USMC Training: A Synthesis of CNA's Work

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Summary

Maintaining a corps of highly skilled Marines is critical to the success of the Marine Corps. Perhaps more than any other Service, the Marine Corps is considered the force in readiness, prepared to respond to any contingency at a moment's notice. But building good Marines takes time. Such a force is the result of well-conceived and properly designed training and education programs. The Center for Naval Analyses' (CNA) training analyses are designed to help the Marine Corps develop and maintain such programs. As this report shows, these analyses have tended to fall into two distinct categories—training assessment/development, and the economics of training (i.e., the links between training and manpower).

In our training assessment/development studies, we usually attempt to answer one or both of the following questions, "Is what is being taught, being learned?" and "Is what is being taught, what needs to be taught?" Only when the answer to both of these is "yes," is the training most effective. To make this determination, we use a skills-based approach to identify the core skills (or in some cases, just the core tasks) that a Marine needs to acquire through specific training and to assess whether the training teaches those skills, or we may analyze whether the skills being trained are the skills that a Marine needs to have for a particular type of operation or mission.

As an example, over the past 20 years, we have applied a skills-based approach to:

- Assess current or proposed training programs based on critical mission skill development
- Develop training parameters/requirements (based on critical mission skill development) for new, or non-standard missions
- Determine how outside factors, such as encroachment and resource constraints, affect the Marine Corps' ability to train critical mission skills

The second general type of training study we undertake explores the links between manpower and the training pipeline, and has two sub-sets. The first sub-set of studies from this category focuses on the rates and causes of attrition, particularly for first-term, non-End of Active Service (non-EAS) Marines, and on critical indicators that the Marine Corps can use to better track manpower throughout the training pipeline. The second sub-set of studies in this category focuses on how long it takes to train a Marine, and the effect of the training process on manpower.

CNA's attrition-based studies found that overall attrition rates had not changed dramatically (either for better or worse) between 1980 and 1992, despite the fact that recruit quality improved considerably over this timeframe.[1] In addition, we found that certain recruit characteristics (mainly lower educational credentials and requiring waivers) were linked to an increased likelihood of attriting early. We also found that many attritions were for physical reasons and proposed several ways to modify recruit training so as to decrease the chance of physical injuries (in turn hopefully, lowering attrition).

CNA's time-to-train studies focused on developing a tool to help the Marine Corps determine how long it really takes to train new Marines. Through this series of studies, we determined realistic times-to-train for each Primary Military Occupational Specialty (PMOS). We further analyzed the total training time to determine its components and created a database that enables the Marine Corps to see:

- How much time is spent in the classroom
- How much time is spent waiting for courses to convene
- How much time is added due to setbacks.

While our analyses show that Marines spend a large amount of time awaiting training, we caution the reader not to jump to the conclusion that there are inefficiencies in the training pipeline. Given the current operating environment, manpower constraints, and

1. We caution that these studies are over 10 years old and some of their findings may no longer hold.

distribution of Marines entering the pipeline, the current system may be operating as efficiently as possible. Rather, our database and recommendations are designed to give the Marine Corps the means to make this determination.

In summary, while the specific findings from any individual study are important in that the analyses hopefully answer the sponsor's particular question at hand, they may be even more significant when considered as part of the entirety of our training analyses. As this report shows, considered together, the approaches, methodologies, and data we use for these studies give the Marine Corps the tools it needs to better assess its training programs, processes, and pipeline, and to better prepare itself for the future.

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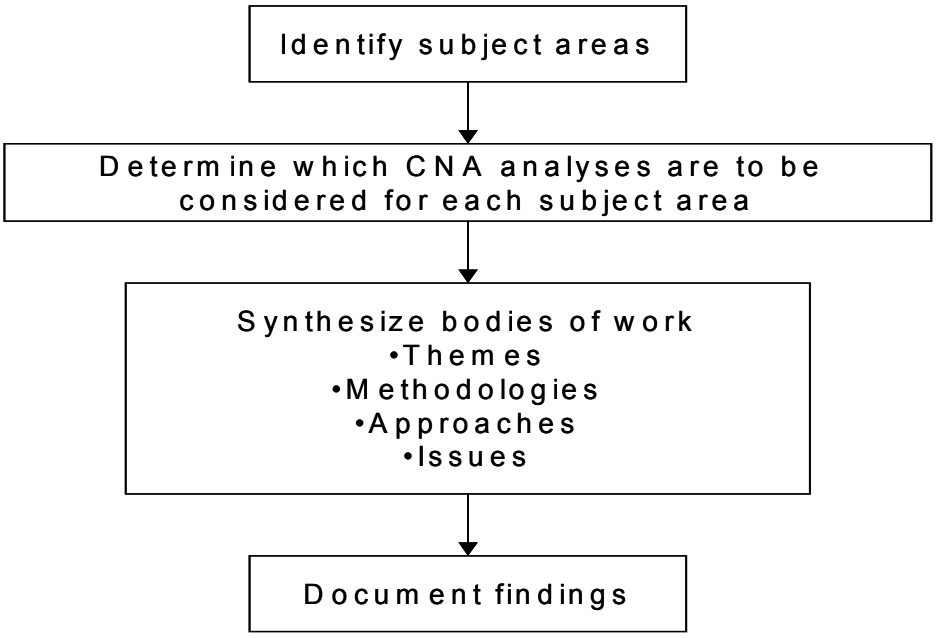
Introduction

The Center for Naval Analyses (CNA) has executed numerous studies for the Marine Corps. These have included both formal studies by analysts at CNA headquarters and less-formal analyses conducted by CNA field representatives in support of their commands. Over the years, many of these analyses have focused on five critical areas: operational assessment, organizational analysis, reconstruction of real-world operations, prepositioning, and training. For several reasons—including the nature of the field representative program, the requirements of various commands, and the disconnect between field work and headquarters-based analyses—most of our efforts in these areas have been discrete and little effort has been made to synthesize their results. In short, there is no overarching document that synthesizes the method and substance of the work we have done in each of these five areas.

Methodology

In this CNA-initiated study, we identify key themes and issues in each of the five areas of analysis. Our overall approach was to take a critical look at the work (especially the more recent analyses) we have done for the Marine Corps in each of the identified key areas. Figure 1 summarizes the four-step process we used to execute our analysis plan. For each of these areas, we present the "bottom line" results of our efforts. We have designed the study to provide for separate documentation for each key area. Our previous reports, *Operational Assessment Primer: A Synthesis of CNA's Work for the Marine Corps*, *Organizational Analysis Primer: A Synthesis of CNA's Work, Real-World Operations: A Synthesis of Issues Challenging the Marine Corps*, and *Prepositioning: A Synthesis of CNA's Work for the Marine Corps*, were published in October 2006, August 2007, January 2008, and May 2008, respectively [1-4]. This is the final task and deliverable for this study, and marks the completion of this phase of our synthesis efforts.

Figure 1. Four-step process



Tasking

This report discusses our work in the area of Marine Corps training. Though some may argue over the distinction between "training" and "education," for our purposes in this report, there is little difference.[2] While each individual study may emphasize one over the other (e.g., training over education, or vice versa), our analyses usually encompass a combination of the two. Therefore, while we use the term "training" throughout this report, the term is meant to encompass both ways (i.e., training and education) that Marines become highly skilled and highly knowledgeable.

2. In general, training emphasizes the performance of skills and procedures (i.e., the proper utilization of an Mk-19), while education emphasizes the method and decision-making framework that would be applied to a scenario [5].

Over the last 20 years, CNA has executed numerous studies on a wide range of training-related issues.[3] A careful review of these analyses shows that our studies generally fall into one of two distinct categories or types—training assessment and development, or the economics of training. The first series of studies, those we categorize as "training assessment," focus on analyzing whether a specific type of training or training event meets the Marine Corps' specified or implied goals. The second series of studies, those we categorize as the economics of training, focus on the link between training and manpower. The two types of studies are very different from one another, and each applies a unique approach to the analyses it encompasses. Our goal in this report is to synthesize the key aspects of each series of studies, showing our intended audience (i.e., CNA analysts, Marine Corps, and other potential sponsors) how we approach the different types of studies and their main lessons or takeaways.

Organization

We organize this report into two main sections, each focusing around one of the two series of studies discussed above. In the first section, we discuss our training assessment, evaluation, and development studies. We describe the primary method that we use to conduct such analyses—the skills-based approach. We show how we use this approach to analyze whether existing (or proposed) training is meeting the Marine Corps' objectives and a trainee's needs. In the second section, we discuss the series of studies that focus on the economics of training and retaining Marines. The studies we examine for this section include our analyses of:

- The relationship between training and non-End of Active Service (non-EAS) attrition

3. While many of CNA's training studies have been executed solely on behalf of the Marine Corps, some studies have been done for non-USMC sponsors. To the extent that such studies informed our Marine Corps analyses, we include their "results" in this report.

- Manpower critical indicators
- “Time-to-train” and its impact on manpower.

We conclude with our final thoughts on the overall body of our analyses in the area of Marine Corps training.

Training assessment

In this section, we discuss CNA's first general type of training study—training assessment and development. We have executed numerous studies that fall into this category. Specific studies have focused on:

- Aircrew and pilot training [6-22]
- Weapons tactics training [23]
- Combined Arms Exercise training [24-27]
- Better methodologies for training management (specifically focused on ground combat training plans)[28-33]
- Marine Expeditionary Brigade (MEB) training [34-37]
- Impacts of encroachment on training [38-40]
- Irregular warfare training [5, 41-44].

As this list shows, this category of training study covers a wide array of specific topics. Less evident is that these studies also varied on the specific training issue or question addressed. In some of these studies we evaluated existing training (or training process) to determine if it was meeting documented objectives/requirements and identify how it might be refined to better do so [6-16, 23-33]. In other studies, we were tasked to develop training or training requirements based on a review of operational requirements [5, 34-37, 41-44]. In other studies still, we assessed the impact of outside influences (e.g., range availability, funding, and equipment resources) on training opportunities, readiness, or performance [17-22, 38-40]. Regardless of the specific training issue or question being addressed by a particular study, however, our basic overall approach was to look at training effectiveness or impacts from the most detailed level possible (e.g., required skills, tasks, or capabilities) given the constraints of the study (e.g., time, availability of data). In this section, we discuss our approach, which we call the skills-based approach, and its applications.

Skills-based approach

Building good Marines doesn't happen overnight. Our training studies are designed to help the Marine Corps assess, refine, and develop training programs and processes that produce well-trained, highly-skilled Marines. At their core, our analyses are designed to answer the questions "Is what is being taught, being learned?" and "Is what is being taught, what needs to be taught?" Only when the answer to both of these is "yes," is the training most effective. Therefore, in these types of studies, we may identify the core skills the Marine needs to acquire through that training and assess whether the training teaches those skills, or we may analyze whether the skills the training is theoretically designed to teach are the skills the Marine needs to have for a particular type of operation or mission. We generally make such assessments using the skills-based approach. While the details of how we apply the approach may vary slightly from one study to another, the overall methodology remains fairly constant.

Background

Maintaining a body of highly skilled Marines is critical to the success of the Marine Corps. Perhaps more than any other Service, the Marine Corps is considered the force in readiness, prepared to respond to any contingency at a moment's notice. This type of force can only be the result of a well-conceived training and education program, which is characteristic of the Marine Corps.

The Marine Corps believes that successful Marine units train as they fight and fight as they train. This ethos is the foundation of unit training in the Marine Corps. Three key elements form the backbone of this ethos:

- Unit Training Management (UTM)
- Systems Approach to Training (SAT)
- Training & Readiness (T&R) standards

UTM uses the Marine Corps Training Principles and the SAT to maximize training results and focus on the training priorities in preparation of wartime missions.[4] The SAT process gives commanders a

model to use when planning and conducting training, and helps ensure that Marines acquire the knowledge and skills essential to be successful. Training & Readiness (T&R) standards, outlined in T&R manuals and matrices, are used to evaluate a Marine's or a unit's proficiency in the tasks required for a specific military occupational specialty (MOS) or a unit's ability to perform a specific combat mission.

Focus

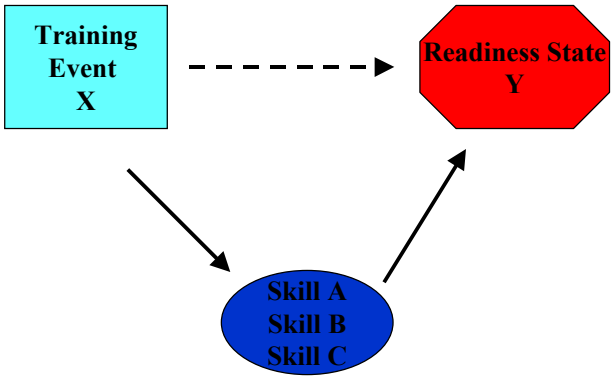
Marines of all specialties undergo a process of continuous tactical training throughout their careers in order to develop and maintain a state of operational readiness for whatever their particular missions or roles. One way to measure readiness or how proficient a Marine or Marine unit is at a given point in time is to track the completion of specific training events or the results of completed missions. While these methods have been used, all indications were that they were not very effective [8, 14].

The skills-based approach uses the achievement of skills (not the completion of events) as the basis for determining the state of readiness, and thus, the effectiveness of a particular training event or program. Figure 2 represents these connections. The dashed line connecting Training Event X to Readiness State Y indicates there is only a secondary relationship between the two. It exists only to the extent that the training event led to the achievement of Skills A, B, and C, which in turn led to the achievement of Readiness State Y. Our approach views proficiency or readiness not in terms of events completed, but rather in terms of the ability to execute critical mission skills.

UTM describes the process of selecting tasks from the T&R standards and designing training plans to practice them. Our skills-based analyses have been integral to developing and maintaining the rigor

4. The Marine Corps Training Principles are: Train as You Fight, Make Commanders Responsible for Training, Use Standards-Based Training, Use Performance-Oriented Training, Use Mission-Oriented Training, Train the Marine Air-Ground Task Force (MAGTF) as a Combined-Arms Team, Train to Sustain Proficiency, and Train to Challenge.

Figure 2. Schematic of the skills-based approach



of this training ethos by helping to determine which tasks and skills are critical to mission success, and helping to demonstrate the connection between the level of practice of the task and the proficiency in performing it. In addition, if tasks are not well articulated, we assist in identifying what to focus on in training. Or, when a new mission arises, we help determine whether current training meets new requirements. By dissecting the new mission into its tasks and skills, we can determine which are already being covered by training events and which are falling through the cracks. When commanders know what training is lacking, they can more precisely design pre-deployment work-ups.

We point to four unique aspects of the skills-based approach. First, using skills as the basis to evaluate training and readiness allows one to clearly understand the connection between practice and performance. Second, the skills-based approach works backwards in that it starts with mission requirements and works "back" to identify the training needed to support those mission requirements. Third, this analytic approach allows one to consider (and stress) the importance of intellectual skills (e.g., decision-making and recognition) and the connections between these skills within the context of the mission. And, fourth, the skills-based approach is practical and reproducible—it is a methodology that commands can use when designing or evaluating other training.

These characteristics of the skills-based approach have helped to refine training in the Marine Corps. Some of the other approaches that were used in the past were unable to link training resources to readiness, which sometimes resulted in tasks being added into training programs without much consideration as to how they fit into a mission's requirements or a trainee's needs. In addition, more classic training design methodologies focus only on those things that are measurable or quantifiable. The skills-based approach has shown that incorporating intellectual skills into training can lead to better training objectives and performance measures.

Finally, it is important to note that, in many instances, a comprehensive list of required skills for a Marine (or set of Marines) is not always readily available. Therefore, in many of our analyses, we start by compiling the required missions required for that unit and/or trained from a specific training event or program. Since operational missions are really just a set of functions that require the execution of actions (i.e., tasks) in a sequential manner, we break the missions down into their component tasks. We break tasks down into smaller pieces (i.e., sub-tasks), and, to the extent possible, we break tasks down into their motor and intellectual skills.[5] This building block effect is represented in figure 3.

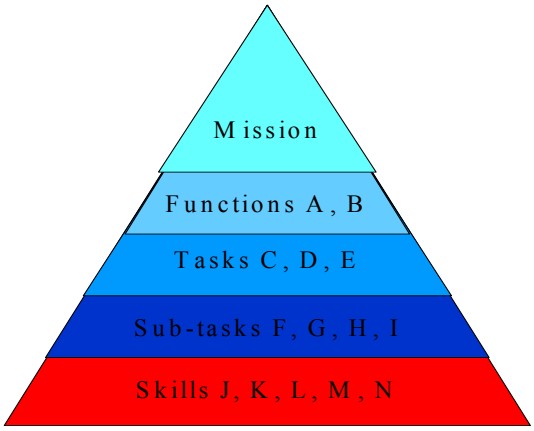
Methodology for assessment

The skills-based approach to training assessment or development has two main steps, each with sub-steps:

- Identify critical skills for mission execution
  - — Develop task list
  - — Apply risk assessment methodology
    - – Make chronological linkages

5. While we call this the skills-based approach, in some instances we are not able to analyze down to this level of granularity. In those instances, we use an abbreviated skills-based methodology, which uses tasks or capabilities as the basis for assessing, evaluating, or developing training events and programs.

Figure 3. Building block approach to skills-based methodology



  - Make functional linkages

- Develop measures of performance
  - Break out mission processes by mission segment
  - Identify functional outputs and observables

As indicated above, the starting point for our skills-based approach is the conduct of a task analysis. Such an analysis identifies all the tasks that comprise a function, as well as their components (sub-tasks).[6] This may result in an extremely detailed and long list of skills, which is too unwieldy to be of practical use to trainers. Our next step is to link the skills chronologically (in terms of mission flow and transitions) and functionally (in terms of mission processes) so that we can identify which skills are critical and determine relational performance measures.

6. For our analyses, we use a wide range of sources to determine mission task lists. These include doctrine, lessons learned, training manuals, training syllabi, memos, guides, interviews, subject matter experts, tactical manuals, journals, operational plans (OPLANs), Universal Joint Task lists (UJTLs), service task lists, higher headquarter guidance, surveys, previous studies, observations, and training standards.

Critical skills

Because the initial list of required skills from step 1 is usually quite detailed and long, a sub-step in the process is usually an effort to pare down the skills list to determine the critical skills. These skills are those that are highly significant to mission success. They must be mapped into training objectives, which are the focal points of training events. While a trainee needs to be able to perform (and so, must practice) all of the tasks and skills identified, the non-critical skills do not necessarily need to be the focus on a specific training event. For example, assume target acquisition is a critical skill. During a training event that focuses on navigating into a target area and designating an intended target, a trainee will still practice taking off and landing, but those skills are not the objectives of the specific training event.

We use a risk assessment method to determine critical skills. We consider three factors:

- *Chronological links* with other skills
- *Significance* and the effect that inadequate skill performance would have on fundamental attention areas
- *Functional links* with other skills as viewed from the process perspective.

We make chronological linkages using execution timelines in order to visualize the inter-relationships between skills. In some cases, there are parallel timelines that must be considered. For example, in our analyses of aircrew skills, we use four broad categories to characterize process timelines—mobility, effectiveness, survivability, and coordination [7, 12]. We use these categories again when assessing significance. We examine each skill (or in some instances, each task) for its importance. In our aircrew training work, we used a three-level ranking structure—low, moderate, and high. Table 1 details an example of the results of our assessment from our F/A-18 study.

We make functional linkages using a mission process-oriented approach. Continuing with the example above, for our aircrew training analyses, we used a five-step aircrew functioning sequence developed by Roscoe—sense, recollect, recognize, decide, and manipulate [7, 45].

Table 1. Examples of ranking significance of aircrew tasks[a]

Task	Mobility	Coordination	Survivability	Effectiveness	Comments
Perform climb to cruise	Low	Low	Low	Low	Not flying optimal profiles will increase fuel used
Perform aerial refueling	High	Moderate	Low	Low	Not refueling will limit mission radius, affect package composition
Assess no go criteria	Low	High	High	Moderate	Not following no go criteria will put mission at risk from reduced force structure or changed conditions
Perform target acquisition	Low	Low	Low	High	Not acquiring the target precludes successful weapons employment
Perform weapon delivery maneuver	Low	Low	Moderate	Moderate	Profile used to deliver weapon in accordance with weaponeering solution and to avoid threat envelopes
Maintain communications with controller	Low	High	Moderate	High	Information flow needed to develop situational awareness on threat, deconflict, and decide to employ weapons

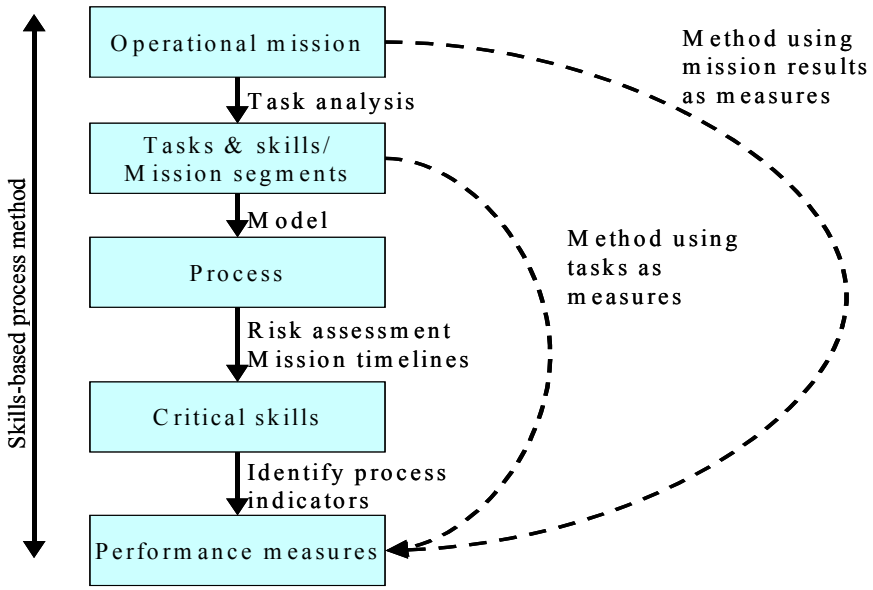
a. Source: [6].

Performance measures

We previously mentioned that research has shown that performance measures based on overall mission results or event completion are generally of low utility. Our approach proposes using performance measures as indicators of successful mission ***process*** execution. Using the critical skills we identified with our risk assessment methodology, we develop relational performance measures for each mission phase or segment. Using process-based measures provides a framework for

a detailed mission analysis and enables the trainer to use the task analysis, mission timelines, and process functional analysis to probe deeper into performance issues [7]. Figure 4 conceptually illustrates the differences among the two traditional approaches and our approach.

Figure 4. Approaches to developing performance measures[a]



a. Revised from [7].

Again, our goal is to develop performance measures that are indicators of successful execution of mission processes. Therefore, we identified the observable indicators of process execution during each mission segment. We do this by establishing the functional outputs and observables from the critical skills identified for each process, and synthesizing them into performance measures. Table 2 lists performance measures for the Search and Rescue (SAR) mission process from our E-2C study.

Table 2. Critical skills and performance measures for E-2C SAR mission (in addition to core)[a]

Mission process	Critical skills	Process step	Performance measures
On-Station	Determine location of mission aircraft	Sense/Recognize	Locate missing aircraft using radar and voice communications. Organize and manage search for downed aircraft. Establish and maintain communications with other assets to coordinate search.
On-Station	Develop tactical picture of the overall situation around SAR effort	Sense/Recognize	Build a picture of the situation from recognized air and surface contacts. Enter and update tracks in a timely manner. Maintain quality of overall picture.
On-Station	Manage and control assets available for SAR mission	Decide/Act	Assume tactical control of SAR assets. Monitor fuel states and tanking available to support effort.
On-Station	Maintain communications flow for SAR effort	Sense/Act	Maintain connectivity required to support information flow. Use established SAR communications procedures and manage traffic. Provide prompt situation reports and briefings.
On-Station	Provide AEW and maritime surveillance against threats	Sense/Recognize	Recognize and monitor threat air and surface contacts in the area. Maintain accurate accounting of friendly assets in the area.

a. Source: [12].

As the table shows, the end result of the skills-based approach is a list of critical skills and related observable performance measures. These tools enable a trainer to consistently evaluate events and trainees for their ability to execute what a specific mission requires. Our analyses show that this methodology has even broader applications.

Applications

In the above paragraphs, we discuss our skills-based approach to training assessment. We describe how this approach connects operational requirements to component skills and skills to training events.

But why make such connections? Our analyses identified several key applications of using this method in assessing and/or developing training programs or events. These include:

- Linking performance measures to readiness in order to determine the effectiveness of training [9, 15, 16, 23]
- Designing improved T&R matrices, training programs, and assessment systems to better match resources to operational training, including better alignment of training opportunities to units and units to exercises [8, 12, 23, 25, 33]
- Examining the use of alternative media (e.g., simulators) for training certain events or skills [8, 14]
- Facilitating more effective coordinated and integrated training [16, 19, 25]
- Determining the training events (or training program) and the environment required
  - for various MAGTF organizations (e.g., the MEB) [37]
  - based on range and resource constraints [40]
- Identifying gaps between what is trained and what is operationally required [5, 37, 41, 43, 44]
- Developing tools to enable commanders to understand the incoming skill-level of their Marines (of various rank) in light of what skills they might expect to use when tactically deployed [5, 42-44].

In the following sub-sections, we discuss these applications in greater detail.

Linking performance measures to readiness

One obvious application for the skills-based approach is to determine the value of the training event. One way to do this is to determine a training event's impact on readiness. This requires making a connection between the skills and performance measures identified in our skills-based approach to operational readiness (or potential readiness), so that we can determine what training is effective and what will

be lost if certain training is forfeited. As an example, we applied the methodology in this way in our F/A-18 training analysis [9].

First, we express each step of a training process in terms of the skill-level. We then connect each step in a training process cycle with its associated skills. For example, the six step aircrew training cycle would be [8]:

1. *Planning*—Determine aircrew mission skills, and critical skills for emphasis. Assess aircrew skill state needed to conduct operations. This effort establishes a goal for the training cycle—which aircrew skills and to what level of proficiency the skills need to be performed.

2. *Initial Assessment*—Assess experience level and skill state of entering aircrews.

3. *Select training events*—Select skills needed, assessing qualification and currency needs. Map skills into training events.

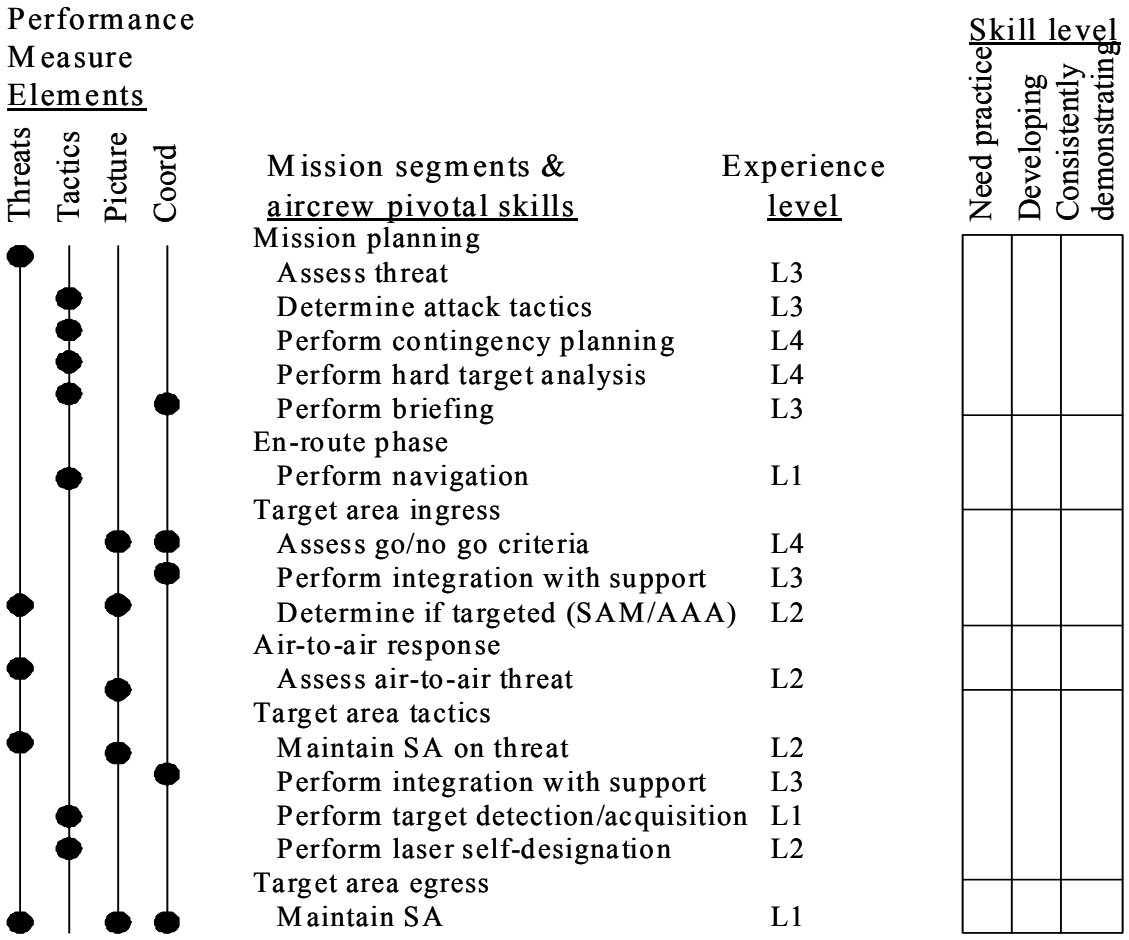
4. *Conduct training*—Exercise skills on training range or in simulator. Emphasize critical mission skills.

5. *Evaluation*—Assess level of skilled performance via debriefing using the identified performance measures. Propose using three levels: needs more practice, demonstrating the skill, and consistently demonstrating the skill.

6. *Readiness assessment*—Assess overall aircrew skill and knowledge state. Return to step 3 to build and maintain skill state. Mission readiness is assessed by comparing that demonstrated state of learning and skilled performance to the established baseline condition.

We can then develop assessment charts for operational missions using the framework developed in step one above. Such charts are based on the critical skills and performance measures identified using our skills-based approach. Figure 5 presents selected results of how we employed this technique in our F/A-18 study. This and other charts like it, designed for different events in the same training program, could be used by trainers in assessing the level of skill shown by the trainee (or trainees) for specific events, which in turn can be translated into how "ready" a trainee or unit is for a real-world operational mission.

Figure 5. Assessment chart for Laser Guided Bomb (LGB) delivery mission[a]



a. Source: [9].

Designing improved matrices, programs, and assessments

We applied (or recommended) this application in several studies, including our F/A-18 aircrew study, E-2C aircrew study, Weapons and Tactics Instructor (WTI) study, Marine Corps Air-Ground Combat Center (MCAGCC) study, and our Better Methodologies for Training study [8, 12, 23, 25, 33].

We have given several examples throughout this report demonstrating how our analyses in the F/A-18 and E-2C studies provided

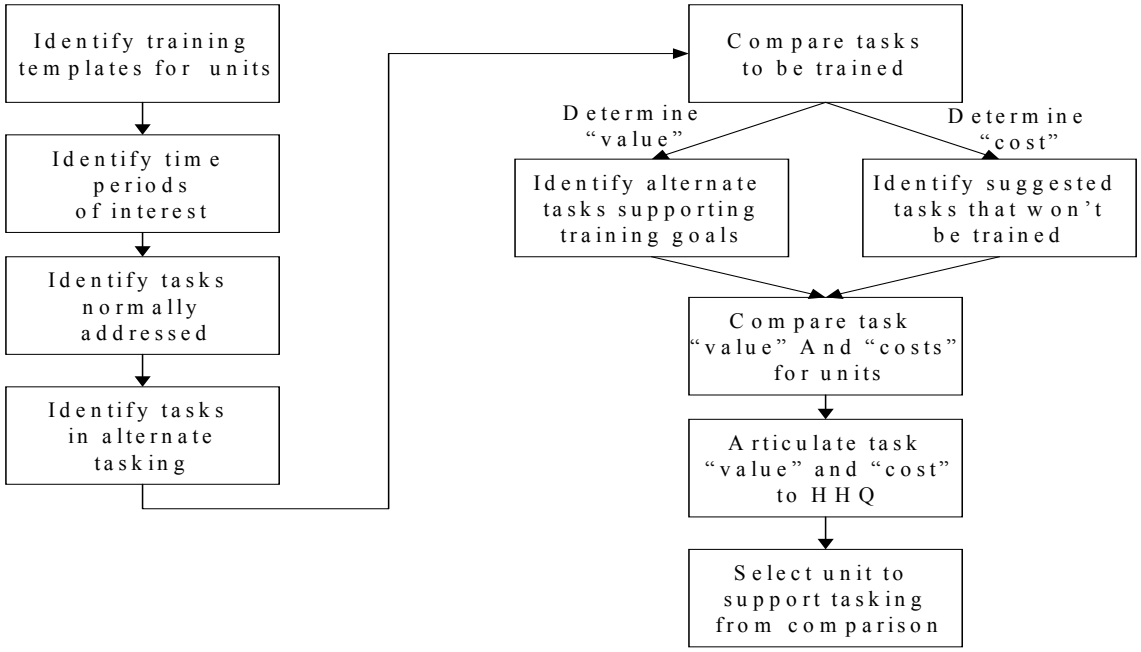
methods and tools that help trainers assess and refine aircrew training. Therefore, we will only briefly present how some of our other studies applied or recommended a similar application.

In the WTI study, for example, we focused on the heliborne assault evolution, constructing a database of mission tasks and/or skills for that evolution using lessons learned (rather than through a traditional task analysis). We constructed a chronological database, highlighting 19 mission critical tasks, and recommended that the Marine Corps consider conducting a training analysis using our task list so that trainers could determine what skills are developed at the WTI course and which skills are expected as prerequisites. This would enable them to refine the training program as needed.

Our focus in the Better Methodologies for Training Management study was to develop analytic tools to help planners at I Marine Expeditionary Force (MEF) and within the MEF's battalions to better match available training opportunities to unit needs, and to better match available units to exercise requirements. In this study, we used an abbreviated skills-based approach by limiting our analyses to the task-level. We developed templates, down to the company level, (e.g., rifle companies, weapons companies, and headquarters and service companies) for each battalion within a regiment, identifying mission tasks down to the platoon level. We listed the mission tasks that were recommended objectives of the training conducted by the unit at a specific time vertically, and indicated whether a specific mission task was recommended to be covered by the unit over the course of training (and how often the task was addressed) horizontally. Next, we applied a methodology to use these templates to help the Marine Corps better manage training. For example, figure 6 shows how the approach matches units to requirements. If employed, the MEF should be able to better manage training as a whole, both for and within the MEF.

To facilitate the use of this approach (of matching units to requirements) in [33], we developed visualization tools for planners. We merged our templates with a Training & Exercise Employment Plan (TEEP)-like view of the combined employment of all of a division's infantry battalions over time, creating one comprehensive training picture. The goal was to remove "white space" from the training

Figure 6. Approach for matching units to requirements[a]



a. Source: [33].

schedule and replace it with a unit's training intentions and activities, and to provide a single display that showed all units intentions and activities in one picture. With this visualization in hand, planners can better select which units should and could participate in MEF or division training requirements.

Examining the use of alternative media (i.e., simulators)

We identified this application in our aircrew training analyses in the late-1990s [8, 14]. We recommended using a skills-based approach to considering the use of simulators in training aircrews. We maintain that developing an established set of aircrew mission skills would allow trainers to begin to make decisions about the utility of different training formats and media (including simulators) for various audiences. In recent years, we executed several studies focusing on the use of simulators, which to varying degrees have relied on determining which required skills can be trained while using simulators [18, 21, 22].

Facilitating coordinated and integrated training

Our analyses indicate that the skills-based approach can be used to identify ways to better integrate training among related communities. We highlighted this application in our analysis of the MCAGCC Combined Arms Exercise (CAX) training. In [24], we analyzed individual CAX events, identified missions and skills exercised in each event, and tried to understand how CAX events are connected. To do this, we developed a mission skill template for each event. We also connected specific skills with specific lessons learned. These steps together allowed us to analyze the skills and examine the content and structuring of the training program, in particular the connections between training events in the building block sequence, and to analyze the lessons learned in order to analytically identify and understand the training issues encountered [26]. Our analysis resulted in a series of modest recommendations to better prepare the force, identify training program issues, and maintain CAX strengths. One of our recommendations in the area of addressing issues had to do with force integration. We noted that many of the tactical skills exercised during CAX involve the coordination and integration of the different communities required to effectively conduct combined arms missions. Effective combined arms missions involve developing an understanding of the capabilities and limitations of other communities, so that participants can better anticipate and be more flexible in performing the mission. We highlighted that stove-piping, particularly between the Ground Combat Element (GCE) and the Air Combat Element (ACE), precluded developing effective integration and should be addressed [25].

Determining the type of training needed and the ranges needed to conduct it

We applied our skills-based methodology to determine the connection between training events and/or programs with the required environment in two cases. In [37], we (1) identified the types of specialized training required for a MEB, in particular its Command Element (CE), (2) characterized the training environment required for such training, and (3) analyzed existing training areas for suitability. The basis for the latter two steps was the results from the first step,

which involved using a capabilities-based approach (another example of an abbreviated or modified skills-based approach) to determining what a MEB must be prepared to do. Our initial analysis indicated that most of the war-fighting and individual skills required by Marines operating as part of a MEB, were already being taught as part of other training programs, and that "new" training was really only needed by the MEB CE. Therefore, we focused what is required of the CE in commanding and controlling its component warfighting elements (e.g., ACE, GCE, and logistic support element) in our examination of required MEB training. We then considered the specifications for the full spectrum of MEB operations (both existing training and the "new" training we identified) to determine the required environmental parameters (e.g., range size, firing limitations). Finally, we analyzed existing training ranges for their suitability to conduct a variety of MEB missions, from the smallest company-level mission to a larger integrated or Joint mission [34-37]. Ultimately, we found that while existing ranges could support some form of MEB training, each had its limitations, which we identified so that the Marine Corps could see what is sacrificed at each [37].

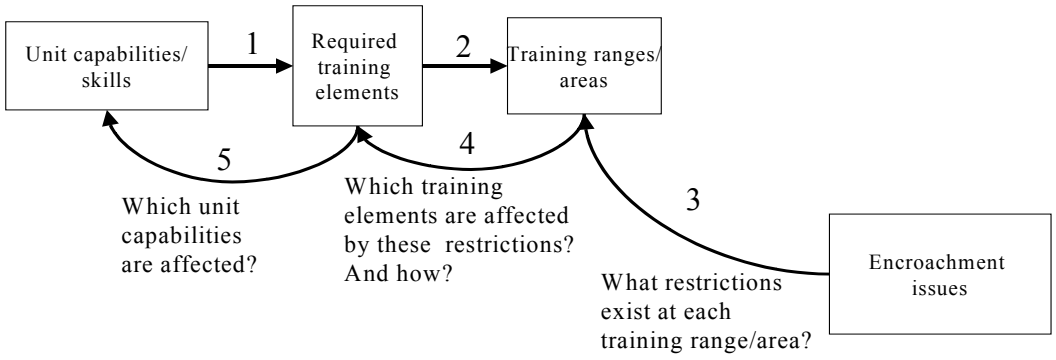
Another application of our methodology is to use our skills-based analysis results to identify the impacts of range and resource constraints. Our analysis of the potential of simulators, discussed above, is one example of how funding and resource constraints make simulators attractive alternatives to live tactical training (e.g., flying hours, bomb drops). Another example involves our study of how encroachment issues have restricted the Navy and Marine Corps use of certain ranges [40]. Figure 7 depicts our approach determining how unit capabilities or skills were impacted by training range restrictions.

In [39], we applied this approach to operational units and the training infrastructure at Camp Lejeune, NC. We recommend that the Marine Corps use follow this same approach when evaluating other encroachment or resource constraints.

Identifying gaps between training and operational requirements

In our analyses of counterinsurgency (COIN) and irregular warfare (IW) training, we applied a skills-based approach to identify gaps between existing training and existing "requirements" [5, 41, 43, 44]. For example, in [5], we mapped lessons learned from Operation

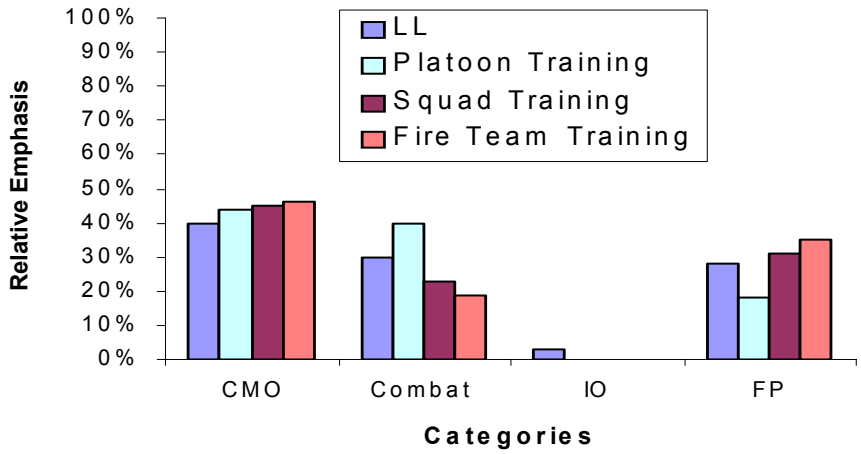
Figure 7. Approach to linking encroachment and unit capabilities/skills[a]



a. Source: [40].

Iraqi Freedom (OIF), training guidance from the Infantry T&R Manual, and the Basic Urban Skills Training (BUST) Package to a set of 25 counterinsurgency-specific tasks that we defined based on background research. We compared the emphasis placed on a specific task in training (per the training guidance) to the relative emphasis placed on it in actual events (i.e., the requirement for the task) by unit level. The disparity between the two was identified as the "gap" in training. We then grouped gaps by category to highlight those types of tasks that have the largest and smallest gaps. Figure 8 depicts our results for one level of our gap analysis. The results depicted below and more detailed mappings (not shown) highlight key gaps between operations and training. These include the complete lack of training for infantry Marines in information operations, coordinated host nation operations, intelligence dissemination and management, and handling captures, despite the fact that COIN and IW operations require such skills. As this example shows, an abbreviated skills-based approach can be applied as part of a gap analysis to show the shortfalls in current training, which could help commanders use unit training time to close the gaps he believes are most critical.

Figure 8. Categorical emphasis of current operations vice T&R training[a]



a. Source: [5].

Developing tools for commanders to assess the skill-level of their Marines

We took the gap analysis conducted in [5] and [42] a step further by developing a tool that commanders could use to assess the training of their Marines (by rank and MOS) for IW requirements. By mapping the IW unit task list to the MOS Training & Education (T&E) continuum, we developed matrices, by MOS, to depict the training (i.e., exposure level) of Marines of various rank to each IW task. Table 3 is an example of such a matrix.

Table 3. Exposure of 0311s to IW unit tasks through individual T&E curriculum[a b]

	Pvt-LCp	Cpl	Sgt	SSgt	GySgt	MSgt	MGySgt
Alert population to occurring/ upcoming operations	0	0	0	0	0	0	0
Clear/ambush insurgent location	3	8	9	14	15	15	15
Collaborate/integrate intelligence with other sources	0	0	0	0	0	1	1
Conduct combined operations with host nation forces	0	0	0	0	0	0	0
Conduct cordon and search.cordon and knock	0	0	0	3	3	3	3
Conduct reconnaissance patrol	0	2	2	3	3	3	3
Conduct security patrol	1	3	4	5	5	5	5
Conduct traffic stops/operate vehicle checkpoint	2	2	2	2	2	2	2
Contain/disperse civil disturbances	0	0	0	1	1	1	1
Defend/protect/escort convoy	0	1	1	3	3	3	3
Disseminate relevant or actionable intelligence	0	0	0	0	1	2	2
Disseminate PSYOPS products	0	0	0	0	0	0	0
Establish and operate checkpoint/ entry control points	1	1	1	1	1	1	1
Identify and disarm mines/IEDs	0	0	0	1	1	1	1
Identify and document population	0	0	0	0	0	0	0
Apprehend and process captures/ detainees	0	1	1	3	3	3	3
Obtain information from residents	0	0	0	0	0	0	0
Organize and manage incoming intelligence	0	1	1	1	3	4	4
Patrol/defend utilities and infrastructure	0	0	0	0	0	0	0
Patrol forward operating/firm base	2	4	6	12	13	13	13
Conduct raid	1	3	4	8	8	8	8
Reconnoiter and survey routes	0	0	0	0	0	0	0
Provide security for events/groups/ personal security detachment	0	0	0	0	0	0	0
Train host nation forces	0	0	0	1	1	1	1

a. Source: [43].
b. Exposure is cumulative over rank; only required courses were assessed.

Unit commanders and trainers must make difficult judgments about how to allocate the limited training time that the current operational tempo provides them. Tools such as these matrices help them focus

training on those tasks/skills Marines need but for which they have had the least training. As an aside, we were able to take this analysis a step further by developing a tool to help commanders estimate future tasking based on the character of their assigned area of operations (AO).

Takeaway

As described above, we have executed numerous studies focusing on training assessment and/or development using the skills-based approach. In short, we have applied this approach to Marine Corps training issues by:

- Assessing current or proposed training programs based on critical mission skill development
- Developing training parameters/requirements (based on critical mission skill development) for new, or non-standard missions
- Evaluating how outside factors, such as encroachment and resource constraints, affect the ability of the Marine Corps to train critical mission skills.

Regardless of the particular training issue, we often use a skills-based approach for determining training effectiveness, training requirements, and impacts on training. Our analysts believe in this approach because it focuses on the very core element of training— skill development. Missions are compilations of functions, functions are compilations of tasks, and tasks are compilations of skills. Therefore, if Marine Corps training consistently develops proficiency in the critical skills that are required to execute a mission, Marines have the best chance of successfully executing their missions.

While we have described some of the key applications of the skills-based approach, these are by no means the only applications. They simply demonstrate how we applied or recommended applying our results to some specific training questions we were asked to analyze. Rather than being all-inclusive, the list is meant to show that the skills-

based approach to training assessment has a wide-range of practical uses for the Marine Corps and other Services.

In this section, we discussed one category of training analysis conducted by CNA analysts over the past 20 years. In the next section, we discuss an entirely different type of analysis related to training— the link between training and manpower.

Training and manpower

In this section, we discuss the two main series of studies analyzing the linkages between training and manpower in the Marine Corps. The first set of studies focuses on attrition, specifically attrition early in a Marine's career. The second set focuses on the training pipeline (i.e., how long it takes to train new Marines, both officer and enlisted) and how the Marine Corps might be able to improve the process. These studies have primarily been executed by analysts in our Resources Analysis Division (or its predecessors) and target what we call in this report the "economics" of training.

Attrition

We executed a series of studies in the late-1980s through the mid-1990s examining first-term attrition in the Marine Corps [46-57]. These studies analyzed various aspects of first-term, or non-EAS, attrition to determine trends/levels, costs, timing, links to characteristics,[7] and causes.

For the most part, we were able to use readily available data (within the Marine Corps or Department of Defense) to determine that while overall attrition was steady from FY 1980 through 1988, it was on the rise in the early 1990s despite improved accession quality during that timeframe [55]. This was a somewhat surprising result.

A second key finding was the link between attrition and certain recruit characteristics. We used a shift-share analysis to predict what attrition rates should have been, given the quality mix of recruits in FY1990 [52]. The shift-share technique divides the recruits into

7. Characteristics were based on educational background, test scores, delayed entry or immediate ship, and various accessions or waivers.

subgroups (based on characteristics) and uses historical attrition rates for each subgroup to predict overall attrition. We found that non-EAS, first-term attrition was higher for recruits who [55]:

- Did not have regular high school diplomas
- Score lower on the Armed Forces qualification test
- Do not enter through a Delayed Entry Program
- Do not meet the retention weight-for-height standard
- Require an age waiver
- Require a medical waiver
- Are trying boot camp for a second time (after failing to complete it on their first "try").

These initial studies did not find any systemic causes for early separation. Therefore, in the mid-1990s we re-examined this issue, strongly focusing on physical attrition [56, 57]. We focused on physical attrition based on guidance from the sponsor and because our initial research indicated that a significant portion of attrition was due to physical reasons. We analyzed attrition rates during bootcamp as well as in the School of Infantry (the follow-on training for Marines with an infantry MOS). By analyzing the coded reasons for attritions at each of these phases, and speaking to those involved in the training, we recommended the Marine Corps consider the following to reduce non-EAS physical attrition for first-term Marines [57]:

- Better preparation for training, including a "remedial" training phase for recruits (particularly for those who fail the Inventory Strength Test), could reduce attrition by 1-2%.
- Sound physical training practices, including more stretching, less training in combat boots, a more gradual buildup in physical training, and a focus on injury prevention in the first 3 weeks (when the vast majority of attrition occurs). For every 10% reduction in injuries, we estimated that attrition would be reduced by 1% overall, 5% for Marines at Marine Combat Training (MCT), and 6% for Marines in the School of Infantry (SOI).

- Additional resources and more attention to injury rehabilitation, particularly at SOI which has a lower rate at which Marines are returned to training (from injury) than boot camp.

Because the studies focusing on attrition for first-term, non-EAS Marines were done 10 to 20 years ago, we advise the reader to use their results cautiously as the situation may have changed considerably from that time. Rather, we include a brief discussion of these studies to highlight the types of analyses we performed in examining how attrition is related to initial training, and how the Marine Corps might modify training programs to reduce it.

Time-to-train

The Marine Corps devotes a large percentage of its budget to personnel costs. Therefore, any improvements in the manpower process can translate into significant savings, while at the same time increasing overall manning and readiness. As such, CNA has undertaken several studies to help the Marine Corps do just that.

In 2002, CNA developed an empirical measure of initial training by primary military occupational specialty (PMOS) by constructing 12-month averages of the time from the start of active duty to the assignment of the PMOS [58]. We called this measure the "time-to-train" and determined that actual training time exceeds planned training time by more than one-third. While this may, in part, be due to over-optimistic planning estimates, it is also very likely a result of inefficiencies in the training process. In addition to developing five critical indicators for the manpower process, we also attempted to determine where inefficiencies might exist, specifically focusing on the components of the total time-to-train. For example, in a CNA-sponsored study, we examined the "time spent waiting for training to begin" for The Basic Course and other local training [58, 59].

An accurate assessment of time-to-train is crucial because it results in more accurate manning and staffing, and highlights those components of time-to-train that the Marine Corps might want to improve. As such, in 2007-2008, we executed another study refining our time-to-train measures by measuring three components [60, 61]:

1. How much time is spent in the classroom
2. How much time is spent waiting for courses to convent
3. How much time is added due to setbacks.

Ultimately, we developed an interactive database that the Marine Corps can use to monitor the training pipeline, by the components listed above [62]. Table 4 shows the type of information that the database can provide.

Table 4. Breakdown of time-to-train days for those with complete course data and uninterrupted training: June 2005 through May 2007[a, b]

	Enlisted Marines		USMC
	Noninfantry	Infantry	officers
Average time-to-train days for assigned PMOS	225.2	181.6	443.4
Percentage of time in initial training before PMOS training	58.9%	50.5%	50.8%
Percentage of time spent in PMOS courses	25.8%	29.1%	22.7%
Percentage of time spent awaiting training	13.7%	13.6%	19.8%
Percentage of time spent in other activities[c]	1.6%	7.3%	6.6%
Number of Marines with complete course data	20,204	11,781	700
Measures of time spent awaiting training (for USMC courses)			
Probability of attending first available convening of PMOS course	50.3%	38.0%	88.8%
Time-awaiting-training if attended first available convening (days)	17.7	9.8	34.7
Time-awaiting-training if did not attend first available convening (days)	43.2	33.6	572.9

a. Source: [62].
b. Percentages may not add up to 100 due to rounding.
c. Other activities include time allowed for travel and time between PMOS course graduation and PMOS attainment.

As the data in the table show, Marines spend a large amount of time awaiting training. In fact, it translates into 2,666 man-years awaiting training.[8] They also show that the penalty for missing the first convening course is lowest for enlisted infantrymen and highest for officers.

8. This is based on the information from the 32,685 Marines that had complete data for the two-year time period June 2005 through May 2007.

It would be incorrect, however, to assume that the data show inefficiencies in the training pipeline. Given the fact that there is an uneven distribution of Marines entering the pipeline throughout the year and that there may be large costs for increasing course capacity only at certain times of the year, the pipeline may be operating as efficiently as possible. The Marine Corps must make such a determination for itself. Our database is designed to give the Marine Corps the means to do just that.

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Conclusion

A lethal and effective Marine is the direct result of well-conceived and well-executed training programs, processes, and pipelines. Since the Marine Corps' goal is to produce such Marines, it spends a considerable amount of time and energy focused on how it trains recruits as well as career Marines. Over the years, CNA has executed numerous studies to help them in this endeavor.

We have utilized and refined a methodology, the skills-based approach, that we believe is very effective in assessing or developing Marine Corps training. As our analyses show, we have applied this methodology in numerous ways to a variety training questions, and a range of Marine Corps communities (e.g., aviation, infantry, etc.). But by no means are the applications we discussed the only ones. Rather, we spend considerable time explaining the how and why of our approach in order to show the reader that such a methodology can be successfully applied to any number of training issues.

We have also done several studies evaluating the impacts on or links between training and manpower. Simply put, Marines (i.e., manpower) are the inputs to the training pipeline. If the training pipeline is functioning well, it will produce well-trained Marines as quickly, effectively, and efficiently as possible. Our studies examining the rates of first-term, non-EAS attrition as well as some of its causes, along with our analyses determining how long it really takes to train a Marine, are designed to help the Marine Corps take a critical look at its pipeline to determine if, and possibly, how it might be improved. Just as important, these analyses give the Marine Corps the tools to understand the variations in time-to-train over the years, and to better prepare itself and its commanders for the future.

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Glossary

AAA	anti-aircraft artillery
ACE	Air Combat Element
AEW	Airbourne Early Warning
AO	area of operations
BUST	Basic Urban Skills Training
CAX	Combined Arms Exercise
CMO	Civil Military Operation
COIN	Counterinsurgency
Cpl	Corporal
EAS	end of active service
FP	Force Protection
GCE	Ground Combat Element
GySgt	Gunnery Sergeant
IED	improvised explosive device
IO	Information Operations
IW	Irregular Warfare
LCpl	Lance Corporal
LGB	laser-guided bomb
LL	Lessons Learned
MAGTF	Marine Air Ground Task Force
MCAGCC	Marine Corps Air-Ground Combat Center
MCT	Marine Combat Training
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
MGySgt	Master Gunnery Sergeant
MOS	Military Occupational Specialty
MSgt	Master Sergeant
OIF	Operation Iraqi Freedom
PMOS	Primary Military Occupational Specialty
PSYOPs	Psychological Operations
Pvt	Private

SA	situational awareness
SAM	surface to air missile
SAR	search and rescue
SAT	systems approach to training
Sgt	Sergeant
SOI	School of Infantry
SSgt	Staff Sergeant
TEEP	Training & Exercise Employment Plan
T&R	training and readiness
UTM	Unit Training Management
WTI	Weapons Training Instructor

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