KEY TEAM COMPETENCIES FOR NAVY AIR WINGS: A CASE STUDY

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Over the past decade, there has been a substantial amount of research aimed at the development of team training interventions. These efforts have resulted in guidelines, tools and methodologies that are being applied to a variety of small aviation and surface teams. The purpose of this paper is to examine a set of team competencies resulting from this work against critical incident data obtained for large tactical teams. These data were collected for naval air wings during predeployment training at the Naval Strike and Air Warfare Center (NSAWC). Our focus was to determine the extent to which these competencies may be useful in this demanding large team environment.

There has been a great deal of work devoted to the identification of competencies required for effective teamwork. Competencies have been identified for navy combat information center teams, for example, that include situation assessment, communication, team initiative/ leadership, and supporting behavior (Johnston, Smith-Jentsch, & Cannon-Bowers, 1997). In another effort, Fleishman & Zaccaro (1992), reported on a team function taxonomy that was validated in domains that included Air Force command and control teams. These teamwork functions were orientation, resource distribution, timing, response coordination, motivating, systems monitoring, and procedures maintenance. Although different labels and organization exist in these two classification schemes, a close examination of the specific competencies identified for these team environments reveals a great deal of similarities. Indeed, comparable functions have also been identified for a variety of other teams including commercial and military aircrews (e.g., Prince, Chidester, Bowers, & Cannon-Bowers, 1992) and nuclear power plant operators (Gaddy & Watchell, 1992).

Thus, while it is true that a particular nomenclature and skill subset serves a particular team environment, it can also be argued that the same or similar competencies appear to apply across many teamwork domains (Cannon-Bowers, Tannenbaum, Salas & Volpe, 1995). Table 1 shows a set of representative knowledge and skill-based competencies identified for teams based on much of the research cited above (adapted from Salas & Cannon-Bowers, in press). The identification of which of these apply for a particular team environment, and how they apply, is one of the crucial first steps to the design of effective training to improve performance. Our intent was to approach this problem for Navy air wings.

A naval air wing may legitimately be classified as a team in so far as team members have meaningful task interdependencies, possess common goals, use multiple information sources, and have specialized roles. However, they possess a number of characteristics that may pose unique training challenges. One of these has to do with the sheer size of the team. A given air wing power projection mission may involve over 100 aviators flying in the multiple platforms and elements required to support a naval strike mission. Table 2 describes the four of the mutually supporting subteams that comprise an air wing. During mission execution, aviators adhere to a strict timeline and positioning plan, and are geographically dispersed so that, for the most part, other team members cannot be seen. Moreover, communications are extremely limited. This demanding war fighting environment is managed by a group of aviators, 50 percent of whom may be recently out of the fleet replacement squadron (FRS). Thus, the coordination of timelines, positioning, communications, and adaptive maneuvers among these subteams poses significant integration issues.

The selection of training strategies for air wings is also complicated by the three distinct phases that comprise a power projection mission: planning, briefing, and execution. Performance in each phase is crucial to overall mission success and we believe that each of these phases is likely to require an emphasis on different teamwork competencies. Our goal was to examine critical incident data for these three mission phases against the competencies identified in Table 1. Our results are presented following a brief description of the NSWAC training deployment and a description of the critical incident database.

Table 1. Representative Team Competencies (adapted from Salas & Cannon-Bowers, in press).

Knowledge-based competencies

- Teammate characteristics: Knowledge of team member strengths and weaknesses
- Task model: knowledge of the task environment including threats or likely challenges, how the task is sequenced, and so forth
- Cue-strategy associations: knowledge related to the ability to accurately recognize and react to environmental cue patterns
- Shared task models: relevant task-related knowledge that is shared with other team members

Skill-based competencies

- Communication: Ability to clearly and accurately send and receive communications
- Assertiveness: Ability to confront ambiguities and conflict in a professional manner and communicate ideas and observations in a persuasive manner
- Team leadership/motivating team members: Ability to direct, prioritize, & coordinate the actions of team members; ability to create a positive atmosphere
- Adaptability: Ability to dynamically adjust strategies based on information gleaned during task performance
- Interpersonal: Ability to optimize the quality of team member interactions

NSAWC TRAINING DEPLOYMENT

Figure 1 shows the air wing training continuum. It can be seen that, once aviators enter the fleet, the training deployment at NSAWC represents one of the first and only opportunities for aviators to acquire key integration or "war fighting" skills. These skills are reinforced only infrequently through fleet exercises following the NSAWC training.

At NSAWC, three training phases are conducted over the course of three weeks in a building block approach. Mission level training (MLT) involves the tactical planning and execution of specific mission areas such as suppression of enemy air defenses (SEAD) or anti-air warfare (AAW). Unlike unit level training, different tactical aircraft are combined and utilized for the execution of the missions. Following MLT, the integrated training phase (ITP) challenges the air wing to plan and conduct tactically sound power projection missions during eight to ten stand alone operations that systematically increase in difficulty. Thus, ITP forces the air wing to integrate all air wing elements in addition to battle group assets. Each ITP event is driven by specific objectives such as performing a night, low altitude mission. Finally, the Advanced Training Phase (ATP) phase follows during which the air wings respond to an evolving, four-day scenario.

Table 2. Air Wing Elements.

Air Wing Element	Description
Strike	Comprised of aircraft such as the F/A-18 and F-14, the function of the strike package in a power projection mission is to depart from a carrier, proceed through a predetermined ingress route toward a target where they deliver ordnance, regroup, and then return to the ship via the egress route.
Anti-Air Warfare	The function of the fighter element is to protect the strike package from enemy aircraft. The fighter element is composed of aircraft such as the F/A-18 and F-14.
Suppression of Enemy Air Defenses (SEAD)	The function of the SEAD element is to protect the strikers from ground-based enemy threats. The SEAD element is comprised of at least one EA-6B aircraft that performs electronic warfare such as jamming enemy radars and communications. In addition, SEAD usually includes aircraft such as the EA-6B or F/A-18, which release missiles to destroy enemy radar sites as well as fighters carrying air-to-air weapons to protect the SEAD package.
Command & Control (C^2)	The E-2C aircraft is used to perform the command and control function. It directs mission aircraft, maintains an overall view of the mission, and provides a link back to the carrier group.

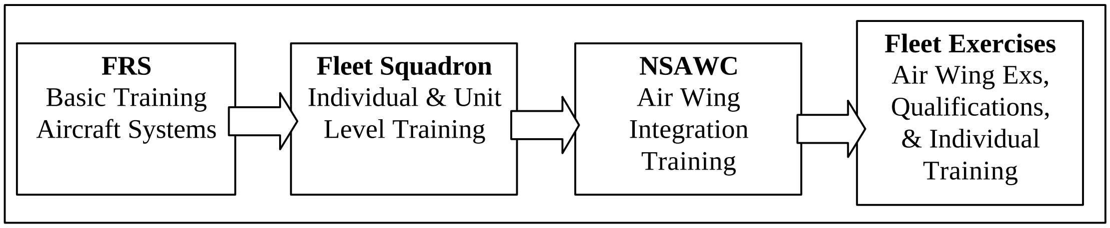

Figure 1. Current Navy Air Wing Training.

Data Base Description

The data obtained from NSWAC are a record of debrief comments made by NSAWC instructors over five air wing training deployments. Each comment describes a specific incident and each incident can be classified as an example of effective or ineffective performance. These incidents were converted to a database which contains approximately 1400 incidents. In addition to being classified as an example of effective or ineffective performance, each incident has been coded by:

- Air wing element. Each comment pertained to one of the air wing elements shown in Table 2. Some comments applied to all elements.
- Mission phase. Each comment applied to the planning, briefing, or execution mission phase.
- Event. Each incident applied to a specific ITP or ATP event. Incidents do not include MLT events.
- Functional area. Subject matter experts coded each comment into an operationally relevant functional area. For example, comments may have pertained to “leakers” or to the use of data link equipment.

RESULTS

Below we examine the key functional areas by each of the three mission phases.

Planning Phase. The planning phase is led and managed by a strike leader who is supported by individuals representing each of the air wing elements participating in the mission. During the planning phase, the strike leader examines the mission tasking and probably very quickly frames the problem. After that, the task becomes one of planning a specific response based on input from representatives of the air wing elements participating in the strike, threat assessments, weapons and platforms available, battle group assets as well as other information.

Figure 2 shows the functional areas mentioned for the planning phase that had a frequency of at least 9 (the same rule was applied to comparable figures for the briefing and execution phases). The frequency of times an incident was mentioned was taken to provide some indication of its importance. The bars shown are also proportioned by the number of times the comment referred to an effective or ineffective action on the part of the air wing. The data shown in Figure 2 suggest that the development of contingencies is crucial based on the frequency with which it was mentioned. As we examined the database in greater detail, we found that comments pertaining to contingency planning cut across elements and functional areas. It was a pervasive task.

Another frequently mentioned category was the “Use of Assets” area. This category refers to how well the air wing assets were understood and integrated for the strike plan. The instructor comments obtained had to do with the number and types of platforms that were selected for the mission, whether adequate resources were used to target threats, the quality of decisions on how assets were to be used to deconflict planes or to provide identification of hostiles, and so forth.

Management skills also appeared to be important during the planning phase. A plan must be developed within a limited timeframe requiring prioritization so that the myriad details can be worked out and so each element has the information required to do their own planning. Thordsen McCloskey, Heaton and Serfaty (1996) found that a key to planning organization is the timing and sequencing of information disseminated to the other platforms so that they may perform detailed planning. Consider some of the air wing subteam interrelationships:

> The positioning and actions of the EA-6B(s) and E-2C depend on where, when and how the strikers will execute their portion of the mission…the F/A-18 pilots

must know which ground-based threats the EA-6B crew members will be able to suppress and which threats they must avoid when approaching the target(s). Conversely, the EA-6B must know when the F/A-18s will reach the target so they can begin to suppress the enemy air defenses at the appropriate time. The E-2C crew members must know where the F/A-18s will be throughout the mission, so that they position themselves in a location that ensures the ability to communicate throughout. (p. 13-14)

Figure 3 plots the proportion of effective behaviors for the areas discussed above (i.e., all the functional areas mentioned with a frequency of at least 20) early and late in the ITP phase. It should be noted that a traditional use of comment data such as contained in the data base is to determine training requirements by examining the types and frequency of critical incidents, as was done in Figure 2. A non-traditional use of such data is shown in Figure 3 which depicts trends. A large assumption is made that the proportion of effective behaviors is indicative of performance quality. This may not be a valid assumption.

It can be seen that even late in the ITP phase, the majority of comments (over half) are negative, at least suggesting that there is a tremendous room for improvement in these areas.

Briefing Phase

The mass brief follows the planning phase. Nearly every aviator participating in the mission attends. During this brief, the object is to convey the "big picture" or overall mission concept regarding the mission goals, threat assessment, operating areas, roles and interactions of the elements, and so forth. While a small subset of the aviators from each element supported the planning process, this brief is the first exposure to the mission for most of the aviators. They must retain, embellish, and implement the information obtained in the mass brief as they attend or conduct the subsequent briefs leading to mission execution (i.e., element briefs, aircrew briefs).

The frequency with which the key areas were mentioned for the briefing phase is shown in Figure 4. "Use of Assets" remains an issue in the briefing phase. The other frequently mentioned areas were organization of the brief and the use of snapshots. Organization comments pertained to the order in which key information was provided to effectively build the big picture. (Building an overall picture was also frequently mentioned). Snapshots are graphics at key time intervals depicting information such as flow, waypoints, and element positions. Comments pertaining to "snapshots" pertained to what information should be included to effectively convey the mission flow. Thus, the overall message from these data is building the overall mission picture or concept. Figure 5 provides some indication that while the snapshots and use of assets improved over the ITP events, the organization of the generally brief remained poor.

Execution Phase

The execution phase can be characterized by strict adherence to the briefed plan. Air wing members build a picture of what is happening through their own instrumentation and through the communications that are issued from the E-2C. These communications build a picture of the threats and include codewords for major mission milestones. Communications usually occur by exception only among the other air wing elements.

Not surprisingly, it can be seen in Figure 6 that communication is a frequent topic for the execution phase. The comments made be the instructors largely pertained to communication brevity, cadence, and terminology and primarily referred to interactions between the E-2C (i.e., C^2) and AAW elements. Figure 7 suggests that only a slight increase in the effective behaviors was seen on this topic, suggesting that this may be a fruitful area for simulation-based training.

A cluster of incident areas shown in Figure 6 related to adherence to the plan. These areas included timeline, positioning and flight discipline. Finally, another cluster of areas pertained to interactions between the E-2C and the fighters in the air-to-air role. Topics pertaining to their interactions include positive identification of hostiles and "Direction." Comments on the latter topic referred to how proactive the E-2C platform was in directing the fighters.

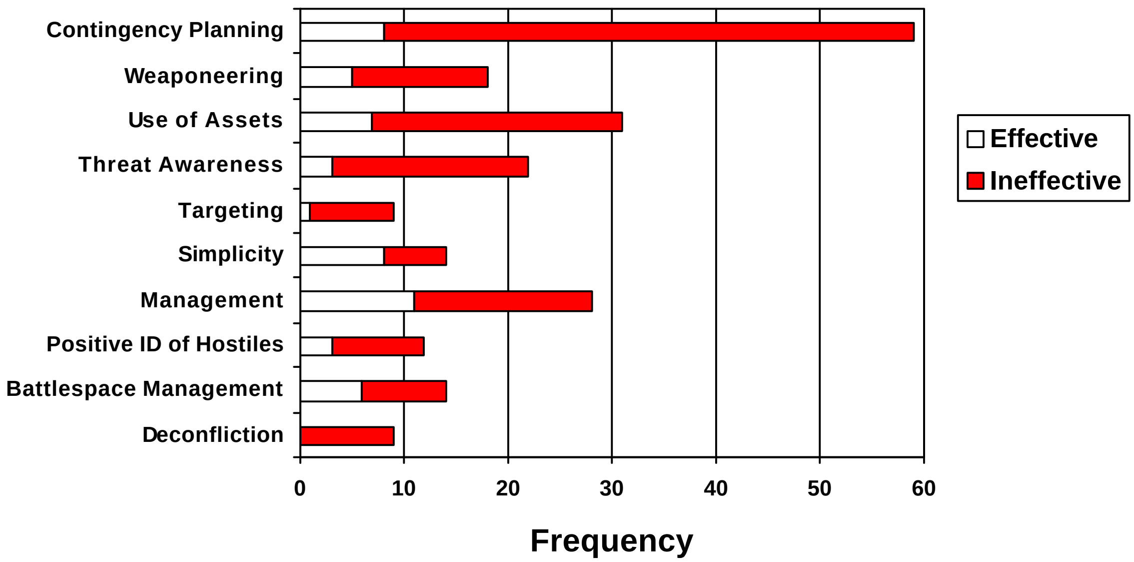

Figure 2. Frequency with which key functional areas were mentioned in the planning phase.

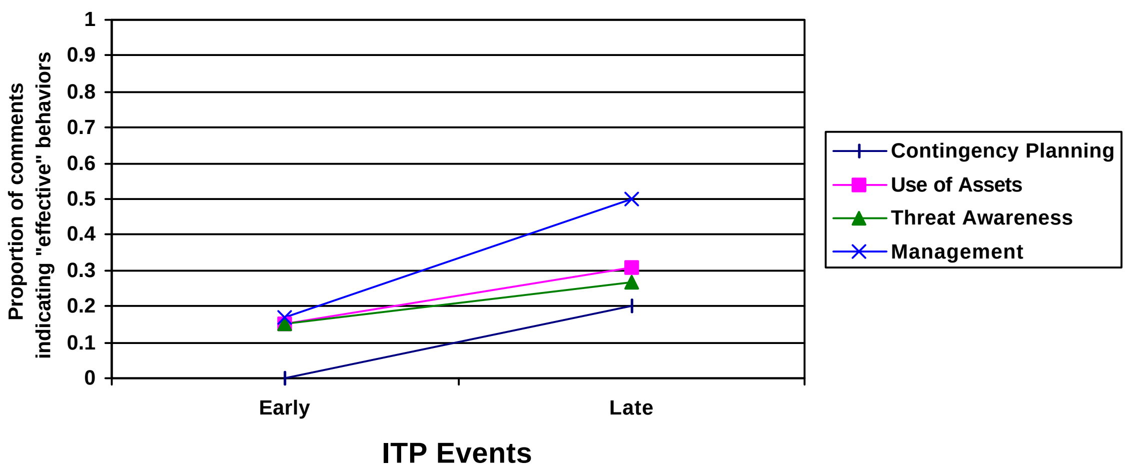

Figure 3. Proportion of comments indicating effective behaviors were observed early (first three events) and late (last three events) in the ITP phase.

IMPLICATIONS

Table 3 summarizes the results from the critical incident database against the set of team competencies introduced in Table 1. Our data suggested that profiles of different team competencies are critical in the different mission phases. During the planning phase, the use of different team and task models or schemas is critical. The frequency of incidents related to the "Use of Assets" suggests that planners are having difficulty using air wing elements in a manner that is fully responsive to the complex mission task demands. The data also suggest that the development of task models for a particular mission need to be extensive, with extensive contingency planning. Context relevant training, which introduces air wing platform capabilities and limitations and exercises their ability to match plans against task requirements would appear to be beneficial.

For skill-based competencies, team leadership is one of the most important skills during the planning phase. Strike leaders, as well as element leaders, need to understand how to prioritize planning tasks and integrate input so that an efficient plan is developed within a constrained timeframe. We would also argue that, during planning, there is also opportunity and a need for interpersonal team skills and skills such as assertiveness. These become less important, and even inappropriate, during the mission execution phase. Conversely, our data suggests that during the mission execution phase, communication, as defined in Table 1, is critical. The need for precise, unambiguous communication is much less important during the planning and briefing phases when, generally, there are ample opportunities to clarify meanings and time is not as critical.

During the briefing phase, the key competency is building a common understanding of the mission. The critical incidents suggested that organization and content of the mass brief are critical. In this area, we believe that principles of schema-based instructional models may be usefully applied to this problem. Such a focus may increase the probability that the aviators, especially novice aviators, will be able to apply the information. Consider how well schema-based approaches fit into the general intent of the brief.

> "…in schema-based instruction, one wants to introduce the domain to students in a top-down rather than a bottom-up way. It is essential to give them the big picture of the domain so that they can begin to organize their knowledge about it in meaningful chunks." (Marshall, 1995, p. 120)

This is exactly the intent of the mass brief. In addition, information in schema-based learning is presented to focus on how it may be used and applied, and stresses how and why different elements, components are related (Marshall, 1995). These "rules of thumb" for schema-based instruction may be directly applied to select and organize information presented in the mass brief to improve shared task models and ultimately to improve mission performance.

In addition, we can also envision a hands on practice training intervention in which junior air wing members must organize information about a mission, build an overall picture, and discern how and why elements are linked. This would potentially be a highly context-relevant and effective training strategy.

The notion of adaptability is one of the most difficult to handle for large tactical teams. Clearly, there is great emphasis on contingency planning and on making these known and understood during the brief. This combined with the restricted communications during execution suggests limited opportunities for adaptability.

Related to this is the notion of "implicit coordination" (Kleinman & Serfaty, 1989; Rouse, Cannon-Bowers, & Salas, 1992). Implicit coordination is a characteristic of well-performing teams. That is, team members are able to coordinate and adapt because they have when they are unable to communicate because the possess common or complimentary knowledge structures, because they know each other and because they have experience performing together as a team. In the literature, words such as "predict," "foresee," and "anticipate" team member requirements are used.

We argue that this mechanism of implicit coordination may have little utility at the

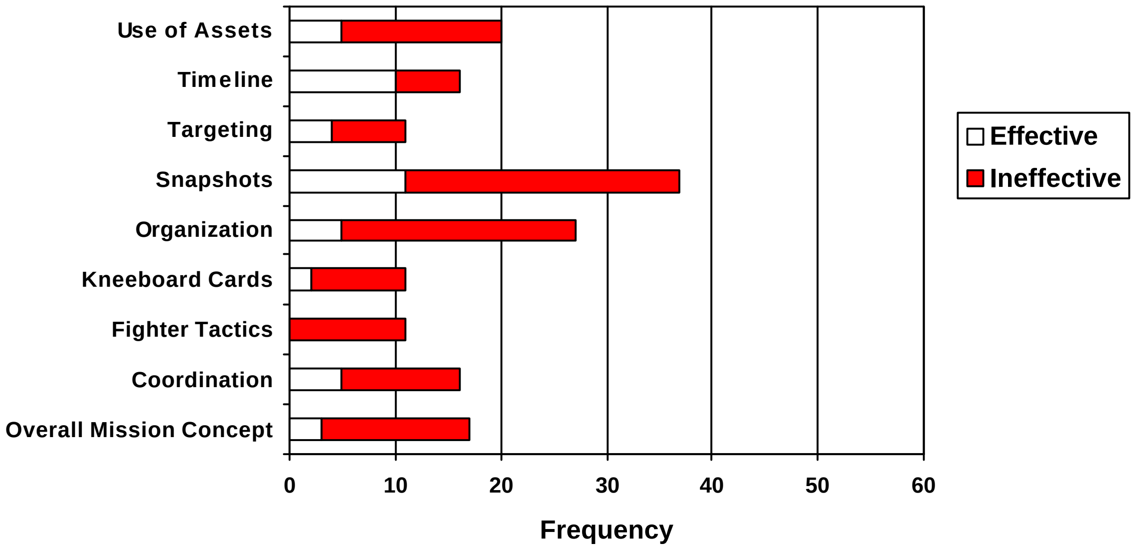

Figure 4. Frequency with which key functional areas were mentioned in the briefing phase.

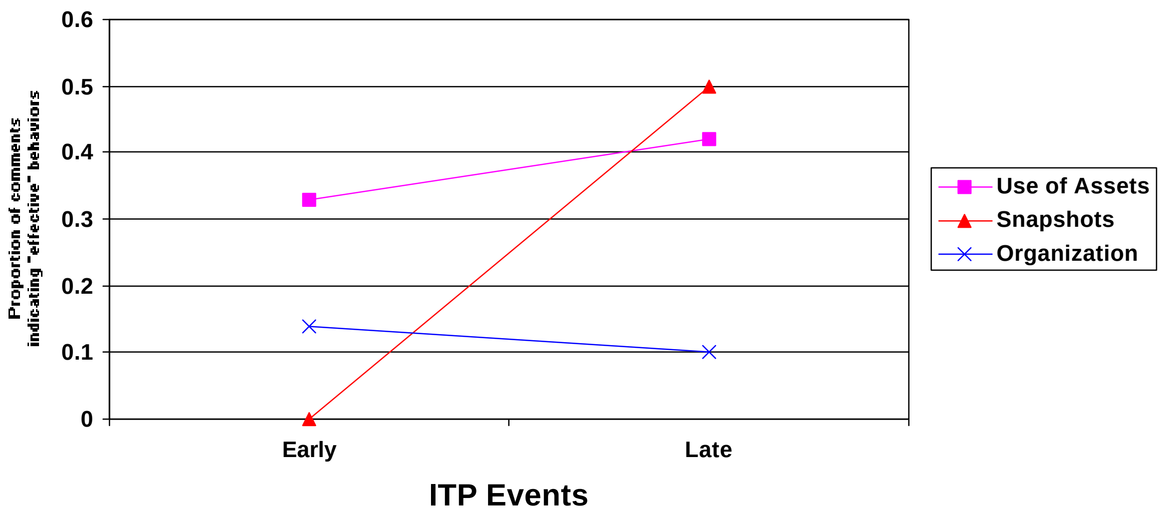

Figure 5. Proportion of comments indicating effective behaviors were observed early (first three events) and late (last three events) in the ITP phase.

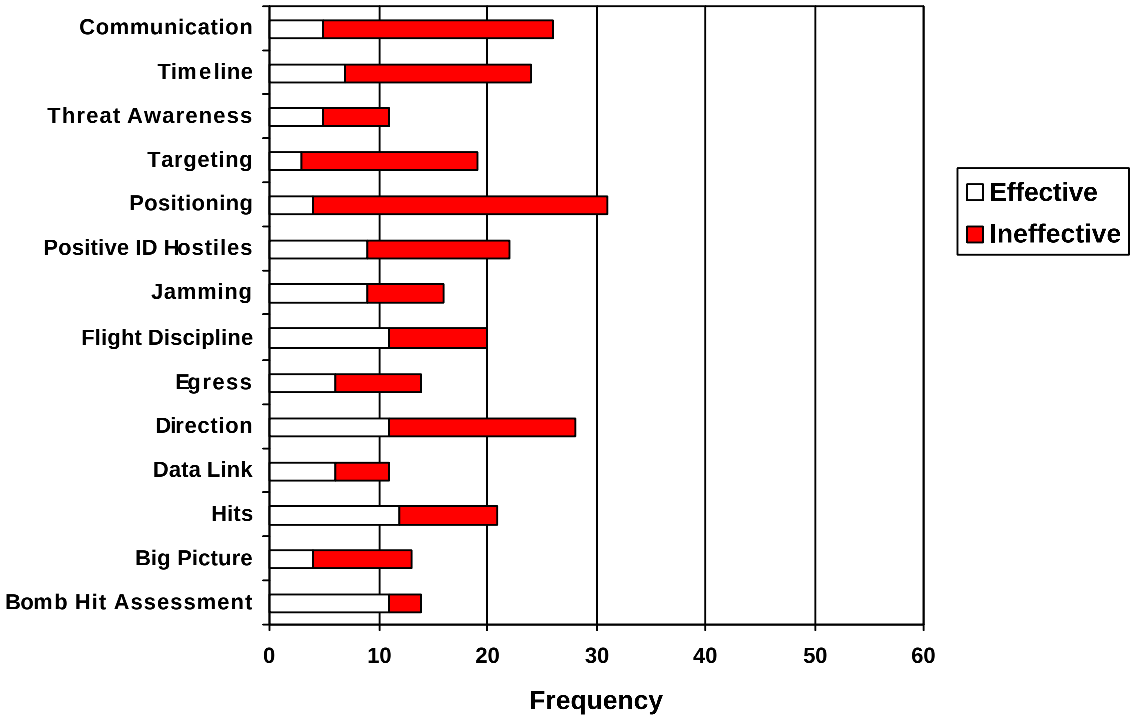

Figure 6. Frequency with which key functional areas were mentioned in the execution phase.

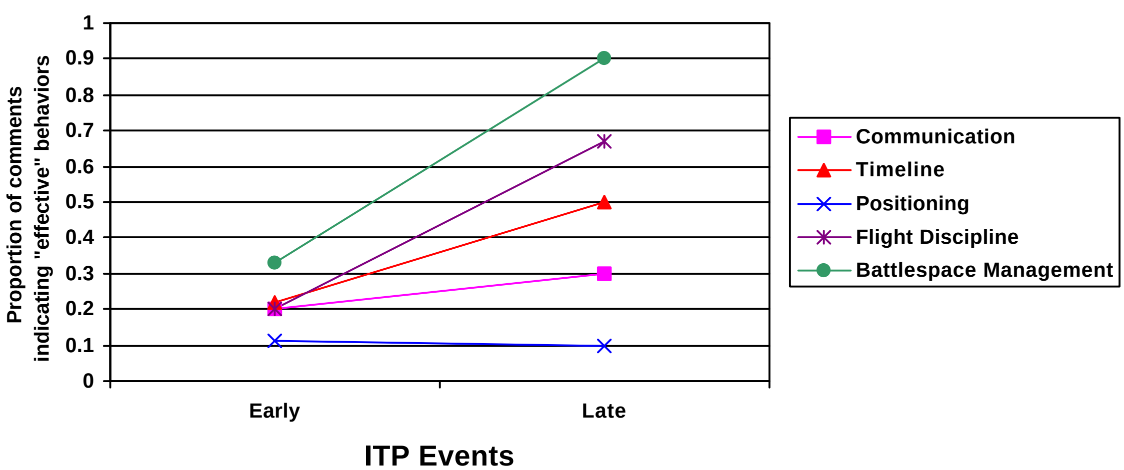

Figure 7. Proportion of comments indicating effective behaviors were observed early (first three events) and late (last three events) in the ITP phase.

Table 3. Team Competencies by Air Wing Mission Phase

Team Competency		Mission Phase		
		Planning	Brief	Execution
Knowledge-based	Teammate/element characteristics	✓		
	Task model	✓		
	Cue-strategy associations	✓		✓
	Shared task models		✓	
Skill-based	Communication			✓
	Assertiveness	✓	✓	
	Team leadership/ Motivating team members:	✓	✓	
	Adaptability			
	Interpersonal	✓	✓	

air wing level. Novel situations of any significance usually require the mission to be aborted because of the difficulty in adaptability on such a large scale. Any appearance of adaptability is a result of the explicit, detailed contingency planning that has been effectively communicated. The few incidents requiring the entire air wing to adapt in our data were usually unsuccessful. In addition, attempts of individual air wing members to deviate from the script, even if those deviations were well intentioned and effective, are labeled as flight discipline problems.

At the subteam level, adaptability and implicit coordination would seem to be viable concepts as long as the general pattern shown remains as expected by the other elements. Elements, for example, may internally handle system problems and effect flight lead changes, as long as they remain on time and in position.

Regarding inter-element adaptability, that too may be a key component for air wings. Our data suggest that the interactions between the C^2 and fighter element are highly dynamic and adaptability is a key requirement. Cue-strategy associations that arise from experience are essential. The frequency with which these inter-element interactions were mentioned during the execution phase suggests that these may be viable candidates for simulation-based training during which the key schemas are identified *a priori* such that the experiences can be purposefully constrained to focus on the key experiences. As an example of this type of simulation, we envision dynamic man-in-the-loop simulation for the C^2 and AAW elements with other air wing elements being simulated. This approach would allow sufficient control over the simulation to prompt the key interactions that should occur to foster schema development. Such training could be provided before attending the NSAWC deployment. Greater competence in these areas prior to the NSAWC deployment is likely to improve the quality of the training received there as well as enhance subsequent fleet level training exercises.

CONCLUSIONS

To summarize, an analysis of critical incident data against key team competencies suggested different competency profiles exist for air wings in the planning, briefing, and execution mission phases. We acknowledge the importance of supporting our conclusions with other sources of data or information. If our preliminary findings hold, several conclusions seem warranted. In the planning phase, the use of preexisting knowledge structures and well-developed execution schemas (Marshall, 1995) appear to be critical. Training interventions might focus on planning scenarios deliberately contrived to provide cross training and enhance key knowledge deficiencies.

In the briefing phase, the development of shared task models was the most critical competency. It was suggested that schema-based instruction fits well into the briefing model and may provide the basis for job aids as well as for training. Finally, for the execution phase, the use of cue strategy associations was identified as a key competency and it was suggested that simulation-based exercises could be an effective training intervention to provide focused practice leading to effective cue-strategy associations.

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