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ENABLING LARGE-SCALE CONTEXT IN LOW-ECHELON TRAINING WITH AIR TASKING ORDER GENERATION

by

Johanna A. Tam

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Thesis Advisor: Imre L. Balogh
Co-Advisor: Christian R. Fitzpatrick

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In training, context from exercise documents enhances realism. Documents created in real-world operations must be manufactured for training exercises, a time-consuming, labor-intensive process, producing documents not usable by Marine Corps simulations. The Marine Corps is producing the Live, Virtual, Constructive-Training Environment (LVC-TE), allowing separated units to integrate with simulated exercises. LVC-TE includes exercise design tools; however, none addresses exercise document production. This thesis focuses on the production of Air Tasking Orders (ATO) for command and control (C2) exercises conducted by the Direct Air Support Center (DASC) using the FLAMES Automated Simulation Trainer (FAST). Real-world ATOs are inaccessible by DASC units for exercises, meaning ATOs must be pulled from archives or created by hand. Archived ATOs include outdated aircraft and munitions, while hand-typed ATOs are extremely error prone. FAST offers an option to upload an ATO with the intent that the system will populate an aviation scenario if the file is correct. This thesis shows that a tool can be designed and implemented to facilitate creation of ATO files for any air C2 exercise that can be correctly ingested by FAST for expedited scenario production. Through this proof of concept, a preliminary investigation was conducted into scaling this capability to simplify exercise document creation for all warfighting functions and integration with LVC-TE's suite of exercise design tools.

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ENABLING LARGE-SCALE CONTEXT IN LOW-ECHELON TRAINING WITH AIR TASKING ORDER GENERATION

Johanna A. Tam
Captain, United States Marine Corps
BA, University of Southern California, 2015

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Approved by: Imre L. Balogh
Advisor

Christian R. Fitzpatrick
Co-Advisor

Gurminder Singh
Chair, Department of Computer Science

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In training, context from exercise documents enhances realism. Documents created in real-world operations must be manufactured for training exercises, a time-consuming, labor-intensive process, producing documents not usable by Marine Corps simulations. The Marine Corps is producing the Live, Virtual, Constructive-Training Environment (LVC-TE), allowing separated units to integrate with simulated exercises. LVC-TE includes exercise design tools; however, none addresses exercise document production. This thesis focuses on the production of Air Tasking Orders (ATO) for command and control (C2) exercises conducted by the Direct Air Support Center (DASC) using the FLAMES Automated Simulation Trainer (FAST). Real-world ATOs are inaccessible by DASC units for exercises, meaning ATOs must be pulled from archives or created by hand. Archived ATOs include outdated aircraft and munitions, while hand-typed ATOs are extremely error prone. FAST offers an option to upload an ATO with the intent that the system will populate an aviation scenario if the file is correct. This thesis shows that a tool can be designed and implemented to facilitate creation of ATO files for any air C2 exercise that can be correctly ingested by FAST for expedited scenario production. Through this proof of concept, a preliminary investigation was conducted into scaling this capability to simplify exercise document creation for all warfighting functions and integration with LVC-TE's suite of exercise design tools.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACM	airspace coordinating measure
ACO	Airspace Control Order
ATO	Air Tasking Order
C2	command and control
CAC2S	Common Aviation Command and Control System
DASC	Direct Air Support Center
DOD	Department of Defense
FAST	FLAMES Automated Simulation Trainer
FLAMES	Flexible Analysis, Modeling, and Exercise System
LVC	live, virtual, constructive
LVC-TE	Live Virtual Constructive Training Environment
MACCS	Marine Air Command and Control System
MAGTF	Marine Air-Ground Task Force
MTWS	MAGTF Tactical Warfighting Simulation
SPINS	special instructions
T&R	Training and Readiness
TBMCS	Theater Battle Management Core System
UI	user interface
USMC	United States Marine Corps
USMTF	United States Message Text Formatting

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I. INTRODUCTION

Title 10 of the U.S. Code proclaims that the "Marine Corps shall be organized, trained, and equipped to provide fleet marine forces of combined arms, together with supporting air components," a purpose and a mission that requires the institution to be adaptable, responsive, and capable of integration both internally and with external services (United States Code, 2012 Edition, Supplement 2, Title 10 – Armed Forces, 2015). This readiness is supported by hard, realistic training, including training exercises that replicate or simulate events, processes, and procedures that will occur in real-world operations. Realism, gravity, and significance are achieved by creating and implementing context to the training exercise. For Marine Corps exercises, from fire team drills up to Marine expeditionary force (MEF) planning exercises, much of that necessary context comes from the fabrication of supporting documents. These documents are usually created and amended in the normal cycle of planning and execution in real-world operations but must be manufactured and maintained by exercise planning cells for training exercises. Often this results in a small team of three to five individuals tasked with producing documents spanning the spectrum of warfighting functions in the Marine Air-Ground Task Force (MAGTF), a process that is time-consuming and labor-intensive. A cycle that operationally employs hundreds of Marines across multiple units and staffs gets funneled into a single-digit exercise planning cell, not only taking inordinate amounts of preparation time, but also opening doors to error and sloppiness.

The Marine Corps is currently pursuing production and fielding of the Live, Virtual Constructive Training Environment (LVC-TE), which should allow units across the Corps and across the world to participate in integrated simulated exercises, enabling better repetition of complex scenarios. Specific examples include the simulated kill chain; creating a simulated environment where forward observers, artillery, aircraft, terminal attack controllers, airspace managers, and infantry units can all participate, in real time, in the locating, closing with, and destroying of enemy targets. According to Marine Corps Systems Command (SYSCOM), LVC-TE will be a system of systems (SoS) that "connect [s] legacy Marine Corps training systems to support training exercises" and will include exercise design tools, however none of the advertised tools seem to involve any streamlined, expedited or automated options for exercise document production (Bryant, 2022).

One such document that is utilized in training across warfighting functions is the Air Tasking Order (ATO). Operationally, the ATO "articulates the tasking for joint air operations for a specific execution timeframe, normally 24 hours" (Joint Chiefs of Staff [JCS], 2021). While specific definitions, procedures, and uses of the ATO will be discussed in later sections of this thesis, it is important to note that for any exercise involving aviation operations, airspace planning, fires deconfliction, and targeting, among other warfighting functions, the ATO provides context enhancing the realism and significance of the operations executed in the exercise. ATOs are the products of a 96-hour cycle currently run by Air Force Air Operations Centers (AOCs) using the Theater Battle Management Core System (TBMCS). Often, TBMCS is inaccessible for small unit or even staff level training, requiring that ATOs be created by hand or that archived documents be reused, clearly highlighting the issues facing exercise designers who must now dedicate large amounts of manhours to create and format yet another exercise document.

The ATO, and accompanying Airspace Control Order (ACO), also play a role in the creation of constructive aviation simulations. Simulation systems exist that can ingest these files and automatically populate constructive aviation scenarios. However, these systems require that the ingested files be formatted properly, with any deviation or error rendering the file useless and requiring the user to build the scenario by hand—a process that can take hours or days depending on the scale of the scenario.

This thesis intends to show that tools can be designed and implemented that will solve both problems: exercise document production, and constructive aviation simulation creation. Through the creation of an application that allows the user to create properly formatted ATOs easily and quickly and ACOs, this thesis will demonstrate that exercise design can be streamlined and made easier to promote better preparation, execution, and repetition of training.

A. PROBLEM STATEMENT

Marine Corps Doctrinal Publication 1 Warfighting states, “the purpose of all training is to develop forces that can win in combat” (United States Marine Corps [USMC], 1997). Training must enable troops to be confident, competent, and adaptable; these outcomes are achieved in the repetition of realistic training. Creating and executing realistic training at any level requires realistic context. No real-world operation exists in a vacuum. Realistic context is created using simulated operational documents, i.e., operations orders, ATOs, ACOs, Communications-Electronics Operations Instructions. However, fielding enough of these documents for multiple iterations of exercises and rehearsals is time-consuming, labor-intensive, and extremely error-prone. The resulting situation is one where exercise planning cells reuse and recycle exercise scenarios and documents to alleviate the workload of creating new products. This creates training that is repetitive and predictable and does not challenge Marines who have previously experienced, attended, or been involved with it.

This problem is exacerbated in training of command and control (C2) agencies. C2 agencies, especially the Direct Air Support Center (DASC), act as hubs of information flow for all participating units and warfighting functions, ensuring maximal situational awareness and efficient responsiveness. As such, C2 agencies utilize and must be familiar with a multitude of operational documents; the ATO is one of the most important as it represents a definitive list of all aircraft and air missions flying or being executed in a given 24-hour period. ATOs are required by many C2 military occupational specialty (MOS) training and readiness (T&R) manuals to meet certain training requirements to produce qualified operators. Especially at the unit-level, the time and labor required to produce these documents makes the execution of multiple, different drills very difficult and reduces the unit’s ability to train to different scenarios, effectively limiting the training that can occur.

Further complications arise from the need to create constructive simulations to aid and augment the training of C2 agencies. Building new and different simulations on systems like the FLAMES Automated Simulation Trainer (FAST) or the MAGTF Tactical Warfighting Simulation (MTWS) is also time-consuming and labor-intensive.

Compounding the time and manpower requirements is the lack of local unit proficiency on these systems. Often there are no Marines at a unit with any knowledge or technical proficiency in computer coding and programming, much less on the specific systems the unit utilizes. These systems have the capability to ingest certain documents and populate entities of a scenario with little to no user input, presenting an ideal solution to the problem. However, for the system to accurately ingest and translate the data from an exercise document into the entities and respective missions of the scenario, the document file must be in the proper format and with the proper file extensions. Given the limitations already discussed in producing exercise documents, specifically the ATO and ACO, it is extremely rare that a unit or Marine could create an ATO or ACO in the proper format with no errors, with the proper file extension. Uploading improperly formatted files results in the user resorting to building the scenario by hand, ergo negating the ingestion capability altogether.

B. RESEARCH QUESTIONS

This thesis will attempt to answer the following research questions:

- Can an application or software be developed to reliably create ATO files in a format that can be correctly ingested into FAST or other USMC constructive simulation systems?
- How can exercise document creation be scaled to provide large-scale, realistic context to exercises at any echelon in any warfighting function?

C. SCOPE

Although the problem of streamlined and potentially automated exercise document production is not limited to C2 documents, this thesis will be limited in scope to focus on the production and formatting of the ATO and ACO. These are documents operationally created using TBMCS with the maintaining of air battle staffs to support the process. The ATO and ACO formatting is governed by MIL-STD-6040B, which specifies the rules for USMTF (United States Message Text Formatting) messages. This research will maintain this limited scope because USMTF is both human and computer readable and inputs for documents that utilize USMTF will be easier to standardize. The hope is that this thesis provides a proof of concept that document production can be facilitated with the creation of data formatting tools that apply to all warfighting functions and all types of exercise documents beyond those produced in accordance with USMTF.

D. THESIS STRUCTURE

- Chapter I provides the introduction to the thesis including a discussion of the Problem Statement. The Problem Statement presents the twofold problem of facilitating exercise design and document production and the creation of constructive simulations. Chapter I also identifies the Research Questions, Scope, Thesis Structure, and Thesis Benefit.
- Chapter II provides Background and a Literature Review covering simulation in the Marine Corps, LVC-TE, the ATO, and the DASC, in conjunction with the scoping of this thesis.
- Chapter III discusses the Prototype System Design and Development including the overall vision and practical framework and architecture development.
- Chapter IV documents the Testing and Evaluation of the system over three testing areas: Document Production, Ingestion by FAST, and Ingestion by MTWS. A testing and evaluation summary follows.
- Chapter V explores the feasibility of scaling the system to encompass production of other operational documents and to accommodate other warfighting functions outside of air C2.
- Chapter VI discusses this thesis's conclusions, contributions, and highlights opportunities for future work, including integration of the developed system into LVC-TE.

E. THESIS BENEFIT

At the smallest scale, if successful, this thesis will provide Marine air C2 units with a tool to create exercise ATOs and ACOs reliably and easily that will be doctrinally accurate and will be ingestible by FAST and other simulation systems to create constructive simulation scenarios. At this small scale, this tool will alleviate the time and manpower required to produce ATOs and ACOs as well as the time required to create constructive simulations. This tool will enable these units to expand the creativity with which they can create exercise scenarios through the ability to produce ATOs and ACOs. There will be no need for recycled archived documents that could be inaccurate, incorrect, and outdated. Training can evolve as operationally required, and Marines can focus on becoming tactically proficient rather than arduously producing or procuring exercise documents.

On a larger scale, this thesis's success would demonstrate proof of concept that exercise document production can be expedited and streamlined through the applied use of data formatting. The time and labor required to create exercise documents across warfighting functions and at all echelons of training would be decreased dramatically, enabling all Marines to focus on the training and not the preparation of the training.

II. BACKGROUND AND LITERATURE REVIEW

Surprisingly, there is a gap in academic literature addressing ATO production, exercise document production, and facilitating constructive simulation scenario creation. In the research for this project, a Naval Postgraduate School thesis was found that offered an ATO optimization model; while promising, this research was outdated and not applicable. It is discussed further in Section B, Subsection 3. Due to the lack of academic literature surrounding the issues identified and solutions proposed in this thesis, this chapter will consist mostly of background on simulation efforts in the Marine Corps, the ATO and air tasking processes, and relevant constructive simulations. It is the hope that this research will act as the impetus for future work and research in the domain of exercise document production, especially as it pertains to automated generation of constructive scenarios.

A. SIMULATION IN THE MARINE CORPS

As a warfighting organization, the Marine Corps trains to maintain a high level of readiness for any mission that may be required by the nation and the Department of Defense (DOD). Combat effectiveness, regardless of mission type or scale, is achieved through the application of hard, realistic training. For the purpose of this thesis, realistic training refers to live training occurring in physical training areas using operational vehicles, aircraft, ships, and/or weapon and sensor systems. Unfortunately, realistic training comes with increased risk of injury or death. Between 2006 and 2021, 32% of active-duty military deaths were attributed to accidents, more than any other category (Fischer & Kaileh, 2006). For comparison, only 24% of those deaths were attributed to Overseas Contingency Operations, many of which were in Iraq and Afghanistan. Mishaps are more likely during realistic training as well; the Naval Safety Center reported a rise in naval aviation mishaps in FY21 and over 500 afloat mishaps between FY19-21 (Naval Safety Command, 2021). In addition to loss of life and injury, training accidents and mishaps are incredibly costly, especially in the case of an aviation mishap that results in the loss of one or more aircraft. Any capability that can provide hard, realistic training while mitigating or eliminating the risks posed by live training has the potential to save lives in addition to large amounts of taxpayer money.

Live training is also extremely expensive. In a cost analysis conducted by Marine Air Support Squadron 3 (MASS-3) in 2019, the dollar value and manhours of conducting a Unit Level Training (ULT) exercise were compared to those associated with deploying a detachment to an Integrated Training Exercise (ITX). ULT 1–19 was a four-day, backyard DASC exercise involving simulated air tracks on the unit's organic C2 system. ITX 3–19, now combined with MAGTF Warfighting Exercise to make up Service Level Training Exercise, was a five-week exercise requiring a detachment of two DASC crews and supporting personnel to travel with operational gear and vehicles to Marine Air Ground Combat Center Twentynine Palms. In 2019, ITX was held five times per year, with MASS-3 participating in three iterations. There were no travel, fuel, or other Temporary Additional Duty (TAD) costs associated with ULT 1–19, as the training took place at the unit's home station. In contrast, the total dollar value of ITX 3–19 for MASS-3 was $6416.49, with $3282.51 in Bill of Materials expenses, $535.00 in unleaded fuel costs, $598.98 in Temporary Additional Duty costs, and over $2000 in Defense Travel System costs (Marine Air Support Squadron 3 [MASS-3], 2019). Over the thirty-seven days of ITX 3–19, zero officer-level DASC qualifications and only four enlisted-level qualifications were achieved. Despite its short duration, ULT 1–19 yielded four officer-level DASC qualifications and thirteen for enlisted controllers. In addition, the man hours required to plan, prepare, execute, and sustain operations at ITX 3–19 were much higher than those required to execute ULT 1–19. Total man hours for ITX 3–19 were 17,008 whereas total man hours for ULT 1–19 were 1,222 (MASS-3, 2019). Although this analysis only examines a single unit for the duration of a single exercise, the implications are universal for all echelons of training across warfighting functions. Simply put, live training is more fiscally expensive than simulated training.

Simulating aspects of a training exercise not only mitigates the risk of mishaps or accidents but also provides the ability to repeat an exercise multiple times with tweaks or updates with minimal cost. Repeating live training exercise iterations often requires hours of clean up, set up, resetting, and maintenance, not to mention safety checks, and the financial cost of refueling aircraft and ground vehicles. Like pilots in flight simulators, a scenario can be run over and over, with the same parameters, at little to no cost. Progressively, the Marine Corps has begun integrating simulators and simulations into training evolutions, from virtual convoy simulators to immersive fire support domes, to employing constructive simulations for staff-level training.

1. The Rise of LVC-TE

In the Commandant's Planning Guidance, General David H. Berger highlights the need to capitalize on advancements in modeling and simulation to optimize training in garrison. He emphasizes that the Marine Corps "must make the most of every learning opportunity in garrison before units go to the field" (Berger, 2019). Although he is not the first Commandant to push for advancements in simulated training, it has been under his leadership that the Live Virtual Constructive Training Environment (LVC-TE) is being developed and beginning initial fielding.

LVC-TE, also dubbed Project Tripoli, emerged partially out of the 37th Commandant, General Robert Neller's "vision for simulations [as] a kind of Star Trek-like holodeck in which any Marine could fight any battle on any terrain in virtual reality" (South, 2018). The underlying motivation for LVC-TE was to connect and integrate the disparate units and functions of the MAGTF under one simulated environment, enabling training to occur for each function, while being safer, repeatable, and less costly. Brigadier General Matthew Reid, Deputy Commanding General of Training and Education Command (TECOM) detailed the end goal as enabling "units…to integrate all elements of the MAGTF from geographically disparate locations to improve and sustain the combat readiness of the entire Fleet Marine Force" ("Marine Corps Looks," 2021). Important to note is that LVC-TE is not creating an entire suite of new simulations, simulators, or simulation systems, but rather enabling the connection, interoperability, and integration of the existing legacy Marine Corps simulation systems to create a persistent training environment.

While LVC-TE offers the promise to provide high-quality, realistic training while minimizing cost and risk, the training will still require large-scale context to ensure realism and significance. That context is only created through the adept execution of exercise design and subsequent creation or exercise products. In Large Scale Exercise 14 (LSE-14), 1st Marine Expeditionary Brigade employed over 3700 live Marines and Sailors, supplementing the rest of the MAGTF with virtual and constructive forces. Various simulated trainers and live C4I systems were connected enabling "the MEB and its [major subordinate commands]…to simultaneously track the locations of all participants…and communicated up, down, and laterally" (Mills, 2014). Although this exercise was conducted before the official inception of LVC-TE, it demonstrated the feasibility of the LVC-TE concept and encouraged further development and investment. Despite this early success, there was no effort made to streamline or facilitate the production of the myriad exercise documents and products required to execute such a large exercise. While it is not documented, it is highly likely that hundreds of manhours were spent creating, formatting, and updating products to enhance the contextual realism of the exercise.

2. Exercise Design

LVC-TE originally advertised a "suite of tools, called Exercise Design Tools," meant to aid in the planning and development of exercises and exercise scenarios ("Marine Corps Looks," 2021). However, the specifics were limited to repositories, after-action report tools, and tools for exercise control. There was no mention of any tool that helps facilitate, streamline, or speed up exercise document production. Currently, the LVC-TE team is working with the Joint Staff J7 on developing their Joint Training Tool (JTT) to meet MAGTF-specific requirements, instead of fielding LVC-TE-exclusive exercise design tools. The JTT is a "web-based collection of capabilities…that provides Joint Commands and Services with an automated and consolidated tool for all facets of the Joint Event Life Cycle" (Joint Staff J7, 2023). The JTT allows users to build out an exercise including force laydown, timeline, and mission and tasks. It even includes a Document Library, however, there is no tool for formatting or producing the requisite exercise documents. Despite the interest in creating tools for exercise design and development, there still is a lack of tools for exercise document production and formatting.

B. THE AIR TASKING ORDER

1. What Is the Air Tasking Order?

The ATO is an operational document that can exist at both the joint and Marine Air Ground Task Force (MAGTF) level. It is "a method used to task and disseminate to components, subordinate units, and C2 agencies projected sorties, capabilities, and/or forces to targets and specific missions" (Joint Chiefs of Staff [JCS], 2016). In simpler terms, the ATO functions as a directory listing of all air missions scheduled over a 24-hour period. The ATO makes up a group of operational documents that, together, "provide operational and tactical direction at appropriate levels of detail" (United States Marine Corps [USMC], 2018). Operationally, there are four ATOs that exist simultaneously at any given time; however, they are not all in execution. There is an ATO under assessment from the day prior, one in execution, one in production and one in planning. The air tasking cycle, discussed below, covers 96 hours of operational time. As the ATO encompasses all air missions of a given day, including those supporting maneuver forces on the ground, complex fires, air to air warfare, aerial reconnaissance, and air to ground strikes, it must be definitive, but also maintain flexibility to "change with the needs of the force as the situation changes" (USMC, 2018). It is a critically important document for the planning and execution of aviation operations at all levels of warfare.

The ATO and its dissemination affect more than simply the aircraft slated to fly missions for that day. C2 agencies of all participating services and echelons must stay abreast of the ATO and any changes or updates that may occur. Ground units that may rely on air support for any aviation function must be aware of the missions flying and those scheduled to be on standby or alert status. The ATO provides one commonly readable document whose format is standard across all components of the DOD, ideally enabling and facilitating broad situational awareness and aiding in seamless C2.

a. U.S. Message Text Format

For standardization and enhanced information exchange, the DOD uses United States Message Text Formatting (USMTF) for many of its operational documents, especially those at the theater level impacting multiple commands from different service components. USMTF is designed to “enhance joint and combined combat effectiveness through standardization of message formats, data elements, and information exchange procedures” (JCS, 2016). This standardized formatting supports “interoperability, supportability, and information sharing” with the goal of making cross-organization cooperation and collaboration easier, faster, and clearer (Joint Chiefs of Staff, 2021). USMTF is also meant to be both human and computer readable; messages can be viewed in a text file format for humans, but also have file extensions (.ATO, .ACO) that can be read by appropriate computer systems and translated for viewing on C2 platforms. Despite this intent, USMTF is difficult to read and understand without proper training, and deciphering documents in this formatting can be tedious and time-consuming. Figure 1 shows a sample ATO as it is produced and disseminated in USMTF.

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UNCLASSIFIED                                    JIEOH 9000
MESSAGE USER FORMATS (4.0)                                                        STATUS: AGREED
IMPL DATE:  31 MARCH 1999                                                         DATE: 17 JUN 1994

                                          AIR TASKING ORDER  (ATO)


MESSAGE EXAMPLE

   EXER/DESERT WIND//
   MSGID/ATO/USCENTCOM/ATO A/OCT/CHG/0//
   AKNLDG/YES//
   TIMEFRAM/FROM:010600ZOCT1998/TO:020559ZOCT1998/ASOF:302100ZSEP1998//
   HEADING/TASKING//
   TSKCNTRY/US//
   SVCTASK/N//
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   6EWDATA
   /EMITTYP   /ELNOT/FC/LOWFRQ     /UPFRQ      /EA-TECQ
   /GCIRDR    /-    /ET/ 365.798GHZ/ 650.477GHZ/INCDRGPO//

REVISION DATE: 07 NOV 1997                                                        ATO-35
UNCLASSIFIED
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Figure 1. Sample Air Tasking Order message. Source: MAWTS-1 (2001).

2. ATO Production in the Operational World

The ATO is produced through the Air Tasking Cycle, which can take place at the joint or service-specific level, depending on the theater and scale of operations. Despite their many similarities, this section will discuss both the joint and MAGTF-specific air tasking cycles. The Joint Air Tasking Cycle is fed by inputs ranging from the Joint Force Mission all the way down to the Joint Air Operations Plan and the Joint Force Air Combatant Commander's (JFACC) Daily Guidance. Figure 2 shows the levels of joint air operations planning and where the ATO and air tasking cycle apply—at the daily operations level.

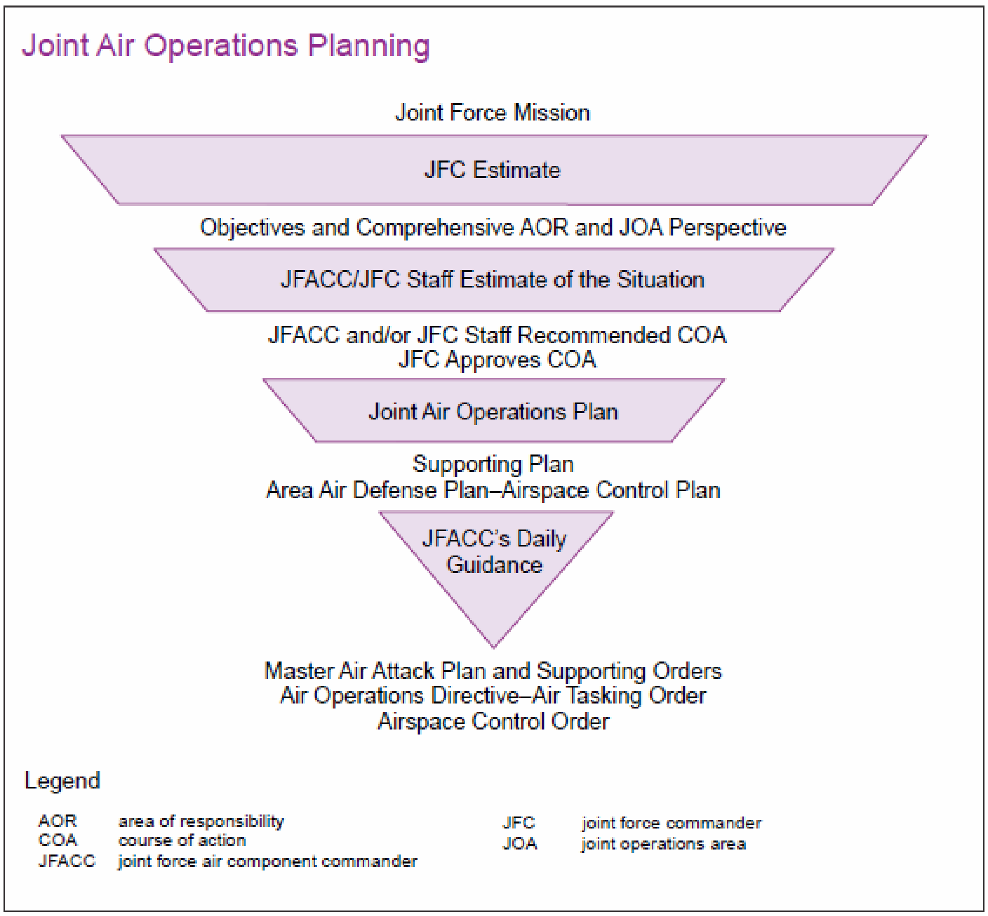

Figure 2. Planning process for Joint Air Operations. Source: (JCS, 2021).

The Joint Air Tasking Cycle consists of six phases as depicted in Figure 3. The first phase, Objectives, Effects, and Guidance is directly influenced by the overall campaign and theater-level planning. The Joint Force Commander's refined concept of operations (CONOPS) and his/her air apportionment decision directly affect this phase. Target Development incorporates all-source intelligence with the air apportionment decision and CONOPS to begin developing prioritized target lists. Phase three, Weaponeering and Allocation, involves the mapping of available assets to prioritized targets with the goal of "quantifying the expected results" of employing these assets (JCS, 2021). Targets are matched with recommended weapon systems, munitions, fusing, and desired effects and incorporated into the Master Air Attack Plan (MAAP), which becomes the basis for the ATO. Also in this phase, air allocation and allotment occur, resulting in the number of sorties required and how those sorties will be allotted to respective units. Phase four is ATO Production and Dissemination, the daily ATO, ACO, and Special Instructions (SPINS) are published and made available to appropriate units and commands. Often, the ACO and SPINS are created for the duration of the campaign or operation and are updated accordingly, and as such, may not be produced and disseminated daily. Phase five is the Execution Planning and Force Execution of the missions and activities laid out in the ATO. Phase six is the Assessment of the execution and is normally performed the day after ATO execution. This assessment feeds into the next round of the cycle, updating the Objectives, Effects, and Guidance.

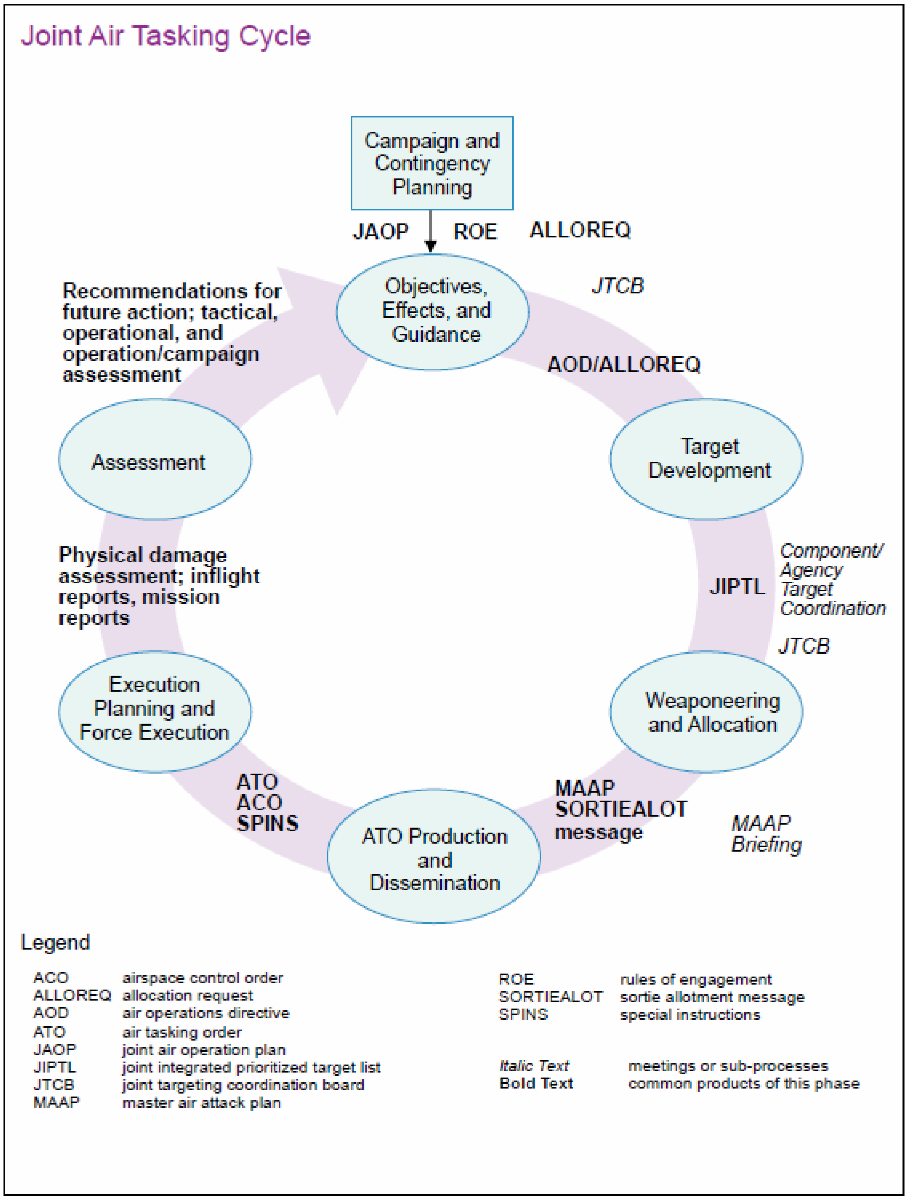

Figure 3. The Six Phases of Joint Air Tasking Cycle. Source: JCS (2021).

The MAGTF air tasking cycle is similar to its joint counterpart, taking place at a smaller scale. The Aviation Combat Element (ACE) commander and his/her staff manage and execute the MAGTF air tasking cycle both if there is no Joint Air Operations Center, and if the MAGTF is nested into a joint force, hence why the MAGTF cycle mirrors its joint sibling. Figure 4 depicts the MAGTF air tasking cycle.

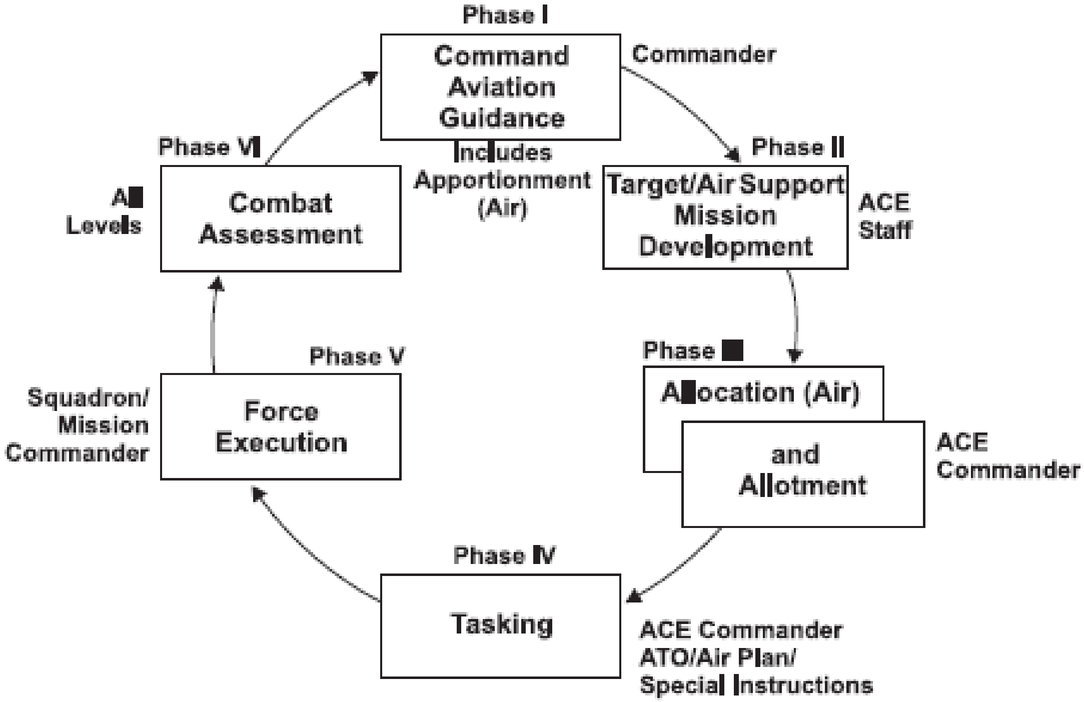

Figure 4. MAGTF air tasking cycle. Source: (USMC, 2018).

An examination of the two air tasking cycles is pertinent to this thesis due to the immense time and manpower loads required to execute one iteration of the air tasking cycle, much less to maintain over a multi-day, week, or month exercise. The full execution of the air tasking cycle, even at the smaller scale of a MAGTF, requires an entire air battle staff to be stood up, complete with intelligence analysts, targeting specialists, current and future operations cells, and operators to produce the ATO. This staff must be supported by communications, utilities, and information technology systems and operators, specifically TBMCS, which is used to produce the ATO. Put simply, it takes a lot of people a lot of time to create the ATO in operational environments, much less for lower echelon exercises for units who may be incapable of standing up a full air battle staff.

a. Theater Battle Management Core System

The Theater Battle Management Core System is an "integrated air [C2] system that performs standardized, secure, automated air battle planning and execution management" for all DOD services as well as many international partners and allies (Collens, Jr. et al., 2005). TBMCS is the primary system used by both the Joint Air Operations Centers and the MAGTF ACE to produce and disseminate the ATO. At the joint level, TBMCS is utilized in the Air Operations Center, Air Support Operations Center, and subordinate Unit-Level Operations Centers, and has the capability to connect to other external C2 systems, such as those used for fires planning and intelligence gathering. At the MAGTF level, TBMCS should exist at the Marine Tactical Air Command Center (TACC), the Tactical Air Operations Center (TAOC), and the DASC. The word "should," is key here as in reality, most units have limited access to TBMCS, and often only have one or two Marines trained in how to operate the system. This has no bearing on a unit's ability to operate in the real world, as TBMCS can interface with Marine Corps operational C2 systems, but this limited access means that creating ATOs and ACOs for exercises becomes that much harder.

3. ATO Production in Exercises Historically

Not all exercises involving aviation planning and execution will involve, require, or be able to support the fielding of an air battle staff, but most aviation exercises require or benefit greatly from the addition of an ATO and ACO. From small unit exercises with multiple iterations and repetitions, to regiment or division-level staff exercises, the ATO is crucial to training air C2 and enhancing situational awareness and increasing the realism of the exercise. The ATO helps create context mimicking the feeling of being nested in a larger operation or campaign, therefore including it in training at any echelon is important for creating more effective, realistic training.

Unfortunately, if the exercise planners and training audience do not have access to or the ability to employ TBMCS and the air tasking cycle, obtaining exercise ATOs becomes difficult. If a unit needs one or more exercise ATOs, they must either create them by hand or find them in archives. Both options are time-consuming and tedious, and neither produces reliable, correctly formatted, and up to date products. Without TBMCS and the operators necessary to use it, a unit must resort to one of these two methods. Given the arduous and meticulous formatting of the USMTF, creating an ATO by hand is extremely time-consuming, much less creating multiples for a multi-day exercise. Archived ATOs are also often incorrectly formatted and still require intensive updating as aircraft and munitions will be outdated. Larger units executing large-scale staff exercises can often spare the manpower to stand up a full air battle staff, but few will opt to do so. Small units trying simply to conduct unit-level training with a high volume of repetition must resort to these tedious and unpleasant ATO acquisition methods.

a. Attempts at a Solution

There are very few tools known or available that can reliably and easily produce ATOs and other USMTF documents, specifically for exercises. The Common Message Processor is an application embedded in the Common Aviation Command and Control System (CAC2S) that can produce USMTF messages, including ATOs. It is a Java-based application that "validates message structure, content, and context" in accordance with the MIL-STD-6040B, which governs the USMTF (JB Management, Inc., n.d.). Despite this application being built with the specific intent of creating and editing USMTF messages, its usability and availability are still limited, making it an unsatisfactory solution to the problem of easy exercise ATO production.

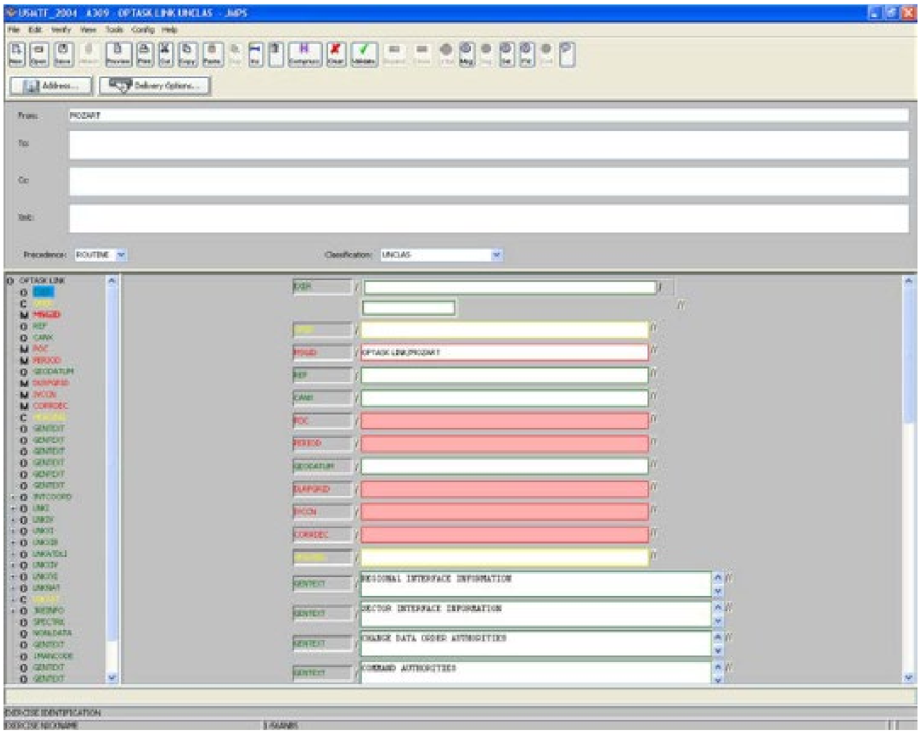

Figure 5. Common Message Processor user interface. Source: Joint Multi-TDL School (2020).

In his 1993 thesis for the Naval Postgraduate School, Lieutenant Matthew Dolan presented a computer based optimization model he claimed would produce a “flyable” ATO in a timely, repeatable manner that would aid in the execution of theater-level wargames. This model was designed to nest with the Enhanced Naval Warfare Gaming System (ENWGS) at the Naval War College and written in the General Algebraic Modeling System (GAMS). Dolan’s model attempted to automate the weapon to target matching process, further saving manhours by covering the Weaponeering and Allocation phase as well as the ATO production and dissemination phases of the air tasking cycle. Upon presentation, the model was scheduled to be implemented into Naval War College wargames and studied for future further use. ENWGS was updated in 1997, and it is unclear if Dolan’s model was carried over. Regardless, his model required a high level of computer coding knowledge and would not be user-friendly to the operators at the small unit level. (Dolan, 1993).

C. AIR TASKING ORDERS AND CONSTRUCTIVE SIMULATIONS

This thesis has thus far defined the ATO, the air tasking cycle, and the difficulties associated with creating and obtaining ATOs for exercises. This thesis will propose a solution to these problems, with the added feature of aiding in the creation of aviation constructive simulation scenarios.

1. FLAMES Automated Simulation Trainer

The Flexible Analysis, Modeling, and Exercise System (FLAMES) is a collection of commercial off-the-shelf (COTS) software products that enable users to build, connect, integrate, and execute live, virtual, and constructive simulations. FLAMES in its full commercial form involves multiple components that allow for full customization of terrain, entities, and mission profiles across all domains of warfare (Ternion Corporation, 2021).

When Marine air C2 units were issued CAC2S, they also received a customized, scaled-down version of FLAMES: FAST. FAST is a constructive simulation platform that allows users to create aviation-centric scenarios ranging from one or two aircraft to large-scale air wing level operations. Being that FAST was embedded in CAC2S, it was intended to be used both in garrison and while deployed, operating seamlessly within the tactical system, enabling the entities created in FAST to populate as simulated radar or datalink tracks on the CAC2S Tactical Display Framework (TDF). This innate connectivity between FAST and CAC2S enables FAST to simulate different forms of information flow methods, as well as to pass information to other simulation systems using standard protocols. FAST can simulate radar tracks from the Marine Corps' organic radar, the TPS-80, datalinks received via the Joint Range Extension Application Protocol (JREAP), messages sent in the Cooperative Engagement Capability (CEC) interface, and messages sent in the Variable Message Format (VMF). FAST is also capable of sending data to other simulation systems via the Distributed Interactive Simulation (DIS) protocol and the High Level Architecture, meaning entities created in FAST can be shared across multiple simulation platforms (Ternion Corporation, 2022).

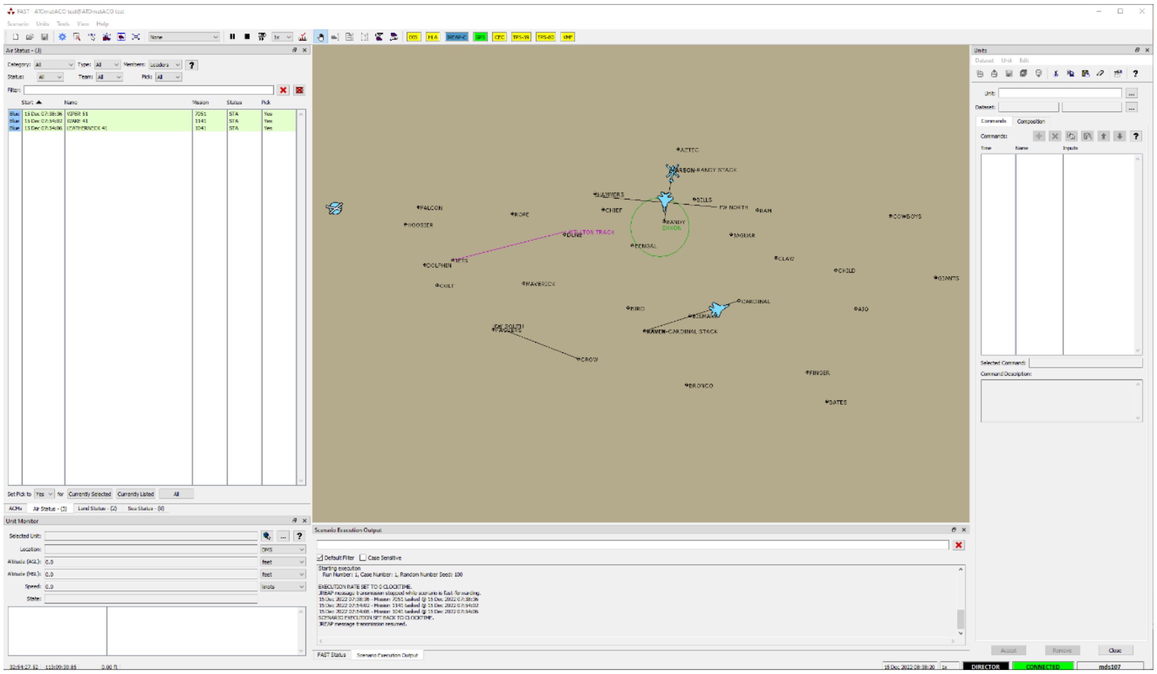

Figure 6. User interface window in FAST. Source: Ternion Corporation (2022).

2. MAGTF Tactical Warfighting Simulation

MTWS replaced the Tactical Warfare Simulation, Evaluation, and Analysis System in 1995 (Blais, 1998). MTWS is a "computer-assisted warfare gaming system" that is designed to support the training of MAGTF commanders and their requisite staff members (Blais, 1994). It is a "constructive, aggregate-level simulation," meaning it displays units at a high level with computer modeling that provides realistic interaction, engagement, sustainment, and operational effects and data (Envision Innovative Solutions, Inc., 2022). MTWS includes data collection and analysis capabilities, allowing the trainers, training audience, and system operators to review the simulation and game events during and after exercise conduct. Like FAST, MTWS can connect and publish to tactical C2 systems, emulating real-world radar and datalink tracks, as well as utilizing the DIS protocol and the HLA to communicate with other simulation systems.

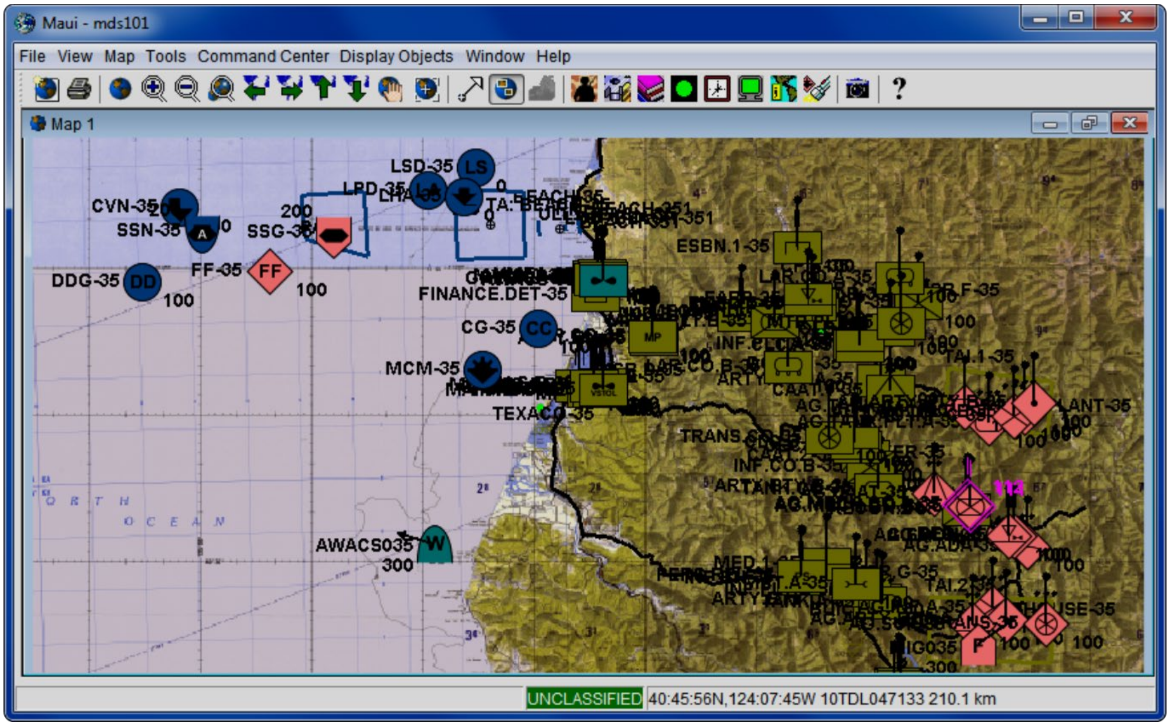

Figure 7. MTWS Maui display. Source: MAGTF Staff Training Program, PowerPoint slides (April 15, 2021).

3. Why Does the ATO Matter?

Although they were created and are implemented at different echelons of command with different training objectives, FAST and MTWS carry many similarities. Key among these is the immense amount of time and system understanding required to create robust, realistic simulations that contribute to the realistic context of a given training exercise. Neither FAST nor MTWS are user friendly to those with little experience on the programs, and MTWS requires a team of contractors to build and execute each scenario. This is where the ATO becomes crucially important. Both FAST and MTWS have the capability to ingest ATOs and ACOs in proper USMTF to auto-populate airspace geometries and air missions. The ability to basically eliminate the work required to build air missions and airspace coordinating measures (ACMs) drastically reduces the time needed to construct these scenarios. However, both systems are very picky regarding how the files are constructed and saved. ATO and ACO files must have the .ATO and .ACO extensions respectively, and they must be in perfect USMTF formatting. Herein lies the issue when units cannot obtain reliably formatted or correct ATOs and ACOs. This crucial capability that has the potential to save hours of time is thwarted by the lower quality of ATOs and ACOs available to units who cannot stand up full air battle staffs. Even those units who can stand up a staff are wasting that time and manpower if the battle staff is not the focal training audience. This thesis will demonstrate the effectiveness of targeted data formatting in the production of an application that allows users to create reliably formatted ATOs and ACOs easily and quickly that are compatible with systems like FAST and MTWS.

D. THE DIRECT AIR SUPPORT CENTER

Although this thesis proposes a solution concept to the problem of producing exercise ATOs for all echelons of training across multiple warfighting functions, it is important to note, quantitatively, how the ATO is used in meeting training and qualification standards. I am a 7208 Air Support Control Officer; our primary duty is to man and operate the DASC to "control and [coordinate] aircraft operating in direct support of [MAGTF] Forces" (Department of the Navy [DN], 2017). As such, the ATO and ACO are critically important documents for our operations, providing context, situational awareness, and operational flexibility to our agency and our operators. As a DASC officer, I have also worked extensively with FAST. CAC2S is our primary tactical system, and we use FAST often to conduct unit-level training by providing simulated air tracks to our TDF. I offer this small insight into the DASC and our training to highlight the importance of having better access to reliable and correctly formatted ATOs and ACOs.

1. How ATOs Fit into DASC Training

DASC training, especially at the unit level, focuses on meeting training objectives spelled out in the DASC T&R Manual. Because there are so few aviation-centric live-flight exercises in the MAGTF training and exercise employment plan, the DASC rarely gets the opportunity to experience the volume of air traffic and events necessary to meet many of these T&R requirements. FAST offers the ability to create robust aviation scenarios which, with the aid of bug pilots, provide hard, realistic training to the DASC operators. Understanding and utilizing an ATO is a requirement in 13 different T&R events across all operating positions, and the ACO is a requirement for eight T&R events across all operating positions. Even without the aid of the ATO in FAST scenario production, the ATO and ACO are required documents to fulfill many DASC T&R qualifications (DN, 2017).

III. PROTOTYPE SYSTEM DESIGN AND DEVELOPMENT

A. THE VISION

When facing the problem of exercise ATO production, the goal became creating a tool that would mimic the ATO production functions of TBMCS while eliminating the time and manpower required in the process. For units who are not training the air tasking cycle, this would be a tool to produce reliable ATOs quickly and easily that would not only be realistic and in proper USMTF format but could be ingested by FAST and other simulation systems. The goal was to solve two problems: eliminate or drastically reduce the time required to create an ATO and eliminate or drastically reduce the time required to create an aviation scenario in FAST using the ATO ingestion feature.

Ideally, users of the tool would require little to no coding or programming knowledge and could utilize the tool to produce ATOs using only their knowledge of the scenario and the operational information. The user interface (UI) would be simple and intuitive with little to no time required for training or education on the system itself.

B. FRAMEWORK AND ARCHITECTURE

1. Understanding the ATO

Due to the inaccessibility of TBMCS and the Common Message Processor, this tool was essentially built from scratch with no template or preset format. This made it imperative to understand the ATO, its components, how those components are expressed, and how each message set was formatted. This was done through a mix of techniques. Sample exercise ATOs were obtained from MASS-3 in Camp Pendleton, California (see Appendix A). Student handouts and training presentations were provided by MASS-3 and the Air Control Training Squadron in Twentynine Palms, California (See Appendix B and C). Possibly most helpful was the ATO Message Set Reference Guide published by Marine Aviation Weapons and Tactics Squadron 1 which lays out every single kind of message set and identifier with definitions and translations of what that message set is meant to represent. These guides and resources were helpful in understanding and breaking out the structure of the ATO and to begin developing the skeleton of a template that would be most intuitive to the user.

The other side of this thesis's goal is that the tool creates exercise ATOs that can be reliably and correctly ingested by FAST and other systems to alleviate the manpower tax of creating constructive simulations by hand. Fortunately, the files accompanying the FAST application include several tutorial ATOs (See Appendix E), and these were used to begin deciphering how FAST ingests this data and what specifically it needs to correctly map the data in the file to an entity and its mission in the simulation. Additionally, libraries and directories were pulled from FAST for certain pieces of message sets (i.e., aircraft type, mission type) in the hope that if the tool could offer a way to select the correctly formatted aircraft or mission type, the mapping process from file to entity would be easier and more seamless.

2. Requirement for the ACO

It was quickly realized that in order to make the ATOs produced by this tool viable in FAST, an accompanying ACO would be required. Through discussions with the Ternion Customer Support Team, it was determined that a "companion" ACO with correctly defined ACMs is required to fully build out the missions delineated in the ATO (D. Hendrix, email to author, November 3, 2022). Thus, the tool was going to need both an ATO and an ACO construction feature. Further examination of the FAST libraries aided in understanding how the system translates ACM types and shapes and then is able to plot them on the FAST UI map. That combined with the FAST tutorial ACOs allowed for the creation of the ACO tab of the resulting application.

3. Applying USMTF

USMTF is a method of formatting operational messages in ways that are both human and computer readable. Governed by MIL-STD-6040B, USMTF applies to over 300 operational messages ranging from requests for logistical resupply to operations task link messages; beyond this, USMTF is used by North Atlantic Treaty Organization (NATO) members under a standardization agreement. While the USMTF Program encompasses the message text formats, Extensible Markup-Language (XML) representations, and other joint reporting standardizations, for the purpose of this thesis, only the message text formatting was required for examination.

In the interest of removing any formatting burden from the user, it was necessary to understand how USMTF could be applied to the user's data to produce an accurate and correctly formatted ATO. Although at first glance, USMTF messages are difficult to read and understand, the process of identifying what information is required in an ATO or ACO was simpler and more straightforward than expected. It came to be understood that a user-friendly, intuitive template was all that was required to enable more efficient and correct creation of these documents. A simple investigation of the components of ATOs and ACOs was conducted, mapping the components to be templated in the application. All USMTF messages are made up of a heading, body text, and an ending. Within these larger sections, the messages are made up of sets, which are similar to sentences. Each set is comprised of the set name and the data fields; each field is separated by a forward slash, also called a field marker, and each set ends with two forward slashes, also called the end of set marker.

For example, the air mission data set, which denotes tasking for air missions, could look like this in a USMTF ATO:

AMSNDAT/1000/-/AB/-/CAS/-/-/KNYL/KNYL//

Once interpreted properly, this line of data tells you that the mission number is 1000, the package identification is AB, the primary mission type is close air support (CAS), and the departure and arrival locations are Yuma International Airport, whose ICAO code is KNYL. To properly apply this formatting to user data in an application, an extensive examination of all message sets used in ATOs and ACOs was conducted; the resulting application is essentially a template that automates the addition of the field markers and end of set markers, while also grouping the sets into segments (a mission segment could include air mission data, mission aircraft, and air mission location) that can be added to and moved throughout the document. The user can create the same air mission data set with a user-friendly, intuitive template, as seen in Figure 8. All other message sets and segment blocks were templated in similar fashion, implementing the USMTF field markers and end of set markers where appropriate in the file export process, allowing the user to focus on the exercise data at hand rather than the tedious task of proper formatting.

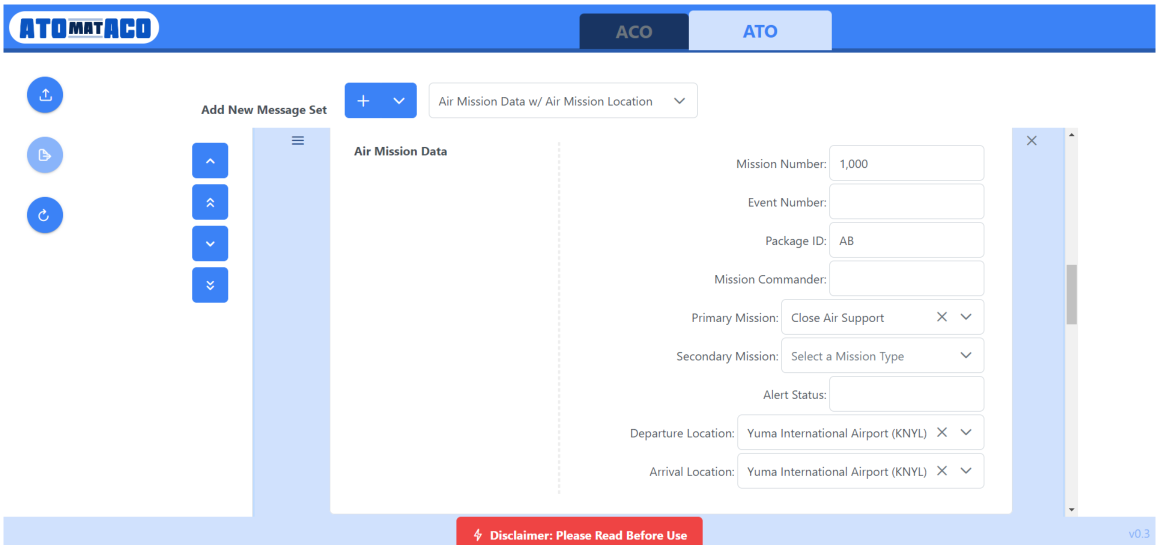

Figure 8. ATOmatACO template for air mission data message set.

4. ATOmatACO

ATOmatACO is the prototype application that uses data formatting to allow the user to create properly formatted ATOs and ACOs quickly and easily that can be exported with the proper file extensions and then uploaded into FAST to automatically populate aviation scenarios. It provides an easily navigable UI with an intuitive layout that separates message sets and the segments within message sets to make the process of entering information into the template as easy as possible, especially for users with little to no knowledge or experience with computer programming, coding, or computer science.

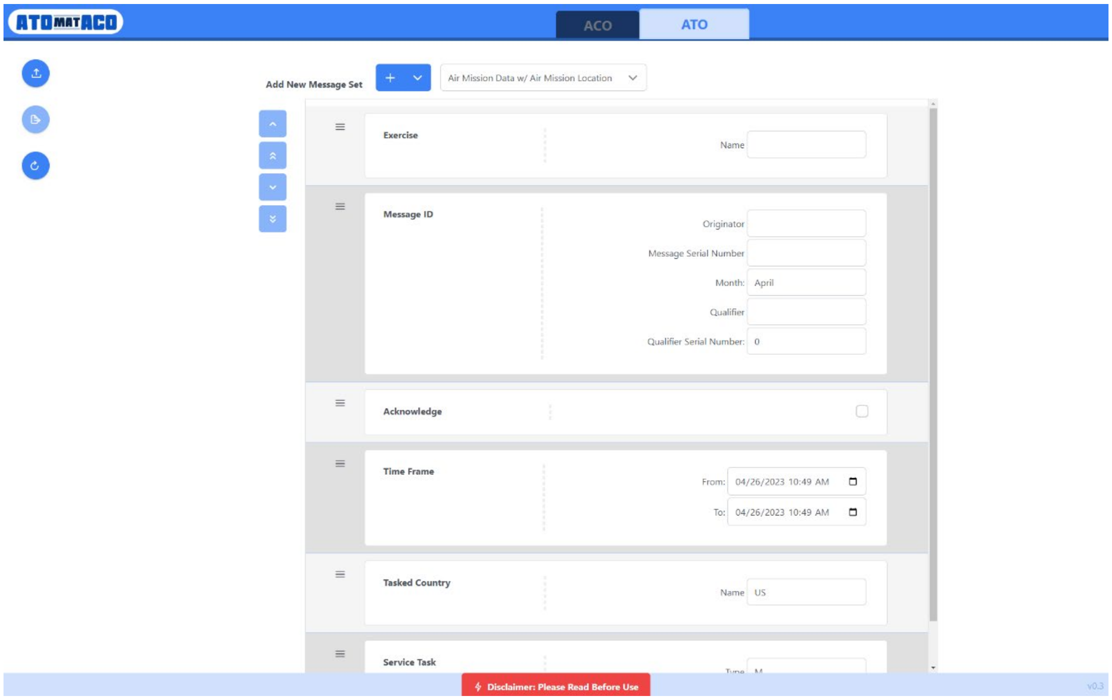

Figure 9. ATOmatACO ATO template with required message sets.

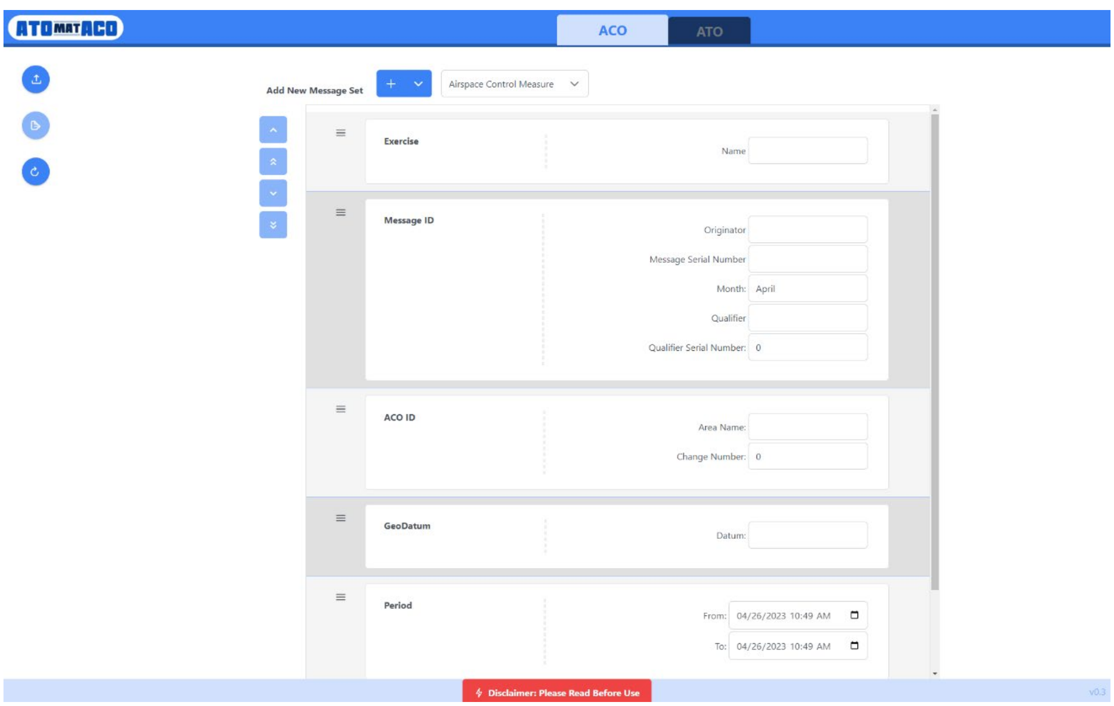

Figure 10. ATOmatACO ACO template with required message sets.

At the simplest, ATOmatACO is "a series of customized form inputs that can export the input data as a .ATO or .ACO file" (E. Heine, email to author, January 9, 2023). With Javascript as the base coding language, the application launches into a static webpage; it does not require any external connectivity. It was built to open in a web browser due to the preexistence of standard form inputs; this saved time and effort over trying to construct a standalone executable application.

> ATOmatACO uses Angular and PrimeNG libraries to build dynamic inputs for a list of Message Sets classes. Each Message Set class has its own definition of data fields, method to write these data fields out in the correct format and is mapped to a specific editor with the correct kind of inputs. In order to make it easier to use, users can add specific preset groups of message sets that typically go together (like an Airspace Control Measure, a shape message set, an Effective Level, and an ACM Period). These message sets are still individual and can be reordered or deleted independently to give more freedom. Also, custom message sets can be added with a dynamic list of fields so users can create their own message sets for ones not previously defined. (E. Heine, email to author, January 9, 2023)

Upon opening the application, the user is presented with a block of message sets that are required for FAST ingestion (and doctrinal ATO/ACO production); these may be reordered but cannot be removed. Upon completion of the ATO or ACO the user can export the file; ATOmatACO will apply the appropriate formatting according to USMTF standards, and the file will contain the correct extension (.ATO or .ACO). The correct file extension is crucial for uploading the file to FAST or another constructive simulation system, something identified early in the research. Something added later on in the development was a feature where a user could upload a previously existing ATO or ACO and the data would populate in the ATOmatACO UI template, allowing the user to edit the file and export a new, updated ATO.

When building a new ATO, the user is presented with the required introductory message sets that identify the exercise name, message identification information, acknowledgement, applicable time frame, tasked country, and service task identifier. The user can then add their own Air Mission Data message set blocks: these include the air mission data, mission aircraft, air mission location, and control agency message sets.

Although these are grouped together and appear in the correct order, the user has the option of adding individual message sets such as aerial refueling information, escort data, forward air controller information, ground target location, point of contact, and reconnaissance data. The user also has the option for a completely customizable custom message set. It is important to note that ATOmatACO was built with DASC unit-level and MAGTF-level training in mind and as such, some higher complexities may be missing. ATOmatACO's construction allows it to be easily editable, and future work could include the addition of all possible ATO message sets and their requisite components.

When building a new ACO, the user is presented with a similar template with required introductory message sets. As ACOs are primarily made up of ACM message set blocks, this is the only message set group the user can add. This block includes airspace control measure, shape points and characteristics, effective level, and period (time frame). The user is able to add or edit the individual components as well.

ATOmatACO uses multiple lists of options for certain components within message sets: International Civil Aviation Organization (ICAO) airport codes, aircraft types, mission types, ACM types, etc. These lists are all built into the application and require no connection or access to anything external to ATOmatACO. The lists in the source code of ATOmatACO were compiled from directories in FAST that are normally used by a user when constructing air missions in the system; this promotes maximum compatibility with ATOmatACO output ATOs and ACOs and FAST, making the uploading and mapping process smoother.

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IV. TESTING AND EVALUATION

A. DOCUMENT PRODUCTION

Once complete, ATOmatACO was used to produce an ATO and ACO for an enlisted DASC controller course for MASS-3. Using exercise air flows and SPINS, a robust ATO/ACO pair was created that not only satisfied training requirements of the course, but also was used to create the constructive simulation in FAST for the course. The airspace geometries and SPINS used for the exercise ACO are based off of those used in the 1–23 iteration of the Weapons and Tactics Instructor (WTI) course in Yuma, AZ, demonstrating that ATOmatACO can create ACOs of real world airspace geometries.

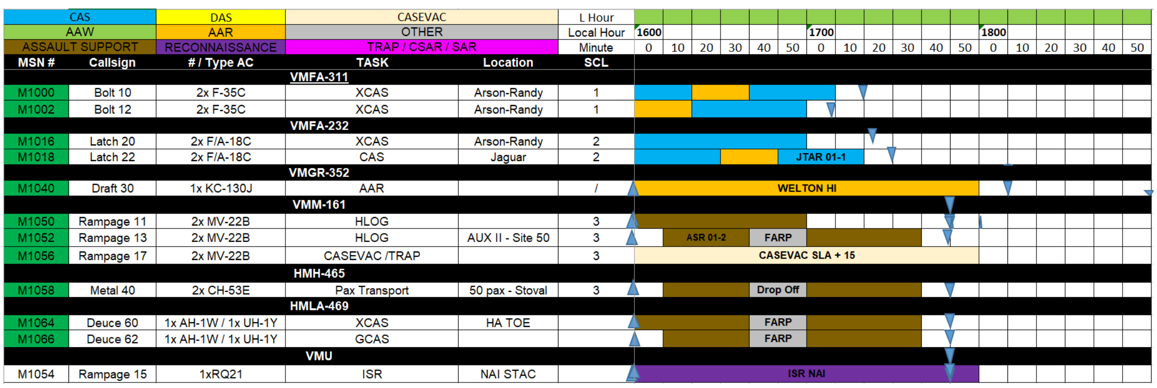

Figure 11. Air flows for MASS-3 Enlisted Controller Course.
Source: MASS-3.

The ATO/ACO pair produced using ATOmatACO took about four hours total to complete. Even with a full air battle staff running TBMCS, ATOmatACO completes the task in a fraction of the time normally required, and the documents were deemed sufficient for use in training for qualification and satisfying T&R requirements by the MASS-3 Weapons and Tactics Training Program Officer-in-Charge, Australian Flight Lieutenant Alysha Poyner.

B. INGESTION BY FAST

Creating a tool that produces ATOs that are human readable was the easy part. Ensuring that it be computer readable by the primary simulation system utilized by the Marine Air Command and Control System (MACCS) was another animal entirely. Initial testing of the application revealed the need for a companion ACO for correct ingestion by FAST. While the ACO tab was under construction, very small incremental tests were conducted using minimalist ATOs and hand-building corresponding airspace into FAST. Figure 11 shows the incremental nature of the initial ATO production testing, slowly adding message data and testing FAST ingestion and entity mapping. Each ATO was then uploaded to FAST, and the system errors were recorded to understand the deficiencies in each ATO. Figures 12 and 13 show these errors, including the requirement of the Message Identifier (MSGID) set, the time frame message set, tasked country, service tasks, and the tasked unit. Some of the errors involved issues with departure/arrival location names and mapping of aircraft types. This prompted the investigation into using FAST's own libraries and directories to create drop-down menus in the application that allow users to select options that are exactly how FAST ingests them, i.e., ICAO codes, mission types, and aircraft types. This does not, however, lock the user into only using FAST-accepted syntax; the user can still type in a specific ICAO/location name, mission, or aircraft type if necessary. Additionally, this initial testing revealed the need to enable the application to create ACOs as well as ATOs.

Test Round 1

```
EXER/OP RED DAWN//
AMSNDAT/2062/-/-/-/XCAS/-/-/NIMITZ/NIMITZ//MSNACFT/2/AC:FA18D /BAT 62/-/-/-/-/-//
CONTROLA/DASC/BROADSWORD/GREEN33/-/-//
```

Test Round 2

```
EXER/OP RED DAWN//
MSGID/ATO/USCENTCOM/ATO A/NOV/CHG/0//
TIMEFRAM/FROM:150800ZNOV2022/TO:160759ZNOV2022//
AMSNDAT/2062/-/-/-/XCAS/-/-/NIMITZ/NIMITZ//
CONTROLA/DASC/BROADSWORD/GREEN33/-/-//
```

Test Round 3

```
EXER/OP RED DAWN//
MSGID/ATO/USCENTCOM/ATO A/NOV/CHG/0//
TIMEFRAM/FROM:150800ZNOV2022/TO:160759ZNOV2022//
TSKCNTRY/US//
SVCTASK/M//
TASKUNIT/VMFA-323/KNFG//
AMSNDAT/2062/-/-/-/XCAS/-/-/KNFG/KNFG//
MSNACFT/2/ACTYP:FA18D /RATTLER22/-/-/-/-/-//
CONTROLA/DASC/BROADSWORD/GREEN33/-/-//
```

Test Round 4

```
EXER/OP RED DAWN//
MSGID/ATO/USCENTCOM/ATO A/NOV/CHG/0//
TIMEFRAM/FROM:150800ZNOV2022/TO:160759ZNOV2022//
TSKCNTRY/US//
SVCTASK/M//
TASKUNIT/VMFA-323/ICAO:KNFG//
AMSNDAT/2062/-/-/-/XCAS/-/-/DEPLOC:KNFG/ARRLOC:KNFG//
MSNACFT/2/ACTYP:FA18D /RATTLER22/-/-/-/-/-//
CONTROLA/DASC/BROADSWORD/GREEN33/-/-//
```

Test Round 5

```
EXER/TESTEX//
MSGID/ATO/MASS-3/1/NOV/ATO/1//
AKNLDG/YES//
TIMEFRAM/FROM:300800ZNOV2022/TO:010759ZDEC2022//
TSKCNTRY/US//
SVCTASK/M//
TASKUNIT/VMFA-323/ICAO:KNKX//
AMSNDAT/1234/-/-/-/OAS/-/-/DEPLOC:KNKX/ARRLOC:KNKX//
MSNACFT/1/ACTYP:F/A-18D/RATTLER11/-/-/-/-/-//
AMSNLOC/300804ZNOV2022/300845ZNOV2022/DALLAS/10000//
CONTROLA/DASC/BLACKLIST/GREEN/PLUM/HOUSTON//
```

Figure 12. First five test ATOs for FAST ingestion.

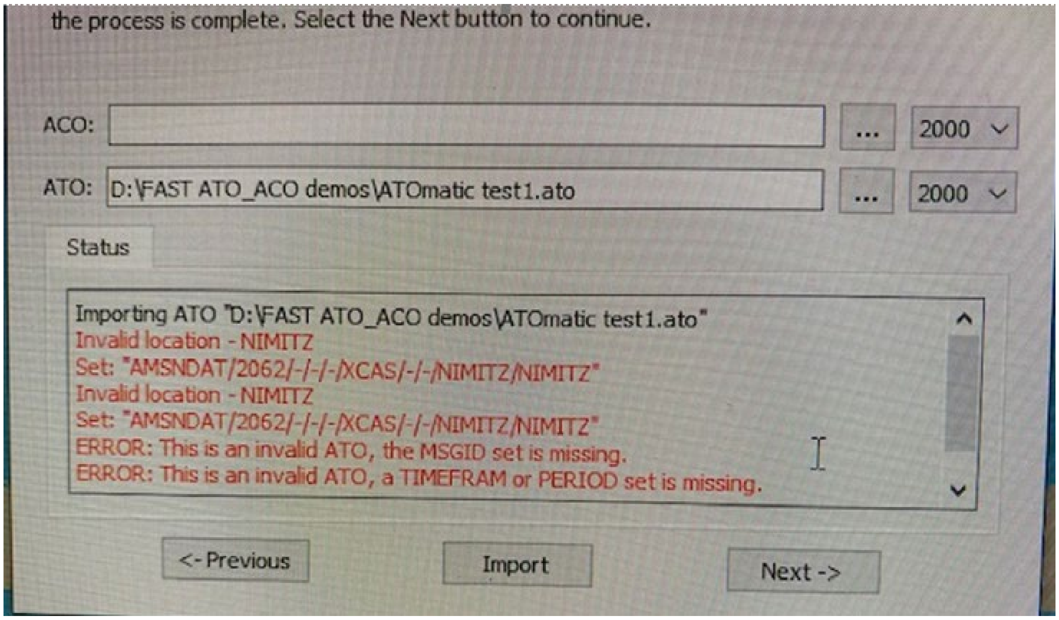

Figure 13. Import errors from ATO Test Round 1. Source: Ternion Corporation (2022).

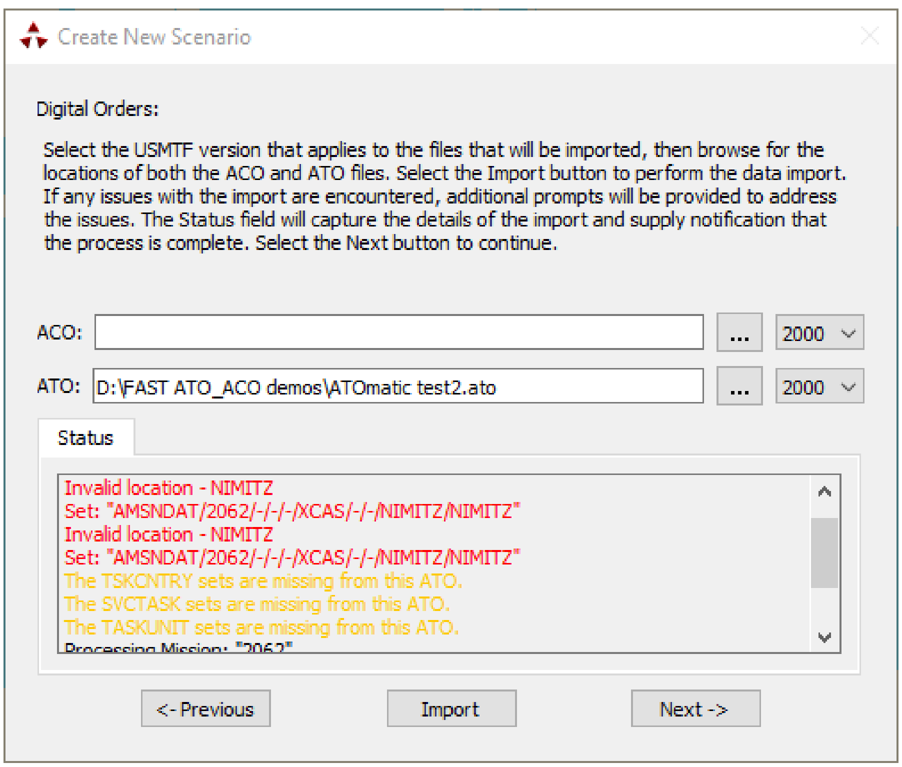

Figure 14. Import errors from ATO Test Round 2. Source: Ternion Corporation (2022).

Creating the ACO tab of ATOmatACO was simultaneously simpler and more complicated. While there is less variation in each message set block of an ACO, there is a wide variation of ACM types, uses, and shapes, and FAST requires each one to be specified appropriately in order to map the airspace correctly. Each ACM type was examined and its requisite usages, shapes, and correct USMTF abbreviations were catalogued and input to ATOmatACO in such a way that the user can select the ACM type and usage by its name and not have to decipher its abbreviation. Figure 13 shows the shape and optional usages of the ACM type Air Corridor/Route (CORRTE) as an example.

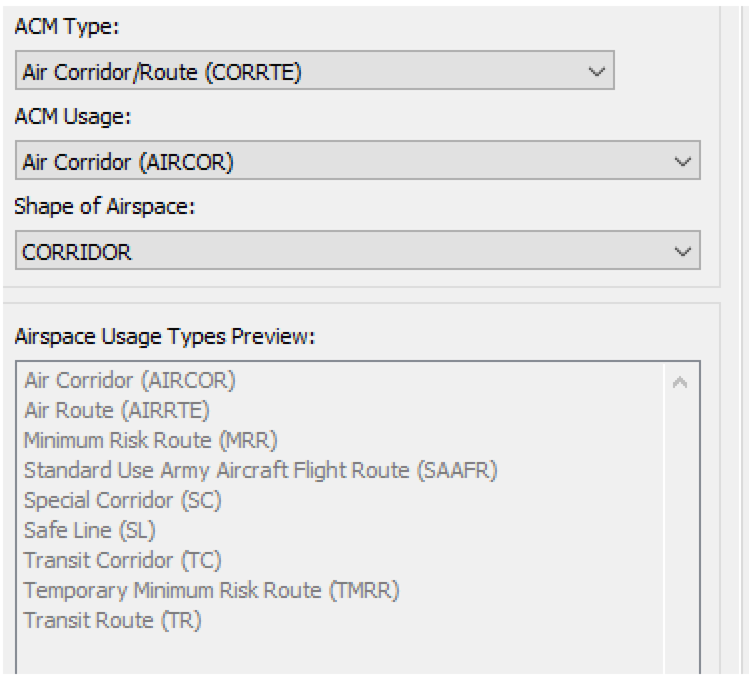

Figure 15. Air Corridor/Route ACM type with shape and usage options. Source: Ternion Corporation (2022).

Testing of ATOmatACO with the ACO feature was conducted using exercise documents from a unit-level training exercise conducted by MASS-3 in 2020 based off of the SPINS, airspace, and base scenario for WTI 1–20. Using samples from these exercise documents (see Appendices F and G) ATOmatACO produced an ATO/ACO pair that was successfully uploaded into FAST, generating a constructive scenario in minutes that would have taken 6–8 hours to build by hand. The resulting ATO and ACO pair can be seen in Appendices H and I, while Figure 15 shows the airspace and missions mapped out in FAST.

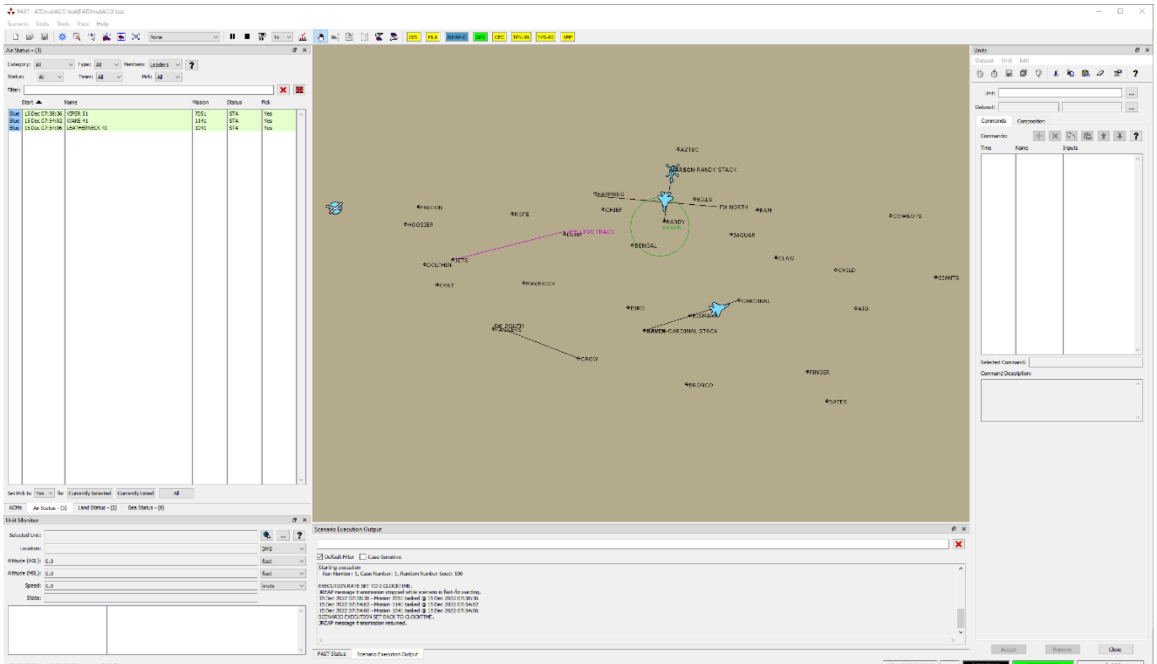

Figure 16. ATOmatACO test with MASS-3 exercise documents. Source: Ternion Corporation (2022).

Following this test, which was conducted using the academic license for FAST obtained by the Naval Postgraduate School for the purpose of this thesis, ATOmatACO was tested using the documents for MASS-3's Enlisted Controller Course and uploaded to the issued version of FAST embedded in MASS-3's CAC2S system. Despite the success of the expedited document production and successful import of the ATO/ACO pair into MASS-3's fielded version of FAST, this test highlighted some small tweaks required to make ATOmatACO more efficient and intuitive for the user. These tweaks included a toggle option between latitude and longitude and the Military Grid Reference System for grid coordinates, a toggle option between measurement standards of altitude (flight level versus above ground level versus mean sea level), and adding ancillary sets like Reconnaissance Data, Escort Data, and Forward Air Controller Information.

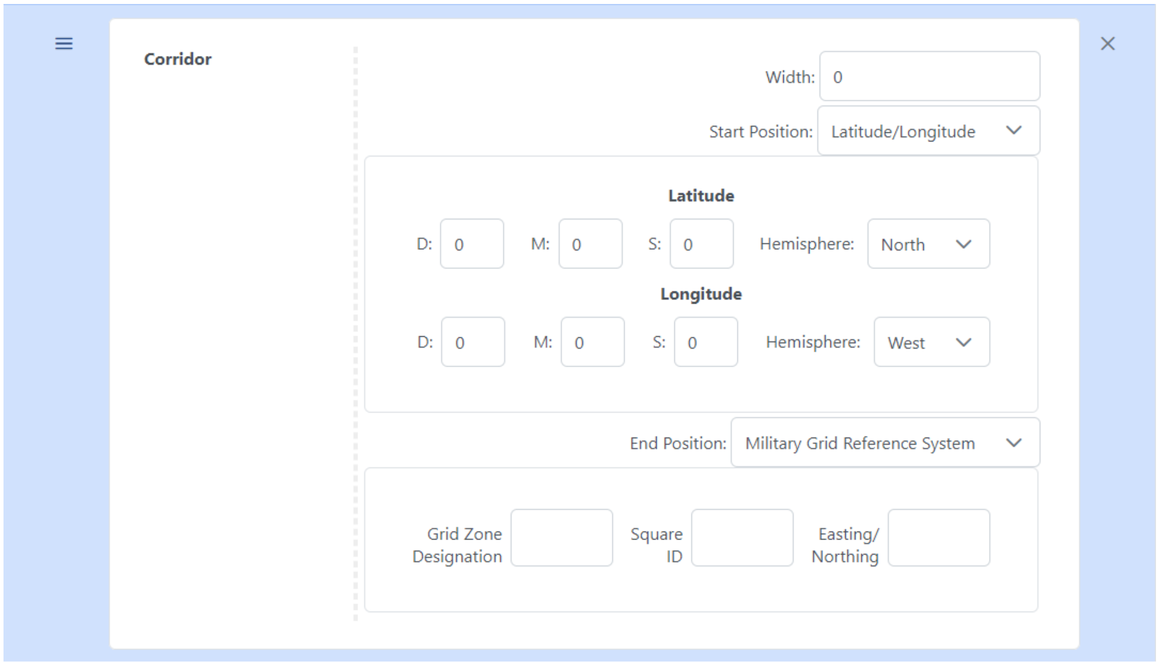

Figure 17. Toggle option for grid coordinates showing option for latitude/ longitude or Military Grid Reference System.

C. INGESTION BY MTWS

MTWS as a whole is a much more complicated and intricate system than FAST. MTWS is intended to create realistic simulations of engagements of units of all types, accounting for terrain, weather, logistic requirements, and many other factors. MTWS does, however have an upload option for ATOs and ACOs, leading to the testing of ATOmatACO produced documents in this system. Uploading ATOmatACO ACOs proved to be seamless and successful. Due to the detailed nature with which ATOmatACO specifies ACM types, usages, and shapes, MTWS was able to accurately and correctly create the ACMs dictated in the ACO. These geometries displayed as an overlay of shapes that could be assigned to an aircraft's mission—a huge success.

Uploading the ATO was a much more tedious, arduous process. Before actually uploading the ATO, MTWS requires certain objects to be created first so that the system can map the missions defined in the ATO to simulated squadrons and aircraft. This high overhead is a characteristic of MTWS and does not invalidate the contribution of ATOmatACO. Any ATO uploaded to MTWS would require the same set of objects to be pre-constructed in order for correct ingestion and mission definition. MTWS requires the following objects to be created:

- Squadrons: for every tasked unit in the ATO, a squadron must be defined and placed at the air mission departure location. The name of the squadron does not have to be a perfect match to what is listed in the ATO, but it should be close (MAG_26 will match to MAG-26, MAG 26, and MAG26).

- Aircraft: the physical aircraft flying the mission must be defined and named appropriately in MTWS using the type and callsign specified in the Mission Aircraft (MSNACFT) message set.

- Ordnance loads: for aircraft carrying a specific ordnance load or a standard combat load (SCL), that must be defined as well.

- Ordnance units: for aircraft carrying ordnance, an ordnance unit must be defined and placed at the departure location for that aircraft. This means, if you have multiple aircraft carrying ordnance coming from separate locations, each location requires an ordnance unit.

- Ordnance: each ordnance unit must be updated to actually have the supply of ordnance required for the air mission.

- Surface craft: if an aircraft is launching off of an aircraft carrier or another surface ship, it must be defined as well.

- Airfields: despite the definition of a squadron, air missions cannot launch without a defined airfield. The squadron of the departing aircraft should be placed near the airfield, represented by the ICAO code in the Air Mission Data message set.
    - Airfield linkage: for a squadron to launch an air mission from a specific airfield it must be linked to the airfield.

- Fuel and ordnance linkage/association: ordnance and fuel units must also be linked and associated with the squadron and airfield in order to be actionable.

- Landing zones: if an aircraft is going to land at a landing zone, it must be defined. However, if the ACO defines the landing zone, MTWS will map it and the user will not need to define it.

- Ship/ground targets: any target specified in the ATO must be created and defined using a name similar to that in the ATO.

If all these objects are defined and properly linked, the ATO can be uploaded and executed with minimal tweaking required. From there the user can either execute the scenario as is or add commands and additional missions using the units and aircraft imported from the ATO.

D. SUMMARY

ATOmatACO was originally intended only to solve the problem of creating an ATO for human consumption and to alleviate the time and manpower burden of building aviation scenarios in FAST. Producing human-readable ATOs was accomplished quickly and easily; here ATOmatACO is a complete success. Over the course of testing and development, the need for ATOmatACO to produce compatible ACOs was discovered, developed, and tested. For use with FAST, ATOmatACO accomplishes its goal by drastically reducing the time to create both the documents and the scenario; when creating the FAST scenario for WTI 1–20, it took a seasoned operator 10 hours to complete both the airspace and the air missions, not accounting for the time required to produce the SPINS and air flows (an ATO and ACO were unavailable for that exercise). Using ATOmatACO, the process took four hours to complete the documents and seconds to populate the scenario.

MTWS is a different beast, given the highly detailed nature of each unit and its interactions with airfields, aircraft, fuel, ordnance, and other factors. The ACO production of ATOmatACO is still highly valuable as MTWS reads ACOs with fewer requirements, but the importing of an ATO to MTWS saves little time, as the sheer number of objects that must be predefined cancels out the time saved in creating the ATO in ATOmatACO.

V. CONCLUSIONS

A. CONCLUSION

Regarding the immediate goal of demonstrating the applicability of data formatting to streamline, facilitate, and expedite the creation of exercise ATOs, ATOmatACO was an overwhelming success. With ATOmatACO, a user can create multiple new ATOs and ACOs, edit preexisting documents, and export them in a format that is human readable and compatible with a currently fielded Marine Corps simulation system. ATOmatACO enables units to produce exercise ATOs and ACOs without the need for TMBCS, a full air battle staff, or the immense amount of time hand-typing and formatting either document. This allows for less time spent on the preparation for training and more time for effective, realistic training that can be repeated and updated for maximum training output.

The ATO is an important document for any training that involves aviation management, airspace management, air direction, air control, air support, and air defense, among others. The ATO creates the feeling that the unit or user is enmeshed in a larger theater of operations, that there are units to the right, left, and above, and that what they do matters and affects the overall operation: it creates large-scale context. Context helps focus a training audience to the mission or operation in the exercise; it provides significance and gravity to the events of the exercise and motivates the audience to put forth maximal effort and proficiency. ATOmatACO makes creating those context-enhancing documents faster and easier, and due to its simple operation, allows a wide range of users to effectively operate it. ATOmatACO also shows that data formatting as a concept can be used to facilitate document production outside of the ATO and ACO: if a document has a format, a tool can be created to aid in the creation and formatting.

1. Scaling Feasibility

a. Usability with Other Kinds of Documents

If specifically referencing the scalability of ATOmatACO, it is important to remember that ATOmatACO was created exclusively for the creation of ATOs and ACOs. That said, because ATOmatACO is made to apply USMTF formatting to these documents, the argument remains that it could be expanded to other kinds of documents that utilize the USMTF formatting and structure. The MIL-STD-6040B USMTF Message Catalog contains over 300 different messages that use USMTF formatting, including Operational Tasking messages (OPTASK) and Operational Status messages (OPSTAT) (A/S, n.d.). Ideally, with access to the catalog and thorough examples and templates of each document, ATOmatACO could be scaled to apply to all USMTF formatted messages, similar to the Common Message Processor, but without being tethered to CAC2S or another tactical system. Due to the volume of USMTF documents, this would increase the complexity of ATOmatACO, but if implemented in the same style (wherein all lists and formats are built into the source code with no external connections), the application should function well and prove a useful tool for exercise planners.

b. Scalability Across Warfighting Functions

ATOmatACO and its very specific method of data formatting limit its applicability to exercise documents and messages within the USMTF Message Catalog. While these messages span across many warfighting functions, there are a vast number of documents that do not conform to USMTF protocols and have less standardized formats. MAGTF operations orders are often not produced in USMTF, and the content does not have standardized formatting. While ATOmatACO's style of data formatting would not be applicable in this situation, the concept of applying data formatting and user-friendly templates is still valuable. Part of what makes ATOmatACO so successful is its user-friendly UI. ATOmatACO is clean and uncluttered with intuitive buttons and tabs that use simple words and titles to guide the user through the process of building an ATO or ACO. The same approach could be taken for something like an operations order.

The standard Marine Corps operations order follows a standard format of Situation, Mission, Execution, Administration and Logistics, and Command and Signal. Within these major sections are smaller subsections that are standard across operations orders. Normally, an exercise planner takes a previous order, deletes the content, and follows the format to fill in the new information for his/her exercise. Applying the concepts of ATOmatACO, one could create a clean, user-friendly template that opens in a web browser with the required sections and subsections, allowing the user to add or edit the data within. For example, Situation could be broken into General, Battlespace, Enemy Forces, Friendly Forces, Attachments and Detachments, Assumptions, and Legal Considerations. These segments would be automatically added with the opening of a new operations order, ensuring the user does not forget to add or consider them. The user would fill in the appropriate information, and then the application would format the data in the appropriate way for export as a Microsoft Word document or Adobe Portable Document format.

The time required to build out tools like ATOmatACO to scale across the various documents in an operations order would be sizeable, however the time saved by removing the formatting woes and ensuring all required sections and subsections are included would reduce errors in the documents and save hundreds if not thousands of manhours for exercise planners across the world. If reviewed and validated by an appropriate authority, this order-creation tool could even be used for real-world operations. ATOmatACO's success demonstrates that data formatting mixed with creating intuitive, user-friendly interfaces can facilitate quicker, more reliable, and repeatable exercise document production.

2. Future and Ongoing Work

If the goal is a suite of data formatting tools similar to ATOmatACO, the future of this application would entail first analyzing other messages that utilize USMTF and adapting ATOmatACO to include more template options. Beyond that, it is not outside the realm of possibility to build an application with formatting templates for the vast range of operational documents from operations orders to their requisite appendices.

a. Joint Training Platform/Joint Training Tool

Currently, Mr. Chris Fitzpatrick of the Naval Postgraduate School is in the process of approaching the developers of the Joint Training Platform and the Joint Training Tool about adding ATOmatACO as a plug-in on the website. If successful, ATOmatACO could be available to all servicemembers and registered users of the Joint Training Platform to enable quick and easy production of exercise ATOs and ACOs. This course of action was pursued over attempting to adapt ATOmatACO into a standalone application that could be housed on the Marine Corps Enterprise Network, a much more complicated endeavor.

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APPENDIX A: EXCERPT OF SAMPLE ATO 1

```
EXER/OP RED DAWN /-//
MSGID/ATO/MASS-2/ATOD1/-/CHG/1//
REF/A/OPORDER/RED DAWN //
AKNLDG/ NO//
TIMEFRAM/ FROM: 0000L28JAN2013/ TO: 2359L28JAN2013//
HEADING/ TASKING//
TSKCNTRY/ US//
SVCTASK/ M//
TASKUNIT/AIRCAVDET/ICAO: BRCH/
AMSNDAT/9111/-/MED/-/DEPLOC:BRCH/280000L/ARRLOC:BRCH/280600L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 11 PEDRO 12/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
AMSNDAT/9115/-/MED/-/DEPLOC:BRCH/280000L/ARRLOC:BRCH/280600L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 15 PEDRO 16/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
AMSNDAT/9119/-/MED/-/DEPLOC:BRCH/280600L/ARRLOC:BRCH/281200L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 19 PEDRO 20/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
AMSNDAT/9123/-/MED/-/DEPLOC:BRCH/280600L/ARRLOC:BRCH/281200L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 23 PEDRO 24/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
AMSNDAT/9127/-/MED/-/DEPLOC:BRCH/281200L/ARRLOC:BRCH/281800L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 27 PEDRO 29/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
AMSNDAT/9131/-/MED/-/DEPLOC:BRCH/281200L/ARRLOC:BRCH/281800L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 31 PEDRO 32/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
AMSNDAT/9135/-/MED/-/DEPLOC:BRCH/281800L/ARRLOC:BRCH/290000L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 35 PEDRO 36/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
AMSNDAT/9139/-/MED/-/DEPLOC:BRCH/281800L/ARRLOC:BRCH/290000L//
MSNACFT/2/ACTYP:AH64 UH60/UGLY 39 PEDRO 40/SCL8/NONE//
AMSNLOC/-/-/-/-//
CONTROL/DASC/BROADSWORD /PDESIG: GREEN33/-/-//
```

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APPENDIX B: EXCERPT OF AIR CONTROL TRAINING SQUADRON TRAINING PRESENTATION ACC 03.16 ON THE AIR TASKING ORDER

Components of an ATO

ATO EXAMPLE

EXER/DESERT WIND//

MSGID/ATO/USCENTCOM/ATO A/OCT/CHG/0//

REF/A/OPODER/ASTS/010600ZMAY2007//

REF/B/ACO ASTS/010600ZMAY2007//

AMPN/REFERENCE A WAS CREATED BY STUDENTS AT MCCES//

NARR/REFERENCES B IS TBD//

AKNLG/YES/INST:REPORT TO PROCTOR UPON RECEIPT OF ATO//

CANX/ATO/MCCES/020559ZMAY2007//

TIMEFRAME/FROM:010600ZMAY2007/TO:020559ZMAY2007//

HEADING/TASKING//

TSKCNTRY/US//

SVCTASK/M//

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APPENDIX C: EXCERPT AIR CONTROL TRAINING SQUADRON STUDENT HANDOUT ACC 03.16 ON THE AIR TASKING ORDER

UNITED STATES MARINE CORPS
COMPANY C
AIR CONTROL TRAINING SQUADRON
MARINE CORPS COMMUNICATIONS-ELECTRONICS SCHOOL
MARINE CORPS AIR GROUND COMBAT CENTER
TWENTYNINE PALMS, CALIFORNIA 92278

STUDENT HANDOUT

AIR TASKING ORDER (ATO)

ACC 03.16

AVIATION COMMAND AND CONTROL COMMON COURSE

M09C2A1

REVISED 11/24/2020

8. **Components of an ATO**. The ATO is comprised of information in USMTF for the squadron/ground units to understand the detailed plan and execution of air requests. This info is given in the following example:

a. ATO example

```
EXER/DESERT WIND/-//
MSGID/ATO/USCENTCOM/ATO A/OCT/CHG/0//
REF/A/OPODER/ASTS/010600ZMAY2007
REF/B/ACO ASTS/010600ZMAY2007
AMPN/REFERENCE A WAS CREATED BY STUDENTS AT MCCES//
NARR/REFERENCES B IS TBD//
AKNLG/YES/INST:REPORT TO PROCTOR UPON RECEIPT OF ATO//
CANX/ATO/MCCES/020559ZMAY2007
```



```
TIMEFRAME/FROM:010600ZMAY2007/TO:020559ZMAY2007//
HEADING/TASKING//
TSKCNTRY/US//
SVCTASK/M
```

b. The ATO is comprised of 73 message sets. There are three rules to "break down" the ATO. These rules will help you read and understand the information set forth in USMTF.

(1) Rule #1: Break down ATO in Message Sets.

(2) Rule #2: Each Message Set begins with a Header. The header will indicate the information "discussed" or presented under that specific header.

(3) Rule #3: Each Message Set ends with two forward slashes.

c. Using an ATO message set you can understand the information in the ATO and how it relates to other info. For example, under the header EXER you will find spaces for information (each piece separated by one forward slash). Using the ATO Message Set Book, you'll find EXER, Set #1, on page 1. The information to understand everything regarding the EXER will be listed on page 1. If the information is not necessary to the operation/exercise a dash will be in place of info. We will now go over some of the ATO Message Sets that you will need to know as a member of the DASC.

(1) Set 1: The EXER Set provides the designated code name or nickname, if the message supports an exercise.

EXER/WILD BOAR/-//

(2) Set 3: Indicates when the info in the ATO is effective.

TIMEFRAM/FROM: 050600ZOCT2001/TO: 052359ZOCT2001//

(3) Set 17: Unit that is tasked to support the mission.

TASKUNIT/HMLA 169/CPEN/-//

(4) Set 18: Provides Point of Contact info from Tasked Unit.

APPENDIX D: EXCERPT OF FAST TUTORIAL ATO

```
EXER/ORANGE JUICE//
MSGID/ATO/MACCS-X/ATOFGAA/-/CHG//
AKNLDG/NO//
TIMEFRAM/FROM:011200ZJUN2007/TO:021159ZJUN2007//
HEADING/TASKING//
TSKCNTRY/US//
SVCTASK/A//
TASKUNIT/PATRIOT BATTERY DET A/ICAO:KMCF//
ADATSK/0005/3/PATRT/000M/5M/011200Z/021159Z//
DEFEND/MEZ/700/-/NAME:MEZ A//
CONTROLA/TAOC/VALIANT/-//
TASKUNIT/PATRIOT BATTERY DET B/LATM:2744N08110W//
ADATSK/0006/3/PATRT/000M/5M/011200Z/021159Z//
DEFEND/MEZ/700/-/NAME:MEZ B//
CONTROLA/TAOC/VALIANT/-//
TASKUNIT/PATRIOT BATTERY DET C/ICAO:KHST//
ADATSK/0007/3/PATRT/000M/5M/011200Z/021159Z//
DEFEND/MEZ/700/-/NAME:MEZ C//
CONTROLA/TAOC/VALIANT/-//
SVCTASK/F//
TASKUNIT/2ND BOMBER WING/ICAO:KHST//
AMSNDAT/3001/-/AF01/MC/AI/-/-/DEPLOC:KHST/ARRLOC:KHST//
MSNACFT/4/ACTYP:B52H/ARCHLIGHT01/12G31X27M82/18M82X8M84/121/23001
/33001//
9PKGDAT
/PKGID/UNIT                /MSNNO   /PMSN  /NO/ACTYPE   /ACSIGN
/AF01 /2ND BOMBER WING     /3011    /AI    / 3/AC:F117A /STALKER11
/AF01 /2ND BOMBER WING     /3001    /AI    / 4/AC:B52H  /ARCHLIGHT01
/AF01 /2ND FIGHTER SQUADRON/3031    /ESC   / 4/OT:F22A  /RAPTOR31
/AF01 /VMAQ-901            /1301    /EA    / 2/AC:EA6B  /REPUBLIC01
//
GTGTLOC/P/-/NET:011710ZJUN/NLT:011725Z/EAST BUILDING 1/ID:KATL/BLDG
/BUILDING/DMPID:333834.9N0842435.1W/WGS 1984/965FT/AA05/002D//
REQNO/0069//
CONTROLA/AWAC/APOLLO/-//
CONTROLA/TAOC/VALIANT/-//
AMPN/CONTROL TASKUNIT: MACS-96//
ASUPTBY/EA/VMAQ-901/1301/REPUBLIC01/2/ACTYP:EA6B//
ASUPTBY/ESC/2ND FIGHTER SQUADRON/3031/RAPTOR31/4/OTHAC:F22A//
RDZDATA/NAME:HYUNDAI HIGH/ALT:270/ARRV:011600Z/N/MN:1301/-//
RDZDATA/NAME:HYUNDAI HIGH/ALT:270/ARRV:011600Z/N/MN:3011/-//
RDZDATA/NAME:HYUNDAI HIGH/ALT:270/ARRV:011600Z/N/MN:3031/-//
GTGTLOC/P/-/NET:011710ZJUN/NLT:011725Z/EAST BUILDING 2/ID:KATL/BLDG
/BUILDING/DMPID:333835.5N0842445.1W/WGS 1984/965FT/AA06/002D//
REQNO/0070//
ASUPTBY/EA/VMAQ-901/1301/REPUBLIC01/2/ACTYP:EA6B//
```

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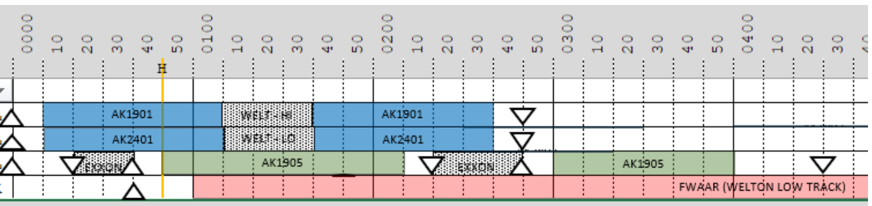
APPENDIX E: SAMPLE OF MASS-3 UNIT LEVEL TRAINING 2020 AIR FLOWS

MSN#	MSN	# A	TYPE	UNIT	CALLSIGN	ORDNANCE	BAS
1041	OCA	2	F-35B	VMFA-122	Leatherneck 41/42		KNYL
1141	OCA	2	F-35B	VMFA-211	Wake 41/42		KNYL
7051	CAS	2	AH-1Z	HMLA-169	Viper 51/52		KNYL
8181	FWAAR	1	KC-135	USAF 54th ARF	Metal 76		KNJK



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APPENDIX F: EXCERPT FROM MASS-3 UNIT LEVEL TRAINING 2020 SPINS

EASTERN CONTROL POINTS

NAME	MGRS GRID	LAT/LONG (WGS-84)
AJO	12S UA 252 833	32 22' 23"N 112 51' 29"W
ARSON	12S TB 685 281	32 45' 59"N 113 28' 17"W
AZTEC	12S TB 704 344	32 49' 25"N 113 27' 10"W
BATES	12S UA 156 544	32 06' 39"N 112 57' 16"W
BENGAL	12S TB 552 046	32 33' 07"N 113 36' 25"W
BILLS	12S TB 751 186	32 40' 56"N 113 23' 55"W
BIRD	12S TA 534 851	32 22' 32"N 113 37' 16"W
BISMARK	12S TA 729 821	32 21' 10"N 113 24' 48"W
BRONCO	12S TA 713 605	32 09' 28"N 113 25' 30"W
BUGGS	12S UB 777 112	32 37' 54"N 112 18' 14"W
CARDINAL	12S TA 884 865	32 23' 44"N 113 14' 59"W
CHIEF	12S TB 463 161	32 39' 12"N 113 42' 18"W
CHILD	12S UA 191 955	32 28' 55"N 112 55' 31"W
CLAW	12S UA 004 997	32 31' 00"N 113 07' 30"W
COLT	11S QR 575 924	32 26' 20"N 114 15' 40"W
COWBOYS	12S UB 366 122	32 38' 07"N 112 44' 31"W
CROW	12S TA 373 695	32 13' 53"N 113 47' 16"W
DOLPHIN	11S QR 534 987	32 29' 48"N 114 18' 11"W
DUNE	12S TB 340 086	32 34' 59"N 113 50' 01"W
FALCON	11S QS 510 168	32 39' 37"N 114 19' 25"W
FINGER	12S UA 080 637	32 11' 37"N 113 02' 13"W
GIANTS	12S UA 505 927	32 27' 41"N 112 35' 26"W
HAMMERS	12S TB 439 211	32 41' 53"N 113 43' 54"W
HOOSIER	11S QS 470 112	32 36' 39"N 114 22' 04"W
JAGUAR	12S TB 864 073	32 34' 57"N 113 16' 32"W
JETS	11S QS 623 004	32 30' 36"N 114 12' 29"W
MAVERICK	12S TA 207 936	32 26' 40"N 113 58' 15"W
MONSTER	11S QS 398 165	32 39' 37"N 114 26' 35"W
NOLLS	12S UB 179 321	32 48' 43"N 112 56' 42"W
OAKLAND	12S TB 438 246	32 43' 46"N 113 44' 02"W
PACKERS	11S QR 756 791	32 18' 53"N 114 04' 22"W
PACMAN	12S UB 501 047	32 34' 11"N 112 35' 49"W
PADRES	11S QS 492 185	32 40' 34"N 114 20' 33"W
PATRIOT	11S QR 686 910	32 25' 26"N 114 08' 37"W
PHOENIX	11S QS 273 044	32 33' 13"N 114 34' 45"W
PISTOL	12S TA 664 952	32 28' 10"N 113 29' 08"W
PRONG	12S TA 342 827	32 20' 59"N 113 49' 28"W
RAIDER	12S TA 249 882	32 23' 49"N 113 55' 29"W
RAM	12S TB 948 148	32 39' 06"N 113 11' 16"W
RANDY	12S TB 654 119	32 37' 11"N 113 30' 01"W
RAVEN	12S TA 584 777	32 18' 36"N 113 33' 58"W
REDSKINS	12S UB 053 209	32 42' 31"N 113 04' 38"W
ROPE	11S QS 806 154	32 38' 26"N 114 00' 32"W
SAINT	12S UB 286 264	32 45' 44"N 112 49' 47"W
SALT	12S UA 004 872	32 24' 14"N 113 07' 20"W
SAN FRAN	11S QS 484 056	32 33' 36"N 114 21' 16"W
SAN JOSE	12S TB 634 339	32 49' 04"N 113 31' 38"W
SEAHAWK	11S QS 688 075	32 34' 21"N 114 08' 12"W
SENTINEL	12S TB 996 405	32 53' 04"N 113 08' 32"W
SIERRA	11S QR 383 970	32 29' 05"N 114 27' 51"W

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APPENDIX G: ATO CREATED FROM MASS-3 UNIT LEVEL TRAINING 2020 DOCUMENTS

```
EXER/MTEX TEST//
MSGID/ATO/TAM/1/DEC/ATO/1//
AKNLDG/YES//
TIMEFRAM/FROM:150800ZDEC2022/TO:160759ZDEC2022//
TSKCNTRY/US//
SVCTASK/M//
TASKUNIT/VMFA-122/ICAO:KNYL//
AMSNDAT/1041/-/-/-/SEAD/-/-/DEPLOC:KNYL/ARRLOC:KNYL//
MSNACFT/2/ACTYP:F-35/LEATHERNECK 41/-/-/-/-/-//
AMSNLOC/150800ZDEC2022/151045ZDEC2022/ARSON-RANDY STACK/210//
CONTROLA/DASC/BLACKLIST/GREEN/-/-//
TASKUNIT/VMFA-211/ICAO:KNYL//
AMSNDAT/1141/-/-/-/SEAD/-/-/DEPLOC:KNYL/ARRLOC:KNYL//
MSNACFT/2/ACTYP:F-35/WAKE 41/-/-/-/-/-//
AMSNLOC/150800ZDEC2022/151045ZDEC2022/RAVEN-CARDINAL STACK/230//
CONTROLA/DASC/BLACKLIST/GREEN/-/-//
TASKUNIT/HMLA-169/ICAO:KNYL//
AMSNDAT/7051/-/-/-/ATK/-/-/DEPLOC:KNYL/ARRLOC:KNYL//
MSNACFT/2/ACTYP:AH-1Z/VIPER 51/-/-/-/-/-//
AMSNLOC/150800ZDEC2022/151225ZDEC2022/ARSON-RANDY STACK/4//
CONTROLA/DASC/BLACKLIST/GREEN/-/-//
TASKUNIT/USAF 54TH ARF/ICAO:KNJK//
AMSNDAT/8181/-/-/-/AR/-/-/DEPLOC:KNJK/ARRLOC:KNJK//
MSNACFT/1/ACTYP:KC-135/METAL 76/-/-/-/-/-//
AMSNLOC/150840ZDEC2022/151540ZDEC2022/WELLTON LOW/130//
CONTROLA/DASC/BLACKLIST/GREEN/-/-//
```

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APPENDIX H: EXCERPT OF ACO CREATED FROM MASS-3 UNIT LEVEL TRAINING 2020 DOCUMENTS

```
EXER/MTEX TEST//
MSGID/ACO/ACO/1/DEC/-/1//
ACOID/MTEX YUMA/0//
GEODATUM/WGS 1984//
PERIOD/150800ZDEC2022/160759ZDEC2022//
GENTEXT/ACO MANAGEMENT INFORMATION/Unused//
ACMID/ACM:REFPT/NAME:ARSON/POINT/USE:ACP//
APOINT/LATS:324559N1132817W//
EFFLEVEL/FLFL:FL080-FL110//
APERIOD/DISCRETE/150800ZDEC2022/160759ZDEC2022//
ACMID/ACM:REFPT/NAME:AJO/POINT/USE:ACP//
APOINT/LATS:322223N1125129W//
EFFLEVEL/FLFL:FL080-FL110//
APERIOD/DISCRETE/150800ZDEC2022/160759ZDEC2022//
ACMID/ACM:REFPT/NAME:AZTEC/POINT/USE:ACP//
APOINT/LATS:324925N1132710W//
EFFLEVEL/FLFL:FL080-FL110//
APERIOD/DISCRETE/150800ZDEC2022/160759ZDEC2022//
ACMID/ACM:REFPT/NAME:BATES/POINT/USE:ACP//
APOINT/LATS:320639N1125716W//
EFFLEVEL/FLFL:FL080-FL110//
APERIOD/DISCRETE/150800ZDEC2022/160759ZDEC2022//
ACMID/ACM:REFPT/NAME:BENGAL/POINT/USE:ACP//
APOINT/LATS:323307N1133625W//
EFFLEVEL/FLFL:FL080-FL110//
APERIOD/DISCRETE/150800ZDEC2022/160759ZDEC2022//
ACMID/ACM:REFPT/NAME:BILLS/POINT/USE:ACP//
APOINT/LATS:324056N1132355W//
EFFLEVEL/FLFL:FL000-FL110//
APERIOD/DISCRETE/150800ZDEC2022/160759ZDEC2022//
ACMID/ACM:REFPT/NAME:BIRD/POINT/USE:ACP//
APOINT/LATS:322232N1133716W//
EFFLEVEL/FLFL:FL080-FL110//
APERIOD/DISCRETE/150800ZDEC2022/160759ZDEC2022//
```

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