NEW CONCEPTION

FOR

AIR-TO-AIR COMBAT

4 Aug 76

John R 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

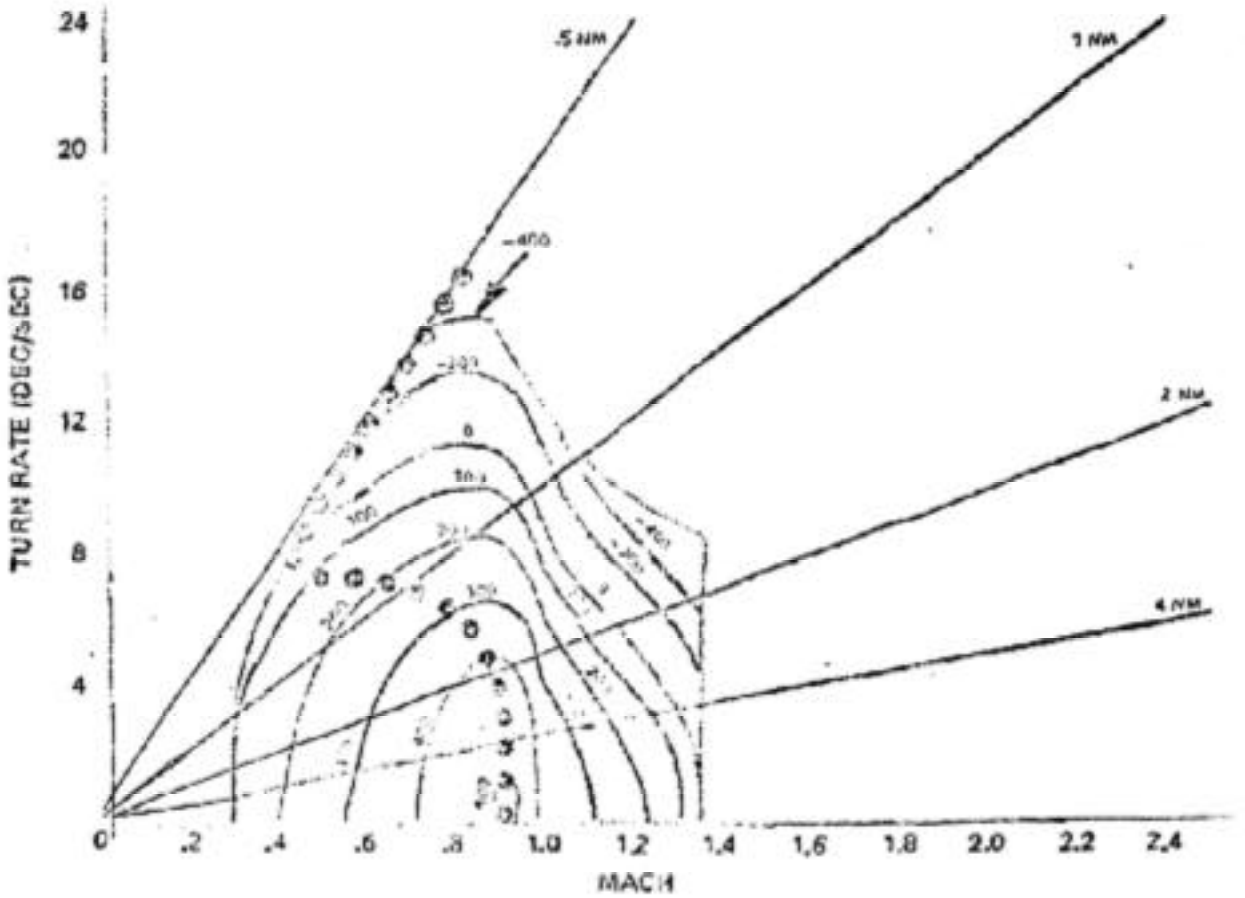
- TURN RATE REPRESENTS HOW QUICKLY A DIRECTIONAL CHANGE CAN BE ACHIEVED

- 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



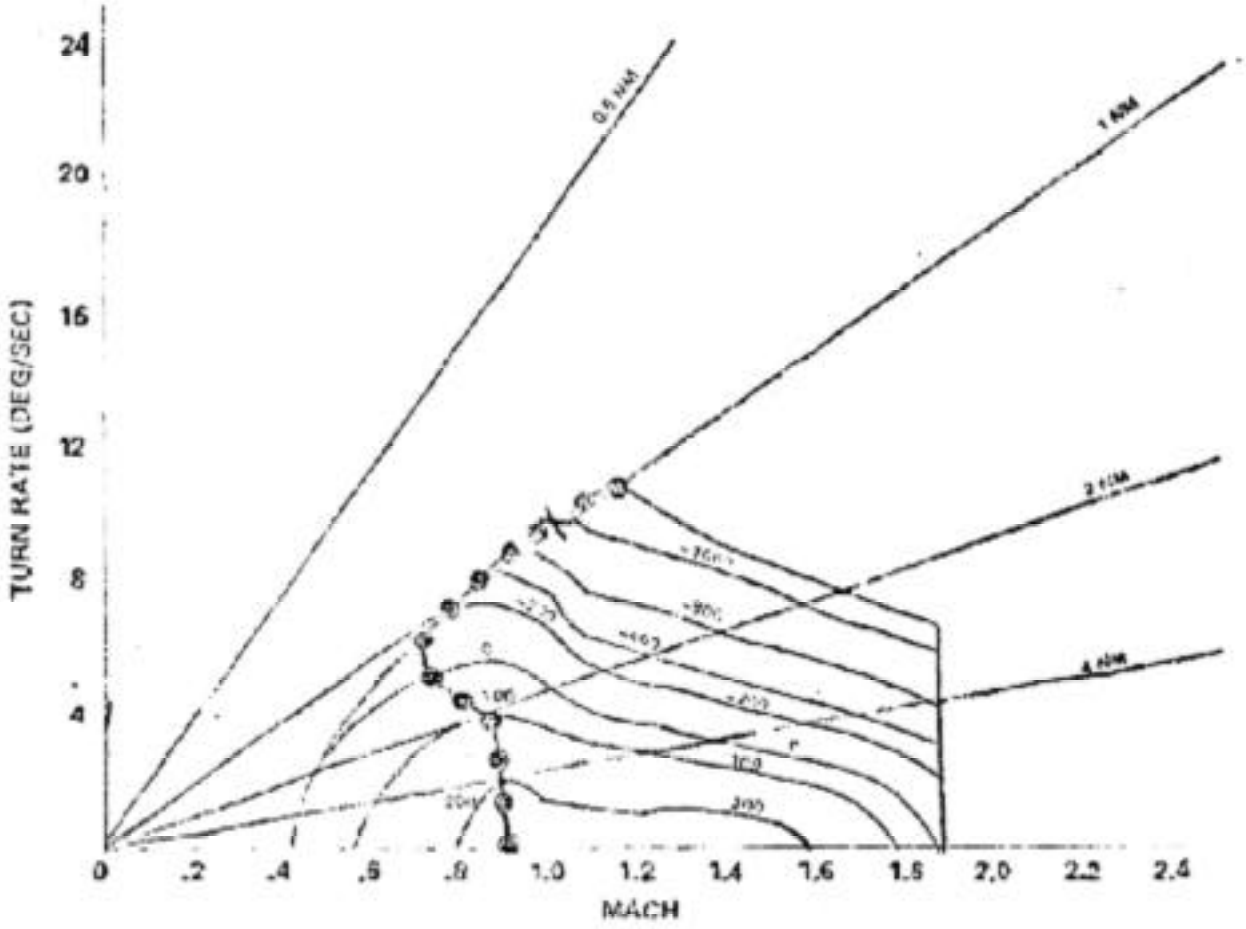
MANEUVER DIAGRAM

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

4 AIM-7E

MAXIMUM POWER

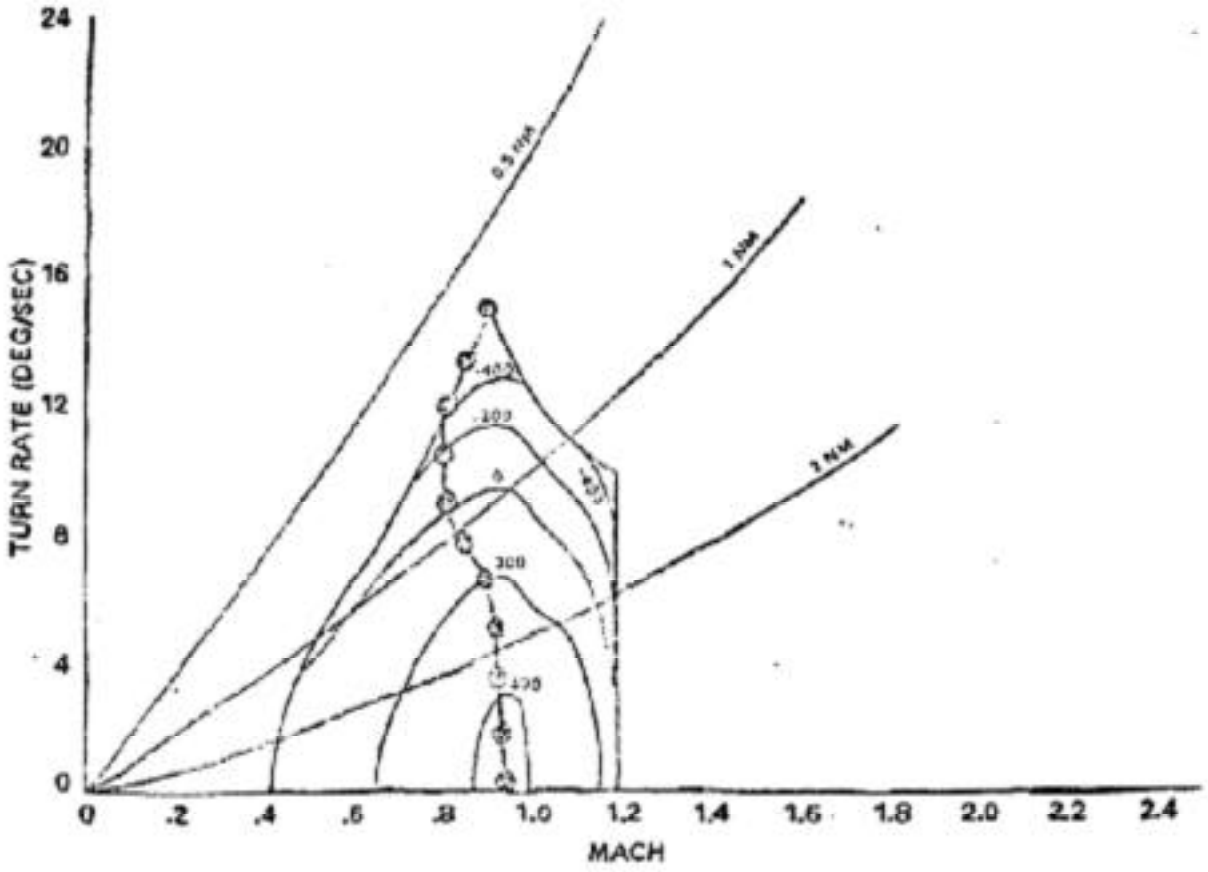
ALTITUDE: 30000 FT



MANEUVER DIAGRAM

ENERGY LEVEL : 30000 FT

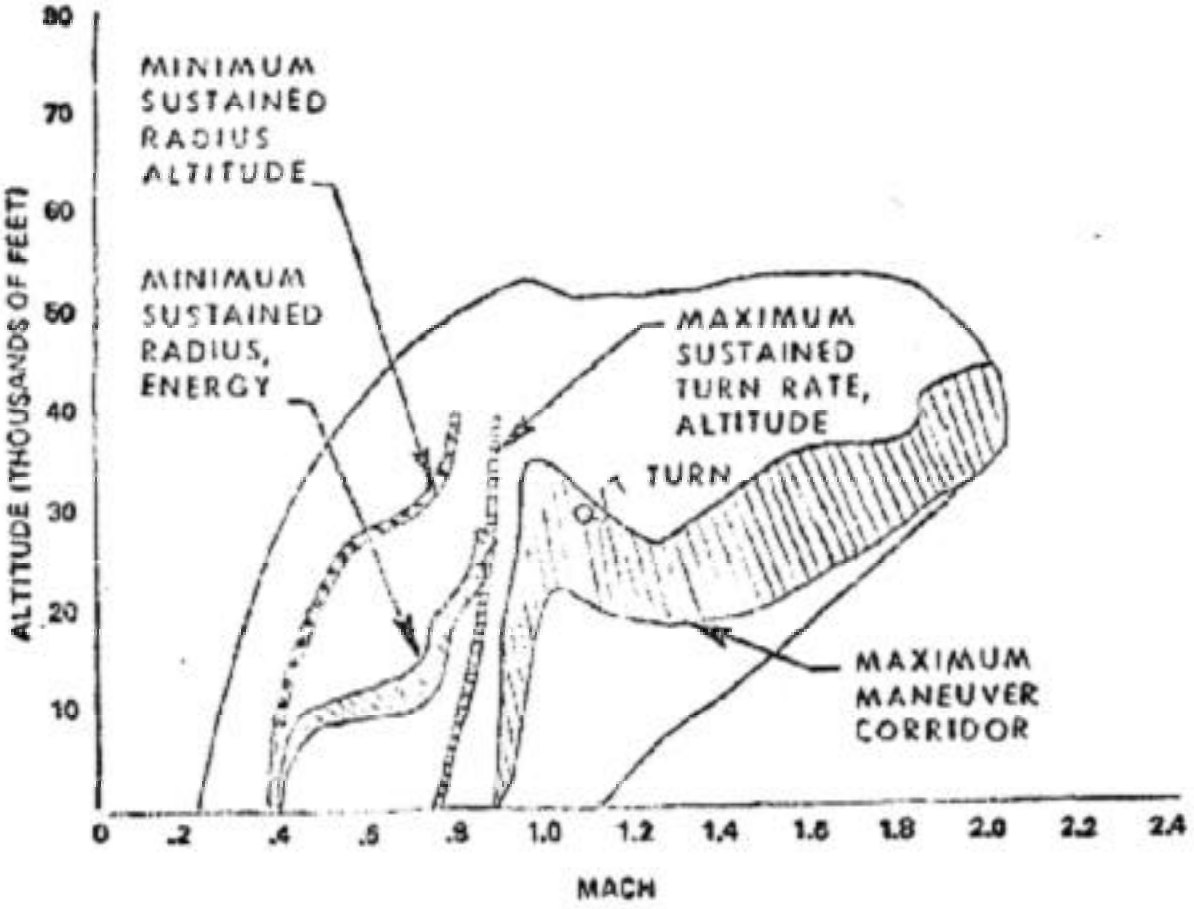
F-4E (LES) (U) 9/74
4 AIM-7E
MAXIMUM POWER



AIR BATTLE ARENA

RETURN: 500 NM

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



MANNED SIMULATION

- ENVIRONMENT
  - ALTITUDE AMBIGUOUS
  - ATTITUDE AMBIGUOUS

  } GET LOST IN VERTICAL

  - RATE OF CLOSURE UNLIKE ACTUAL SITUATION

  } CONTRIBUTES TO OVERSHOOTS

- 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 BA

  ARENA

OR STATED ANOTHER WAY

- NEED FIGHTER THAT HAS A HIGHER ENERGY RATE FOR ANY TURN RATE/RADIUS, OR A H

  TURN RATE/LOWER TURN RADIUS FOR ANY ENERGY RATE, WITHIN THE AIR BATTLE AREN

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 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 $\left[\frac{C_{L_{MAX}}}{W/S}\right]$ 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

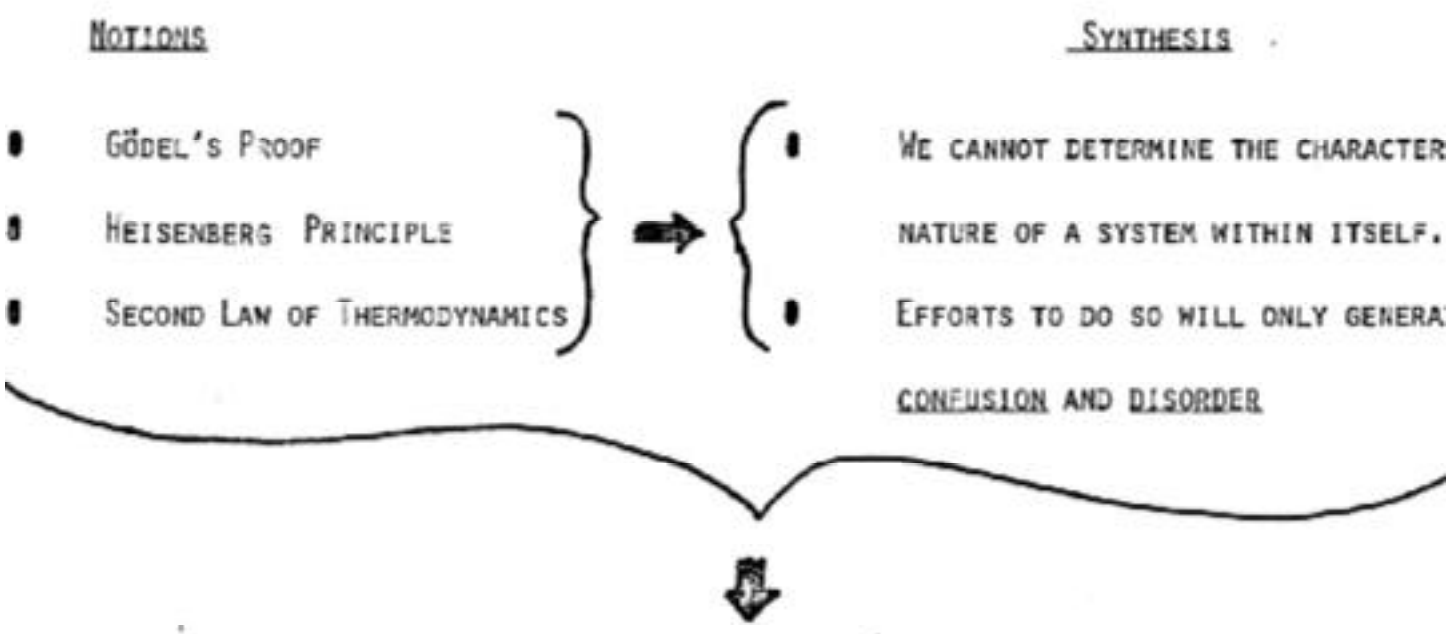
- IDEA OF FAST TRANSIENTS SUGGESTS THAT - IN ORDER TO WIN OR GAIN SUPERIORITY - WE SHOULD OPERATE AT A FASTER TEMPO THAN OUR ADVERSARIES OR INSIDE OUR ADVERSARIES TIME SCALES.

- 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



- 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 BY CAUSING HIM TO OVER AND UNDER REACT BECAUSE OF ACTIVITY THAT APPEARS UNCERTAIN, AMBIGUOUS OR CHAOTIC.

A-To-A & A-To-G

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
  - Quick SHOOT WEAPONS AND FIRE CONTROL SYSTEMS
  - OFF BORESIGHT

MESSAGE

HE WHO CAN HANDLE THE QUICKEST RATE OF CHANGE

SURVIVES.