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Assessing the Requirements for the Transformable Craft, A Framework for Analyzing Game Changing Capabilities

Rowden, Bobby

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A Framework for Analyzing Game Changing Capabilities

LT Bobby Rowden, USN
Department of Systems Engineering
Naval Postgraduate School
Monterey, CA 93943 U.S.A.
bjrowden@nps.edu

LT Michael Hellard, USN
Department of Systems Engineering
Naval Postgraduate School
Monterey, CA 93943 U.S.A.
mjhellar@nps.edu

Prof. Eugene Paulo, NPS
Department of Systems Engineering
Naval Postgraduate School
Monterey, CA 93943 U.S.A.
eppaulo@nps.edu

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ABSTRACT

This study assesses the impact of functional requirements for the Transformable Craft project, sponsored by the Office of Naval Research. Although focused on the "game changing" nature of these requirements, this study provides a framework for analysis of generic logistics connectors, sea basing alternatives, and force structures by means of operational scenarios and simple simulation and analysis tools. This study demonstrates the means by which these tools can assist military decision makers in understanding complex and high level issues.

1. INTRODUCTION

In 2005, the Office of Naval Research (ONR) issued a Broad Agency Announcement (BAA) for a prototype Transformable Craft (T-Craft) that can deploy in an unloaded condition from an intermediate support base to a Seabase and then be used as a sea base connector, transporting wheeled and tracked vehicles, cargo, and personnel through the surf zone and onto the beach.[1] The research presented here is part of a larger study to build a concept of operation (CONOPS) that makes a case for the "game changing" capabilities a T-Craft would bring to enable Sea Basing, Operational Maneuvers from the Sea (OMFTS), and Ship-to-Objective Maneuver (STOM).

2. SCOPE OF WORK

As part of the larger CONOPS effort, this study provides a quantitative assessment of the "game changing" value of high-level design requirements.

In support of that objective, the authors developed a series of operational scenarios used to flex the capabilities of the logistics forces involved. These scenarios represent a useable cross-section of challenges to expeditionary logistics and can be used as a baseline by which logistics connectors, sea base composition, and employment methods can be demonstrated.

Furthermore, this study demonstrates how high-level issues can be assessed by relatively simple analysis tools; namely Microsoft Excel®, ExtendSim by Imagine That!™, and Google Earth™.

3. REQUIREMENTS FRAMEWORK

ONR BAA #05-020 lists a series of desired capabilities, desired threshold/objectives, and other information relevant to the "game changing" capabilities of the T-Craft. Desired capabilities addressed in this study are:

1. Un-refueled range, in a no cargo condition, of 2,500 nautical miles in a Fuel Efficient/ Good Sea Keeping Mode (20 knots, through Sea State 5).
2. Maximum Speed, full load condition in High Speed, Shallow Water Mode = ~40 knots through top end of Sea State 4.
3. Maximum un-refueled, fully loaded range of 500-600 nautical miles (40 knots, through Sea State 4).

Desired threshold/goals addressed in this study are:

1. Cargo payload weight of 300 LT (threshold), 750 LT (objective).
2. Crew size of 3 (threshold), 2 (objective).
3. Beach slope climbing of .5% (threshold), 2% (objective).

Other information considered in this study includes:

1. No habitability/living spaces required.
2. No organic capabilities to handle pallets, quad-cons, or 20ft containers.

4. OPERATIONAL SCENARIOS

In order to determine potential "game changing" capabilities a T-Craft might bring to the table, a series of operational scenarios were developed to flex these capabilities. These scenarios represent a wide swath of the Range of Military Operations as found in JP 3-07 *Joint Doctrine for Military Operations Other Than War*.[2] Namely, the scenarios chosen are Major Theater War, Peacekeeping/Peace Enforcement, Regional Conflict, and UN Security and Stability. The scenarios were developed

with various sea base structures and ranges, shore base sizes, and situational dependent challenges.

Additionally, the authors incorporated threat scenarios developed by Naval Postgraduate School and Naval War College courses in order to present a feasible geo-political scenario that supports the scale of military operation depicted therein. Sea base range, shore spot numbers, and scheme of maneuver were developed using geographic information systems (GIS) data on the operational environment. The background, scenario, and US military action is detailed for each operation below.

4.1. Major Theater War

4.1.1. Background

Since the expulsion of UN inspectors in 2009, North Korea has been working to improve its nuclear arsenal and missile delivery systems. Despite requests by the international community for North Korea to rejoin diplomatic talks, Pyongyang has continued its sabre-rattling, threatening military force could be used if economic equality with the South would not be obtained, or for threats against the country's "inherent right of nuclear power and space exploration".

The situation in North Korea was made further unstable by the passing of Kim Jong Il in 2012 from complications secondary to diabetes. His youngest and favorite son, Kim Jong Woon, had been heir apparent for many years, despite a lack of official notification to the Guidance Department of the ruling party. After the sudden passing of Kim Jong Il's, ruling officials were split on the order of succession. Seizing power, Ri Chan Bok, commander of KPA forces along the demilitarized zone, used his position to usurp the party and install himself as the country's new leader. The General has often stated the "inevitability of war" with the US and South Korea over trade restrictions, and that the war would "begin on the Korean peninsula".

Despite six years of development, it is unlikely that nuclear weapons have been miniaturized adequately for missile employment, although KPA officials have hinted that this capability does exist. However, North Korea's missile development has continuously improved over these years. Analysts suggested that North Korea had an untested variant of the Taepo Dong missile capable of reaching the west coast of the continental United States.

In June of 2015, the DPK planned a test launch of the missile, again under the guise of placing a communications satellite into orbit. Despite international pressure not to further its missile capability, particularly from the US who threatened to shoot down missiles perceived as a threat to the US and its allies, North Korea conducted the test launch on 15 June. The missile was engaged by a TBMD capable US ship in the Pacific Ocean. As a result, Ri Chan Bok has promised a "quick and decisive blow to the US and its puppet government to the south for this outrageous breach of international law."

4.1.2. Scenario

Five days after the missile test, South Korean forces noticed unusual movements and routines of border forces. Increased aircraft routes and ground vehicle movements were noted of such magnitude that area commanders deduced that a major operation must be underway. Increasing WATCHCON and DEFCON in the area, Commander US Forces South Korea has requested mobilization of reinforcements to repel a probable North Korean assault.

Two days later, KPA troops stormed the demilitarized zone under cover of darkness and a forming monsoon. This meteorological combination negated the superiority of ROK and US air support, and allowed the KPA forces to overrun the demilitarized zone with forces amassed in underground collection areas. Superior training and firepower has slowed the initial onslaught towards Seoul, but the scale of enemy troop levels has overwhelmed forces on the ground. As expected, KPA troops have turned their sights on Seoul using short range missiles and rockets to amass casualties to soften resolve as it marches towards the city. US and ROK forces can slow the onslaught until the weather clears air operations can be restored. Air support should stop the assault until US reinforcements can amass. Once the counteroffensive begins, forces shall destroy as much of the KPA forces, push them back past the DMZ, and continue on to Pyongyang and enable a reunification of the Korean peninsula under favorable terms.

4.1.3. Action

Reinforcement of Seoul is the first priority. As such, the remainder of I Corps, namely the 25th Infantry Division, 17th Fires Brigade, and 42nd MP Brigade will land near Inchon. These forces will be augmented with the 75th Ranger Regiment. These forces will be landed via T-Craft, meet up with US/ROK forces, and expel KPA forces.

In the second phase, Task Force Cougar, comprised of the III MEF, 82nd Airborne Division, and 10th Mountain Division, will land near Gangneung. Marine forces will land via ESG connectors, while Army units will land via aircraft at the regional airport. After massing forces, the Task Force will drive north and repel DPK assaults on the DMZ and push on into North Korea.

At this time, the majority of III Corps will be landed south of Wonsan, North Korea. The Corps will be landed via T-Craft from MPF ships 250 nm to the south. III Corps will "cross the T" of retreating DPK forces, then continue on to Pyongyang.

Sea bases will be established in the Yellow Sea and Sea of Japan to support landings on both coasts of Korea. Due to the threat of DPK diesel submarines, the sea bases will be located 250 nm offshore, taxing the logistics

connectors to the maximum required range. This submarine threat also prevents movement of undefended stores ships in the area. As such, additional T-Craft will be used to replenish the sea base, making runs from the relatively close port of Fukuoka on the Japanese island of Kyushu. Their speed and maneuverability will enable the T-Craft to operate largely unimpeded by the submarine threat without using scarce naval resources as convoy protection. The Japanese Maritime Self Defense Force (MSDF) will patrol their own territorial waters in the name of defense, but due to Korean political mistrust of the Japanese, their forces will not be used in combat roles.

4.2. Peace Keeping / Peace Enforcement

4.2.1. Background

The year is 2025 and the Colombian Civil War has raged in the country for sixty years. The current elected president Mario Gutierrez Pedroza assumed the presidency of Colombia after a record low voter turnout. It seems the people of Colombia have lost total confidence in the democratic process and the Colombian Government. The Colombian economy is experiencing the worst crisis the country has seen. The level of violence in the country is unprecedented. During the past two years guerrillas and the San Jose Cartel murdered approximately 1,800 public officials including town mayors, federal and state legislators, judges, and prosecutors. More than 17,000 people have been killed in 420 recorded massacres.

The San Jose Cartel was born from the ashes of the Medellin and Cali Cartels, which were virtually dismantled in the year 2007. In early 2012 a new drug called "magia" (*magic*) first appeared in the U.S. Then, months later, *magic* made its debut in the European Union and Asia. The drug is a stimulant that accelerates physical and mental states, produces euphoria and eases physical and mental pain. In many cases, the user is prone to violent behavior. Today, the use of *magic* has reached epidemic proportions. It is estimated that in the US there are more than 15 million addicts and an estimated 80 million worldwide. The death toll in the U.S. attributed directly or indirectly to the use of *magic* has surpassed 500,000 since the appearance of the drug in 2012.

With the advent of *magic*, the San Jose cartel has been able to establish an alliance with the Colombian insurgency movement, in particular the Revolutionary Armed Forces of Colombia (FARC). Soon after the 2013 government campaign against the rebels, the National Liberation Army (ELN) joined forces with the FARC, and the Common Front for the Liberation of Colombia (CFLC) was born. Today, the CFLC has become the security force for the San Jose Cartel. The CFLC has taken advantage of increased drug revenue and to build up their conventional arsenal, largely purchased from neighboring Venezuela. Last year, the annual CFLC income was estimated at over US $800 million.

The current situation in Colombia has taken its toll not only on the U.S., but also in the region. The political and economic instability of the neighboring countries has ignited the formation of a series of new narco-guerrilla groups. The violence is rapidly spreading to neighboring Ecuador, Peru, and Venezuela. With their respectable arsenal and forces, the San Jose Cartel and the CFLC's objective is to continue to disrupt and eventually to overthrow the Colombian Government. The CFLC desires to establish a government that will allow the San Jose Cartel to continue to massively export *magic* worldwide, but particularly to the United States.

4.2.2. Scenario

In the last two years, the CFLC has practically crippled the Colombian Armed Forces. In a coordinated attack, CFLC forces infiltrated into four air force bases and destroyed most of the aircraft. Only the airbases at Barranquilla and Santa Maria were able to minimize the damage inflicted by the CFLC. The naval base at Puerto Tamuco was also attacked and 37 out of 41 patrol craft were seized by the guerrillas. Intelligence reported the possible deployment of floating mines in the ports of Buenaventura and Tamuco. Those reports were later confirmed by the sinking of the merchant ship *Tulango* after a mine explosion 37 miles NW of Buenaventura. The Colombian Army has also suffered a series of devastating blows that practically left the CFLC in control of Colombia south of the 4th parallel. In addition, the CFLC has systematically destroyed most of the transportation infrastructure west of the *Cordillera.* The few usable roads are under heavy guerrilla guard and practically unsuitable for the transportation of heavy equipment.

The United Nations Security Council has held several meetings over the instability in the region. The US has sought a resolution (NSCR) calling for a UN peacekeeping force to restore the failed government, eliminate the CFLC and other cartels, and deal a blow to the drug trade by supporting stability and security to the region. However, Russia, as Venezuela's ally, has vetoed these efforts citing "US imperialists are seeking to restore their former oppressed provinces". Russia claims Venezuela is capable of leading a "Latin Partnership" capable of restoring security to the region, despite Venezuela's part in supplying the cartels.

4.2.3. Action

Citing the Monroe Doctrine, the US intends to unilaterally insert a force capable of securing the country, destroy the drug cartels, resist possible Venezuelan influence, and ultimately restore a democratic government.

Elements of the 7th Special Forces Group will utilize El Dorado International Airport as an APOD to quickly enter the capital city of Bogota to reestablish a Colombian security force, conduct counter insurgency operations, and secure the city to enable an interim government to be established.

Conventional forces to be inserted include the 2nd MEB embarked on the Iwo Jima Expeditionary Strike Force, the 10th Mountain Division, and the 1st Cavalry Division. The MEB will be inserted utilizing ARG connectors near the city of Covenas. The geographic proximity to Venezuela will provide a deterrent from that country sending troops into Colombia.

Meanwhile, the Army units will primarily be transported ashore via T-Craft, near the town of Tumaco on the southern coast in order to take advantage of the highway network that originates in the area. Forces shall be staged at a sea base fifty miles offshore. Initial objectives are known or suspected cartel operation areas. Troops will drive inland to meet up with Ecuadorian troops acting as advisors and translators to US forces. Utilizing these advisors to gain information on cartel operations, US troops shall continue to determine cartel operation areas, secure them, and restore local law enforcement.

4.3. Regional Conflict

4.3.1. Background

The Kalimantan Republic became an independent nation in October 2002, when General Gegwan Riady proclaimed that the four Indonesian provinces on Borneo were seceding from Indonesia to create a new republic. The secession was justified by claims that the Jakarta government was inadequately providing for the economic well being of the Kalimantan people. Riady claimed specifically the central government's failure to invest in Kalimantan infrastructure, as opposed to the vast wealth exported from the southern island's reported vast petroleum stores. The Jakarta government, unable to counter Riady's move, begrudgingly acceded to Kalimantan's declaration of independence. After the accession, the Kalimantan Republic was generally accepted internationally, including by the United States.

However, in the recent years the Kalimantan Republic has suffered a reversal in its economic fortunes since the collapse of the world petroleum market. Economic worries deepened when improved survey techniques discovered that previous estimates of Kalimantan's offshore energy reserves had been grossly overestimated. Now seriously overextended, the Riady government suspended most of its "New Kalimantan" initiatives, including a number of tourism and infrastructure-related construction and development projects. Suspension of these projects has lead to 40% unemployment. This unemployment and intermittent civil disturbances, including food-line riots and dramatically increased level of crime, has hit the larger cities of Kalimantan.

Riady sought financial aid from Malaysia and Brunei. But, with Kalimantan's dept now totaling nearly $12 billion, neither of its Borneo neighbors was willing to extend either outright grants or unsecured loans to the struggling nation. This denial led to public denouncements by Riady, citing the "affluent" north had turned its back on their "brothers to the south". Riady swore to correct the "blatant and discriminatory economic inequality" that exists between the north and south. Over the course of a few months, "One Borneo, One Nation" became not just a diplomatic theme; it also became the central focus of the Kalimantan (KA) military planning.

4.3.2. Scenario

Hostilities commenced shortly after a public statement by Riady, stating that Malaysia had been using off shore oil terminals to steal petroleum from Kalimantan fields. He stated that Kalimantan would not sit idly by as the discriminatory north steals the very resources that it refused to help develop. He made a call on the "Iban", a Malaysian separatist movement, to help Kalimantan in the coming fight for economic equality. Immediately after the public address, two Kalimantan army divisions began using air and amphibious forces to gain footholds in Malaysia. The 1st Kalimantan Division (KD) landed near Kuching and began driving west through Malaysian territory. The 3rd KD moved into Sandakan on the east coast of Malaysia, and began driving west towards Brunei. Reportedly, KA naval forces laid sea mines in the Trusan Strait, effectively blocking Malaysian and Brunei naval forces.

It is believed that KA forces are taking an operational pause to restructure their positions before advancing inland. Two divisions remain in the south near the Kalimantan capital of Banjarmasin. While one is expected to remain near the capital, naval movements suggest the other may be used to reinforce units in place before the main force advances. Malaysian and Brunei forces, outnumbered by the well equipped KA divisions, were forced to fall back to defensive positions. Two Malaysian brigades are emplaced near Bitulu along the 1st KD's expected line of advance. Two additional Malaysian brigades are near the city of Kota Kinabalu, blocking the 3rd KD drive towards Brunei. Two battalions of Brunei troops are located in the capital city of Bandar Seri Begawan.

Malaysia is requesting US assistance in preventing further loss of territory until it can mobilize troops to remove KA forces occupied in the region. The mobilization and movement of Malaysian troops is expected to take up to 120 days.

4.3.3. Action

The US will reinforce Malaysian units in order to deter further KA expedition and to support blue forces should deterrence fail. The 10th Mountain Division will support forces near Kota Kinabalu, while the 3rd MEB will support forces near Bintulu. The threat of sea mines will prevent the use of the major SPODs until MCM assets can clear the restricted waterways. As such, forces will arrive via T-Craft to beach heads near friendly forces. The sea base will consist of two MPF(F) squadrons, colocated to reduce naval security presence. The MPF(F) ships will stage the US divisions and provide sustainment for them and allied Malaysian and Brunei forces.

4.4. UN Security and Stability

4.4.1. Background

Nigeria, an Organization of Petroleum Exporting Countries (OPEC) member, is important to world energy markets because it is one of the world's largest oil exporters. The Nigerian economy is largely dependent on its oil sector, which accounts for nearly 50% of Nigeria's gross domestic product (GDP) and 95% of the country's foreign exchange earnings. The country is a major oil supplier to the United States and Western Europe. Nigeria is today's fifth largest supplier of oil to the United States. (SOURCE: U.S. Energy Information Agency).

Nigeria has been experiencing civil unrest, violence and strikes for several months. These problems stem from bitter competition among the country's estimated 250 ethnic groups, and religious strife between Muslims and Christians. The two largest ethnic groups, each comprised of tens of millions of Nigerians, are the Hausa in the north and the Yoruba in the south. In the past 30 years, Nigeria has careened between five military dictatorships and two democratically elected leaders. Nigeria's President Obasanjo is a Yoruban and former military commander. He is the second democratically elected president to serve as such in the past 30 years. The Hausa, however, controlled the former military government and dominate Nigeria's military today.

Obasanjo's election has not calmed ethnic unrest. Locations of the latest outbreaks of violence include the Lagos area, southwestern Nigeria, the oil producing states in the southeast, and Kaduna. There has been an increase in the number of unauthorized vehicle checkpoints, operated by armed bands of police, soldiers, or bandits posing as or operating with po1ice or soldiers. Many incidents, including murder, illustrate the increasing risks of road travel in Nigeria. Reports of threats against firms and foreigners associated with the petroleum sector have been growing.

This violence and unrest has hindered Nigerian oil production. Disturbances, including sabotage, occupation of oil facilities, hostage-taking and kidnapping, have occurred in many areas of the oil-producing Niger River Delta. Production disruptions have intensified recently.

The U.S. Department of State lists 10,000 U.S. citizens living in Nigeria. Americans have not been specifically targeted in the disturbances. Nonetheless, they and their vehicles may inadvertently become caught up in a disturbance.

Finally, Chevron said that saboteurs had deliberately spilled an estimated 2,000 barrels of oil from its pipeline in southern Nigeria. So far this year more than 50,000 barrels of oil have been spilled in 40 separate sabotage incidents.

4.4.2. Scenario

The Hausa-led military reversed last year's decision to hand over the government to a Yoruban civilian president. They took action, sweeping south from the Kaduna-Abuja region, while Obasanjo was on a state visit to Washington. The Army's chief, General Mtubi, has demanded Obasanjo's resignation and a return to military rule, while his staff has initiated negotiations with oil exporters on a "revised" payment schedule. The U.S. Department of State has refused to recognize the Mtubi regime.

The military remains split between units loyal to the Yoruban government and the Mtubi regime. Major battles have not broken out, but Mtubi units control the north and have indicated intent on taking first, Abuja, Nigeria's capital, before marching south to take control of the oil producing regions.

Obasanjo, on CNN, appeals for direct U.S. military assistance. He cites the familiar phrase "ethnic cleansing" in referring to an as yet unconfirmed report of hundreds of Yoruban massacred by rampaging Hausas on their maneuver southward.

4.4.3. Action

The US, leading a multinational peacekeeping force as authorized by the United Nations, will land the 22nd MEU and 2nd Stryker Brigade Combat Team with the goal of securing the Nigerian capital, protecting civilian populations, preventing further insurgency southward, and holding the Mtubi loyalist units in the north until a permanent peace can be restored. The US is responsible for supplying its units as well has supporting the other nation units, totaling about a division equivalent.

Due to the limited use of airports and the poor state of internal roadways, combined with the expedient nature of the operation, the US will land forces and supplies utilizing the navigable Niger River. T-Craft will land all forces and 30 days of supplies to a position as close to Abuja as the river allows. A location 20 miles to the north of Lokoja has been identified as the logistics release point (LRP) due to its relative security and proximity to the major A-2 highway. Troops, equipment, and supplies will then be transferred via the highway to Camp Leo. Camp Leo is the UN forces

forward operating base, located near the capital. Because the location is far inland, a refueling position will be established at the city of Onitsha. The refueling position will refuel T-Craft during ingress and egress of the river.
A sea base consisting of one MLP, one LMSR, and one MPF ship will be established approximately 25 nm from the entrance to the Niger River. The relative security of the littorals allows for the sea base to be located close to shore and with limited naval protection.

4.5. Humanitarian Aid / Disaster Relief

4.5.1. Background

In December 2004, a 9-magnitude earthquake struck deep under the Indian Ocean off the west coast of Sumatra, triggering massive tsunamis that wiped-out villages and resorts in six countries across the southern and southeast Asia coastlines.[3] The destruction wrought by the tsunami was particularly severe in the Aceh Province of Indonesia, at the northwestern tip of the island of Sumatra. There entire villages were destroyed within minutes as waves of thirty feet or more advanced far inland, while destruction of the main coastal highway made the entire region virtually inaccessible to Indonesian authorities ashore. While reports of the destruction were slow in coming, by February estimates stated that 114,573 people had been killed, 127,749 were missing, and over 400,000 had been displaced.

Almost immediately, US Pacific Command Navy and MSC ships were dispatched to aid in the multinational humanitarian assistance and disaster relief (HADR) operation. Fleet assets included the *Abraham Lincoln* CSG, the *Bonhomme Richard* and *Essex* ESGs, Maritime Prepositioning Ships Squadron THREE and various MSC ships, *USNS Mercy*, and numerous fixed and rotary wing aircraft.

4.5.2. Scenario

Naval forces utilizing a sea-based logistics train are uniquely suited for providing relief to the tsunami stricken region of Aceh on the northern coast of Sumatra. Due to political and cultural concerns by the Jakarta government, US troops are not to remain ashore overnight. Even with this restriction, there is widespread concern over the use of foreign troops in providing aid. The US must coordinate a joint and combined logistics force to provide relief to remote areas with heavily damaged infrastructure and assist in recovery operations. Again, due to political concerns, US involvement in the operation must conclude by March 2005.

4.5.3. Action

Historical analysis states that between the arrival of the first US ships on 01 January 2005 to the disestablishment of Combined Support Force 536 on 12 February 2005, over 9.5 million pounds (4,750 tons) of aid was delivered, over half of which was delivered via 1,800 helicopter sorties. In this scenario, the T-Craft will be used as a mobile distribution hub. Due to the limited crew, intermodal support, and organic capability of the craft, an augmented HADR "mission package" has been included with each sortie. This mission package is similar to the concept employed by the Littoral Combat Ship. This package consists of a second crew and aid workers; berthing, sanitation, and personnel transport modules; equipment to offload stores such as fork trucks and pallet jacks; and trucks with trailored small boats to be used for distribution to sites away from the landing area. The T-Craft will move vast amounts of aid to the primary refugee camp locations, move relief and medical teams, and establish temporary helicoptor pick-up sites. These sites will reduce round-trip helicopter flights by up to 60 miles, greatly reducing the number of helicopter sorties required; thereby reducing flight hours, alleviate crew and maintenance team fatigue, and increase the rate of flow of aid to the shore.

The sea base will consist of ships already in the area. T-Craft connections will include the ESG ships *Essex* and *Bonhomme Richard* and the MPSRON ships *Lummus*, *Hauge*, *Anderson*, *Bonnyman*, and *Martin* for a total of eight potential T-Craft spots.

5. METHOD OF ANALYSIS

To analyze the potential for "game changing" capability, a series of analysis tools will be used. These tools include a capacity optimization using discrete modeling, a trade off study analyzing capacity, cargo capacity, speed, and maximum range using discrete modeling and spreadsheet analysis, and qualitative analyses on human factors and environmental/geographic operating environments.

5.1. Craft Capacity Optimization

It is assumed that different levels of conflict, as outlined by the Range of Military Operations, will require different numbers of T-Craft, or capacity. To determine the proper number of T-Craft per each scenario, the authors will use discrete simulation (ExtendSim by Imagine That!™,) to vary the distance from shore to sea base, the cargo capacity of each craft, and the number of sea and shore spots. To gauge efficiency, the model will report the utilization of the sea and shore spots and the amount of time incurred in queues waiting to be serviced at sea or ashore. The goal will be to maximize spot utilization while minimize queue waiting time. This analysis will suggest a feasible number of craft to be used in each scenario and will help provide a starting point to force structure and fleet CONOPS for T-Craft operation.

5.2. Tradeoff Study

Using the capacity numbers from the optimization explained above and other variables determined in each

threat scenario, a tradeoff study will be conducted by varying the cargo capacity and operating speed of each craft. This tradeoff will add quantitative data to the design and operating parameters of the craft. The resulting analysis will help determine effective mixes of cargo capacity, speed, and sea base range for each scenario.

Although costs associated with each variable are not addressed in this study, the performance marks associated with each variable will give design teams and decision-makers insight into the potential benefits of pairing certain parameters when viewed together as a system alternative.

5.3. Human Factors

Separate from the above analysis, the authors will use qualitative analysis to address the BAA requirements of 1) No habitability/living spaces required, 2) no organic capabilities to handle pallets, quad-cons, or 20ft containers, and 3) Crew size of 3 (threshold), 2 (objective).

Although these requirements will not be modeled as above, the authors will use their operational experience and the insight of other subject matter experts to address the effects these requirements may have on operational employment from a human systems integration paradigm.

5.4. Environmental Factors

As with the human factors assessment, the authors will use a separate analysis of meteorological and surf-zone geography to assess the BAA requirements of 1) Beach slope climbing of .5% (threshold), 2% (objective) and 2) operate at speeds of 40 knots in Sea State 4.

While the goal should be to maximize the number of beaches the T-Craft can use for landing, the 2% objective slope is significantly less than the current 5% slope attainable by the US Navy's Landing Craft Air Cushion (LCAC). The authors will use geographic data to determine the percentage of beaches world-wide approachable by T-Craft.

Similarly, the authors will use meteorological data to determine the game changing significance of being able to operate at sea state 4 when considering scenario-geography weather statistics and the constraints weather plays on other assets in the sea base.

6. ASSUMPTIONS AND LIMITATIONS

The limited scope and nature of this study demand that certain simplifications be adopted in order to complete the project on time and within given resources. To that extent, the following assumptions and limitations are noted.

6.1. Assumptions

The T-Craft is operating as both an expeditionary connector and logistics connector. As such, with the assumed limited force protection capabilities of the craft, it is assumed that a Sea Shield is in place and capable of protecting the craft throughout its operation.

The ability to dock to a sea base is a critical technology requirement that is challenging design teams working on the T-Craft and the sea base concept. Although not a proven capability, it is assumed that the craft is capable of docking at a sea spot and transferring the required cargo load. Similarly, it is assumed that the time to dock at a sea spot is similar to the time required to dock a current connector (LCAC, LCU, etc) in the well deck of amphibious class ship (LHA, LPD, LSD, etc).

For modeling purposes, the required cargo throughput is simulated using standard training serial loads, as found in SEAOPS Volume IV.[4] Detailed planning is conducted by trained and experience cargo officers prior to moving the vast amounts of vehicles, cargo, and personnel. In order to simplify this process and to have a basis for cargo load times, the training serials are meant to reflect the types of serials that could be move by T-Craft, and estimate the throughput times associated with the different loads. Onload and offload times are a function of LCAC load times, multiplied by a factor of 4, 6, 8, or 10, and divided by two to allow for the parallel loading of equipment. This methodology has been reviewed by Loadmaster Instructors at Naval Beach Group ONE and has been deemed feasible for this study.

6.2. Limitations

The scenarios were developed to flex the game changing nature of the craft, and as such make use of T-Craft has the sole or nearly sole logistics connector. As such, there are added threats that prevent the use of current connectors and docking of the sea base ships to sea ports of departure (SPOD). It is acknowledged that a mixed force structure is best to reflect a realistic operation, but the insight gained in this study will enable future work including mixed force structure utilization.

Other simulation methods, such as agent based modeling software like ARENA or Naval Simulation System could better capture the interactions inherent in a complex expeditionary logistics structure. However, the simple analysis tools used in this study were purposely used to demonstrate how these tools can be used to address high level issues relevant to military operations.

7. ON-GOING WORK

Using the framework detailed in this report, the authors will complete the analysis before the project ends in July 2009. The authors will issue a final report detailing the findings of the project, and propose follow-on studies that will assist ONR, design teams, and decision-makers as the T-Craft project approaches Phase III determination in 2010.

REFERENCES

[1] Office of Naval Research, "Broad Agency Announcement #05-020." August, 2005.

[2] Commander, Joints Chiefs of Staff. Joint Publication 3-07 *Joint Doctrine for Military Operations Other Than War.* 16 Jun. 1995.

[3] Elleman, Bruce. "Waves of Hope: The US Navy's Response to the Tsunami in Northern Indonesia." Naval War College Paper 28, February, 2007.

[4] Commander, Naval Sea Sytems Command. "Safe Engineering and Operations (SEAOPS) Manual for Landing Craft, Air Cushion, Volume IV." October, 2008.

BIOGRAPHIES

Bobby J. Rowden is a Lieutenant in the US Navy and graduated from Naval Postgraduate School in December 2008 with a MS in Systems Engineering and Analysis.
He is reporting to the Defense Language Institute in July 2009 and Department Head School in Newport, RI in July 2010.

Michael J. Hellard is a Lieutenant in the US Navy and graduated from Naval Postgraduate School in December 2008 with a MS in Systems Engineering and Analysis.
He is reporting to the Defense Language Institute in July 2009 and Department Head School in Newport, RI in July 2010.

Eugene P. Paulo, Ph.D., is an Associate Professor of Systems Engineering at the Naval Postgraduate School. His research interests include modeling and analysis of combat systems, systems engineering, and system simulation.