

Lead Me, Guide Me: Reflective Leadership Practices in Capstone Design Projects

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This paper describes the application of the L.E.A.D. leadership model in capstone design projects in the Naval Architecture and Marine Engineering program at the U.S. Coast Guard Academy. The L.E.A.D. framework champions a reflective learning model achieved through frequent quality faculty-student interactions and mentorship. The L.E.A.D. model is implemented in four sequential activities: Learn from theory, Experience through practice, Analyze using reflection and Deepen understanding through mentoring. The specific implementation of this model, with a focus on target leadership competencies of team-building and effective communications, is presented in the context of a ship design project. The specific pedagogical approaches and capstone course format used to create the reflective learning environment are described and faculty-student mentoring approaches are discussed. The efforts demonstrate the utility of the L.E.A.D. model in achieving a meaningful undergraduate capstone leadership development experience.

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Introduction & Motivation

The primary mission of the U.S. Coast Guard Academy (USCGA) is to develop leaders of characters for public service in the U.S. Coast Guard. To support the overarching mission of the Institution, the Naval Architecture and Marine Engineering (NA&ME) program has structured its capstone design project to be a leadership development experience for students.

Historically, USCGA leadership development has been rooted in military and professional training; it has not been deliberately considered in the academic realm. This is shortsighted – well-developed leaders require *multiple* leadership experiences across many *different* domains; professional, military and academic.

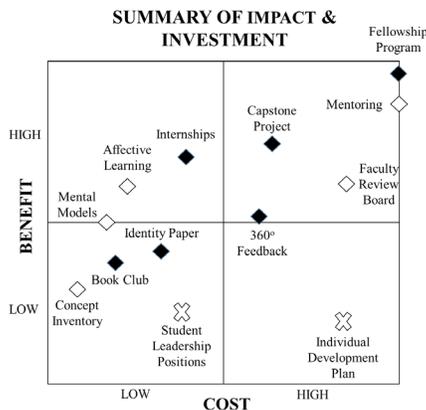


Figure 1: Leadership Assessment Cost vs. Benefit¹

Figure 1 illustrates the relative cost and benefit of leader development programs and assessment points at the Academy. Although capstone projects occur in the high cost-high benefit quadrant of the spectrum, they abound with opportunities to practice leadership, even without formal leadership roles within a team. Incorporating leadership development in academic courses is apropos, as the newly adopted ABET Engineering Accreditation Commission Criteria, specifically Student Outcome 5, identifies leadership as an outcome of undergraduate engineering programs.

L.E.A.D. Leadership Model

The U.S. Coast Guard Academy leadership philosophy is primarily guided by the L.E.A.D. leadership model^{1,2}. The model, shown in Figure 2, serves as a lens to observe, strengthen and improve leader development, with each level of the model representing a different level of leader development.

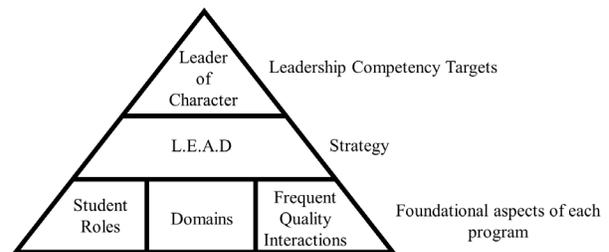


Figure 2: L.E.A.D. Leadership Model

Leadership Competencies

Leadership competency targets must be first identified in the L.E.A.D. model. In this instance, leadership competencies were determined by the intersection of the 13 U.S. Coast Guard Leadership Competencies³, ABET Criteria 3 (Student Outcomes 1, 3 & 5) and the desired personal and professional competencies of the pre-professional engineer⁴. Team building and self-awareness, effective communication, technical proficiency and learning are the target leadership competencies in the NA&ME capstone design project.

This paper will only present the leadership development approaches for *team building* and *effective communication* – admittedly a small sample of the collective leadership landscape – ideally, the implementation of the L.E.A.D. model across multiple academic courses, each with its own leadership competency targets, could result in a holistic leadership development experience for students.

The L.E.A.D. model can be applied across various domains and student developmental roles. In capstone projects, the model is applied in the academic domain where the student role is one of leaders and pre-professional engineers (vice follower or role modeler). Leadership development success is predicated on frequent quality interactions (FQIs) between students and faculty or capstone advisors. Other stakeholders, e.g., project sponsors, should also interact with students often during the capstone project.

L.E.A.D Strategy & Tenets

To develop capstone leadership competencies, the four elements of the L.E.A.D leadership model must be systematically integrated in the project. The elements of the strategy are:

- Learn from theory
- Experience through practice
- Analyze using reflection
- Deepen understanding through mentoring

Learn from Theory

At the Coast Guard Academy, students learn leadership theory through a combination of courses and practicum exercises. Courses in *Leadership and Organizational Behavior*, *Ethics* and *Engineering Ethics* provide the theoretical background in leadership while practical experience is gained through the military training program and summer training. Leadership theory does not have to take place in a formal academic environment; leadership seminars, workshops, short courses and exercises all serve to help students learn leadership theory. Once leadership theory is learned, it must next be practiced.

Experience through practice

Practice makes perfect; we cannot become better leaders until we practice what we have learned. Luckily, the nature of capstone projects, e.g., complex and open-ended design, is rich with leadership opportunities. In fact, the NA&ME program refers to the capstone design project as a *capstone design experience* – the leadership laboratory where students develop leadership proficiency by practicing leadership competencies.

But the experience is meant to be *much more* than just the capstone project; it is the vehicle through which individual and team experiences are created to practice leadership principles – and faculty must be key actors in the development of these experiences. While the experiences need not be unduly manufactured, they must be effective, deliberate and effective.

Analyze using reflection

Student reflection is a critical component of this leadership development approach. Oftentimes, during challenging leadership experiences, students just act – they don't deliberately think about their actions and the consequent results. But through reflective practice, a developing leader [student] can surface and criticize the tacit understandings that have grown up around the experiences and make new sense of situations of uncertainty or uniqueness⁵.

This is not to say that students don't reflect – they do – but oftentimes the reflection is a product of necessity or emergency, and not necessarily focused on leadership. Because most adolescent students have not adopted a reflective mindset, it is critical that team advisors actively guide student reflection in this step of the model. It is important to note that student reflection can also occur during the mentoring process.

To encourage reflection, team advisors must engage in frequent quality interactions with students; that is, advisors must challenge student leadership perceptions in the *action-present*, in which an action can still make a difference in the particular situation. The frequency, formality and extent of faculty-student interactions used to promote reflection should be a collaborative effort between students and faculty. Reflective practice doesn't always require faculty to reinvent the wheel; oftentimes it can be as simple as modifying the course pedagogy, format or approach.

Deepen understanding through mentoring

Mentoring, especially in terms of psychosocial support, aids in the leadership development of students¹. Growth occurs when faculty members help students to reflect and evaluate their own leadership development. Because the mentoring relationship is protégé-centric, it provides a way to individualize leader development¹.

In their role as engineering supervisors, advisors encourage students to review their work, identify potential obstacles, address time management challenges – all with the goal of identifying adjustments students intend to make regarding their interactions and leadership. In addition, faculty rely upon their own experiences to shape and develop future leaders, while at the same time, modulate group work and interactions. Mentoring is key to sustained growth and development of student leaders.

L.E.A.D. Applied to Capstone Projects

Students in the NA&ME program experience the design process through a team-based “clean-sheet of paper” ship design. Each design team is provided Top Level Requirements, developed by the faculty, that detail the expected missions, capabilities and performance of the ship(s) to be designed. During the year, each team submits 18 formal design reports or “submittals.” Each submittal covers a particular aspect of the ship design, e.g., hull geometry, general arrangements, propulsion, damaged stability, crewing, etc. The design experience is executed through three required courses across two academic semesters.

Since frequent quality interactions are the foundation of this strategy, the NA&ME program modified the schedule of the two 4.0 credit capstone courses to increase opportunities for faculty-student interactions. Originally scheduled as three 50 minute lectures and one 150 minute laboratory period, the capstone courses were reformatted to *two* 50 minute lectures and *two* 150 minute laboratory periods. The additional laboratory time provides the backdrop for effective faculty mentoring and student reflection.

Team building & self-awareness

Faculty utilized the first two phases of Tuckman’s stages group development⁵, *Form* and *Norm*, to develop student competency in team building and self-awareness.

During the *forming* phase, the team identifies goals, opportunities, challenges and obstacles. Due to the rigorous academic program at USCGA, coupled with extraordinary demands on student time outside of class, the program utilizes Comprehensive Assessment of Team Member Effectiveness (CATME) TeamMaker to assist in the formation of capstone teams (catme.org). Attributes such as GPA, writing competency, software proficiency, hands-on skills, preferred teammates, extra-curricular activities, preferred leadership roles and personality traits are considered when dividing the class into teams. This approach promotes student success by minimizing conflicts and balancing strengths and weaknesses of the team at the onset of the project. The program also aims to achieve diversity in gender and ethnicity of design teams, as well as to harness the

benefits of dissimilar backgrounds, experiences and approaches in the design process.

Once design teams are established, members are required to develop a Team Operating Agreement (TOA) to focus their purpose and guide group interactions. The TOA can be an important mentor resource for resolving team conflict. Elements of the TOA are modeled from the BGI Team Handbook⁶ and contain, at minimum, the 10 Articles shown in Table 1.

Contact Information	Purpose & Shared Goals
Standards of Excellence	Communication
Logistics	Meetings
Monitoring	Decisions
Conflicts	Slacking

Table 1: Elements of Team Operating Agreement

To kick-start the *norming* phase, where group identity is established through team bonding, the program provides each capstone team with funding to support an extracurricular activity of their choice. Many teams choose to have dinner together, while others select more active pursuits such as paintball or bowling. Student feedback on these informal gatherings was positive and anecdotal faculty observations were that the teams were more cohesive and performed better earlier in the semester. Additional student reaction to the social excursions will be collected in senior exit interviews at the end of the academic year.

To assess team effectiveness and work-balance in the *action-present*, three student completed CATME surveys provide faculty with the contextual information for effective team mentoring. The surveys query team interactions, work contribution, work quality and team communication. CATME surveys provide a direct assessment of team and individual performance and provide the most insight to capstone team dynamics.

Student-reported contributions to team work also inform faculty advisors about team effectiveness and work-balance. The program has moved away from exaggerated team-reported hourly contribution of work to an individual, but team-reported, percentage contribution on each assignment. This results in a relative ranking of effort amongst group members on each submittal. To further clarify individual student effort on each assignment, students are required to identify their *specific* contribution to each individual assignment.

Work-balance is also captured by two anonymous “Pay Days.” On Pay Days, each student distributes a hypothetical sum of money amongst team members based on their perceived contribution to the team. To hedge against the natural tendency to pay each team member equally, an end-of-semester survey requires produce a relative ranking of effort amongst all team members.

Overall, these approaches provide context, clues and indicators of team success. Faculty interact with students in a reflective environment and mentor them accordingly to improve team performance and group dynamics.

Student Communication Skills

The program emphasizes written communications during the fall semester of the project and oral communication during the spring semester. The 18 required project reports are highly technical in nature, both in terms of naval architecture content and writing aptitude. Students are expected to use strong professional and technical writing to present their design decisions accompanied by adequate analysis and consideration of engineering rules and standards. To identify individual contributions to written reports, each team member is asked to identify his/her written work by placing their initials at the end of each paragraph they author. In addition to technical design reports, students must also deliver mid-term and final design presentations, as well as a final poster of their design.

Initially, rubrics are provided to students to assist with their technical writing. Rubrics outline both the technical and non-technical (communication) requirements of the assignment. Chronologically, each rubric targets one a particular aspect of the writing process, e.g., the abstract. Rubrics also promote consistent assessment and provide a natural framework for mentoring students in communication. As students become more confident in their writing abilities, advance copies of rubrics are discontinued. This approach forces students to reflect on their work and builds self-confidence in their writing ability.

All submittals are graded by faculty and returned with ample feedback to effect a rewrite and design changes. This rewritten work then becomes the foundation for the next submittal. Students meet with team advisors before and after each assignment to assess proficiency. Reflection is further achieved through a peer review requirement the mandatory rewrite of each design submittal that must be turned in before the next assignment. A similar approach has been adopted for verbal and visual communication skills.

NA&ME capstone courses also employ the Coast Guard Academy's Hewitt Reading & Writing Center to polish communication skills. Students are required to attend two team tutoring sessions with writing center mentors to gain further proficiency in communication skills. Reflection is achieved by summarizing feedback from the Writing Center in the next design report. The Writing Center staff can also provide specialized speaking and writing workshops to the students if faculty observe deficiencies in a particular area.

Reflection

The U.S. Coast Guard Academy's Naval Architecture and Marine Engineering program is creating a structure to assess the utility of the L.E.A.D. model in developing the teamwork and communication skills of students. The most valuable feedback we receive is from the students themselves. During senior exit interviews, students reflect on their capstone journey and regularly mention their growth during the capstone experience, with specific reference to their teamwork and communication skills. Because our graduates are employed by the U.S. Coast Guard, we maintain contact with them after graduation, and in some instances, continue to serve as mentors during their professional careers. The program takes pride in the routine feedback we receive from supervisors on the technical proficiency and leadership competency of our graduates.

The success is attributed, in part, to the implementation of the L.E.A.D. leadership model within the capstone design sequence and the dedication of our faculty in executing this model. The capstone experience allows the student to practice leadership principles in the context of an academic exercise while the high level of mentorship fosters sustained growth and development of the student-leader.

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