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June 2007

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# The PRIM: Extracting Expert Knowledge For Aiding in C2 Sense & Decision Making



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- **Introduction**
  - Problem identification
  - Design considerations
  - Usability Scenario
- **PRIM: A possible solution?**
  - Gathering expert knowledge (Input)
  - Processing expert knowledge (Output)
- **Benefits**

- **Today's Command & Control (C2) environment**
  - Rapid and continual information
  - High volume, high tempo and uncertainty
- **Need to help battlefield command synthesize information for action**
  - Accurately capture experts' decision making processes via a computer interface
  - Encourage intra-team collaboration to a common solution
- **The Probability & Ranking Input Matrix (PRIM)**
  - Allow experts to input effect and likelihood of occurrence of a variable, as well as variable importance in deciding on one course of action.
  - Test PRIM with a hypothetical walk through.

- **“Skilled problem solvers and decision makers are chameleons...can simulate all types of events and processes in their heads” (Klein, 1999)**
- **Humans:**
  - **Poor statisticians (Clemen, 1996; Kahneman & Tversky, 1979; Wiener & Nagel, 1988)**
  - **Only process through a few alternatives when thinking about solutions (Gigerenzer, Todd, & Group, 1999)**
  - **Do not process through all attributes when making a decision (Slovic, Fischhoff, & Lichtenstein, 1978; Wiener & Nagel, 1988)**

## Design Considerations

- **Experts:**
  - Quickly categorize and act from these categories (Wiener & Nagel, 1988)
  - Typically assign variables into 3 to 4 categories and work from there (Klein et al., 2004)
  - 3 advantages (Clemen, 1996):
    - Specialized knowledge
    - Make many forecasts
    - Receive immediate feedback
- **No added accuracy for models with greater than 10 variables, just greater confidence in decision. (Wickens, Lee, Liu, & Becker, 2004; Oskamp, 1965)**
- **Teams:**
  - Collective conscious (Klein, 1999)
  - Social dimensions (Gigerenzer, Todd, & Group, 1999; Klein, 1999)

## Scenario

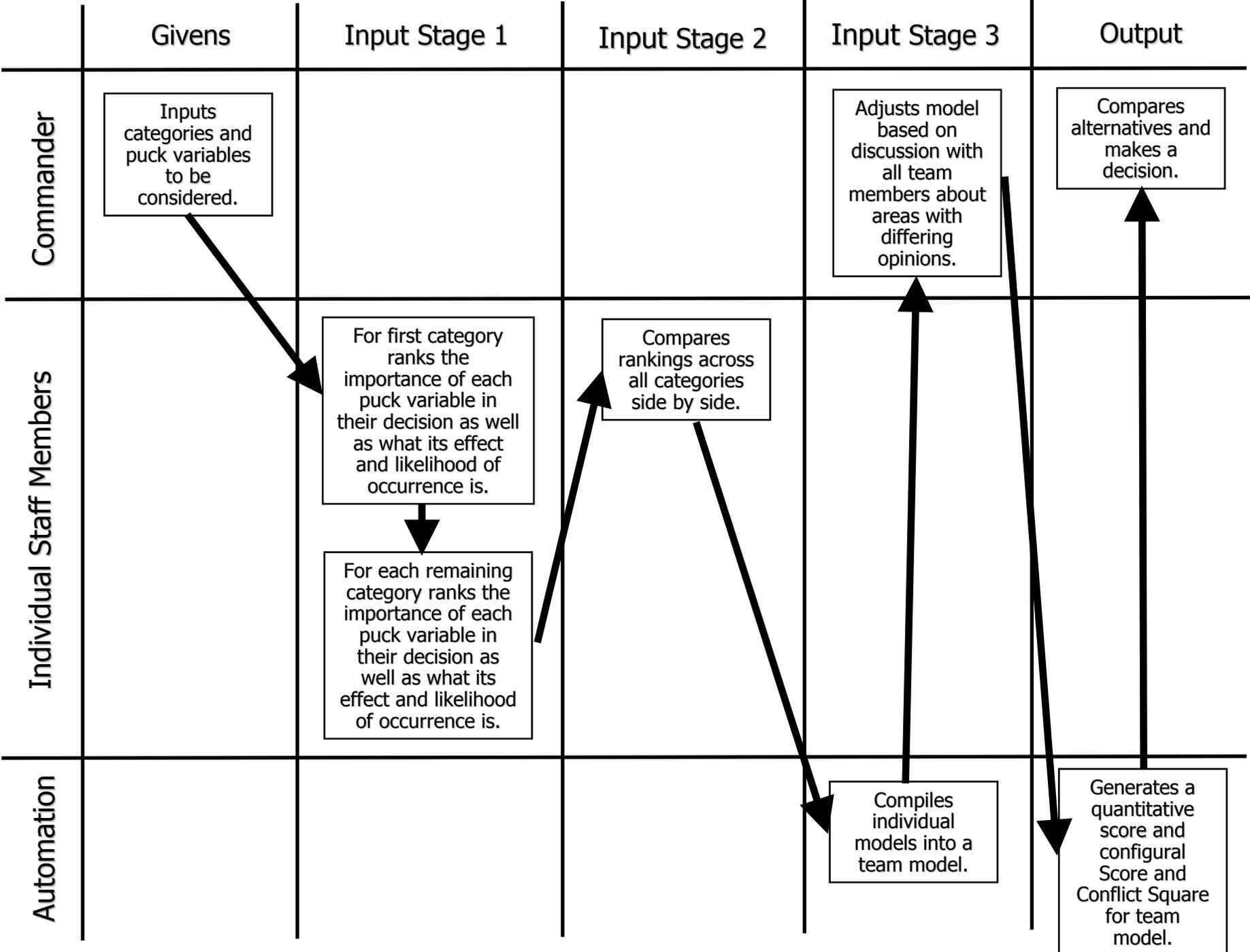
- You are a member of an Air Force battle staff that must decide if a mission for tomorrow should launch as scheduled or be delayed a day.
- Your staff has 3 hours to make the decision.
- The mission is to bomb and destroy 3 key industrial factories supporting the re-supply of the enemy's Unmanned Drones. These Drones are linked with the enemy's ability to maintain 24/7 surveillance of your troop movements.
- Your commander has given you a list of key variables classified into 3 categories he believes they should be considered within.
  - the crews' readiness
  - the aircraft & munitions' readiness
  - the target
- Your commander wants you to input the importance and likelihood of the variables' positive or negative influence on the outcome.
- You should complete this for all proposed courses of action (the current timeline and the delayed timeline).

## Scenario—Continued

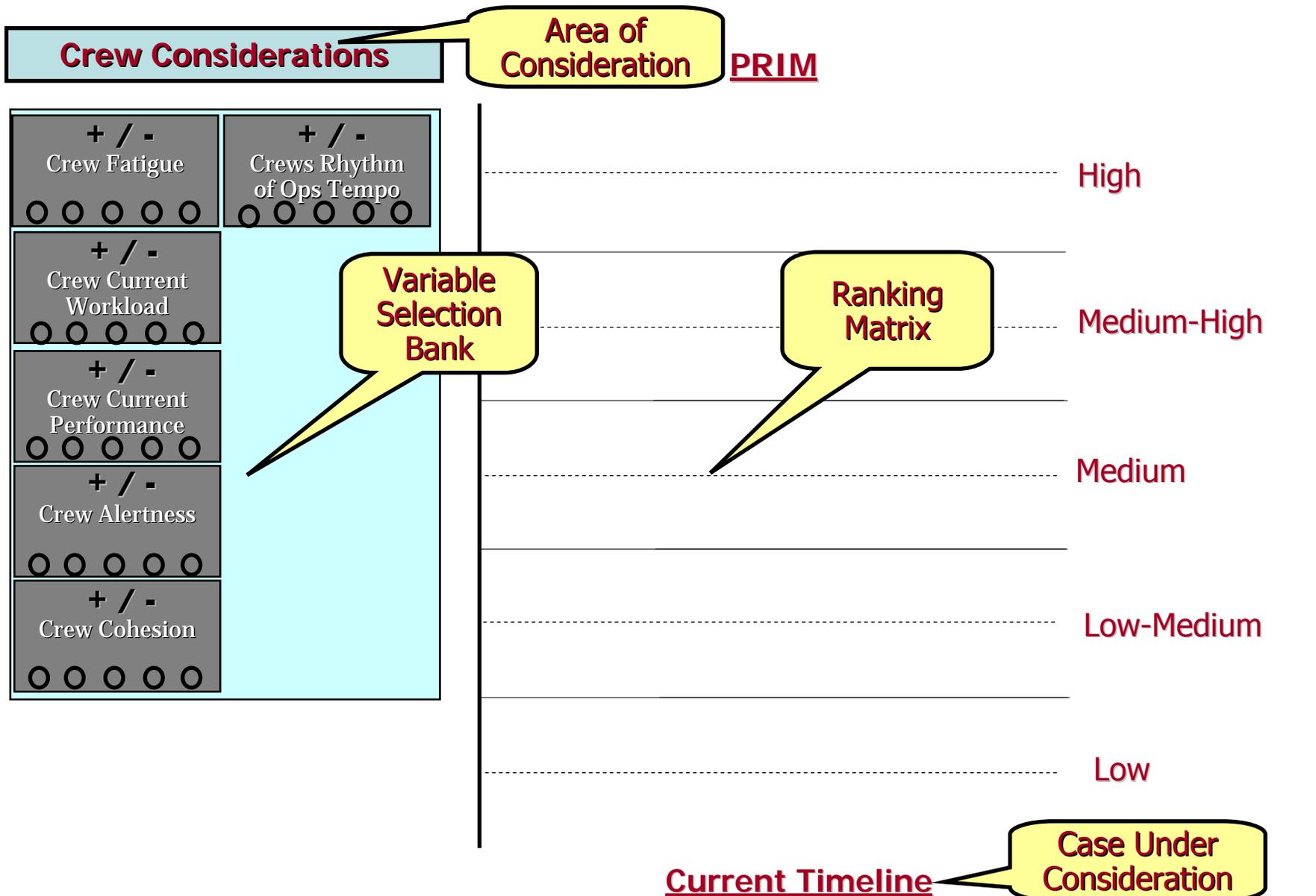
- Notes to be aware of:

- Your crews have been working 12 hour shifts, 7 days a week since the war began 6 weeks ago.
- The weather is forecasted to be overcast with scattered thunderstorms for the next 18 hours. The clouds may block the precision munitions. After the thunderstorms, it is forecasted to be clear blue skies for the next week.
- Over the last 7 days 95 percent of all missions have been deemed a success (the set targets/objectives were achieved).
- Currently 30 percent of your aircraft are inoperative. Half of those aircraft have gone in the shop in the last 3 days.





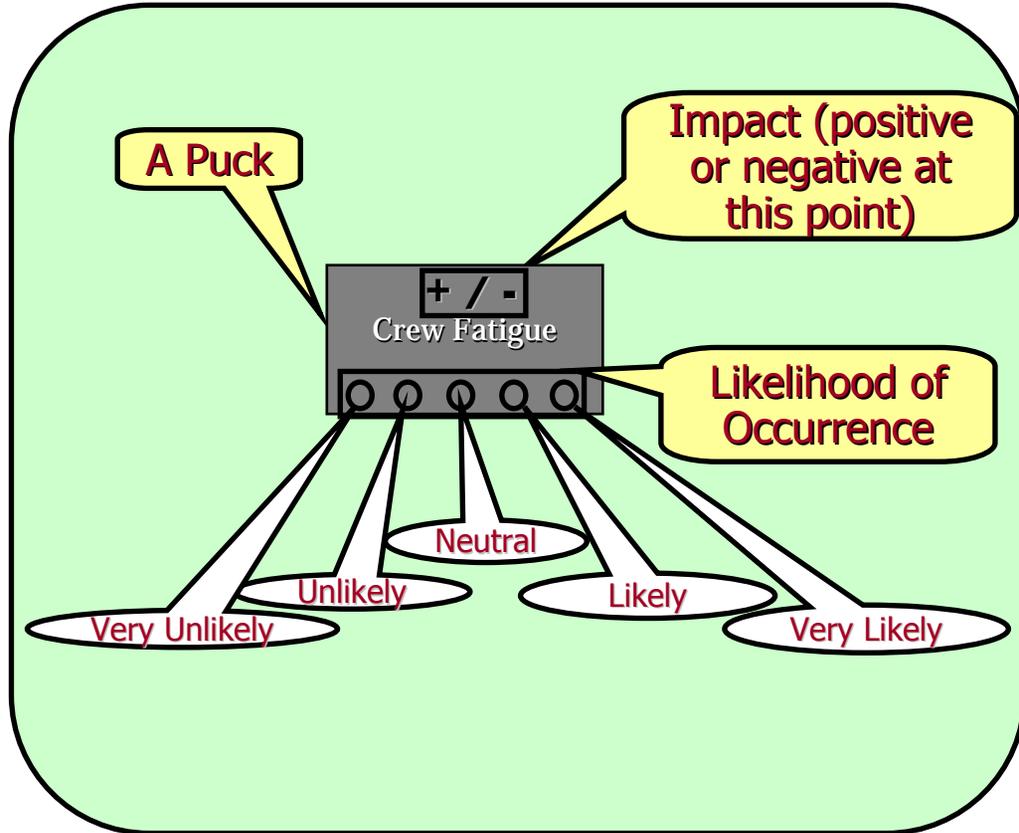
# PRIM: The Components of PRIM



# PRIM: The Pucks

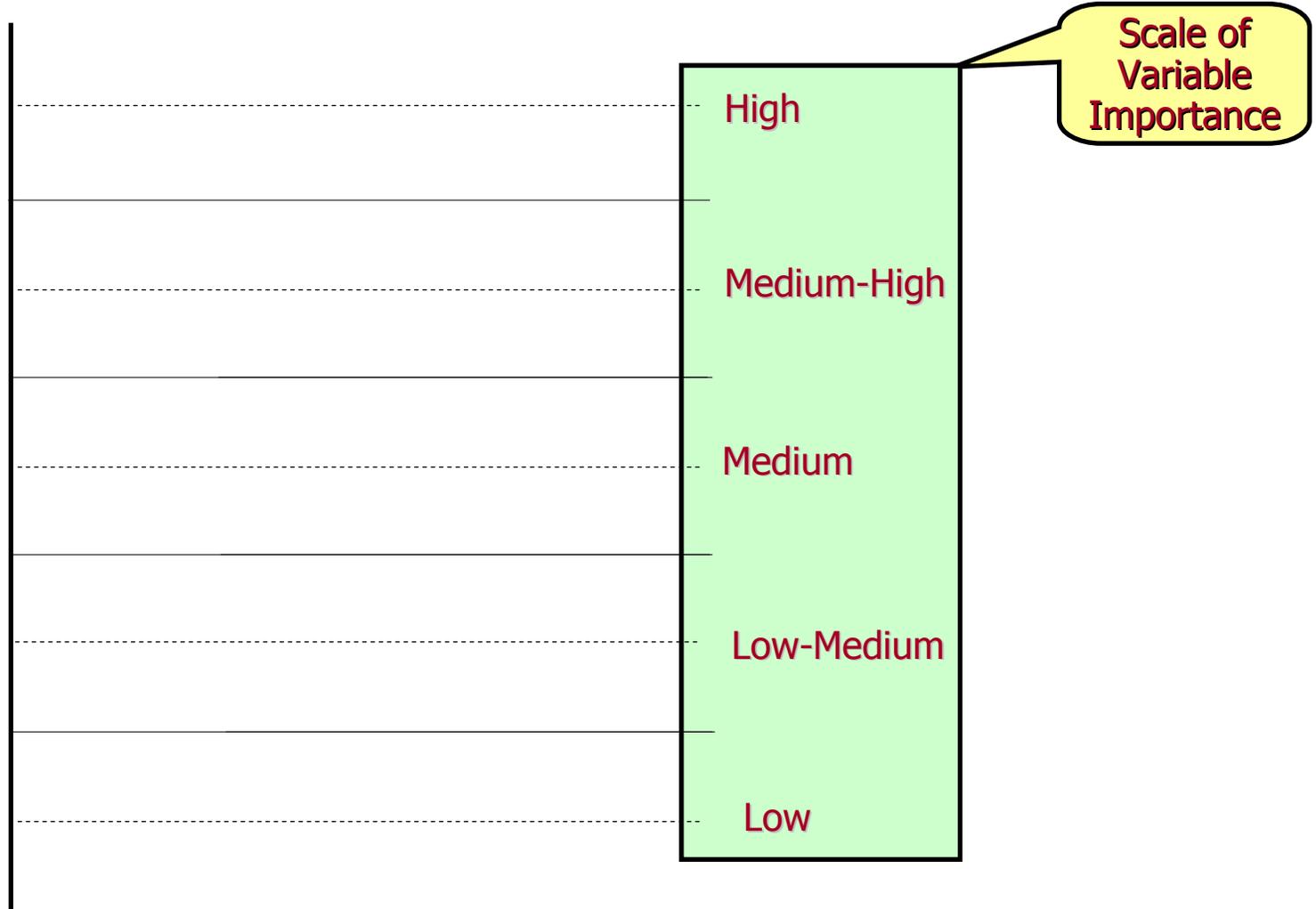
Variable Selection Bank

+ / - Crew Fatigue ○○○○○	+ / - Crews Rhythm of Ops Tempo ○○○○○
+ / - Crew Current Workload ○○○○○	
+ / - Crew Current Performance ○○○○○	
+ / - Crew Alertness ○○○○○	
+ / - Crew Cohesion ○○○○○	



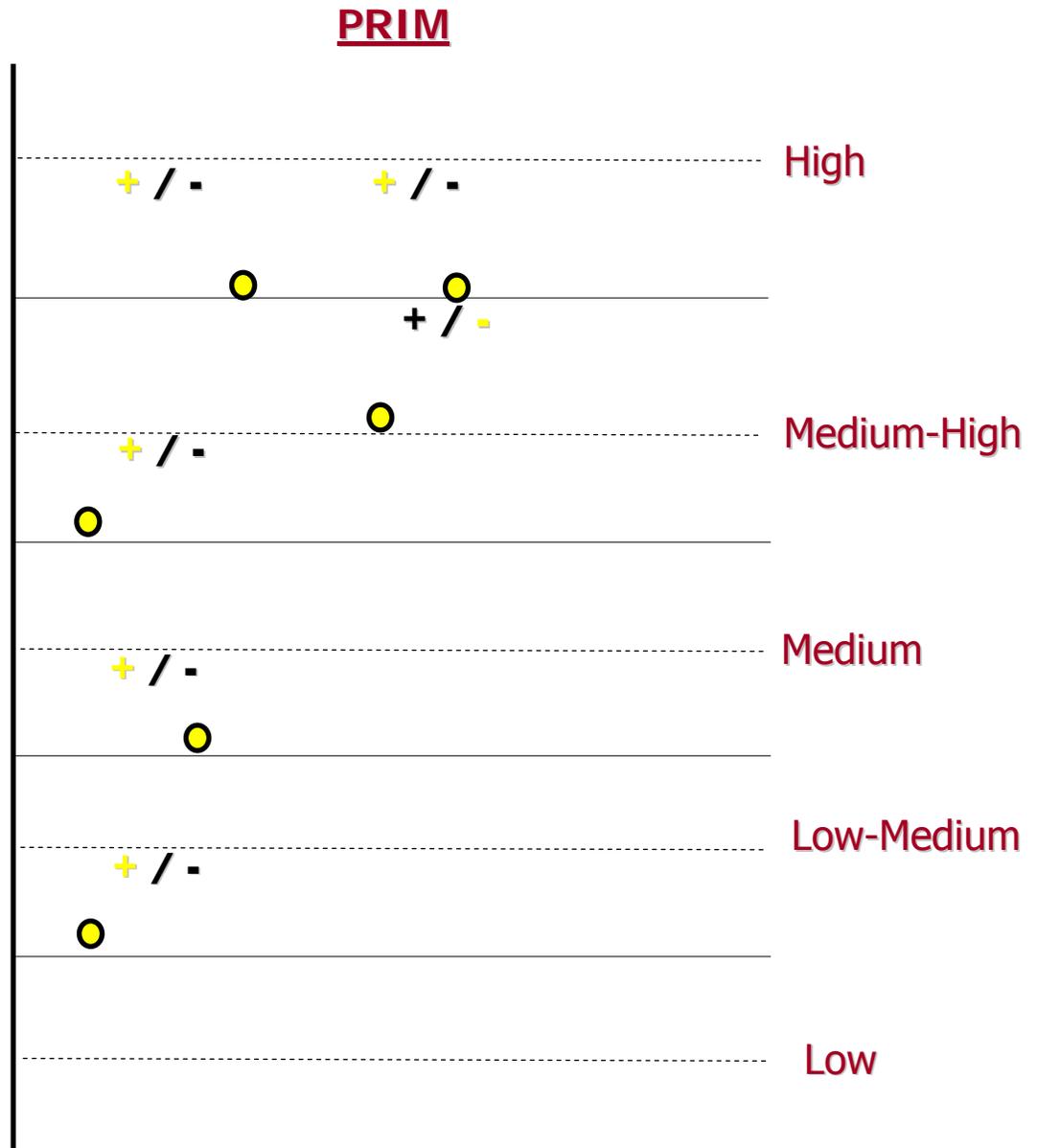
# PRIM: Ranking Matrix

PRIM



# PRIM: Application of Individual Considerations

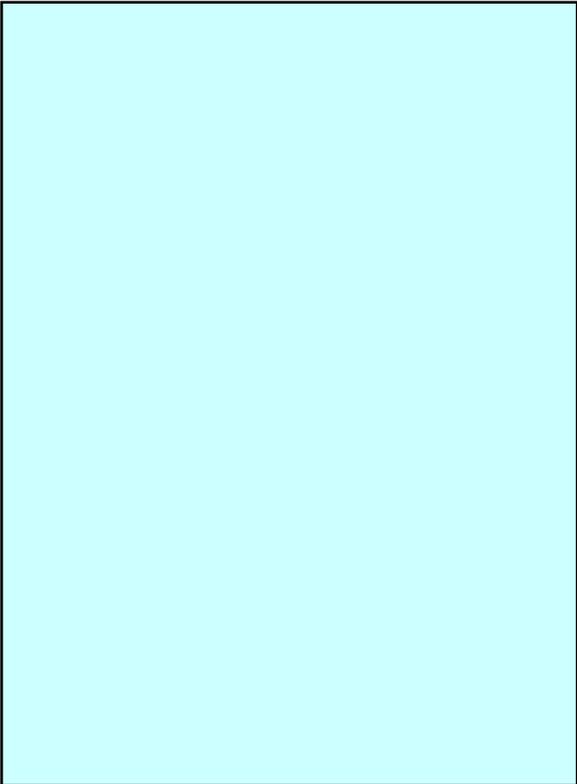
Crew Considerations	
+ / - Crew's Current Performance ○ ○ ○ ○ ○	+ / - Crew's Cohesion ○ ○ ○ ○ ○
+ / - Crew's Rhythm of Ops Tempo ○ ○ ○ ○ ○	
+ / - Crew's Current Workload ○ ○ ○ ○ ○	
+ / - Crew's Fatigue ○ ○ ○ ○ ○	
+ / - Crew's Alertness ○ ○ ○ ○ ○	



**Current Timeline**

# PRIM: Application of Individual Considerations

## Aircraft/Munitions Considerations



## PRIM

+ / -  
Aircraft Fatigue  
○ ○ ○ ● ○

High

+ / -  
Munitions Performance in Weather  
○ ● ○ ○ ○

Medium-High

+ / -  
Aircraft Available  
○ ○ ● ○ ○

+ / -  
Munitions Available  
○ ○ ○ ○ ●

Medium

Low-Medium

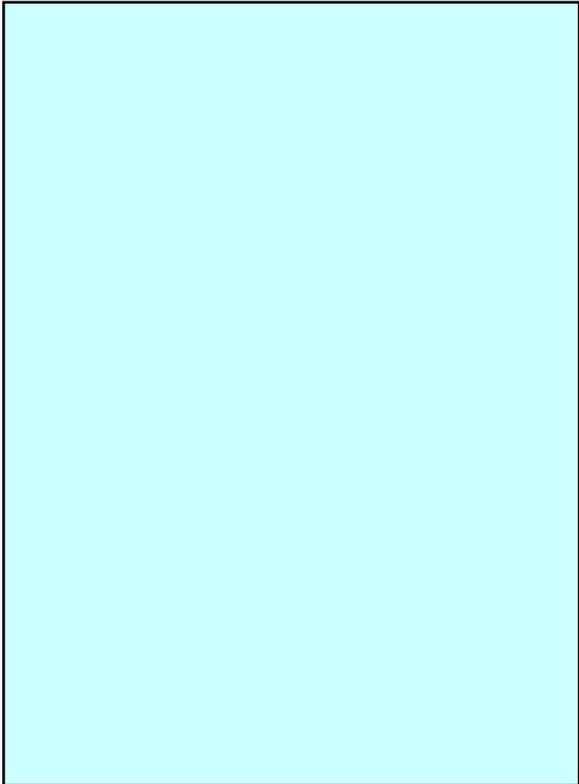
+ / -  
Aircraft Performance in Weather  
○ ● ○ ○ ○

Low

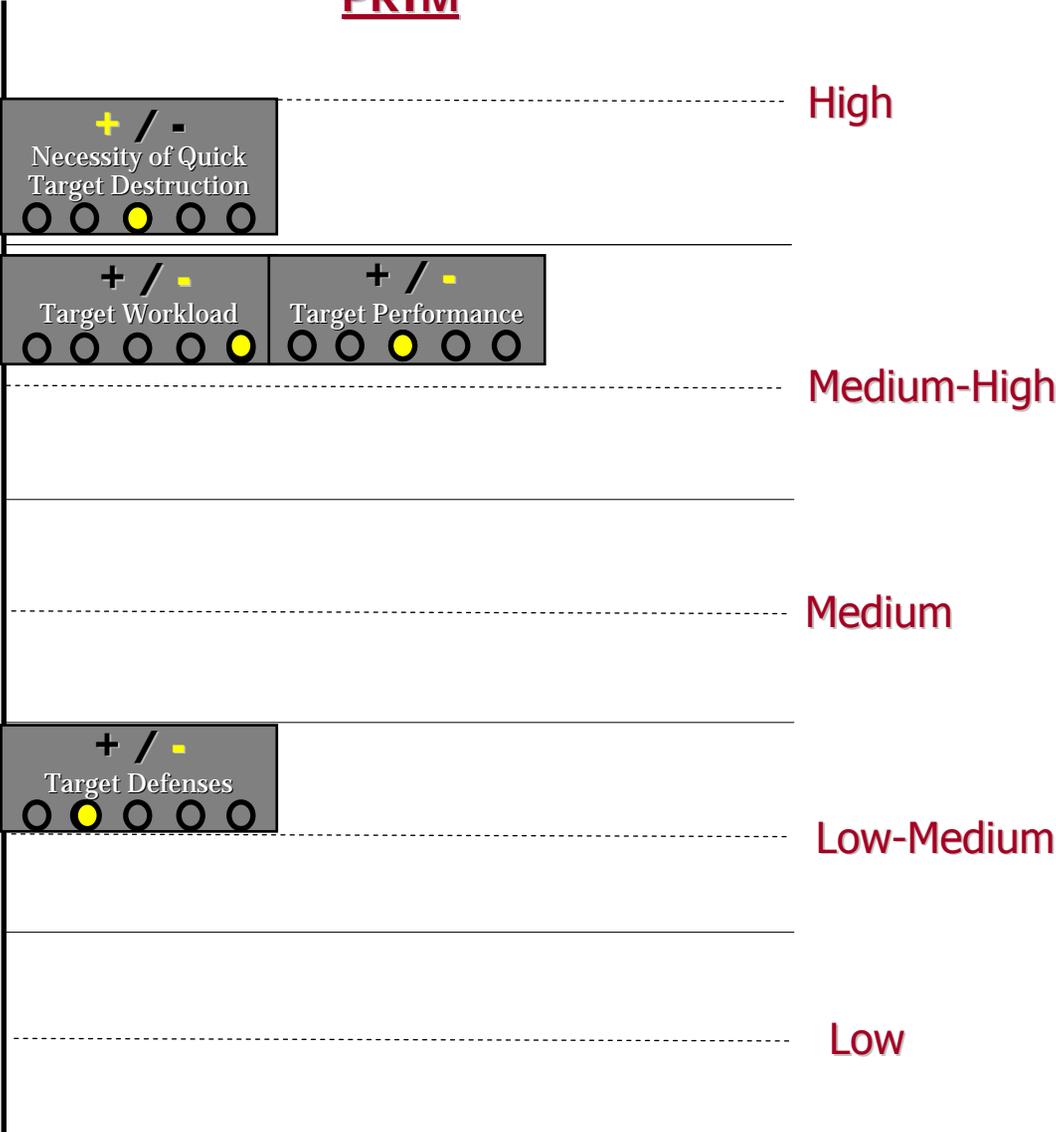
## Current Timeline

# PRIM: Application of Individual Considerations

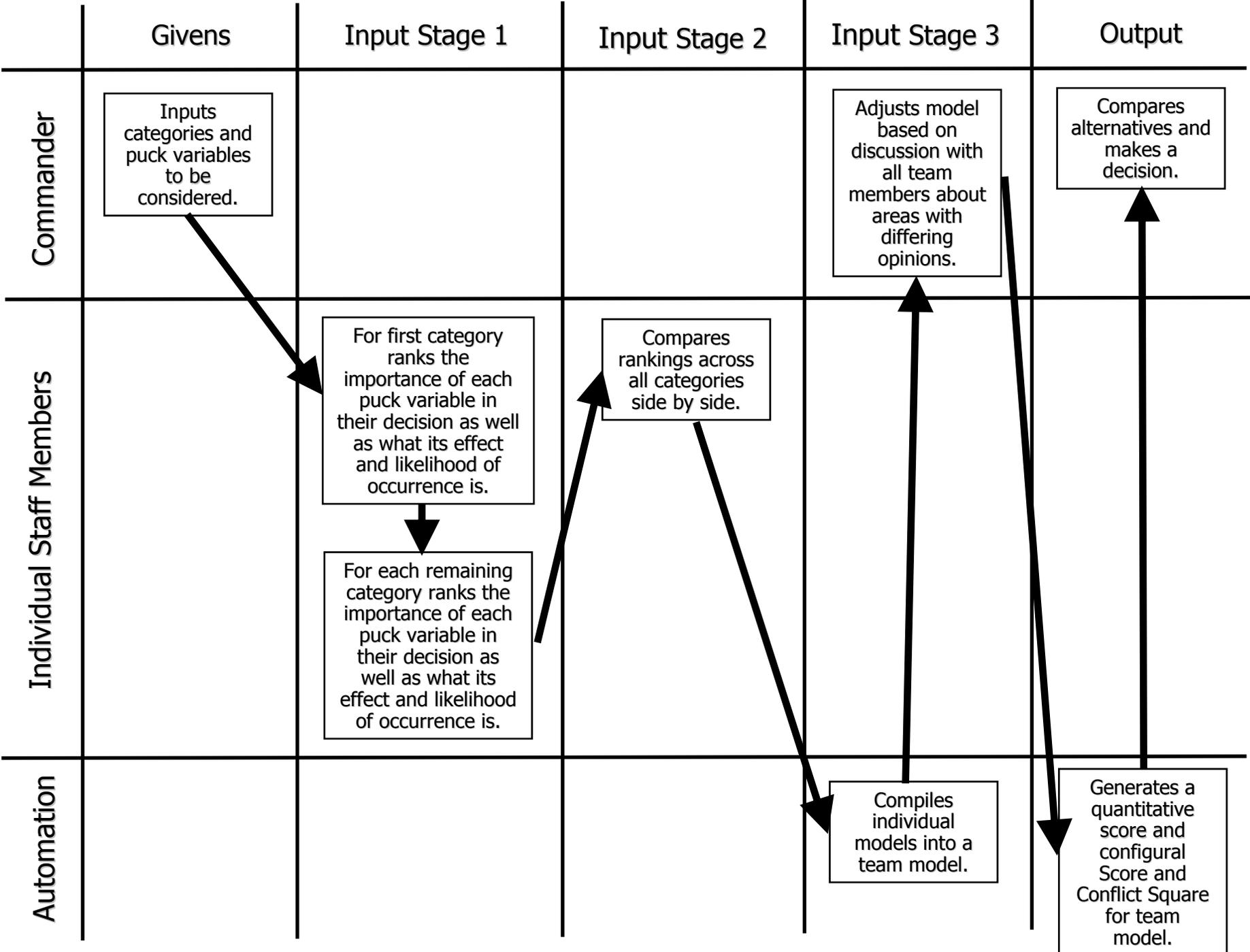
## Target Considerations



## PRIM



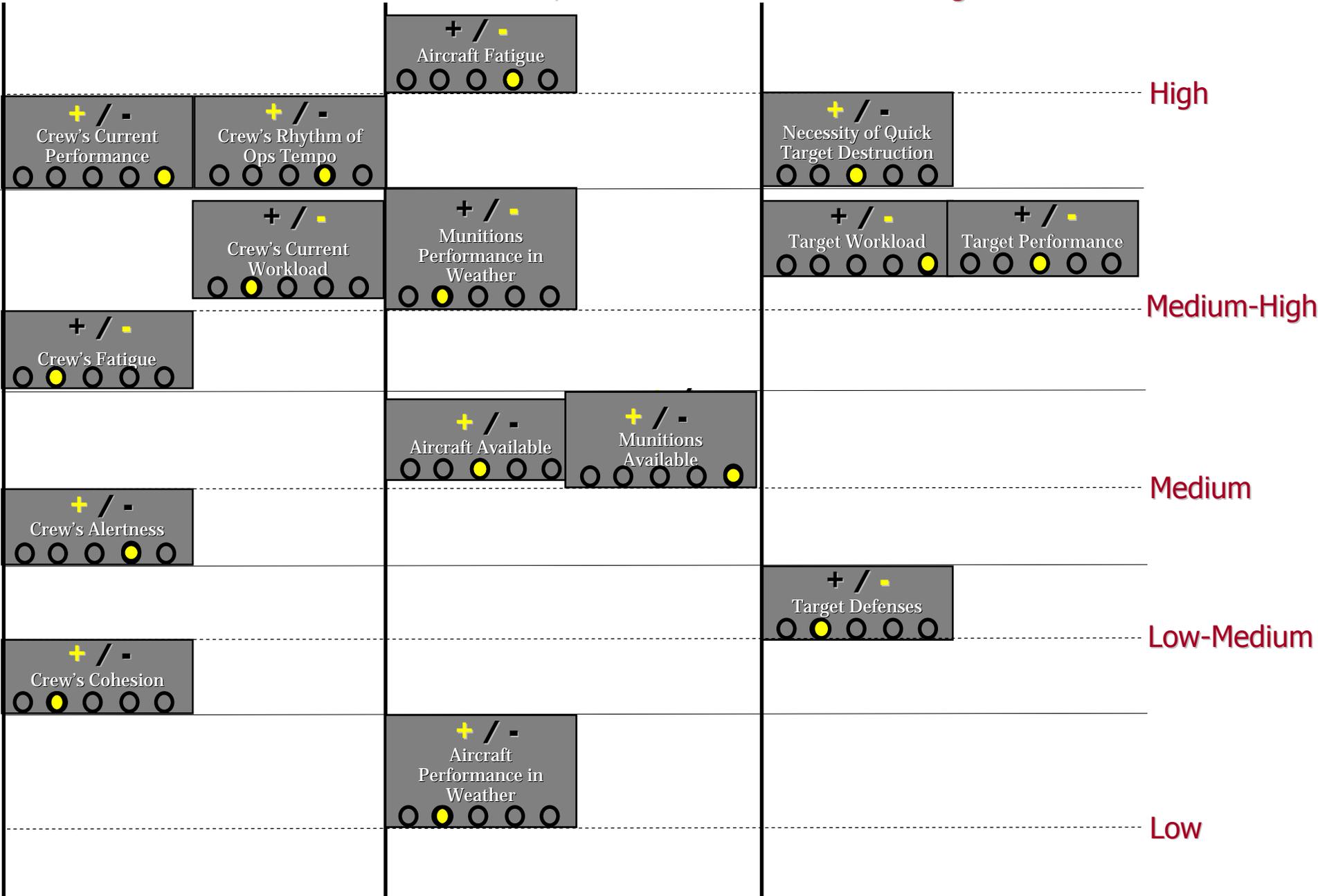
## Current Timeline



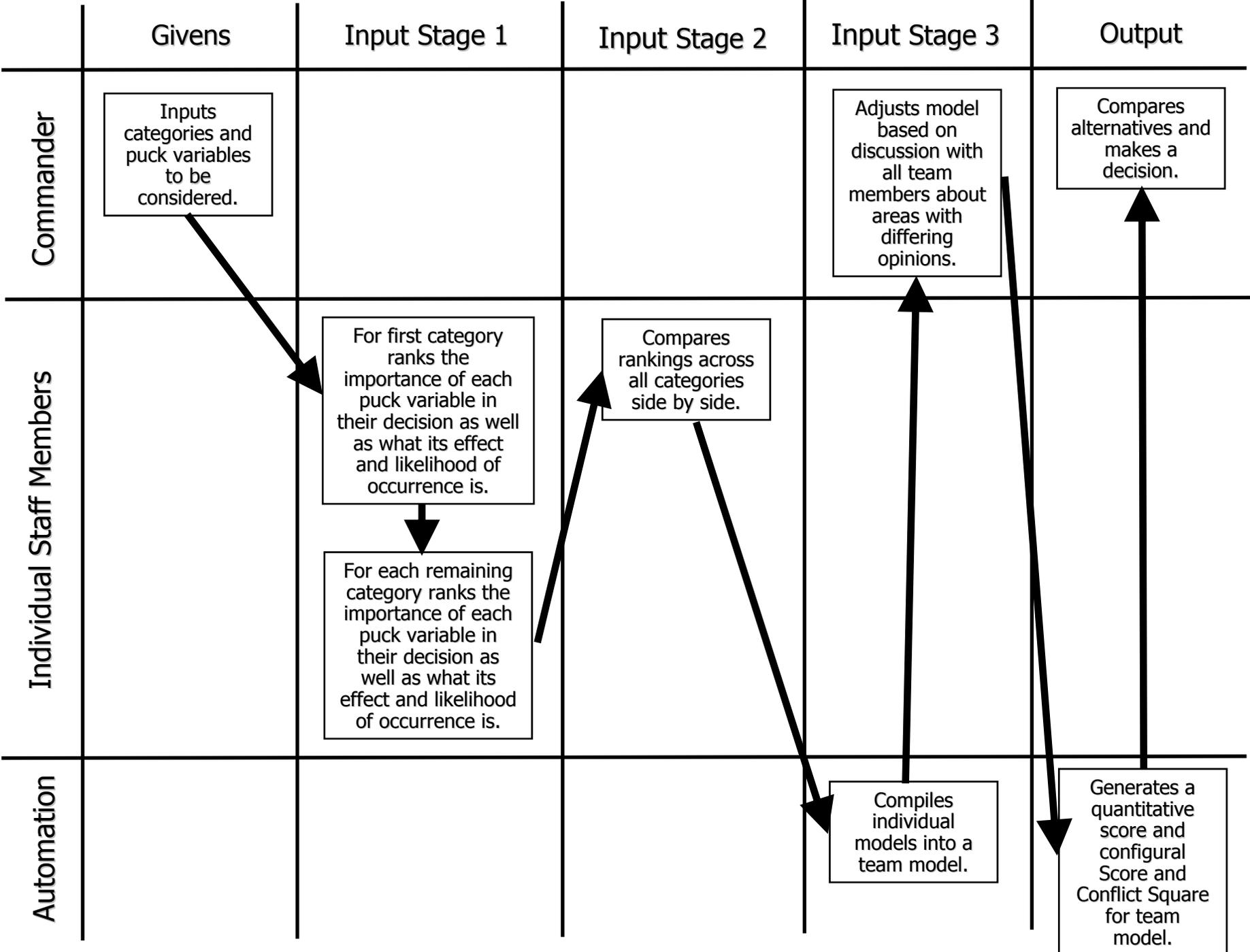
Crew

Aircraft/Munitions

Target



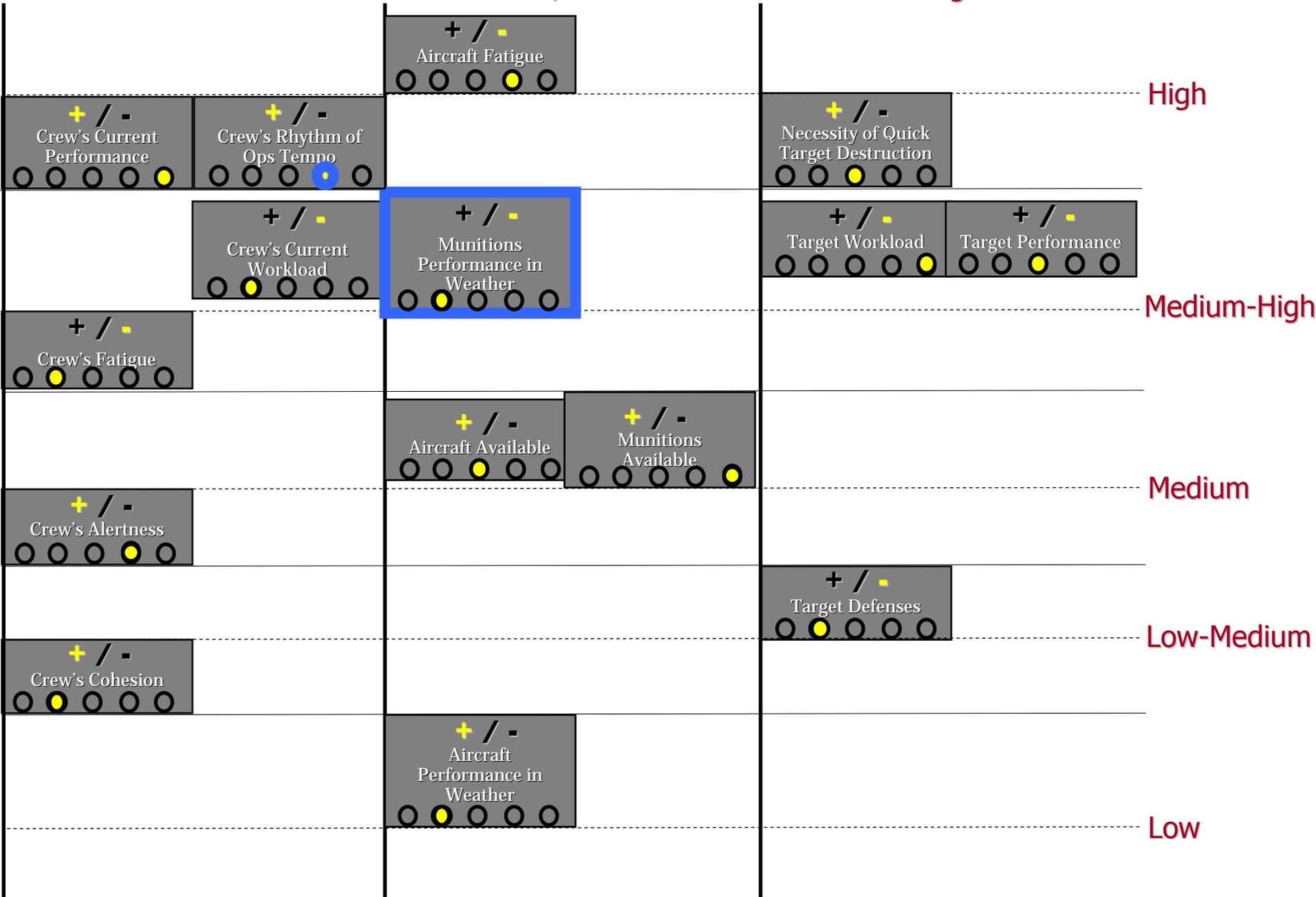
Current Timeline

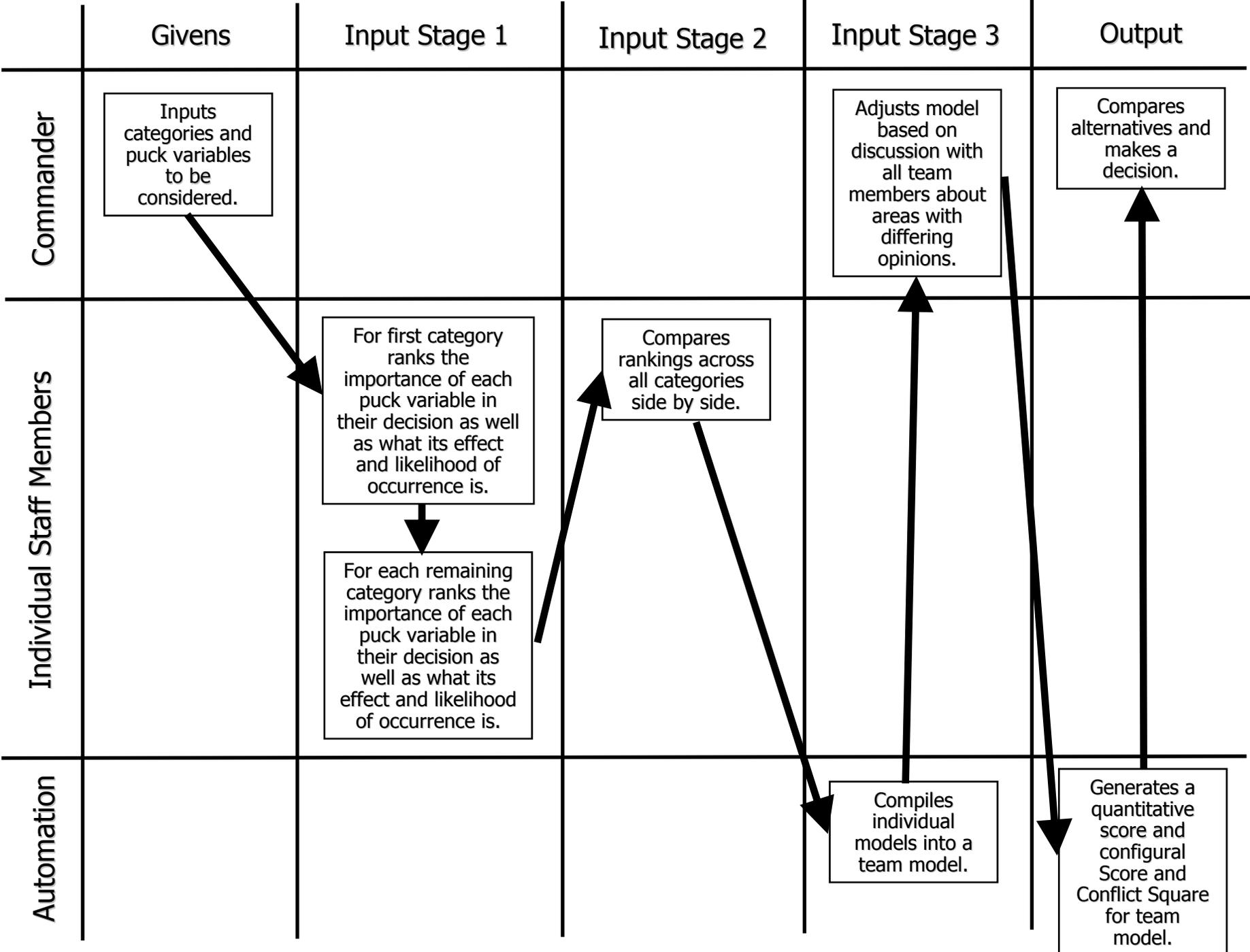


Crew

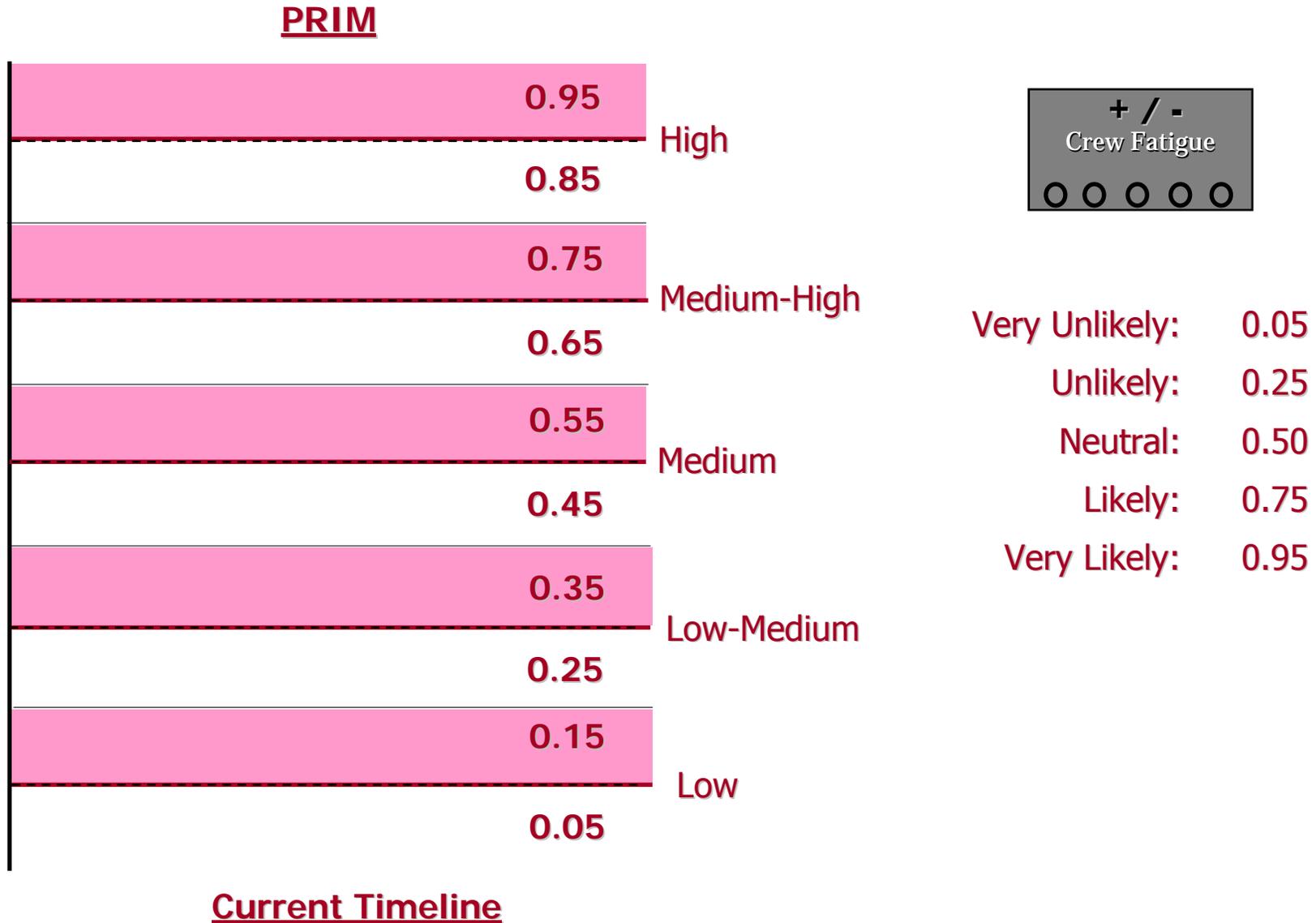
Aircraft/Munitions

Target

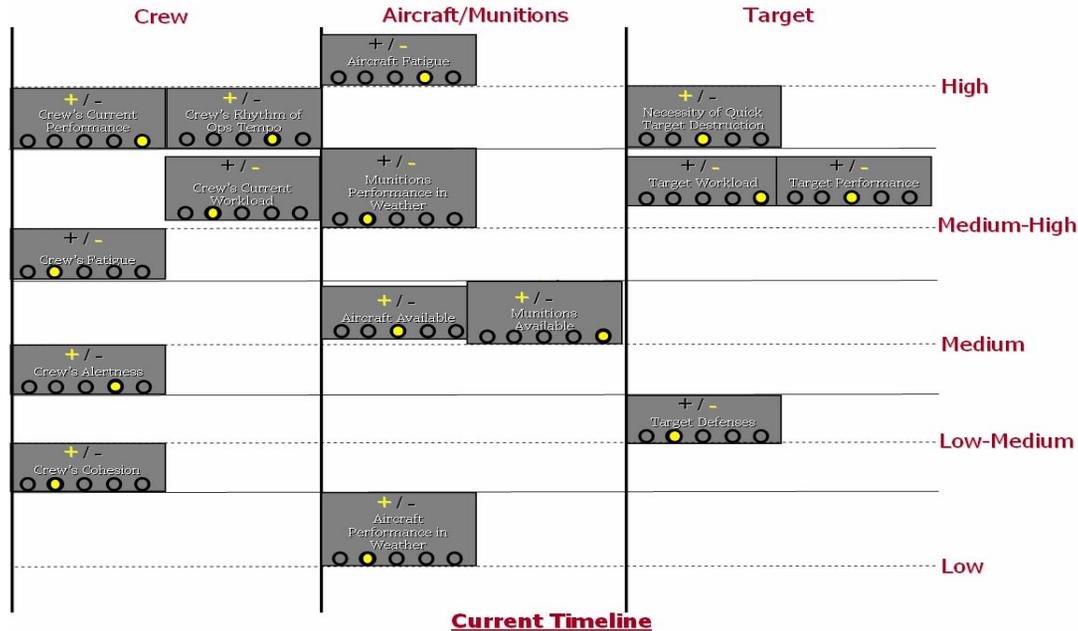




# PRIM: Behind the Scenes



# PRIM: Multi-Attribute Equation



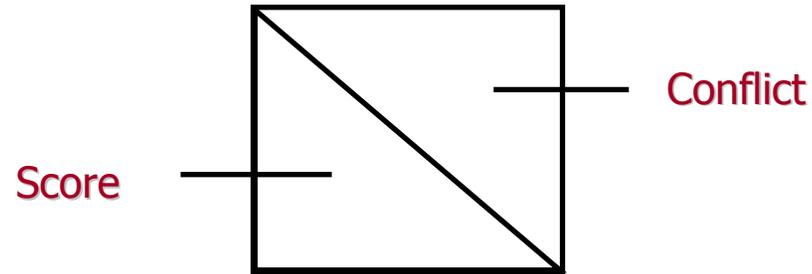
$$Score = C \bullet \sum_{i=1}^j [p(x_i)^{1.5} \bullet U(x_i)]$$

- $i$  is the puck being considered at the time
- $j$  is total number of different pucks for  $x_i$  through  $x_j$ .
- $p(x_i)$  is the likelihood (probability) rating of that puck's variable occurring
- $U(x_i)$  is the importance (utility) rating of the puck's variable in the decision.
- The  $U(x_i)$  is positive or negative based on what is marked on the puck.
- Normalize by multiplying by  $C$  to put on a scale of -100 to 100.

# PRIM Output

<u>Option</u>	<u>Score</u>
Current Timeline	9.788
Delay Timeline	4.830

## Score & Conflict Square (SCS)



- The Score & Conflict Square (SCS)
  - Configural display of results
  - Comprised of two triangles
    - Score
    - Conflict

## Score & Conflict Square (SCS)



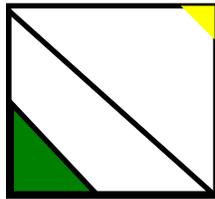
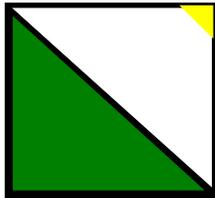
- Score

- Fills with green triangle based on how high scoring the option is (the best choice is always completely full, as seen in a)

- Conflict

- Fills with a yellow triangle based on how many of the variable characteristics (probability and utility) are in conflict for the option

# PRIM Output



<u>Option</u>	<u>Score</u>
Current Timeline	9.788
Delay Timeline	4.830

## General Benefits

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- **PRIM is a possible design solution**
- **Technology may not generate a solution, but may facilitate dialogue toward a solution from qualified experts**
- **Focus discussion on critical differences**
- **Highlight key factors for decision**

## Resources

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# Questions?



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