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Empirically-driven Analysis for Model-driven Experimentation: From Lab to Sea and Back Again (Part 1)

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Abstract:

The Expeditionary Strike Group (ESG) is a versatile military organization, designed to effectively handle missions as diverse as air warfare, tactical ballistic missile defense, and maritime interdiction operations. Over the past several years, ESG organizations have allocated command responsibilities in several ways, each permutation affecting organizational dynamics. The Adaptive Architectures for Command and Control (A2C2) program has been using model-based experimentation to investigate the congruence of organizational structure with mission requirements. The ESG provides an opportunity to apply the principles developed in previous A2C2 research to a rapidly evolving operational organization. Relevant doctrine and case studies were reviewed, current operational personnel were interviewed, and observations were made in an ESG during routine operations. This led to insight about questions of interest for the Navy, such as the allocation of Composite Warfare Command (CWC) roles, the inclusion of an ISR coordinator, and the division of tasks under both CWC and Joint Amphibious Doctrine. This information will be used to increase the fidelity of the representations and processes used in models, to create realistic scenarios, and to help with experimental designs that can inform decisions about organizational structure.

Adaptive Architectures for Command and Control (A2C2)

Over the past decade, the Adaptive Architectures for Command and Control (A2C2) research program, sponsored by the Office of Naval Research (ONR), has focused on examining command structures for future Naval, Joint and Combined forces. As the primary adversaries of the United States change from Cold War monoliths to smaller asymmetric threats, new C2 structures need to be explored which are ideally suited to meeting new challenges. The charter of the A2C2 program is to help develop these organizational structures, structures that are *adaptable* in the face of new enemies and new missions.

However, the A2C2 program is valuable not just for its mission, but for its methodology. The driving force behind the A2C2 program is the concept of **m*odel-based experimentation***. Figure 1 depicts the process that begins with theoretical and operational concepts and moves in an iterative fashion through modeling and experimentation. Early in the process, models are refined through consultation with subject matter experts and first-run simulations, which produce definitions of scenarios and organizations, as well as guidance for experimental design and data collection measures. Organizational concepts are informed and refined, based on data collected, leading to additional cycles of the modeling and experimentation. Critically, this model-test-model-experiment process leads to well specified hypotheses and precisely defined measures. The resulting operational concepts are brought back to decision makers, providing empirical evidence as they make choices about organizational change.

However, for the A2C2 process of model-based experimentation to be worthwhile, the issues being investigated in the laboratory and in the simulation must reflect the major challenges faced in a changing military. That is, A2C2 researchers must employ ***operationally anchored*** model-based experimentation, and the results of the empirical investigations must provide the decision makers with information they currently lack. Previous efforts have accomplished this goal through extensive consultation with Navy personnel, and have led to several successes. Early research involved working with the Chief of Naval Operations (CNO) Strategic Studies Group (SSG) XVIII to help define adaptive command structures for what will become Sea Power 21. Next, the A2C2 team worked with Commander Carrier Group One (COMCARGRUONE), to conduct a one-week experiment with model-driven alternative command structures in preparation for Global Wargame 1999 (Levchuk et al., 2000; Hess et al., 2000). In 2001, A2C2 team members conducted a series of quantitative modeling and simulation analyses to support the

SSG XXI Cognitive Concept Generation Team. The goal was to align the Navy's tactical C2 organization and processes with the FORCEnet concept, the Navy's implementation of network-centric warfare. Results highlighted the superiority of FORCEnet structures over Composite Warfare Commander (CWC) structures for future missions (Serfaty et al., 2002). More recently, the A2C2 program has been using the model-based experimentation paradigm to investigate the congruence of organizational structure with mission requirements, and the elements required for effective strategic and structural adaptation (Diedrich et al., 2003; Entin et al., 2003, 2004; Weil et al., 2005).

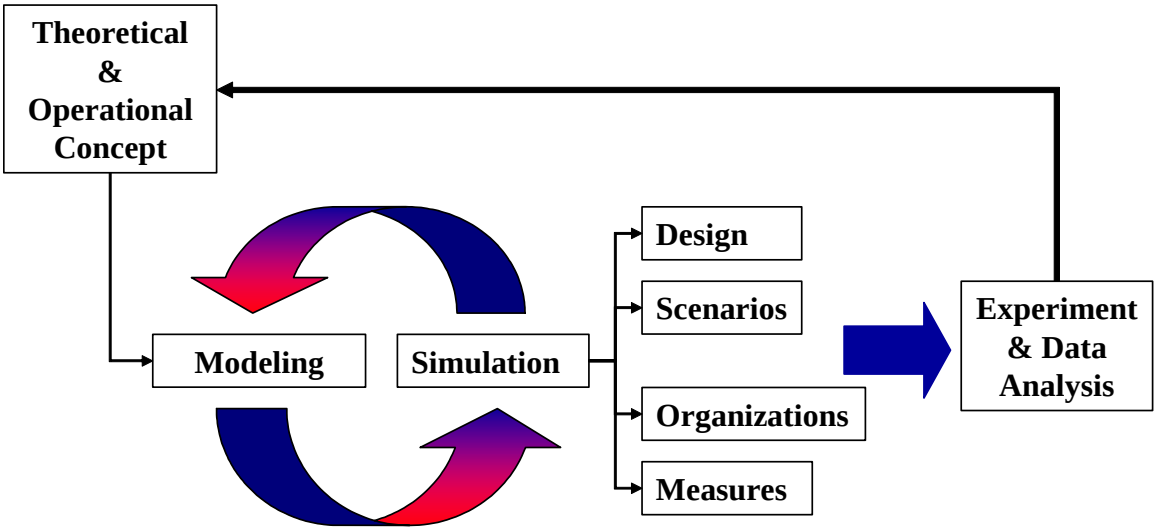

Figure 1. Basic Process Illustration of A2C2 Operationally Anchored Model-based Experimentation.

The Expeditionary Strike Group

Our current research utilizes the model-based experimental approach to assess organizational constructs and structures for the Expeditionary Strike Group (ESG). At its core, an ESG is a US Navy task force that is scalable, adaptable, and capable of planning and executing a wide range of missions. It combines the amphibious capabilities of a traditional Amphibious Readiness Group/Marine Expeditionary Unit (Special Operations Capable) (ARG/MEU[SOC]) with the combatant firepower of Navy cruisers, destroyers, and frigates (Hutchins et al., 2005). Amphibious landing ships transport troops, vehicles, and supplies wherever they are needed and provide great flexibility to commanders in planning operations. However, amphibious ships are not designed for fighting hostile naval forces, especially highly maneuverable patrol craft found in coastal environments. Moreover, traditional ARG/MEU(SOC) deployments had no capability to provide naval surface fire support (NSFS) for Marines ashore or to strike targets at sea. In order to counter littoral threats, the Navy has transformed ARGs into ESGs by assigning dedicated combatant ships – cruisers, destroyers, and frigates – to protect the amphibious ships (ESG OPS 2005). ESGs are now able to provide NSFS and Tactical Land Attack Missile (TLAM) strikes in support of Marines ashore. This increased combat capability includes a variety of assets to conduct Intelligence, Surveillance, and Reconnaissance (ISR), Strike and Naval Fire Support, Air Warfare, Antisubmarine Warfare (ASW)/Surface Warfare, Maritime Interdiction Operations, and Tactical Ballistic Missile Defense.

In addition to being a flexible organization, the ESG is also an experimental organization. Responsible for missions traditionally guided by both Composite Warfare Command (CWC) and Joint Amphibious Doctrines, the internal C2 organization of the ESG has not yet been standardized. When the first ESG deployed in 2003, the Commander (CESG) viewed the ESG as the maritime component for the Global War On Terrorism (GWOT). This West Coast model of the ESG has a flag or general officer (FO/GO)

led staff, which provides the combatant commander with: (1) a subordinate staff capable of planning at the operational level; (2) the capability to task organize, which included taking command of inorganic forces as required; and (3) a single source commander capable of providing maritime and land force (US Fleet Forces Command, 2002). A second ESG deployed in 2004 from the East Coast. The two deployments were similar in terms of ship and aircraft composition, but they were different in ESG organizational structures and command relationships (Deal et al., 2004; Hutchins et al., 2005). The group composition of both pilot deployments increased the group's offensive and defensive capabilities. The differences in command structure and responsibility affects organizational dynamics. The evolving organizational structure, integration of Joint resources, part-time inclusion of coalition assets, and competing demands for mission prioritization make the ESG an ideal subject of inquiry for the A2C2 program.

A unique and key advantage of the ESG is s*tructural adaptability.* This inherent characteristic permits the ESG to support a wide range of missions (from amphibious assault to disaster relief). The unique command structure that integrates the Navy and Marine Corps forces is key to this adaptability. An aspect of this adaptable structure entails activating alternate warfare commanders, who operate in supported/supporting roles depending on the mission, in order to distribute workload. Lateral collaboration is employed as an enabler of structural adaptability with a reliance on non-traditional communication and coordination.

Table 1. Integrated Mission Essential Tasks Conducted by an Expeditionary Strike Group.

Both USN and USMC	
Conduct Intelligence, Surveillance and Reconnaissance	Conduct Amphibious Assault
Conduct Information Operations/ Warfare	Conduct Amphibious Withdrawal
Tactical Deception Operations	Conduct Amphibious Demonstration
Provide Operational Fires (Joint/ Coalition)	Conduct NEO
Provide Anti-Terrorism/ Force Protection	Conduct Humanitarian/ Disaster Assist
Conduct Terminal Guidance Operations	Conduct Peace Operations
Conduct MIO/ EMIO Operations	Conduct Deliberate Planning
Conduct ESG Force Defense (AD/USW/SUW/DAF)	Provide Contingency Support Packages (TRAP, CASEVAC, QRF, MASS, CASUALTY)
Conduct VBSS (compliant/ non-compliant)	**USMC Specific**
Conduct Sustainment Operations	Conduct Amphibious Raid
Provide Command, Control, Communications and Computers	Conduct Direct Action Operations (Precision Raid or VBSS)
Conduct Initial Terminal Guidance Operations	Conduct Airfield/ Port Seizure
USN Specific	Conduct Security Operations
Provide Theatre Missile Defense Warning	Conduct Limited Expeditionary Airfield Op's
Provide Sea Lines of Communications Protection	Employ Non-Lethal Weapons
Provide Sanctions Enforcement	Conduct Enhanced Urban Operations
Deploy/ Conduct Operational Maneuver	

The result of this unique combination of assets and structural adaptability is a highly mobile group of platforms with a lean command and authority structure. Their ability to provide a rapid response is enabled by the capability to rapidly coordinate, deploy, and move to locations where they are needed. ESGs are also designed to be self-sustaining, as well as capable of autonomous action due to the diverse set of capabilities they provide. ESGs provide Combatant Commanders with more flexible, robust, and distributed offensive combat capability and enhance Naval expeditionary force survivability. Core capabilities provided by ESGs include: (1) Power projection, (2) Maritime superiority for air, surface and

subsurface, (3) Maritime special operations, (4) Amphibious operations, (5) Military operations other than war, (6) Enabling operations, (7) Supporting operations, and (8) serving as a Joint Task Force enabler. Table 1 presents a list of the integrated essential tasks that are conducted by an ESG.

ESG: Organizational Issues

As the ESG is a relatively new Navy concept, there are several issues regarding organizational structure that merit investigation. The combination of the ARG/MEU(SOC) with the Navy cruisers, destroyers, and frigates historically assigned to Carrier Battle Groups is not simply a novel aggregation of resources; the underlying C2 philosophy must be reconsidered in light of new capabilities. The list of missions described in Table 1 require not just increased training, but a deliberate allocation of command responsibility over a finite number of commanders. The diverse leadership and staff structures chosen by East and West Coast models impact the relationships among major sub-commands, specifically the MEU and the Amphibious Squadron (PHIBRON).

An adaptive C2 architecture for an ESG — referring to both structure and process — should be able to work smoothly – for both planning and operations – as an unitary entity, or as part of a Joint Task Force (JTF), working directly for the Joint Force Commander (e.g., operating as a theater reserve or operating as a small JTF). This requires a large degree of flexibility, and a C2 apparatus that can seamlessly metamorphose on response to the mission and tasking. Given A2C2's mission and methods, and given the tasks envisioned for the ESG, the pairing is ideal.

The challenge, then, is to achieve the operational anchoring required for fruitful model-based experimentation. This requires information of two different sorts:

A. High level challenges to be investigated, their origins, and their implications. This ensures that the hypotheses addressed in the laboratory will have resonance in the planning rooms and operations centers.

B. Low level information about the organization. This could include specifications of resources, current or candidate organizational structures, and patterns of information flow. These details are essential for modeling the correct processes and for adding realism to experimentation.

Over the past year, these two types of information have been gathered regarding the ESG, in preparation for planned modeling and experimental efforts. The methods for collecting this information included interviews with high level members of an ESG staff, extensive review of doctrine and procedures, monitoring of mission progress via closed and open sources, and first-person observation of C2 processes during deployment. The ultimate goal of this process is to inform the model-based experimental process and provide the most relevant information to the individuals responsible for organizational structure.

Within the ESG, multiple Navy and Marine Corps sub-organizations must coordinate their actions to meet varied mission objectives. Over the past several ESG deployments, a number of interesting organizational challenges were noted, and the A2C2 team was asked to investigate. A three-phased research program focusing on organizational analysis and design was put forward. This encompassed:

- **Assessment:** Qualitative analysis and assessment of the current ESG structure along with a diagnosis of problematic areas and suggestions for potential organizational remedies.
- **Comparison:** Comparative modeling of current ESG structure versus selected alternative structures in order to provide a quantitative assessment of performance pay-offs.
- **Optimization:** Optimization-based design and simulation of alternative C2 architectures. Quantitative assessment of performance pay-offs.

The *assessment* portion of the research program is designed to provide the ESG with immediate actionable guidance based on past experience, and provide the A2C2 project team with the information required for effective operationally anchored model-based experimentation. To these ends, a list of

(observed or assumed) potential areas of interest, along with associated recommendations, was developed. These were drawn from collected A2C2 experiences, attendance at a number of training exercises, interviews with ESG personnel, and a review of the literature pertaining to ESGs, including lessons-learned from previous deployments. Seven topics were chosen for further study based on their importance to mission success; these are described below.

Topic 1: Restructuring the Amphibious Squadron (PHIBRON) cell – Part A: Amphibious Warfare

The PHIBRON cell in a recent West Coast model ESG was responsible for both amphibious operations (such as embarkation, transit, and assault under combat conditions) and Sea Combat Command (SCC) operations (such as Surface Warfare, Undersea Warfare, Maritime Interdiction Operations [MIO], and Maritime Security Operations [MSO]). During high operational tempo conditions, it is possible for the limited PHIBRON staff to become overloaded by the number of concurrent missions. This could be problematic when conducting amphibious operations in parallel with ongoing SCC/MIO/MSO duties. This potential for overload is exacerbated by the fact that the CPR has a small, junior staff who is experienced in amphibious operations, but less so in MIO/MSO/SCC duties. Additionally, at issue was how to retain CPR command focus on the (changing) primary current mission area. Finally, it was noted that this node is operating under two different doctrines: Joint Amphibious Doctrine and Composite Warfare Commander (CWC) doctrines.

Our recommendations based on a review of available documentation, limited interviews with senior staff, as well as previous experience with organizational design in general and the A2C2 program in particular included:

- Have the Commander of the PHIBRON (CPR) retain the title of AWC (Amphibious Warfare Commander) to handle amphibious operations under existing amphibious supported-supporting (S-S) doctrine.
- Augment the CPR staff as needed during amphibious operations
- Split off remaining areas (MIO/MSO/SCC) under subordinate, co-equal or alternate commander(s) to operate under CWC doctrine. [Note: It is essential for alternate commanders to have continual training/practice in their roles.]
- Conduct formal training intervention on teamwork behaviors that mitigate overload.

Topic 2: Restructuring the PHIBRON cell – Part B: Maritime Operations

The high number of potential contacts (and critical contacts of interest) in a busy maritime region could lead to high workload in the PHIBRON, especially when conducting MIO/MSO. Moreover, the nature of MIO differs significantly from other maritime duties, requiring different staff expertise and information utilization. MIO utilizes different information (e.g., maritime and shipping databases, coordination with ships' country of origin, following international procedures, etc.), and uses assets unique to visit, board, search and seizure (VBSS) operations.

Our recommendations included:

- Establish a self-contained MIO commander and cell operating under a CWC-like doctrine. The MIOC could be either subordinate to, or co-equal with, the SCC.
- Staff this cell with people having expertise pertinent to MIO, with very tight coordination with the intelligence cell (N2).
- We noted that MIO and MSO may be combinable, as both use very similar maritime picture. This may allow giving the remaining sea defense (of own forces) role to an alternate commander (e.g., CG, LHA) to further off-load CPR and staff especially when under high MIO tasking.

Topic 3: ISR Coordinator or Commander

The importance of intelligence, surveillance, and reconnaissance (ISR), especially as part of the War on Terror, was stressed repeatedly in training. Yet the ESG has a limited access to ISR-dedicated assets which could lead to possible "*stovepiping*" of ISR assets and requests by separate air/sea/ground areas, and inefficient use of scarce (low number, high-demand) assets to cover a large area. It is essential to make effective use of the inherent ISR capabilities of *all* assets (including ESG, theater, and national level) and to maximize multi-capable ISR platforms (e.g., UAV, E2C, P3) including external ISR support and reachback.

Our recommendations included:

- Establish the position/role of ISR commander or coordinator (ISR-C) to prioritize asset utilization for ISR.
- This node should have tasking authority of ISR-dedicated assets (e.g., UAV), and should coordinate tasking of other assets for ISR purposes.
- ISR-C must be part of the ESG planning cells especially current operations.

Topic 4: Hybrid Supporting-Supported Structure and Internal Control

Supported-supporting (S-S) relationships, according to Joint Doctrine, are a somewhat vague, but very flexible arrangement. There may often be a spectrum of S-S relations: from preset to fully dynamic or contingent. In a dynamic context, conflicts are possible when supporting multiple concurrent missions, especially if that commander is the supported commander for another mission. It is also noted that a supported commander needs sufficient staff to plan and guide the mission. However, within an ESG, it is not clear when S-S relationships that are determined on a mission-by-mission or contextual basis break down (e.g., under high workload, dispersed forces, heterogeneous tasking, etc.). One objective of the A2C2 research is to identify potential challenges in implementing S-S relationships.

Our recommendations included:

- The ESG should be prepared to augment the planning capability/staff of a supported commander.
- Senior staff in current operations (COPS) must be ready to resolve conflicts that may arise when a commander is supporting multiple concurrent missions, or between a commander's primary warfare role and supporting roles. In addition, the S-S commanders must alert N3/N5 early enough on potential conflicts.
- The assignment of who is supported and who is supporting must consider other factors (e.g. current loading) in addition to expertise and C2 capability.

Issue 5: Expeditionary Action Groups "Unplugged" and Distributed Command and Control

An Expeditionary Action Group (EAG) – typically one ARG ship, one surface combatant ship, and some aircraft that are deployed to some location outside the immediate battlespace – is no longer under some or all of the protective umbrellas (air, sea, etc.) of the ESG. Thus, dispatching an EAG can leave significant holes in the remaining/residual ESG forces.

Our recommendations included:

- Augment the EAG staff as required to enable operation as a self-contained entity (multi-area defense capable) with possible assist from shore-base or other sea-based assets.
- Have a Liaison Office (LNO) on the ESG Flagship to maintain lines of communication (C2) and overview between the ESG and the EAG.

- Consider consolidating CWC roles among remaining ESG forces and activating alternate warfare commanders: e.g., merge sea and air defense into a single ESG defense node. (See related comments under the CPR topic).

Issue 6: Command and Control of "Revolving Door" Assets

Based on prior ESG experiences, it was expected that assets would be attached to and detached from (TACON) the ESG on a frequent (as needed) basis. Many of these assets are Coalition ships, some are from different services/groups (Coast Guard, Carrier Strike Group, shore-based, etc.) and follow their individual doctrines/processes, and dual chain of command. Expertise in effective use of these assets may not be resident in the ESG, and different information access may constrain tasking options. Long-range planning becomes challenging if assets are revolving in and out of the ESG.

Our recommendations included:

- Pass tactical control (TACON) of assets down to the most relevant warfare commander (or ship commanding officer) to avoid the need for the SCC to manage a large number of assets (typically ships).
- Use S-S relationships to adjust the TACON assignments, on a mission-by-mission basis.
- Use liaison officers (LNOs) as necessary for attached forces.
- When assets that are playing key roles are detached, consider consolidating CWC roles among remaining ESG forces and activating alternate warfare commanders.

Issue 7: Direct Tasking of MEU Assets (particularly the Air Combat Element)

A Marine Expeditionary Unit (MEU), such as is found in an ESG, is the smallest type of Marine Air Ground Task Force (MAGTF). Given the utility of assets controlled by the MEU, divergent priorities and objectives on the use of MAGTF assets among Warfare Commanders, MAGTF-CO, and ESG staff, were deemed likely unless procedures were established. From the Marines' perspective it was essential that the ESG task MAGTF assets without violating the integrity of the MAGTF while also maintaining readiness of these assets to support impending MEU operations. It was noted that there may be doctrinal and command relationship issues involved here between "big" Navy and Marines.

Our recommendations included:

- Tasking MAGTF assets as needed to support S-S relationships with the MAGTF commander whenever possible, and ensure that appropriate MAGTF staff are involved in the planning process.
- Encourage a joint Marine Corp-Navy study to examine best way to task/employ *all* ESG assets to accomplish ESG missions.

Other Issues

In addition to these major issues, several additional issues were noted.

- Control of assets – the management and allocation of limited assets over many possible missions
- Synchronizing multiple planning cycles and commander's intent – noting that the Navy uses a defined planning cycle whereas the Marines utilize a 6-hour Rapid Response Planning Process (R2P2).

These issues and associated recommendations described above were presented to the Commander of the ESG, and senior members of his staff for their comments and for prioritizing the subsequent A2C2 research efforts. The top three prioritized topics that emerged from this meeting were:

1. **Restructuring the PHIBRON (CPR) Cell.** This choice of this topic, which combined our issues 1 and 2, underscores the experimental aspect of the combined Amphibious/SCC responsibilities allocated to the PHIBRON in the ESG.

2. **Establishment of an ISR Commander/Coordinator.** If the ESG is to have a level of autonomy in the global war on terror, the intelligence gathering must be well synchronized. This is especially difficult as the intelligence sources are collected by many different organizations within the ESG, using dispersed systems and sensors.
3. **Hybrid Supporting-Supported Structures.** When the West Coast ARG/MEUs were augmented with additional capabilities and a FO/GO led staff to become ESGs, the change was more than a simple addition of resources. The way in which the major sub-commands (i.e., PHIBRON and MEU[SOC]) interact may have changed as well. How do Supported-Supporting relationships manifest themselves in this new organization?

With these three topics as guidelines, the A2C2 team went forward in its efforts, and arrangements were made for several researchers to visit the flagship of the ESG just prior to its deployment.

Interview and Observation

The recommendations outlined above are based on a review of available documentation, limited interviews with senior staff, as well as previous experience with organizational design in general and the A2C2 program in particular. However, additional information was required in order to ensure that suggestions for change matched the true operational needs. Furthermore, as we plan to explore the challenges of the ESG using A2C2's model-based experimentation paradigm, more detailed information detail is required. With these three topics as guidelines, three members of the A2C2 team visited the flagship of an ESG just prior to its deployment in and around theater. While the A2C2 researchers were aboard, ESG participated in a joint-coalition land/sea exercise. The embarked team interviewed both senior and junior staff members of the ESG, PHIBRON, and MEU(SOC) (see Table 2), observed senior level briefings, reviewed information sources, and monitored the Joint Operations Center (JOC).

Table 2. Staff Members Interviewed.

ESG	**PHIBRON**
Commander, ESG	Commodore
Deputy Commander	Future Operations
N2: Intelligence	Current Operations
N3: Operations	Intelligence
N5: Future Operations	**MEU (SOC)**
N6: C4I	Executive Officer
Other staff officers…	Communications, Planning, Watch Officers…

In order to learn as much as possible while underway, the team needed to have goals as to what information to collect. However, the methods used needed to be flexible to take advantage of the emergent nature of a real world military environment. This was accomplished by having all members of the A2C2 team create a list of queries prior to the trip. Each item was created to assist in refinement of the organizational areas of interest through experimentation. That is, the information to be obtained would either help in the design of a future model or a human-in-the-loop experiment.

While conducting the interviews and observing, the researchers ensured that the queries previously generated were addressed. However, it became clear very early on that previously unidentified issues

were important as well. When these issues presented themselves, the researchers departed from the query list to investigate.

A secondary method of data collection was direct observation of operations. Members of the A2C2 team monitored the Joint Operations Center (JOC) where the Flag Watch Officer and the Assistant Flag Watch Officers coordinate activities with liaisons from the MEU(SOC) and PHIBRON. Observations were made in the JOC during each watch to ensure that the full range of operational tempos was observed. The A2C2 team also observed meetings with the CESG and his staff, including future and current operations meetings (FOPS & COPS). Interviews with staff members provided valuable insight about questions of interest for the CESG and for the Navy in general, and the observation of activities increased our understanding of information flow and decision making techniques in hybrid organizations such as the ESG.

For both interviews and observations, particular emphasis was placed on those three topic areas identified by the CESG as being of high criticality. Our observations in these areas are outlined below.

Topic 1. PHIBRON Organizational Structure

Members of the CPR staff recognized the value of utilizing the same staff to conduct both SCC and Expeditionary Warfare operations. However, resources were limited and personnel experience was lower than the ideal. For example, resources allocated to the CPR were the same as had been allocated to them as part of an ARG/MEU. However, an ESG has additional responsibilities and tasking. Similarly, the experience level of the personnel, and their resulting rank, was lower than their equivalents in other ESG component organizations.

One of the most interesting issues we wanted to address was the impact of multiple doctrines. Specifically, the PHIBRON must operate under two doctrines, composite warfare (CWC) for the SCC responsibilities, and joint amphibious for the amphibious operations. In actual experience, the members of the PHIBRON reported that they experienced this more as a conflict of two different missions than a conflict between two doctrines. The PHIBRON commander was thus acting like a single warfare commander executing two missions. To reduce possible overload, in high operational tempos the PHIBRON staff reported naturally creating two sub-groups, one responsible for SCC and the other for amphibious operations. The PHIBRON commander, in turn, could oversee both types of operations and ensure coordination.

With regard to Maritime operations (i.e., MIO, MSO), the ESG had not yet entered areas in which those activities would have been required. Follow-up interviews will be conducted to investigate these operations.

Topic 2: ISR Coordinator or Commander

ISR is increasingly important in modern warfare, as our capabilities are tied to having accurate information. The rationale behind a single ISR coordinator is that battlespace awareness can be maintained with a single information holder collecting and distributing information. At the ESG level, the ISR and intelligence organization seemed to be working well. The ESG had designated the N2 of the ESG staff to serve as the ISR Coordinator. His responsibility in this arena was to ensure that (1) the use of scarce resources was consistently in support of the commander's intent, and (2) that the intelligence gathered was processed and integrated to be acted upon when necessary.

The ESG was focusing on several geographically dispersed areas simultaneously, which challenged their capabilities. However, by aligning the use of all the ESG intelligence assets with the commander's intent, they were able to handle those areas simultaneously. Both ESG current operations and future operations

staffs were happy with the intelligence support they were receiving. Because the initial data were gathered before the ESG entered it's final operating environment, further data will be gathered upon a return visit to assess the ISR coordination topic. Of particular interest is the effectiveness of using the ISR capability of assets that have a different primary purpose; thus expanding the overall ISR capabilities of the ESG.

Topic 3: Hybrid Supporting-Supported Structure and Internal Control

The nature of S-S relationships in the ESG is of great interest to the A2C2 project. Various mission contingencies require the coordination of resources and capabilities by different commanders. It is not difficult to imagine conditions in which two commanders are supporting each other simultaneously on two separate efforts. The mechanism to enable this support was unclear before we embarked.

Conceptually, the S-S arrangement in the ESG is based on the commander's intent. When a situation arises that requires support, the CESG's priorities guide how the commands relate to each other. Support is determined on a capabilities level rather than the asset level whenever possible. That is, the PHIBRON may request transportation from the MEU, but would not ask for a particular vehicle. We imagine that this may lead to some tension when resources that are the most efficient for a certain task are not offered.

Following our visit, we are unsure of how critical an issue this is. The current S-S relationships seem to have worked well up through our visit, but complex situations where S-S relationships might be taxed had not been experienced yet. The current scheme works fine when there are only a few situations in which in occurs. However, if the ESG is envisioned to engage in activities in which there are multiple, reciprocal, simultaneous S-S relationships among commands, greater specification may be required. We will be exploring their experiences with S-S relationships during our follow-up visit in the coming months.

Bringing the ESG into the Laboratory

Information gathered during our time with the ESG will be used both to provide immediate ideas to the Navy regarding the organizational structure of the ESG and to inform our future modeling and experimentation. The A2C2 program has a long tradition of identifying critical organizational issues in the military, abstracting fundamental properties of those issues, and investigating those issues using converging experimental and modeling approaches. In the ESG, this tradition continues with additional operational relevance. As the military moves towards more agile, self-contained organizations, it is imperative it does so with deep understanding of the organizational issues based on both deliberate expert analysis of unconstrained operational environments and controlled empirical investigation in the laboratory.

Based on the high level information gained through review of relevant doctrine, interviews with ESG, PHIBRON, and MEU(SOC) staff, and direct observation of operations in an ESG, several activities will be undertaken:

- Modeling and simulation of several ESG configurations, including the staff organization, subordinate commands, and major platforms. The configuration of the CPR cell, the nature of supported/supporting relationships, and the characteristics of information flow can be determined.
- Validation and expansion of conclusions drawn from the modeling and simulation effort via laboratory experimentation. These experiments, which use military participants, will address the issues of organization/mission congruence, the complexity of supported/supporting relationships, and the impact of divergent priorities on mission efficiency and performance.
- Development or repurposing of scenarios that capture both
    - The missions and tasks for which the ESG has been designed, and

- The types of missions and tasks that have been actually assigned to recent ESGs.

The A2C2 team has the personnel and the facilities to conduct both agent-based modeling and simulation and team-in-the-loop experimentation, and has the knowledge and experience to recognize which combination of approaches would be most beneficial for a given problem. With regard to the ESG, several efforts are envisioned (see Levchuck et al 2006 for more detail).

ESG in Action: Two Case Studies

The relevance of the modeling and experimental activities planned are contingent on their resemblance with the activities of existing ESGs. The review of doctrine and the interaction with active ESG personnel has allowed us to provide the initial recommendations contained in this report. However, much insight can be gained from surveying the missions undertaken by ESGs. Over the past several years, ESGs have played key roles both in the war on terror and in disaster relief. These case studies illustrate the breadth of missions that ESGs are capable of accomplishing, provide details for parameterization in simulation and modeling, and ground experimental scenarios in real-world events. ESGs have been vital to several relief efforts, including the Indian Ocean tsunami and South-Asian earthquake. Furthermore, ESGs have played a vital role in the war on terrorism by supporting Maritime Interdiction Operations (MIO) and Maritime Security Operations (MSO).

Operation Unified Assistance – Indian Ocean Tsunami

On December 6, 2004, the ESG-5 led by the USS Bonhomme Richard departed San Diego for the Arabian Gulf. Twenty days later, a devastating Tsunami reeked disaster on the nation of Indonesia. The seven ships carrying thousands of sailors and marines changed course while the PIHIBRON 7, 15th MEU, and ESG-5 commanders generated plans for the new mission, Operation Unified Assistance.

The large number of sailors and marines provided much needed manpower to clear roads, build temporary shelters, and set up water purification plants. In addition, these numbers contained special skills that were of great value. The culinary staff baked sustenance items (e.g., high nutrient corn bread) and treats such as cookies and brownies for the children. The dental staff set up a clinic at the hospital in Meulaboah, which saw 40 patients in the first 3 days. Additionally, the medical staff of the ESG stood ready to aid victims if needed, and welders provided assistance in the repair of a Singaporean ship, adding two more landing craft to the international team.

In addition to the manpower and skills, the ESG-5 provided numerous physical assets and technology that were vital to the relief effort. En route, the ships began making and storing 30,000 gallons of potable water a day for the victims to drink while their purification systems were repaired or rebuilt. Once in position, the Bonhomme Richard established a communication system to coordinate the efforts of the international relief [?] team. In addition, the 3 Air Cushioned Landing Craft (LCAC) were able to ferry the personnel, heavy equipment (including forklifts and tractors), food, water, medical supplies, and personnel to the coastal areas. While the 29 helicopters airlifted food, water, medical supplies, as well as military and NGO personnel to inland locations now unreachable by ground. The helicopters also performed search and rescue operations. In total, the LCACS and helicopters of the ESG-5 delivered 1.5 million of the 2.75 million pounds of aid before being relieved by the USS Essex.

After departing the Sea of China, the ships deployed to their original destination, the Arabian Gulf. Once there, the marines departed the ships; this time to provide security during Iraq's first election in decades. The naval assets safeguarded oil rigs and performed MIO that captured drugs that the insurgents were planning to sell to finance their terrorist activities. These activities continued until the ship returned to San Diego in early June 2005.

All activities were planned and coordinated by the 15th MEU and PHIBRON 7 working in support of the CESG-5. As noted, the activities on this deployment were diverse and emergent. The commanders needed to be prepared for a new mission quickly. This requires an organization that is flexible and adaptive.

South-Asian Earthquake Relief

Like ESG-5, ESG-1 departed San Diego on July 22, 2005 led by the USS Tarawa. After participating in a civilian relief operation in the Philippines and a multinational exercise in Egypt, ESG-1 moved towards its destination in the Arabian Gulf. On October 8, an earthquake occurred in South Asia. The Pakistani government requested assistance from the US government and, in partial response, Admiral Michael LeFever, CESG-1, was designated as the coordinator of the Combined Disaster Assistance Center (CDAC), Pakistan.

In addition to the coordination of US assets, the CDAC had a major role in the integration of international military efforts, Non-Governmental Organizations (NGOs) and other international organizations, and worked closely with representatives of the State Department, USAID Disaster Assistance Response Team (DART), ODRP (Office of Defense Representative-Pakistan) and others. Overall, these organizations were following the guidance and requests of the Pakistan government.

Within two days, Admiral LeFever and key members of his staff were on the ground in Islamabad. The quick installation of a FO/GO-led planning staff in response to this crisis demonstrates an important aspect of the adaptability of the ESG.

The CDAC was to act in support of the Government of Pakistan (GOP), keeping as limited a footprint as possible, while providing a range of capabilities. Some of the immediate capabilities were provided by ESG-1 platforms. The USS Pearl Harbor arrived almost immediately to offload heavy machinery to be used in support of the relief effort. Sailors worked in coordination with personnel from Naval Mobile Construction Battalions (NMCB, or "Seabees") in using this machinery to clear debris and improve road access. Other ESG-1 amphibious ships were also used to transport relief supplies coming from donor nations. ESG-1 sailors worked side-by-side with military personnel from other countries to off- and on-load relief supplies. The ESG's limited helicopter capability was quickly supplemented by a Helicopter Sea Combat Squadron (HSC) from NAVCENT.

An excerpt from Commander's Comments section of the situation report of CDAC(U) dated 12 December 2005 illustrates both the daily activities and the cumulated total of services provided:

"Another great day of weather in support of relief efforts: 212 MASH maintained their solid effort, treated 152 (6,409 total) patients, conducted 04 (313 total) surgeries, and maintained nine bed occupancy. CMRT-3 treated 148 (4,230) total patients, conducted 1 surgery (34 total)…TF Eagle had another solid flight day supporting the relief effort with six CH-47 and two S-70s providing 22 sorties, carrying 71.20 tons of humanitarian assistance, 01 [casualty evacuations] and 71 [displaced Pakistanis]. Task Force Wright pumped 45,439 gallons (257,470 gallons total) for 15 (451 total) aircraft at Muzaffarabad and 8,601 gallons (61,659 gallons total) for 16 (128 total) aircraft at Shinkiari. PBS News Hour revisited 212 MASH to cover MASH operations."

After four weeks, the ships of the ESG-1 were re-assigned to other operations in the region (see section below). The initial request for assistance from CDAC was to be limited to 90 days, but with the degree of devastation and the isolation of many of those needing assistance with the onset of winter, this period has been extended.

Maritime Interdiction Operations (MIO) and Maritime Security Operations (MSO)

While some assets of ESG-1 were supporting the disaster relief effort, other resources were used for MIO and MSO, part of ESG-1's regular mission set. The MIO efforts seek to prevent terrorists from attempting to use the maritime environment as a venue for attack or as a medium to transport personnel, weapons or

other illicit material. The MSO mission in the northern Persian Gulf helps to protect the integrity of Iraqi territorial waters as well as defending Iraq's oil terminals.

As part of an MIO effort, ESG-1 released TACON of the USS Tarawa, the USS Cleveland, and – for a short time – the USS Gonzales to Combined Task Force 150 (CTF150) for a pulse operation in the North Arabian Sea and Gulf of Oman that was led by a French Admiral and also included ships from several other countries. The remaining assets of ESG-1 *supported* CTF150 in this mission, especially for information and intelligence gathering.

Intelligence gathering for this MIO pulse effort was supplied by coalition maritime patrol aircraft, helicopters from the Tarawa and USS Oscar Austin, and the Scan Eagle UAV operated from the Cleveland. The ESG retained OPCON and TACON of the Scan Eagle, thus requiring coordination among the PGC-N2, the CTF150-N2 and the ESG-1-N2 for both requests for information (RFI) and dissemination of UAV images. Tasking of the Scan Eagle assets was done via the Current Operations (COPS) cell of the ESG-1.

Of interest to our research program is the C2 relationships that were established during this mission. The PHIBRON (CPR-1) wore multiple hats that reported to different higher authorities. One of these hats was as the (supported) Pulse Group Commander (PGC), and was TACON to CTF150. In addition, the PHIBRON retained his role of Sea Combat Commander (SCC) under ESG-1. In all likelihood, this required a splitting of the CPR-1 staff.

The MSO operations in the northern Persian Gulf (under CTF152) were supported by the USS Pearl Harbor and USS Chosin. The Chosin had a major role as Air Defense Commander (ADC) for the MSO operation; however as the remaining ESG-1 were in a different geographical region than was the Chosin, it was necessary to activate the alternate ADC on the Tarawa. For a time, the Gonzalez and the frigate USS Ingraham were assigned to support CTF150 in conducting maritime operations. These ships were subsequently involved in other missions within theater. Noteworthy to the experience of this ESG-1 was clearly the distribution of its forces across missions and areas. As quoted by CAPT David Clopp, the operations officer (N3) for ESG-1, "We're in four different places, doing four different missions at the same time. It definitely shows the agility of the ESG. We are able to conduct multiple missions at once."

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