Supporting Organizational Change in Command and Control: Approaches and Metrics

Shawn A. Weil, Georgiy Levchuk, Frederick J. Diedrich, Elliot E. Entin, Katrina E. See, Daniel Serfaty

Stephen Downes-Martin

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The General Problem:

→ How would you design a command team organization for this mission?

→ How would you derive human requirements for the organization?

→ How would you evaluate its performance for this mission?

→ How would you design adaptability into this organization?
The A2C2 Project

Objectives

- Develop & test theory of adaptive architectures
- Investigate fit between organizational structures & mission scenarios
  - Incongruence as a motivation to alter organizational structure
- Create conditions of incongruence & observe the adaptation process
  - Facilitators & inhibitors
Congruent teams outperform incongruent teams
  • Model-based organizational design for congruence (Diedrich et al., 2003)

Mission effectiveness would be enhanced through organizational adaptation.
  • However, teams are reluctant to change their structures to achieve congruence (Entin et al., 2004)
    • Adaptations observed were modest and variable
      • Most changes were small, some not adaptive
    • Participants often recognized the need for organizational change, but were reluctant to do so
Inducing Change

How can structural adaptation be supported?

- **Lack of Authorization**: Organizations may feel that they lack the authority to make alterations to their structures.
  - *Provide Targeted instruction*

- **Lack of Training**: Organizations may lack the training to make organizational changes effectively, and will therefore be reluctant to change.
  - *Provide Fully formed, sound organizational designs*

- **Lack of Sensitivity**: Organizations may resist organizational change even when it is indicated.
  - *Provide “Congru-o-meter” to signal change*

- **Lack of Familiarity**: Organizations may feel uncomfortable switching from established structures to those that are less well known.
  - *Model based prospective performance measures*
### Functional (F)

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<td>ISR</td>
<td>AWC</td>
<td>SuWC/MINES</td>
<td>SOF/SAR</td>
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### Divisional (D)

- Asset “ownership” and control shape team structure:
  - Multi-function vs. single-function responsibilities
  - Geographic Area of Responsibility: Local vs. Global
  - Heterarchical, not Hierarchical, organization
Design: Manipulating Congruence

- Congruence Manipulation
  - Capitalizes on Roles and Geography (task and asset locations)

- Strategies for Manipulation of Congruence
  - Coordination Requirements
  - Task Phasing
  - Limited Assets
Example: 
Functional (f) Scenario

- **2 SOF**: aggregated defend task, showing possible subtasks
- **2 SOF**: aggregated encounters task, with possible subtasks
- **M**: mission tasks (that must be done); known in advance
- **M**: GEVA may spawn as a result of performing task

**TASK RESOURCE REQMTS**

- **SDG**: 2 ASuW
- **SPT, SPH**: 1 ASuW
- **SGUN**: 2 FAB
- **SSAR**: 2 SAR
- **SMIN**: 2 MINES
- **GEVA**: 2 SAR
- **GCDL, GSML**: 1 STRK
- **GSAM**: 2 TLAM (from 2 different platforms)
- **GSA3**: 2 STRK (1 F18S)
- **GSA6**: 2 TLAM (from 2 different platforms)
- **GRGF**: 3 STRK
- **AAC, APH, ACDM, AXOC**: 1 AAW
- **ACAP**: 3 AAWS
- **AMIS**: 1 ABM

- other unanticipated tasks via HELP

---

* indicates that these must be distinguished from neutral (or decoy) counterparts
Example: Divisional (d) Scenario

- aggregates defend task, showing possible subtasks
- aggregates encounters task, with possible subtasks
- mission tasks (that must be done); known in advance
- GEVA may spawn as a result of performing task

**TASK RESOURCE REQMTS**

**SDG:** 1 ASuW + 1 AAW  
**SPT, SPH:** 1 ASuW  
**SHOS:** 1 SAR + 1 FAB  
**SSAR:** 1 SAR + 1 FAB  
**SMIN:** 1 MINES + 1 F18A  
**GEVA:** 1 SAR + 1 F18A  
**GCDL, GSML:** 1 STRK  
**GSAM:** 1 TLAM + 1 SOF  
**GSA3:** 2 STRK (1 F18S)  
**GSA6:** 2 TLAM (from 2 different platforms)  
**GRGF:** 2 STRK  
**AAC, APH, ACDM, AXOC:** 1 AAW  
**ACAP:** 2 AAW  
**AMIS:** 1 ABM  

- other/unanticipated tasks via HELP

* indicates that these must be distinguished from neutral (or decoy) counterparts
Consultants

- Study run at the Naval War College
  - July & August, 2004
- Four teams of highly trained consultants
  - Three Naval Reserve teams
  - One NWC student team

<table>
<thead>
<tr>
<th>Rank</th>
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<tbody>
<tr>
<td>Captain</td>
<td>2</td>
</tr>
<tr>
<td>Commander</td>
<td>10</td>
</tr>
<tr>
<td>Lieutenant Commander</td>
<td>7</td>
</tr>
<tr>
<td>Lieutenant</td>
<td>3</td>
</tr>
<tr>
<td>Chief Petty Officer</td>
<td>1</td>
</tr>
<tr>
<td>Petty Officer 2^{nd} Class</td>
<td>1</td>
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Experimental Design

<table>
<thead>
<tr>
<th>Session</th>
<th>Description</th>
<th>Team Structure</th>
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<tr>
<td>Congruent</td>
<td>Team Structure and Mission Task Requirements in alignment</td>
<td>Divisional or Functional</td>
</tr>
<tr>
<td>Incongruent 1</td>
<td>Team Structure and Mission Task Requirements in discord</td>
<td>Divisional or Functional</td>
</tr>
<tr>
<td><strong>Planning Session:</strong></td>
<td><strong>Opportunity to Change Structure in Response to Incongruence</strong></td>
<td></td>
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</tbody>
</table>
| “Incongruent” 2        | Congruence between Team Structure and Mission Task Requirements *dependent* on Chosen Team Structure | Divisional  
*Divisional  
D2 - Divisional/Functional Hybrid  
Regional  
F2 – Functional/Divisional Hybrid  
Functional* |
Organizational Structures

- **Divisional** – Each participant controls a single platform.
- **D2 – Divisional/Functional Hybrid** – Four participants control of a single platform each; two players control functional assets across the theatre.
- **Regional** – Theatre is divided into two geographic regions. Groups of three participants divide the assets functionally within those two regions.
- **F2 – Functional/Divisional Hybrid** – Four participants control functional assets across the theatre; two players control of a single platform each.
- **Functional** – Each participant controls a single function across the theatre.
Prospective Information and Congru-o-meter

- Performance feedback provided the second and third missions to encourage adaptation.
- Several Measures Presented
  - Performance (Percent Tasks Completed)
  - Perceived Workload
  - Gain

- Prospective information given before Planning Session, based on models
  - Gain
  - Coordination Workload
## Results: Adaptation

<table>
<thead>
<tr>
<th>Team</th>
<th>Original Structure</th>
<th>Chosen Structure</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>Functional</td>
<td>D2</td>
<td>Nearly congruent</td>
</tr>
<tr>
<td>Team 2</td>
<td>Divisional</td>
<td>Functional</td>
<td>Fully congruent</td>
</tr>
<tr>
<td>Team 3</td>
<td>Divisional</td>
<td>Functional</td>
<td>Fully congruent</td>
</tr>
<tr>
<td>Team 4</td>
<td>Functional</td>
<td>D2</td>
<td>Nearly congruent</td>
</tr>
</tbody>
</table>
Results: Performance

Percentage of Collaborative Tasks Attacked in Sessions 2 & 3

- Team 1 (F)
- Team 4 (F)
- Team 2 (D)
- Team 3 (D)

Session 2 (Pre-adaptation)  Session 3 (Post-Adaptation)

Percentage of Collaborative Tasks Attacked
Percentage of Collaborative Tasks Attacked with 100% accuracy in Sessions 2 & 3
Conclusions

Supporting Adaptation for Mission Effectiveness
- Teams will adapt their organizational structures if given the authority, education, incentive, and information to do so effectively

Library of Organizational Designs
- Creation of several model-based organizational structures allowed rapid adaptation

Measuring Adaptation
- The extent and impact of adaptation can be measured using tailored metrics
Thank You
Experiment 9 Pilot
Experiment 9 Pilot

- Teams of participants at the Naval Postgraduate School

- Follow directly from Experiment 8 results
  - Observe and assess adaptation in response to *incongruence*
    - Will an organization that is in an incongruent situation *recognize* this fact, and adapt its structure (e.g., who owns what, who does what) in order to become more “congruent” with its environment?

- Evaluate our ability to induce, guide, support and measure strategy and *structural adaptation* via:
  - Training, procedures, triggers, feedback, decision aids, …

- Affect adaptation during *facilitated* off-line planning sessions, **not** during on-line dynamic play
### Pilot 9 Design (1)

- **H** is a hybrid organization, “midway” between D and F
  - Exposes players to elements of Functional & Divisional structures

- First “adaptation” (F $\Rightarrow$ F₁, etc.) to external SCUD threat
  - Requires players to allocate new assets (TTOM, ABM) and new roles

<table>
<thead>
<tr>
<th>Start Org</th>
<th># of teams</th>
<th>Training (Hashx2)</th>
<th>Play#0 Congruent 1 (no SCUD)</th>
<th>Adapt for SCUD (PS #1)</th>
<th>Play#1 Congruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>2 (B,D)</td>
<td>(OrgH)h₁ (OrgF)h₂</td>
<td>Ff (no SCUD)</td>
<td>F₁</td>
<td>F₁f</td>
</tr>
<tr>
<td>D</td>
<td>3 (A,C,E)</td>
<td>(OrgH)h₁ (OrgD)h₂</td>
<td>Dd (no SCUD)</td>
<td>D₁</td>
<td>D₁d</td>
</tr>
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</table>
Observational and self-reporting instruments were designed to collect data during planning sessions.

Feedback and aids utilized during planning sessions.
Planning Session Protocol

- Planning/adaptation occurs prior to the next play
  - Questions posed to team by facilitator:
    - How are we doing?
    - Should we adapt in some way? If yes, how?
  - Discussions were recorded for analysis
  - Asset changes recorded for immediate implementation
  - Strategic changes and rationale recorded
Congru-o-meter

- Provided feedback before each planning session based on team performance to encourage adaptation
  - Model-Based Performance data was available within minutes.

- Measures displayed were suggested by previous study as leading indicators and/or model based
  - Performance (Percent Tasks Completed)
  - Perceived Workload
  - Communications Distribution
  - Gain (UCONN)
  - Cognitive Demand (CMU)
Adaptation Analysis

- To assess how adaptive changes made by the teams were, we:
  - Broke asset allocation into the smallest meaningful elements
  - Measure percent overlap between team asset allocation for each mission with the modeled organization

- The result is: overall similarity between the team-generated allocations and the modeled class of organizations
Team A adapted in anticipation of incongruence.

Team C made few, minor changes.

Team E changed in a maladaptive fashion.

*Blue:* Percentage of Assets that are Functional

*Red:* Percentage of Assets that are Divisional
Team B made adaptive changes in reaction to incongruence.

Team D made few, minor changes.

Blue: Percentage of Assets that are Functional

Red: Percentage of Assets that are Divisional
Manipulating Congruence (2)

- Congruence Manipulation
  - Capitalizes on Roles and Geography (task and asset locations)
- Strategies for Manipulation of Congruence
  - Coordination Requirements
  - Task Phasing
  - Limited Assets
Previous Experiments
Realization of Model-based Experimentation

- Model-based Organizations (F, D)
- Scenarios (f,d)
- Successful Manipulation of Congruence
  - Congruent out-performed Incongruent
  - Differences in communications & workload – leading indicators of incongruence
- New Model-Based Measures

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Demonstration of structural adaptation in some teams based on model-based congruence manipulation

- Open-ended adaptation
- Adaptations observed were modest and variable
  - Most changes were small, some not adaptive
- Participants often recognized the need for organizational change, but were reluctant to do so

Implementation of initial version of congru-o-meter

- Model-based measures available for planning
- Near real-time information available
- Observations indicated that more detailed performance feedback would be beneficial