Decision Making Constructs in a Distributed Environment (DCODE)

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### Decision Making Constructs in a Distributed Environment (DCODE)

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Organization:

• (1) Objectives
  – DCODE Concepts/Issues
• (2) Experiments
  – NPG School
  – Colorado State
• (3) Expected Final Product
• (4) Demos/Validations
  – Camtasia AVIs
  – Cortex
  – HSI Lab
• (5) Software Development
• (6) Publications
• (7) Lessons Learned
(1) Objectives

- Overall Objective: the development of computer-based methods for obviating the problems of the exchange, sharing and integration of uniquely held information among decision participants in a distributed, asynchronous collaborative team environment.
  - The project proposes an integration of EWall technologies with Knowledge Elicitation Tools and develops a simplified subjective assessment template for knowledge elicitation.

- This year: The specific objectives for this year are (1) to complete a “shrink-wrapped” version of the DCODE software with (2) the appropriate audio-visual training tools for how to use and apply the DCODE technology and (3) continued experimental validation of the efficacy of the DCODE approach to individual and group decision making.
DCODE

Decision Making Application Areas

• Information Fusion, Analysis and Situation Assessment

• Option Generation/Selection

• Course of Action (COA) Recommendations

• Consensus Building

Multiple Options, Multiple Information Items About Each Option
Two Problem Areas Addressed

The most important, high impact items

#1 How do we improve the process of getting to here…

#2 How do we form an aggregate opinion from conflicting inputs.

1000’s of possible decision relevant information items….
DCODE Approach

• Improve the ability of both individual and group decision makers to:
  – Abstract
  – Encapsulate
  – Assess
  – Share

…all decision relevant information items.
**EWall & DCODE**

- **EWall:** Architecture for the Abstraction, Encapsulation and Sharing of information.

- **DCODE:** Process for capturing and displaying the cognitive assessments of each information item (“what does this mean?”)

*The DCODE assessment “bar”*

*The DCODE assessment template*
Cognitive Assessments
4 Major Categories

(1) Which Option?
e.g. SEALS, Marines, Army

(2) Impact on Option? (Color)
Very Negative  Negative  Positive  Very Positive

(3) Importance of Information? (Size)
Average  High  Very High

(4) Quality of Information?
Confidence  Timeliness  Credibility
Information Abstraction, Encapsulation and Assessment

Convert candidates from original format into EWall IOBs (Abstraction, Encapsulation)

“Typhoon has serious and very negative effect on using the Marines”

Perform DCODE assmt. on IOBs that are retained for use/sharing in final decision making. (Assessment)
IOB format can be tailored to specific decision tasks.
Sample Use of DCODE (AVI)
Why do we Recommend this IOB Configuration?

- Display Real Estate
- Use of Pictures
- Color Conflict
Real Estate

• Example: Three possible decision options, 12 relevant information items for each option. “Big Picture” requires display of 36 IOBs.
Default Cards, 32 on 1024 x 768 monitor
Reduce size/eliminate picture...

115 x 140 pixels

Eliminate Picture area
Go to 115 x 80 pixels
Display of 36 IOBs on 1024 x 768 Monitor
Default Cards vs. Reduced Size

32 Cards

36 Cards
Sorting the Workspace

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zodiac</td>
<td>7 man, 15 mph</td>
</tr>
<tr>
<td>2 workers are injured</td>
<td></td>
</tr>
<tr>
<td>Robots have Stinger missiles, 5 mi range</td>
<td></td>
</tr>
<tr>
<td>Robots have land mines</td>
<td></td>
</tr>
<tr>
<td>West side of Island in friendly hands</td>
<td></td>
</tr>
<tr>
<td>SEALs need local translator</td>
<td></td>
</tr>
<tr>
<td>SEALs located on USS Enterprise</td>
<td></td>
</tr>
<tr>
<td>SEALs trained as medics</td>
<td></td>
</tr>
<tr>
<td>Coral reefs passable only at high tide</td>
<td></td>
</tr>
<tr>
<td>High tide between 7-9 am or 8-10 pm</td>
<td></td>
</tr>
<tr>
<td>45 min from shore to church</td>
<td></td>
</tr>
<tr>
<td>Night vision capability</td>
<td></td>
</tr>
<tr>
<td>Enterprise 200 mi east of church</td>
<td></td>
</tr>
<tr>
<td>DRADP topography</td>
<td></td>
</tr>
<tr>
<td>Helos can be heard for 5 mi</td>
<td></td>
</tr>
<tr>
<td>Navy Seahawk all weather night</td>
<td></td>
</tr>
<tr>
<td>Seahawk 184 mph, range 395 mi, fuel in all</td>
<td></td>
</tr>
<tr>
<td>SEALs have no night vision capability</td>
<td></td>
</tr>
<tr>
<td>SEALs minimize contact with enemy</td>
<td></td>
</tr>
<tr>
<td>Morning of January 15 heavy fog</td>
<td></td>
</tr>
<tr>
<td>Rain forest terrain</td>
<td></td>
</tr>
<tr>
<td>Sunrise 6 am sunset 7 pm</td>
<td></td>
</tr>
<tr>
<td>SEALs are very covered</td>
<td></td>
</tr>
</tbody>
</table>

“OK, what is this saying?”
Reduced Size Helps Between-Option Comparisons

A vs. B
Most Impt. Items

A vs. B
Average Impt. Items
Another Approach

Most Positive Items

Most Negative Items
Eliminate IOB Pictures?

It will take 2 days to repair the Stennis catapult.

The reef is only passable at high tide.

China has detained two Taiwanese fishing vessels.

Typhoon Leoni is veering away from ops area.

Philippine Minister of Defense will run for President.

Does the IOB need a picture?
If so, what picture?
Where do we get the picture?
Is it worth the time/lost space?
Color Conflict
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• (5) Software Development

• (6) Publications

• (7) Lessons Learned
(2) Experiments & Findings
NPG School Experiment
18 Officers

- Display: Text vs. IOBs
- Decision: Positive vs. Negative

<table>
<thead>
<tr>
<th>Display</th>
<th>Text Only</th>
<th>IOBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>N=5</td>
<td>N=5</td>
</tr>
<tr>
<td></td>
<td>N=4</td>
<td>N=4</td>
</tr>
<tr>
<td>Negative</td>
<td>N=9</td>
<td>N=9</td>
</tr>
</tbody>
</table>

N (tot)=18
Task:

• Volcanic disaster in the Pacific

• Should we recommend Islandia as the refugee site?

• Sees 30 information items (randomized)
  – 5 decision criteria
  • 6 items per criteria
The Five Decision Criteria

[COMmunications - TSPortion - LABor - ADMistration - SANitation]

- **Communications Facilities (COM):** Assess the communication facilities that are available in Islandia, including land telephone systems, radio, TV, cellular phone availability and coverage, etc.
- **Transportation Facilities (TSP):** Assess the transportation facilities that are available in Islandia, including roads, docks, airports, etc.
- **Labor Pool (LAB):** Assess the labor pool that would be available to staff the camp in Islandia, including size of the pool, quality of workers, work ethic/tradition, etc.
- **Administrative Requirements (ADM):** Assess the administrative requirements needed to set up the camp in Islandia, including, permits, fees, environmental considerations, bureaucratic red tape, graft, bribes, etc.
- **Sanitation/Health/Medical conditions (SAN):** Assess the sanitation, health and medical conditions expected in Islandia, including drinking water, sewerage disposal, medical facilities, infectious diseases, etc.
Decision Tasks:

- 5 Criteria Decisions
- 1 Overall Decision
A cultural tradition in Islandia is that each worker is given a single two month vacation each year, which he can take anytime during the year. All the employee has to do is give the employer a one week notice before going on vacation. This has caused unexpected and disrupted work shortages when several employees elect to take the vacation at the same time.

Read this, then assign it to one of the five criteria

(30 of these)

- Communications Facilities (COM): Assess the communication facilities that are available in Islandia, including land telephone systems, radio, TV, cellular phone availability and coverage, etc.
- Transportation Facilities (TSP): Assess the transportation facilities that are available in Islandia, including roads, docks, airports, etc.
- Labor Pool (LAB): Assess the labor pool that would be available to staff the camp in Islandia, including size of the pool, quality of workers, work ethic/tradition, etc.
- Administrative Requirements (ADM): Assess the administrative requirements needed to setup the camp in Islandia, including permits, fees, environmental considerations, bureaucratic red tape, grants, bribes, etc.
- Sanitation/Health/Medical Conditions (SAN): Assess the sanitation, health and medical conditions expected in Islandia, including drinking water, sewerage disposal, medical facilities, infectious diseases, etc.
IOB Condition (9 subjects)

Read this, then:
- Assign a keyword
- Assign it to a criterion
- Evaluate its effect on the criterion

(This experiment uses only the subjective assessment of EFFECT, does not tap Importance, Credibility, etc.)

Communications Facilities (COM): Assess the communication facilities that are available in Islandia, including land telephone systems, radio, TV, cellular phone availability and coverage, etc.

Transportation Facilities (TSP): Assess the transportation facilities that are available in Islandia, including roads, docks, airports, etc.

Labor Pool (LAB): Assess the labor pool that would be available to staff the camp in Islandia, including size of the pool, quality of workers, work environment, etc.

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Sanitation/Health/Medical conditions (SAN): Assess the sanitation, health and medical conditions expected in Islandia, including drinking water, sewage disposal, medical facilities, infectious diseases, etc.
INSTRUCTIONS

You have now evaluated all 30 items. Your last task is to assign rating scores to each criterion, as well as one final overall rating. Your previous scoring of the items has been used to create an "Information Object" (IOB) for each information item.

This IOB includes the information you previously assigned, i.e. the keywords, the criterion and the rating. The keywords are hyperlinked to the original text item so that you can call it up for review by simply clicking on the keywords. When you do this, the text will appear in a window to the right of the display. The effect you selected for each item is represented by the color bar in the IOB. A sample IOB is presented below:

Your Keyword
Your criterion Assignment
Your assessment of the Effect on selecting Islandia

The IOB items are available to you for review using a drop-down sorting menu that can present all the IOBs associated with all the criterion or you can elect to see only the IOBs associated with one individual criterion.

How to sort your data
Decision Display: IOB

Communications

<table>
<thead>
<tr>
<th>Communication</th>
<th>COM</th>
<th>TSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>104: 77</td>
<td>Red</td>
<td></td>
</tr>
<tr>
<td>109: 99</td>
<td>Red</td>
<td></td>
</tr>
<tr>
<td>95: 666</td>
<td></td>
<td></td>
</tr>
<tr>
<td>114: 557</td>
<td></td>
<td></td>
</tr>
<tr>
<td>121: 444</td>
<td></td>
<td></td>
</tr>
<tr>
<td>99: 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120: 999</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transportation

<table>
<thead>
<tr>
<th>Transportation</th>
<th>TSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>100: 22</td>
<td></td>
</tr>
<tr>
<td>105: 775</td>
<td></td>
</tr>
<tr>
<td>96: 777</td>
<td></td>
</tr>
<tr>
<td>91: 666</td>
<td></td>
</tr>
<tr>
<td>99: 666</td>
<td></td>
</tr>
<tr>
<td>92: 669</td>
<td></td>
</tr>
<tr>
<td>112: 777</td>
<td></td>
</tr>
<tr>
<td>118: 666</td>
<td></td>
</tr>
</tbody>
</table>
The items the subject assigned to the Communications criterion
IOB Subjective Assessment

One Last Request: Please select one of the options below in terms of how useful the IOBs were in making your scoring decision (this would be as versus just seeing the text listing of the items you assigned to each criterion)

<table>
<thead>
<tr>
<th>Somewhat distracting</th>
<th>No Effect</th>
<th>Helped Somewhat</th>
<th>Helped a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Submit
Positive vs Negative

½ of Subjects should make a decision that is Positive:

3 of 5 criteria are Positive

½ of Subjects should make a decision that is Negative:

3 of 5 criteria are Negative

Positive Criterion: 4 of the 6 statements are positive
Negative Criterion: 4 of the 6 statements are negative
RESULTS
Subjective Assessment

Max = 9

IOBs HELP?
Time Factor

IOB subjects took an average 18 seconds longer per item to enter keyword and make evaluation.
TIME TO MAKE THE 6 DECISIONS

Significant Difference

<table>
<thead>
<tr>
<th>M INUTES</th>
<th>Text &amp; IOB combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Positive

Negative
Score Assignment to Criteria

![Bar Chart]

- **TEXT**
- **IOB**

Y-axis: Score (0 to 16)

Legend:
- Red
- Yellow
- Gray
- Green
- Blue
Errors:

• All criteria should have been scored as either positive or negative
  – Assignment of a neutral rating is scored as an error
  – For the IOB subjects, whether the correct decision was Positive or Negative was based on the subject’s ratings
  – For the Text subjects, correct decision was based on experimenter’s classification
  – **Reversal Error (most serious):** Positive group of information given a Negative rank (or vice versa)
Errors in **Criterion Scoring**

- **Text (includes neutral)**: 18
- **IOB (includes neutral)**: 14
- **Text (Reversals only)**: 4
- **IOB (Reversals Only)**: 1
Score Assignment to Overall

Errors

TEXT

IOB
Summary of Results

Six of the 9 IOB subjects made the correct assignment.

None of the 9 Text subjects made the correct assignment.

6/9 of the IOB subjects showed unwillingness to commit to a decision. Other 3 made reversal errors.

No Differences between Text and IOBs
Summary

• No members of the Text group made a correct Overall decision:
  – Preferred the neutral rating
• Six of the nine IOB group made a correct Overall decision
• Subjects took longer to make a decision when preponderance of data was Positive
• IOB subjects gave favorable ratings to use of IOBs in decision making
The use of Information Objects (IOBs) and DCODE in decision making (Experiment at Colorado State 4/04)
Task

• Select the best company to invest in out of a group of three.*
• Read a report about each company
  – Profits, work force, CEO, new markets, etc.
• Create IOBs about each company
  – Instructed on how to create and use IOBs and the DCODE color bar options.
  – Creation, layout, contents, & DCODE options totally under subjects control.
• Make a final Rank Ordering of the 3 companies.
• $ incentive for best performance

* A published, standardized task, correct answer based on consensus of SMEs
Overview

• 36 subjects participated
  – 14 Females
  – 22 Males

• 15 of the subjects used the DCODE color bar option
Subjects

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCODE</td>
<td>13 (13)</td>
<td>8 (2)</td>
<td>21 (15)</td>
</tr>
<tr>
<td>No DCODE</td>
<td>9</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

(XX) = # of subjects that actually used DCODE color Bar
DCODE/No DCODE

Example:
Use of DCODE color bar

Example:
No usage of DCODE color bar
Use of DCODE:
Decision Performance (M & F combined)

54% of DCODE users ranked Best choice as #1
33% of non-DCODE users ranked Best choice as #1

28% of DCODE users ranked Worst choice as #1
54% of non-DCODE users ranked Worst choice as #1
Male vs. Female
Use of DCODE color bar

Male: N=13  13/13 100%
Female: N=8   2/8   25%
Decision Quality
Male vs. Female

Male: N=22
Female: N=14
Male vs. Female
(no DCODE)

Male: Rankings of the 9 males who did not use DCODE
Female: Rankings of the 12 Females who did not use DCODE
SUMMARY

• People made better selections using the DCODE option
• People were better at avoiding the worst option when they used DCODE
• Females were less likely to use DCODE
• Comparing performance of males vs. females who did not use DCODE, females performed more poorly than males.
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(3) Expected Final Product

- Overall “concept of operations” of how to best use EWall-DCODE for selected decision making paradigms/tasks.
- Set of AVIs on how to create, sort and share IOBs.
- High-level marketing brief on application of DCODE to military/intelligence decision making.
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• (7) Lessons Learned
(4) Demos/Validations of Technology

• Cortex

Third Fleet Flag Briefing and Collaboration Facility (on Point Loma). Four Major packages:

1. Display Space Management (DSM)
2. Information Services (“KWEB”)
3. Geospatial Collaboration Service (GCS)
4. Geospatial Replication Service (GRS)

– Both an innovation and AND an operational command center.
– Expect to introduce DCODE technology into Cortex on a test basis in 2005
Composeable FORCEnet Human Systems Integration Laboratory (CFnHSI)

Located at SPAWAR Systems Center, San Diego, operated by SPAWAR Systems Command. EWall/DCODE already installed in facility, which is well designed for both individual and group testing of DCODE usability concepts.
Instructional AVIs

The good news: EWALL has many options (very flexible).
The bad news: EWALL has many options (a lot to learn).

DCODE will produce a number of AVI tutorial aids to simplify the learning process.
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• (5) Software Development
• (6) Publications
• (7) Lessons Learned
(5) Software Development and Other Supporting Tools

- Software development and configuration management is controlled by MIT.
- DCODE project has supplied software design recommendations for use and display of DCODE assessment template.
- DCODE has created a variety of AVI instructional videos introducing the DCODE concepts.
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  – Cortex
  – HSI Lab
• (5) Software Development
• (6) Publications
• (7) Lessons Learned
(6) Recent & Planned Publications


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• (6) Publications
• (7) Lessons Learned
(7) Lessons Learned

- Critical Missing Feature to DCODE is the Absence of Automated Sorting Algorithms.

These were moved and sorted by hand.....
Possible Sorting Interface

Wide variety of possibilities.
- Options
- Importance
- Impact

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>IMPORTANCE</th>
<th>IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td></td>
<td>○</td>
</tr>
</tbody>
</table>
Compare
Option A vs. Option B on Importance

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>IMPORTANCE</th>
<th>IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>●</td>
<td>○</td>
</tr>
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<td>B</td>
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<td></td>
</tr>
<tr>
<td>ALL</td>
<td>○</td>
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</tr>
</tbody>
</table>
A vs B on Importance Parameter

<table>
<thead>
<tr>
<th>Importance Parameter</th>
<th>Option A</th>
<th>Option B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>All 15s</td>
<td>All 15s</td>
</tr>
<tr>
<td></td>
<td>All 12s</td>
<td>All 12s</td>
</tr>
<tr>
<td></td>
<td>All 6s</td>
<td>All 6s</td>
</tr>
<tr>
<td></td>
<td>All 3s</td>
<td>All 3s</td>
</tr>
<tr>
<td>High</td>
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<td>All 13s</td>
<td>All 13s</td>
</tr>
<tr>
<td></td>
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<td>All 10s</td>
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**Compare**

Option A vs. Option B on Impact

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<th>IMPACT</th>
</tr>
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<tbody>
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<td>● A</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>● B</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>○ C</td>
<td></td>
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<tr>
<td>○ ALL</td>
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</tbody>
</table>
Display

Option A
Pos to Neg

Option B
Pos to Neg
Summary

• **EWall** is a highly efficient approach to the abstraction, encapsulation and sharing of information.

• **DCODE** brings the critical element of information assessment to the decision making process.

• This added element significantly enhances the ability of an **individual** to form an overall **composite opinion** as well as for a **group** to reach **consensus** on option recommendation.
The Last……

• Slide of this brief
• Brief of this Conference
• Brief of my Career

Jan 20, 1955                                       Jan 20, 2005