

Making Decisions

Nature of Decisions

Decision—A choice between options

Utility Theory proposes that we make decisions to maximize utility or usefulness

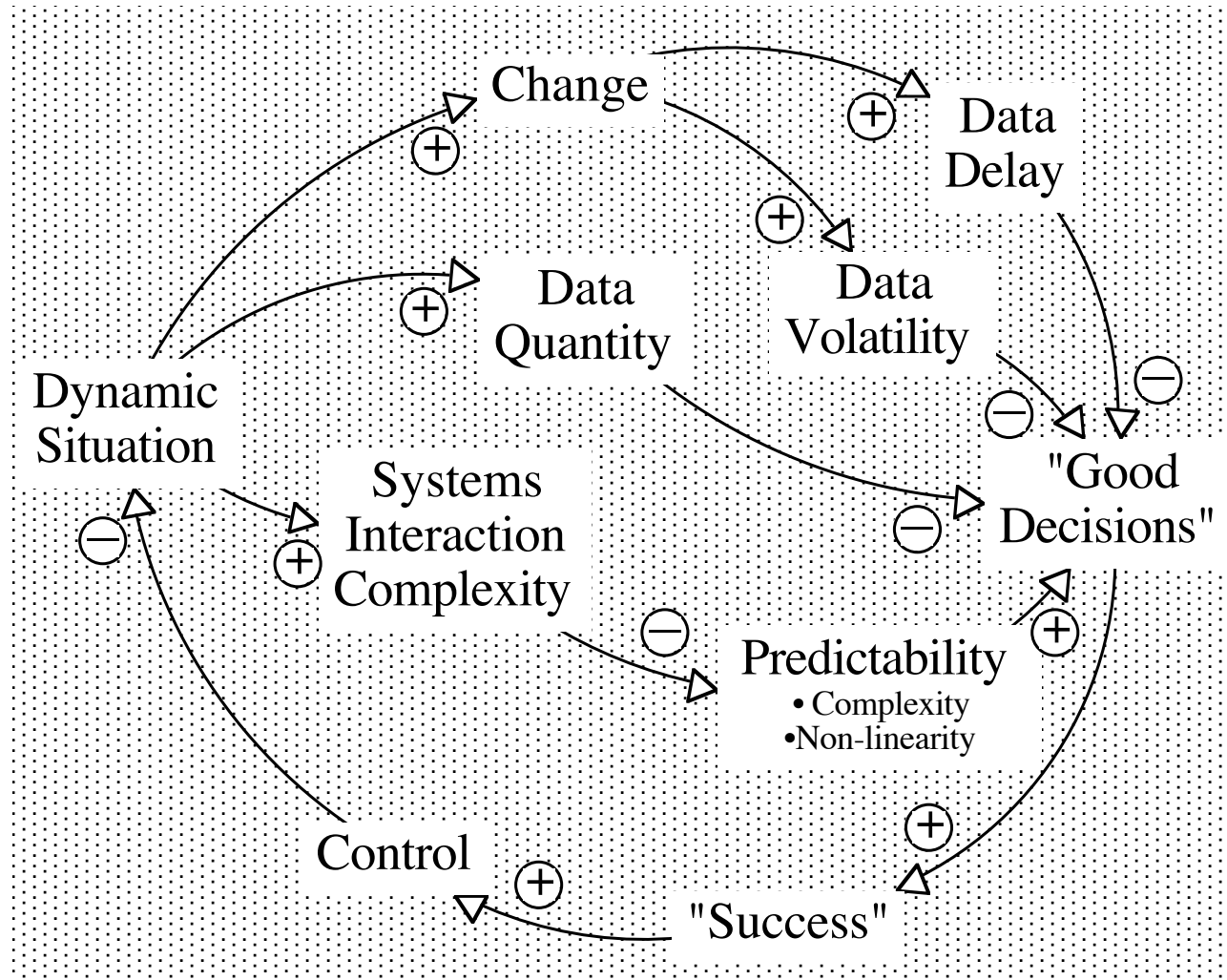
Statistical, Catastrophe and Chaos Theories indicate that the future may be as predictable/unpredictable as the weather—long-term stable but short-term unstable, according to climate

How can we *choose* between *options* in *dynamic situations* if the future is *unknowable*?

Can we/should we avoid making decisions if the future is unknowable?

How do we go about making decisions anyway?

"Good Decisions" ?



Is a "Good Decision" simply one that succeeds, or is it logical, comprehensive and omniscient in an unknowable situation?

Decision Maker's Cognitive Bias—1

Ian White

Adjustment & Anchoring. Decision Maker selects a Datum and fits other data to it improperly

Availability. Uses only freely-available data. An event is believed to occur frequently if it is easy to recall similar events

Conservatism. Failure to revise estimates as frequently as necessary

Data Saturation. Reaching premature decisions on too small a sample and then ignoring further data

Self-fulfilling Prophecy. Values certain outcomes and acquires and analyses only data that supports that outcome

Attribution Error. Associates success with inherent personal ability and failure with bad luck. "When you are wrong, you screwed up, when I'm wrong it was just bad luck"

Decision Maker's Cognitive Bias—2

Ian White

Gambler's Fallacy. Assumes the occurrence of one set of events enhances the probability of an event that has not yet occurred. "I have smoked for 10 years without getting cancer—clearly I am immune, so I can go on smoking

Habit. Familiarity with one rule results in its excessive use

Law of Small Numbers. Confidence in predictions based on small samples with non-discomforting evidence, than in predictions based on large samples with discomforting evidence

Order Effects. Order of information presentation affects retention and weighting

Outcome Irrelevant Learning. Use of an inferior rule leads to belief in results because of inability to evaluate choices not selected

Panic. Under stress, facing many options which cannot be evaluated, either selects at random or fails to act at all

Risky Shift

There is evidence to show that a group of people, isolated from outside influence and under pressure to make a decision, will polarize

Such polarization results in an extreme decision

"Extreme" may mean either very conservative or very risky—hence
Risky Shift

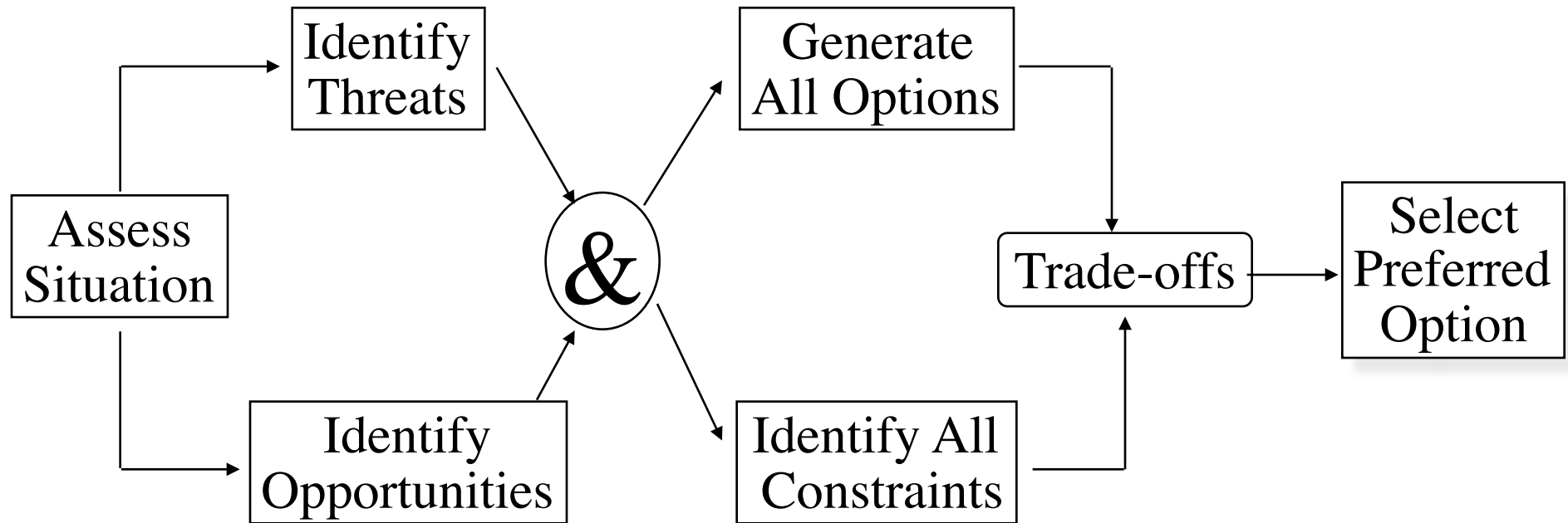
President Kennedy and the Bay of Pigs represents the archetypal Risky Shift decision.

Psychologists identify a distinct group dynamic in such situations

Group decision-making is of special interest to Command & Control and to Business

Groups exhibit inertia—resistance to intellectual change. Development of group consensus takes time according to the number in the group and the degree of their initial diversity.

Models of Human Decision-Making—1



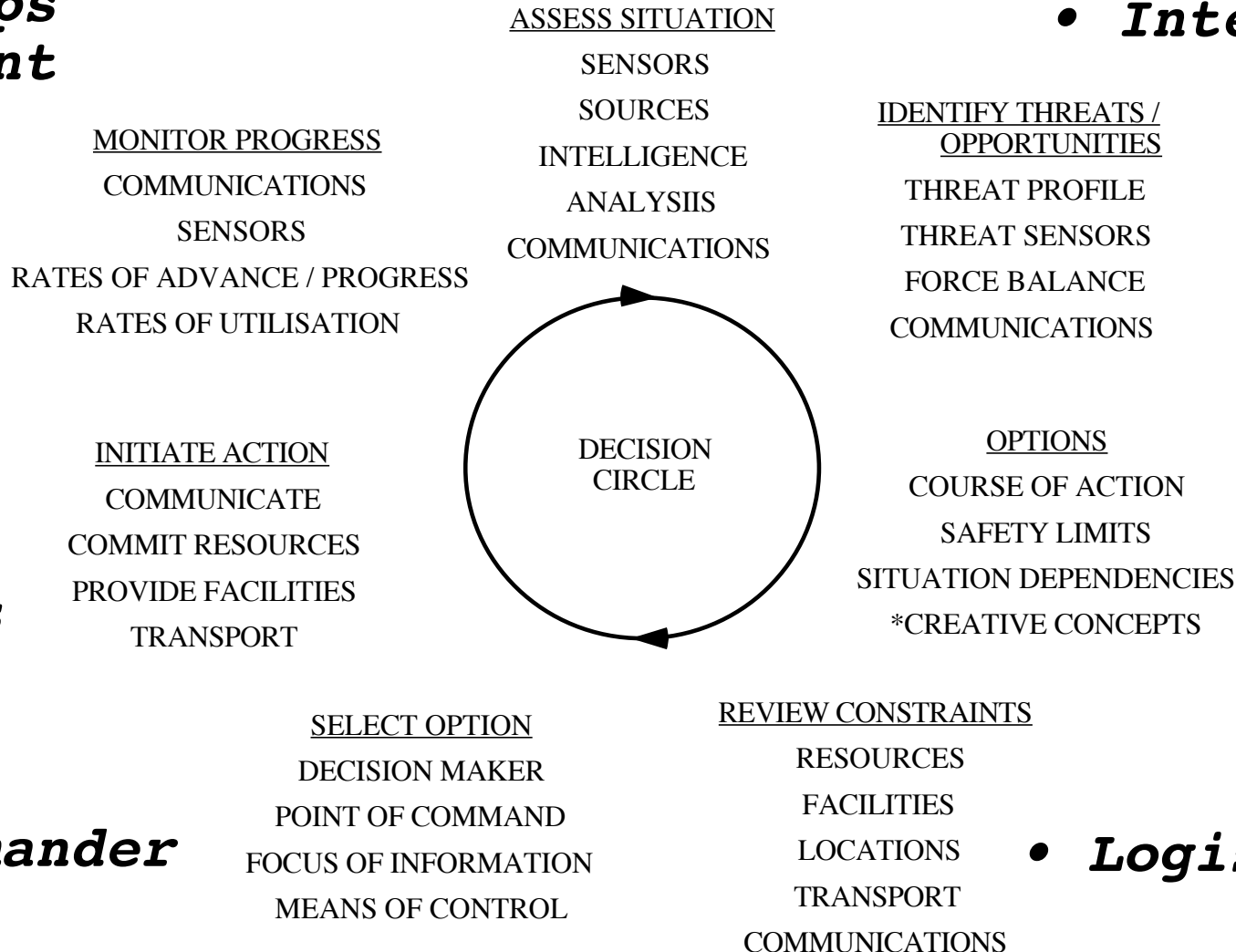
Characteristic of:—The Military Appreciation
Systems Engineering
Current C2 System Technology

Decision Contributions

- **Commander**
- **Operations**
- **Intelligence**

- **Ops**
- **Int**

- **Intelligence**



- **Ops**
- **Int**
- **Logs**

- **Int**
- **Ops**

- **Commander**

- **Logistics**

Assess Situation

Recognize Situation Cues

Choose
Situation
Memory
closest to
Observed
Situation

Initiate Action

*Cues do
not match*

Satisficing & Evolution

Humans evolved as Satisficers—otherwise, we might never have evolved.

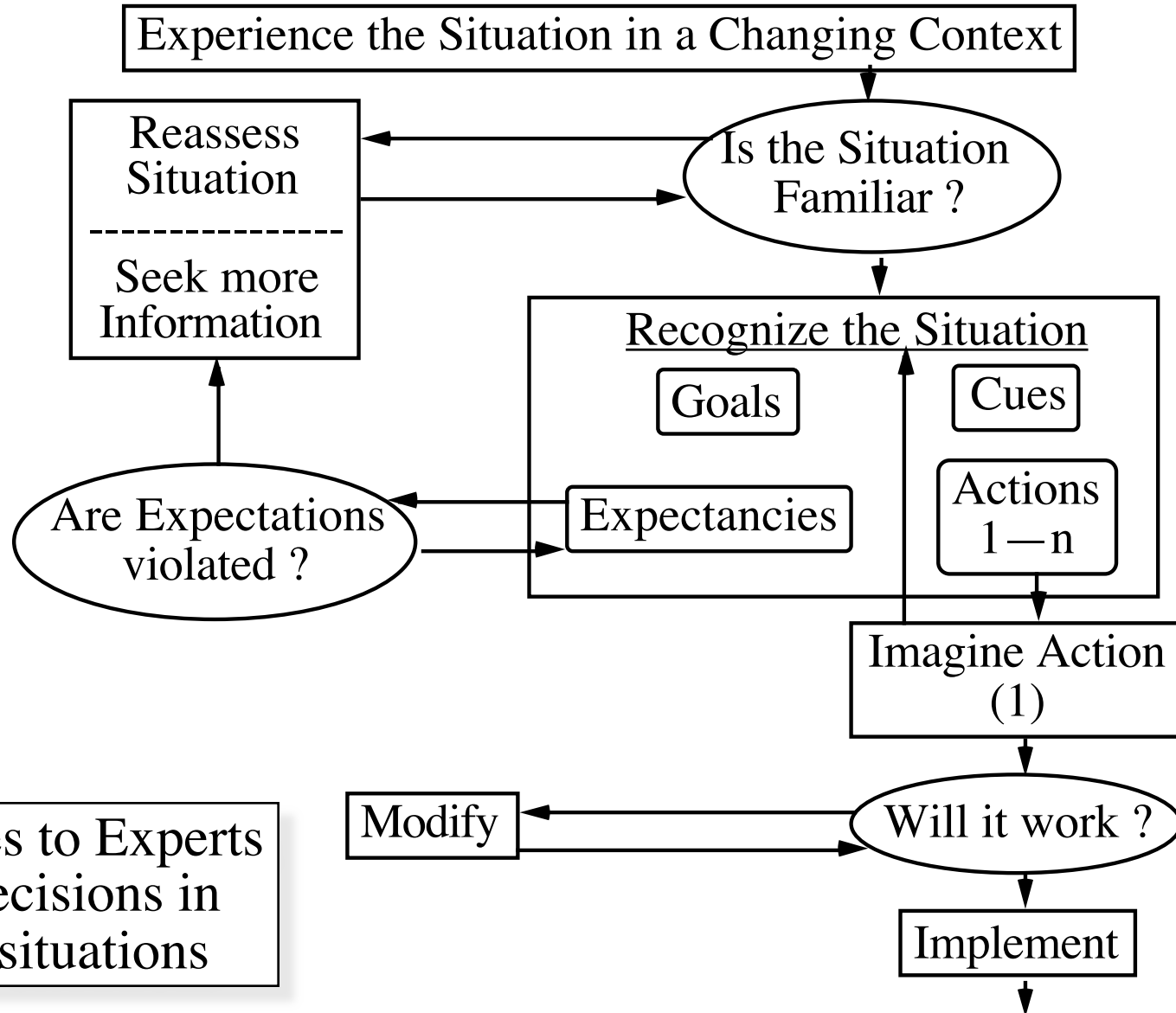
Who weighs up all the options when the tiger is 2 steps behind you?

Satisficing is quick, experienced-based and effective in known, or similar-to-known, situations.

C2 Systems presently operate along the Military Appreciation route—easier to understand, analyse, mechanize.

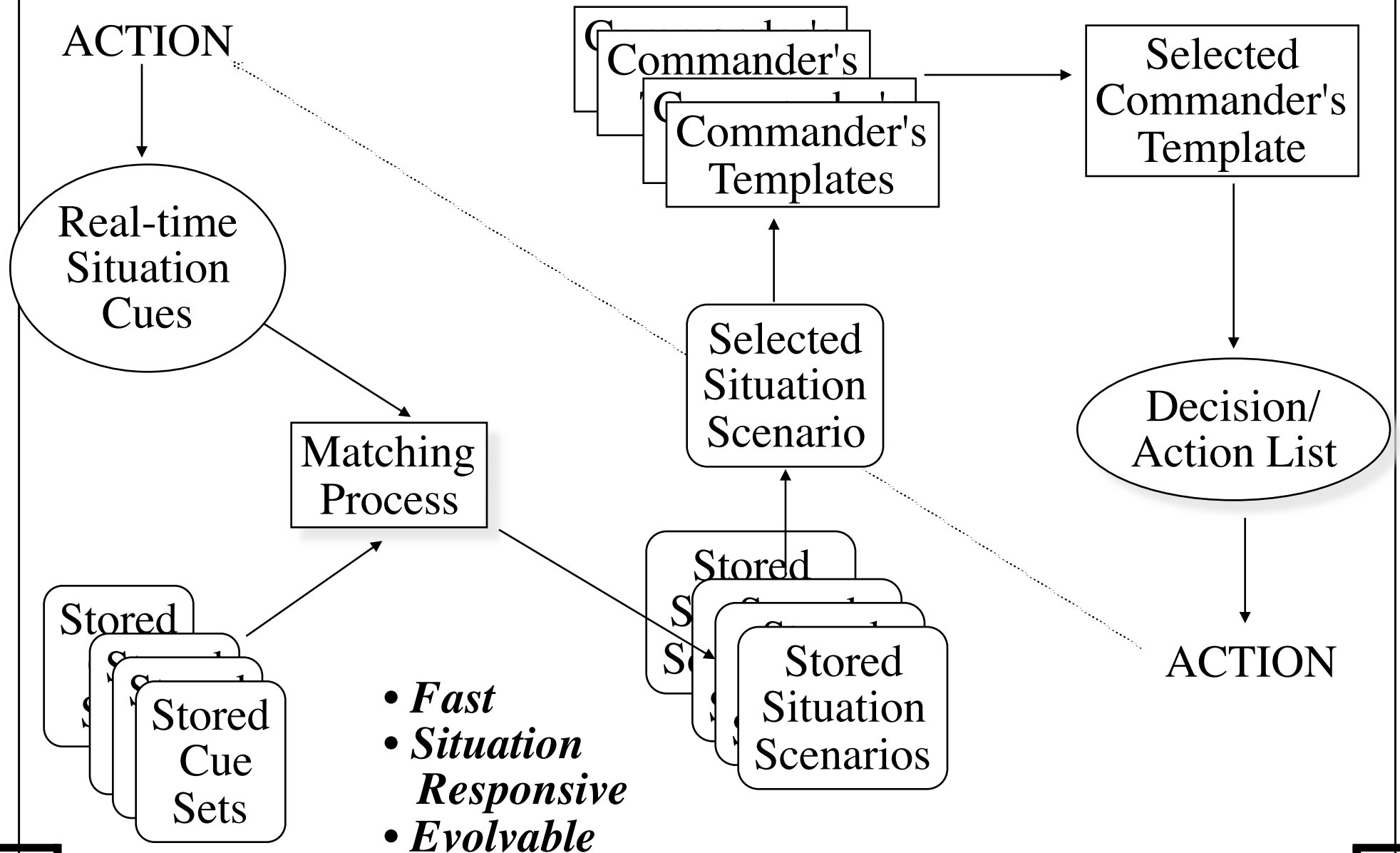
Commanders generally satisfice under pressure—like any human!

Klein's Recognition-Primed Decision Model—"Satisficing"



N.B. Applies to Experts making decisions in Stressful situations

Satisficing Technology?



Correlation—relating different data about the same thing

Fusion—joining different data such that the original sources are no longer separable (c.f. welding two pieces of metal)

- Several Sources of Data refer to the same event/object/situation.
- To correlate the separate data would seem an obvious benefit.
- If sources are mutually remote, then maximum information content would facilitate correlation, so transmit as 'raw' data.
- BUT—comprehensive reproduction requires full bandwidth:—
 - e.g. for radar, could transmit raw video, plots or tracks, in reducing entropy-order
- AND—comprehensive reproduction equates to comprehensive processing

This is the Entropy/Bandwidth dilemma

We assess the world around us using our mental models of "how things work"

Children learn to throw a ball from one hand and catch it "blind" behind them with the other.

This action requires a cognitive model of the ball's trajectory when it is out of sight and of the relative positioning of the catching hand.

Such models are fundamental to our thinking, judging, and responses.

Some expert systems are compatible with our innate models

Others may not be.....

Cohen's Analysis—1988

USER VIEWPOINT	ANALYST VIEWPOINT
<ul style="list-style-type: none">• Pilot, uncertain about presence of an enemy surface-to-air missile installation on his planned path• Pilot seeks to develop a single, concrete, "worst-case" scenario	<ul style="list-style-type: none">• Analyst, whose goal is to help the pilot• Analyst seeks to develop a system that mathematically aggregates the possibilities— average of probabilities, weighted according to probable outcome. Display corresponds to no actual outcome e.g. "expected danger" contours

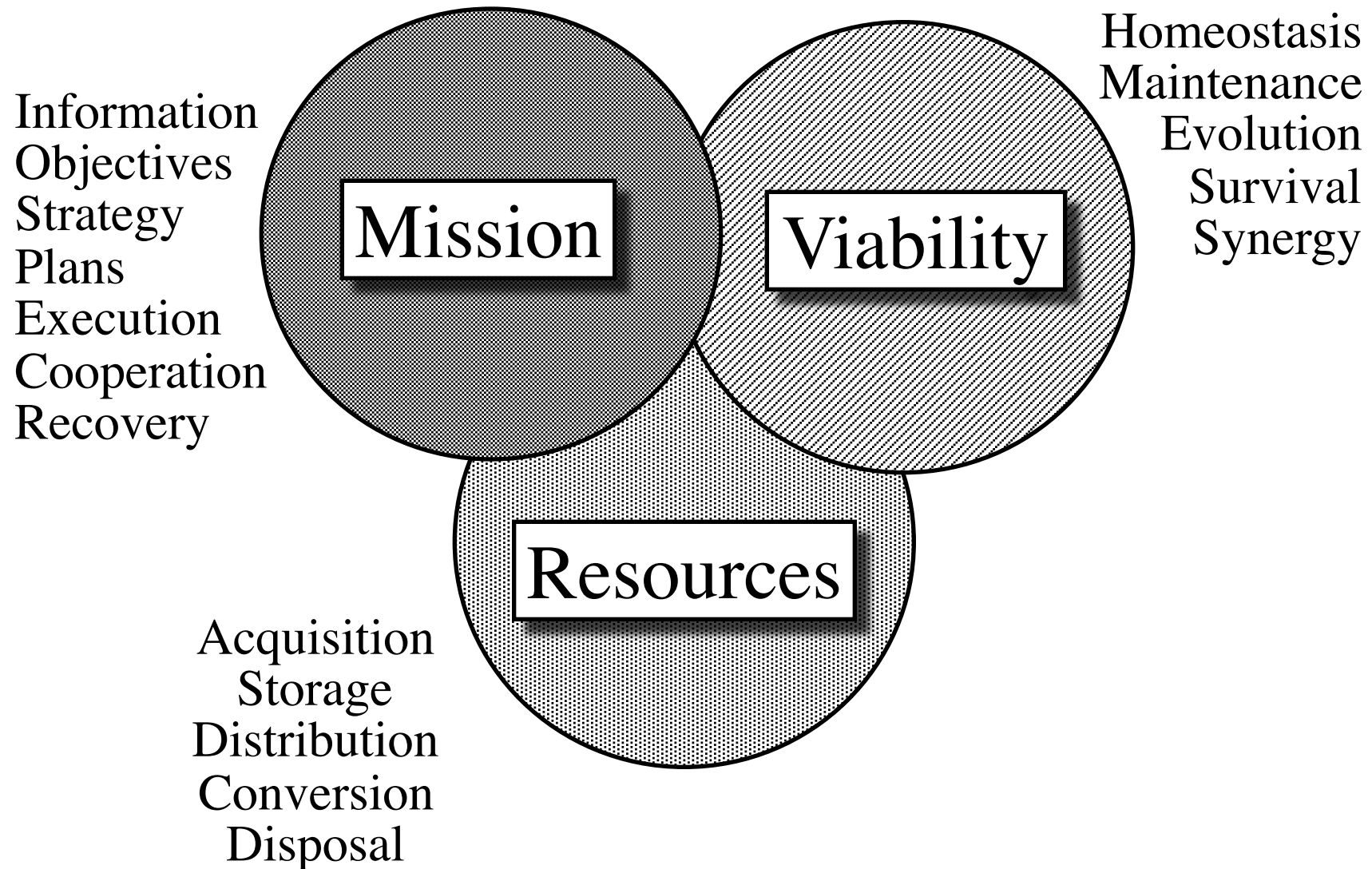
RESEARCH FINDING (COHEN)

- Research shows that pilots prefer a single possibility-outcome e.g. worst case. Pilots adopt a sophisticated, active process of problem solving underlying selection and rejection of single possibility presentations. Research further suggests that pilot's approach is powerful, and approaches theoretical best.

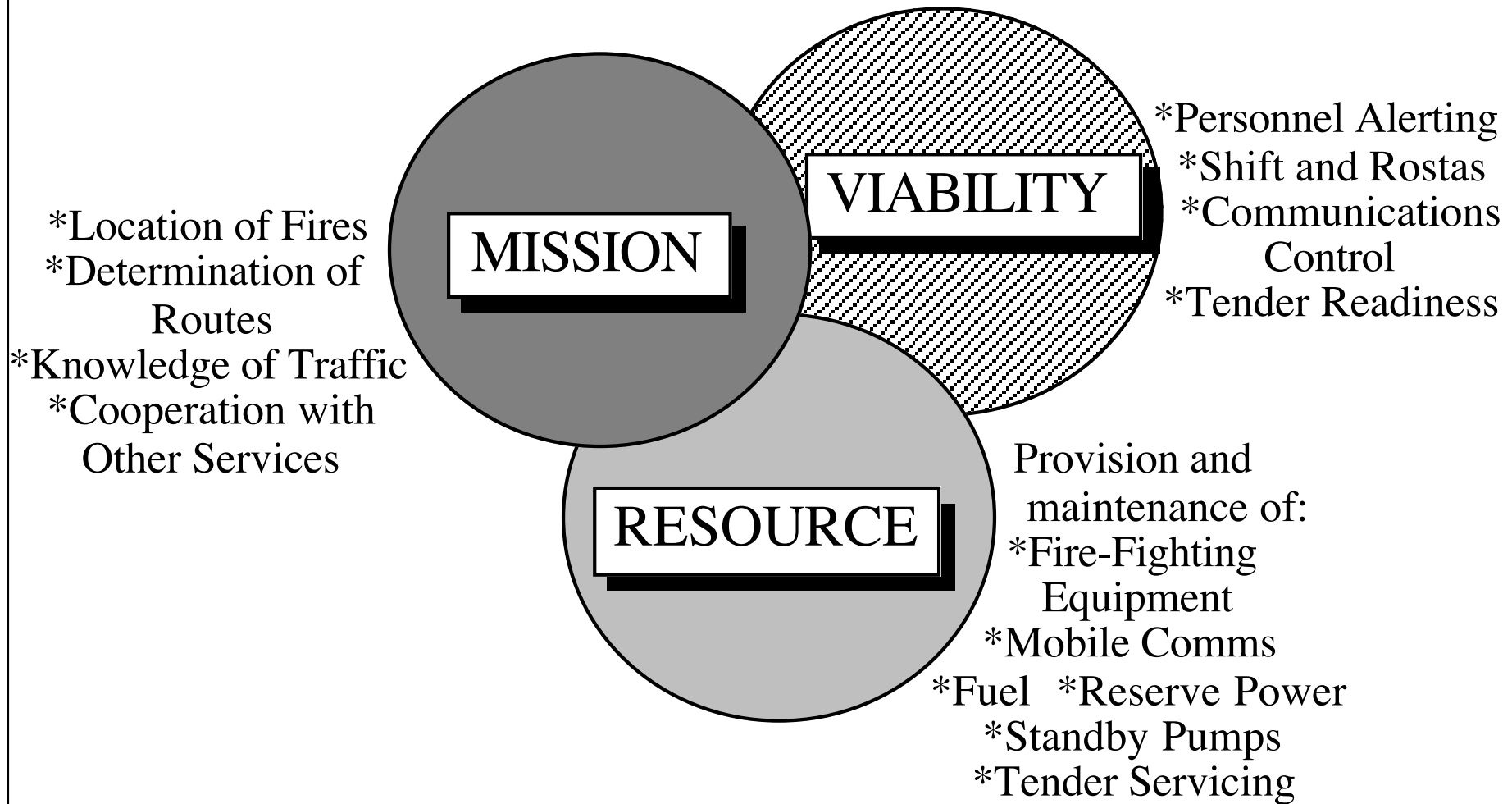
- *What price knowledge based devices which present time-constrained users with views incompatible with their mental models ?*

Decision Formulation Methods

The Generic Management Set

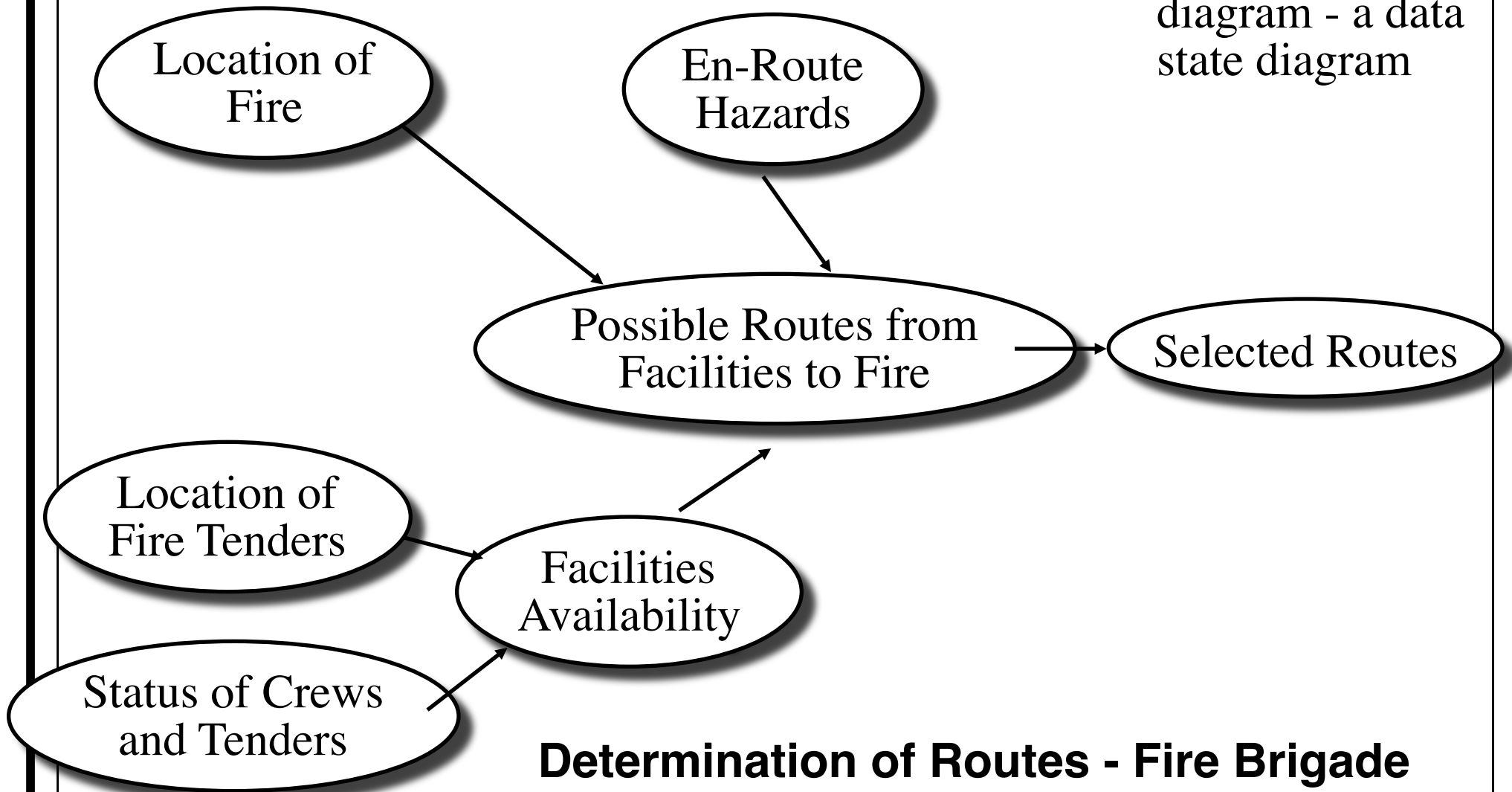


A Fire Brigade HQ Management Set



Mission Management - Determination of Routes

N.B. Not a flow diagram - a data state diagram



Determination of Routes - Fire Brigade

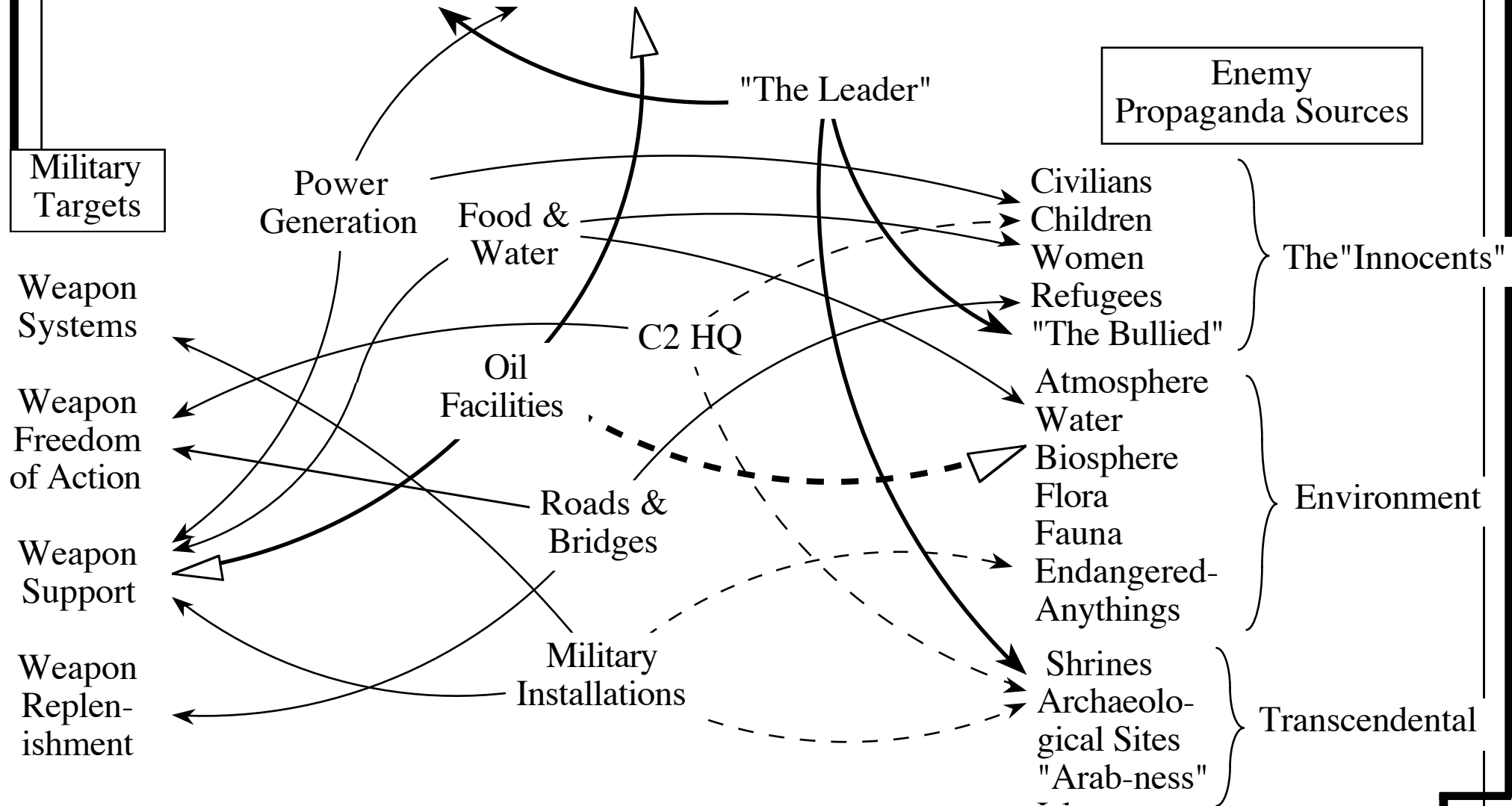
The Targeting Dilemma

Ideologies Figureheads Economies Relationships Boundaries

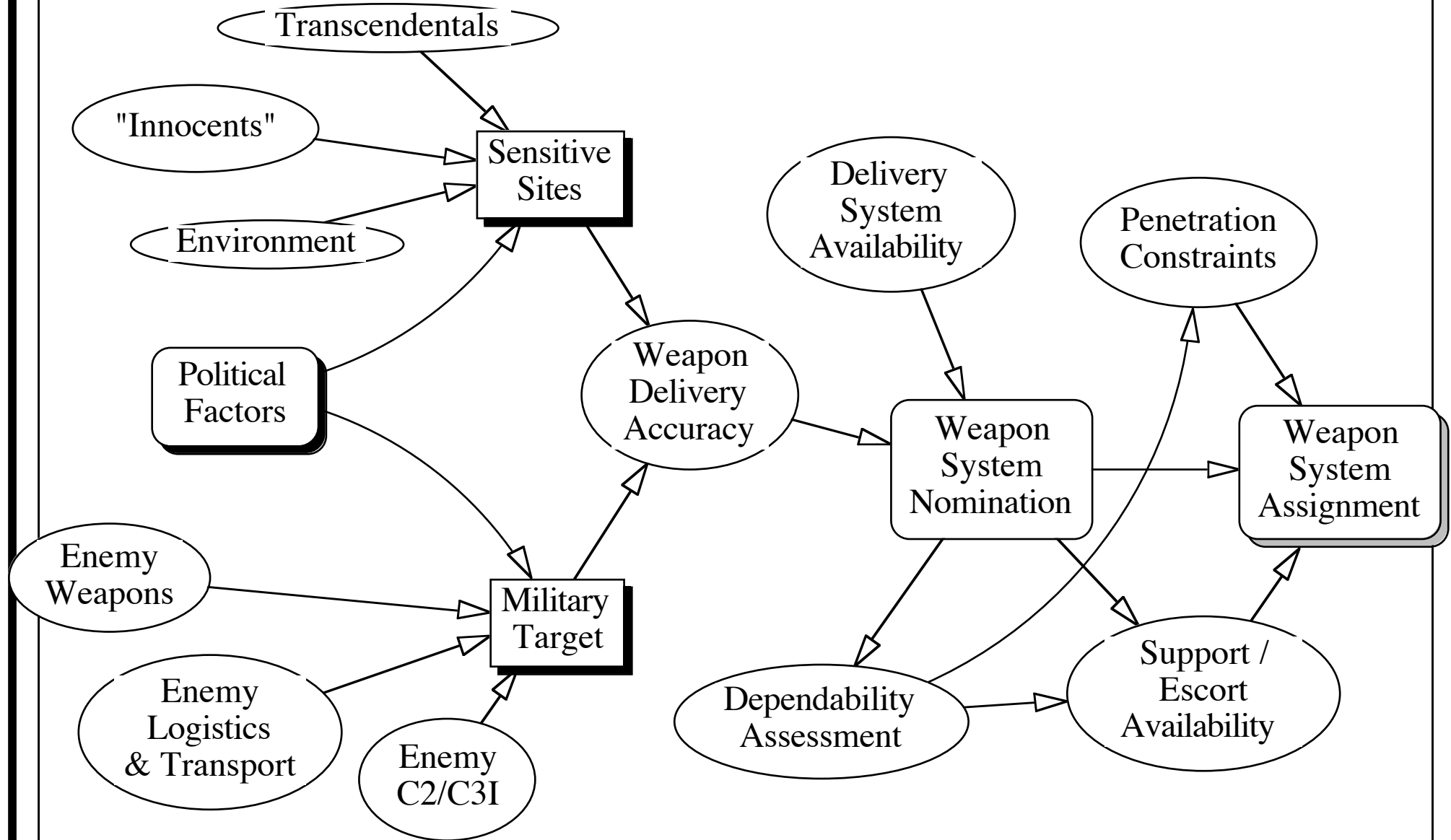
Political Targets

Enemy
Propaganda Sources

Military
Targets



Air Operations Planning



Weapon System—Decision Tree

Desert Storm

What price close-in Iron Bombs in terms of lost aircrew, aircraft and reputation?

+22.55

-15.78

Standoff Precision-guided Munitions ?

?
Close-in Iron Bombs

0.95

0.8 hit target

0.2 miss target

0.05 lost to enemy Air Defence

0.85

0.3 hit target

0.7 miss target

0.15 lost to enemy Air Defence

0.7

kill

0.3

damage

0.1

hit non-target

0.9

miss

0.4

kill

0.6

damage

0.3

hit non-target

0.7

miss

Value

48

13

-50

0

-100

50

15

-50

0

-95

NB All values notional only

Good Decisions, Bad Decisions

- Evolution & "Satisficing"
- Assumption:— More information = better decision
- In dynamic situation, information dated, future uncertain
- Near-term future unknowable?
 - Self-Organized Criticality, Catastrophe, Chaos*
- More, Better Information → Objective → Predictable → Defeat
- Subjective = Animal Cunning?

What *is* a better decision?
Simply, one that turns out better

Sometimes, an instinctive reaction may be better

* Present C3I technology: slow, expensive, expert systems, fused data, multilevel security.....

* Does not add up to "good decision"

The Essence of the Problem

- Combat Systems are "human activity systems" —HASs
- HASs adapt readily and effectively to changing situations
- Present technology does ***not*** adapt readily
- Procurers are intent on fixed-price, fixed spec—the notion of adaptability is anathema!!!!
- We don't understand how individuals grasp information presented on screens, e.g. 3-D from PPI, fused data display dynamics
- We don't understand how individuals make decisions—*we certainly don't review all the options when under pressure*
- We don't understand how *groups* make decisions—e.g. "risky shift", group polarization—or about team cohesion and spirit

In spite of all this, we place our faith in technology to support decision-making under stress

About Humans Making Decisions

- Individuals and groups make decisions differently
- Experts make decisions differently from naive beginners
- Experts make decisions in different ways according to the urgency
- Experts under pressure "satisfice"
- Homo sapiens evolved by satisficing—who trades off the options when the tiger is two steps behind?
- Research showing that users may perform better with "worst / best" case presentations than fused-data displays
- Present trends are: more fused-data displays; decision-support software for naive users; full option trade-offs, not satisficing.

We do not understand yet how we comprehend
and make decisions