Developing Simulation-Based Training for Command and Control Strategy Teams

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ABSTRACT

The operational planning environment within the Air and Space Operations Center (AOC) can appear more like an office than a combat system. Yet, the operators in this setting are responsible for planning entire air campaigns within their assigned combat theaters. Despite the importance of this mission, training typically is ad hoc, relying on traditional on-the-job methods. This paper describes the initial development and assessment of simulation-based training technology for operational planners. Immersive Training for Operational Planners (ITOP) is an information simulation environment along with scenario authoring, instructor management and synthetic role player (SRP) technologies to provide realistic team training for AOC Strategy Division personnel. In an AOC training research exercise, operators, researchers and engineers were brought together to assess the effectiveness and realism of this system. Participants reported ITOP provided effective training relevant to other training activities available for operational planning. Materials and SRP communications were also reported to be realistic and added value to the training event. These findings are discussed along with future research and development efforts associated with this project.

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INTRODUCTION

High fidelity simulation-based training capabilities are common for many operators in the United States Air Force (USAF) to develop requisite expertise. For example, fighter pilots participate in robust training scenarios at Mission Training Centers (MTCs) to practice and hone flying skills. Yet, USAF strategists and planners at the operational-level of warfare have little training beyond classroom experiences provided at a schoolhouse. Simulation-based training capabilities have not been extended beyond more tactical types of warfare. In fact, most of the procedural "training" that is conducted for these strategy planners at their units is for them to act as training aids to other operators such as those involved with the actual execution of their plans. Indeed, strategists largely rely on an on-the-job (OJT) training model which may or may not address important training needs that are critical for readiness in current and future operations.

This shortfall is exacerbated by the nature of warfare. Existing operations and world events emphasize that we are not just facing long-time adversaries with plans that can be grabbed off of the shelf. Effective deliberate and crisis action planning is necessary to address the complexities of new adversaries and rapidly evolving technologies around the world. Future contingencies may require planners at the operational-level of war to conduct activities that are distinct from current operations.

To address these challenges, we developed simulation-based training for planners (i.e., Immersive Training for Operational Planners; ITOP) within an Air and Space Operations Center (AOC). Compared to more common flight simulators, the attributes of the operational planning environment are unique. In many ways, for example, the operational planning environment resembles the office environment of a large corporate enterprise. Microsoft Office© tools document information and generate operational planning products, communication occurs via e-mail and collaborative capabilities such as video teleconference (VTC) systems, and web–hosted shared repositories are used to post documents, organize, and manage information. Representing this information environment in a realistic way and providing a structured way to stimulate training within this environment were central goals of ITOP.

This paper describes the development of ITOP to this end as well as an experimental research exercise to test the realism of a prototype of an ITOP prototype. We start by describing the mission and environment of planning at the operational-level of warfare in the AOC. With this as context, we describe the simulation-based tool developed to train operators that perform these functions. Because it is unique compared to more standard simulators, we describe this system in detail and how it provides an environment for training and exercises. Finally, we report a study conducted to assess the realism and effectiveness of ITOP in an ecologically-valid research exercise.

TRAINING PLANNERS AT THE OPERATIONAL LEVEL OF WARFARE

At the broadest level, the Air and Space Operations Center (AOC) is the senior command and control node for the planning, execution, and assessment of operations in a given region. The planning aspects of the AOC include the development of near- and long-term strategy and day-to-day air and space tasking. To carry out these functions, the AOC consists of two specialized divisions dedicated to planning at the operational-level of warfare: Strategy and Combat Plans (USAF, 2007). A third division in the AOC, the Intelligence, Surveillance and Reconnaissance Division, supports both of these planning divisions. For a more thorough description of the AOC and its organization, see USAF (2007).

"Operational" in this sense refers to one of three levels of warfare. At the highest level, strategic warfare is focused on broad, national objectives. In contrast, tactical warfare is focused on battlefield engagements such as air combat or troops in contact. The operational level of warfare is focused on the level in between the strategic and tactical levels. At this level, the overarching vision provided by the strategic level is translated into military campaigns to be carried out at the tactical level. Activities at this level include establishing objectives, sequencing events and providing high-level support to tactical personnel.

The Strategy Division (SD) is responsible for the overall strategy of an air campaign. This includes specifying objectives to be achieved and tasks to be performed, apportioning assets and resources to the objectives and tasks and specifying metrics to assess progress against the plan. The Combat Plans Division (CPD) translates the broader strategy into day-to-day tasking of air assets.

As the organizations that chart the course of the campaign and allocate and task resources to implement the plan, the performance of SD and CPD teams and personnel can have a significant impact on the success of an air campaign. Despite their importance to campaign success, opportunities for planning personnel to train are limited. Formal training courses are available, but once out of school there are no simulation-based training capabilities for conducting continuation training. Units are left to their own devices. Since there is no formal pipeline for selection into this team, training requirements vary widely among team members. In fact, most training is accomplished ad hoc with a heavy reliance on more experienced personnel to train new team members or publications to fill knowledge gaps. The overarching goal for ITOP was to create simulation capabilities to provide more advanced training in the “art and science” of planning.

Developing a Simulation Environment for AOC Planners

The initial implementation of ITOP was focused on the Strategy Division. The Strategy Division consists of three teams: Strategy Plans (SPT), Strategy Guidance (SGT) and Operational Assessment (OAT). Planners within this division develop campaigns along with branching and follow-on plans to support objectives set by the Joint Force Air Component Commander (JFACC). The team consists of permanently assigned members in a wide variety of specialties and attached personnel to augment these individuals. The operators within the Strategy Division are involved with processes that require obtaining information from and disseminating information to units internal and external to the AOC. The information is fused into reports and documents which are used to build courses of action (COAs), defense plans, airspace control plans and similar products.

Within the Strategy Division, we initially focused ITOP development on the SPT. Through the use of a variety of military orders, briefings and other information sources, the SPT is provided with broadly defined campaign goals and objectives (e.g., achieve airspace superiority by day X) and constraints and bounding conditions (we cannot over-fly country Y) along with information on available resources (specific units/ order of battle; logistics information such as fuel and weapons stocks; expected force flows). The SPT uses this information first to conduct a mission analysis. In the mission analysis, team members compile and document a basic understanding of the campaign and formulate known facts, assumptions and limitations about the situation and mission. They outline tasks to be performed (specified, implied and essential) and evaluate risks (e.g., the most likely and most dangerous courses of action by the adversary and risks to friendly forces).

Using the mission analysis as a point of departure, detailed planning activities are performed through a series of processes that develop courses of action (COAs), evaluate alternative COAs and then recommend one COA for use in the campaign. Described very simply, COA development begins by decomposing assigned missions and tasks into a hierarchy of operational objectives, tactical objectives and tactical tasks. The objective-task hierarchy is somewhat analogous to the work breakdown structure (WBS) used in project planning. Like a WBS, the objective-task hierarchy provides a basis for apportioning resources and sequencing hierarchy elements into phases and tasks within phases.

The concept of effects-based operations (EBO) is central to the development of operational objectives and tasks. In EBO, the adversary is viewed as a complex system of systems. Campaign objectives are expressed in terms of desired effects on a system component and/or interrelated sets of systems and components. After desired effects have been specified along with associated objectives and tasks, alternative COAs are proposed that adjust tasking priorities, apportionment and scheduling. Methods such as wargaming are applied to evaluate the alternatives in terms of a set of predefined criteria (e.g., economy of force, risk, etc.). Based on results of the wargaming, a course of action is selected for detailed plan development. The detailed plan is published in a formalized document.

With the mission and environment described above as context, the next section provides an overview of ITOP. We think this simulation-based training tool is somewhat unique relative to more standard simulators (e.g., flight simulators). Thus, we detail the components of ITOP in some depth before reporting on the exercise we conducted to assess the effectiveness of the training capability.

Components of the Operational Planning Environment

Figure 1 depicts the major components of the operational planning environment that characterize the SPT. The team, players, tools, materials and processes provided the basis for specifying the mission environment elements the ITOP simulation represented to stimulate training. Each component has unique attributes that drove the design of the ITOP capability.

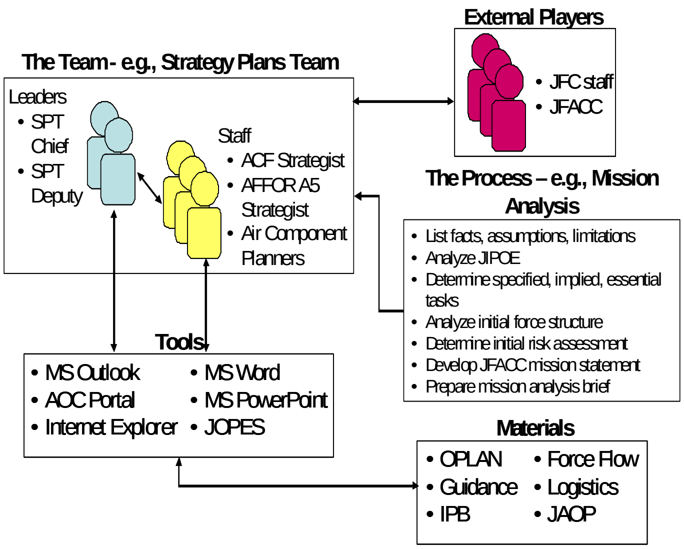

Figure 1. Operational Planning Environment

Processes

Processes were the central component of the operational planning mission environment for ITOP development. Though a conceptual rather than physical element, they were essential because they shaped the other components that ITOP represents and provided structure for training content. Processes generate the mission critical products of operational planning, define the work to be done, determine who executes the work and the materials and tools that are involved. As a unit level training device, it is assumed that trainees using ITOP have been through some kind of schoolhouse training on their positions (though not required per se). While a function of ITOP is to maintain individual proficiency, its primary function is to generate effective team performance. This team performance occurs within the context of processes. Consequently, ITOP training events are organized around processes.

Materials

Much of the work activity involved in operational planning consists of manipulating information in a variety of forms to extract specific information elements (e.g., list known facts), create new information (e.g., specify assumptions, specify essential tasks) and make decisions (e.g., select the optimal COA). Information comes in a variety of forms that include documents, briefings, e-mails, spreadsheets, databases and AOC specific applications. These materials are not static. Over time their content evolves to reflect changes in the understanding of the adversary, the current situation in the battlespace and the availability of resources. A key requirement for ITOP was to provide realistic materials to trainees and role players.

In ITOP, materials are the representation of the battlespace. Whereas other warfighters (e.g., fighter pilots) operate within and interact directly with the battlespace, operational planners view the fight via information generated by others and "operate" in the battlespace by broadly directing and focusing the actions of others. Furthermore, although other warfighters interact with the battlespace in real-time, operational planners work with a body of information that is collected over time and reflects the evolving situation in the battlespace. These factors have significant implications for ITOP. For example, the range of material types is broad, the content is diverse and they are developed by external players from a wide range of specialties. A more thorough analysis of the unique aspects of planning versus other types of activities can be found in Alberts and Hayes (2007).

Materials in ITOP must be "synchronized" in terms of an underlying story that frames a conflict or other mission situation and specifies associated battlespace events and their effects over time. A driving force behind ITOP was to provide planners the opportunity to train for unexpected contingencies under time constraints and high workload. To this end, scenarios consist of a series of events in which materials are delivered or otherwise made available to trainees. Generally, these materials are related to a battlespace event or series of events that have occurred to that point in the conflict story. Synchronization of materials requires that factors such as references to players and forces (e.g., unit designations, dispositions, resources and status), battlespace event locations, timing and sequences are consistent across materials. We assumed any failure to synchronize materials could confuse trainees and detract from the learning process. Planning is inherently about the future and dealing with uncertainty. Thus, materials in ITOP provide some information, but are often intentionally vague, misleading or partial to better represent the real world. Instructors can alter materials to this end and incorporate more local information to enhance contextual relevance to a given theater or mission.

Tools

SPT personnel use a variety of tools to communicate, access and manipulate information sources (materials) and generate products. As noted earlier, these include standard Microsoft Office© and other applications (e.g., Word, Outlook, Internet Explorer), as well as AOC specific tools. Instead of creating new tools for trainees, ITOP uses these very same tools for training. ITOP was developed with functionality to provide materials in the proper file formats and via the appropriate mechanisms (e.g., e-mail, document posting on a portal) to a standard SPT desktop through these tools. This design decision eliminated the need for separate trainee stations and allows ITOP to run within a real AOC environment. Additionally, since ITOP leverages these common tools, it mitigates the requirement to learn new interfaces and other common functionalities. Finally, tools were kept similar in the ITOP training environment to match the real world experience. This blurring between training and operations was deemed optimal for training transfer (see Holding, 1965; Thorndike & Woodworth, 1901).

The Team

Operational planning teams can vary in size and roles performed. As teams to be trained become larger and members' roles more diverse, it becomes more challenging to ensure that each trainee receives stimulation for his/her specific skill set and appropriate to his/her role. To meet this challenge ITOP provides a means for developing training scenarios that makes available information on the skills and knowledge different team members employ to accomplish process activities. As described in detail below, this scenario authoring functionality allows instructors insight into the team for more individualized scenario events and activities. One goal of ITOP is to not only represent the operational context of the Strategy Division, but also the training context (e.g., previous experience, proficiency levels, etc.) to provide a basis for specifying scenarios that address the training needs of all participants.

External Players

SPT personnel interact with a variety of players that are external to the team. For example, orders and guidance come from higher echelons. Other interactions include more horizontal communications with liaison officers who provide insight into the objectives, tasks and plans of their respective components. These personnel are important sources of guidance and information that shape the work of the team. Depending upon the process being trained, a number of role players may be needed to represent external players. Live role players add cost to the event. They also can impede training when they cannot be obtained or personnel are used who do not understand their roles. One goal of ITOP was to leverage synthetic role player technology to reduce the requirement for these individuals to support team-level training.

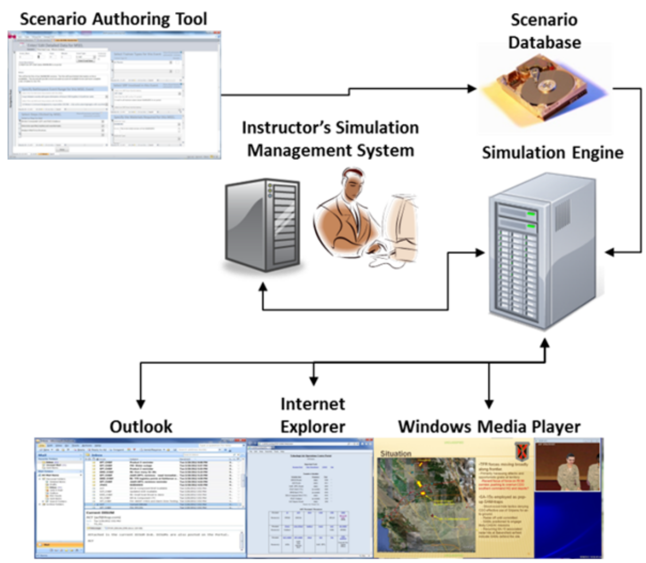

Figure 2. Major components of the ITOP system

THE ITOP SYSTEM

Figure 2 depicts the major components of the ITOP system used to represent the above environment. An authoring tool allows training managers to develop and adapt scenarios for a training event. Once selected, the scenario is controlled by an instructor through a simulation management system. A simulation engine provides the content to trainee workstations. Because planners get information from systems such as Outlook, VTCs and the Internet, it was important for ITOP to provide simulated information to common interfaces at trainee workstations. Each component is described in more detail in this section.

Scenario Authoring Tool

The ITOP Scenario Authoring Tool (SAT) employs what can be described as a performance-based approach to scenario development. ITOP scenario development begins by first specifying the personnel and performance to be trained. An operational planner database stores information on organizational structure including team makeup and roles on teams. Performance is organized in terms of Mission Essential Competencies (MECs™) including skills and knowledge that have been specified by experts (Colegrove & Alliger, 2002; Rowe, Prost, Schreiber, & Bennett, 2008; Schreiber & Bennett, 2006; Tossell, Garrity & Gildea, 2006). These are broken down further and associated with the processes they encompass and associated scenario elements. Data are provided for these steps which include initiating conditions, work elements performed, information sources and other materials needed to support work processes and outputs. The performance database and interfaces to it provide a structured, systematic means for enabling scenario developers to specify the personnel to be trained in an event and the tasks, skills and knowledge to be trained for each individual. The detailed data associated with these steps provides insight into the events needed to stimulate performance and the types of materials and content that need to be provided to enable performance.

ITOP scenarios exist in the context of a larger conflict story. The SAT provides interfaces for building this story in terms of content that later will be important for developing materials. Types of content associated with a conflict story include bios of the key players, descriptions of the countries and other groups involved, their goals and motivation, centers of gravity and vulnerabilities, order of battle, etc. Some information is about blue force only. This includes asset/resource status and availability, phasing of operations and flow of assets and resources into the theater. One of the most important elements of the conflict story is the battlespace event timeline. This timeline specifies the major events that have brought the trainees to a given point in their scenario. Descriptions of the events and their outcomes provide grist for the development of materials that will be delivered to trainees during a scenario.

The Simulation Engine

The ITOP simulation engine controls and executes ITOP scenarios. It performs standard simulation functions such as loading scenario files; starting, pausing, and stopping the scenario as directed by the instructor; and executing events at the prescribed time. The simulation engine also manages subsystems that deliver materials to trainees during event execution.

E-mail Server. ITOP hosts an e-mail server that manages e-mail communication between trainees, the instructor and synthetic role players (SRP). Incorporation of a mail server into ITOP (rather than using existing servers in an AOC) makes it easier to do things such as logging e-mail for performance assessment purposes and integrating SRP e-mail interfaces. It also helps avoid the possibility of disrupting any operations that might be occurring in the AOC. Yet, systems like Microsoft Outlook© can still be used as an interface to avoid requiring users to learn new interfaces.

Synthetic Role Players. SRPs are a key component of ITOP. They reduce or eliminate the number of live role players needed for an event. In ITOP SRPs compose and send e-mail, respond to e-mails from trainees, post documents to portals and make presentations in VTCs. SRPs are driven by the Improved Performance Research Integration Tool (IMPRINT) human performance modeling environment (Allender, 2000). Grammars are integrated with the IMPRINT models to interpret message content. At present, the SRP can answer only simple questions. For VTCs, the IMPRINT models control avatars that make presentations accompanied by PowerPoint slides in a virtual briefing room. The avatar voices are created from recordings of voice actors. Figure 3 shows a screen shot from a VTC that contains avatars.

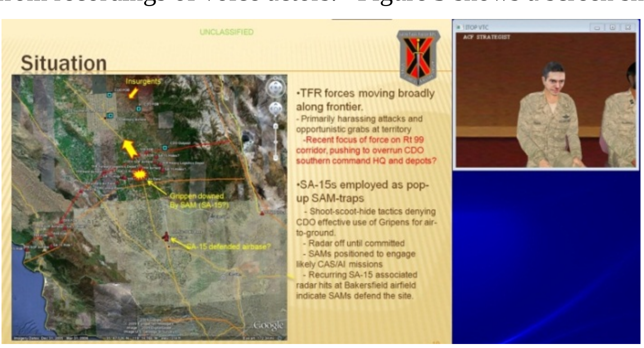

Figure 3, Sample VTC screen with SRP driven avatars

Video Teleconference Streaming Video and Audio. To create the simulated VTC, the avatars and virtual briefing room were merged with presentation of the PowerPoint slides and the presentation of the slides must be synchronized with the information being communicated verbally by the avatar. The Video Teleconference Streaming Video and Audio component performs this merge and then broadcasts it as a video stream that can be viewed on trainee workstations. In real-world strategy development within an AOC, planners typically view slides in conjunction with viewing the speaker in a separate window along with the associated audio. Most often the audio content is heard through headsets. The goal in ITOP VTC systems was to mimic these methods of information delivery.

Portal. Similarly, an Internet portal was developed to represent the interface found on planners' workstations. Within the AOC, documents of interest to multiple organizations and staff are posted on portals where they can be accessed via web browsers. Organization and structure of these portals can be complex and confusing. Representing a portal provides an opportunity for familiarization training with those structures as well as exercising document search skills. ITOP includes storage media that can be used to reproduce a portal and provides a web interface that trainees can initiate with their browser.

Performance Assessment. Providing trainees with feedback on their performance is an essential function of the ITOP training system. The simulation engine supports this process by logging simulation events as they occur along with selected trainee activities. These include logging when e-mail is received and opened by trainees as well as when they compose and send e-mail. Document manipulation, opening and closing of documents and posting of documents to the portal are also logged.

Instructor's Simulation Monitoring and Control Station

In many ways, the instructor's simulation monitoring and control station (SMCS) has functions routinely performed by instructor control stations. The instructor can load a scenario, start it, pause it and stop it. He/she also can fast forward as needed. The scenario can be modified during execution as the instructor deems appropriate. This includes changing event times, deleting events and adding events. One of the most powerful features, however, is the instructor's ability to role play. Under this function the instructor can assume the identity of any SRP in the scenario and create or respond to e-mails on their behalf. The instructor also can help an SRP when the SRP cannot answer a question posed by a trainee. In this instance the SRP has evaluated the text in an e-mail sent by a trainee and has determined it is unable to formulate a response. It sends a message to the instructor stating it cannot answer the e-mail and attaches a copy of the original e-mail from the trainee. The instructor has the option of sending a response on the SRP's behalf, having the SRP respond that is does not know the answer to the question or simply having the SRP ignore the email message.

Trainee Desktop

The trainee's station can be his/her actual workstation and desktop. ITOP interacts with trainee stations using standard network communications. If desired, a client application can be installed on the trainees' workstations that provides ITOP specific information such as scenario time, any special instructions or notifications (e.g., we will take a break at 1130) or directions to take a test. As mentioned above, ITOP sits behind many of the common tools used on workstations within the AOC Strategy Division and common to most readers (Figure 2).

ASSESSING THE REALISM OF ITOP

ITOP was developed to provide AOC Strategy Division personnel with an environment for team training using realistic tools, materials and processes. Using SRP technologies, instructors can implement this training without a large number of support personnel. After developing an initial prototype of ITOP, several research questions were assessed in a training research exercise. In this section, we report research conducted to assess the realism and training effectiveness of ITOP through a training exercise in the AOC Testbed at Wright-Patterson Air Force Base. The event took place over four consecutive days.

Figure 4. The ITOP training research exercise within the AOC Testbed.

Method

Participants. Nine experienced AOC operators participated in the exercise (M = 4.1 years of experience within a Strategy Division). All of the participants were in the USAF and stationed within Strategy Divisions at various AOC units during the time of this exercise. Participants were divided into two teams that participated in the study concurrently over a period of four days. Participants were randomly assigned to teams. Each team was also assigned an instructor to facilitate the training through ITOP. The exercise instructors were also experienced in providing training to AOC personnel.

Materials. We performed this study in an environment that was developed to be ecologically valid. The AOC Testbed consists of computer systems, software and architecture that aim to mimic a Strategy Division in an AOC (Figure 4).

Scenarios. The overall scenario involved the secession of a province from an ally country of the United States. This breakaway province successfully seceded and threatened the sovereignty of the ally country. With help from a near-peer superpower, they received support in the form of material, intelligence and advisory support. The United States stepped in to keep this coup from happening. With help from a nearby country to the east, the US is using bases to plan and execute missions to stabilize the region.

With this as context, the training event consisted of two procedural-based scenarios with each team performing one of the scenarios. Based on the overall scenario, Team A was charged with developing a mission analysis briefing to provide the JFACC (i.e., senior leader) a decision briefing outlining several plans including the recommended option. Team B was charged with developing a mission analysis briefing, a course of action briefing and developing a branch plan based on the chosen course of action. The teams both received a debrief and feedback on their presentations.

Measures. Self-reports such as scenario evaluation and reactions towards training surveys were provided to each participant. These surveys assessed the realism and the training effectiveness of ITOP and its sub-components. Performance measures were also captured through logged data and subjective assessments.

Procedure. Before arriving at the exercise, participants were given a study packet containing background information such as schedules. This provided overarching guidance and structure for the exercise period. Upon arrival, participants were given an initial briefing from the research team with information about what to expect during the exercise and shown the workspace. During the initial briefings, members of the research team started the ITOP system and ensured the trainee computers were connected. After the exercise ended for the day, an after-action review and feedback session was conducted with the participants. If important deficiencies in scenario or process were identified in the feedback sessions, we made changes where possible making sure to stay within the scope of the research and tasking. This process was repeated for each day of the exercise.

Results

Each instructor was able to provide training to their respective team of planners in the AOC SPT training research exercise. All participants successfully completed the four-day training event and the associated end-of-course surveys assessing the realism and effectiveness of ITOP and the overall exercise. The surveys administered to both teams after the exercise used a scale that ranged from 1 – *Strongly Disagree* to 4 – *Strongly Agree*. The first survey contained 46 items and focused more on the Training Research Exercise (TREX) as a whole. A portion of the items were negatively worded and therefore responses were reverse coded prior to the analysis. Responses were then consolidated into 11 categories as listed in **Error! Reference source not found.**. The means and standard deviations reflect that, for all but one category, participants agreed that the training was effective, mission difficulty was appropriate and the event met their expectations. Interestingly, the only category in which ratings average less than "somewhat agree" is "home unit support of skills training in TREX is sufficient." In other words, respondents indicated they did not receive home unit support for the skills trained in the TREX exercise. Because of the low sample size, we did not calculate significance tests. Still, participant self-reports provided evidence that the training event driven by ITOP was effective in providing realistic

Table 1. Reaction Survey Categories.

Reactions Survey Categories		Mean	St Dev
1	TREX was effective for combat mission training overall	3.7	0.48
2	TREX was effective in training/developing skills and tactics	3.4	0.66
3	Home unit support of skills trained in TREX is sufficient	2.4	0.84
4	TREX exercise presentation and design was effective	3.5	0.63
5	TREX environment/scenarios were realistic and operationally applicable	3.4	0.62
6	TREX pace was appropriate	3.3	0.59
7	TREX mission difficulty was appropriate	3.2	0.51
8	TREX preparation for the field was sufficient	3.4	0.53
9	My preparation for TREX was sufficient	3.3	1.00
10	TREX met my expectations	3.4	0.63
11	Support expansion and future use of TREX	3.6	0.58

training.

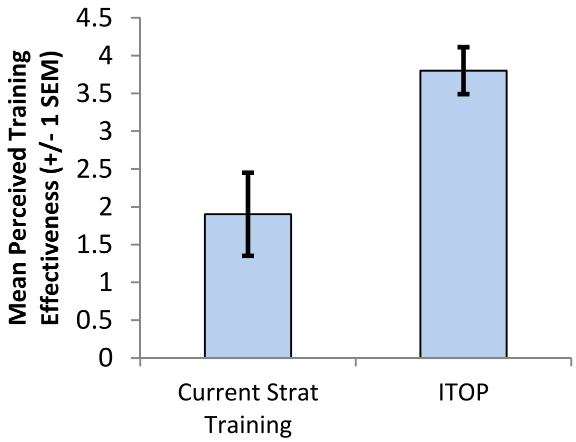

Figure 5. Training effectiveness of ITOP versus home unit SD training available at local units during the time of the exercise.

The second survey utilized a similar scale. Instead of focusing on the entire training research exercise, this survey focused on ITOP capabilities and functionality along with the scenario content provided through ITOP. The 14 items were reduced to seven for analysis. As shown in Figure 5, participants reported ITOP provided effective simulation-based training relative to the capabilities that existed at their units. Table 2 shows the means and standard deviations associated with responses from the other measures. The high mean value associated with items D and E at least partially reflects the realism of synthetic role player technologies within ITOP.

DISCUSSION

The initial implementation and test of ITOP demonstrated the feasibility of using simulation to train operational planners and introduced functionality that enables the training to be delivered by one instructor without a large number of role players. The ITOP approach to scenario authoring emphasized using detailed and realistic information for the personnel, tools, processes, activities and mission environment events that stimulate those activities. This approach leads to focused scenario design in which events and materials are specified that ensure key skills of all trainees are exercised and reduces effort expended creating unnecessary materials.

ITOP is a different type of simulation compared to more typical simulation trainers because it recreates a unique environment. ITOP represents the operational planning environment and the large volume of information in the form of various documents and data sets that come to planners via e-mail, VTCs and portals from a diverse set of people. It is also different with regard to the involvement of role players. The ITOP SRP provides a credible representation of other entities through communications found realistic by trainees. Although not every aspect of ITOP was evaluated in the TREX, the functionalities that were assessed yielded effective training according to the experienced planners that took part in our research event.

Table 2. Survey items assessing aspects of ITOP.

Combined Survey Items	Mean	SD
a. The materials and briefings you were given provided the information needed to perform the assigned tasks.	3.5	0.8
b. The materials were realistic in terms of the content provided, format(s) used, and language used and were consistent with what you would expect from a given document type.	3.6	0.6
c. The pace at which you received e-mail and materials was realistic.	3.4	1.1
d. The e-mail messages you received were what you would expect and from roles you would expect to provide it.	3.7	0.5
e. The answers you received to questions you asked were reasonable (you might not have gotten the response you hoped for but the one you got was realistic).	3.7	0.6
f. Within the scope of activities stimulated by the scenarios, critical strategy planning cognitive skills and abilities were exercised.	3.9	0.4

Finally, the ability for the instructor to assume roles when needed resulted in scenarios that flowed seamlessly while imposing a relatively low workload on the instructor. Standard AOC exercises utilize a number of support personnel to conduct team training to manage all of the communications external to the team and guide the scenario. ITOP SRP technology proved useful to reduce the number of these support personnel and supplement one experienced instructor for training. Future research should assess the effectiveness of training vis-à-vis the ratio of live support personnel to the number of trainees within the training environment. The use of synthetic instructor support could also be assessed against live instructor support in a similar manner.

Though we did not use tests of statistical significance, the data obtained from experienced AOC operators after using the system indicated ITOP was successful in providing realistic training to operational planners.

Planning is a critical function to successful military operations (e.g., Schreiber, Rowe, & Bennett, 2006; Johnston, Serfaty, & Freeman, 2003). This study provides evidence of the effectiveness of simulation-based training to enhance the personnel involved in this important activity. Indeed, ITOP was perceived as realistic from experienced operators. They reported this was the case in general and very specific components of the system. Although we did not assess transfer specifically, the data collected here provides some evidence that ITOP was effective in providing realistic training.

The ITOP capability has application well beyond operational planning training. It can be applied to a broad range of information and data dominated work domains in which analysis and decision-making processes are driven by a variety of inputs that occur over a period of time and are overlaid on a dynamic, evolving situation. These domains include intelligence analysis, system acquisition, forensic analysis of certain types of criminal activity, enterprise management and program management. Consequently, we believe ITOP provides a significant advancement in simulation technology and application.

Future Research

Looking out into the future, several threads of research have spun from this original effort. First, the above focus of ITOP was on one team in the AOC Strategy Division. Future projects will explore other teams that bridge the gap between planning and execution. Second, other military applications that rely on similar types of information to prompt training will be explored. For example, many types of intelligence analysts process, exploit, and disseminate information analogous to materials within the ITOP environment. Finally, we hope research in natural language recognition will continue to grow and provide ITOP and similar systems with a more robust capability to understand user inputs and respond appropriately.

ACKNOWLEDGEMENTS

The views expressed in this paper are those of the authors and do not reflect the official policy or position of the United States Air Force, Department of Defense, National Geospatial-Intelligence Agency, or the U.S. Government. The authors would also like to thank Harry Heaton, Michael Sargent, Roger Overdorf, Brittany Carter, Geoffrey Barbier, Todd Denning, Cullen Jackson, and Winston Bennett for their work on this project. We also thank Leah Rowe and Tiffany Poeppelman for their terrific reviews on earlier versions of this paper.

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