



# Quantification of subjective information assessments in C2 decision option selection

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# BACKGROUND

- **In the past...**
  - **a major cause for a lack of consensus in a group decision making task was that all participants did not have the same information.**
- **Today...**
  - **A major cause is differing subjective assessments (importance, impact) of the same information.**
    - **Particularly true in multicultural/coalition groups**
- **Decision Making Constructs in a Distributed Environment (DCODE) is a decision support system for the elicitation, display, sharing and comparison of individual subjective information assessments.**



# Decision Making Constructs in a Distributed Environment (DCODE)

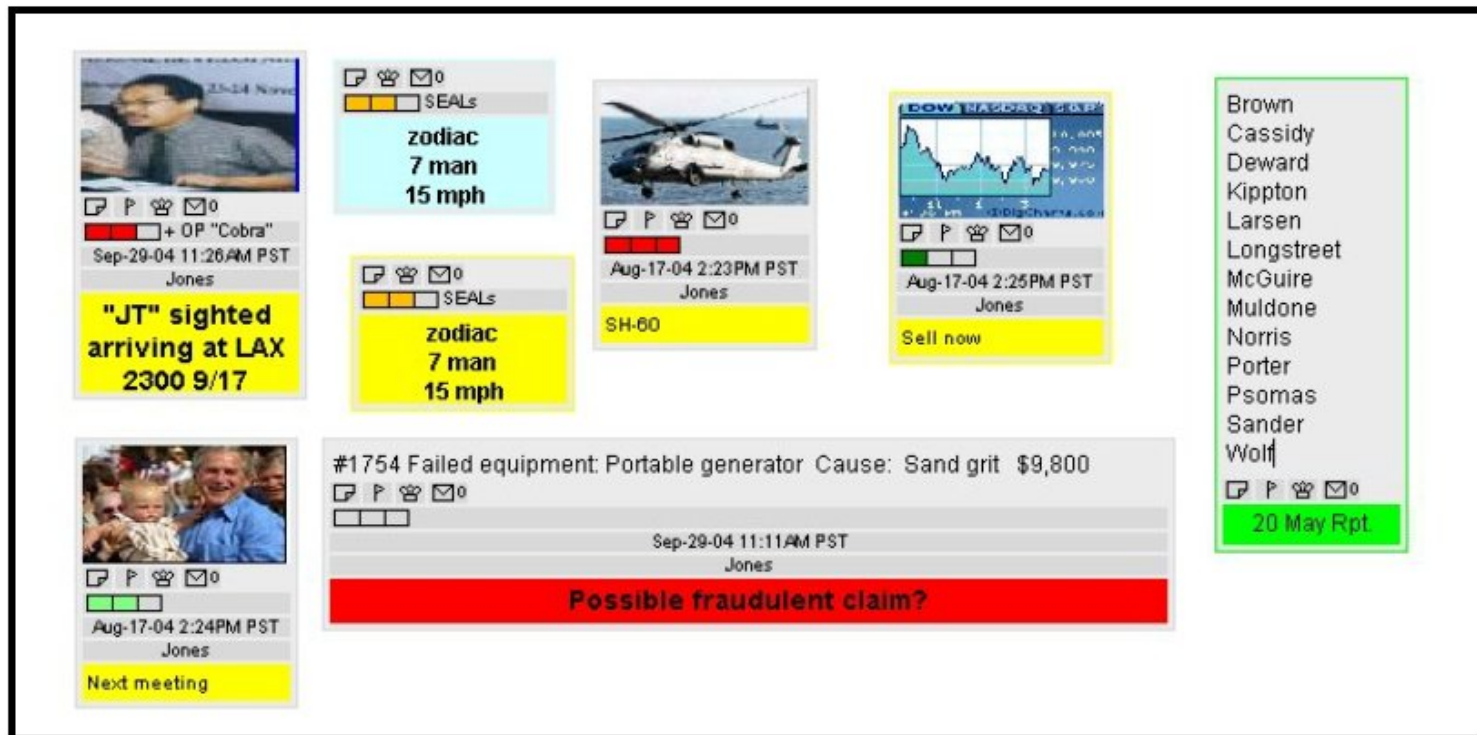
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**DCODE is a component of MIT's Electronic Card Wall (EWall) project, and has been developed by SPAWAR Systems Center in San Diego.**

**DCODE Overall Objective: the development of a decision support tool for reducing the problems involved with the storing, sharing and integration of subjective information assessments.**

**The use of DCODE in the quantification and sharing of these subjective assessments can improve the quality of group decision making and significantly reduce the time devoted to conflict resolution and team consensus building.**

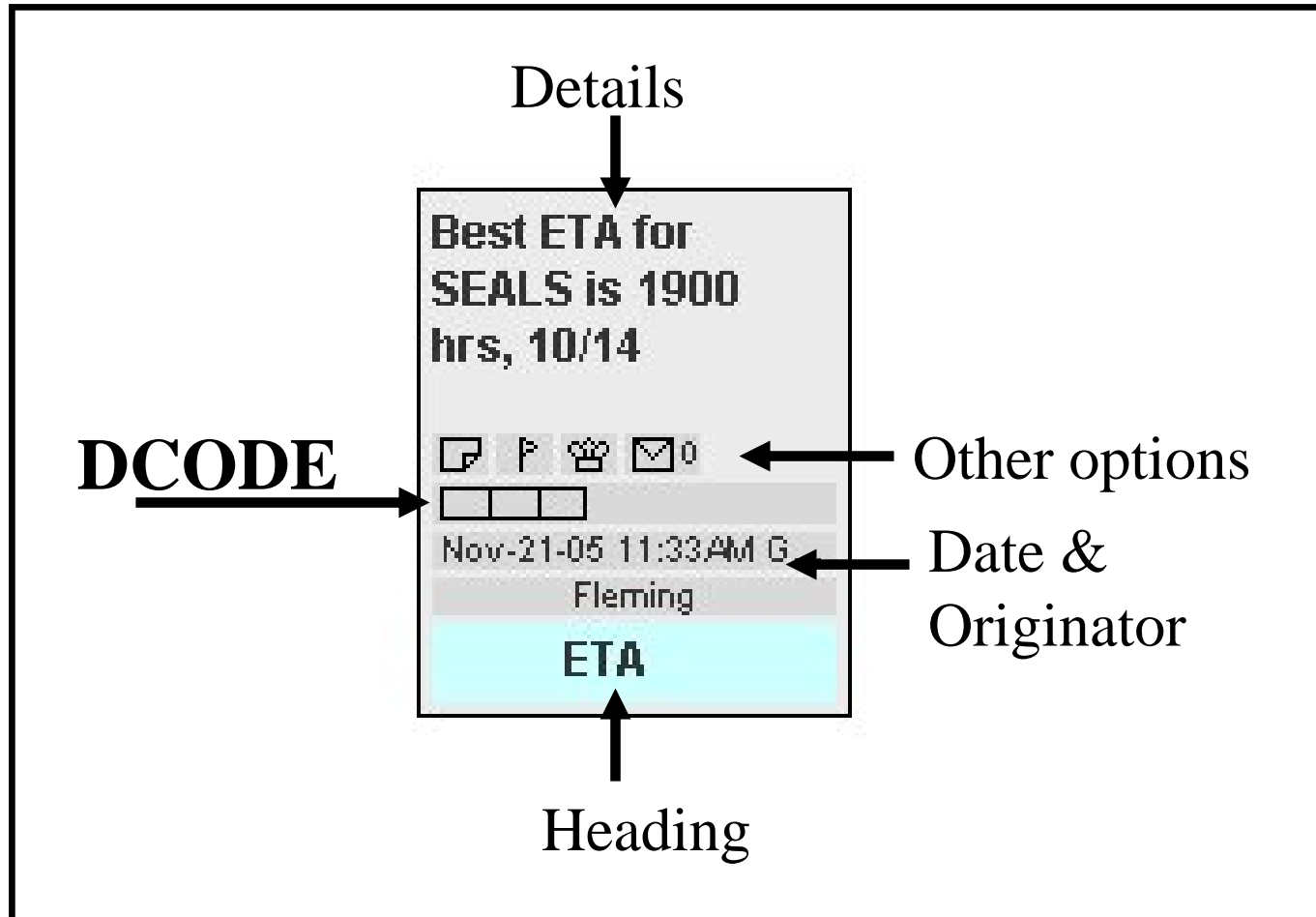
EWall cards are small iconic representations of relevant information items and include a series of information parameters. They can be configured in a variety of formats.



The image displays several EWall cards with the following content:

- Card 1 (Top Left):** Features a photo of a man, a date/time stamp "Sep-29-04 11:26AM PST", the name "Jones", and a yellow bar at the bottom with the text "**'JT' sighted arriving at LAX 2300 9/17**".
- Card 2 (Top Middle-Left):** A light blue card with a crown icon, a status bar, and the text "zodiac 7 man 15 mph".
- Card 3 (Top Middle-Right):** Features a photo of a helicopter, a date/time stamp "Aug-17-04 2:23PM PST", the name "Jones", and a yellow bar at the bottom with the text "SH-60".
- Card 4 (Top Right):** A yellow card with a line graph, a date/time stamp "Aug-17-04 2:25PM PST", the name "Jones", and a yellow bar at the bottom with the text "Sell now".
- Card 5 (Bottom Left):** Features a photo of a man with a child, a date/time stamp "Aug-17-04 2:24PM PST", the name "Jones", and a yellow bar at the bottom with the text "Next meeting".
- Card 6 (Bottom Middle):** A grey card with the text "#1754 Failed equipment: Portable generator Cause: Sand grit \$9,800", a date/time stamp "Sep-29-04 11:11AM PST", the name "Jones", and a red bar at the bottom with the text "Possible fraudulent claim?".
- Card 7 (Far Right):** A vertical grey card with a green border containing a list of names: Brown, Cassidy, Deward, Kippton, Larsen, Longstreet, McGuire, Muldone, Norris, Porter, Psomas, Sander, Wolf, and a green bar at the bottom with the text "20 May Rpt".

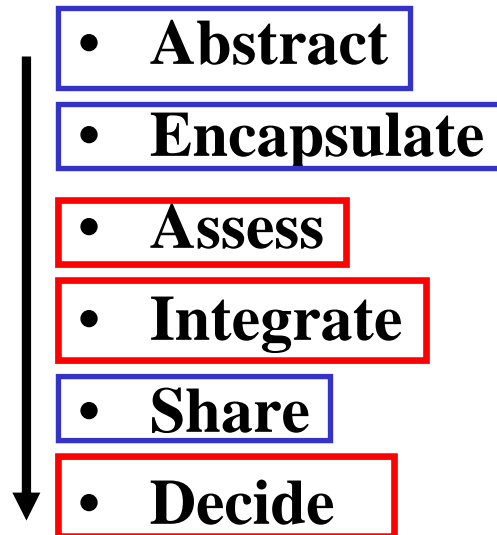
# EWall Card





# DCODE Process

The use of DCODE as a decision support tool involves the following sequential process for each decision relevant information item:



 EWall processes

 DCODE processes



# Information Abstraction and Encapsulation

**Mission: Rescue hostages from Islandia**  
**Decision Options: Marines; SEALs; Army**  
**Factors: Speed (ETA), Covertness, Risk, etc**

**Situation Assessment:**  
**Is Carlos still in Columbia?**

CINCPAC email

To: LTCJohnson@cinpac.mil  
From: steve.thomas@noaa.gov  
Subject: Islandia tides and currents

Hello LTC Johnson

I have been looking at detailed marine charts of Islandia's reef system. Based on this analysis I would say that only one small section of the reef (coordinate G17) is passable, and then **only at PEAK high tide**. This will next occur at 1700 10/14. The word of caution is that the soundings are over 25 years old and may have changed (either for the better or the worse) regarding ease of crossing.

V/R  
Steve Thomas

Homeland Security email

To: joseph.donovan@dea.gov  
From: william.kays@omb.gov  
Subject: Re: acct. activity

Mr. Donovan

Fred Barnes in Finance Tracking informs me within the last 10 days, \$27K was deposited in the referenced account (10/7) and \$25K was withdrawn on 10/9. This is unusual activity for this account

V/R  
Bill Kays

**Best ETA for  
SEALS is 1900  
hrs, 10/14**

Nov-21-05 11:33AM G...

Fleming

**ETA**

Information  
is abstracted,  
encapsulated  
but **NOT**  
Assessed!

**Unusual \$ activity  
in Carlos'  
checking  
account 10/7, 10/9**

Dec-19-05 9:03AM GM...

Fleming

**Money Activity**

# DCODE Information Assessment

Best ETA for  
SEALS is 1900  
hrs, 10/14

📄 P 🏠 📧 0

Nov-21-05 11:33AM G...

Fleming

ETA

Which option(s) is impacted?  
How is it impacted?  
How important is this item?  
Quality of the information?  
Timely?  
Credible source?  
Well documented?

Best ETA for  
SEALS is 1900  
hrs, 10/14

📄 P 🏠 📧 0

🟡🟡🟡 + SEALS

Nov-21-05 11:43AM G...

Fleming

ETA

EWall Information Card

Information Object (IOB)

This DCODE coding  
tells me that this  
information ...

- **Negatively impacts the viability of the using the SEALS option.**
- **Is considered of high importance.**
- **There is some issue with the quality of this information.**



## DCODE Information Assessment (cont.)

Unusual \$ activity  
in Carlos'  
checking account,  
10/7, 10/9

0

in Columbia

Money Activity

Every time Carlos has  
left Columbia, there  
have been large deposits  
and withdrawals in his  
account

Unusual \$ activity  
in Carlos'  
checking  
account 10/7, 10/9

0

in Columbia

Dec-18-03 9:05AM Ont...

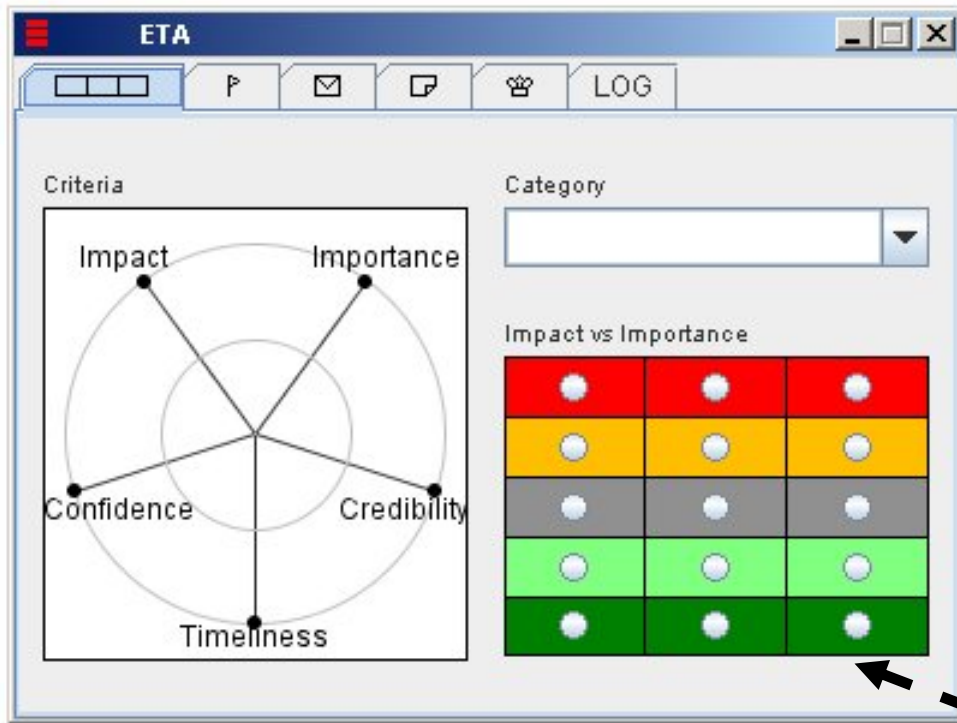
Fleming

Money Activity





This DCODE coding  
tells me that this  
information ...



- **Very Negatively impacts the likelihood Carlos is in Columbia.**
- **Is considered of high importance.**
- **There is no question about the quality of the information.**

# Activating the DCODE Assessment Template



Best ETA for  
SEALS is 1900  
hrs, 10/14




 0

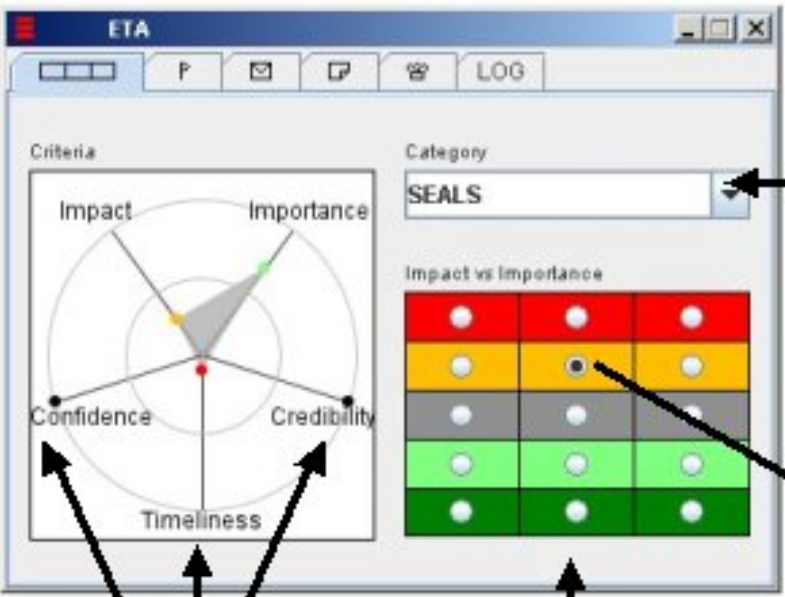



Nov-28-05 10:45AM G...

Fleming

**ETA**

# The Assessment Template



The screenshot shows the 'ETA' software interface. On the left is a radar chart with five axes: Impact, Importance, Confidence, Credibility, and Timeliness. A grey shaded area is plotted on the chart. On the right is a 'Category' dropdown menu set to 'SEALS' and an 'Impact vs Importance' table with a 5x3 grid of colored cells (red, yellow, grey, green, dark green) and white dots.

Impact	Importance	Confidence
Red	Red	Red
Yellow	Yellow	Yellow
Grey	Grey	Grey
Green	Green	Green
Dark Green	Dark Green	Dark Green

Information Quality

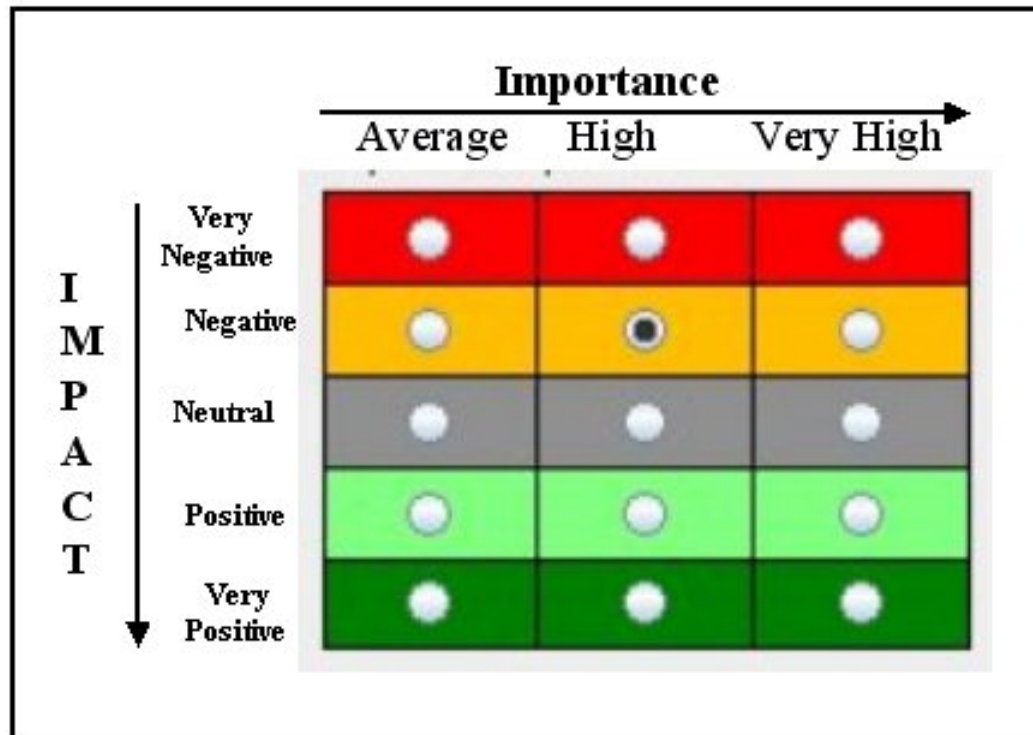
Information Importance & Impact

Drop-down menu for option selection

Best ETA for SEALS is 1900 hrs, 10/14

Nov-21-05 11:40AM 0...  
Fleming  
ETA

# Scoring Impact and Importance



Item is of “High” importance (2 boxes) and has a “Negative” impact (yellow) on this option.

# IMPORTANT (# boxes filled):

AVERAGE (1)



HIGH (2)



VERY HIGH (3)



# IMPACT:

(color)

Very Positive



Positive



Negative

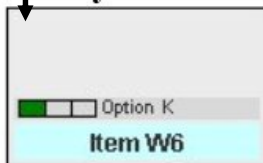


Very Negative



Average Importance

Very Positive



High Importance

Very Positive



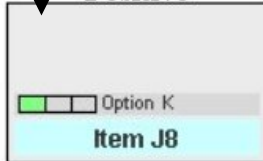
Very High Importance

Very Positive



Average Importance

Positive



High Importance

Positive



Very High Importance

Positive



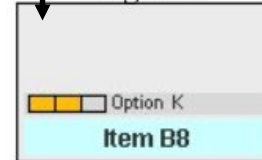
Average Importance

Negative



High Importance

Negative



Very High Importance

Negative



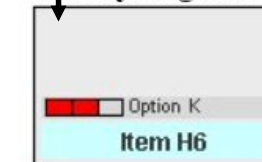
Average Importance

Very Negative



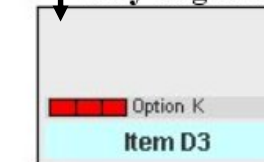
High Importance

Very Negative



Very High Importance

Very Negative





# Sample DCODE Assessments

## Selecting a House

22 min.

📄 P 🏆 0

🟢🟢 Concord Blvd  
Nov-28-05 11:29AM G...  
Fleming

**Commute time**

47 min.

📄 P 🏆 0

🟡🟡 Adams St.  
Nov-28-05 11:29AM G...  
Fleming

**Commute Time**

Parking Lot

📄 P 🏆 0

🟡🟡 Concord Blvd  
Nov-28-05 11:32AM G...  
Fleming

**View**

Shoreline

📄 P 🏆 0

🟢🟢 Adams St.  
Nov-28-05 11:32AM G...  
Fleming

**View**

## Selecting a Car

9.7 mpg

📄 P 🏆 0

🔴🟡 Hummer  
Nov-28-05 11:24AM G...  
Fleming

**Gas Mileage**

28.1 MPG

📄 P 🏆 0

🟢🟡 Civic  
Nov-28-05 11:27AM G...  
Fleming

**Gas Mileage**

## Selecting a College

📄 P 🏆 0

🟢🟢 Wisconsin  
Nov-28-05 11:33AM G...  
Fleming

**Parties**

📄 P 🏆 0

🔴🔴 Utah  
Nov-28-05 11:40AM G...  
Fleming

**Parties**

## Single Option: Buy stock "A"?

87

📄 P 🏆 0

🟢🟢  
Dec-1-05 10:39AM GM...  
Fleming

**P/E ratio**

7.9%

📄 P 🏆 0

🟡🟡  
Dec-1-05 10:39AM GM...  
Fleming

**5-yr avg. return**

"Hold"

📄 P 🏆 0

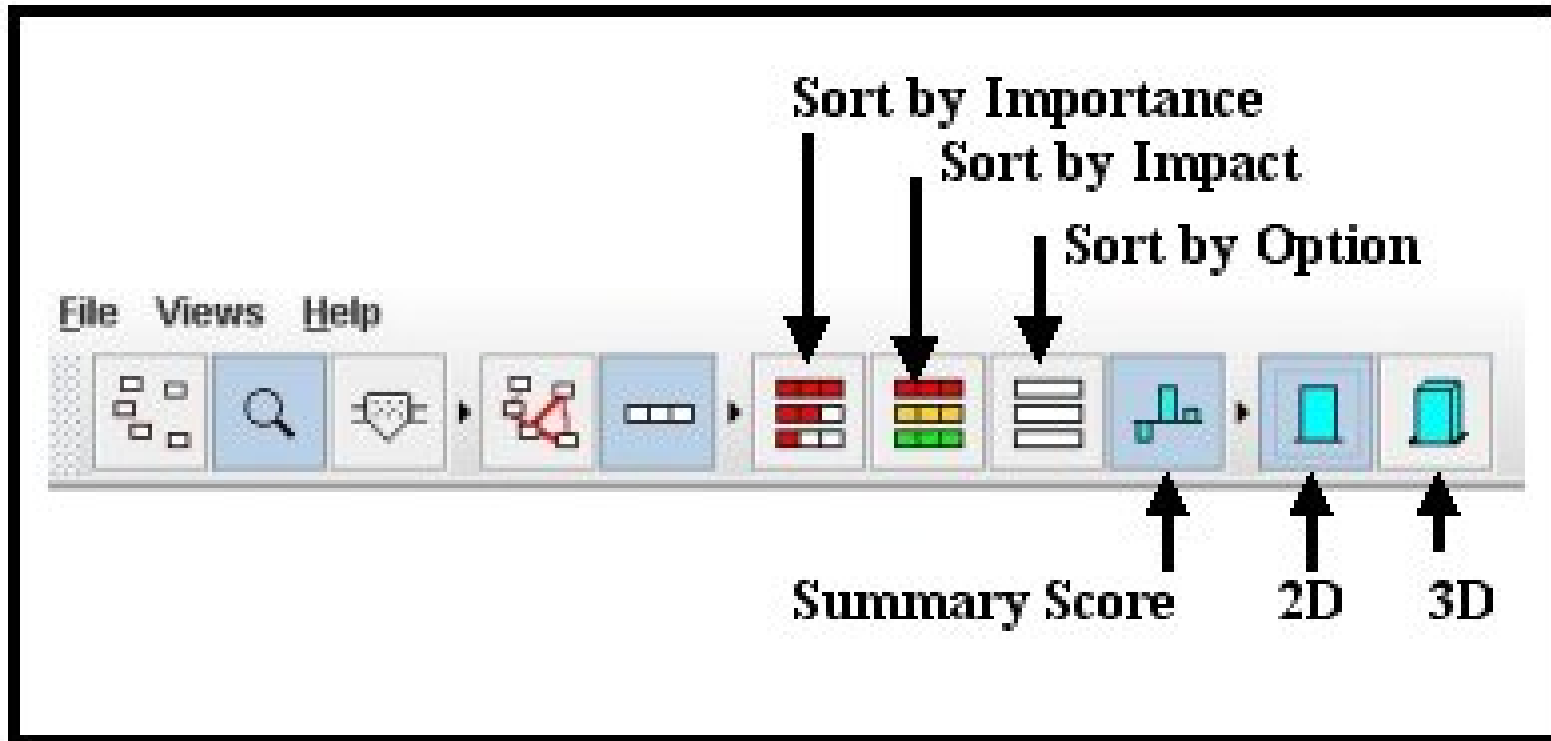
🟢🟢  
Dec-1-05 10:39AM GM...  
Fleming

**Broker rating**

# Which is the BEST option?

  <b>Rebels have no night vision capability</b>	  <b>SEALS have just returned from another mission</b>	  <b>Bridges on roads do not have high load capacity</b>	  <b>Army will be the most expensive option</b>
  <b>SEALS are very covert</b>	  <b>There will be dense fog in the morning</b>	  <b>Army will have the most firepower</b>	  <b>Off-road terrain difficult for Army vehicles</b>
  <b>Seal team can be activated immediately</b>	  <b>Very small time window for landing SEALs</b>	  <b>Use of Army will have least impact on our reserve</b>	  <b>Army team predicted to have least casualties</b>
  <b>Seal team does not have a translator</b>	  <b>Injured worker will have to spend 2 hours in Zodiac</b>	  <b>Army team has corpsman and translator</b>	  <b>Army unit has trained on island and knows terrain</b>
  <b>SEALS are especially trained in hostage rescue</b>	  <b>SEAL team has a corpsman</b>	  <b>Army unit is very fresh and at full strength</b>	  <b>Army response will not be covert</b>
  <b>SEALS should spend least time on the island</b>	  <b>Reef is only passable at high tide</b>	  <b>Army will have the slowest response time</b>	  <b>Use of Army would have good public relations</b>

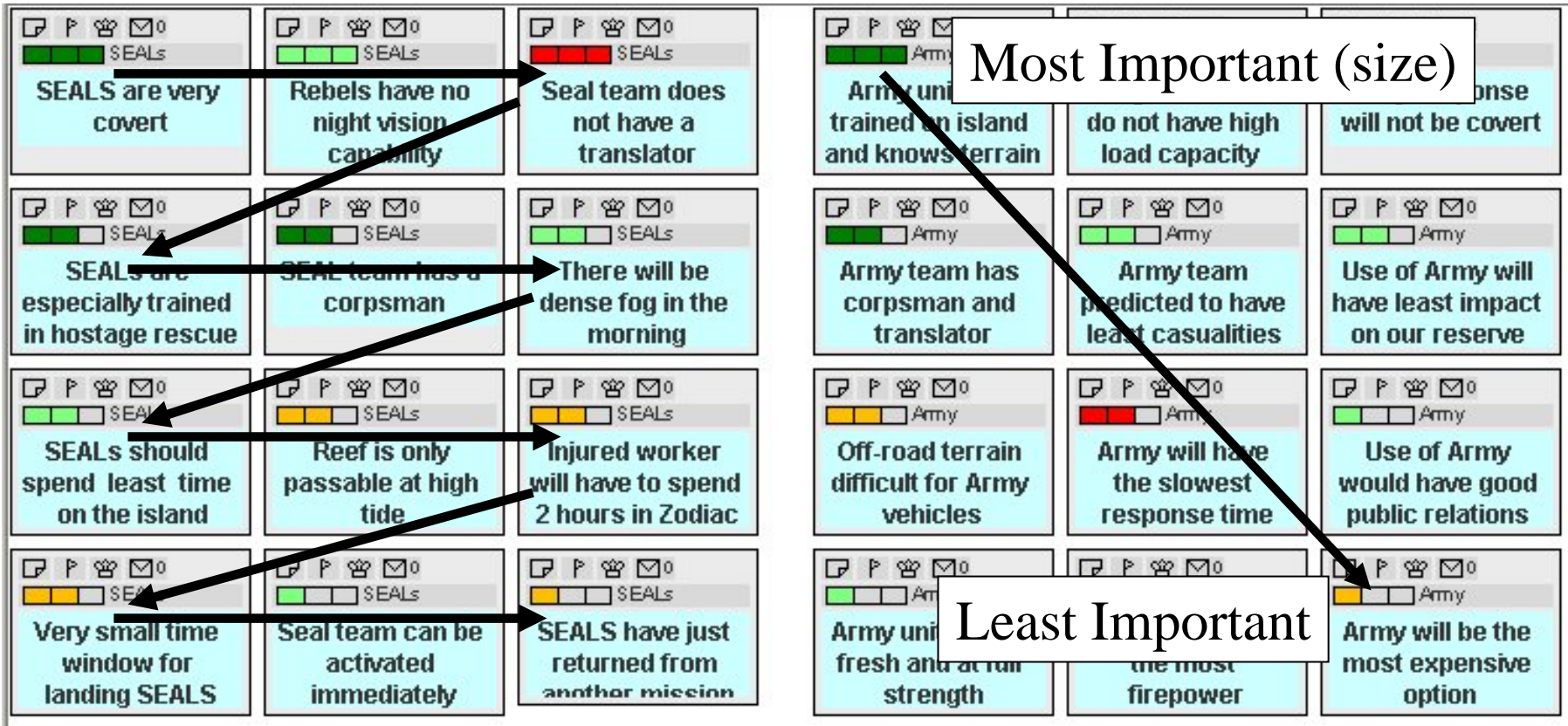
# Integration of IOBs







# Sorted by Importance: Very High – High -- Average





# Sorted by Impact:

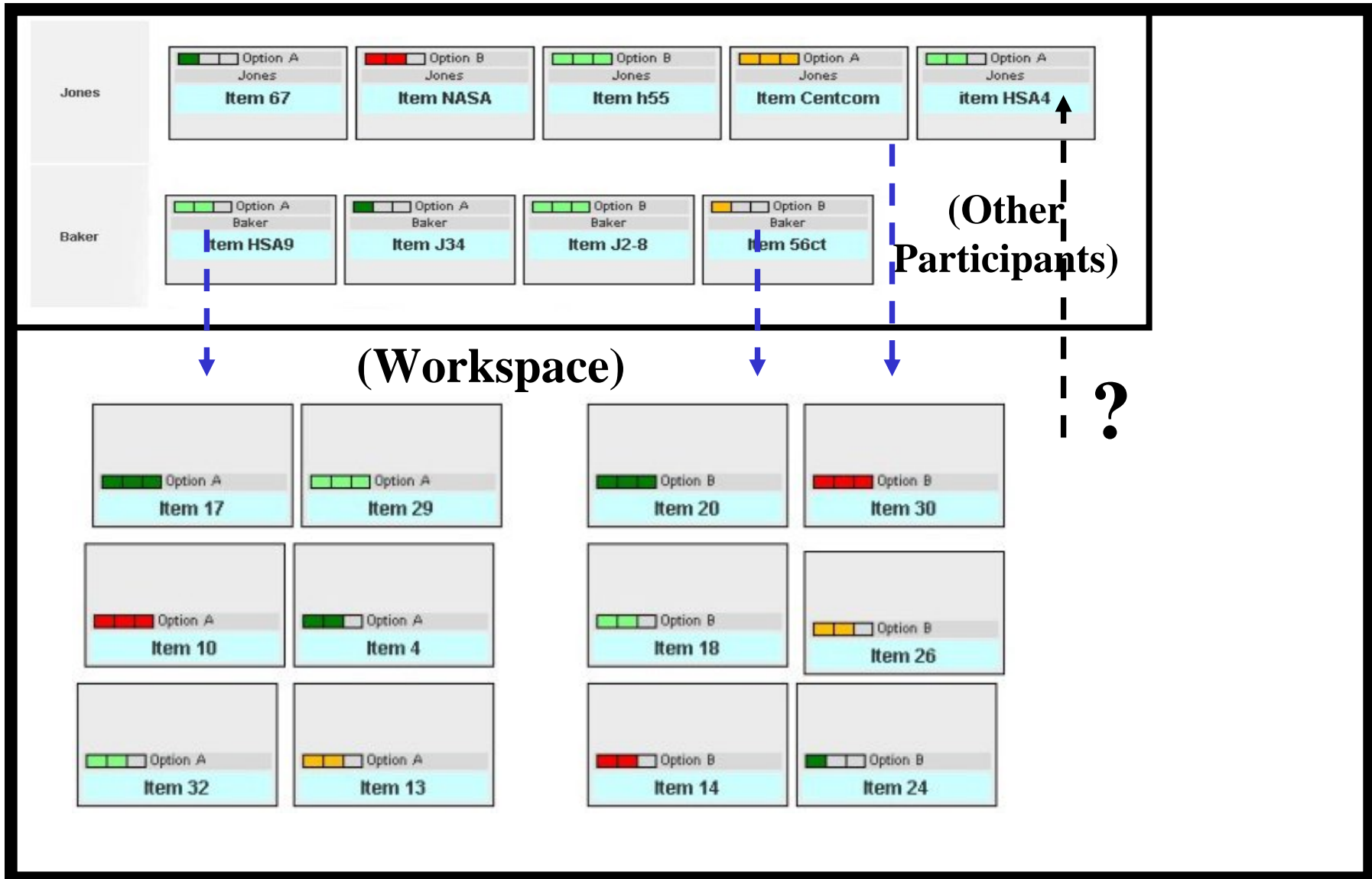
Very Positive, Positive, Negative, Very Negative





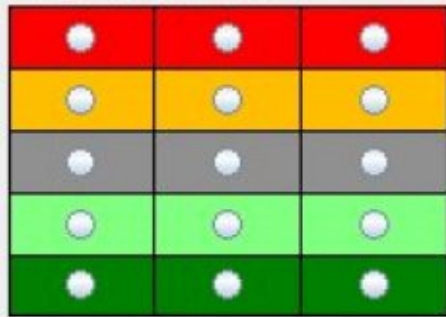
# DCODE Sharing

Research & Engineering  
Development, Inc. (RED-Inc)



Smith's Display (EWall workspace + Exchange view)

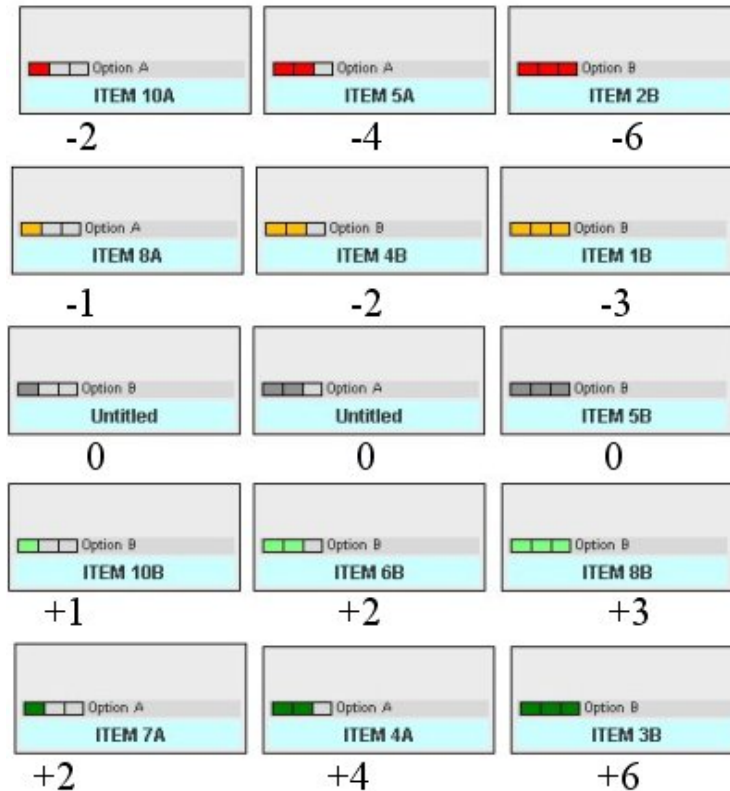
# Making Decisions with DCODE (the weighting matrix)



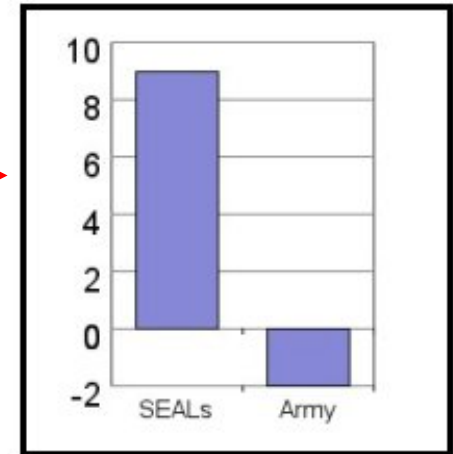
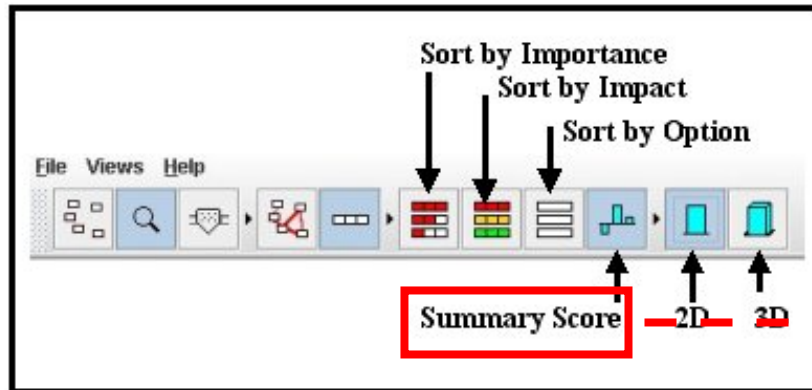
**IMPORTANCE**

	X	X	X
	1	2	3
I	-2	-2	-4
M	-1	-1	-2
P			
A	1	2	3
C	2	4	6
T			

**Weighting Matrix**



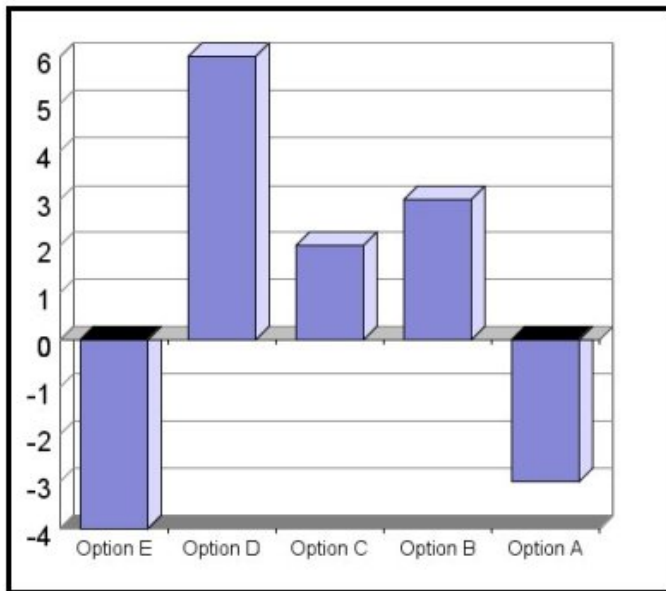
# Summary Score Bar Chart



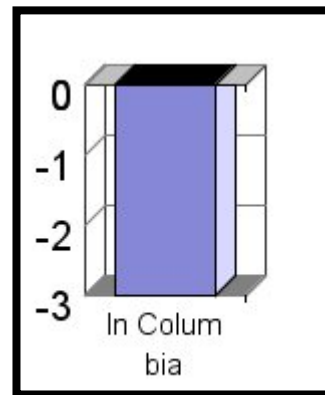
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>SEALs are very covert</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>SEAL team has a corpsman</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>SEALs are especially trained in hostage rescue</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army unit has trained on island and knows terrain</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army team has corpsman and translator</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Use of Army will have least impact on our reserve</b>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>Rebels have no night vision capability</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>There will be dense fog in the morning</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>SEALs should spend least time on the island</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army team predicted to have least casualties</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Use of Army would have good public relations</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army will have the most firepower</b>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>Seal team can be activated immediately</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>Very small time window for landing SEALs</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>Injured worker will have to spend 2 hours in Zodiac</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army unit is very fresh and at full strength</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Off-road terrain difficult for Army vehicles</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army will be the most expensive option</b>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>Reef is only passable at high tide</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>SEALs have just returned from another mission</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 SEALs <b>Seal team does not have a translator</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Bridges on roads do not have high load capacity</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army response will not be covert</b>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 0 Army <b>Army will have the slowest response time</b>

Algebraic sum of all IOBs for each option.

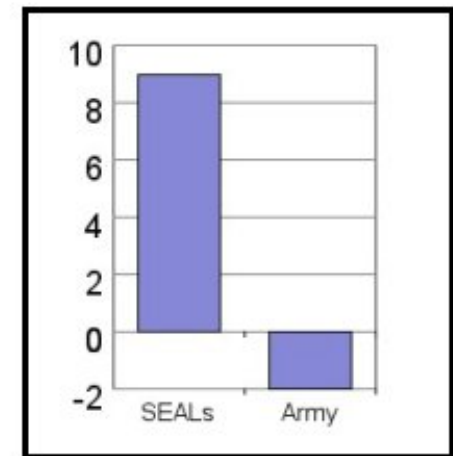
# Sample DCODE Summary Results



Multiple Options



Single Option  
(Yes-NO, Act-Don't Act)



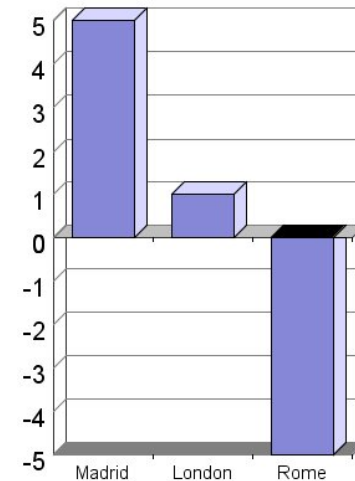
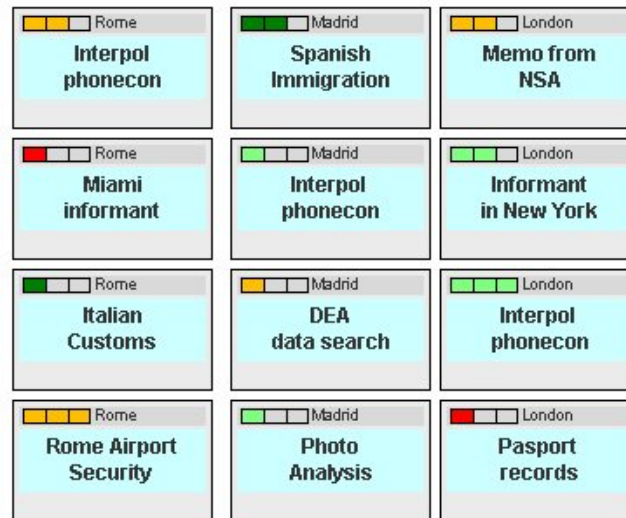
Two Options

# Use of DCODE in the Intelligence Community

“Is Carlos still in Columbia?”



“Where is Carlos?”



# DCODE Process

Best ETA for SEALS is 1900 hrs, 10/14

Nov-21-05 11:33AM G...  
Fleming

**ETA**

- Abstract
- Encapsulate

Best ETA for SEALS is 1900 hrs, 10/14

Nov-21-05 11:43AM G...  
Fleming

**ETA**

- Assess

- Option
- Importance
- Impact
- Quality

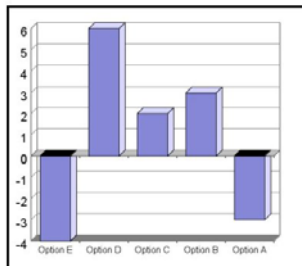
- Option
- Importance
- Impact

<p>Army unit has trained on island and knows terrain</p>	<p>Bridges on roads do not have high load capacity</p>	<p>Army response will not be covert</p>
<p>Army team has corpsman and translator</p>	<p>Army team predicted to have least casualties</p>	<p>Use of Army will have least impact on our reserve</p>
<p>Off-road terrain difficult for Army vehicles</p>	<p>Army will have the slowest response time</p>	<p>Use of Army would have good public relations</p>
<p>Army unit is very fresh and at full strength</p>	<p>Army will have the most firepower</p>	<p>Army will be the most expensive option</p>

- Integrate/Sort

<p>Option A Jones Item 67</p>	<p>Option B Jones Item NASA</p>	<p>Option B Jones Item h55</p>	<p>Option A Jones Item Centcom</p>	<p>Option A Jones Item HSA4</p>
<p>Option A Baker Item HSA9</p>	<p>Option A Baker Item J34</p>	<p>Option B Baker Item J2-B</p>	<p>Option B Baker Item 50ct</p>	

- Share



- Decide





# Recent DCODE Developments



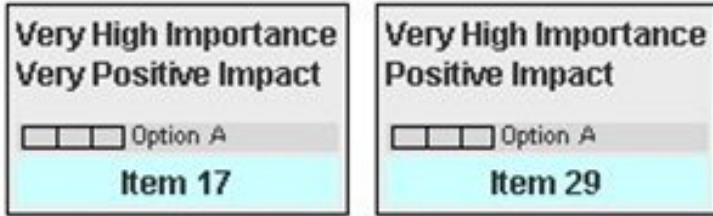
# Does DCODE Work?

## DCODE Experiment

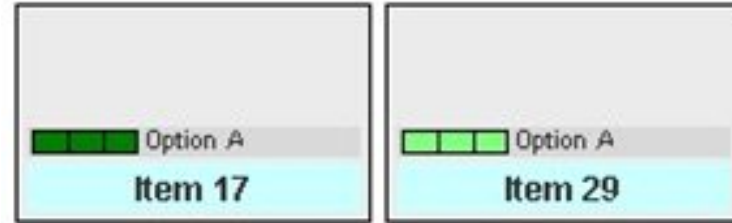
- 123 College Students
- Task: Rank order three cities (A, B and C) in terms of expansion sites for a new plant
- 12 items of information about each city
- Items had been rated on importance (three levels) and impact (4 levels)
- Given 30 min. for task (most took 10-15 min.)
- Text vs DCODE COLOR coding
- Male vs Female



# Text versus Color Condition



Two Text Item Examples



Color Equivalent

OPTION A		OPTION B		OPTION C	
Very High Importance Very Positive Impact Option A Item 17	Very High Importance Positive Impact Option A Item 29	Very High Importance Very Positive Impact Option B Item 28	Very High Importance Positive Impact Option B Item 19	Very High Importance Very Positive Impact Option C Item 20	Very High Importance Very Negative Impact Option C Item 30
Very High Importance Very Negative Impact Option A Item 10	High Importance Very Positive Impact Option A Item 4	Very High Importance Positive Impact Option B Item 15	High Importance Very Positive Impact Option B Item 27	High Importance Positive Impact Option C Item 18	High Importance Negative Impact Option C Item 26
High Importance Positive Impact Option A Item 32	High Importance Negative Impact Option A Item 13	High Importance Negative Impact Option B Item 12	High Importance Very Negative Impact Option B Item 23	High Importance Very Negative Impact Option C Item 14	Average Importance Very Positive Impact Option C Item 24
High Importance Negative Impact Option A Item 9	High Importance Negative Impact Option A Item 16	Average Importance Negative Impact Option B Item 8	Average Importance Negative Impact Option B Item 22	Average Importance Positive Impact Option C Item 3	Average Importance Positive Impact Option C Item 36
Average Importance Very Positive Impact Option A Item 25	Average Importance Positive Impact Option A Item 1	Average Importance Negative Impact Option B Item 5	Average Importance Negative Impact Option B Item 21	Average Importance Positive Impact Option C Item 6	Average Importance Positive Impact Option C Item 34
Average Importance Positive Impact Option A Item 7	Average Importance Negative Impact Option A Item 11	Average Importance Negative Impact Option B Item 31	Average Importance Negative Impact Option B Item 33	Average Importance Negative Impact Option C Item 2	Average Importance Very Negative Impact Option C Item 35

36 Item Display  
Text Condition

OPTION A		OPTION B		OPTION C	
Item 20	Item 30	Item 17	Item 29	Item 28	Item 19
Item 18	Item 26	Item 10	Item 4	Item 15	Item 27
Item 14	Item 24	Item 32	Item 13	Item 12	Item 23
Item 3	Item 36	Item 9	Item 16	Item 8	Item 22
Item 6	Item 34	Item 25	Item 1	Item 5	Item 21
Item 2	Item 35	Item 7	Item 11	Item 31	Item 33

36 Item Display  
Color Condition



# Response Sheet

-Write your choice as Best  
option on the “100” line.

-Write your choice as Worst  
option on the “0” line.

-Circle the number that best  
represents where you would  
assign the remaining option.

100	<u>Option C</u>
90	
80	
70	Option A
60	
50	
40	
30	
20	
10	
0	<u>Option B</u>



# Results

- Color condition had significantly fewer errors
- Color condition had significantly more people get all 3 rankings correct
- Color condition was significantly better at assigning position to the Middle rank
- Text condition had more people select the Best option—but then performed significantly worse than chance on the last two rankings
- Males had significantly more confidence in their rankings



# DCODE **S**mall business **T**echnology **T**ransfer Program (**STTR**) Awarded

- N06-T025 Decision Making Constructs for a Distributed Environment (DCODE)
- OBJECTIVE: Enable quick-response knowledge interoperability in coalition operations decision making.
- PHASE I: Develop a cognitive processing-based concept, tool or methodology to
  - improve the ability of both individual and distributed group decision makers to evaluate, share, and integrate decision-relevant information items and
  - to improve decision time by reducing the time and effort devoted to conflict resolution and consensus building in reaching an overall group decision.

**Three Phase I proposals accepted by ONR 6/06**



# More Information

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- DCODE documentation, updates:
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