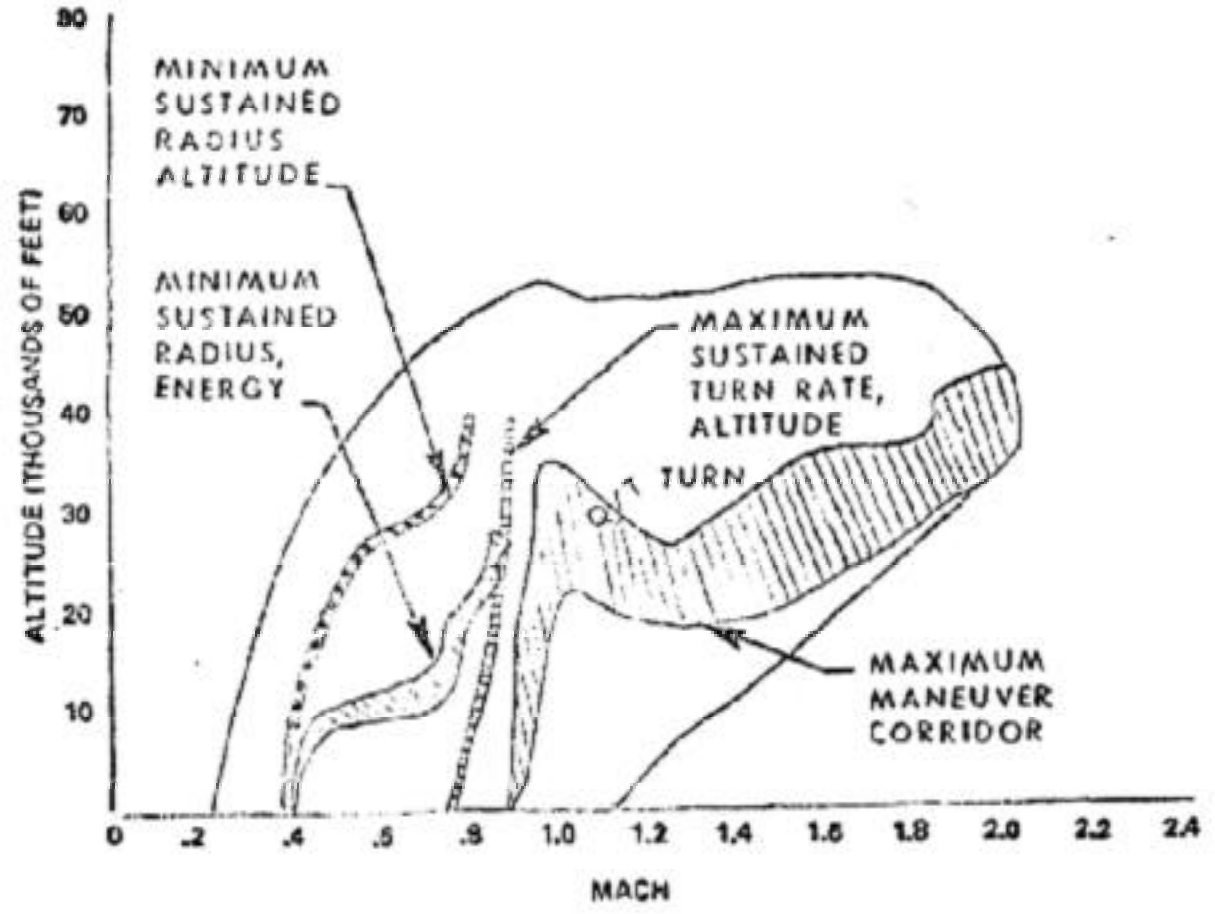
MAXIMUM POWER



# AIR BATTLE ARENA

RETURN: 500 NM

F-4E (LES) (U) 9/74  
4 AIM-7E  
MAXIMUM POWER



MANNED SIMULATION

● ENVIRONMENT

- ALTITUDE AMBIGUOUS } GET LOST IN VERTICAL
- ATTITUDE AMBIGUOUS }
  
- RATE OF CLOSURE UNLIKE } CONTRIBUTES TO OVERSHOTS
- ACTUAL SITUATION }

● 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 S  
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 OUTTURN 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 1) 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 IN THE VERTICAL PLANE.

DEEPER GENERALIZATION - "WARP II"

- NEED FIGHTER THAT CAN BOTH LOSE ENERGY AND GAIN ENERGY MORE QUICKLY WHILE OUTTURNING AN ADVERSARY

- SUGGESTS A FIGHTER WITH A HIGHER  $G \left[ \frac{CL_{MAX}}{W/S} \right]$  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.

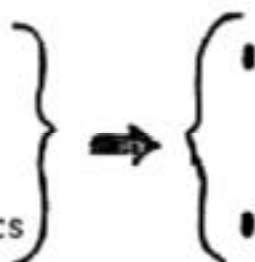
### EXAMPLES

- BLITZKRIEG VS MAGINOT LINE MENTALITY (1940)
- F-86 vs MiG-15 (1951 - 53)
- ISRAELI RAID (1976)

ILLUMINATION

NOTIONS

- GÖDEL'S PROOF
- HEISENBERG PRINCIPLE
- SECOND LAW OF THERMODYNAMICS



SYNTHESIS

WE CANNOT DETERMINE THE CHARACTER  
NATURE OF A SYSTEM WITHIN ITSELF.  
EFFORTS TO DO SO WILL ONLY GENERA  
CONFUSION AND DISORDER



- FAST TRANSIENTS (FASTER TEMPO) TOGETHER WITH SYNTHESIS ASSOCIATED WITH GODEL, 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 ADVERSARIES CAPACITY TO ADAPT TO SUCH AN ENVIRONMENT (SUPPRESS OR DISTORT OBSERVATIONS).

GOAL: UNSTRUCTURE ADVERSARIES SYSTEM INTO A "HODGE PODGE" OF CONFUSION AND DISORDER <sup>by</sup> CAUSING HIM TO OVER AND UNDER REACT BECAUSE OF ACTIVITY THAT APPEARS UNCERTAIN, AMBIGUOUS OR CHAOTIC.

A-To-A & A-To-G

214

RECIPE FOR GENERATING CONFUSION AND DISORDER

OBSERVATIONS

- QUICK/CLEAR SCANNING SENSORS
- SUPPRESSED/DISTORTED SIGNATURES

ACTIVITY

- QUICK AND PRECISE PERFORMANCE
  - SUPERCruise
  - RAPID ENERGY GAIN AND RAPID ENERGY LOSS COUPLED WITH HI TURN RATES AND LO TURN RADII
  - HI PITCH RATES/HI ROLL RATES/HI YAW RATES COUPLED WITH EASE OF CONTROL
- KILL MECHANISM
  - <sup>Quick</sup> ~~Shoot~~ SHOOT WEAPONS AND FIRE CONTROL SYSTEMS
  - OFF BORESIGHT

MESSAGE

HE WHO CAN HANDLE THE QUICKEST RATE OF CHANGE  
SURVIVES.