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# Engineer of 2020 outcomes and the student experience

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***Abstract*— An NSF Scholarships in STEM (S-STEM) program has provided scholarships for cohorts of undergraduate engineering students since 2009, giving specific attention to the National Academy of Engineering's vision for the engineer of 2020 (E2020). Four E2020 outcomes are emphasized in Iowa State's program: leadership, global awareness and understanding, systems thinking, and innovation and entrepreneurship. These outcomes, or pillars, are being integrated into curricular and co-curricular activities. The four pillar areas are introduced in a one-semester first-year seminar and reinforced in a two-semester second-year seminar. These seminars supplement the regular program of study for engineering students. In this paper, we describe the curriculum and its planned integration beyond the scholarship program. We present student feedback about their experience in the program. We also introduce relevant core competencies associated with the outcomes as judged by faculty and industry representatives.**

***Keywords—leadership, systems thinking, innovation, entrepreneurship, global awareness***

## I. Introduction

The E2020 Scholars Program is a National Science Foundation Scholarships in STEM (S-STEM) program. It is designed around a cohort model involving direct-from-high-school and transfer undergraduate engineering students from diverse backgrounds. It leverages and complements the college's learning community infrastructure and builds upon the aspirations and attributes of the National Academy of Engineering's (NAE) vision for the engineer of 2020. E2020 programming includes a set of student development and learning opportunities consistent with this vision and includes curricular and co-curricular activities [1], [2], [3].

The first two years include weekly seminar courses that introduce the E2020 scholars to knowledge, skills and abilities in each of the four developmental areas of the program, also called pillars. The pillars are:

- Leadership development, including teamwork, communication, and service;
- Systems thinking, including interdisciplinary engineering design;
- Innovation, including creativity and entrepreneurship; and
- Global awareness and understanding, including cultural adaptability.

Each pillar area is led by a faculty member. These faculty leaders work with other E2020 faculty to teach the seminar courses. In addition to providing learning opportunities for the scholars, the seminar courses are a means to develop learning experiences to be integrated into the first year experience or other engineering courses for all engineering students.

After completing the seminar series, and beginning in the third year of the program, scholars continue to develop a deeper understanding of the pillars through capstone-like experiences using project-based learning.

Fig. 1 illustrates a semester-based timeline for the student experience in the E2020 program over four years, or eight semesters, upon entry into engineering. The graphical icons represent the pillars of the program: star, leadership; arrow, systems thinking; exclamation, innovation; and circle, global awareness. Section III gives more details about the seminars.

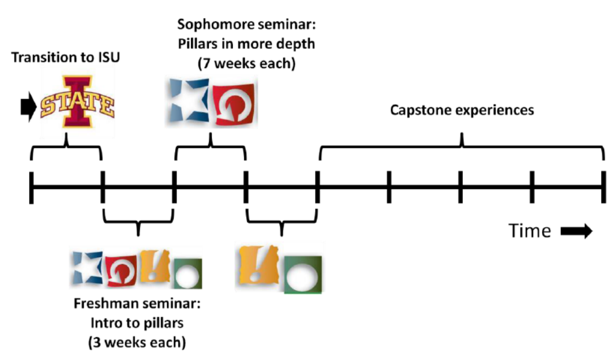



Fig. 1. The E2020 student experience.

The E2020 program, though developed independently, is similar to a number of initiatives motivated across the U.S. in response to the NAE's report [4]. One of the earliest was the University of Wisconsin's introductory course on the engineering grand challenges [5]. Since then, Purdue University and other universities have implemented engineer of 2020 programs [6]. The Grand Challenge Scholars Program (GCSP), a collaboration of Duke University, Olin College of Engineering, and the University of Southern California, is an NAE-sponsored version of Iowa State's NSF-funded E2020 Scholars Program [7]. Several universities have established programs affiliated with GCSP.

## II. Student Cohorts

The first scholarships were awarded for a cohort entering fall 2009. A total of three rounds of scholarships were awarded. The scholarship application and selection processes are described in annual reports available at the program website [2]. An online application that included essay questions pertaining to E2020 pillars was used. A selection committee reviewed and discussed every application. The entering cohorts included both direct-from-high-school (DFHS) and community college (CC) transfer students. The statistics for each cohort are summarized below.

2009 cohort:

- 22 total, 14 DFHS students, 8 CC transfer students
- 4 women and 5 minority students
- 17 of 21 entering scholars remain in or completed the program.
- 12 scholars graduated through spring 2013.
- 86% 3rd year retention in engineering; 81% 4th year retention in engineering; 90% retention at ISU.
- 2 scholars changed to non-STEM majors (economics, history).
- One scholar died in a car accident in fall 2010.

2010 cohort:

- 26 total, 12 DFHS students, 14 CC transfer students
- 12 women and 4 minority students
- 24 of 26 entering scholars remain in or completed the program.
- 10 scholars graduated through spring 2013; one scholar entered the concurrent BS/MBA program.
- 92% 2nd year retention in engineering; 81% 3rd year retention in engineering; 92% 3rd year retention in STEM; 100% retention at ISU.
- 3 scholars changed to non-engineering STEM majors (biology, industrial design); 2 scholars changed to non-STEM majors (elementary education, psychology).

2011 cohort:

- 25 total, 16 DFHS students, 9 CC transfer students
- 11 women and 3 minority students
- 24 of 25 entering scholars remain in the program.
- One scholar graduated through spring 2013.
- 96% 1st year retention in engineering; 88% 2nd year retention in engineering; 96% 2nd year retention in STEM; 100% retention at ISU.
- 2 scholars changed to non-engineering STEM majors (biology, math); one scholar changed to a non-STEM major (communication studies).

The scholarship awards have been administered through the College of Engineering student services office. Scholars who switched to non-STEM majors were no longer eligible to receive an S-STEM scholarship. Scholars who switched to non-engineering STEM majors and who remained active in the program continued to receive a scholarship. Continuing eligibility also adhered to university policies, such as satisfactory academic progress. Overall, sixty-five of seventy-two scholars remain in the program, giving an overall retention of over 90% in the program.

## III. Seminar Courses

A one-credit seminar course, ENGR 110, is taken by scholars during the second semester of their first year in the program. It introduces students to each of the four pillars over twelve weeks. With three weeks per pillar, the first week introduces the students to knowledge related to the pillar; the second week focuses on developing basic skills through an active learning activity; and during the third week, students work in teams to demonstrate their ability to apply the new knowledge and skills to a real-world problem. Peer mentor sessions are interspersed with the class sessions.

Another one-credit seminar course, ENGR 210, is taken during fall and spring semesters of the second year, and provides more in-depth investigation into the pillars. The fall semester seminar is split into two seven-week periods, one for the leadership pillar and another for systems thinking. The spring semester seminar is split between the innovation and global awareness pillars. A faculty leader for each pillar has developed pillar-specific learning modules and assessment methods.

### *A. Leadership*

"I now understand that leadership is not just about leading other people, but being able to lead myself." E2020 Scholar

The leadership seminars were designed to highlight that good leadership may be achieved differently by each leader. This concept must be understood and practiced. In the first-year seminar, we concentrated our effort on getting students to appreciate various aspects of these main topics: (1) knowing yourself, (2) teamwork, (3) communication, and (4) self-discipline. The three weeks were focused on students leading themselves. By the end of the sophomore seminar, the students were expected to achieve the following learning objectives: For any given situation, students will (1) build and foster interpersonal relationships, (2) explain why engineers must effectively communicate thoughts and ideas in writing and orally, and (3) identify ways to effectively serve as a member of a team as a leader and/or follower.

Students in the first-year seminar took the *Keirsey Temperament Sorter-II*® and received classroom instruction on personality types and temperaments [8]. Through this experience, students analyzed and described their personality and temperament preferences. Through written reflections, students performed metacognition to gain a deeper understanding of why knowing this information is important to becoming a leader. Next, students participated in a modified version of the “Stranded in the Desert” exercise from Johnson and Johnson’s *Joining Together* [9]. This exercise and the following discussion helped to highlight the importance of teamwork in solving a problem. Finally, the students worked in teams to build a tower made of various common office items. Each team member was given a specific “job” and asked to perform their role. Through this experience, students were able to appreciate the complexity of solving a problem through communication, collaboration, and coordination.

The first-year seminar created the framework and opportunity for students to view themselves as leaders. During the sophomore seminar, students were introduced to new topics and exercises to emphasize the importance of interpersonal relationships, communication skills, and teamwork. Nearly every class period was delivered with students sitting in a circle or at team tables to foster the sharing of thoughts and ideas. Students were able to practice their leadership skills by working together on a service learning project. Teams were charged with finding an activity to research, plan, and accomplish together to positively impact the lives of others. Students were encouraged to find a community interest item and devote one-two hours of their time to make a difference. Students practiced their communication skills by presenting their service learning project in either poster sessions or oral presentations. Hartmann provides more background on methodology to many of these teaching methods [10].

The students were generally effective in achieving the learning objectives. After the sophomore seminar, most students were able to clearly articulate their strengths and contributions as a leader in their personal life and organizations within the university and their communities. Reflections from students indicated a greater appreciation and understanding for the importance of engineers to have strong interpersonal relationships, effective communication skills, and teamwork skills.

### *B. Systems Thinking*

“I came to realize just how many things you have to consider when you are working on a project. Not only how something works, but also how it is going to affect the surrounding environment and those who use it.” E2020 Scholar

Many definitions of systems thinking have been proposed, but several features appear in most definitions: viewing a problem broadly and holistically; identifying interdependence and feedback; synthesizing as well as analyzing individual components; and accounting for dynamic (time-varying), nonlinear behavior. In the first-year seminar, we focused on getting the students to appreciate the complexity arising from the interaction of factors from inside and outside engineering—that is, we aimed to have students explain the importance of taking a broad view of a problem and considering feedback and dynamic behavior. By the end of the sophomore seminar, the students were expected to achieve the following learning objectives involving tools of systems thinking: For complex, ill-defined, dynamic problems involving engineering, social, ethical, cultural, environmental, business, and political issues, students will (1) identify connections between subsystems with rich pictures, (2) explain relationships with causal loop diagrams, and (3) sketch the behavior over time of key variables in the system.

Students in the first-year seminar worked in teams to draw a rich picture for a topic related either to a grand challenge problem [11] or a successful team—in sports, school, music, work, etc. A rich picture uses pictures, cartoons, text, and sketches to depict connections between various elements of a systems or problem, including structures, processes, and concerns [12]. An example of a rich picture drawn by students is shown in Fig. 2. The students then presented their work either in an oral presentation or a poster session. In the sophomore seminar students chose similar problems involving at least five of the seven issues stated in the learning objective and identified the key variable measuring success or failure. Then they applied three tools of systems thinking: rich pictures; causal-loop diagrams, which show relationships between elements; and behavior-over-time graphs, in which the behavior of the key variable is sketched as a function of time. Rehmann et al. provide more details on the tools and activities [13].

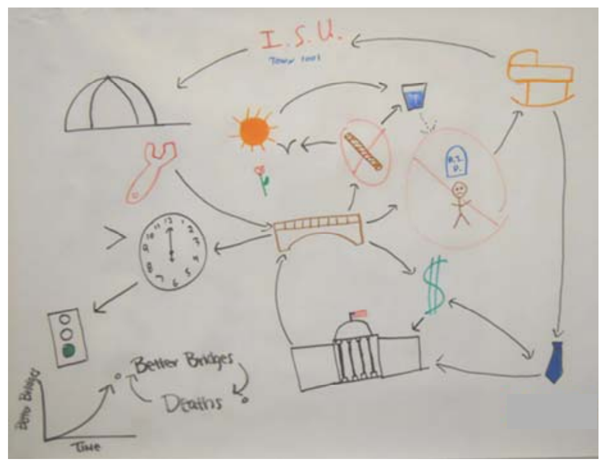



Fig. 2. Example of a rich picture drawn by a group in the FY seminar on the problem of infrastructure and safe bridges. (See [13] for a larger image.)

Based on a review of student work and written reflections, the students were mostly successful in achieving the outcomes. After the first offering of the first-year seminar, most students wrote that before the module, they did not know much about systems thinking. After the module, they knew much more and appreciated the number and diversity of issues that must be considered in a successful engineering project. In the sophomore seminar, students addressed the technical content adequately, though they struggled with identifying an appropriate key variable and sketching behavior over time. In particular, after carefully deriving a causal-loop diagram from a rich picture, many groups would mostly abandon their previous work and resort to mental models not reflected in their rich picture. Although the instructional activities can be adjusted to help students achieve the learning objectives more fully, most students demonstrated appreciation for the range of issues affecting an engineering problem and proficiency with the tools of systems thinking.

### *C. Innovation and Entrepreneurship*

"Innovation is not just thinking of new ideas, but working together in a team, taking initiative, accepting criticism, and being creative." E2020 Scholar

Innovation and entrepreneurship involve key skills and abilities for practicing engineers. While engineering programs offer numerous design courses throughout the curriculum, these often overlook thinking like an entrepreneur. One of the primary goals of this pillar is increase students' awareness that the skills of an entrepreneur will help them to be better engineers. In the first-year seminar, students were introduced to elements of entrepreneurship and explored what it means to approach problems from an entrepreneurial viewpoint. By the end of the sophomore seminar, students developed a business plan for a proposed company to solve some aspect of a grand challenge problem [11]. The students then presented their work to a panel of judges to pitch their ideas.

The first-year seminar first introduced students to innovation by having them think about things (inventions, products, technologies, etc.) that have changed their lives. Students were then assigned to small groups, and each group selected a topic related to a grand challenge problem. The groups were asked to think more deeply about the problem and possible solutions. During the second week, students worked in their groups to refine their ideas and organize them into a presentation to the class. In the third week, groups presented their ideas, which were scored using a rubric that judges creativity of the solution as well as presentation skills. The first-year seminar concluded with feedback to the groups with an emphasis on innovation.

The sophomore seminar focused more on entrepreneurship, with the first week defining entrepreneurship and examining its relationship to engineering. The instructor again primed students on innovation, engaging them in a discussion of the greatest innovations of their time and drivers behind these innovations. These innovations were then placed in the context of grand challenge problems. Groups were formed, and each group was assigned a different grand challenge problem area. Groups were tasked to make a short "sales" pitch as to why their assigned problem area should be targeted by a company. The students then voted to select a single problem domain for their business plans the rest of the seminar. Students learned more about business plans and proceeded to work in groups to finalize their business plans. As in the first-year seminar, business plans were presented and judged. Given the same problem domain, the best plan was identified, adding an element of competition to the learning experience.

Students developed a better understanding about entrepreneurial concepts and effectively communicating their ideas. They were introduced to skills that will enhance their work as a student as well as prepare them for the workforce.

### *D. Global Awareness*

"I never realized the importance of culture and customs in designing a product to meet a country's needs. This class has helped me to realize that there is more to engineering than just building something that works for us." E2020 Scholar

For engineers, global awareness has several possible meanings. In the E2020 project, we defined global awareness as being aware of and respectful of cultural and international differences in needs and values, understanding how regional and cultural differences affect the engineering design process and engineering business enterprise in general, and being able to work effectively with others from different cultures.

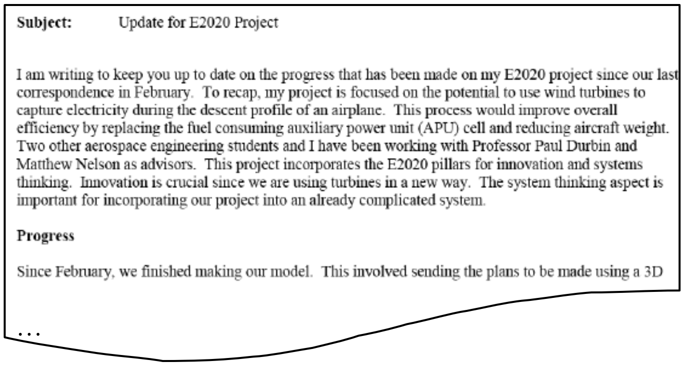
The first-year seminar introduced students to the impact of global and cultural differences on the engineering enterprise, through class discussions and brief case studies. The learning objective for the first-year seminar was that students would have a better understanding of the need for questioning and analyzing their own assumptions (about needs, values, constraints, criteria, resources, economics, etc.) when working on engineering projects.

In the sophomore seminar, the emphasis was on identifying cultural dimensions to an engineering project, with a two-pronged emphasis: one, that framing an engineering problem (and later, developing a solution) must consider the cultural and local norms and needs of the users or beneficiaries of the project, and two, that working with others from different cultures presents challenges that one can to some degree prepare for. After discussion and readings on global awareness in engineering, technology, and business, students were asked to research one of the grand challenge problems, chosen at random for each team of 4-6 students, in the context of one country, also chosen at random for each team. Drawing on the skills gained in the Systems Thinking module, in the first half of this project they were to draw a rich picture describing aspects of the grand challenge problem in their assigned country. Then through discussion and further research, each team distilled their findings to a single engineering problem statement, including constraints and criteria. Ideally, this would be aided by their work in the Entrepreneurship model to frame and communicate an engineering problem. In the second half of the project, students were introduced to Hofstede's cultural dimensions [14], a classification of major cultural norms by country; this is system widely used in international business training. The students were then asked to review their problem statement and imagine that they were paired with a team of engineers native to their assigned country, and using Hofstede's cultural dimensions, explore how each country-team might approach the problem and its solution differently, and how cross-cultural dynamics might affect their work together.

## IV. PROJECT-BASED INDIVIDUALIZED LEARNING

After completing the ENGR 110 and 210 seminar series, and beginning in the third year of the program, scholars continue to develop a deeper understanding of the pillars through individualized, capstone-like experiences using project-based learning. Students from the 2009 and 2010 cohorts are at various stages of independent study experiences with faculty mentors. The project-based independent study assignment is described below.

As part of project management and communications skills development, scholars report their progress. A memorandum format was adopted. A memo is submitted by a student to the E2020 Blackboard site. An excerpt is shown in Fig. 3.


**Subject:** Update for E2020 Project

I am writing to keep you up to date on the progress that has been made on my E2020 project since our last correspondence in February. To recap, my project is focused on the potential to use wind turbines to capture electricity during the descent profile of an airplane. This process would improve overall efficiency by replacing the fuel consuming auxiliary power unit (APU) cell and reducing aircraft weight. Two other aerospace engineering students and I have been working with Professor Paul Durbin and Matthew Nelson as advisors. This project incorporates the E2020 pillars for innovation and systems thinking. Innovation is crucial since we are using turbines in a new way. The system thinking aspect is important for incorporating our project into an already complicated system.

**Progress**

Since February, we finished making our model. This involved sending the plans to be made using a 3D

…

Fig. 3. Memo excerpt from project-based independent study assignment.

A project-based learning (PjBL) approach was selected to facilitate independent learning and a deeper understanding of the material. Through their E2020 PjBL experience, scholars are expected to develop self-directed learning skills. As part of the assignment, scholars do the following:

- Complete a project under the guidance of a faculty mentor, selected by the scholar.
- Propose a project that meets certain criteria.
- Enroll in independent study credit to earn at least one credit per semester for the PjBL experience.
- Provide project updates, presentations, and a report to the E2020 Program.

Scholars can choose to work on projects oriented toward research, education or service. For a research project, a scholar takes an open-ended technical question, investigates it, and creates a solution. For an education project, a scholar may develop an innovation for a course that helps other students learn. For a service project, a scholar identifies a societal problem and approaches it through service learning, applying particular expertise to meet a need. A scholar is allowed to work as part of a group on a project. A scholar proposes a project in consultation with a faculty mentor and E2020 faculty. The scope and pace of a project is individualized to a particular student's situation, such as timing with respect to other activities to be leveraged (such as a design competition, study abroad, undergraduate research experience, Honors Program project, etc.). A scholar is encouraged to create a PjBL experience that complements and leverages current coursework and/or co-curricular activities.

As noted, students are encouraged to consider undergraduate research projects for their capstone experience. For example, student "Joe" transferred from an Iowa community college as an E2020 scholar in fall 2011 in mechanical engineering. He participated in the ISU BioMaP (Biological Materials and Processes) REU while a community college student during summer 2011. BioMaP consists of a variety of projects with topics such as nanovaccines, drug and gene delivery, and clinical trials with an artificial pancreas. Joe is pictured in Fig. 4, standing on the left. Joe has since participated in an industry internship while an E2020 scholar. He has benefited from early student engagement through research, first- and second-year learning experiences, and synergistic project activities. He will build on these research and experiential learning experiences to define an E2020 project that deepens his understanding and application of E2020 pillars.

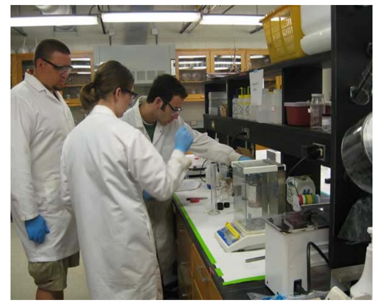


Fig. 4. Project-based learning by an E2020 scholar (http://innovate.engineering.iastate.edu)

## V. Student Feedback

A survey was administered to the cohorts each year to obtain feedback on their experiences in the program. Quantitative and qualitative analysis methodologies were used to analyze the survey data. Statistical evaluation of data included descriptives and frequencies of responses. Open-ended questions were coded for common themes [15] [16].

After the first year of the program, student feedback was quite positive with 89% of student respondents agreeing (indicating either Somewhat agree or Strongly agree) that their involvement in the E2020 program: was a positive experience; supported their growth as a person; enhanced their educational experience; and fit well with their courses. An E2020 scholar wrote: **"**I have had an extremely positive experience with being involved in E2020. E2020 has given me the opportunity to interact with students I wouldn't have otherwise met and faculty members in the college of engineering. I enjoyed coming to class once a week and I feel that I learned a lot about myself as an aspiring engineering major and of what I need to work on in order to be a successful engineer in the future." Results for the question "My involvement in E2020 has been a positive experience" are shown in Table I for the 2009 cohort.

TABLE I. Survey results, 2009 cohort: "My involvement in E2020 has been a positive experience" [16]

| Response | Percent | n |
|---|---|---|
| Strongly agree | 66.7% | 12 |
| Somewhat agree | 22.2% | 4 |
| Neutral | 11.1% | 2 |
| Somewhat disagree | 0.0% | 0 |
| Strongly disagree | 0.0% | 0 |
| Total | | 18 |

Prepared by RISE, Iowa State University

The comments by the students elicited the following themes:

- Overall: Students liked meeting other engineering students, enjoyed the discussion of the four pillars, learned a lot about being an engineer, and now think of the role of an engineer differently.
- Women: Had a very positive experience and gained greater insight into the role of an engineer.
- Transfers: The program really helped with their transition, helped them meet people, and helped them understand the four pillars.

Average transfer student responses on survey items tended to be higher (more positive) than DFHS responses, though the differences were not statistically significant. Having transfer student responses generally as positive as DFHS responses suggests that the program has provided an effective pathway for transfer students through E2020 programming.

79% of the 2009 cohort and 85% of the 2010 cohort reported that E2020 helped them feel better prepared to succeed in college. Students in their comments expressed that the pillars had expanded their perspective on the field of engineering and allowed them to see common threads across their classes. One student summarized the E2020 program experience, saying: "The ability to work with other students in different engineering disciplines on topics that are universal to all engineers will have a big impact and importance in my future endeavors as a successful engineer. Also the coordinators and my fellow scholars are amazing people!"

Results from the second survey provided a comparison between students taking ENGR 110 (2010 cohort) and ENGR 210 (2009 cohort). In the 2009 cohort, 100% percent of students agreed that the content covered in the scheduled E2020 seminars helped them to understand what the pillar concepts were all about, though students reported learning more about some of the pillars than others. In the 2010 cohort, 92% agreed. Not surprisingly, given the longer time spent with each of the pillars in ENGR 210, students in the 2009 cohort were more likely (than the 2010 cohort) to agree they had increased their knowledge, skills, and abilities in the pillar areas.

Student comments indicated that the opportunities for networking and support provided in E2020 were extremely valuable, and students commented that networking opportunities were the best aspect of the E2020 Scholars Program. Students also appreciated the learning opportunities, having a creative outlet, learning how to incorporate the four pillars into their work, enhancing their interviewing skills, having people who were willing to answer questions, learning about themselves, and learning to work in teams. The full survey reports are available from the authors.

## VI. CURRICULUM INTEGRATION

One of the goals of the E2020 program is to identify ways to introduce the pillar topics to all engineering students, not only to E2020 scholars. The logical avenues are through the first-year experience and learning communities, using modules from ENGR 110 and 210; or via senior design, similar to the E2020 PjBL. This approach would be consistent with a recent national study that concluded:

- Engineering program chairs and faculty subscribe to most of the goals of The Engineer of 2020.
- Faculty and chairs give less attention to professional topics than to technical ones, despite the emphasis on professional skills in the NAE report and ABET criteria.
- Professional topics are typically emphasized in first-year design and capstone courses rather than integrated throughout the curriculum [17].

We have been working with the learning community program coordinators, instructors and peer mentors in the college to share instructional materials for each of the pillars. The faculty leader for the leadership pillar (Hartmann) delivered a two-part workshop during spring 2012. The faculty leader for the systems thinking pillar (Rehmann) delivered a seminar at Iowa State's Learning Communities Mid-Year Institute during spring 2013. There was interest in and outside of engineering to incorporate materials, including later in the curriculum.

Integrating E2020 pillar topics, resources and active learning experiences is an ongoing effort by E2020 faculty.

## VII. FUTURE WORK

E2020 faculty have not yet formalized assessment of the pillars through well-defined student learning outcomes and instruments. Several rubrics and surveys have been used to assess aspects of the program and student learning. Previous work by E2020 faculty with the Engineering Leadership Program piloted a competency-based leadership model closely aligned with ABET student outcomes [18], [19], [20]. In the ELP model, there were eight learning outcomes that described the knowledge and skills achieved by an ELP scholar through participation in the program. Five of the outcomes were from ABET Criterion 3; three of the outcomes reflected additional skills attained through the program. These additional learning outcomes included an ability to create a vision, an ability to innovate, and an ability to value diversity and create an inclusive environment. Associated with these outcomes, ELP identified nineteen competencies and specific key actions for each competency. This competency-based approach was based on a framework developed for the College of Engineering as described by Brumm, Hanneman, and Mickelson [21].

In the college's framework, student outcomes are multi-dimensional and represent some collection of workplace competencies necessary for the practice of engineering at the professional level. Fifteen competencies are measured within this framework: Analysis and Judgment, Communication, Continuous Learning, Cultural Adaptability, Customer Focus, Engineering Knowledge, General Knowledge, Initiative, Innovation, Integrity, Planning, Professional Impact, Quality Orientation, Safety Awareness, Teamwork. Each competency is uniquely defined with a set of observable and measurable key actions that a student may take that demonstrates their development of that competency. For example, the Initiative competency has the following definition and key actions.

Initiative: Taking prompt action to accomplish objectives; taking action to achieve goals beyond what is required; being proactive.

Key Actions:

> Responds quickly. Takes immediate action when confronted with a problem or when made aware of a situation.
>
> Takes independent action. Implements new ideas or potential solutions without prompting; does not wait for others to take action or to request action.
>
> Goes above and beyond. Takes action that goes beyond job requirements in order to achieve objectives.

An assessment of the student's demonstration of competencies asks the following question for each of the key actions: "When given the opportunity, how often does the student perform the key action?" The response uses a Likert scale: 5 = always or almost always; 4 = often; 3 = usually; 2 = sometimes; and 1 = never or almost never. There is a mapping of the competencies to the ABET (a-k) student outcomes.

It would be possible to follow the ELP assessment approach for each of the E2020 pillars, resulting in a set of competencies and key actions for each pillar. This would align with and leverage the college's assessment framework. The identification of competencies appropriate for each pillar would draw from emerging engineering education research on assessment of leadership, critical thinking, entrepreneurship, and cross-cultural skills.

E2020 program evaluation is also ongoing, including annual surveys of scholars and surveying of graduated scholars.

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