PROBLEM SOLVING: A Combat Multiplier in Math Class

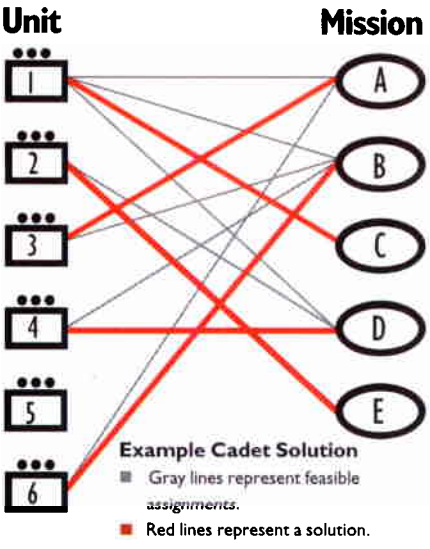
by MAJ Howard D. McInvale '93 and CPT Ian McCulloh

THE ABILITY TO SOLVE PROBLEMS IS AN IMPORTANT SKILL FOR EVERY ARMY OFFICER.

A RESOURCE OR TOOL THAT COMBINES WITH OTHER OPERATIONAL MEASURES TO PROVIDE INCREASED COMBAT POWER IS A COMBAT MULTIPLIER. Problem solving is a combat multiplier because it empowers leaders to quickly develop effective solutions to challenging problems. Rooted in almost eveything cadets are required to do at the Academy is the development of this combat multiplier.

The Department of Mathematical Sciences places the development of cadets as problem solvers at the forefront of its instruction. Instructors are encouraged to expose cadets to ways in which they can use mathematics to solve meaningful, relevant problems, and at a time when our nation is at war, military applications are both meaningful and relevant. Such scenarios are popular vehicles for presenting a problem-solving process.

The first few weeks of instruction in the fall 2004 plebe mathematics course, MA103, was dedicated solely to problem solving. The goal of this instruction was to instill a problem-solving mindset in the cadets that they could refine throughout the course. In a cooperative effort with the Department of Behavioral Sciences and Leadership (BS&L), several mathematics instructors conducted a problem-solving lab in BS&L's Battle Simulation Lab. Being in the lab provided a tactical environment that included camouflage nets, sandbags, battle boards, and even a mock M577 command track. COL Lawrence Shattuck '76, Professor of Engineering Psychology, Department of Behavioral Sciences and Leadership, offered "We're glad for the opportunity to share our lab facilities with faculty from other Departments. BS&L enjoys a close collaborative relationship with several departments at the Academy, especially the Math Department. These relationships facilitate interdisciplinary and integrative educational opportunities for both cadets and faculty."



Clockwise: CDTs Alex Smith, Kevin Ramirez, Doug Jones, Jon Smith, and David Bounds

The mathematics lab exercise required cadets to role-play typical military staff positions in a scenario where they used problem-solving techniques to address a variety of tactical planning problems. The exercise was a mathematics problem in which students were required to assign tactical units to various upcoming missions. Each unit had unique capabilities; each mission had specific requirements, and optimal mission assignment was the goal. For most of the cadets, this was their first tactical experience since their foot march from Lake Frederick in Cadet Basic Training. In an attempt to maintain an operational focus during their academic instruction, several mathematics instructors used the exercise to allow cadets a glimpse into the military planning process. Cadets also learned how mathematics can be used in various aspects of military problem solving.

Organized into groups of four, each student took on a role that corresponded to a position on the staff. Led by a battle captain, each group included intelligence, operations, and plans officers. Each cadet was given different information pertaining to his or her role on the staff, the types of missions, the capabilities of the units, and time and resource constraints that applied. The battle captain was responsible for leading the four-person team in assigning the different missions to various units. The other three members of the group each had unique information and constraints that they had to share with the group in order to effectively assign the missions. The intelligence officer reviewed maps and satellite photographs of the mission locations. In addition, the intelligence officer was given terrain and weather effects. The operations officer managed unit capabilities and knew which missions each unit was qualified to perform. The plans officer was given task orders containing the required missions, coordinating instructions, and even some information that did not bear on the group's problem. The extraneous information served to make the groups identify and use only the information that was mission essential. Group members had to communicate effectively in order to succeed at this exercise. Failure to sort out important information and share it with the group significantly impeded progress. The most crucial step in the process was defining and understanding the problem. Teams that

> "We were forced to integrate a problem-solving strategy into our work. This exercise helped us work together as a team, and also made us realize that if one of us failed to provide information, it would affect the whole mission."
>
> —CDT Patrick Martin '08.

CDTs Daniel Ferency, Matthew Meggs, and Marydell Westman.

Instructor CPT Ian McCulloh, Colin Lindley, Karl Kocher, Vladislav Silayev, and Lily Tharp.

tried to take shortcuts around this step were not successful and found that they were better off following the problem-solving process taught in class. Cadets' solutions varied from random assignment to the use of more advanced techniques from network and graph theory. Once the groups carried out their plans and assigned all missions to the units, they were able to review their decisions. In some cases, they revised their solutions and made them better. It was very satisfying to observe that the groups using analytical techniques were faster, more accurate, and had little need to revise their plans. The problem-solving techniques of these groups proved to be effective combat multipliers. On the other hand, groups using trial and error needed to make several revisions, and in some cases, these groups never developed a feasible plan within the 50-minute exercise.

The cadets involved in the exercise experienced the power of mathematics to quickly produce effective solutions to a challenging problem. So, how did the cadets rate this experience? "The exercise was probably the coolest thing that I have ever done in a math class. Not only was it effective in teaching the problem-solving process, it also taught me a lot about the Army." —CDT Daniel Ferency '08.

The cadets found the exercise particularly useful in demonstrating the value of a process to solve problems, particularly ill-defined problems. They felt that the problem was both enjoyable and relevant to their future careers as Army officers. Feedback from end-of-course surveys indicated that the participating cadets overwhelmingly rated the exercise as the single most effective activity in the course for teaching problem solving. Additionally, over 90% of the cadets surveyed now believe that mathematics is critically important to their success as future Army officers.

Students who can firmly grasp sound problem-solving techniques are better able to understand principles in mathematics, science, technology, and engineering. Emphasis on problem-solving in the Core Mathematics program helps develop analytical habits of the mind. The Department of Mathematical Sciences continues to lead an effort to develop competent, confident problem-solvers. Our efforts support the overarching goal of the Academy's Academic Program "to enable its graduates to anticipate and respond effectively to the uncertainties of a changing technological, social, political, and economic world." —*Educating Future Army Officers for a Changing World* (USMA Operational Concept for the Academic Program)

MAJ Howard D. McInvale '93, is an assistant professor and Course Director for MA103 in the Department of Mathematical Sciences. CPT Ian McCulloh teaches MA103 and developed the problem-solving exercise.

"Technology has altered the role of information in our lives. It used to be, that most of the information provided to cadets had been selected for them and digested for them. Now, with electronic media, our cadets must learn how to properly acquire, select, evaluate, analyze, synthesize, and apply information. The USMA Core Mathematics Program must adapt to support this change by focusing more on problem-solving skills."

—COL Gary W. Krahn '77, Professor and Head, Department of Mathematical Sciences.

CDTs Christopher Sanders, Matthew Meggs, and Daniel Ferency.