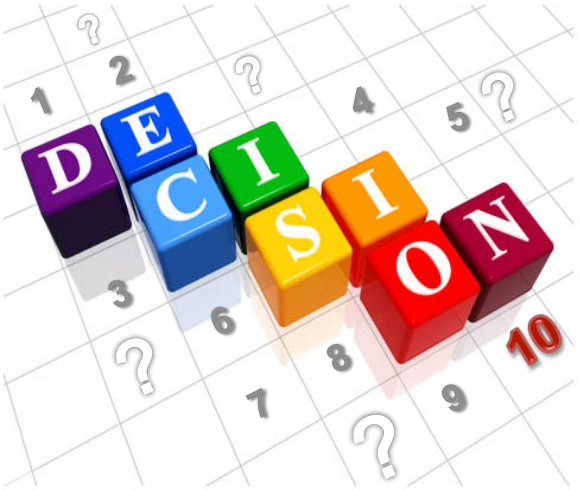
Presentation to: C2 Symposium: Learning the Lessons for the Last 20 Years of Science and Techology
Tidworth, UK, 24 March 2015



Have we learned anything about decision making and cognition in the past 20 years?

Gary Klein, Ph.D.
MacroCognition LLC

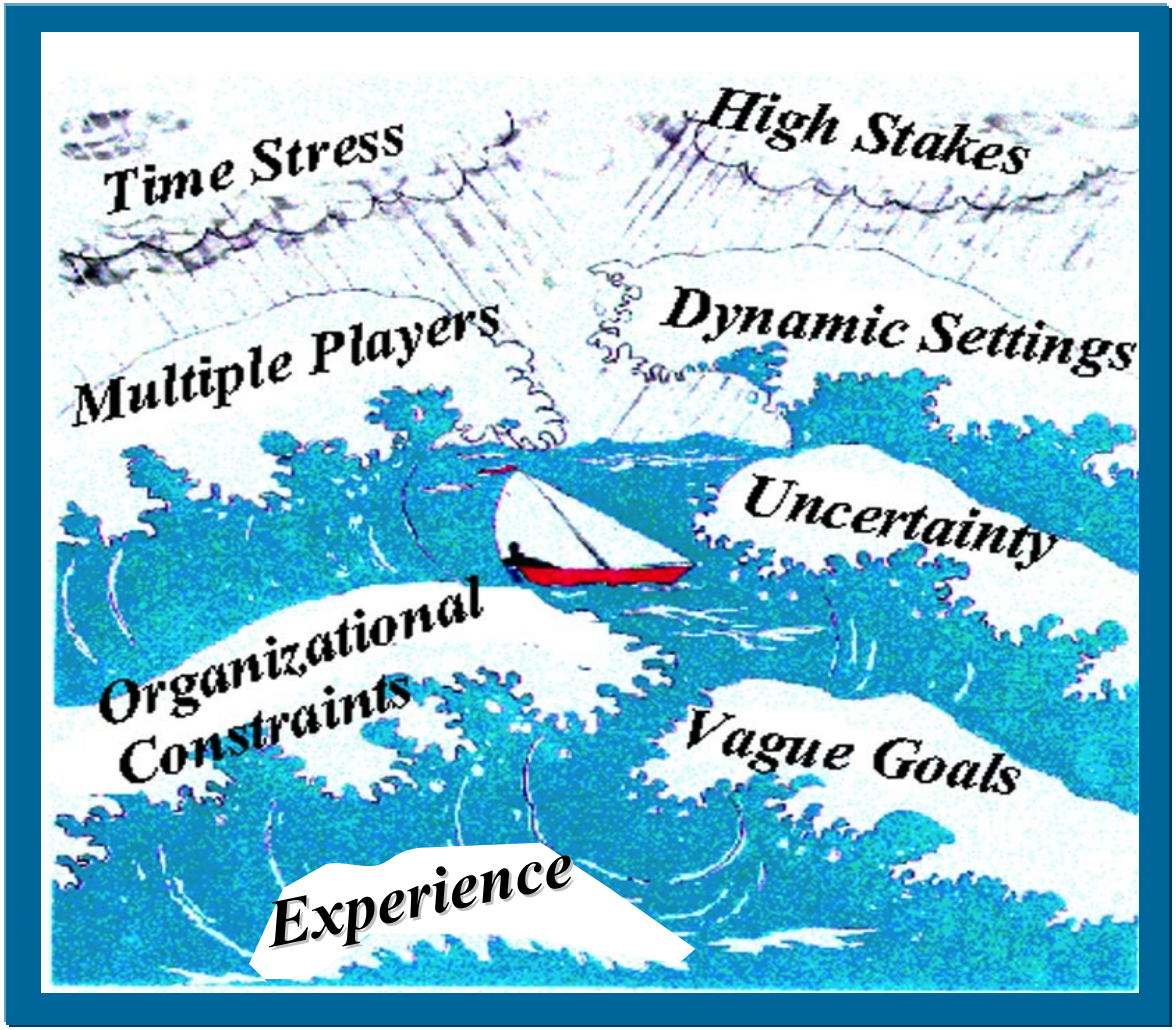
[dstl]

MacroCognition

Core Beliefs – 1990

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. Deep down, people from other cultures are just like us
5. Improve performance by teaching Critical Thinking and other methods to reduce errors
6. Insights arise by overcoming a mental set
7. Train decision making by automatizing a standard process (e.g., Military Decision Making Procedure)
8. When the workload gets too high, add more people to the team
9. Organizations promote innovation by encouraging insights
10. Don’t start any projects without a clear description of the goal

Features of Naturalistic Decision Making



[dstl]

MacroCognition

Core Beliefs – 1990: Decision Making

1. **To make a decision, generate several options and compare them to pick the best one**

Rational Choice Model of Decision Making

Evaluation Dimensions	Options		
	A	B	C
1	√		
2		√	√
3	√		
4	√	√	√
Total	3	2	2

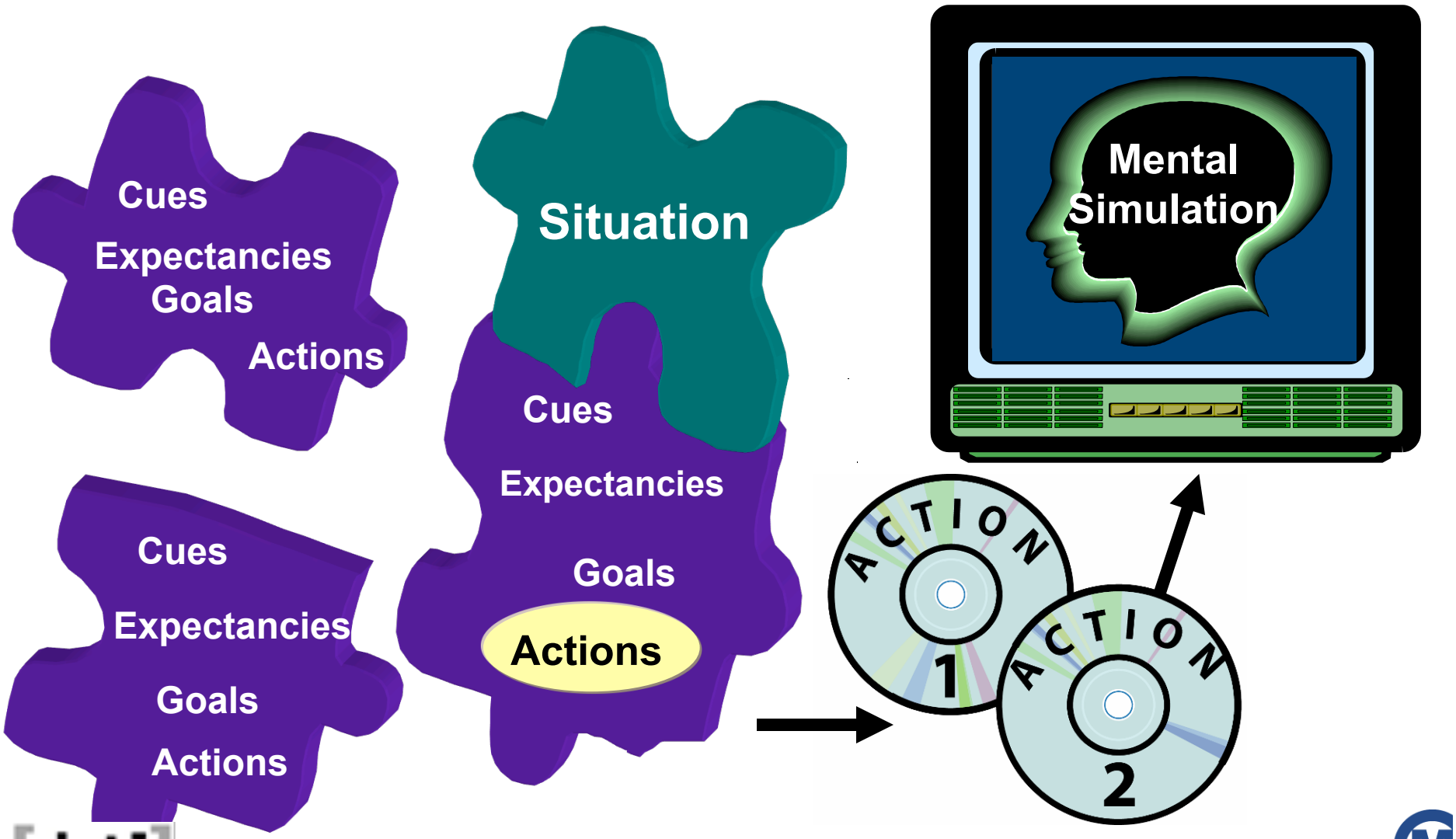
Limitations

- Requires too much time
- Requires too much data
- Can result in worse performance
- Little value to training or decision aids
- Gaming the method

[dstl]

MacroCognition

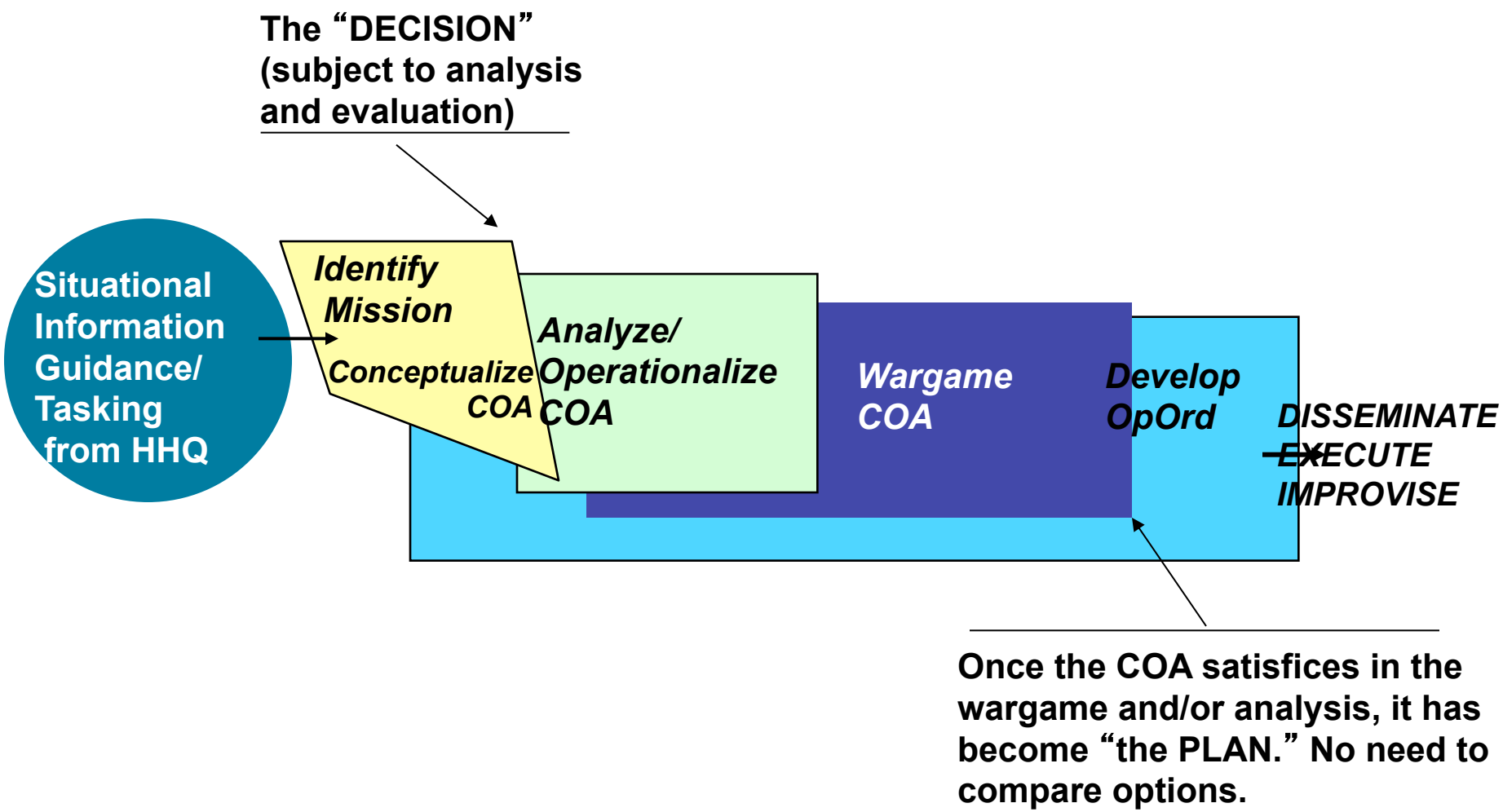
Recognition-Primed Decision Making (RPD)



[dstl]

MacroCognition

Recognitional Planning Model



[dstl]

MacroCognition

Core Beliefs – 1990: Expertise

1. To make a decision, generate several options and compare them to pick the best one
2. **Build expertise by teaching the rules and procedures**

The Boundary Conditions for Procedures

- Procedures are advisable for well-ordered situations.
- The become brittle in complex situations.
  - They may be insensitive to context, and can mislead us.
- They are insensitive to tacit knowledge.

Six Types of Knowledge

Explicit Knowledge:

1. Declarative information
2. Routines & procedures

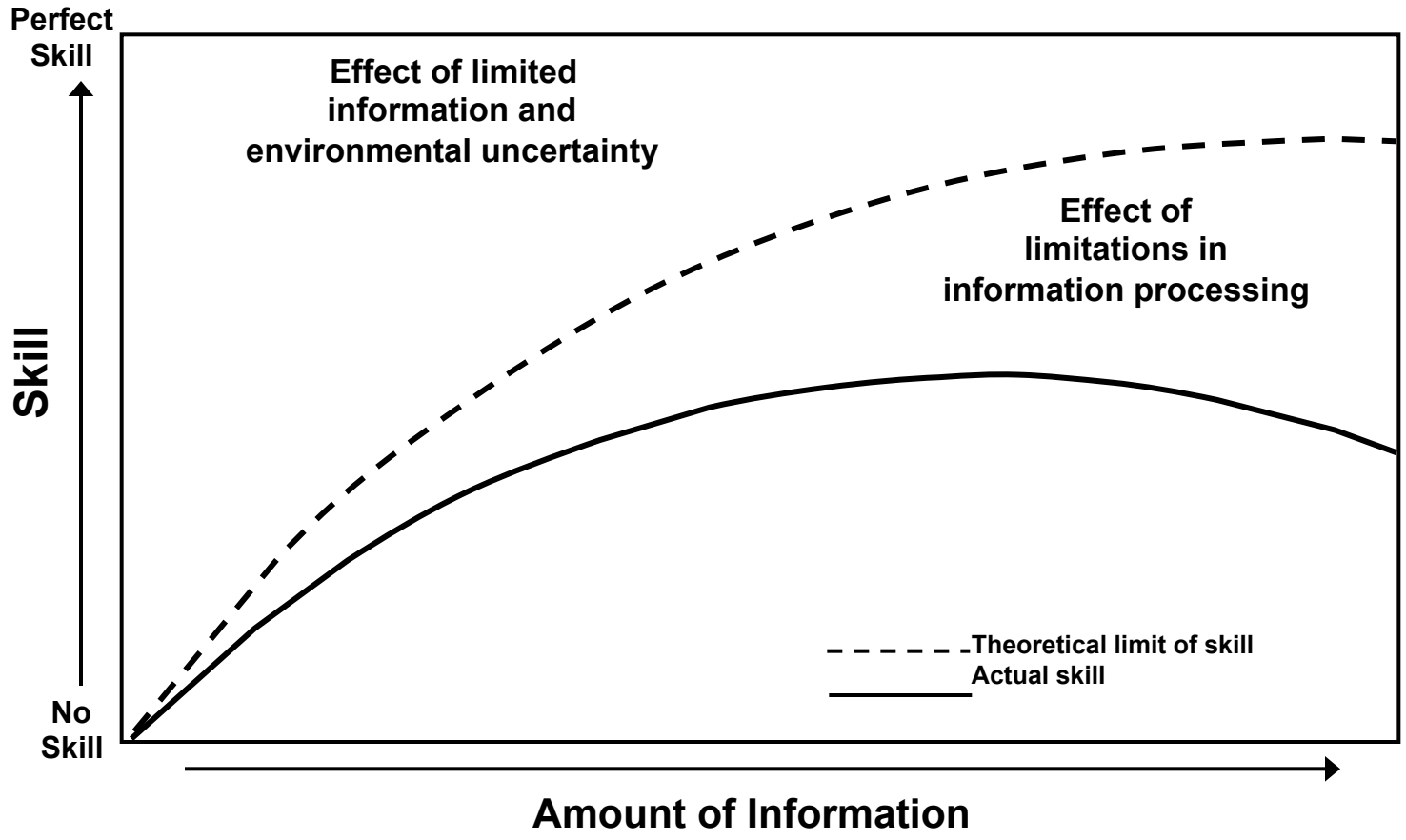
Tacit Knowledge:

3. Pattern recognition
4. Perceptual discriminations
5. Mental models
6. Judging typicality

Core Beliefs – 1990: Reducing Uncertainty

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. **Reduce uncertainty by gathering more information**

Effect of information on skill



[dstl]

MacroCognition

Why does additional data reduce performance?

Overconfidence

- Additional data produces overconfidence (Oskamp).

Reduced Marginal Value

- Marginal value/data point gets smaller, while the additional data become harder to integrate, and the likelihood of misusing the cues increases (Stewart).

Prioritizing

- Additional information means you have to prioritize and inspect the data. Firefighters tried to use all the information and traded quality of integration against quantity of data reviewed (Omodei).

Complacency

- DMs with unreliable information worked hard to sort out implications, vs. DMs with reliable information who didn't scrutinize very carefully (Omodei).

Big Data vs Deep Insights

- Big Data assumes that more data produces better performance
- But data analysis is not an end in itself. The point is to achieve insights, not to get the most out of the available data.
- Deep insights usually require people to abandon some strongly held beliefs. It is not a simple accumulation: data – knowledge – information – understanding.
- The way we design data bases cannot accommodate deep insights that render the data base structure obsolete.
- The way we analyze and code data reflects current beliefs – which can and should change as we gain insights.
- Further: extrapolating trends into the future assumes that conditions won't change.
- Data crunching depends on increasing speed and power, not on reflecting on unexpected nuances that require re-framing.

Core Beliefs – 1990: Cultural Cognition

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. **Deep down, people from other cultures are just like us**

Cultural Passport (H.A. Klein)

- **Based on the Cultural Lens model, and 30 years of research on cross-cultural cognition.**
- **Achievement vs. Relationships.** Does achievement or ties to family/friends take priority? Is there an obligation to give job preference to family members?
- **Power.** Which people are powerful and how is respect shown (e.g., is it considered rude to contradict the leader in public)?
- **Mastery vs. Fatalism.** Do they believe that hard work can change conditions or that change is beyond their control?
- **Tolerance for Uncertainty.** Are they comfortable or distressed with uncertainty?

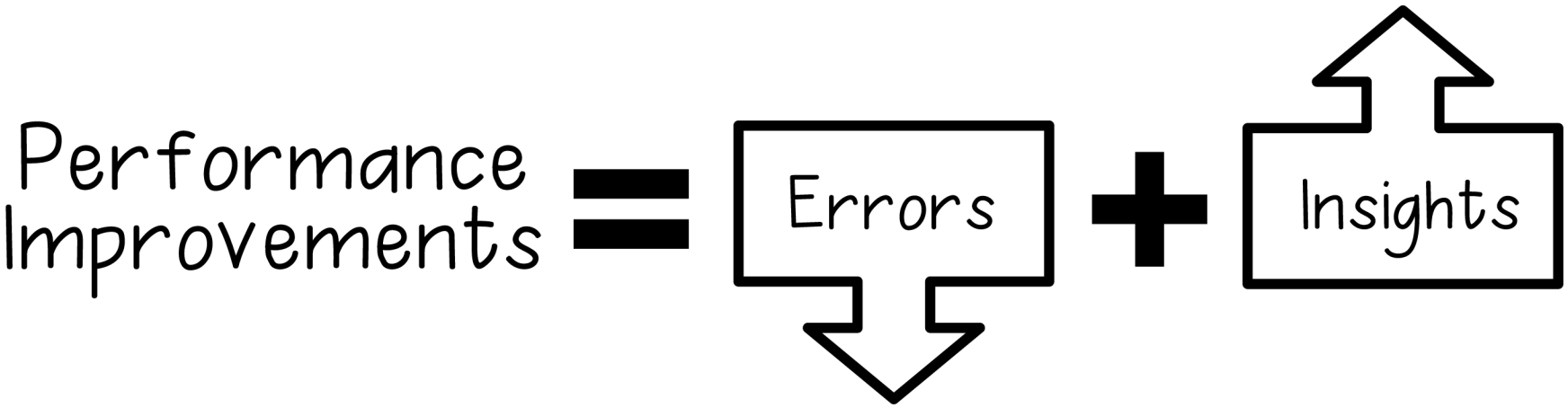
Core Beliefs – 1990: Critical Thinking

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. Deep down, people from other cultures are just like us
5. **Improve performance by teaching Critical Thinking and other methods to reduce errors**

Decision Biases

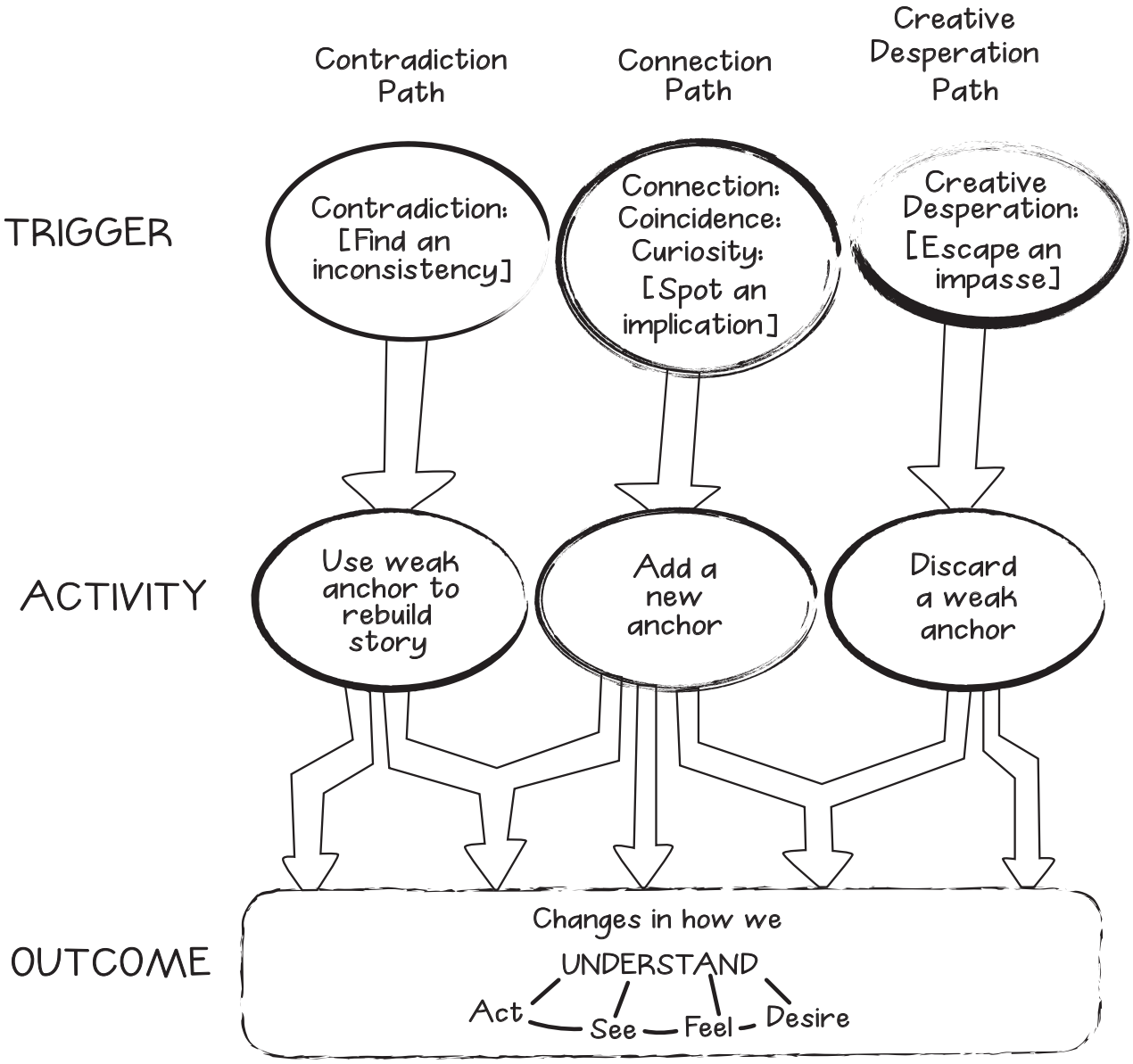
- Heuristics and Biases movement asserts that all of us, including experts, are prone to crippling decision biases
- Expansion and popularization into books on irrationality:
  - *Predictably irrational*. (Ariely)
  - *Blind spots.* (Van Hecke)
  - *Everyday irrationality*. (Dawes)
  - *Thinking Fast and Slow* (Kahneman)
- But: Concerns about Decision Biases have been overstated
- Use of Bayesian standard is questionable
  - Too brittle, doesn't generalize well to natural settings. See Klein (2011) *Critical thoughts about critical thinking*.
- Cognitive de-biasing doesn't work
- The risks of de-biasing
  - The heuristics are valuable

Balancing Act



Core Beliefs – 1990: Insights

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. Deep down, people from other cultures are just like us
5. Improve performance by teaching Critical Thinking and other methods to reduce errors
6. **Insights arise by overcoming a mental set**



[dstl]

MacroCognition

Core Beliefs – 1990

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. Deep down, people from other cultures are just like us
5. Improve performance by teaching Critical Thinking and other methods to reduce errors
6. Insights arise by overcoming a mental set
7. **Train decision making by automatizing a standard process (e.g., Military Decision Making Procedure)**

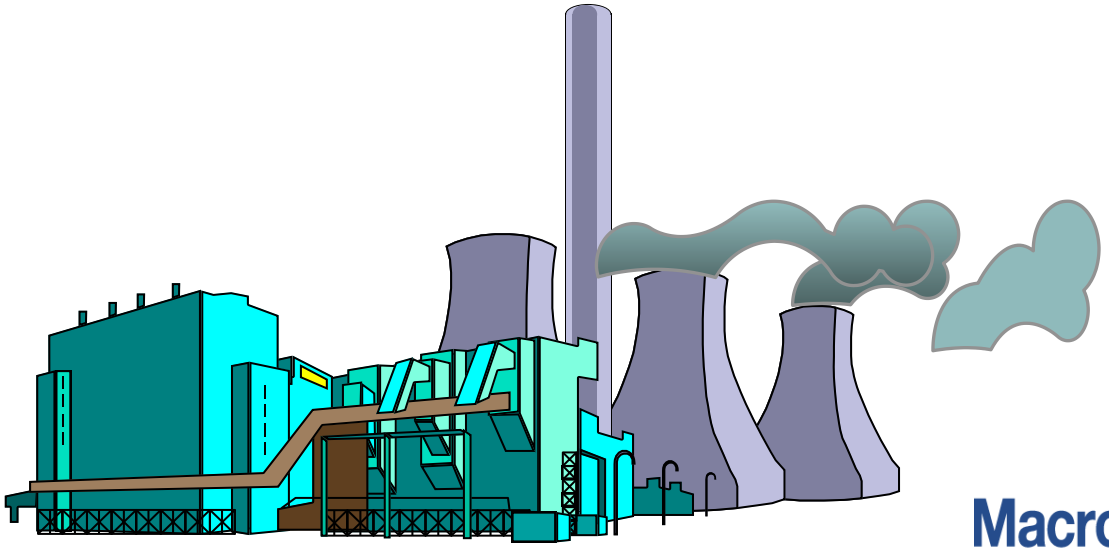
ShadowBox Training Method

- **Problem:**
  - Subject Matter Experts (SMEs) and skilled facilitators are important for training, but are costly and often unavailable
  - Inefficiency of low student/SME ratio for training
- **ShadowBox Training Method:**
  - Present complex scenarios, with periodic Decision Points: Multiple-choice response options, priorities, information to track, etc.
  - Trainees rank the alternatives and record their rationale
  - Trainees compare their responses and rationale to a panel of SMEs
- **Rationale: Shadow the Subject-Matter Experts (SMEs).**
  - Enabling trainees to see the world through the eyes of the experts
  - Appreciate the mental models of experts. And no SMEs have to be present
- **Evaluation studies: 18% to 27% improvement after ½ day of training**
- **Versions: Paper/Pencil; Android tablet; Laptop/web-based.**
  - Text scenario, storyboard, video

Core Beliefs – 1990: Team size

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. Deep down, people from other cultures are just like us
5. Improve performance by teaching Critical Thinking and other methods to reduce errors
6. Insights arise by overcoming a mental set
7. Train decision making by automatizing a standard process (e.g., Military Decision Making Procedure)
8. **When the workload gets too high, add more people to the team**

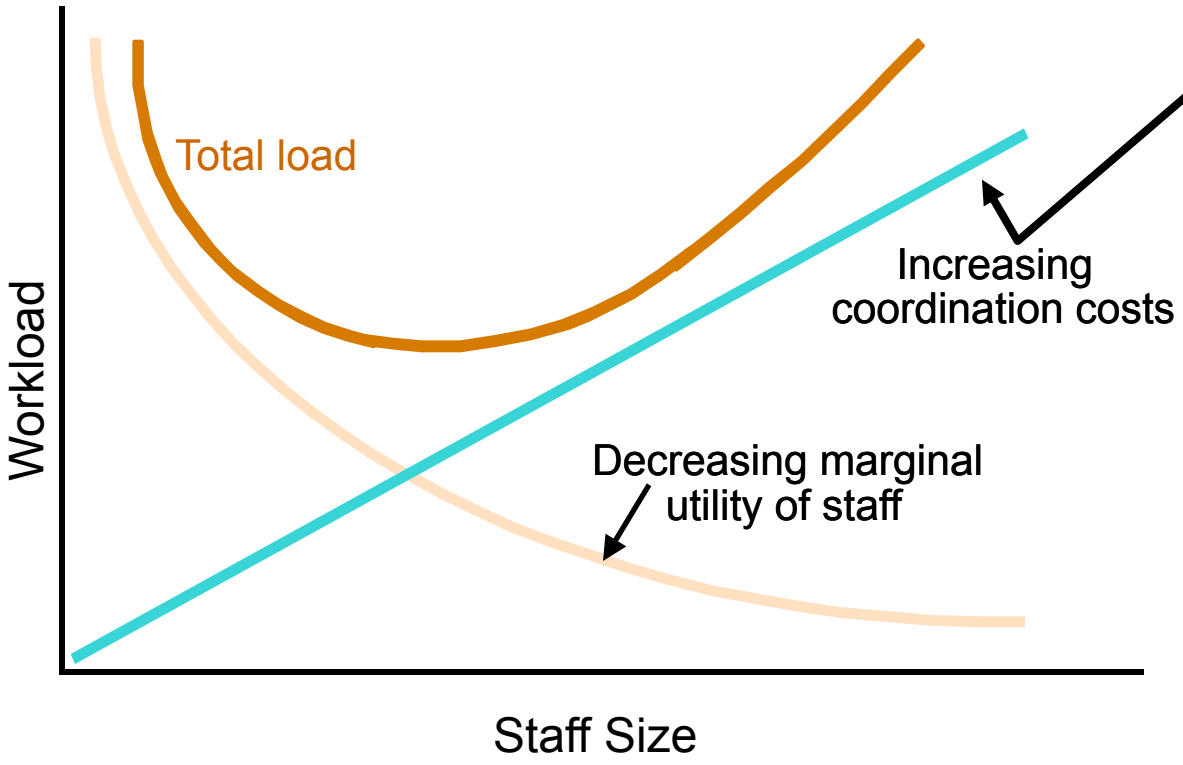
- **Frederick Brooks: The Mythical Man Month (1975)**
- **Klinger and Klein (1999): Nuclear Power Plant Emergency Response Center – Reduced personnel from 80 to 35.**



[dstl]

MacroCognition

Team Size and Effectiveness



Coordination costs:

- Communication overhead
- Synchronization overhead
- Common Ground overhead

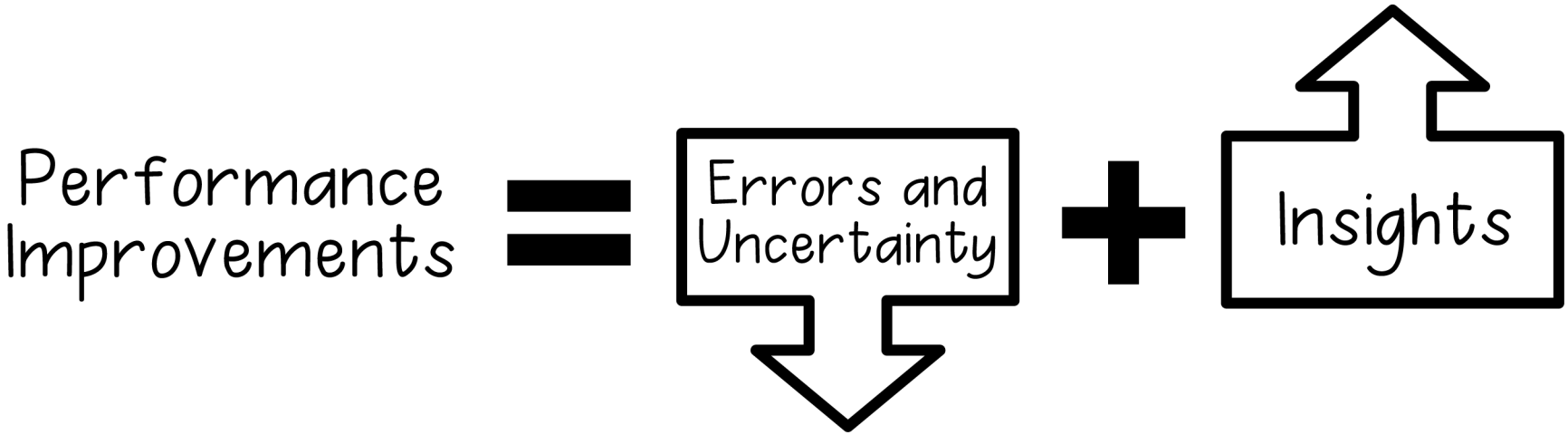
[dstl]

MacroCognition

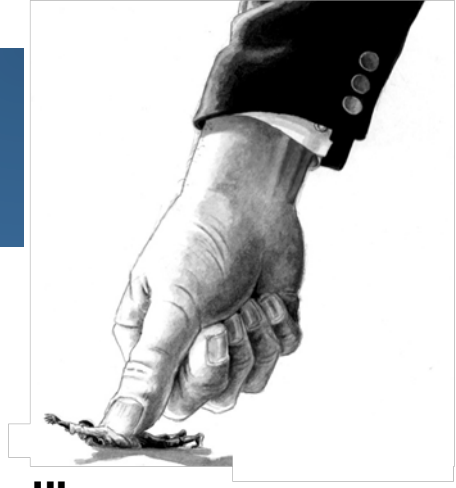
Core Beliefs – 1990: Innovation

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. Deep down, people from other cultures are just like us
5. Improve performance by teaching Critical Thinking and other methods to reduce errors
6. Insights arise by overcoming a mental set
7. Train decision making by automatizing a standard process (e.g., Military Decision Making Procedure)
8. When the workload gets too high, add more people to the team
9. **Organizations promote innovation by encouraging insights**

Improving Performance



Why Do Organizations Fear Insights?



- Insights are disruptive – They are *dis*organizing
- Distrust of creativity. Mueller et al. (2012).
  - Risk of taking an unconventional approach
  - "The pioneers get the arrows – the settlers get the land"
- Predictability allows effective management
  - Insights come without warning, take unexpected forms, and open up unimagined opportunities.
- Perfection enables effective management
  - Managers value error reduction over making discoveries
  - Prefer accuracy over information value
- Effort. Insights usually require extra work to make changes
- Goal fixation – even when facing wicked problems
  - Sengupta et al. (2007 HBR) simulation study. Faced with changes in scope or unexpected events, managers failed to revise their goals

[dstl]

MacroCognition

Core Beliefs – 1990: Goal fixation

1. To make a decision, generate several options and compare them to pick the best one
2. Build expertise by teaching the rules and procedures
3. Reduce uncertainty by gathering more information
4. Deep down, people from other cultures are just like us
5. Improve performance by teaching Critical Thinking and other methods to reduce errors
6. Insights arise by overcoming a mental set
7. Train decision making by automatizing a standard process (e.g., Military Decision Making Procedure)
8. When the workload gets too high, add more people to the team
9. Organizations promote innovation by encouraging insights
10. Don't start any projects without a clear description of the goal

Wicked Problems (WPs)
(Rittel & Webber, 1973; 1984)

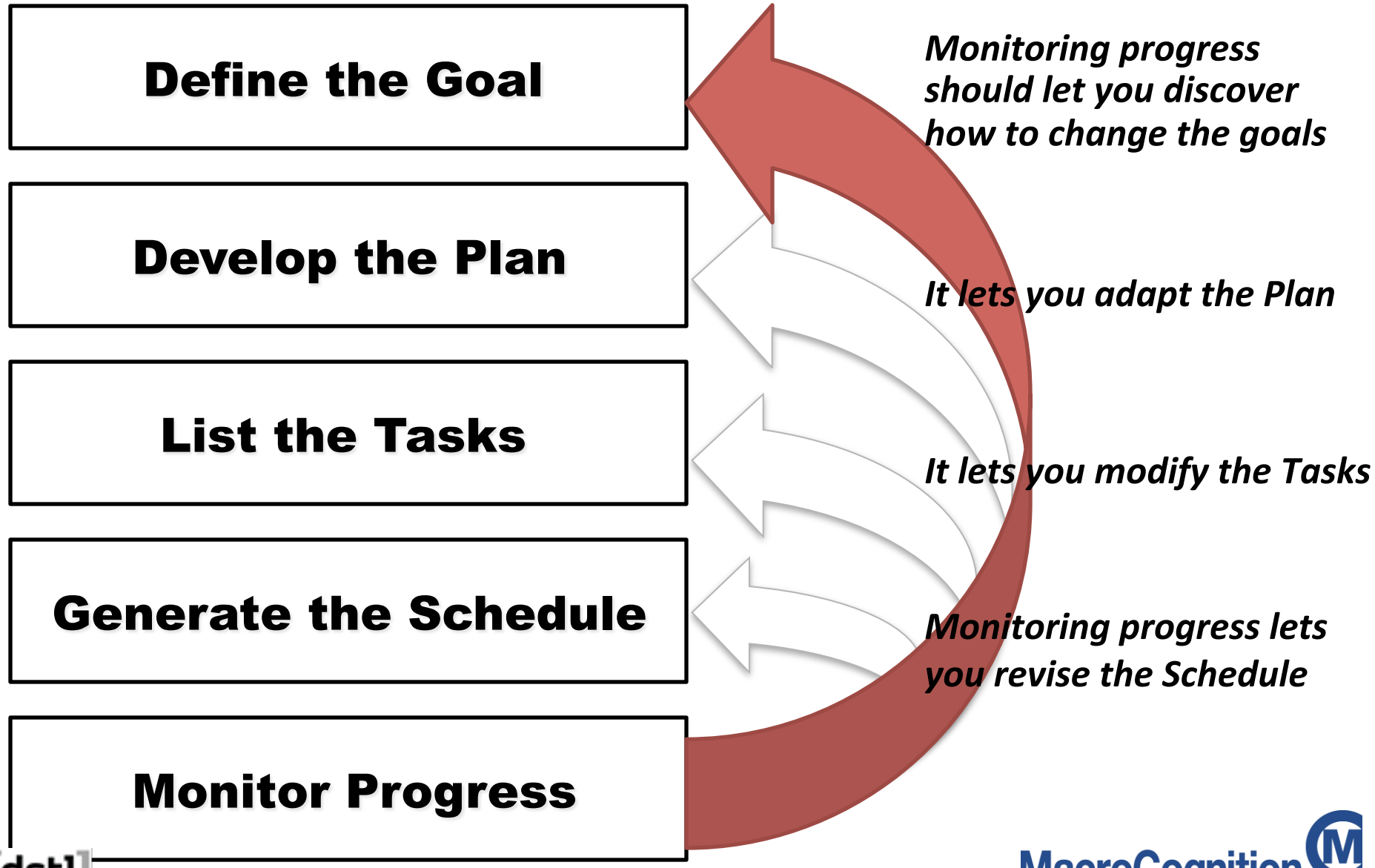
- Solutions to WPs aren't true or false, but good or bad.
- There is no immediate and no ultimate test of a solution to a WP.
- WPs have goal features that are incomplete, changing, sometimes contradictory.
- Attempts to solve WPs often lead to a new and deeper understanding of the problem.

Tip: Don't insist that the client retain the original goal! Evolving and clarifying the goal is essential with wicked problems.

[dstl]

MacroCognition

MANAGEMENT BY DISCOVERY



[dstl]

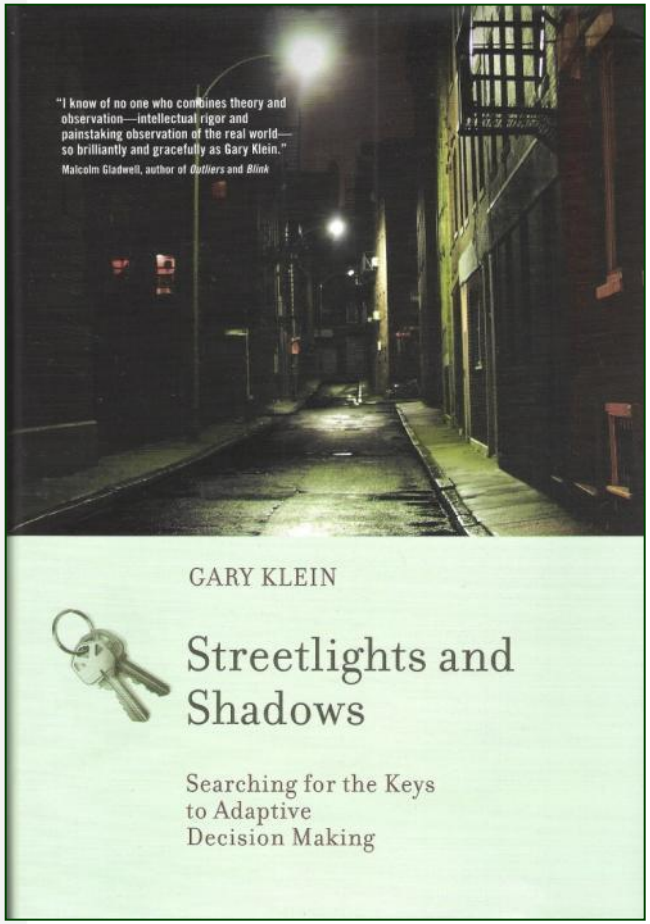
MacroCognition

Cognitive Challenges for C2

- Developing warfighters who are truly adaptive
  - Richer mental models, better sensemaking, increased insights
- Becoming less fragile and more agile
- Balancing the need to reduce errors with the need to increase insights
- Using Cognitive Systems Engineering and Resilience Engineering to design IT systems that support expertise rather than suppress it
- Achieve better teamwork with smaller teams
- Handle the sensemaking challenges of deceptive cyber adversaries and partially compromised systems

[dstl]

MacroCognition



Streetlights and Shadows:

Searching for the keys to adaptive decision making

Gary Klein, Ph.D.
MacroCognition LLC
gary@macrocognition.com
www.macrocognition.com

MacroCognition

[dstl]