

## Reflection as an Assessment Measure

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### I. Introduction

As I teach and advise engineering students, I am constantly amazed at their motivation, their capacity for hard work, their intelligence. But I am also often amazed at their lack of self-awareness, at their “can’t see the forest for the trees” approach to getting through each hour, each day, each semester, a college education. They refer, often jokingly, to “getting out,” instead of graduating, and they seem sometimes to see their college years as a kind of initiation, something that must be survived before they can enter the “real world.”

In thinking about this common view among engineering students, my colleagues on the Tutorial Committee of the McBride Honors Program and I began to discuss ways in which the program might be able to help engineering students become more reflective. We ultimately decided upon a reflective portfolio assessment program. Students in the McBride Program are now required to maintain a longitudinal portfolio over their three and one-half years in the program. Each semester both the student and his/her McBride professors write a brief reflection on the student’s progress towards meeting the program’s goals. Each student also submits a representative sample of his/her work from that seminar. The portfolios are then evaluated to assess both the program and the individual student. In addition, when they complete the program students write an essay reflecting on the strengths and weaknesses of the program as a whole and on their contributions and growth over the previous 3 ½ years. This essay is the basis for an exit interview/summative assessment.

### II. What is Reflection?

The use of reflection as a learning tool is nothing new; for example, it has been used in writing classes for some time<sup>1,2,3</sup>. Basically, it consists of asking people to write about their goals, the strategies they use for reaching their goals, and their progress towards reaching those goals or others. Kathleen Yancey describes reflection in the following way:

In method, reflection is dialectical, putting multiple perspectives into play with each other in order to produce insight. Procedurally, reflection entails a *looking forward* to goals we might attain, as well as a *casting backward* to see where we have been. When we reflect, we thus *project* and *review*, often putting the projections and the reviews in *dialogue* with each other, working dialectically as we seek to *discover* what we know, what we have learned, and what we might understand. When we reflect, we call upon the cognitive, the affective, the intuitive, putting these into play with each other: to help us understand how

something completed looks later, how it compares with what has come before, how it meets stated or implicit criteria, our own, those of others. Moreover, we can use those processes to theorize from and about our own practices, making knowledge and coming to understandings that will themselves be revised through reflection <sup>4</sup>.

### III. Why Should We Care About Reflection?

It can be argued that a hallmark of the educated (as opposed to trained) individual is the ability to reflect on his/her goals and how he/she has met or failed to meet them. Any engineering curriculum that encourages, even requires, its students to be reflective will help to ensure that engineering graduates are thoughtful, educated citizens. In addition, on a more practical level, when we look at the *ABET Criteria 2000* <sup>5</sup>, several of the outcomes in Criterion 3 are either directly or indirectly tied to a person's ability to be reflective. For example, the ability to design and conduct experiments, as well as to analyze and interpret data (3b) may require the designer to reflect on his/her preferred learning style, ability to interact effectively with others, etc. In addition, outcomes 3d (an ability to function on multi-disciplinary teams), 3g (an ability to communicate effectively), 3h (the broad education necessary to understand the impact of engineering solutions in a global and societal context), and 3j (knowledge of contemporary issues) all require a degree of self-reflection. Finally, outcome 3i (a recognition of the need for, and an ability to engage in life-long learning) is impossible without a self-reflective component. Thus, activities that encourage students to be reflective can help to produce students who possess skills important to the engineering community of the 21<sup>st</sup> century.

### IV. How Can Students Be Encouraged to be Reflective?

There are a number of ways in which students can be encouraged to become what Donald A. Schön calls "reflective practitioners" <sup>6</sup>. Schön argues that, "as we have come to see with increasing clarity over the last twenty or so years, the problems of real-world practice do not present themselves to practitioners as well-formed structures. Indeed, they tend not to present themselves as problems at all but as messy, indeterminate situations." Although Schön's examples are largely drawn from such fields as architecture, musical performance, and psychoanalytic practice, many of his observations are also applicable to engineering practice. He argues that what he calls a practitioner's reflection-in-action is underpinned by a "*constructionist* view of the reality with which the practitioner deals—a view that leads us to see the practitioner as constructing situations of his practice, not only in the exercise of professional artistry but also in all other modes of professional competence."

Schön believes that there are three ways to view the practicum experiences that produce practitioners. In the first approach, professional knowledge is seen in "terms of facts, rules and procedures applied nonproblematically to instrumental problems" and coaching consists "in observing student performance, detecting errors of application, pointing out correct responses." In the second type of practicum, students are trained to "think like a \_\_\_\_\_ (e.g. lawyer, doctor, engineer)." Students learn relevant facts, but also learn "the forms of inquiry by which competent practitioners reason their way, in problematic instances, to clear connections between general knowledge and particular cases." In this type of practicum, "coaches may emphasize either the rules of inquiry or the reflection-in-action by which, on occasion, students must

develop new rules and methods of their own.” In the third type of practicum, the kind of education Schön advocates, “practitioners sometimes make new sense of uncertain, unique or conflicted situations in practice,” and it is assumed that neither “existing professional knowledge fits every case nor that every problem has a right answer.” In this approach, “coaches will emphasize indeterminate zones of practice and reflective conversations with the materials of a situation.” This is also referred to as reflection-in-action.

The reflection-in-action type of practicum can perhaps be found most commonly in engineering education in situations where students are given authentic tasks (e.g. design projects) or when they are asked specifically to reflect on the materials they study and/or produce (e.g. journals, portfolios). This type of reflection-in-action resonates with Billy Koen’s definition of the engineering method as “the use of heuristics to cause the best change in a poorly understood situation within the available resources”<sup>7</sup>. In other words, good engineers are those who practice reflection-in-action; engineering educators can help by emphasizing that much engineering problem solving involves dealing with “poorly understood situations” where reflection helps with understanding of both the problem and the practitioner.

#### V. How Can Reflection be Used for Assessment?

A reflective component is often included in portfolio assessments. Most often, students are asked to write a reflective piece (a letter or introductory essay) that summarizes or evaluates the works they have chosen to include in their portfolio. According to Yancey, “reflection is thought to enhance the *validity* of the assessment—that is, the likelihood that the assessment will measure what it purports to measure—precisely because it *requires* that students narrate, analyze, and evaluate their own learning and their own texts and thus *connect the assessment to their own learning*”<sup>1</sup>.

At Rose-Hulman Institute of Technology, for example, the electronic portfolio (RosE-Portfolio) system being implemented requires students to select examples of their work to demonstrate mastery of a variety of Institute goals and then to write short reflective justifications for the pieces they include<sup>8</sup>.

In the McBride Honors Program at the Colorado School of Mines, the students and faculty engage in a longitudinal reflective portfolio assessment. The McBride Honors Program offers CSM’s engineering and applied science majors an opportunity to earn a minor in public affairs<sup>9</sup>. Less than 10 percent of each year’s entering class is chosen for the program based on high school leadership activities and grades, standardized test scores, recommendations, an essay and an interview. Once they are selected, students enroll in one seminar in the program every semester for three and one-half years. The program emphasizes small seminars, interdisciplinary learning and teaching, close tutorial relationships with faculty, and opportunities for students to hone their writing and speaking skills. The program has a mission and goals statement (Appendix A) which emphasizes specific skills, knowledge, and values that graduates of the program should possess. These skills, knowledge, and values map closely on several of the ABET Criteria 3 categories as shown in Table 1.

Table 1  
Mapping of McBride Honors Program Goals on ABET Criterion 3 Attributes

<b>McBride Honors Program Goal</b>	<b>ABET Criterion 3 Attribute</b>
They should be able to communicate effectively, orally and in writing, to a variety of audiences.	3g, an ability to communicate effectively
They should be competent in the art of civil discourse.	3g, an ability to communicate effectively
They should be able to work effectively both alone and in teams.	3d, an ability to function on multi-disciplinary teams
They should have the ability to analyze and critically evaluate both their own ideas and those of others.	3i, a recognition of the need for, and an ability to engage in life-long learning
They should possess the knowledge necessary to explore the relationships among economic, political, social and cultural systems.	3h, the broad education necessary to understand the impact of engineering solutions in a global and societal context. 3j, knowledge of contemporary issues
They should have first-hand experience of the concepts discussed in their seminars.	3j, knowledge of contemporary issues
They should possess strong values including reflective minds, personal responsibility, sensitivity to diversity, love of learning, and appreciation of interconnectedness in a changing world.	3i, a recognition of the need for, and an ability to engage in life-long learning

In the McBride Honors Program, the assessment process works as follows: the moderators for each seminar identify 2-4 key program goals, e.g. oral communication, knowledge of the political system of a specific region, and personal responsibility, to focus on for the semester; they make these goals explicit to the students. At the end of the semester, the student selects material to include in his/her portfolio, writes a reflection on the piece included and on the seminar, and attends a tutorial with one or more of the seminar moderators. The moderators review each portfolio from their class, hold a tutorial with each student, and write a brief evaluation of the student's progress towards meeting the program goals. At the completion of the McBride Program, each student writes a more lengthy evaluation of his/her growth in the program. The complete portfolio is then evaluated by a faculty team, which meets with the student for an exit interview and summative assessment. Feedback from the portfolio process is used for two purposes: to inform the McBride Program faculty about needed changes in the curriculum and to inform the individual student about his/her growth over the course of the program.

In submitting a portfolio entry, the student is given the following guidelines:

“Attach a brief essay and this form to the assignment you are submitting for this semester. In the essay, reflect on:

- 1) Which of the McBride goals you made progress in meeting this semester and how the assignment reflects that progress.
- 2) How you have grown through the McBride seminar this semester.

- 3) What areas of personal/intellectual growth you would like to focus on next semester.
- 4) What we could have done differently in the seminar to help you meet your personal/intellectual goals and those of the program.”

Moderators are asked, “Based on your knowledge of this student’s contributions to the seminar this semester, your reading of his/her portfolio, and your tutorial meeting(s), please comment on the following areas:

- 1) What were this student’s greatest contributions to the seminar?
- 2) What areas would you recommend that s/he continue to work on?
- 3) Which of the McBride goals did s/he show growth in?”

Moderators are then asked to evaluate the student’s performance in the seminar overall as exceeding, meeting, or failing to meet expectations.

These instructions guide both moderators and students to use the process described by Yancey as both “looking forward to goals we might attain, as well as a casting backward to see where we have been.” Students are encouraged to “call upon the cognitive, the affective, the intuitive” and to “theorize from and about [their] own practices, making knowledge and coming to understandings that will themselves be revised through reflection.” How does this reflective portfolio work in practice? Some examples from student portfolios may be illustrative.

## VI. Examples of Portfolios and the Use of Reflection

Students who are completing the McBride Program in the spring of 2000 are the first class to participate in the portfolio process through their entire time in their program. Of the approximately 30 senior students in the program, none has a complete portfolio and entries for the spring 2000 semester have come too late for consideration in this paper, though they will be discussed in the presentation. All of the portfolios include at least three reflections and/or moderator comments. Two of the more complete portfolios will be discussed here, those of senior students Jennifer and Paul, both of whom submitted a portfolio entry for every semester but one.

### Jennifer

In her first semester Jennifer took a seminar that focused on the fine and performing arts. In her admissions interview she had been described as “not particularly outgoing” and “a little shy.” At the end of the first semester, although the moderators said that she still needed to work on class participation and communication skills, they thought that she had improved in her ability to work in a group and had “tried harder to participate.” Jennifer’s own reflection on the semester focused on the goal of leadership. She wrote that “I have learned I can be a leader. Although I still have a lot of room to grow in this area I have gained a lot of valuable leadership experience.” She also noted that “the loudest person also is not always the leader. A person who can guide or facilitate a group can be a leader by a few actions or words.” In this reflection, she was beginning to, in Yancey’s words, “discover what we know, what we have learned, and what we might understand.” Jennifer saw that even a quiet person like herself can be a leader. By the second semester, her moderator wrote, “You are coming out of your shell.” Jennifer reflected that “There is still a lot in the leadership area which I need to learn. I would like to learn more of what I need to be a better leader during the next semester.”

In the third semester the theme from her moderator was the same: “The main area that Jennifer needs to work on is self-expression, in writing and particularly in speaking. She has important things to say and needs to have the confidence to say them....Having said that, I feel that the McBride goal that she most showed growth in was oral communication.”

By the next semester Jennifer felt she had made the most improvement “in being able to analyze and evaluate both my own ideas and those of the people around me.” She said that “being able to change my opinions when someone else makes a point has been hard for me to learn to do but I have figured out that if I take the time to understand what they said I may see different points which I agree with and change my ideas either a small amount or completely.” In this class she worked in a group on a large research project related to privacy on the internet. She had to learn a great deal about an important contemporary issue.

In the spring of her junior year, Jennifer’s moderators felt she showed growth in working on teams, knowledge, and communicating. She said that she had made progress in “both the oral communication and being a more reflective and open person,” although she was still pushing herself to develop her speaking skills. She argued that “I have gained a better ability to communicate with others in both a formal setting, such as presentations, as well as informal settings, like class.”

In her senior year, the moderators described Jennifer as “capable!” and commented that, although she still needed to work on building self-confidence, she had shown growth in working in groups. Using her reflective essay for both “looking forward” and “casting backward” Jennifer looked back to her first year: “When I began the program, I had a difficult time speaking in front of large groups of people. Now, when I have a presentation in McBride or any other class I feel much more confident that I will be able to get through the entire presentation in an effective and clear manner. I have also improved greatly in the written communication area....If my writing from this semester was compared to that of my first semester in the program, I think that any person would not be able to tell the same person wrote both papers.” Judging from the assignments Jennifer chose to include in her portfolio, she has good reason to be pleased with her improved writing skills. Looking forward, Jennifer predicted that “if I work some on each [McBride] goal I will be able to leave the program proud of myself for all that I have accomplished.”

Examining her portfolio as a whole, it is clear that Jennifer is still struggling with the same issues that were present in her first semester—ability to communicate effectively the most prominent among them. However, she clearly has grown. She acknowledges increased confidence, a competence also noted by her moderators, and increased ability to communicate both orally and in writing. She concludes that the McBride program, “made me a better, more well-rounded person.” Her portfolio provides evidence that this is true.

### Paul

Paul felt that his speaking and writing skills improved in the first McBride seminar. He added, “I also forced myself to participate in this class more than in past classes of a similar format.” He concluded that “I would also like to continue working on my writing skills and, as always,

continue learning about myself.” Of course, “learning about myself” is an important component of reflection.

In his second seminar (cultural anthropology), Paul saw his major accomplishment as learning to see the world differently. Each student in the seminar is required to conduct an ethnographic study of a subculture in the Denver area. Through this experience, Paul concluded that “there are many situations, which because of this class, I will better be able to approach knowing that the situation is a cultural one...Before this class I also never knew where we came from could make such an amazing impact on the way we think and act...The final project was extremely helpful in that it made me solve a completely open-ended problem, hypothesize an answer, and research my hypotheses until I felt I found the correct solution. This kind of open-ended problem solving, I feel, is a great tool to possess.” Paul was obviously making progress toward meeting several McBride (and ABET goals) including ABET 3b, “the ability to design and conduct experiments, as well as to analyze and interpret data,” 3h, a broad education, and 3j, a knowledge of contemporary issues.

In his junior year seminars, Paul felt that he continued to gain “both a better understanding and greater respect for those people who strive to improve public policy.” In addition, although he wanted to continue to improve his writing and speaking skills, he felt that he was making progress towards this goal. In his senior leadership seminar, Paul felt that he had “grown by getting a better idea of what it takes to be a leader. I definitely want to hold a position of leadership in the future, and the ideas presented in this seminar will help me do that.” Like Jennifer, he is both “looking forward” and “casting backward” on his McBride experience. His portfolio contains ample evidence, from his reflective essays, his moderators’ comments, and his sample work, that he is well on his way to meeting the Program goals.

In addition to helping students to become more reflective practitioners, the portfolio program also offers the opportunity for them to provide feedback to their instructors and to the program as a whole. Sometimes the students’ suggestions are general. Paul, for example, suggested that his first seminar might have gone more smoothly if less difficult material had been chosen for the first several weeks’ readings. In other cases, very specific suggestions are made. In one class, Paul suggested that there should have been a few more graded writing assignments which “would have made me more carefully read some of the material.” In addition to hearing such suggestions first hand at their tutorial meetings, moderators are encouraged to read the portfolio entries of all of their students and make appropriate changes in the seminar for the next offering.

## VII. Challenges

Although the portfolio assessment plan has been largely successful, we continue to refine it to meet the twin goals of providing feedback to the program for curriculum improvement and feedback to the students for their personal growth. Closing the feedback loop is a perpetual problem in continuous improvement efforts. We need to modify the process so that faculty receive better feedback about their seminars in a more timely manner. In addition, students need to be encouraged to take better advantage of the feedback provided in their portfolios for formative assessment. Finally, we need to monitor the program more carefully to assure a higher level of regular participation from both faculty and students.

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## BARBARA M. OLDS

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## Appendix A

### Colorado School of Mines McBride Honors Program *Mission and Goals*

The McBride Honors Program provides a select community of CSM students the enhanced opportunity to explore the interfaces between their areas of technical expertise and the humanities and social sciences; to gain the sensitivity to project and test the moral and social implications of their future professional judgments and activities; and to foster their leadership abilities in preparation for managing change and promoting the general welfare in an evolving technological and global context.

In preparing to become leaders, students completing the McBride Honors Program should possess the following skills, knowledge, and values:

#### **Skills**

- They should be able to communicate effectively, orally and in writing, to a variety of audiences.
- They should be competent in the art of civil discourse.
- They should be able to work effectively both alone and in teams.
- They should have the ability to analyze and critically evaluate both their own ideas and those of others.

#### **Knowledge**

- They should possess the knowledge necessary to explore the relationships among economic, political, social and cultural systems, an ability central to the mission of the Program.
- Whenever possible, they should have first-hand experience of the concepts discussed in their seminars through internships, overseas experiences, in-depth research, and community service.

#### **Values**

- They should be persons of high principle and character.
- They should develop reflective minds.
- They should accept personal responsibility for their actions as leaders, as professionals, and as citizens.
- They should be aware of and sensitive to diverse languages, cultures, and beliefs, both in this country and abroad, through direct experience wherever possible.
- They should exhibit a love of learning and the promise of continuing it throughout their lives.
- They should appreciate interconnectedness in the changing world.